The 29th Chinese Control and Decision Conference

Technical Programme

Sunday, 28 May, 2017

SunA01 **Room01**
Adaptive control (I) **14:00-16:00**
Chair: Chuanjing Hou Shanghai Jiao Tong Univ.
CO-Chair: Caiyun Wu Shenyang Ligong Univ.

14:00-14:20 **SunA01-1**

Study on the application of a new prediction model based on penalty constraint to flotation process

Yong Zhang Science and Technology Liaoning Univ.
Xuqiang Liu Science and Technology Liaoning Univ.

The flotation process is a complicated multi-input and multi-output process with the characteristic of strong non-linearity, heavy coupling and large delay. Due to the difficulty of measuring the concentrate grade and tailing grade index online, and its dynamics varying with the process conditions, such a control objective by far is difficult to achieve by the existing control methods to control the product quality indices into their technical targeted ranges and even cause fault work-condition. This paper presents a clustering algorithm based on punishing constraint of swarm intelligence (PCSI). Directed by the nature of PSO, PCSI could randomly search the centers of clusters and obtain the number of clusters. The process prior knowledge and PCA method are used to reduce dimension of the input data and select auxiliary variables. And then a new hybrid recursive algorithm of RBFNN based on simplified rival penalized competitive learning method (SRPCL) to make an adaptive clustering is developed. The method proposed has successfully been applied to two production lines of a mineral processing plant of Anshan Iron and Steel Group Corporation, and its effectiveness is proved evidently.

14:20-14:40 **SunA01-2**

Adaptive Neural Dynamic Surface Control of Morphing Aircraft with Input Constraints

Zhonghua Wu Northwestern Polytechnical Univ.
Jingchao Lu Northwestern Polytechnical Univ.
Jingping Shi Northwestern Polytechnical Univ.

A robust adaptive neural dynamic surface control (DSC) approach is presented for the longitudinal dynamics of a morphing aircraft in the presence of unknown dynamics and input constraints. For the altitude subsystem, neural systems are utilized to approximate the unknown nonlinear functions with smooth robust compensations to counteract the lumped approximation errors. By combining dynamic surface control and minimal learning parameter techniques, a robust adaptive neural control scheme is proposed and a simple adaptive algorithm is constructed. Meanwhile, an auxiliary system is incorporated into the control scheme to overcome the problem of input saturation. The highlight is that the proposed neural controller not only owns less updated neural parameters, but also has the ability of handling input constraints. It is proved that all the signals in the closed-loop system are bounded. Simulation results demonstrate the effectiveness of the proposed control scheme.

14:40-15:00 **SunA01-3**

Second Level Adaptive Control Based on Combination Multiple Model

Yong Chen East China University of Science and Tech.
Xin Wang Shanghai Jiao Tong Univ.
Zhenlei Wang East China University of Science and Tech.

Since all of adaptive models converge to the same point in parameter space, classical second level multiple model adaptive control method cannot deal with linear time-varying system. In order to deal with this drawback, this paper proposes a modified second level adaptive control method based on combining the advantages of adaptive model and fixed model for a class linear discrete time-varying plant where only a little prior information which is known. Firstly, multiple adaptive models are selected in the space of parameters, and the parameters are identifying and the controller is designed based on second level adaptive method. Secondly, when one of sub-model of the adaptive models are closed to the real parameters of the system, all of these adaptive models are fixed, and then the controller is designed based on multiple fixed models. Lastly, simulations have demonstrated that this method is effectively to a class of linear time-varying system.

15:00-15:20 **SunA01-4**

A full state constrained prescribed performance controller design with constraints

Yang Zhang Naval Aeronautical and Astronautical Univ.
Wenhai Wu Naval Aeronautical and Astronautical Univ.
Jie Wang Naval Aeronautical and Astronautical Univ.
Liang Yu Chengdu Aircraft Industry Corporation

For a class of nonlinear systems with constraints, a full-state constrained prescribed performance controller based on the command filtered is designed. By combining the adaptive backstepping technique, the constraint command filter is adopted to adapt the constraint and avoid the expansion of the calculation. Pseudo-control hedging techniques are combined with command filters to compensate for errors. And the full state of transient performance of the tracking error is analyzed. Based on the Lyapunov stability theory, the controller design is proposed. Simulation interpretation and verification methods.

15:20-15:40 **SunA01-5**

Adaptive Fault-tolerant Output Feedback Control of Uncertain Nonlinear Systems with Unknown High-frequency Gain Sign

Chuanjing Hou Shanghai Jiao Tong Univ.
Lisheng Hu Shandong Jianzhu Univ.

This article develops an adaptive control method for accommodating actuator faults in a class of unknown nonlinear systems without a priori knowledge of high-frequency gain. An adaptive high-gain K-filters with switching laws is proposed to suppress the nonlinearities which are dependent on the unmeasured states. Combining the Nussbaum-gain approach with backstepping design, an adaptive controller with high-gain function can be obtained. It is proved that the proposed control approach can guarantee that all the signals of the resulting closed-loop system are bounded and tracking error can be made as small as desired by appropriate choice of the design parameters. Simulation results are presented to show the effectiveness of the proposed scheme.

15:40-16:00 **SunA01-6**

Adaptive Fault-tolerant Control for Uncertain Nonlinear System with Guaranteed Pre-described Performance

Zhiyuan Nie Chongqing Univ.
Yongduan Song Chongqing Univ.
Liu He Chongqing Univ.
Kai Zhao Chongqing Univ.

In this paper we present a computationally inexpensive adaptive control method for a class of single-input single-output (SISO) uncertain nonlinear dynamic system with actuator failure, modeling uncertainties and external disturbances. By blending system deep-rooted information into backstepping control design and with the help of Nussbaum gains, we develop a robust adaptive control scheme to deal with system uncertainties and actuation failures, which ensures pre-described performance specifications without involving complex online computations. Both theoretical analysis and numerical simulation verify the effectiveness and benefits of the proposed method.

SunA02 **Room02**
Robust control (II) **14:00-16:00**
Chair: Liying Sun Zhejiang Univ.
CO-Chair: Shuyue Zhang Univ. of Chinese Academy of Sciences

14:00-14:20 **SunA02-1**

H∞ Suboptimal Input-Output Decoupling for Linear Systems

Jun-e Feng Shandong Univ.
Beiyou Li Shandong Univ.
Qilu University of Tech.
Aigong Ge Shandong Univ.

A new approximating input-output decoupling approach is proposed for linear time invariant systems, which is called H∞ suboptimal input-output decoupling method. The designed decoupling controller ensures not only the closed-loop system to be stable, but also the closed-loop transfer function approximating a nonsingular diagonal one, which is resulting from the feedback controller. This paper mainly discusses two kinds of decoupling controllers, that is, state feedback controllers, static output feedback controllers. Some necessary and sufficient conditions for the existence of H∞ suboptimal decoupling controllers are derived. Via linear matrix inequality with one matrix equality constrain, the corresponding design algorithm is presented. One numerical example is given to show the effectiveness of the provided method.

14:20-14:40 **SunA02-2**

Passivity and Robust Passivity of Reaction-Diffusion Cohen-Grossberg Neural Networks with Multiple Time-Varying Delays

Weizhong Chen School of Computer Science and Software Engi neering, Tianjin Polytechnic Univ.
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Shunyan Ren School of Mechanical Engineering, Tianjin Polyte chnic Univ.

The problem of passivity is discussed in this paper for reaction-diffusion Cohen-Grossberg neural networks (CGNNs) with multiple time-varying delays. By constructing suitable lyapunov functionals and employing some inequality techniques, several sufficient conditions guaranteeing the passivity of CGNNs are obtained. Furthermore, several criteria for robust passivity are also derived for the case that parameter uncertainties appear in CGNNs. Finally, a numerical example is given to validate the reasonableness and effectiveness of the proposed results.

14:40-15:00 **SunA02-3**

Robust H∞ Controller Based on Multi-objective Genetic Algorithms for Active Magnetic Bearing applied to cryogenic centrifugal compressor

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J. Li Technical Institute of Physics and Chemistry
Huazhong University of Science and Tech.
J. H. Wu Technical Institute of Physics and Chemistry
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This paper proposes a robust H∞ controller based on Multi-objective genetic algorithms (MOGAs) to control the active magnetic bearings (AMBs) with application to superfluid helium cryogenic centrifugal compressor (CCC). Basic weighting function formulas with seven parameters in all are suggested for H∞ controller, whose physical connections with system performance are clearly explained. Weighting function parameters are defined in a relatively narrow range according to actual operating feature of AMB systems. Then, based on these priori information, such as search-domain and weights expression, tuning and optimizing of the design performance function is carried out applying a MOGA. The control strategy avoids time consuming task in the progress of tuning parameters and provides a complete and versatile method to obtain weighting functions for a H∞ controller. Simulation results demonstrate that the optimized H∞ controller guarantees AMB system better closed-loop behavior performance while retaining low value of control signals.

15:00-15:20 **SunA02-4**

Research on Linear Quadratic Robust Control Algorithm for Non-stochastic Uncertain System

Jiaoru Huang Xi'an Technological Univ.
Xi'an University of Tech.
Jiayue Ma Xi'an Technological Univ.
Fucai Qian Xi'an University of Tech.
Chaobo Chen Xi' an Technological Univ.
Xiaoru Song Xi' an Technological Univ.

A Linear Quadratic robust control algorithm is proposed for the system with non-stochastic uncertainties. In this paper, the uncertainties are the noises which lie in a bounded ellipsoid set. The assumption weakens the requirements of the known Gaussian distribution in the traditional Linear Quadratic Gaussian (LQG) control. Based on the linear characteristic of the system and robust optimization theory, the linear quadratic robust controller is designed. The simulation results show the effectiveness of the algorithm.

15:20-15:40 **SunA02-5**

Multi-mode Active Vibration Control of a Nanobeam using a non-square MIMO PID controller

Mihailo Lazarević University of Belgrade, Belgrade
Milan Cajić Mathematical Institute of the SASA
Petar Mandić University of Belgrade, Belgrade
Tomislav Šekara University of Belgrade
HongGuang Sun State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering
Danilo Karličić Mathematical Institute of the SASA

In this paper, we suggest a robust non-square MIMO (4x8) PID controller for the multi-mode active vibration damping of a nanobeam. Nanobeam is modeled by using the nonlocal continuum theory of Eringen to consider the small-scale effects and Euler-Bernoulli beam theory. The problem is analyzed for the free vibration case with Heaviside type disturbance of a nanobeam with and without the controller. The proposed system has four inputs and eight outputs, where by using the static decoupling method, decoupled system of four transfer functions is obtained. The controller parameters dependig on one tuning parmeter are designed to suppress the step disturbance on the input without overshooting. All theoretical results are verified with several numerical examples.

15:40-16:00 **SunA02-6**

A Novel Nonlinear Adaptive Robust Control for Multi-Machine Power System with STATCOM

Liying Sun Liaoning University of Tech.
Yan Zhao Liaoning University of Tech.

For the Multi-Machine power system with STATCOM, it is equivalent to the two machine system. A nonlinear robust STATCOM controller is designed by using the improved backstepping method, immersion and invariant adaptive control and sliding mode control. Firstly, the parameter substitution law of damping coefficient is replaced by the immersion and invariant adaptive control. Then, based on the traditional backstepping method, the k-class function is added to improve the convergence rate of the system. And, in the last step of the backstepping design, the sliding mode control is added to enhance the robustness of the controller. The simulation results show that the STATCOM controller is more robust and adaptive ability, accelerates the convergence speed of the system, and obviously improves the stability of the multi-machine power system.

SunA03 **Room03**
Optimal control and optimization (III) **14:00-16:00**
Chair: Ye Yuan Huazhong University of Science and Tech.
CO-Chair: Lianzheng Ge State Key Laboratory of Robotics and System

14:00-14:20 **SunA03-1**

Optimal Preview Control for Seismic-excited Active Damping Mechanical Systems with Earthquake Actions

Fucheng Liao University of Science and Technology Beijing
Jiang Wu University of Science and Technology Beijing
Rui Zhang University of Science and Technology Beijing

This paper is concerned with the preview control problem for a class of mechanical systems abstracted from a class of seismic-excited active damping structures. First of all, the class of systems is transformed into state equation form, and then it is discretized. By introducing a performance index to reflect the characteristics of the problem, the complete optimal control problem is formulated. The seismic activity is mostly presented in the aspects of the system affected by ground motion acceleration, and the approximate data for these effects can be obtained from history records. Thus, we design an optimal controller with preview action based on these effects. By constructing an augmented system, the problem is converted into a general regulator system, and then the controller is designed. Returning to the original system, the optimal preview controller is obtained. If a lifting technique is used sufficiently in the design, the time delay in input can be formally eliminated. In this paper, the controllability (stabilizability) and observability (detectability) of the augmented system are discussed exactly. A numerical simulation for a 3-degrees-of-freedom building structure model validates the theory of the paper.

14:20-14:40 **SunA03-2**

Curve lane detection based on the binary particle swarm optimization

Shoutao Li Changchun University of Architecture &Civil Engineering
Jinlin Univ.
Jingchun Xu Jinlin Univ
Wei Wei Jinlin Univ
Haiying Qi Changchun University of Architecture &Civil Engineering

The method of B-spline curve fitting linebased on the binary particle swarm optimization is presented in this paper. First,according to the characteristics of the vertical and transverse width of the line must be straight, to extract the lane line feature points, and sorting out the feature points. Then, we select the cubic B-spline curve to fit the curve lane,first the discrete bunary particle swarm algorithm to optimize the number n of the control points ,then by the least square method to calculate the control points of B-spline curve,according to the B-spline crrve fitting out the corresponding curve line. In order todetect corners recognition performance in a variety of road conditions has carried on the experimental study and the results show that the method has great adaptability.

14:40-15:00 **SunA03-3**

Performance Analysis of Deeply Integrated GPS/BDS/INS

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Deeply GPS/INS integration has been shown to improved navigation performance under low signal-to-noise ratio and high dynamic situations by using INS aided GPS acquisition and carrier tracking. It's important to develop the research on deeply GPS/BDS/INS integration with application of the BDS system. Herein, the decisive technologies in GPS/BDS/INS were investigated and a navigation filter algorithm was designed. The entire performance was simulated on a software receiver and PSINS simulator. Test results and analysis are then presented that the inclusion of BDS in the deeply integration does not provide a navigation improvement over using GPS/INS but can improve availability.

15:00-15:20 **SunA03-4**

On the Powerball Method

Ye Yuan Huazhong University of Science and Tech.
Mu Li Carnegie Mellon Univ.
Claire Tomlin University of California at Berkeley

We propose a new method to accelerate the convergence of optimization algorithms. This method simply adds a power coefficient γ [0,1) to the gradient during optimization. We call this the Powerball method and analyze the convergence rate for the Powerball method for strongly convex functions and show that it has a faster convergence rate than gradient descent and Newton's method in the initial iterations. We also demonstrate that the Powerball method provides a 10-fold speed up of the convergence of both gradient descent and L-BFGS on multiple real datasets.

15:20-15:40 **SunA03-5**

Algorithm of Palletizing Robot Vibration Suppression Based on the Principle of Optimal Trajectory Planning

Lianzheng Ge State Key Laboratory of Robotics and System
Jian Chen Wuhu Robot Technology Research Inst.
Ruifeng Li State Key Laboratory of Robotics and System

High speed motion will bring the residual vibration for palletizing robot with flexible joints, which will affect the dynamic performance of robot. The time-domain motion character of palletizing robot is analyzed based on modal analysis theory, and the residual vibration model is provided. The problem of residual vibration suppression using motion planning method is regarded as functional extreme value problem, and the

functional extreme problem is converted to solving the BVP (boundary value problem) of ordinary differential equations based on the Pontryagin maximum principle. The vibration suppression trajectory planning algorithm is designed considering the flexible dynamic model of palletizing robot simultaneously. Simulation results verify the effectiveness of the optimal trajectory planning for the vibration suppression of palletizing robot.

15:40-16:00 **SunA03-6**

Optimal Guaranteed Cost Control for Linear Systems Based on State Feedback

Lei Liu North China University of Tech.
Zejin Feng North China University of Tech.
Shaoying Lu North China University of Tech.
Cunwu Han North China University of Tech.

For the constant linear system and a given quadratic performance index, study the optimal guaranteed cost analysis and control problems based on the linear matrix inequality (LMI) method. Through some lemmas, the conditions of the guaranteed cost state feedback control are converted into a problem of LMI solvability. By solving the LMI, the guaranteed cost controller parameters can be obtained. In turn, give an optimization algorithm with LMI constraints, to obtain optimal guaranteed cost control law. The results can be implemented by the Matlab, and the curve of control and state can be simulated by the Simulink. Finally, two numerical examples are used to verify the feasibility and the correctness of the result.

SunA04 Room04
Fractional Calculus and Fractional-order Systems (I) 14:00-16:00

Chair: Yan Li Shandong Univ.
CO-Chair: Guocheng Wu Neijiang College

14:00-14:20 **SunA04-1**

Dynamical behaviors of the fractional order HCV model

Biao Liu Anhui Univ.
Ranchao Wu Anhui Univ.
Liping Chen Anhui Univ.

In this paper, a fractional-order model of hepatitis C virus (HCV) with inhibition due to infection is studied. Based on the basic reproduction number, backward bifurcation of such model is investigated under some conditions. When the efficacy of interferon- therapy is low, it is shown that the phenomenon of backward bifurcation will appear in the model. It means that there coexist disease-free and endemic equilibrium points. Then a critical basic reproduction number is given, which could be used as a threshold to control the virus. Using the generalized Lasalle invariant set principle, it is found that the disease-free equilibrium point of the model is globally asymptotically stable. The optimal efficacy of interferon- therapy is also studied. Numerical simulations have been used to verify the theoretical analysis.

14:20-14:40 **SunA04-2**

Hausdorff dimension of continuous functions with at most finite UV points on closed intervals

Xiaoer Wu Nanjing Univ. of Science and Tech.
Yongshun Liang Nanjing Univ. of Science and Tech.
Wei Xiao Nanjing Univ. of Science and Tech.
Junhuai Du Dazhou Hydrowater School in Sichuan Province

In this paper, we present a new method to investigate continuous functions with at most finite unbounded variation points on closed intervals. We need to point out that, although the issue is interesting in the prior investigations, the new method should be emphasized. Using this method, Hausdorff dimension of any continuous functions with one unbounded variation point on closed intervals is 1 has been given. Furthermore, definition of unbounded variation point has been given. In the end, if unbounded variation point is at most finite, corresponding conclusion still holds.

14:40-15:00 **SunA04-3**

State Estimation of Fractional Order Network System Based on Modified Fractional Order Kalman Filter

Yi Wang Hohai Univ.
Yonghui Sun Hohai Univ.
Zhinong Wei Hohai Univ.
Guoqiang Sun Hohai Univ.

Accurate state estimation is essential for the application of fractional order network system. In order to provide a more reliable state estimation method to address the inevitably data packet dropout problem of network control system, in this paper, a modified fractional order Kalman filter is developed by combining of the conventional fractional order Kalman filter and the proposed adaptive compensation approach. Simulation results are provided to demonstrate that the proposed method possesses much better estimation performances than the conventional fractional order Kalman filter.

15:00-15:20 **SunA04-4**

Characteristic Analysis of Fractional-order Super-capacitors and Batteries

Yuhang Lei Xian Jiaotong Univ.
Gangquan Si Xian Jiaotong Univ.
Lijie Diao Xian Jiaotong Univ.
Jianwei Zhu Xian Jiaotong Univ.

Modeling and analyzing electrical energy storage devices appears crucial for recently research in engineering study. This paper researches the power and impedance of fractional-order electric circuit models: super-capacitors and batteries. For super-capacitors and batteries models, the fractional order α plays an essential role in the power and energy obtained. An interesting phenomena found out is that the fractional-order super-capacitor ($0 < \alpha < 1$) can gain more energy than the normal one ($\alpha = 1$). The reactive power of the battery model is analyzed versus different order α, which decreasing with when $0 < \alpha < 0.29$ and increasing with α when $0.29 < \alpha < 1$. Apart from it, the impedance $Z(j\omega,\alpha)$ of the two models are given in the paper.

15:20-15:40 **SunA04-5**

A fractional order composite MRAC for multi variable systems basedon LDU factorization of Kp

Songsong Cheng Univ. of Science and Tech. of China
Yiheng Wei Univ. of Science and Tech. of China
Yanan Xiao Hefei 168 Taochonghu School
Yuquan Chen Univ. of Science and Tech. of China
Yong Wang Univ. of Science and Tech. of China

By utilizing LDU factorization of high frequency gain (HFG) Kp, a novel fractional order composite model reference adaptive control (MRAC) is investigated for a class of fractional order multi variable systems. Firstly, in the proposed method, the stringent symmetry assumption related with the plant high frequency gain matrix is removed. Besides, by means of fractional order tracking differentiator, the parameter estimation errors is obtained to construct the fractional order parameter updating laws, which can improve the tracking performance and reduce the control cost. In addition, by utilizing indirect Lyapunov approach, the convergence of closed-loop control systems and parameters estimation are proved. Finally, for the purpose of showing the effectiveness of the proposed method, a numerical example are developed.

15:40-16:00 **SunA04-6**

Grey Differential System and Control Problems Based on the Fractional Calculus

Yang Yang Northeastern Univ.
Dingyü Xue Bohai Univ.

The fractional-order has been studied as an alternative calculus in mathematics and many dynamical systems can be described by its differential equations. Grey theory is used to process the system when the information is partly known or the data samples are incomplete. Therefore, combining the advantage of grey and the fractional system will become a strong tool to estimate the real world. The purpose of this paper is to develop fractional-order grey mathematical models based on the operation properties of fractional calculus and grey numbers. The general Linear Time Invariant (LTI) system with fractional and grey numbers was given. The simulation results illustrated that fractional-order grey system could better depict the system, which will be widely used in the control theory and related field.

SunA05 Room05
IntelliSense and Advanced Sensing, Detection Technology (I) 14:00-16:00

Chair: Yong Zhao Northeastern Univ.
CO-Chair: Rongbao Chen Hefei Univ. of Tech.

14:00-14:20 **SunA05-1**

Vision Localization Algorithms for Apple Bagging Robot

Hongwei Gao Shenyang Ligong Univ.
Yuying Liu Shenyang Ligong Univ.
Dongbin Li Shenyang Ligong Univ.
Yang Yu Shenyang Ligong Univ.

Vision localization apple bagging robot is researched in this paper for young apples. The key technologies of the young fruit stereoscopic images recognizing and positioning are studied in the visible light of the natural environment. Firstly, the Otsu segmentation algorithm is used to preprocess the collected young apple images. Secondly, the improved connected component labeling algorithm is used to mark and label the preprocessed young apple images. Small areas where do not meet the requirements are removed by setting the threshold. The shape feature value circularity is used to recognize young apples and mark automatically. Thirdly, the binocular stereo vision system is used for three-dimensional positioning of the apple fruit. The three-dimensional information is used to grasp the fruit. A large number of experimental results prove the effectiveness and feasibility.

14:20-14:40 **SunA05-2**

A Fusion Method of Dual Mode Process Tomography Based on D-S Evidence Theory

Zhining Si North China Electric Power Univ.
Pei Tian North China Electric Power Univ.

In order to improve the image quality of multiphase flow process tomography system, a new fusion method of dual mode process tomography based on D-S evidence theory is proposed. For CT system, due to the small angle of projection, the reconstructed image edge prone to distortion, but Ray's hard field characteristics determine the image has a higher resolution; and ECT system, as the "soft field" characteristic of sensitive field, making the edges of the image with the actual situation reconstruction matches, but lower image resolution. Based on the analysis of the imaging mechanism and the aim of the fusion, the D-S

evidence theory is applied to the CT/ECT image fusion, and the basic probability assignment is indicated by the distance between the gray value and the cluster center. The simulation results show that the proposed method can improve the quality of reconstructed image, and it is verified by the root mean square error.

14:40-15:00 **SunA05-3**

Acoustic Velocity Tomography for Damage Detection in Concrete

Jinghe Li Guilin Univ. of Technology
Li Gan The Guangxi Zhuang Autonomous Region Transportation Planning Survey and Design Institute
Hang Qin Guangxi Transportation Research Institute

Acoustic measurement in time domain is only helped to obtain the positions of concrete quality defects. A acoustic velocity tomography for monitoring the properties of concrete quality defects is proposed in this paper. The integral equation (IE) in forward process and the contrast source inversion (CSI) in inverse process are incorporated in acoustic velocity tomography. With the ability of this optimization operator, it is designed to distinguish the different properties filled inside the defects with nondestructive testing. Numerical cases are applied to validate the effectiveness of this acoustic velocity tomography.

15:00-15:20 **SunA05-4**

Optimization of photonic crystal fiber for optical hydrogen sensing

Qilu Wu Northeastern Univ.
Yong Zhao Northeastern Univ.
Yanan Zhang Northeastern Univ.

Now coupling interferometer structure based on photonic crystal fiber (PCF) gets extensive attention in hydrogen sensing. Because of its structural stability, high sensitivity characteristics, it has achieved good results in the hydrogen sensor, when combine with the hydrogen-sensitive film such as Pd-WO3. In the initial experiment, the hydrogen sensor based on PCF coated with Pd-WO3 showed good linearity with the sensitivity of 1.09nm/%. Through mechanism modeling and simulation, a relationship between the output wavelength and the refractive index of hydrogen-sensitive film had been established. On the basis of the above, three new PCF interference structures ware designed for better sensing performance and practical potential: cone structure, misalignment structure, hollow fiber-liquid filled structure. Refractive index sensitivity of sensitive film got 3340 nm/RIU, 4268nm/RIU, 8884nm/RIU through the analysis and optimization. Sensing performance had been improved contrast with the experimentally verified structure, which can predict that their hydrogen detection sensitivity could reach 1.7nm/%, 2.2nm/%, 4.7nm/%. Finally, the characteristics and hydrogen sensing performance of the three structures were compared. Hollow fiber with liquid filled structure was determined as the best experimental structure and the further optimization direction was put forward.

15:20-15:40 **SunA05-5**

A New Liquid Level Measurement Method Based on Randomized Hough Transform

Dongdong Geng East China Univ. of Science and Tech.
Na Luo East China Univ. of Science and Tech.

Traditional level measurements based on sensors were easily affected by circumstance especially in severe industrial process, whose accuracy of measurement cannot meet the control requirement. In order to deal with the problem, a new level measurement method based on randomized Hough Transform was proposed. After pre-processing, noise-reduction and filtering to the original image, the randomized Hough Transform was used to recognize the liquid level. Experiment results showed that the error of the proposed method is within 2% and the average recognition time is within 0.1s. The proposed method can meet the requirement in industrial fields.

15:40-16:00 **SunA05-6**

Realization of Moving Object Detection and Tracking Algorithm Based on Frame Difference Method and Particle Filter Algorithm

Yaoming Zhuang Northeastern Univ.
Chengdong Wu Northeastern Univ.
Yunzhou Zhang Northeastern Univ.
Sheng Feng Northeastern Univ.

With the multimedia sensor is widely used, moving objects detection and tracking based on video have gradually become a popular research field in multimedia sensor networks. For the multimedia sensor networks, the existing target detection and tracking algorithm cannot meet the system requirements of real-time and accuracy, which existing the problem of slowness and target missing. Therefore, this paper proposes moving target detection and tracking algorithm based on frame difference method and particle filter algorithm. At the same time, a WMSN node experiment platform based on ARM embedded system is constructed. Through the practical experiment, the effective detection and tracking of the moving target are realized on the platform. Compared with the general computer simulation experiment, the experimental results running on the experiment platform is closer to the practical application. Finally, the experimental results show that the algorithm proposed in this paper is superior to Kalman filter in speed and stability.

SunA06 **Room06**
Identification and estimation (I) **14:00-16:00**
Chair: Jiling Ding Jining Univ.
CO-Chair: Jian Yang Air Force Engineering Univ.

14:00-14:20 **SunA06-1**

Graph Theory Based Decentralized H∞ Filtering for Large-scale T-S Fuzzy Systems

Xiao-Jian Li Northeastern Univ.
Shaokun Liu Northeastern Univ.
Guang-Yu Zhao Changchun Univ. of Science and Tech.
Hui-Jun Bi Jilin Rrovincial Experimental School
Ying-Hao Sun Datang Northeast Electric Power Test & Research Inst. Co.,Ltd

This paper is concerned with the problem of decentralized H_∞ filtering for large-scale T-S fuzzy systems, where the interconnections are nonlinear and with known weights. The algebraic graph theory is used to construct a new Lyapunov function such that the effects of the nonlinear interconnections can be included in some constants related with the interconnected weights. As a result, a novel decentralized filtering scheme is derived, and the corresponding filter synthesis conditions are given in terms of the solutions of a set of linear matrix inequalities (LMIs). In contrast to the conventional filtering schemes, where the interconnections are assumed to be local linear, the proposed decentralized filter design conditions are based on fewer fuzzy rules and less computational burden. Moreover, a unified filter design framework is derived for the large-scale T-S fuzzy systems with or without time-delayed nonlinear interconnections. Finally, a simulation example is provided to illustrate the effectiveness and advantages of the theoretical results.

14:20-14:40 **SunA06-2**

The Hierarchical Gradient Identification Algorithm for Multi-Input Output-Error Autoregressive Systems

Jiling Ding Jining Univ.

This paper deals with identification problems for multi-input output error autoregressive (OEAR) systems. The main contribution of this paper is to propose iterative algorithms for multi-input OEAR systems using the hierarchical identification principle. Firstly, a gradient based iterative (GI) identification algorithm is given for multi-input OEAR systems as a comparison. Secondly, using the hierarchical identification principle, we present a hierarchical gradient based iterative (H-GI) identification algorithm. Finally, one example is provided to test the proposed algorithms, the simulation results indicate that the H-GI identification algorithm can produce more accurate parameter estimates than the GI identification algorithm.

14:40-15:00 **SunA06-3**

An Improved Method of SINS/CNS Integrated Navigation Algorithm Based on Dual Quaternions with Gyro Error Corrected Online

Yanling Min Nanjing Univ. of Aeronautics and Astronautics
Zhi Xiong Nanjing Univ. of Aeronautics and Astronautics
Li Xing Nanjing Univ. of Aeronautics and Astronautics
Jianye Liu Nanjing Univ. of Aeronautics and Astronautics
Dequan Yin Nanjing Univ. of Aeronautics and Astronautics

In consideration of the high dimension problem in the existing SINS/CNS integrated navigation system based on dual quaternions, the observable degree analysis method of system states based on singular value decomposition is introduced. According to the analysis result, the state components with good observability are estimated and the bad ones are removed, thus the computation time of Kalman filter is significantly decreased and the real-time performance of SINS/CNS is improved. To ensure that inertial navigation can also maintain high accuracy over a period of time when celestial auxiliary information is lost, an improved method of SINS/CNS integrated navigation algorithm based on dual quaternions with gyro error corrected online is proposed. The Kalman filter estimates constant gyro drift with the aid of celestial information and utilizes the calibration value to compensate gyro output online. The simulation results demonstrate that the proposed method can realize the effective estimation of constant gyro drift. In addition, the accuracy of inertial navigation is improved effectively.

15:00-15:20 **SunA06-4**

An Improved Binocular Visual Odometry for High-Speed Automotive Applications

Huan Yu Beijing Inst. of Tech.
Jiabin Chen Beijing Inst. of Tech.
Liujun Wang Beijing Inst. of Tech.
Ling Xie Beijing Inst. of Tech.
Chunlei Song Beijing Inst. of Tech.
Qinghe Wu Beijing Inst. of Tech.

In this paper, we present an improved motion estimation method by adding extra information for binocular visual odometry (VO) which is especially suited for improving high-speed pose change estimation. The extra information is obtained by structured object detecting, taking lane line detection as an example. We can get an accurate position information by calculating the interval of each dotted lane line and counting the number of the dotted line which can be fused with the pose information obtained from visual odometry. The outlier rejection of the VO is also improved, making it adapt to highway situation. In the fusion process, a Kalman filter is adopted to estimate the motion and location information for a high speed vehicle. The experimental results show that the approach proposed is valid and can increase the positioning accuracy significantly compared with ordinary visual odometry.

15:20-15:40 **SunA06-5**

Calculation and Analysis of Added Mass for an Object during Its Vertical Water Exit

Jian Yang Air Force Engineering Univ.
Jin-fu Feng Air Force Engineering Univ.
Duo Qi Air Force Engineering Univ.
Xiao-qiang Zhang Air Force Engineering Univ.
Yong-li Li Engineering Univ. of CAPF
Jing-kun Zhang Army Aviation Equipment Quality Control Office

The vertical water-exit process of object involves the problem of the two-phase flow and fluid-structure coupling which is one of the key problems that need to be solved urgently in dynamic modeling and controller design of the water-exit stage of the object. Nowadays, added-mass is relatively mature and convenient method of decoupling.
Because of the time-variant characteristic of the object's added-mass in water-exit process, the traditional calculation method for the added mass cannot be used directly. For this purpose, in the paper, from the dynamic equations, the computational formula of added-mass is deduced, and a new numerical strategy based on the numerical simulation is proposed to calculate the real-time changes of added mass in different stages of water-exit. On this basis, the added-mass of sphere under different velocity and acceleration conditions are computed by numerical model which is established based on FLUENT. The method is confirmed through the comparison between computational value and theoretical value of the sphere's added-mass in water-exit process. Then, the rules of added mass changes of a sphere and a cylinder during vertical water exit are studied. The results demonstrate that both vertical added mass horizontal added mass of the sphere and cylinder are decreasing in the process of vertical water exit, of which, the vertical added mass changes slowly at a submerged depth of 0.9-0.4 and the horizontal added mass changes approximately linearly. The added inertial moment changes slowly around the submerged depth of 0.5. Added static moment increases first then decreases, and reaches its peak value at the submerged length of 0.7-0.5. The new added mass calculation method is helpful to improve the accuracy of the water dynamics model of various submerged weapons. At the same time, the relevant conclusions also have some reference significance for the object of the water-exit process research, controller design and motion prediction.

15:40-16:00 **SunA06-6**

The Application of R-T-S Smoothing Algorithm in the Post-processing of the Integrated Navigation

Tian Sang Beijing Inst. of Tech.
Jiabin Chen Beijing Inst. of Tech.
Chunlei Song Beijing Inst. of Tech.
Huan Yu Beijing Inst. of Tech.

Integrated navigation system usually uses Kalman filter to make it possible for error compensation. In order to improve the precision of navigation and the stability of data, we introduce the R-T-S (Rauch-Tung-Striebel) optimal fixed-interval smoothing into the post-processing of data. On the basis of the forward Kalman filter, we add the backward information filter to the system and use the measured data to verify the algorithm. The results show that compared with the traditional Kalman filter, the R-T-S optimal fixed-interval smoothing can not only improve the precision of the position and posture but can also improve the precision of navigation significantly in case of lock-lose, making it possible as an effective way of data processing.

SunA07 Room07
Intelligent systems (II) 14:00-16:00

Chair: Zhihua Cui Taiyuan Univ. of Science and Tech.
CO-Chair: Lou Yang East China Univ. of Science and Tech.

14:00-14:20 **SunA07-1**

Neural Network Adaptive Critic Control with Disturbance Rejection

Ding Wang Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Chaoxu Mu Tianjin Univ.
Derong Liu Univ. of Science and Tech. Beijing

A neural-network-based adaptive critic control method is established for continuous-time input-affine uncertain nonlinear systems to achieve disturbance rejection. The present problem can be formulated as a two-player zero-sum differential game and the adaptive critic mechanism is employed to solve the minimax optimization problem. A neural network identifier is developed to reconstruct the unknown dynamical information. The optimal control law and the worst-case disturbance law are designed by introducing and training a critic neural network. The effectiveness of the present self-learning control method is also illustrated by a simulation experiment.

14:20-14:40 **SunA07-2**

NSGA-II with Local Perturbation

Maoqing Zhang Taiyuan Univ. of Science and Tech.
Zhuanghua Zhu Shanxi Finance & Taxation Coll.
Zhihua Cui Taiyuan Univ. of Science and Tech.
Xingjuan Cai Taiyuan Univ. of Science and Tech.

To improve the overall performance of one algorithm, most researchers focus on the fitness assignment, preserving diversity and hybridizing different search methods. Different from the above strategies, this paper focuses on the convergence. According to the analysis of the convergence of NSGA-II, local perturbation strategy is introduced to improve the efficiency of NSGA-II in the paper. Local perturbation strategy is able to enlarge the search space and more optimal solutions can be found with large probability. To illustrate the effect of local perturbation, the proposed LPNSGA-II with other three outstanding algorithms is tested on six test instances. Experimental results illustrate that the proposed LPNSGA-II outperforms the three algorithms and the convergence of NSGA-II is improved greatly using local perturbation strategy.

14:40-15:00 **SunA07-3**

Motion Coherence Based Abnormal Behavior Detection

Zheng Xu Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Baoxiao Fu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications
Fang Fang Southeast Univ.

To improve the accuracy and speed of the global abnormal detection, a novel method based on motion coherence model is here proposed. Specifically, motion features of each tracking objects are firstly extracted; then, global abnormal behavior detection models are learned based on the energy model, dispersion model and Lagrange particle dynamics model respectively; finally, global abnormal behavior is detected and labeled based on the learned three models. The proposed method is conducted on public UMN dataset which demonstrates that the proposed method can improve the accuracy and efficiency of abnormal behavior detection.

15:00-15:20 **SunA07-4**

Trajectory Data Association Based MultiObject Tracking

Dongliang Jin Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications

A multitarget tracking method based on data association and trajectory evaluation is proposed in this paper. Firstly, the data association and trajectory evaluation are integrated into the same conditional random field model, which is transformed to obtain the minimum energy problem. Secondly, from the time, if two of the same track label appear with a physical space, the symbiotic label cost is used to constrain the correlation; from the space, the pairwise energy term between the different observation targets is introduced to prevent the occurrence of false data label. Finally, in the discrete continuous optimization process ofthe energy, this paper uses the improved a-expansion algorithm and the gradient descent method to solve the minimum energy in non convex and non sub module functions. The experimental results of PETS2009/2010 benchmark and TUD-Stadtmitte video sequence database show that the proposed algorithm in this paper is superior to the current advanced level ofmultitarget tracking technology.

15:20-15:40 **SunA07-5**

On-line Signature Verification Based on Gaussian Mixture Models

Lou Yang East China Univ. of Science and Tech.
Mandan Liu East China Univ. of Science and Tech.

In this paper for on-line signature verification, wavelet packet analysis will be used to extract dynamic local features, combining global features to keep distortionless in signature data. More importantly, in order to overcome shortcomings that the traditional expectation maximization algorithm seriously depends on parameters initialization and easily falls into local optimum when used to train Gaussian Mixture Models, we first employ an improved Splitting-EM algorithm based on Bayesian Ying-Yang learning system to train Gaussian Mixture Models. Splitting-EM algorithm can search for optimal number of Gaussian components so that a unique, user-dependent signature model can be established to ensure a better approximation. Experiments show that the verification accuracy based on wavelet packet analysis to extract features and Splitting-EM algorithm training Gaussian Mixture Models reaches 95.8%, which is a satisfactory verification result.

15:40-16:00 **SunA07-6**

Pulmonary Nodules Detection Algorithm Based on Robust Cascade Classifier for CT Images

Xia Li Shandong Univ.
Yang Yang Shandong Univ.
Hailiang Xiong Shandong Univ.
Shangling Song Shandong Univ.
Hongying Jia Shandong Univ.

Lung cancer has been the deadliest among all other types of cancer. Our purpose is to propose an efficient method to detect the pulmonary nodules from CT images and classify the nodule into either cancerous (Malignant) or non-cancerous (Benign). We achieve this by framing the problem as a constructing classifier task and exploit data in the form of classifier to learn a mapping from raw data to object classification. In particular, we propose a learning method based on a form of cascade classifier which allows learning in a supervised manner, only based on pulmonary nodule image block extracted from the original CT images without access to around-information annotations. In order to validate our approach, we use a synthetic database to mimic the task of detecting pulmonary nodule automatically from CT images-as commonly encountered in automatic detection of medical images applications-and show that classifier can automatically detect pulmonary nodules from the lungs CT images accurately. The method is able to achieve an overall accuracy of 97.01%.

SunA08 Room08
Decision-making theory and method (I) 14:00-16:00
Chair: Fuli Wang Northeastern Univ.
CO-Chair: Xia Liu Beihang Univ.

14:00-14:20 SunA08-1

Reliability Evaluation of Thermal Power Units Based on AHP and ELECTRE-III

Le Wei North China Electric Power Univ.
Xiaowei Li North China Electric Power Univ.

The security and stable operation of thermal power units plays a very important role in a power system, so the reliability evaluation of thermal power units has become a critical problem. By combining the advantages of the Analytic Hierarchy Process (AHP) and the Elimination et Choice Translating Reality (ELECTRE)-III, a reliability evaluation method for thermal power units based on AHP and ELECTRE-III is put forward. A new method of proposed "net" procedure is presented to rank these scheme with valued outranking relation. The advantages and disadvantages of the scheme are expressed from the harmony index and the discordance index, which constitute valued outranking relation by ELECTRE III and weights of criteria are determined by AHP. This method is clear and easily to be accepted by the decision maker with the person's actual decision thinking of human being. And the results of the example analysis show that the method is feasible for the reliability evaluation of thermal power units.

14:20-14:40 SunA08-2

Limited Information Sharing and Market Information Efficiency

Xia Liu Beihang Univ.
Shancun Liu Beihang Univ.
Zuowei You Beihang Univ.

We present a typical noisy rational expectation model where private information can be transmitted in the informed traders' social network to find out the impact of information sharing mechanism on market efficiency. We mainly come to two conclusions. One is that information sharing increase the price informativeness when information acquisition is exogenous. The other one is obviously in contrast with previous literatures in that we find that when information is endogenous, information sharing can improve price informativeness and market depth, and thus promote market information efficiency though the sharing mechanism has a crowd-out effect on information production due to traders' "free-ride".

14:40-15:00 SunA08-3

A Time-difference PLS Based Soft Sensor Method of Underflow Concentration for Thickener in Hydrometallurgy

Jie Yuan Northeastern Univ.
Shu Wang Northeastern Univ.
Fuli Wang Northeastern Univ.
Kang Li Northeastern Univ.

To address the real-time measurement problem of underflow slurry concentration in hydrometallurgy, a soft sensor method based on time-difference partial least square (TD-PLS) is proposed. The time difference is utilized to overcome the data misalignment
problem caused by the slurry crystal on the surface of sensors. The input secondary variables of the method are time difference press value relative to the initial time, and all the press sensors located in different depth, while the output is the corresponding time difference value of underflow slurry concentration relative to the initial concentration. It is essential that the initial slurry concentration should be measured precisely. A large amount of data is used to training the soft sensor model, and the method can estimate the real-time thickener underflow slurry concentration accurately. The method is applied to a thickener in certain refinery, and the measurement error is in the allowable deviation.

15:00-15:20 SunA08-4

On modified soft rough sets (MSR-sets)

Piyu Li Northeastern Univ. at Qinhuangdao
Jing Liu Northeastern Univ.
Zhi Kong Northeastern Univ. at Qinhuangdao
Wenli Liu Anshan Normal Univ.
Changtao Xue Northeastern Univ. at Qinhuangdao

In this paper, we consider the concept of modified soft rough sets (MSR-sets) which was introduced by Shabir et al. [20]. We establish that MSR-sets can be viewed as a class of classic Pawlark rough sets.

15:20-15:40 SunA08-5

A Three-way Decisions Model for Decision Tables

Linzi Yin Central South Univ.
Xuemei Xu Central South Univ.
Jiafeng Ding Central South Univ.
Zhaohui Jiang Central South Univ.
Kehui Sun Central South Univ.

In order to resolve the degradation phenomenon of the classical three-way decisions model based on rough set three-regions, the notion of decision trap is proposed to make a novel three-way decisions model for decision tables (3WD-D). 3WD-D adopts the trisection-acting frame, and redefines three types of strategies in acting component as accept right decisions, reject decision traps and non-commitment, respectively. Based on the new strategies, the universe is divided into three new regions. They are acceptance region (AR), rejection region (RR), and delay region (DR), respectively. The related theory analysis and experiments show that 3WD-D resolve the degradation phenomenon and is effective in decision tables.

15:40-16:00 SunA08-6

Research on the Cooperative Evolving Network Model of the Growth Factors of Innovative Enterprises

Yumei Wang Qingdao Univ. of Science and Tech.
Guangming Li Qingdao Univ. of Science and Tech.
Linghui Wang Qingdao Univ. of Science and Tech.

The growth of innovative enterprises is a cycle of the process. The growth factors and business growth performance will eventually form a closed loop. In an innovative enterprise growth system, strategy, Tech, system, culture, organization, market and social service are the indispensable elements of enterprise growth.

SunA09 Room09
Networked control systems (I) 14:00-16:00
Chair: Songlin Hu Nanjing Univ. of Posts and Telecommunications
CO-Chair: Duanjin Zhang Zhengzhou Univ.

14:00-14:20 SunA09-1

Guaranteed Performance Consensus for Multi-agent Systems with Nonlinear Dynamics

Zhong Wang High-Tech Inst. of Xi'an
Ming He High-Tech Inst. of Xi'an
Yanfei Liu High-Tech Inst. of Xi'an
Yuan Zhao High-Tech Inst. of Xi'an
Xiaodong Fan Advanced Equipment Inst. of Liuzhou

The guaranteed performance of the consensus control for general linear multi-agent systems with Lipschitz nonlinear dynamics and directed interaction topologies is investigated, where the directed interaction topology contains a spanning tree. By a special matrix transformation, the guaranteed performance consensus problems are transferred into guaranteed performance stabilization problems. Then, the criterions of guaranteed performance consensus for nonlinear multi-agent systems with directed interaction topologies are obtained and an upper bound of the introduced performance function is given. Finally, a numerical simulation is given to illustrate the effectiveness of the obtained conclusion.

14:20-14:40 SunA09-2

Fault Detection of Networked Control Systems with Passive Time-Varying Sampling Period and Communication Constraints

Duanjin Zhang Zhengzhou Univ.
Jie Gao Zhengzhou Univ.
Yu Cao Zhengzhou Univ.

This paper investigates the problem of fault detection for networked control systems with time-varying sampling period under the condition of communication constraints. Considering the factors of delay and limited communication, the residual system can be modeled as a parameter-uncertain discrete system by using the parameter uncertainty-based approach to deal with the time-varying sampling periods. The sufficient conditions for the residual system to be stochastic stable and meet the H-infinity performance are given in terms of the Lyapunov stability theory and linear matrix inequality approach. The design method of the fault detection filter is also provided. A numerical example is given to illustrate the effectiveness of the proposed method.

14:40-15:00 SunA09-3

Flocking Control of Multi-Agents Based on Self-Adaptively Weighting Observers Driven Only by Local Position Measurements

Xinbiao Lu Hohai Univ.
Jin Zhang Hohai Univ.
Jun Zhou Hohai Univ.
Buzhi Qin Nanjing Polytechnic Inst.
Huimin Qian Hohai Univ.

The most methods to achieve flocking control of multi-agent systems take both position and speed information of all the multi-agents into the control laws. However, various factors and their magnitudes, related to mutual position difference vectors, between the multi are neglected. In this paper, based on distributed observers, flocking control algorithms driven only by local position measurements and with self-adaptively weighting coefficients are proposed. The suggested algorithms are sketched as follows. Firstly, distributed observers are introduced to each individual agent to estimate its speed only by local position measurements of the agents locating in the corresponding neighborhoods. Secondly, by self-adaptively adjusted weighting coefficients to the observers, possible attraction/dispersion force variations caused by position measurement uncertainties are exploited for facilitating flocking formation. Moreover, major properties of the suggested flocking algorithms are analyzed rigorously, and numerical simulations are shown to verify effectiveness of the proposed algorithms.

15:00-15:20 SunA09-4

A Case Study of Whether or not Intentionally Network-induced Delay Vibration Control

Yanping Yang Shanghai Univ.
Dawei Zhang Shanxi Univ.

Xinchun Jia Shanxi Univ.
This paper investigates whether and how network-induced delays positively benefit the networked active vibration control for multi-degree-of-freedom structural systems subject to earthquake excitation. By intentionally introducing proper network-induced delays in the feedback control loop, the structural control system in the networked control system architecture is described by a system with an interval time-varying delay. By using a complete Lyapunov Krasovskii functional, a delay-dependent H∞ control design result is obtained in terms of linear matrix inequalities with an equality constraint. An iterative algorithm is presented to design the controller such that the vibration effect is reduced as much as possible. The effectiveness of the proposed method is validated by a numerical example.

15:20-15:40 **SunA09-5**

Stabilization and H∞ Control for Networked Control System with Random Time-delay

Chuanxu Qiu Jiangnan Univ.
Wei Feng Jiangnan Univ.
Jiwei Wen Jiangnan Univ.
Li Peng Jiangnan Univ.
This paper is concerned with the stabilization and H} control problem for a class of continuous-time networked control systems (NCSs) with random time-delay modeled as a Markov process with incomplete transition rates. The research motivation is to achieve numerical testable stabilization criteria. First, the stochastic stabilization of the underlying NCS with jumping parameters is investigated by transferring the original system into a singular one, which has equivalent mean square stability. Then, based on the results of stabilization, the H∞ disturbance attenuation is further considered. The sufficient conditions are presented in the form of standard linear matrix inequalities (LMIs), which is rarely reported in the existing references. Finally, a numerical example is given to demonstrate the effectiveness of the main results.

15:40-16:00 **SunA09-6**

H∞ Performance Analysis of Networked Control System with a New Periodic Event-Triggering Scheme

Chuangwei Shang Coll. of Automation, Nanjing
Songlin Hu Nanjing Univ. of Posts and Telecommunications
Huaibin Xie Coll. of Automation, Nanjing
In this paper, a new approach to event-triggered H∞ performance analysis of linear networked control systems is proposed. First, a new parametrization of event-triggering scheme is designed, in which a positive diagonal parameter matrix with n elements (corresponding to the dimension of the system under consideration) is introduced, resulting in different weights for each state component. Under this event-triggered formulation together with delay system modeling approach and a discontinuous Lyapunov functional, the criteria for H∞ performance analysis are derived in terms of linear matrix inequalities. Finally, simulation results on a practical example are given to indicate that the proposed method has some advantages over some existing ones.

SunA10 **Room10**
Fault diagnosis and fault-tolerant control (I) **14:00-16:00**
Chair: Ke Zhang Nanjing Univ. of Aeronautics and Astronautics
CO-Chair: Bin Jiang Nanjing Univ. of Aeronautics and Astronautics

14:00-14:20 **SunA10-1**

Robust Finite-Time Fault Diagnosis for Leader-Follower Multi-Agent Systems

Xingxing Chen Nanjing Univ. of Aeronautics and Astronautics
Ke Zhang Nanjing Univ. of Aeronautics and Astronautics
Bin Jiang Nanjing Univ. of Aeronautics and Astronautics
This paper concerns with the robust finite-time fault diagnosis of leader-follower multi-agent systems with actuator faults. Using linear matrix inequality (LMI) and robust finite-time boundedness theory, a sufficient condition is firstly presented for a dynamic system to be robust finite-time bounded. The observer is constructed based on relative output estimation error. Then the existence conditions of robust finite-time fault diagnosis observers are shown by means of LMI. According to the solution of LMI, the design method of the observer is given. Finally, two examples are given to illustrate the effectiveness of the proposed method.

14:20-14:40 **SunA10-2**

Observer-Based Fault-Detection of Broken Rotor Bars in Traction Motors

Xiaoqing Yu Nanjing Univ. of Aeronautics and Astronautics
Bin Jiang Nanjing Univ. of Aeronautics and Astronautics
Ke Zhang Nanjing Univ. of Aeronautics and Astronautics
In this paper, an observer-based approach is used to detect the fault of broken rotor bars in three-phase squirrel-cage traction motors of CRH5 electric multiple units(EMU). Firstly, the healthy and faulty models are established. Then, the faulty models are divided into two subsystems such that the first subsystem has the fault of broken rotor bars but without load disturbance and the second subsystem has load disturbance but is absent from faults. According to the special form of subsystems, a Luenberger observer is designed for the first subsystem to detect the broken rotor bars and a SMO is proposed to eliminate the uncertainties of load disturbance. The stability of proposed observers is proved by Lyapunov function and the sufficient condition is expressed as linear matrix inequalities (LMIs). Eventually, simulation results are shown to illustrate the effectiveness of the proposed fault-detection method.

14:40-15:00 **SunA10-3**

Conductive EMI Analysis and Suppression Technology of Electric Vehicle Driving System

Hong He Tianjin Univ. of Tech.
Chen Zhang Tianjin Univ. of Tech.
Zhihong Zhang Transmission and Launch Department, Tianjin Radio and TV Station
With the electric vehicle drive system running electromagnetic compatibility problems become more and more serious, how to effectively suppress the conducted interference problem has become a technical problem. In this paper, the mechanism and the coupling path of conducted EMI in EV drive system are analyzed, and the suppression effect of electromagnetic interference is discussed from the aspect of safety capacitance. Then, according to the interference limit stipulated by national standard GB 9254-2008, after the initial disturbance of the system and access safety capacitance common-mode/differential mode interference simulation. Through the test, the interference effect of different connection modes of the safety capacitor is obtained, which is very important for the EMI suppression of the drive system of the electric vehicle.

15:00-15:20 **SunA10-4**

Nonlinear PLS Monitoring Based on ANFIS

Hongbin Liu Nanjing Forestry Univ.
South China Univ. of Tech.
Xiangyu Li Nanjing Forestry Univ.
Changkyoo Yoo Kyung Hee Univ.
An adaptive neuro-fuzzy inference system-based partial least squares (ANFIS-PLS) method was proposed for monitoring nonlinear processes. The ANFIS was used as a predictor to represent the nonlinear relationship between input and output score variables in each inner loop of PLS, and fuzzy c-means clustering was employed to determine the number of fuzzy rules. Moreover, the hybrid learning algorithm was used to update and optimize the parameters of ANFIS. To determine the confidence limits for monitoring, the non0parametric kernel density estimation method was performed. A case study on the benchmark simulation model 1 of nonlinear biological wastewater treatment process was evaluated to demonstrate the efficient monitoring performance of the proposed method. The results show that the proposed method can give superior monitoring performance compared to the traditional principle component analysis monitoring method.

15:20-15:40 **SunA10-5**

Improved Fault Detection for Nonlinear Mechatronic System Based on Uncertain Bond Graph

Ming Yun Hefei Univ. of Tech.
Si Chen Hefei Univ. of Tech.
This paper deals with the improved fault detection for nonlinear mechatronic system based on the uncertain bond graph. Parameter uncertainties are taken into consideration and are represented in linear fractional transformation (LFT) for calculating the improved adaptive threshold. The uncertainties are incorporated in the calculation of the analytical redundancy relations whose numerical evaluations are used for fault detection purpose. The main contribution of this work aims to eliminate uncertainties from the traditional adaptive threshold and obtain the improved one which is less conservative. Therefore, the sensitiveness of fault detection has been improved by utilizing the improved adaptive threshold. The principle implementation of the method is validated by a mechatronic system with a motor reducer and an external load. The simulation results shows the effectiveness of the proposed method.

15:40-16:00 **SunA10-6**

A Improved Way for Fault Diagnose Based on EEMD and SVM

Ping Yang Heilongjiang Univ.
MingLiang Liu Heilongjiang Univ.
Quanwei Peng Heilongjiang Univ.
Yaowen Xing Heilongjiang Univ.
Bin Li Heilongjiang Univ.
The change of the vibration signal can reflect the mechanical state of the HV circuit breaker. An efficient method of feature extraction of the vibration signal usually pays a key role in the validity of the fault diagnosis and also lays the foundation for the fault classification in the subsequent stage. The paper presented a feature extraction method which is based on average empirical mode decomposition (EEMD) and GP algorithm. The EEMD algorithm is used to decompose the non-stationary signal into several the conqueror functions (IMFs). However, the first four orders usually have great influence on the classification of signal, so we select the first four orders to calculate the correlation dimension. Finally, the SVM (Support Vector Machine) is used to classify different types of fault signals after decomposing (EEMD) and calculating correlation dimension. The test indicates that the represented method have a high recognition rate. To a certain extent, the method is likely to provide a new method for fault diagnosis.

SunA11 **Room11**
Delay systems (I) **14:00-16:00**

Chair: Xian Zhang Heilongjiang Univ.
CO-Chair: Jie Fu Chongqing Univ.

14:00-14:20 **SunA11-1**

Exponential Passive Filtering for A class of Neutral-type Neural Networks With Time-varying Mixed Delays

Ning Zhao Heilongjiang Univ.
Xiaofei Fan Heilongjiang Univ.
Yu Xue Heilongjiang Univ.
Yantao Wang Heilongjiang Univ.
Xian Zhang Heilongjiang Univ.

This paper is concerned with the problem of the exponential passive filter design for neutral-type neural networks with time-varying mixed delays. First, a Luenberger-type filter is designed for estimating the network states. Second, by constructing an appropriate Lyapunov-Krasovskii functional and using the so-calledWirtinger-based integral inequality to estimate its derivative, a delay-range-dependent and delay-rate-dependent criterion is presented to ensure the filtering error dynamic system to be exponentially stable and passive with an expected dissipation. Third, since the criterion is presented in the form of linear matrix inequalities with nonlinear constraints, a cone complementarity linearization algorithm is proposed to solve the nonlinear problem. Finally, a numerical example are given to demonstrate the effectiveness of the proposed method.

14:20-14:40 **SunA11-2**

New Absolute Stability Criteria for Neutral-type Delayed Lur'e Systems

Xin Li Heilongjiang Univ.
Xian Zhang Heilongjiang Univ.
Yantao Wang Heilongjiang Univ.
Xin Wang Heilongjiang Univ.

This paper is concerned with the absolute stability analysis of neutral-type Lur'e systems with interval time-varying delays and sector-bounded nonlinearity. By using the reciprocally convex technique, convex technique and Wirtinger-type integral inequality simultaneously, neutral-delay-range-dependent absolute stability criteria are presented. The obtained criteria can be regarded as an extensive version of all existing results, since the latters are independent from the lower or upper bounds of the neutral delay. A numerical example is provided to demonstrate the effectiveness of the proposed method.

14:40-15:00 **SunA11-3**

Extended Dissipative Filter for Discrete-time Uncertain System with Time-varying Delay

Weifeng Xia Nanjing Univ. of Science and Tech.
Baoyong Zhang Nanjing Univ. of Science and Tech.
Yongmin Li Huzhou Teachers Coll.
Yuming Chu Huzhou Teachers Coll.
Qian Ma Nanjing Univ. of Science and Tech.

This paper considers the problem of extended dissipative filter for discrete-time uncertain systems with time-varying delay. The uncertainty is assumed to be time-invariant belongs to a ploytope. Based on delay-partitioning approach and parameter-dependent Lyapunov-Krasovskii functional, a sufficient condition for the stability and performance analysis of the filtering error system is proposed. A numerical example is given to illustrate the effectiveness of the filter design method.

15:00-15:20 **SunA11-4**

Finite-Time State Observer for Delayed Reaction-Diffusion Genetic Regulatory Networks

Xiaofei Fan Heilongjiang Univ.
Yu Xue Heilongjiang Univ.
Xian Zhang Heilongjiang Univ.
Fanbiao Li Central South Univ.

This paper focus is concerned with the finite-time state estimation problem for delayed reaction-diffusion genetic regulatory networks (DRDGRNs) under Dirichlet boundary conditions. The aim of this paper is to design a finite-time state observer which is used to estimate the concentrations of mRNAs and proteins via available measurement outputs. By constructing a Lyapunov-Krasovskii functional (LKF) concluding quad-slope integrations, we establish a reaction-diffusion-dependent and delay-dependent finite-time stability criterion for the error system. The derivative of LKF is estimated by employing the Wirtinger-type integral inequality, Gronwall inequality and convex (reciprocally convex) technique. In addition, the expected finite-time state observer gain matrices can be represented by a feasible solution of the set of LMIs. Finally, a numerical example is presented to illustrate the effectiveness of the theoretical results.

15:20-15:40 **SunA11-5**

Robust H_infty Filtering for Nonlinear Discrete Time-Delay Markov Jump Descriptor Systems

Zhumahan Kulan Changji Coll.
Shuping Ma Shandong Univ.
Liping Zhu Changji Coll.

The robust H_infty filtering problem for a class of nonlinear uncertain discrete time-delay Markov jump descriptor systems is investigated, where the nonlinear function satisfes a quadratic constraint. By using the linear matrix inequality (LMI) technique, a sufficient condition is proposed to guarantee the nominal filtering error system is regular, causal, stochastically stable, has a unique solution in a neighborhood of the equilibrium point and satisfies H_infty performance. By applying this condition and a series of matrix inequalities, another LMI sufficient condition is derived to guarantee the nominal Markov jump descriptor filtering error system is regular, causal, stochastically stable, has a unique solution in a neighborhood of the equilibrium point and satisfies H_infty performance. The design method of robust H_infty filter is given, the filter obtained can be full order or reduced order standard Markov jump system. A numerical example demonstrated the advantage and effectiveness of the method proposed in this paper.

15:40-16:00 **SunA11-6**

Time-delay analysis of a magnetorheological elastomer actuator for semi-active control

Junfeng Bai Chongqing Univ.
Jie Fu Chongqing Univ.
Junjie Lai Chongqing Univ.
Guanyao Liao Chongqing Univ.
Miao Yu Chongqing Univ.

Time delay in the semi-active vibration control system will lead to unsatisfied control results. This paper studies the time delay problem of semi-active vibration control system with MRE actuator (isolator). The response time of output force generated by MRE actuator is analyzed in theory, which is consists of time delay produced by the isolator mechanical structure and MRE material, and the response time of the coil in MRE actuator. The response times are obtained by experiment under various step voltage and fixed displacement excitation. Experimental results show that the isolator mechanical structure is main effective factor to system response time, coil structure has a limited influence, and displacements and pulse-width modulated (PWM) voltage values have no influence on response time.

SunA12 **Room12**
Motion control (I) **14:00-16:00**

Chair: Jin Zhao Huazhong Univ. of Science and Tech.
CO-Chair: Tao Wang Shanghai Jiao Tong Univ.

14:00-14:20 **SunA12-1**

Path Following Based on Line-of-Sight with Nonlinear Adaptive Compensation of Side-Slip Angle

Tao Wang Shanghai Jiao Tong Univ.
Chao Wu Shanghai Jiao Tong Univ.
Jianqin Wang Shanghai Jiao Tong Univ.
Tong Ge Shanghai Jiao Tong Univ.

In this paper, a line-of-sight (LOS) guidance law with nonlinear adaptive side-slip angle compensation for 2D path following under external constant disturbance is proposed. When the vehicle follows path on the ocean, the vehicle is exposed to the constant ocean current, and which drags the vehicle away from the desired path. So a nonlinear adaptive compensation line-of-sight guidance law is proposed for the vehicle to follow the desired path of 2D. A side-slip angle should be estimated to compensate the effect of the ocean current. First, the cross-track error is calculated by geography method; Second, the accurate side-slip angle compensation based LOS controller is designed and the global asymptotic stability (GAS) of which is proved; Third, a nonlinear adaptive estimation of the side-slip angle is proposed; and the GAS of the LOS combined with the estmated side-slip angle is proved. Finally, an example is simulated which shows the LOS with nonlinear adaptive compensation can take shorter adjust time than intergral-LOS, and the proposed method guarantees the vehicle to accurately track the desired path.

14:20-14:40 **SunA12-2**

Spinning Missile Attitude Estimation Method Based on the Solar Vector and MEMS

Guangyan Xu Shenyang Aerospace Univ.
Peichong Liao Shenyang Aerospace Univ.
Hongmei Zhang Shenyang Aerospace Univ.
Jinshuang Zhang Shenyang Aerospace Univ.

In this paper, a new method of estimating the attitude to spinning missile was proposed. The author designed the method of using solar vector to correct the gyro bias of MEMS sensor and using the Kalman filter algorithm to estimate the spinning missile attitude. According to the nature of spinning missile, this paper designed a special sun sensor that is used to measure the solar vector replaced the commonly used in MEMS sensor of accelerometer and magnetometer to correct the gyro bias of MEMS sensor. The solar vector measuring device comprises the transparent shell, the photocell array, the real-time clock and the controller. When the sun shines through the transparent shell illuminates the photocell array, the photocell array can convert the solar energy into the electric potential signal. According to the size of the solar energy and the angle of the photocell laying, combining with the accurate time provided by the real time clock, the solar vector of this time is obtained through the main controller processes data. The Kalman filer state equation and observation equation established by the quaternion differential equation is used to estimate the spinning missile attitude. The simulation results show that this method can obtain the higher accuracy attitude angle of spinning missile.

14:40-15:00 **SunA12-3**

Path following control for an under-actuated autonomous airship in constant wind field

Weixiang Zhou Shanghai Jiao Tong Univ.
Chang Xiao Shanghai Jiao Tong Univ.
Pingfang Zhou Shanghai Jiao Tong Univ.
Yueying Wang Shanghai Jiao Tong Univ.
Dengping Duan Shanghai Jiao Tong Univ.

In this paper, a path following control method related to the planar motion for an under-actuated autonomous airship is presented. First, the dynamic and kinematic model of the airship is introduced. Planar path-following error equations are proposed based on the virtual guidance law. Then, a nonlinear disturbance observer (NDO) is designed to estimate the constant wind force. A back-stepping method and an approach angle are introduced to design the path-following controller. The controller designed is simpler compared with the traditional back-stepping method and the approach angle is helpful to adjust the transient maneuver during path approach phase. In addition, it overcomes the singularity problem. The stability of the system is proved. Simulation results illustrate the effectiveness of the proposed controller.

15:00-15:20 **SunA12-4**

Research on the Precise Control for Sensorless Brushless DC Motor

Yong Zhou Northwestern Polytechnical Univ.
Yanzhao Mi Northwestern Polytechnical Univ.
Long Chen Northwestern Polytechnical Univ.
Yanting Han Northwestern Polytechnical Univ.
Chao Zhang Northwestern Polytechnical Univ.

To realize the precise control for the sensorless Brushless DC Motor (BLDCM), the BEMF-crossing-zero detecting is utilized to detect the rotor position. The A/D converter converts the terminal voltage signal of three-phase winding into digital signals, and the relationship between the three-phase winding terminal voltage and the back-EMF (BEMF) of the non-conduction phase is derived. Then, the zero-crossing point of BEMF could be resolved. In addition, a three-stage starting strategy is presented to start the motor in this paper. When the motor is beginning to start, a specified phase is energized to find the initial position of the rotor. Then, the external-synchronous acceleration is switched to the self-synchronous acceleration. At last, a simulation model of sensorless BLDCM is built in LabView. The results of the simulation and experiments verify the effectiveness and reliability of the strategy.

15:20-15:40 **SunA12-5**

Model Predictive Direct Speed Control of Interior Permanent Magnet Synchronous Motor

Xuecong Xu Huazhong Univ. of Science and Tech.
Jiajiang Sun Huazhong Univ. of Science and Tech.
Caizhong Yan Shanghai STEP Electric Corporation
Jin Zhao Huazhong Univ. of Science and Tech.

This paper presents an investigative work about the direct speed control (DSC) of interior permanent magnet synchronous motor (IPMSM) based on finite control set model predictive control (FCS-MPC). A compensation is applied to the speed prediction model because of the unknown load torque and varied rotary inertia. And a multi-constrained cost function with dynamically adjustable weight factors is designed to realize speed tracking and guarantee the currents operating points lay on q-axis in d-q axis frame. The effectiveness of the proposed strategy is evaluated through simulations.

15:40-16:00 **SunA12-6**

Design of Longitudinal Control System for Target Missiles Based on Fuzzy Adaptive PID Control

Zhe Dong Beijing Inst. of Tech.
Jiabin Chen Beijing Inst. of Tech.
Chunlei Song Beijing Inst. of Tech.
Hongye Cao Beijing Inst. of Tech.

To achieve a better robustness and get a static response of a certain target missiles in longitudinal control, a mathematical model of target missiles is established. The uncontrolled trajectory, the predetermined trajectory and the requirements of the predetermined trajectory are analyzed next. Then the trajectory instruction angle is designed to ensure the stable flight of the target missiles system. To solve the problem that the PID controller cannot adjust parameters online and the output is easy to be disturbed by external noise, the fuzzy adaptive PID control is designed. It enhanced the robustness of the target missiles by fuzzy control, and also has a good response by using PID control. The simulation experiments show the fuzzy adaptive control system can track the predetermined trajectory rapidly and smoothly, and the static error and overshoot were significantly reduced. When the system are affected by noise, the fuzzy adaptive PID control can achieve a good robustness than traditional PID controller.

SunA13 Room13
Signal processing (I) 14:00-16:00

Chair: Gang Chen Chongqing Univ.
CO-Chair: Chunling Fan Qingdao Univ. of Science and Tech.

14:00-14:20 **SunA13-1**

Dynamic Feature Extraction for Speech Signal Based on Formant Curve and MUSIC

Zhiyan Han Bohai Univ.
Jian Wang Bohai Univ.

In order to improve the robustness of speech recognition in noise environmental conditions, this paper proposed a new dynamic feature extraction method based on formant curve and Multiple Signal Classification (MUSIC) spectrum. It uses Hilbert-Huang transform to estimate speech signal formant frequency characteristics, and then gets the first formant curve by combining the first formant frequency characteristics of each frame from the first frame to the last frame, and so forth, gets the second formant curve, the third formant curve and the fourth formant curve. And then calculates the MUSIC spectrum and the energy spectrum for each formant curve, takes logarithm transform and discrete cosine transform. Compared with the method of MFCC, the proposed dynamic feature of speech signal has the time correlation, reveals the close correlation between the speech signal frames, improves the performance of speech recognition.

14:20-14:40 **SunA13-2**

A Simple Multiple Cross-correlations Phase Delay Estimator

Ting'ao Shen Logistical Engineering Univ.
Hua'nan Li Logistical Engineering Univ.
Ming Li Logistical Engineering Univ.
Qixin Zhang Logistical Engineering Univ.
Yanlin Shen Logistical Engineering Univ.

A simple multiple cross-correlations phase delay method (MCC) for unbiased estimation of the phase-shift between two real sinusoidal signals in white noise is proposed. The estimator removes the bias of the correlation methods and enhances the signal-to-noise rati (SNR) by utilizing multiple cross-correlations of the real signals. The results obtained by MCC in simulations and on real samples are given. A comparison between the phase delay results estimated by MCC, general cross correlation (GCC) method, quadrature delay estimator (QDE), unbiased QDE (UQDE), Sliding Goertzel algorithm (SGA), and discrete-time Fourier transform (DTFT) algorithm is presented. Computer simulations and field test results validate the effectiveness of the proposed method (MCC).

14:40-15:00 **SunA13-3**

Robust Guaranteed Cost Steady-State Kalman Predictors for Systems with Multiplicative Noises, Colored Measurements Noises and Uncertain Noise Variances

Chunshan Yang Heilongjiang Univ.
Heilongjiang Coll. of Business and Tech.
Zili Deng Heilongjiang Univ.

This paper is concerned with the guaranteed robust prediction problem for discrete-time systems with multiplicative noises, colored measurements noises and uncertain noise variances. By applying the augmented state approach, combining with a fictitious measurement noise technique, the system under considered is converted into a system only with uncertain noise variances. By parameterizing the perturbations of uncertain noise variances, two classes of guaranteed cost robust Kalman predictors are presented based on the minimax robust estimation principle. The proposed guaranteed cost robust predictors can concurrently give the minimal upper bound and maximal lower bound of accuracy deviations. The guaranteed cost robustness is proved by the Lyapunov equation method. A numerical example verifies the robustness of the proposed estimators.

15:00-15:20 **SunA13-4**

A New Infrared Image Enhancement Algorithm

Liming Sun Communication Univ. of China
Jintao Wang Communication Univ. of China
Shanshan Li Communication Univ. of China

In order to solve the problem of fuzzy details, low contrast and poor visual effect of infrared image. A novel scheme for infrared image enhancement is proposed in this paper, which solved drawbacks of the histogram equalization algorithm that loss detail information of image and some areas are bleached, greatly improved the visual effect of the infrared image. Firstly, bilateral filter is performed on the original infrared image, we can obtain a base layer and a detail layer. At base layer, most value normalizing and gray linear mapping is applied to enhance the global contrast. At detail layer, S-curve algorithm is applied to enhance detail information. Finally linear weighted synthesis is used to achieve the integration of base layer and detail layer, to improve the visual effect of the infrared image. This algorithm could also be applied to 14 bit infrared image, compressing 14bit image to 8 bit image and achieving good detail enhancement. Through simulation on MATLAB, the results show that the proposed scheme could noticeably enhance image contrast, and obtain a good enhanced infrared image, at end.

15:20-15:40 **SunA13-5**

Robust Measurement Fusion Kalman Predictors for Systems with Uncertain-Variance Multiplicative and Additive Noises

Zhibo Yang Heilongjiang Univ.
Beihua Univ.
Chenjian Ran Heilongjiang Univ.
Zili Deng Heilongjiang Univ.

In this paper, the robust measurement fusion prediction problem for multi-sensor systems with stochastic parameter uncertainties in state equation and uncertain noise variances are investigated, where the stochastic parameters uncertainties are described by multiplicative noises. Especially, both the multiplicative and the additive noise

variances are uncertain. By introducing the fictitious noise, the original system is converted into that with only uncertain noise variances. By the Lyapunov equation method, the mini-max robust centralized and weighted measurement fusion steady-state Kalman predictors are presented, and the minimal upper bound of the actual fused estimation error variances is given. Their equivalence and robustness are proved. By computation count analysis, the weighted measurement fusion algorithm can significantly reduce the computation burden compared with the centralized fusion algorithm. It's proved that the robust accuracy of the fused predictor is higher than that of each local predictor. A simulation example of AR signal is given to show the effectiveness of the proposed method.

15:40-16:00 **SunA13-6**

Identification and analysis of gas liquid two phase flow pattern

Chunling Fan Qingdao Univ. of Science and Tech.
Jianjun Cui Qingdao Univ. of Science and Tech.
Lichao Fan Qingdao Univ. of Science and Tech.

In this paper, we present a discrete fractional Hilbert transform. This method analyzes the mutation signal in detail according to the order of P. We also can analyze and extract the local information of the signal according to it. We know the difference between the square wave signal and the sine signal by the way of fractional Hilbert transform. And this method is applied to the identification of gas-liquid two-phase flow. We analyze the variation of the marginal spectrum under different orders of the two phase flow signals, and get a better performance of flow pattern recognition.

SunA14 Room14
Data processing (I) 14:00-16:00

Chair: Wenbing Chang Beihang Univ.
CO-Chair: Fusheng Yu Beihang Normal Univ.

14:00-14:20 **SunA14-1**

An Improved Aircraft Hard Landing Prediction Model Based on Panel Data Clustering

Silin Qian Beihang Univ.
Shenghan Zhou Beihang Univ.
Wenbing Chang Beihang Univ.

This paper proposes a hard landing prediction method based on panel data clustering with flight data. The hard landing is a hazard that is critical to flight during the landing phase. It may cause damage to the aircraft structure, resulting in direct or indirect economic losses, damaging to human comfort and other adverse consequences. Firstly, based on the panel data in economics, the flight panel data is established; secondly, extracts the characteristic information of several key flight variables that affect the hard landing in each landing. The feature information includes mean, standard deviation, median, maximum, kurtosis, skewness and trend, and constitutes the eigenvectors describing the landings; then the k-means method is used to cluster the feature information. Finally, the empirical study is carried out on the 22 landing data of fixed wing unmanned aerial vehicles (UAVs). The results show that the clustering of flight panel data can be applied to hard landing prediction, and the prediction effect is obvious.

14:20-14:40 **SunA14-2**

A Fuzzy Clustering based Method for Effect Evaluation of Operational Simulation Training

Peng Wang National Univ. of Defense Tech.
Ge Li National Univ. of Defense Tech.
Zhonghua Yang National Univ. of Defense Tech.
Kedi Huang National Univ. of Defense Tech.

Extracting intuitive and useful information from the high-dimensional, fuzzy and complex operational simulation training data is in urgent need. In this paper, the operational simulation training data refers to the quantitative, numeric data that is usually used as the simulation results. The traditional statistical analysis methods have some limitations in clustering, visualizing and evaluating the operational simulation training data. We propose a new fuzzy clustering based method for evaluating the training effect of operational simulation training. Data clustering is an important technique for statistical data analysis and it enables the identification of a finite set of categories or clusters to describe the high-dimensional operational simulation training data. The classical partitional clustering algorithm, such as fuzzy c-means, is sensitive to the selection of the initial centers and may converge to a local minimum of the criterion function value if the initial centers are not properly chosen. Furthermore, the classical partitional clustering algorithm also has the problem of being unable to identify cluster centers that are uniformly distributed in a manifold. To solve these problems, we propose a geodesic distance and centrality based fuzzy c-Medoid clustering algorithm. Then we propose a fuzzy transitive closure based comparison algorithm to grade the cluster centers to get the qualitative synthetical grades. The method is demonstrated to be effective by an example of a virtual simulation training system of earthquake rescue.

14:40-15:00 **SunA14-3**

Deep Feature of Image Screened by Improved Clustering Algorithm Cascaded with Genetic Algorithm

Liqiang Pei Zhengzhou Univ.
Jinyuan Shen Zhengzhou Univ.
Runjie Liu Zhengzhou Univ.

Feature extracting and screening get more important and necessary because of data analysis will become very slow and difficult with the increasing of data dimension. To reduce the dimension of features, we propose a new way of feature screening in this paper. The improved clustering algorithm is employed to screen the features preliminarily, and then the genetic algorithm synergistically combined with the random forest is cascaded to screen the features deeply. To validate the way feasible, 1588 tobacco leaves belonging to 41 grades are used to be classified in the experiments. The results show that both the recognition rate and the speed can be improved. This demonstrates that the presented cascaded screening approach can raise not only the recognition rate but also the speed because the feature dimension is decreasing effectively.

15:00-15:20 **SunA14-4**

HFSWR Ship Trajectory Tracking and Fusion with AIS Using Kalman Filte

Jiabao Wen Inner Mongolia Univ.
Guochen Yu Inner Mongolia Univ.
Liqing Gao Inner Mongolia Univ.
Yongxin Liu Inner Mongolia Univ.
Xiaomin Nie Inner Mongolia Univ.

Because of the complexity of the marine environment, the High Frequency Surface Wave Radar (HFSWR) in dealing with marine information will be accompanied by a lot of interference and noise. To solve this problem, first of all, we use the logic method to measure the trace information of the radar in order to find out the logical starting track. Secondly, the Kalman filter is used to predict and calculate the trajectory based on the existing starting track. So as to realize the purpose of finding the track in the complex HFSWR track signal. In this paper, the data comes from HFSWR data and Automatic Identification System (AIS) data on China's Bohai Bay. Finally, in order to show the accuracy of the method, the HFSWR track results calculated by the method used in this paper are compared with the track results of AIS.

15:20-15:40 **SunA14-5**

Horizontal Collaborative Fuzzy Clustering Based on Similarity Matrix

Yan Liu Beijing Normal Univ.
Fusheng Yu Beijing Normal Univ.
Jing Xu Beijing Normal Univ.

The collaborative information in horizontal collaborative fuzzy clustering is transmitted by partition matrix, which requires that the dimensions of collaborating partition matrix and collaborated partition matrix must be the same. It requires that the collaborative datasets are clustered into the same number of clusters, but in many cases it is not suitable or difficult to do. In this paper, a new collaborative information transfer mechanism is proposed, which utilizes the similarity matrix to transfer the collaborative information. In this way, when the objective function is designed, the operation of the partition matrix can be transformed into the operation of the similarity matrix, so as to realize the horizontal collaborative fuzzy clustering in the case of different number of clusters. The experimental results show that the proposed algorithm is effective, which extends the application range of horizontal collaborative clustering.

15:40-16:00 **SunA14-6**

Methods of Data Processing and Error Control in UAV Landing Gear Drop Test

Jia Ren Aircraft Strength Research Inst. of China
Jianbo Yang Aircraft Strength Research Inst. of China

The development of UAV promotes the drop tests of UAV landing gear more and more attentions. But gradually increasing UAV landing gear drop tests cause the problems of large errors among theoretical energy, measurement energy and drop energy. In this article, methods of data processing and error control are proposed here at the basis of the reasons of errors are detailed analyzed. At beginning, the main equipment of hardware and software, and some important concepts are given. And at the second, methods of filter, effects of electromagnetic lock demagnetization time delay and the friction force when falling system falling are discussed, the same as the errors from sensors such as time delay of displacement sensor and the influence of vibration to sensors, and the ways to solve the problems are given as following. At last, two kinds of heading speed simulation methods are discussed to explain the importance of heading speed, control methods are also given here. Test results of some aircrafts show that all of above methods of data processing and error control can be used to reduce the error of UAV landing gear drop tests and improve test accuracy.

SunA15 Room15
Intelligent automation (I) 14:00-16:00

Chair: Chunbo Xiu Tianjin Polytechnic Univ.
CO-Chair: Xianbo Xiang Huazhong Univ. of Science and Tech.

14:00-14:20 **SunA15-1**

Forming Defects Prediction for Sheet Metal Forming Using Gaussian Process Regression

Jingdong Lin Chongqing Univ.
Li Huang Chongqing Univ.
Hongbo Zhou Chongqing Univ.

Forming defects like fracture and wrinkle are key factors to influence the forming quality of sheet metal. Accurate prediction of forming defects is

essential for the sheet metal forming process. In this paper, an approximation model technique based on Gaussian process regression (GPR) is proposed to predict the forming defects in sheet metal forming process. Finite element analysis is applied to simulate the drawing process. Design variables include drawbead resistance coefficient and blank-holding force. Forming limit diagram is used to calculate the values of defects. A dash board drawing case demonstrates that the proposed approach is more accurate and effective than support vector machines method and conventional response surface method.

14:20-14:40 **SunA15-2**

A Knowledge Based Intelligent Control Method for Dehydration and Mixing Process

Kang Li Northeastern Univ.
Fuli Wang Northeastern Univ.
Dakuo He Northeastern Univ.
Shuning Zhang Ludong Univ.

In the production process of hydrometallurgy, the concentration and flow rate of the slurry in the dehydration and mixing process have an important influence on the leaching process. However, due to the lack of online hardware analyzers in the dehydration and mixing process, it is difficult to realize the automatic control of the concentration and flow rate of the slurry and the artificial control method still widely used. Thus, it has become the bottleneck of the whole production process of hydrometallurgy. Therefore, an intelligent control method based on the knowledge was proposed to control the concentration and flow rate of the slurry in the dehydration and mixing process. The knowledge was extracted from the industrial data, process mechanism and expert experience. In addition, this method is successfully applied to a certain dehydration and mixing process in a hydrometallurgical plant, and achieved a satisfactory control effect.

14:40-15:00 **SunA15-3**

Tracking Algorithm Based on the Improved Template Matching

Chunbo Xiu Tianjin Polytechnic Univ.
Xiaonan Pan Tianjin Polytechnic Univ.

It is a basic element to judge the value of a video tracking system whether it can achieve the real-time and accurate identification of moving objects and the tracking of the system. For the defect of traditional template matching algorithm which is low efficiency and slow calculation speed, after analyzing the disadvantages of the existing target recognition algorithm, proposing a new template matching algorithm based on extracting differential information of images in this paper. Firstly, the rough matching is performed to determine the initial region of the target, then enlarge the search region and the differential information of images are set up. The results of experiment showed that compared with the traditional template matching algorithm, the algorithm proposed in this paper greatly reduces the interference of complex backgrounds to tracking targets, and it is a kind of target tracking algorithm with low false recognition rate and high robustness.

15:00-15:20 **SunA15-4**

Visual Tracking Algorithm by Harmony Search and Co-training Learning Based on Multi-cues

Qiao Sun Xian Research Inst. of Hi-Tech
Shengxiu Zhang Xian Research Inst. of Hi-Tech
Lijia Cao Sichuan Univ. of Science & Engineering
Artificial Intelligence Key Laboratory of Sichuan Province
Xiaofeng Li Xian Research Inst. of Hi-Tech
Naixin Qi Xian Research Inst. of Hi-Tech

To Improve the robust performance of visual tracking in various kind of scene, a novel method by harmony search and co-inference learning based on multi-cues was proposed. The candidate state was achieved by the harmony search and co-inference learning .Then the harmony memory vector corresponded the biggest fitness function was chosen as the state vector. Compared with the harmony search visual tracking with the color cue and the multi-cue integrating with multiply fusion strategy, our algorithm has a better robustness in complex environments such illumination change seriously and motion blur.

15:20-15:40 **SunA15-5**

Action Characteristic Monitoring System for Permanent Magnet Vacuum Circuit Breaker Based on CAN Communication Technology

Fucheng Lang Electric Power Research Inst. of State Grid Liaoning Electric Power Co. Ltd.
High Voltage and Large Current Laboratory of State Grid Corporation
Xiaoxue Tai Electric Power Research Inst. of State Grid Liaoning Electric Power Co. Ltd.
High Voltage and Large Current Laboratory of State Grid Corporation
Haorong Zhao Guilin Electrical Equipment Scientific Research Inst. Co.

In order to assure the stability of power system and meet the development requirements of electrical equipment technology, a set of action characteristic monitoring system for permanent magnetic vacuum circuit breaker based on CAN communication technology is developed. The system contains three parts: high-precision sensor group, DSP monitoring subsystem and signal isolation conversion unit. The core of the system is DSP monitoring subsystem, which collecting the curves of contact travel and time of the high precision sensor group, and feedback to the monitoring host through the CAN communication interface. The monitoring system not only realizes centralized management of multiple distributed permanent magnet vacuum circuit breakers, but also provides a large number of dynamic information for state assessment and fault diagnosis of vacuum circuit breakers.

15:40-16:00 **SunA15-6**

Control System Design of an Autonomous Surface Vehicle

Shuaiqi Gan Huazhong Univ. of Science and Tech.
Xianbo Xiang Huazhong Univ. of Science and Tech.

This paper introduces an autonomous surface vehicle (ASV) named HUST-1 prototype, which can provide remote control, autonomous pilot, senor data acquisition and processing. First, the overall system structure and perfor- mance of the HUST-1 are presented. Second, it is introduced in details that the composition of the vehicle's hardware system and the design of software system. The hardware system consists of microcontroller, motor driving system, GPS, INS, wireless data transceiver, etc. The software system includes the onboard control system and the remote monitoring station. The remote monitoring station communicates with the onboard control system by radio channel and achieves such functions as real-time navigation status display, control parameter adjustment and path planning. Finally, the results of field experiments are provided to validate the effectiveness of the HUST-1 vehicle's control system.

SunA16 **Room16**
Space and underwater robots (I) **14:00-16:00**

Chair: Daqi Zhu Shanghai Maritime Univ.
CO-Chair: Xiaowei Fu Northwestern Polytechnical Univ.

14:00-14:20 **SunA16-1**

Formation Tracking and Transformation Control of Nonholonomic AUVs Based on Improved SOM Method

Xin Li Shanghai Maritime Univ.
Daqi Zhu Shanghai Maritime Univ.
Yangyang Chen Shanghai Maritime Univ.
Qingqin Liu Shanghai Maritime Univ.

Formation tracking and transformation are the key problems in formation control of multi-AUV (autonomous underwater vehicle) system. In this paper, an improved self-organizing map (SOM) neural network method is proposed for solving the formation issues of a group of autonomous underwater vehicles (AUVs). All the AUVs in the formation are treated equal to be the leaders or the followers. The desired locations are set as input vectors of SOM network. Self-organizing competitive calculations are carried out with workload balance taken into account. Output vectors of the SOM network are the corresponding AUVs coordinates, so that a group of AUVs are controlled to reach the designated locations. This method hold the followers' positions in the formation when the formation moves as a whole along pre-planned trajectories. Moreover, the formation could changes its shape as needed in the procedure. Formation transformations are efficient and reasonable using this stragegy. Finally, due to the characteristics of SOM neural network, adaption and fault tolerance can be achieved. Simulation results demonstrate the effectiveness of the proposed approach.

14:20-14:40 **SunA16-2**

Safely Flying Strategy of Space Robot for Approaching a Tumbling Satellite

Xinglong Wang China Academy of Space Tech.
Zhicheng Zhou China Academy of Space Tech.
Guangji Qu China Academy of Space Tech.

In order to capture and rescue a tumbling satellite, a space robot is required to plan an appropriate path to approach the target satellite in limited time and avoid collisions in the approaching path. This paper focuses on the safely flying strategy for space robot approaching a tumbling target satellite. First, kinematic models of space robot and target satellite are built to parameterize their geometric envelopes and obtain the relative motion equations between them. Then, two safely flying strategies are developed, including the definitions of safely capturing corridors, the selections of straight paths as well as the orbit and attitude control strategies of space robot in different approaching phases. Furthermore, the capabilities of the two strategies are analyzed through a numerical simulation. The results illustrate that both the two strategies are effective for the mission of approaching a tumbling satellite. Finally, the comparison between the two strategies is made and the strategy selection criterion is summarized as conclusions.

14:40-15:00 **SunA16-3**

Modeling and Control of a Two-link Flexible Space Manipulator Using the Wave-based Method

Yanyan Li Tsinghua Univ.
Deshan Meng Tsinghua Univ.
Harbin Inst. of Tech.
Houde Liu Tsinghua Univ.
Xueqian Wang Shenzhen Key Lab of Space Robotic Tech. and Telescience
Bin Liang Tsinghua Univ.

The vibration control of flexible space manipulator is challengeable due to

the complex dynamics model and uncertain parameters. Thus, the non-model-based control method is one of the important research directions of the vibration suppression of the flexible system. The wave-based method proposed by O'Connor can well eliminate residual vibration for single-input flexible system. However, there are very few studies on multi-input multi-output flexible system using wave-based method. In this paper, we research vibration control of a two-link flexible space manipulator based on the principle of waves. Firstly, based on the pseudo-rigid body method, the dynamics model ofa two-link planar space manipulator with joint and link flexibility is established. Then, the basic principle of wave-based control method is briefly introduced. The wave transfer function and the wave propagation in the flexible body are discussed. Moreover, the steady-state error of the two-link control system is studied and we proposed an elimination method of the steady-state error of the manipulator joint. Finally, the simulations of a single-link and a two-link flexible space manipulator are conducted to verify the effectiveness of the presented approach. The simulation results verify the validity of the proposed method.

15:00-15:20 **SunA16-4**

Path Following Controller Using light of sight method and Angular Loop Dynamic Inversion Control Approach

Shuo Wang China Aeronautical Radio Electronics Research Inst.
Zhong Liu Northwestern Polytechnical Univ.
Xiaowei Fu Northwestern Polytechnical Univ.

A kind of path following controller using the angular loop dynamic inversion control approach is presented. In light of the waypoint data and the demand of guidance law, it provides the on-line path planning algorithm to compute the anticipating path. The lateral acceleration formed by nonlinear guidance law drives the UAV to the anticipating path, and the stability of guidance law is proved. The tangential acceleration is deduced by introducing the feedback of velocity for the demand of controlling velocity. Combined with the nonlinear dynamic inversion theory and the variable measured by the actual sensor, the maneuver command generator and single-loop angular velocity controller are designed. The validity of the proposed approach is demonstrated by six-degree-of-freedom simulation.

15:20-15:40 **SunA16-5**

Three-dimensional Trajectory Tracking Control of an Underactuated AUV

Zhao Wang China Univ. of Petroleum
Yuan Wang China Univ. of Petroleum
Shenghui Jiang China Univ. of Petroleum
Shurong Li China Univ. of Petroleum

To deal with the three-dimensional trajectory tracking control problem for an underactuated AUV, a non-smooth controller based on adding a power integrator approach is designed in this paper. Firstly, the trajectory tracking error system is established based on the kinematic equation and dynamic equation of underactuated AUV. And the trajectory tracking error system is represented as a cascade system of position errors and velocity errors by designing desired velocities. Then, the controller is designed by using adding a power integrator approach for the trajectory tracking error system. Finally, it is proved that the underactuated AUV can track the desired trajectory in finite time by constructing suitable Lyapunov functions. Simulation results demonstrate the effectiveness of the proposed control method.

15:40-16:00 **SunA16-6**

Adaptive Reaction Null-space Control of Dual-arm Space Robot for Post-capture of Non-cooperative Target

Chunting Jiao Tsinghua Univ.
Bin Liang Tsinghua Univ.
Xueqian Wang Tsinghua Univ.

In this paper, a dual-arm space robot model is derived and an Adaptive Reaction Null Space (ARNS) motion control approach is proposed to satisfy the principal objective of maintaining a minimum disturbance to the base in the post-capture of a non-cooperative target. Since the target becomes an integral part of the manipulator after capture, the position and orientation of space base will be affected in an unknown way because of the dynamics coupling between the manipulator and space base. In addition, the amount of unknown angular momentum of a spinning target transferred to the space manipulator can lead the reaction wheels to their saturation state due to limitations on the available output torque. In order to overcome this problem, we develop a new concept, adaptive reaction null space control for a dual-arm space robot system, with one arm (mission arm) for accomplishing the capture mission and the other (balance arm) for compensating for the disturbance of the base. The mission arm can motion along with the trajectory of the target without consideration of the disturbance to space base. This algorithm is applied from the post-capture stage till the unknown parameters are identified. The adaptive algorithm is developed based on the momentum conservation of the system and the recursive least squares algorithm is employed for parameter adaption. The simulation results are presented to demonstrate the effectiveness of the proposed approach.

SunA17 **Room17**
Renewable energies (I) **14:00-16:00**
Chair: Zhi Zhang Dong Guan Univ. of Tech.
CO-Chair: Zengrui Yang Chongqing Univ.

14:00-14:20 **SunA17-1**

Dual-Input DC/DC Converter for Photovoltaic System with Reverse Charging

Gang Li Key Laboratory of Geophysical Exploration Equipment Jilin Univ.
Jing Shi Jilin Univ.
Shengbao Yu Key Laboratory of Geophysical Exploration Equipment Jilin Univ.

With the development of renewable resource, the power generated by several renewable resources need to supply the load Simultaneously. Multi-input DC/DC converter is proposed for this application. In order to stabilize the power generation of renewable energy, energy storage system is widely used. Generally, the storage system is the intermediate links, which supply the power to load under the condition of low input voltage. A novel dual-input DC/DC converter is proposed in this paper. The power generation of renewable energy and battery can deliver the energy to load simultaneously or separately. The utilization efficiency of the system is improved. On the condition of no load, power generation of renewable energy can charge the battery. The proposed converter expands the applications of the dual-input buck converter. The battery can be used as an independent power source to improve the output voltage of the converter. And the PV source can charge the battery when the converter has light or no load. The operation principle of the proposed converter is analyzed in detail. The analysis of inductor current in different stages is given. The simulation results verify the feasibility of converter.

14:20-14:40 **SunA17-2**

A New Maximum Power Point Tracking Method for PV System

Zhiqiang Gao Tianjin Univ. of Tech.
Song Li Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Youjie Ma Tianjin Univ. of Tech.
Jian Zhao Tianjin Univ. of Tech.

Maximum power point tracking (MPPT) technique is used in photovoltaic (PV) power generation system to assume the maximum power point (MPP) no matter how the PV panel temperature and irradiation conditions change. It plays a decisive role in PV power generation system. Therefore, this paper introduces a modified optimal voltage control (OVC) method coupled with active disturbance rejection control (ADRC) algorithm. The proposed method focuses on parameter optimization corresponding to variable panel temperature and irradiation conditions. The results, comparing with OVC method, show that the proposed method improves power tracking speed and efficiency of energy conversion simultaneously. Finally, through the simulation by MATLAB/SIMULINK platform, we verify the feasibility and effectiveness of the proposed method.

14:40-15:00 **SunA17-3**

Analysis of Improved PSO and Perturb & Observe Global MPPT Algorithm for PV Array under Partial Shading Condition

Zengrui Yang Chongqing Univ.
Qichang Duan Chongqing Univ.
Jiamiao Zhong Chongqing Univ.
Mingxuan Mao Chongqing Univ.
Zhili Xun CRRC Yongji Electric Co., Ltd,

The power-voltage (P-V) characteristic curve of photovoltaic (PV) system have nonlinear and multiple peaks characteristics under partial shading condition. This paper proposes a novel maximum power point tracking (MPPT) control method for PV system based on an improved particle swarm optimization (PSO) algorithm and variable step perturb and observe (P&O) method. Firstly, the grouping idea of shuffled frog leaping algorithm (SFLA) is introduced into the basic PSO algorithm, ensuring the differences among particles and the searching of global extremum. And then, the variable step P&O method is used to track the global maximum power point (GMPP) accurately with the change of environment. Finally, the superiority of the proposed method over the traditional PSO algorithm in terms of tracking speed and steady-state oscillations is highlighted by simulation and experimental results under partial shading condition.

15:00-15:20 **SunA17-4**

An Overview about VSCF and LVRT in Wind Power Generation

Zhiqiang Gao Tianjin Univ. of Tech.
Chen Tang Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Youjie Ma Tianjin Univ. of Tech.

In recent years, wind power has been developing rapidly. As the wind power penetration from large scale wind turbines has been increasing rapidly in the transmission system, there is a higher requirement for the frequency stability and power generation efficiency of the wind power generation system, and the power grid puts forward higher continuous operation requirements for the grid connected wind turbine in the power grid fault and demand that the wind power generator has to ride through the grid faults,especially the grid voltage dips. This overview mainly introduces the variable speed constant frequency and low voltage ride through technology in the wind power generation system. This paper introduces respectively their development, technical problems and future trend. Wherein three main programs of VSCF wind power generator system are presented: DFIG, BDFG and PMSG, two types of LVRT technology are summarized: DFIG and PMSG.

15:20-15:40 **SunA17-5**

Active Disturbance Rejection Power Control for a Floating Wind Turbine

Lei Wang Chongqing Univ.
Hu Zhang Chongqing Univ.
Ming Cai Chongqing Univ.
Zhiwei Luo Chongqing Univ.

In recent years, a feasible scheme has been provided by the floating wind turbine for wind power generation changing from the coastal sea to the deep sea. However, the stability of the floating wind turbine power output is seriously influenced by the uncertainty of the model and the external disturbances like wind and wave. Therefore, a power control method for floating wind turbine based on active disturbance rejection (ADR) is proposed in this paper.The purpose of the controller is to avoid increasing the platform load caused by the power regulation on the premise of guaranteeing the stability of power output. Firstly, in order to avoid the large overshoot of the system, the step input signal is transformed into a continuous and smooth signal by designing the tracking differentiator. Secondly, a nonlinear observer is designed to estimate and compensate the unknown time varying nonlinear and disturbances in the system online. Finally, the pitch control is realized by the conventional PD controller. The proposed control approach is tested and compared with NREL baseline controller using the NREL offshore 5MW wind turbine model mounted on a Barge floating platform run on FAST and Matlab/Simulink, operating in the above-rated wind speed condition. The simulation results show that the proposed control strategy has a better performance on floating wind turbine power control.

15:40-16:00 **SunA17-6**

A New PWM Method for Cascade H-Bridge Three-level Rectifier

Zhi Zhang Dong Guan Univ. of Tech.
Xueliang Liu Dong Guan Univ. of Tech.
Hao Zhou Dong Guan Univ. of Tech.
Xiao Tang Dong Guan Univ. of Tech.
Chang Liu Dong Guan Univ. of Tech.
Longyun Kang Souch Chian Univ. of Tech.

Taking two power cells cascaded as an example, a PWM algorithm is proposed for single-phase cascaded H-bridge three-level converter. Rectification operating mode of the three-level converter is described in detail in this paper. In order to lower the switching frequency and balance the capacitor voltage, the output voltage vectors are optimal selected for the rectification operating modes, and the proposed PWM is verified by simulation and experiment, the algorithm is general, simple and easy to digital realization. The simulation and experimental results prove its validity and feasibility.

SunAIS **Room18**
Interactive Session **14:00-16:00**

SunAIS-01

An adaptive algorithm using FIR filter for speech enhancement systems

Caiyan Wu Shenyang Ligong University
Xiaoying Wang Tianjin Railway Technical and Vacational Coll.
Hong Zhao Shenyang Ligong University

An adaptive algorithm for speech enhancement is studied in this paper. We propose the adaptive Lyapunov speech enhancement algorithm for nonlinear speech enhancement system using FIR filter. By using the Lyapunov stability theory, the filter coefficients can adaptively adjust so that the error converges to zero asymptotically. The adaptive algorithm ensures the speech enhancement system has a better performance than the traditional least mean square algorithm. For the case that the size, weight and power consumption, the design of a microphone array for hearing aids are serious hard to establish, the algorithm still work. At last, an example of speech enhancement system result demonstrated the feasibility and effectiveness of the proposed adaptive algorithm.

SunAIS-02

Research on Manipulator trajectory tracking with model approximation RBF neural network adaptive control

Jing Jiang Shenyang Ligong Univ.
Linlin Pan Shenyang Ligong Univ.
Ying Dai Shenyang Ligong Univ.
Long Che Shenyang Ligong Univ.

According to the problem of manipulator trajectory tracking accuracy, model approximation RBF neural network adaptive control is applied in the manipulator trajectory tracking. In this paper, integral approximation method and model block approach method are used. The control law is designed. Finally, the computer simulation results show the different adaptive abilities and tracking performances. Mode block approximation method can get the short transiton time. The overshoot of integral approximation method is very small.

SunAIS-03

Stability Analysis for a class of Systems with Time-varying Delay

Zixiang Guo Hangzhou Dianzi Univ.

In this paper, the problem of stability for linear systems with time-varying delays is investigated. By constructing a suitable augmented Lyapunov-Krasovskii functional and its derivativeis estimated by using Jensen integral inequality. Then we obtain a less conservativstability criteria.Finally,The superiority and validity of the proposed criteria are verified by comparing maximum delay bounds under various conditions via a numerical example.

SunAIS-04

Adaptive fuzzy Back-stepping Control System of Permanent Magnet Synchronous Motor

Long Li Guidaojiaotong Polytechnic Inst.

With the rapid development of control theory and popularity of permanent magnet synchronous motor (PMSM), Permanent magnet synchronous motors are widely applied to the AC drive system. Control of Permanent Magnet Synchronous Motor became more difficult in the case of parameter perturbations and load disturbance. Traditional PID controller has been unable to adapt to high-precision and highly flexible processing requirements of modern industrial control systems. In this paper, an adaptive algorithm is adopted to estimate the load disturbance, the friction coefficient of viscosity and inertia load. Disturbances caused by parameter perturbations such as armature inductance and stator resistance changing are approximated of adaptive fuzzy system. An adaptive fuzzy controller based on Back-stepping is designed in this paper. Through the simulation of speed controller of PMSM, The results showed that, compared with the conventional PI control, the control method has better speed reference tracking performance under parameter perturbations and load disturbance, the system has good dynamic and static performance and satisfying robustness.

SunAIS-05

Adaptive strategy for the automatic transmission shifting improvement

Zhenkun Dai Shengrui Transmission Corporation Limited
Peng Dong Beihang Univ.
Wei Guo Shengrui Transmission Corporation Limited

Shift quality and shift time of the automatic transmission is required to be consistent in mass production and with mileage accumulation. In order to compensate for the influence of build-to-build variations and life-cycle variations on shifting process, there should be an adaptive control in the software in addition to the base control of the shifting process. The adaptive control can adjust control parameters to compensate for the variations of physical characteristics. Thus shift quality will be improved step by step through the learning process. Some adaptive control methods are proposed in this paper. In torque phase, the adaptive strategy tries to keep the clutch slip in a small range to avoid clutch tie-up and engine flare. In inertia phase, the adaptive strategy tries to keep the time of the speed synchronization process in a proper range to avoid a long shifting time or a shifting impact. Vehicle tests verified that this adaptive control strategy can effectively eliminate the engine flare, and the clutch tie-up in power on up shift and to get a better shift quality and proper shift time.

SunAIS-06

Adaptive fault-tolerant control of MIMO nonlinear systems

Lu Zhang Beijing Jiaotong Univ.
Yongduan Song Beijing Jiaotong Univ.
Liu He Beijing Jiaotong Univ.

This paper presents a low-cost control for a class of high-order nonlinear multi-input multi-output (MIMO) systems in the presence of actuation faults. The proposed control bears the PI form with analytical algorithms for PI gains auto-tuning. The resultant control action is continuous and is able to ensure uniformly ultimately boundedness of all the signals of the closed- loop system. The salient feature also lies in its low complexity in computation and effectiveness in dealing with modeling uncertainties and nonlinearities as well as actuation faults.

SunAIS-07

Attitude Control for Flexible Spacecraft with Swinging Components

Xiwang Xia Shanghai Engineering Center for Microsatellites
Key Lab of Microsatellites, Chinese Academy of Sciences
Keke Zhang Shanghai Engineering Center for Microsatellites
Key Lab of Microsatellites, Chinese Academy of Sciences
University of Chinese Academy of Sciences
Shanghai Institute of Microsystem and Information Tech.
Han Du Shanghai Engineering Center for Microsatellites
Key Lab of Microsatellites, Chinese Academy of Sciences
Chaoyong Li Zhejiang Univ.
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Xuecong Zhao Shanghai Engineering Center for Microsatellites
Key Lab of Microsatellites, Chinese Academy of Sciences
Lei Xia Shanghai Engineering Center for Microsatellites
Key Lab of Microsatellites, Chinese Academy of Sciences
Shanwu Liu Shanghai Engineering Center for Microsatellites
Key Lab of Microsatellites, Chinese Academy of Sciences

Large spacecrafts, such as Astronomy Observation Satellite or International Space Station docked with manned or cargo spaceship, are

complex ones composed with multiple rigid and multiple flexible bodies. The rotation of the onboard expanded limbs, manipulators or solar panels with respect to the spacecraft platform would change the composite spacecraft's attitude, centroidal coordinate and moment of inertia, and would induce disturbance to the attitude control system of the spacecraft as well. To guarantee the pointing accuracy, the precise inertial parameters should be determined and perfect attitude control algorithm should be designed. In this paper, According to Moment of Momentum Theorem, a double rigid-body dynamic model was formulated, which could be used to determine the inertial tensor of the complex spacecraft system. Quasi Euler Angles are introduced to describe the attitude of the spacecraft. Considering the flexibility of the flexible parts, a trap filter is employed to depress the noises that have an approximate frequency with the fundamental frequency of the flexible parts of the spacecraft. The output of 3-D modeling software indicated that the double rigid-body dynamic model is perfect and Simulation results indicate that the attitude control scheme is effective.

SunAIS-08

A Nonlinear Attitude Control of Tiltrotor Aircraft Based on Dynamic Surface Adaptive Backstepping

Tingting Liang Beihang Univ.
Weihong Wang Beihang Univ.
Ningning Wang Beihang Univ.
Sentang Wu Beihang Univ.
Ke Lu Science and Technology on Rotorcraft Aeromechanics Laboratory

In this paper, the tiltrotor aircraft model is established based on the multi-body dynamics method, in order to further improve the modeling accuracy, an augmented Pitt-Peters dynamic inflow model was used to establish the induced velocity model of the rotor. Based on the presented model, aiming at the uncertainties of the nonlinear dynamics of aircraft, the dynamic surface adaptive backstepping control strategy is used to make the flight control system more adaptive and robust to the nonlinear, uncertain and unmodeled controlled objects with dynamic characteristics. The adaptive adjustment function is used to compensate the influence of system uncertainty, a robust term function is designed to solve the problem of approximation error, and the possible problem of controller singularity can be avoided by introducing projection operator. In the design of adaptive backstepping, the first-order filter is introduced to obtain the differentiation of the virtual control input by using the dynamic surface design method which eliminates the problem of differential explosion" in the traditional backstepping design. The Lyapunov stability theorem guarantees the error uniformly bound. Simulation verification shows effectiveness of the design of attitude control.

SunAIS-09

Influence of Damping Factor on Ship PID Course Control Performance

Mukun Zheng Navigation college,Jimei Univ.
Lina Li Navigation college,Jimei Univ.
Zhihui Hu Navigation college,Jimei Univ.
Tianrui Zhou Navigation college,Jimei Univ.
Zhiming Zhang Computer Engineering College,Jimei Univ.

For the adaptive problems of ship type in the fuzzy self-tuning PID course control algorithm.According to the ideal range of damping factor in the second-order system’s step function response.Adopt weighted comprehensive evaluation method of course control performance.The appropriate damping factor is used to optimization course control by MATLAB simulation experiment method.The optimal PID initial value is obtained by determined weighting coefficient of quadratic object function. The fuzzy self-tuning PID course control algorithm optimization is achieved by this program.The results showed that the reasonability of the system damping factor has a great influence on the PID course control performance.It was improved the adaptability of fuzzy self-tuning PID course control algorithm by reasonable selection of damping factor for different ship types.

SunAIS-10

Clustering Analysis based on Chaos Micro Variation Adaptive Genetic Algorithm for Radio Fuze Jamming

Guoxin Xu Shenyang Artillery Academy
Xin Tong Institute of Scientific & Technical Information of Liaoning Province
Wei Pan Shenyang Artillery Academy
Tao Ren Northeastern Univ.

To improve the accuracy of clustering classification the Adaptive Genetic Algorithm was proposed. The code is float, the selection operator is rank-based fitness assignment and elitist model, the crossover operator is real valued recombination, the mutation operator is real mutation. The adaptive crossover probability and adaptive mutation probability are proposed, which consider the influence of every generation to algorithm and the effect of different individual fitness in every generation. Theory and experiment shows that the algorithm can get global optimum clustering center, and greatly improve the amplitude of operation.

SunAIS-11

Robust Predictive Control of Networked Uncertain Systems with Control Input Quantization

Yang Ou Qingdao Univ.
Binqiang Xue Qingdao Univ.
Zhen Gao Qingdao Univ.

In this paper, we mainly study the stability analysis and robust predictive controller design of networked uncertain systems with control input quantization. Firstly, a logarithmic quantizer and sector-bounded method are adopted. The system is modeled as a linear uncertain system model with sector-bounded uncertainties. Then, the quantization control problem is transformed into a solution of a sector-bound bounded uncertainty Robust Control problem. Secondly, based on the model and the robust stability analysis, a robust predictive controller design method is proposed to guarantee the asymptotic stability of the closed-loop system with certain control performance in the form of linear matrix inequality. Finally, the theoretical results of this paper are verified by simulation. The simulation results show that the proposed controller can guarantee the stability of the closed-loop system and achieve a certain control performance, and the robust predictive controller is effective and feasible.

SunAIS-12

New Results on Delay-Dependent Stability Criterion for Discrete-Time Systems

Xiaolei Liu Yangzhou Univ.
Ying Zhang Yangzhou Univ.
Rui Zhang Yangzhou Univ.

This paper considers the linear discrete-time systems with time-varying delays. Based on a novel summation inequality and the Jensen’s inequality, a new delay-dependent stability criterion is derived. Combined two inequalities with a new technique to deal with the variable dk, a less conservative result is gained. Two classical numerical examples are given to demonstrate the advantages of the proposed method.

SunAIS-13

Nonlinear Robust Control Design for Static Synchronous Compensator

Xingyu Lv Office of Educational Administration, Guizhou Institute of Tech.
Bangjun Lei School of Electrical and Information Engineering, Yunnan Normal Univ.
Shumin Fei Southeast Univ.

This article proposes a nonlinear robust control design for Static Synchronous Compensator (STATCOM) to improve stability and oscillation damping of power system. Considering the parameter deviations, external disturbances and unmodeled dynamics, the nonlinear dynamic model of STATCOM can be translated into a Hamiltonian structure by means of coordinate transformation. Based on the Hamiltonian structure of STATCOM, a nonlinear robust (NR) control is designed for STATCOM. Numerical simulation results on the two-area four-machine power system demonstrate the robustness and effectiveness of the proposed NR control in comparison with the feedback linearization (FL) control. The comparative study results indicate that the NR control has better performance than the FL control.

SunAIS-14

Design of State Feedback H∞ Controller for Multivariable Rolling Process Based on State Space Model

Mingchun Li Northeastern Univ.
Shubin Tan Northeastern Univ.

For the rolling system, it should be a multi-variable, strong disturbance and coupled nonlinear system. As the precondition of ensuring the precision of strip thickness, it is necessary to ensure that the system is robust. The controller should be able to suppress the disturbance of the system and remain the system stable under the uncertain parameters. Taking into account the complexity of the system, this paper established a linear state space model of the hydraulic roller system, main drive system and rolling process system for the deeper study on the relationship between the variables in the rolling process. Considering the complexity of the external disturbance, this paper choose the H∞ control strategy. MATLAB is used to solve the linear matrix inequalities. By selecting the appropriate performance index, the state feedback controller could be found. The simulation result shows that the H∞ state feedback control system has the better robustness and performance index.

SunAIS-15

Backstepping Adaptive Fuzzy Control for a Class of Nonlinear Systems

Chunhui Liang Changchun Institute of Tech.
Lei Wang JIlin Profit Science and Technology Ltd.

In this paper, we propose a modified backstepping adaptive fuzzy control method in view of the nonlinear dynamic model of spacecrafts landing on irregular asteroids. Fuzzy logic systems are used to approximate complex nonlinear functions and the modified adaptive backstepping method is applied to constructing the controller. The proposed controller can realize the quick tracking of the reference signal when system parameters are uncertain with external disturbances. System stability and convergence is demonstrated by Lyapunov method. The efficiency and robustness of this control method is demonstrated by the numerical simulation.

SunAIS-16

Robust filter design for discrete-time switched fuzzy systems with mode-dependent average dwell-time

Jian Li Yangzhou Univ.
Qiang Li Yangzhou Univ.

This paper is concerned with robust filtering problem for discrete-time switched systems in which each subsystem is described by T-S fuzzy models. The switching law is mode-dependent and each subsystem has its own average dwell-time. The premise variables choose the system output. The robust filters are designed such that the augmented system is asymptotically stable, and also guarantee weighted L2 performance. Moreover, the gains of filters are obtained by solving conditions formulated by linear matrix inequalities. Finally, an example is given to illustrate the effectiveness of the proposed method.

SunAIS-17

Non-fragile Control for the Welding Process Systems by Pole Constraints

Shigang Wang Heilongjiang Univ.
Yongli Bi Heilongjiang Univ.

The welding process is one of the most important application in uncertain sampled-data system. In this paper, the study deals with a fundamental issue of non-fragile control for a class of uncertain sampled-data system. The focus is to design non-fragile controller against possible perturbation by combining pole contraints theory and the linear matrix inequality approach which results in sampled-data system is D-stable, moreover, the existence condition and the design approach of non-fragile controller are derived. Finally, simulation examples are proposed to demonstrate the effectiveness of the attained algorithm.

SunAIS-18

Robust H∞ Control of Generalized Delta Operator System

Zhen Gao Qingdao Univ.
Xinzhuang Dong Qingdao Univ.
Jianglong Yu Qingdao Univ.

We study about robust H∞ control problem of generalized delta operator system which have uncertainty of derivative. However, to study the robust H∞ control problem, we first give about sufficient and necessary conditions for the admissibility of generalized delta operator system which has uncertainty of derivative. The sufficient and necessary conditions for the robust H∞ control problem of linear generalized delta operator system is proposed under the condition that the delta operator system is admissible, based on these two conclusions, we design a state feedback controller to achieve the purpose of control. In this paper, some examples are given to prove the validity and feasibility of the theoretical results.

SunAIS-19

On a New Coupling-Based Robust Control for Generic Reentry Vehicles

Zongyi Guo Northwestern Polytechnical Univ.
Jun Zhou Northwestern Polytechnical Univ.
Jianguo Guo Northwestern Polytechnical Univ.

This paper presents a new coupling-based robust control for generic reentry vehicles. First of all, the error dynamics of generic reentry vehicles is obtained based on backstepping technique. Then, a disturbance observer is proposed to estimate and compensate the lump disturbances. Finally, a robust coupling-based control scheme is proposed combining with disturbance observer, and the closed-loop stability is guaranteed through the Lyapunov theory. The aerodynamic parameters perturbation and actual actuator constraints are considered in numerical simulations, and the results demonstrate the validity of the control method in this paper.

SunAIS-20

Attitude μ-Control with Initiative Morphing Strategy for A Gull-wing

Tianhao Guo National University of Defense Tech.
Zhongxi Hou National University of Defense Tech.
Shangqiu Shan National University of Defense Tech.
Wenkai Wang National University of Defense Tech.

Instead of regarding morphing of aircrafts as a way to adapt the environment, this paper is focused on using morphing as a mean of flight control. With morphing aircrafts taken as bodies with variable center of mass and inertia tensor, the centroid dynamic equations are analyzed, which are then simplified for gull-wings with folding angles as the morphing parameters, and linearized and decoupled to meet the controller design requirements. The μ−synthesis is introduced and the control channels are specified for the convenience of aircraft design and control parameters modification. The attitude control approach is validated by the nonlinear simulations, which show that the initiative morphing strategy has the ability to reduce the influence of the nonlinearity.

SunAIS-21

Resilient H∞ filter design for continues-time systems with D stability constraints

Hongli Zhang Heilongjiang Bayi Agricultural Univ.
Hongyan Zhang Heilongjiang Bayi Agricultural Univ.
Jun Xiong Wuhan University of Science and Tech.

This paper discusses the resilient H filtering problem for a class of continuous-time linear systems with D stability constraints. Attention is focused on the design of a filter such that the filtering error system is quadratic D stability and guarantees a prescribed H performance level, where the filter to be designed is assumed to be with multiplicative gain variations. The design conditions for the resilient H filter are proposed in terms of linear matrix inequalities (LMIs). By solving these LMIs, an explicit expression of a desired H filter is given. A simulation example is given to show the efficiency of the proposed design methods.

SunAIS-22

Non-fragile H∞ Filtering for Continuous-time Singular Systems

Hongli Zhang Heilongjiang Bayi Agricultural Univ.
Hongyan Zhang Heilongjiang Bayi Agricultural Univ.
Zhimin Li Wuhan University of Science and Tech.

This paper considers the problem of designing non-fragile H∞ filter for continuous-time linear singular systems. Attention is focused on the design of a non-fragile H∞ filter such that the filtering error system is admissible (regular, impulse-free and stable) and the transfer function from the disturbance to the filtering error output satisfies a prescribed H∞ noise attenuation level, where the designed non-fragile filter is assumed to have additive gain variations. Based on bounded real lemma and fisher lemma, sufficient conditions for the existence of the non-fragile H∞ filter are expressed in terms of linear matrix inequalities (LMIs). Finally, a numerical example is presented to demonstrate the applicability of the proposed method.

SunAIS-23

Dynamic Matrix Controller in Wind Tunnel Flow Field Based on Incomplete Step Response

Wenshan Yu China Aerodynamics Research and Development Center
Fan Yi China Aerodynamics Research and Development Center.
Zhiwei Jin China Aerodynamics Research and Development Center
Jiao Li Northeastern Univ.
Ping Yuan Northeastern Univ.

In order to improve the quality of flow field in wind tunnel in China, The 2.4 m x 2.4 m intermittent wind tunnel control Mach number is required to achieve the accuracy of 0.001. Dynamic matric control is a great way to handle multi-variable, time delayed nonlinear control system, and there are nonlinear, time-delayed problems of Mach number control in intermittent wind tunnel. The prediction models use step response coefficients to be the parameters of the wind tunnel system, however, the time of wind tunnel test is about 90s, if the quantity of step response coefficients N is too large, it spends a long time collecting step response coefficients and we have limited time for aircraft blowing test. We need to get four different kinds of step response coefficients. So, we have to use incomplete step response coefficients as prediction model, if the number N is less than the number of the stable value of the step response, the truncation error is generated in the prediction process. In order to get a less number N and at the same time eliminate the truncation error, this paper improves the dynamic matrix control algorithm to get better results.

SunAIS-24

Valve Stiction Compensation Based on Equivalent-Input-Disturbance Approach

Qi Lei Central South Univ.
Xi Lei Central South Univ.
Min Wu Hubei key Laboratory of Advanced Control and Intelligent Automation for Complex Systems

The presence of stiction in a control valve causes loop oscillation, and limits the control loop performance. To address this problem, the paper proposes a method based on equivalent-input-disturbance (EID) to control valve stiction. In this method, a classic two-parameter stiction model is adopted. Then, an EID estimator is utilized to estimate the effects of valve stiction in control system. And the controller is designed in the spirit of repetitive control. The simulation control results are compared with the traditional method. The results demonstrate that the proposed EID method can effectively improve the control performance of valve stiction and eliminate the stiction-induced oscillations.

SunAIS-25

An Automatic Control Method of Heat Extraction System in Thermal Power Unit

Deliang Zeng North China Electric Power Univ.
Yaohan Wang North China Electric Power Univ.
Yanqiao Chen Guodian Science and Technology Research Inst.
Shan Hua Guodian Science and Technology Research Inst.

Affected by the operation mode of "ordering power by heat", the peak regulation shortage of combined heat and power (CHP) units in north China limits the absorption of renewable energy. To solve this problem, the improvement of heat steam extraction system control performance is essential. An automatic control method of heat extraction system is presented. The regulation of heat steam flow is realized by periodic execute pulse, and an open-loop control strategy is designed to regulate the supply water temperature of heating network. The renovation is applied to a 330MW CHP unit. The result shows the safe and reliable use of the heat steam extraction system control method, which lays the foundation of peak regulation study of CHP unit based on heat network energy storage..

SunAIS-26

Comparative Study of Linear and Nonlinear ADRC for an Inverted Pendulum

Binwen Zhang North China Electric Power Univ.
Wen Tan North China Electric Power Univ.
Jian Li North China Electric Power Univ.

This paper applies ADRC algorithm to the inverted pendulum stabilization problem. Since the extended state observer and control law can be nonlinear or linear, different combinations are designed to balance the pendulum's angle. It also offers a practical solution that the nonlinear parameters are tuned as the linear ones. The output response speed and control variable are compromised to determine the preferable structure. Simulations showed that ADRC has good performance on stability, anti-interference and robustness.

SunAIS-27

Design of Servo Motor Synchronous Control System for Instrumented Wheelset Calibration Test Bench

Bangcheng Zhang Changchun University of Tech.
Wei Wei Changchun University of Tech.
Yamei Ju Changchun University of Tech.
Jianqiao Lin Changchun University of Tech.
Zhi Gao Changchun University of Tech.
Yu Zhong Changchun University of Tech.

In order to improve the synchronization motion precision of servo motor synchronous control system of Instrumented Wheelset Calibration Test Bench (IWCTB), a new synchronous control system control model is presented based on fuzzy PI algorithm and the combine of equivalent control model and deviation coupling model. In this paper, in terms of the principle of fuzzy PI parameters, the free channel adjusts the PI parameters by the error of the free channel and the input signal, the follow channel adjusts the PI parameters by the error of the follow channel and the input signal, and the error between the following channel and the free channel. The purpose of this paper is to change the rules to eliminate the portal frame on both sides synchronous control steady-state error. Simulation results verify the proposed method can reduce the portal frame on both sides stable error, change the dynamic characteristics, and has better control effect.

SunAIS-28

Industrial Process Operating Optimality Assessment Based on Gaussian Mixture Model

Yan Liu Northeastern Univ. State Key Laboratory of Synthetical Automation for Process Industries
Fuli Wang Northeastern Univ. State Key Laboratory of Synthetical Automation for Process Industries
Yuqing Chang Northeastern Univ. State Key Laboratory of Synthetical Automation for Process Industries

As a new research issue, the operating optimality assessment for industrial processes has received growing interests in recent years. In this study, a novel online operating optimality assessment method based on Gaussian mixture model (GMM) is proposed for industrial processes. The offline training data can be automatically divided into several data sets by the proposed performance grade division method, and it lays the foundation for establishing the assessment models. Then the assessment models are developed not only for each stable performance grade but also for the performance grade conversions for the first time, which provides important guidelines for online assessment. In online assessment, the multiple hypotheses testing technology is used to ensure the reliability of the assessment results through controlling the false discovery rate. The validity and superiority of the proposed operating optimality assessment strategy are then validated through case study on gold hydrometallurgical process.

SunAIS-29

Chattering free and nonsingular terminal sliding mode control for attitude tracking of a quadrotor

Wei Wang Jiangsu Univ.
Xin Yu Jiangsu Univ.

This paper considers a nonsingular terminal sliding mode control problem for the attitude tracking of a quadrotor. To solve the chattering problem of sliding mode control, a novel terminal sliding mode controller based on a second-order sliding mode algorithm known as super-twisting algorithm is proposed. With the help of the proposed terminal sliding mode controller, the pitch, roll and yaw angles of quadrotor with disturbances can be guaranteed to track the desired trajectories in finite time. Finally, the simulation shows the effectiveness of the proposed control algorithm.

SunAIS-30

Terminal Angle Constrained Integrated Guidance and Control for Missile Pitch Channel in the Presence of Input Saturation

Guangbin Liu Beihang Univ.
Weihong Wang Beihang Univ.
Sen Wang Beihang Univ.

In this paper, in order to attack a fixed target and solve actuator saturation, an integrated guidance and control (IGC) scheme based on LESO and dynamic surface control algorithm with constrained terminal impact angle for missile pitch channel is proposed. Firstly, based on Coriolis theorem, an IGC model for pitch channel is established which does not assume that the initial velocity of the missile coincides with the line-of-sight (LOS) approximately. Then, an auxiliary system including a Nussbaum function is introduced to settle actuator saturation. The dynamic surface control algorithm with LESO which is used to estimate the disturbances of the system is designed to track the states of the system. What's more, the stability of the closed-loop system is proved theoretically according to Lyapunov theorem. The simulation results show that the missile can hit the target in desired impact angle stably without input saturation, which reflects validity of the control scheme.

SunAIS-31

Variable Structure Guaranteed Cost Control for Discrete Uncertain Networked Systems with Time Delay

Hejun Yao Anyang Normal Univ.
Fushun Yuan Anyang Normal Univ.
Yue Qiao Anyang Normal Univ.

The problem of variable structure guaranteed cost control for discrete uncertain networked systems with time delay has been considered in this paper. Based on the Lyapunov stability theorem, by introducing a discrete compensator, a novel sliding mode manifold that can compensate time delay has been designed. Then, by using linear matrix inequalities approach, a guaranteed cost controller is designed to make the sliding mode manifold stable. Finally, a numerical example is given to demonstrate the application and effectiveness of the proposed method.

SunAIS-32

Comparative Analysis of Direct Torque Control and DTC based on Sliding Mode Control for PMSM Drive

Lingnan Meng Chinese Academy of Sciences, University of Chinese Academy of Sciences
Xiaojun Yang University of Chinese Academy of Sciences

This paper firstly introduces the mathematical equations of PMSM (permanent magnet synchronous motor), an overview of direct torque control (DTC) and a DTC based on sliding mode control for PMSM, and then builds PMSM control system simulation models with above two methods in MATLAB /Simulink environment. Finally, we got the starting response, torque ripple and load perturbation responses of DTC and SMC-DTC by comparison the simulation results of the two models.

SunAIS-33

Full-Order Terminal Sliding-Mode Observer for Induction Motor Speed Servo Systems

Minghao Zhou Harbin Institute of Tech. School of Science, RMIT Univ.
Yong Feng Harbin Institute of Tech.
Fengling Han School of Science, RMIT Univ.
Xinghuo Yu School of Engineering, RMIT Univ.

This paper proposes a novel observer for induction motor speed servo systems by utilizing full-order sliding-mode control. A full-order terminal sliding-mode manifold is designed for the observer, and the related control laws guarantee the strong robustness of the observer to internal parameter variations and external disturbances. The chattering and singular phenomenon existed in conventional sliding-mode control systems are eliminated. Continuous control signals of the observer can be directly used for the estimation algorithms for the speed and rotor flux. The proposed observer can be utilized to implement the sensorless control of induction motors. The simulations validate the proposed method.

SunAIS-34

Sliding-Sector Based Variable Structure Control for a class of uncertain Stochastic Markov Jump Systems

Lu Zhong Nanjing University of Information Science and Tech.
Miao Wei Nanjing University of Information Science and Tech.
Bo-Chao Zheng Nanjing University of Information Science and Tech. Southeast Univ.
Tao Li Nanjing University of Information Science and Tech.

This paper is concerned with sliding sector based variable structure control design of a class of Itˆo-type stochastic Markov jump system subject to transition rate uncertainties and actuator failure. First, some notions about the sliding-sector for the stochastic Markov jump systems are presented. Sufficient conditions for the design of PRsliding sector are then established in the framework of linear matrix inequalities (LMIs). The PR-sliding sector based variable structure control is subsequently developed to ensure stochastic stability of closed-loop systems and no chattering phenomenon occurs during whole implementation process. An example is presented to show the effectiveness of the proposed method.

SunAIS-35

Controller design of second order sliding mode control systems with mismatached perturbations

Lu Liu Jiangsu Univ.
Keqi Mei Jiangsu Univ.
Shihong Ding Jiangsu Univ.

The method to obtain the dynamics of second-order sliding mode (SOSM) is usually adopted by directly taking second derivative on the sliding variable ... However, some uncertain terms will appear in the first derivative of the sliding variable. As a matter of fact, the second derivative imposing on these uncertain terms will enlarge the uncertainties in the control channel. This paper presents an effective method to diminish the uncertainties in the control channel, which regards the uncertain terms as a mismatched perturbation and then hold this mismatched perturbation in the first derivative of the sliding variable. A novel backstepping-like design methodology will be proposed by using the Lyapunov analysis. Mathematical proof and academic example are given to verify the effectiveness of the proposed method.

SunAIS-36

Sliding Mode Control of Electro-Hydrostatic Actuator Based on Extended State Observer

Ataklti Eyasu Alemu Beihang Univ.
Yongling Fu Beihang Univ.

To achieve the desired performance of an electro-hydrostatic actuator (EHA), this paper proposes a linear extended state observer (ESO) based sliding mode control (SMC). An ESO is used to estimate the external disturbance, the uncertainties, speed and acceleration of the EHA. The nonlinear mathematical model of EHA is a function of the derivatives of the friction force and externally applied force. However it is either difficult or impossible to get these values. To avoid these difficulties the EHA model is constructed in AMESim, the control system is developed in Matlab/Simulink and a co simulation is carried out. The performance of the proposed controller is compared with a PID controller. The simulation results illustrated superior tracking performance and robustness of the ESO based SMC.

SunAIS-37

Minimax Controller Design Based on Backstepping Sliding Mode for TCP Network Systems

Kun Wang Northeastern Univ.
Yuanwei Jing Northeastern Univ.
Siying Zhang Northeastern Univ.

This paper proposes an active queue management (AQM) controller based on Backstepping Sliding Mode control for a class of nonlinear TCP network congestion systems in the presence of uncertain parameters and unknown external disturbances. At the same time, based on the idea of the Minimax method in game theory, a novel output feedback controller is specially designed. Considering the situation that the system got the max impact when being disturbed by Lyapunov stability theory, the controller is optimally designed to deal with the system under the worst condition. The simulation results show that the proposed control strategy is effective to improve the transient stability and robustness of the system.

SunAIS-38

Min-max Model Predictive Control for Biaxial Feed Drive System

Yu Gao Soochow Univ.
Yuanliang Zhang Huaihai Institute of Tech.
Kil To Chong Chonbuk National Univ.

A min-max model predictive controller is developed in this paper for tracking control of a biaxial feed drive system. The tracking error dynamic model with uncertain disturbances is formed to predict the future behavior and the control policy is derived from the worst-case optimization of a quadratic cost function, which penalizes the contouring error and control variables in each sampling time over a finite horizon. The performance of the control algorithm is verified via computer simulations with a predefined trajectory. The result shows that the proposed method has a good tracking performance and convergence.

SunAIS-39

Model Predictive Optimal Control for the Coordinated System of Supercritical Power Unit Based on Firefly Algorithm and Neural Network Modeling

Liangyu Ma North China Electric Power Univ.
Pengrui Cao North China Electric Power Univ.

With the widespread implementation of Automatic Generation Control (AGC) in regional power grids, large-capacity supercritical and ultra-supercritical (SC/USC) power units are required to participate in peak load regulation frequently and often operate under wide-scope variable load conditions. Since a SC boiler unit is a MIMO strong coupling system with nonlinearity and large time delay characteristics, the traditional coordinated control strategy based on PID controllers often cannot meet the requirements with slow load response and large steam pressure fluctuations. Therefore, a model predictive optimal control (MPOC) scheme is proposed for the coordinated system control of a supercritical power unit on the basis of an improved firefly algorithm (FA) and neural network modeling. The MPOC scheme is programmed with MATLAB software and implemented in the full-scope simulator of a 600MW supercritical power unit. The test results show that the method can greatly improve the load response speed and keep the main steam pressure within safety limits.

SunAIS-40

Robust Optimization of Supply Chain Coordination Considering Retailer Altruistic Behavior

Zhongjie Chen Chongqing Technology and Business Univ.

In order to explore the effect of altruistic behavior on supply chain policies and performance, based on the wholesale price contract, we establish a game model consisted of an altruistic retailer and a self-interested supplier, and obtain the robust optimal solution when the demand information is missing. We find, the improvement of the selfish supplier gains are at the expense of the altruistic retailer's earnings. Specifically, part altruism of retailer is ineffective for retailer utility and supply chain efficiency, but full altruism is effective for the two. That is, on the basis of the wholesale price contract, full altruism rather than partial altruism can coordinate the supply chain.

SunAIS-41

Two Modified PRP Conjugate Gradient Methods and Their Global Convergence for Unconstrained Optimization

Zhongbo Sun Northeast Normal Univ.
Changchun University of Tech.
Xue Cao Northeast Normal Univ.
Yingying Guo Northeast Normal Univ.
Yuncheng Ge Northeast Normal Univ.
Yue Sun Northeast Normal Univ.

In this paper, two modified PRP conjugate gradient methods which satisfy sufficient descent condition are proposed for solving unconstrained optimization problems. We develop two sufficient descent directions at every iteration. Under some suitable conditions, theoretical analysis shows that the algorithm is global convergence. Numerical results show that this method is effective in unconstrained minimizing optimization problems.

SunAIS-42

The Integrated Allocation of Weapon System's Operational Readiness Indicators Based on FEGA

Zongren Xie Naval Univ. of Engineering
Quli Ma Naval Univ. of Engineering
Yifan Xu Naval Univ. of Engineering
Guangqiang Wang Naval Univ. of Engineering

Due to the shortage of the relationship among the indicators of the system-subsystem-device level of weapon system, and the numerous following impact, operational readiness indicators transferring and spreading relationships among three levels are analyzed. The integrated allocation model of readiness indicators which can meet all the requirements, enable to lower technical and economic cost, and has all-level consistent indicators is explored. According to the multivariate optimization characteristics of the model, an optimized solution of the genetic algorithm based on float-encoding (FEGA) is selected. A MATLAB program is generated and a typical example with its optimized calculation is presented. By considering the actual situation in the operation and maintenance of weapon system, the technical and economic feasibility along with cost-effectiveness and other factors, trading-off analyses on the calculation results are achieved. The upper results have realized the multi-level (system-subsystem-device level) coordination and integration of the weapon system, and lay a convictive foundation for the design, development and certification test of weapon system.

SunAIS-43

Loss-Minimizing Control Based on QP Sequence of the IPMSM Drive systems for Electric Vehicles

Qinmu Wu Guizhou Univ.
Tingting Wang Guizhou Institute of Tech.
Xiaoyan Li Guizhou Univ.

This paper proposes a method based on the quadratic programming (QP) sequence for solving loss-minimizing current, which yields minimum loss of motor, of control system for interior permanent magnet synchronous motor (IPMSM) of electric vehicle. First, the efficiency optimization of IPMSM is modeled as a constrained programming problem, and then transformed it into linear constraint QP sequence. The convergence of QP series solution and the identity of the solution of the primal programming problem are proved. By simulation analysis, it is very suitable for efficiency-optimizing control performed in numerical controller for IPMSM control systems because of the fast convergence, and a small calculation amount.

SunAIS-44

Maneuver Trajectory Design for Hypersonic Glide Vehicles in Dive Phase

Ruizhi He National University of Defense Tech.
Luhua Liu National University of Defense Tech.
Guojian Tang National University of Defense Tech.
Weimin Bao National University of Defense Tech.
China aerospace science and technology corporation

In this paper, a planning approach of maneuver trajectory based on dynamic inversion is proposed, which can greatly improve the penetrability of hypersonic glide vehicles in dive phase. Maeuvering and guiding overloads are combined using a weight coefficient, which is designed as the function of altitude. Enough adjust ability is guranteed at the end of dive phase, and more complex maneuver trajectories are achieved. Firstly, four different modes of maneuver trajectories are realized by coordinating the maneuver in longitudinal and lateral sub-planes, respectively. Dynamic inversion is employed to establish the relationship between the designed trajectory and the needed overload. Secondly, the minimum energy loss is selected as the optimization index, and the optimal overload is obtained based on the maximum principle. the final path angle constraint is also considered in this algorithm. Finally, the maneuvering and guiding overloads are combined using a weight coefficient, and the corresponding angle of attack and bank are obtained. The approach is tested using common aero vehicle-H (CAV-H) model, and the results demonstrate that the method proposed in this paper can realize the maneuver trajectory in dive phase with high terminal accuracy and strong penetration ability.

SunAIS-45

Design of fractional - order PID controller based on genetic algorithm

Lingxin Wang Changchun University of Science and Tech.

Chunyang Wang Changchun University of Science and Tech.
Li Yu Changchun University of Science and Tech.
Yonghua Liu Changchun University of Science and Tech.
Jingxue Sun Changchun University of Science and Tech.
Aiming at the characteristics that dynamic systems can be described by integral and differential equations involving non-integer orders, this tool is also introduced into fractional-order controllers, that is, controllers with fractional integral and differential. A modified genetic algorithm The integer order PID controller and the fractional order controller are used to simulate and compare the controller parameters of the integer and fractional order systems respectively by using the genetic algorithm, The results show that the fractional-order controller is better than the integer-order PID controller in the same parameter tuning range.

SunAIS-46

Optimization of Evacuation Path Decision with BIM and Psychological Support

Ting Wang Beijing Univ.
Jia Wang Beijing Univ.
When people pass through a narrow passage, once the perceived disaster will cause the crowd to generate pressure, to promote their competitive behavior, which lead to disorder and congestion.This is a very serious threat to the evacuation rate and export efficiency of the evacuees. How to optimize the crowd's guidance after taking these effects is an important issue. Based on the advanced micro-pedestrian model and simulation, this paper establishes a new network flow model. For the large and complex geometric layout of the infrastructure, the computer-aided approach can make the decision more accurate and efficient. We combined network analysis with building information modeling (BIM) to facilitate the decision making for response operations.Retrieve the geometric and topological relationships of the building from the BIM model to construct graph theory and find directions. At the same time, evacuation behavior of the crowd is supported by psychological discovery and simulation research. Fire, smoke and psychological factors can enhance the desire of the crows to escape-the desired flow rate. When the desire flow exceeds the capacity of the passage will be disorder and blocked, causing the crowd flow in a non-linear and random way sharp decline. In order to efficiently guide the crowd, based on the group to reduce the complexity of the operation and reflection of psychological discovery "divide and rule" method developed. However, when the crowd is moving while the fire is spreading over time, such guidance is problematic because some of the exports may be overcrowded or blocked by fire and smoke. Innovative optimization techniques are then used to find efficient evacuation routes. A large number of results show that our approach can continually update the guidance in the event of an important change in the form of emergency, and our approach can help evacuate people to achieve greater evacuation efficiency compared to recent egress methods.

SunAIS-47

Thermal Control System for the FOG-Based SINS with TEC

Huaxin Lu Beihang Univ.
Li Fu Beihang Univ.
Lingling Wang Beihang Univ.
Fiber Optic Gyro (FOG) is the core component of the FOG-Based Strap-down Inertial Navigation System (SINS). Since FOG is sensitive to the temperature changes, it is necessary to establish a temperature control system to guarantee the FOG-Based SINS in the proper temperature (20-30 degrees) while the ambient temperature changes. On the basis of a 2-level temperature control system developed in our previous work [3], a thermal control system with Thermoelectric Semiconductors Cooling (TEC) is established in this paper. Our contribution consists of three parts. Firstly, a thermal dynamics model of FOG-based SINS, which TECs are installed stick on the shell of FOGs, is established via computational fluid dynamic (CFD) simulation. Secondly, the thermal control system with reduced-order modeling (ROM) is proposed through Proper Orthogonal Decomposition (POD) and prediction error method (PEM). Thirdly, a thermal control system using Linear Quadratic Regulator (LQR) is established in Simulink platform. The results of CFD simulation show that with the thermal control system, the temperature of the FOG in SINS can be controlled in the proper temperature while the ambient temperature changes.

SunAIS-48

Study of the Measuring Area of Magnetic Decoy's Aerial Magnetic Field Based on Haar Wavelet

Shi Jian Naval University of Engineering
Zhongle Liu Naval University of Engineering
Minjia Zhou Military Representative Office of Navy in Wuxi District
Pengyang Cai Naval University of Engineering
Aeromagnetic detection equipment presents a considerable threat to submarines, and launching magnetic decoys is one of the main methods to cope with them. Magnetic decoy's aerial magnetic field needs to be verified in the process of studying magnetic decoy. However, there're different distribution characteristics of magnetic decoy's magnetic field in different areas at a specified altitude, the optimal measurement area should be located. The distribution status of magnetic decoy's magnetic field in different areas at a specified altitude are analyzed through Haar wavelet, the high-frequency and low-frequency coefficient matrixes are acquired, then the comentropy of each point in the matrixes is computed, thus the change of each magnetic field component in corresponding frequency domain is got. The selection of the optimal measurement area under a specific condition is studied based on it, which provides a theoretical basis for the selection of the measurement area.

SunAIS-49

Optimal Analysis of the Weighted Matrices in LQR Based on the Differential Evolution Algorithm

Xiongfeng Deng Aeronautics and Astronautics Engineering Coll.
Xiuxia Sun Aeronautics and Astronautics Engineering Coll.
Ri Liu Aeronautics and Astronautics Engineering Coll.
Wei Wei Aeronautics and Astronautics Engineering Coll.
The general method of determining the weighted matrices Q and R in the linear quadratic regulator (LQR) is trial and error via simulation. The way is simple but inefficient, and it is more complicated for high-dimension systems. In order to overcome these shortcomings, this paper introduces an optimization algorithm, which is the Differential Evolution Algorithm (DEA), to optimize the weighted matrices of the LQR. Through the strategy of real coded for the weighted matrices Q and R, the best weighted matrices and the feedback matrix K can be obtained. By simulation analysis of the selected system, the results showed that a better effect is obtained based on the DEA to optimize the weighed matrices of the LQR. The system's regulation time and the peak value also have a big improvement.

SunAIS-50

UAV Real-time Route Planning Based on Multi-Optimized RRT Algorithm

Jinglin Hu Air Force Engineering Univ.
Xiuxia Sun Air Force Engineering Univ.
Ri Liu Air Force Engineering Univ.
Xiongfeng Deng Air Force Engineering Univ.
Maolong Lv Air Force Engineering Univ.
UAV route planning in complicated environment is researched. The UAV route planning algorithm based on MO-RRT is proposed to ensure the safe execution in the complicated battlefield with incident threatens. First, threaten avoidance model is established by radar identification mechanism which can highly reduce its threaten space. Then the target heuristic strategy is utilized to accelerate the convergence of the algorithm. Finally, redundant point deletion strategy can reduce the route length and improve its smoothness. Simulation results show that the proposed algorithm can avoid the incident threatens promptly and generate route with good optimization. The proposed algorithm can make the UAV execute mission with good performance in complicated environment.

SunAIS-51

UAV Path Planning Based on Receding Horizon Control with Adaptive Strategy

Zhe Zhang Shanghai Jiao Tong Univ.
Jun Wang Shanghai Jiao Tong Univ.
Luoyang Electronic Equipment Test Center of China
Jianxun Li Shanghai Jiao Tong Univ.
Xing Wang Luoyang Electronic Equipment Test Center of China
Recently, researchers show great interest in Unmanned Aerial Vehicle (UAV) path planning problem due to development of artificial intelligence algorithms. However, the convergence of these kinds of heuristic methods can not be proved. Therefore, the UAV path planning problem has been modeled as a linear optimal control problem to ensure the convergence. But the computing time will increase exponentially as the scale of the problem enlarge. Hence, the Receding Horizon Control (RHC) is introduced to the problem to guarantee the efficiency. Nevertheless, how to choose a proper receding horizon span to keep balance between efficiency and accuracy becomes a new problem. An adaptive strategy is proposed to choose a proper parameter to meet the real-time requirement and fuel consuming in this paper. The strategy has better performance in the two simulation scenes, which indicates the effectiveness of the algorithm.

SunAIS-52

A Real-Coded Multi-Objective Quantum-Inspired Evolutionary Algorithm and its Application

Yong Li Shenyang University of Tech.
Xiaohong Wu Shenyang University of Tech.
Yuxian Zhang Shenyang University of Tech.
A real-coded multi-objective quantum evolutionary algorithm is proposed with the extension of a real-coded single-objective quantum evolutionary algorithm, and it is applied to the optimization design problem of low voltage large current vehicle-based generator. The update mechanism and intelligent search mechanism are improved for multi-objective problem solution. Meanwhile crowd distance and population mutation are also taken into considered. The proposed algorithm is applied to test functions with two objectives and three objectives. Simulation shows better performance both in convergence and distribution compared with NSGA-II. According to design requirements, motor efficiency and material costs are selected as objective functions, and then the multi-objective model of low voltage large current vehicle-based generator is established. Applying the proposed algorithm to the model, better designing schemes are obtained compared with original scheme. The validity of the algorithm is proved.

SunAIS-53

Research on Improved Particle-Swarm-Optimization Algorithm based on Ant-Colony-Optimization Algorithm

Dong Li Shenyang Jianzhu Univ.
Northeastern Univ.
Huaitao Shi Shenyang Jianzhu Univ.
Northeastern Univ.
Jianchang Liu Northeastern Univ.
Shubin Tan Northeastern Univ.
Chi Li Northern Heavy Industries Group Co., Ltd.
Yu Xie Shenyang FIDIA CNC Machine Tool Co., Ltd

In order to alleviate Linearly Decreasing Weight of Particle Swarm Optimization (LDW-PSO) algorithm falling into the local optimum, Particle Swarm Optimization combined with Ant Colony Optimization (PSO-ACO) algorithm is designed. A pseudo-random-proportional rule is introduced to the determination of the swarm optimum value in PSO for improving the swarm diversity. The calculation expression of particle positions is improved in combination with the calculation expression of the pheromone concentration, which makes particles pay more attention to the current search information and accelerate the search speed. The simulation experiment results show that PSO-ACO has higher convergence accuracy and satisfactory solution speed in the solution of several typical test-functions.

SunAIS-54

Failure Trend Analysis Using Time Series Model

Yu Zhou Inner Mongolia Univ.

Failure trend analysis has to be based on observed operational failure data. Assume the failure data can be viewed as a series of data over time. And a set of time series will be obtained. So it is perfectly natural to use the time series model to test the failure trend. Then we consider the failure number arranged by time order as a variable. As a result of the effects of seasons and cycles, we found the structural time series model is the appropriate model for modeling the public transport vehicles failure data. The structural time series model used in this paper is added with four components, namely trend, cyclic, seasonal and irregular. The failure number forecasting and correcting are also be given. In order to illustrate the efficiency of the structural time series model, a real-world example will be presented.

SunAIS-55

A Population Extremal Optimization Based Modified Constrained Generalized Predictive Control Method

Hai-Yang Liu Wenzhou Univ.
Kang-Di Lu Wenzhou Univ.
Donghua Univ.
Guo-Qiang Zeng Wenzhou Univ.
Huan Wang Wenzhou Univ.
Hunan Univ.
Yu-Xing Dai Wenzhou Univ.
Hunan Univ.

As one of the most popular and successful methods in industrial applications, model predictive control (MPC) has attracted increasing interest in the past two decades. However, one of open issues in this research filed is how to solve the constrained nonlinear optimization problems in MPC. From the perspective of evolutionary algorithm, this paper presents a novel population extremal optimization (PEO) based modified constrained generalized predictive control (CGPC) method called CGPC-PEO. The key idea behind the proposed CGPC-PEO is using PEO for rolling optimization to minimize the weighted objective function subjecting to a set of constraints. Its superiority to other evolutionary algorithms such as genetic algorithm and particle swarm optimization based CGPC is demonstrated by the simulation results on an industrial process plant.

SunAIS-56

Hydraulic Turbine Governing Optimal Control System Research

Yongling Li State Grid Ji bei Electric Power Co. Ltd. Skill Training Center
Department of Automation North China Electric Power Univ.
Zuo-liangYang State Grid Ji bei Electric Power Co. Ltd. Skill Training Center.

A linear active disturbance rejection controller is used to control the running hydro-generating unit with large disturbances. Because there is non-minimum phase in hydraulic turbine regulating system, it is hard to adjust the linear active disturbance rejection controller parameters which depended on experience to a large extent. In order to solve the problem, the high speed convergence quantum particle swarm optimization (QPSO) algorithm is put forward to optimize the LADRC controller parameters. At first, it used the typical test functions to verify the effectiveness of the proposed algorithm, and then it was utilized to optimize LADRC controller parameters of hydraulic turbine regulating system. The simulation results show that the optimized linear disturbance rejection controller can restrain overshoot, reduce negative regulation and shorten adjustment time, it still has strong robustness, and can achieve better control effect than the PID controller especially when the system conditions change.

SunAIS-57

Based on the two-order oscillation particle swarm optimization algorithm of the regional logistics demand forecasting research

Jun Wang Air Force Logistics Coll.
Qiang Huang Air Force Logistics Coll.
Li Zhang Air Force Logistics Coll.

In this paper, based on two-order oscillation particle swarm optimization algorithm, the regional logistics demand forecasting model is established. The model integrated the kernel principal component analysis (KPCA), least squares support vector machines (LSSVM) and the two-order oscillating particle swarm optimization (TOOPSO). First, the nonlinear features of the influential factors of regional logistics demand were extracted by KPCA. Then, the kernel principal components were input into LSSVM and regional logistics demand forecasting model was established. Finally, TOOPSO algorithm was used to optimize the parameters of LSSVM. The empirical research shows that the proposed model not only reduces the dimension of the input variables and accelerates convergence speed of the model, but also improves the forecasting accuracy of regional logistics demand.

SunAIS-58

Path Planning and Cooperative Control for Multiple UAVs Based on Consistency Theory and Voronoi Diagram

Xia Chen Shenyang Aerospace Univ.
Guang-yao Li Shenyang Aerospace Univ.
Xiang-min Chen Shenyang University Of Chemical Technology Ke Ya Coll.

In order to solve the path planning problem about multiple unmanned aerial vehicles (UAVs) attacking multiple targets under static environment, the method based on consistency theory is proposed in this paper. The Voronoi diagram method is used to create threat field and the total path cost is established firstly. Then, path planning model is constructed and the payment function of multiple UAVs path planning is designed. The idea that multiple UAVs cooperatively seek the optimal path based on consistency theory is further defined by establishing the path solving framework, the purpose of which is that multiple UAVs take off and arrive at prescribed target points at the same time. Finally, the simulation experiment is conducted, the results of which demonstrate that using the consistency theory combined with Voronoi diagram can guarantee the optimal path of UAVs and complete multiple UAVs cooperatively attacking multiple targets.

SunAIS-59

A New Evaluation Strategy-based Interval Optimization Algorithm and Its Simulation Analysis

Shou-ping Guan Northeastern Univ.
Yuhuan Han Northeastern Univ.
Xiuyuan Peng Northeastern Univ.
Chuang Lu Northeastern Univ.

This paper presents a new interval optimization algorithm (ESIA) combining interval algorithm with evolution strategy in bionics, to improve the search efficiency and make the accelerated tool constructed easier comparing with the traditional interval algorithm (IA), hence it can be applied to high dimensional optimization problems better. The ESIA employed the evaluation strategy to construct accelerated tool, which can be used to cut off the interval elements with low probability of including the global optimal solution, and a reliable upper bound is provided to prune intervals and the calculation of the algorithm is reduced. Meanwhile, a new splitting rule is proposed to make the reliable interval, which probably contains the global optimal solution, have more chance to split, so as to further improve the search efficiency. The numerical experiments on several typical test functions show that the ESIA is more efficient than traditional IA

SunAIS-60

Study on Valve Management of Nozzle Governing Steam Turbine

You-yuan Sun Huadian Electric Power Research Inst.

Valve management is an important function of Digital Electro-Hydraulic Control System (DEH), which has important significance for the safety and economic operation of the unit. In view of the abnormal problem occurred in the valve switching process, a 600MW nozzle governing steam turbine is taken as an example in this paper, and then its valve management theory model is established. In order to improve the performance and trait of the valve control, the opening order of the governing valve, the flow proportion and bias factor and valve overlap degree function are amended, and the governing valve flow characteristic curve is obtained in sequence valve operation based on the field test and theoretical calculation, which provides certain reference for the optimization of valve management in nozzle governing steam turbine.

SunB01 **Room01**
Presentations by Finalists of Zhang Si-Ying Outstanding Youth Paper Award **16:20-18:20**

Chair: Changyun Wen Nanyang Technological Univ.

16:20-16:40 **SunB01-1**

Disciplined Multi-Convex Programming

Xinyue Shen Tsinghua Univ.
Steven Diamond Stanford Univ.
Madeleine Udell Cornell Univ.
Yuantao Gu Tsinghua Univ.
Stephen Boyd Stanford Univ.

A multi-convex optimization problem is one in which the variables can be partitioned into sets over which the problem is convex when the other variables are fixed. Multi-convex problems are generally solved approximately using variations on alternating or cyclic minimization. Multi-convex problems arise in many applications, such as nonnegative matrix factorization, generalized low rank models, and structured control synthesis, to name just a few. In most applications to date the multi-convexity is simple to verify by hand. In this paper we study the automatic detection and verification of multi-convexity using the ideas of disciplined convex programming. We describe an implementation of our proposed method that detects and verifies multi-convexity, and then invokes one of the general solution methods.

16:40-17:00 **SunB01-2**

Parameterized Frequency-dependent Balanced Truncation for Model Order Reduction of Linear Systems

Xin Du Sandtorstraße 1 Shanghai Univ.
Peter Benner Sandtorstraße 1 Shanghai Univ.

Balanced truncation is the most commonly used model order reduction scheme in control engineering. This is due to its favorable properties of automatic stability preservation and the existence of a computable error bound, enabling the adaption of the reduced model order to a specified tolerance. It aims at minimizing the worst case error of the frequency response over the full infinite frequency range. If a good approximation only over a finite frequency range is required, frequency-weighted or frequency-limited balanced truncation variants can be employed. In this paper, we study this finite-frequency model order reduction (FF-MOR) problem for linear time-invariant (LTI) continuous-time systems within the framework of balanced truncation. Firstly, we construct a family of parameterized frequency-dependent (PFD) mappings which transform the given LTI system to either a discrete-time or continuous-time PFD system. The relationships between the maximum singular value of the given LTI system over pre-specified frequency ranges and the maximum singular value of the PFD mapped systems over the entire frequency range are established. By exploiting the properties of the discrete-time PFD mapped systems, a new parameterized frequency-dependent balanced truncation (PFDBT) method providing a finite-frequency type error bound with respect to the maximum singular value of the error systems is developed. Examples are included for illustration.

17:00-17:20 **SunB01-3**

Optimal DoS Attack Strategy against Remote State Estimation Over Lossy Networks

Menglin Li Univ.of Sci. and Tech.of China
Jiahu Qin Univ.of Sci. and Tech.of China
Ling Shi Hong Kong Univ. of Sci.and Tech.
Xinghuo Yu RMIT Univ.
Huijun Gao Harbin Institute of Tech.

This paper considers a Denial-of-Service (DoS) attack scheduling problem. Specifically, a sensor employs the wireless link to send the data packet to the remote estimator at each time step, while an energy-constrained attacker launches DoS attacks against the remote state estimation, and designs an optimal attack strategy to maximize damage to the remote estimation quality. The packet will drop if the channel is jammed. In most of the existing works on DoS attacks, it is assumed that the wireless channel is perfect, i.e., the packet dropout never occurs in the absence of attack. However, this is far from the practical situation. To encompass the lossy nature of wireless networks, we study the scenario of lossy networks in which the packet may drop even without attack, and construct the optimal attack strategy that maximizes the average expected estimation error at the remote estimator over lossy networks. Numerical simulations are provided to demonstrate the effectiveness of the theoretical results.

17:20-17:40 **SunB01-4**

A New Distributed Method for Clock Synchronization in Sensor Networks

Yong Qiao Zhejiang Univ.
Wenlun Yang Zhejiang Univ.
Minyue Fu Univ. of Newcastle Fudan Univ.

In this paper, we present a new distributed protocol to achieve the synchronization of time variations and initial times simultaneously. The protocol combines the design methods of controller and estimator to obtain more precise synchronization with higher robustness against noisy inputs mainly generated by crystal oscillators of clocks. Furthermore, the control input is ensured bounded while achieving the clock synchronization, which makes our protocol more applicable in practice. The implementation of the protocol allows sampling in the receiving end to be event-triggered with a specifically designed communication scheme. Numerical simulations are shown to illustrate the performance of the protocol.

17:40-18:00 **SunB01-5**

Cooperative Output Regulation for a Class of Nonlinear Heterogeneous Multi-Agent Systems

He Cai Nanyang Tech. Univ.
Guoqiang Hu Nanyang Tech. Univ.

This paper considers the cooperative output regulation problem for a class of heterogeneous multi-agent systems with linearly parameterizable nonlinear matching uncertainties, which can be used to model electrical energy storage systems. Such a problem cannot be solved by the existing control approaches due to the heterogeneity and multiinput multi-output property of the agents' dynamics. To overcome the technical difficulties, we propose two distributed observer based control approaches which integrate the distributed observer/adaptive distributed observer techniques with the certainty equivalent adaptive control design. Sufficient conditions are given on the convergence of the estimated errors of the uncertain system parameters. Simulation results show the application of the proposed control approaches to the energy management of a battery energy storage system.

SunB02 Room02
Process control (I) 16:20-18:20

Chair: Chunhui Zhao Zhejiang Univ.
CO-Chair: Yupeng Du East China University of Science and Tech.

16:20-16:40 **SunB02-1**

Model Predictive Control Integrated With Multi-Agent Particle Swarm Optimization-based SVR

Xian-lun Tang Chongqing University Of Posts And Telecom munications
Nian-ci Liu ZBJ Network Inc.
Ya-li Wan Chongqing University Of Posts And Telecom munications
Wen-xing Lin Chongqing University Of Posts And Telecom munications

The kernel function's selection has a great impact on the performance of support vector regression (SVR). A new method of nonlinear model predictive control (NMPC) based on polynomial kernel SVR is put forward, and multi-agent particle swarm optimization algorithm is introduced to obtain the optimal control law of rolling optimization in NMPC. Compares with the NMPC based on quadratic polynomial kernel SVR, the simulation results show that the characteristics of our method, such as, overshoot, volatility and tracking are superior to those of quadratic polynomial kernel SVR.

16:40-17:00 **SunB02-2**

Research on an Unconstrained Dynamic Matrix Control Algorithm

Xiaoqin Liu Anhui University Of Tech.

In this paper, dynamic matrix control is proposed for the first order inertial system in the presence of measurable and unmeasurable disturbances. A state estimator is designed based on step response model, which is used to estimate the unmeasured state. By means of the basic principle of model predictive control, control law can be obtained eventually. Numerical simulation results are presented to illustrate the effectiveness of the proposed control schemes.

17:00-17:20 **SunB02-3**

Study on the Charging and Discharging Control Strategy of Battery and Super Capacitor

Wenhui Ma Guizhou Univ.
Zhiqin He Guizhou Univ.
Jin Zhou Guizhou Univ.
Ruiwan Yang Guizhou Univ.

For the unstable output power of off-grid wind power system, Extensive use of pulsating power loads and the time-varying of user's demand, single battery energy storage have been unable to meet the demand. A charge discharge control strategy is proposed based on the research on the charging and discharging of battery-ultra-capacitor hybrid energy storage system combined with some characteristics of the off-grid wind power system. Finally, the Simulink simulation model was built to verify the superiority of the hybrid energy storage device and the correctness of the control strategy.

17:20-17:40 **SunB02-4**

Blood Glucose Control Based on Rapid Model Identification with Particle Swarm Optimization Method

Chenrong Li Zhejiang Univ.
Chunhui Zhao Zhejiang Univ.
Hong Zhao Zhejiang Univ.
Chengxia Yu Zhejiang Univ.

Fully automatic controllers are designed to regulate blood glucose (BG) concentrations in people with Type 1 diabetes mellitus (T1DM) which must be controlled in a normal range. The model based on control algorithms may not obtain satisfied BG values if the prediction model of BG is mismatched. One of the challenges in glucose control is the lacking of accurate individual prediction models for T1DM patients because of limited modeling data. In order to solve this problem, in this paper, a rapid and economic modeling method in T1DM is first pointed out for glucose control. Using the idea of model migration with PSO, the ARX model structure is adaptively adjusted from person to person with limited data individually. Then the developed prediction model is used for glucose control using the zone model predictive control with the control-relevant constraints. The effectiveness of the proposed method is tested on the UVa/Padova metabolic simulator. It is shown that the proposed method has good control performance where 95% of the simulation time for glucose control can be regulated within the normal range. Further, the experimental results show that there are no statistically significant differences between the individual ARX model with sufficient data and the

developed prediction model using paired t-test. The proposed glucose control method is effective and economic which can take place of repetitive subject-dependent control method especially when the modeling data are insufficient.

17:40-18:00 **SunB02-5**

Control Performance Assessment of Multivariable System Based on Multi-time-variant-disturbances Mixing GMV Method

Yupeng Du East China University of Science and Tech.
Zhenlei Wang East China University of Science and Tech.
Xin Wang Shanghai Jiao Tong Univ.

The disturbance in chemical process is complex and has the multiple characteristics, and the control performance assessment of multivariable system with multiple disturbances is one of the hot topics. In this paper, the control performance assessment method of multivariable systems, based on multi-time-variant-disturbances mixing generalized minimum variance (MMGMV), is proposed. Firstly, the generalized minimum variance control is introduced into the multivariable system performance assessment, and the weight matrix is designed according to the time-varying control object. Then, the multivariable MMGMV controller is designed combining with the idea of multi-model weights mixing for all multi-time-varying disturbances. Next, the output variance of each controlled variable is obtained using MMGMV controller. The average variance of controlled variable in the MMGMV controller acts as the criterion of performance assessment, and combining with the output variance of actual controller for the controller performance assessment. Compared with the minimum variance benchmark, the developed method is more reasonable and practical for the control performance assessment of multivariable systems. The developed approach is demonstrated by a numerical simulation and a heavy oil fractionation of process control system.

18:00-18:20 **SunB02-6**

On Some Basic Properties of Bilinear Systems with Internal and External Delays

Manuel De la Sen University of the Basque Country

The bilinear system class under consideration is driven by two inputs: the control input plus a bilinear action input. The paper investigates the properties of positivity, transparency and excitability under the presence of state and external delays.

SunB03 **Room03**
Optimal control and optimization (IV) **16:20-18:20**
Chair: Haoxiang Chen Nanjing University of Aeronautics and Astronautics
CO-Chair: Haibing Ouyang Guangzhou Univ.

16:20-16:40 **SunB03-1**

Long and Medium Term Power Load Forecasting Based on a Combination Model of GMDH, PSO and LSSVM

Jinlian Long College of Electrical Engineering, Guizhou Univ.
Yufen Zhang College of Electrical Engineering Guizhou Univ.
Jiaxuan Lu College of Big Data and Information Engineering, Guizhou Univ.

In this paper, a new method based on Group Method of Data Handling (GMDH), Improved Particle Swarm Optimization (PSO), and Least Squares Support Vector Machine (LSSVM) is proposed to solve the problem in power load forecasting, which is difficult to determine the input node and model parameters of minimum support vector machine (LSSVM) modeling. The specific method is as follows: firstly, the authors use the GMDH algorithm to obtain the input variables of the LSSVM modeling. Secondly, the adaptive mutation PSO algorithm is analyzed to optimize the parameters of the LSSVM model, and then the trained LSSVM model is utilized to predict the test samples. Furthermore, a real case about the actual load of a certain city from the year 2008 to 2013 is analyzed, and the power load in 2014, 2015 were forecast. The simulation results verify that the forecasting accuracy has been improved obviously.

16:40-17:00 **SunB03-2**

An Orbit Transfer Method for Spatial Object Tracking

Jun Shu The PLA Information Engineering Univ.
Limin Xu The PLA Information Engineering Univ. Tsinghua Univ.
Jianbing Li The PLA Information Engineering Univ.

In this paper, an orbit transfer method for spatial object tracking is proposed. The main goal of this method is to finish the orbit transfer task of the far range guided phase to dispatch the chaser to an approximate proper location close to the target within a special interval. The essence of the two-impulse orbit transfer method is an optimization problem about how to minimize the fuel costing and some tolerable error to the final-location. The Sequential Unconstrained Minimization Techniques (SUMT) algorithm is adopted to solve the nonlinear programming problem. Simulation results indicate the validity and flexibility of the proposed method.

17:00-17:20 **SunB03-3**

Modified teaching-learning based optimization for 0-1 knapsack optimization problem

Haibin Ouyang Guangzhou Univ.
Qing Wang Guangzhou Univ.
Xiangyong Kong Jiangsu Normal Univ.

In this article, a modified teaching-learning-based optimization (MTLBO) algorithm is proposed for solving 0-1 knapsack optimization problems. The MTLBO incorporated estimation of distribution operation into teaching phases, which aims at reaching the possibility of premature and predicting an elite teacher. A stochastic local exploitation is used in teaching phase for improving local searching capacity. Moreover, in the learning phase, a new global learning operation is presented to boost learning efficiency. Several classic 0-1 knapsack cases are selected to evaluate the performance of MTLBO. Numerical results reveal that the proposed algorithm surpasses TLBO and several other promising heuristic methods.

17:20-17:40 **SunB03-4**

Study on the Control Strategy for Low Thrust Low Energy Moon Return

Yue Liu DFH Satellite Co. Ltd.
Yingjing Qian Beijing University of Tech.
Wuxing Jing Harbin Institute of Tech.

In this paper the low thrust propulsion control strategy of the low energy Moon return transfer is researched. By establishing the dynamical equations in the elliptical four body problem, the characteristics of the low energy moon return trajectory is analyzed and the whole returning mission is divided into two sections, the moon escaping and the return manifold injecting. In each of the section, the low thrust propulsion control strategy is designed with iteration method. From the simulation result, the low thrust low energy moon return method is of significant advantage in fuel consumption.

17:40-18:00 **SunB03-5**

Multiple Flight Vehicles Trajectory Global Optimization Based on Improved Natural Running Process Algorithm

Haoxiang Chen Nanjing University of Aeronautics and Astronautics
Ying Nan Nanjing University of Aeronautics and Astronautics

Natural running process algorithm (NRPA) is a novel algorithm for multiple flight vehicles trajectories optimization problem. In this paper we provide an improved NRPA to optimize cooperation and confrontation trajectories for multiple flight vehicles. A new concept of rational value is proposed to make combined substances to evolve or eliminate depending on their states current and subsequent. This paper also introduces the calculation steps of the improved NRPA, and confirms the accuracy in solving optimization problem of multi-phase, multi-target, multilateral confrontations. Regarding on the cooperation and confrontation among multiply flight vehicles, several numerical simulation results have been provided to prove the feasibility of the improved NRPA, as well as superiority for the multilateral confrontations problem.

18:00-18:20 **SunB03-6**

Positioning method research for unmanned aerial vehicles based on Meanshift tracking algorithm

Cheng Yi Institute of Electronic Engineering and Automation, Tianjin Polytechnic Univ. Key Laboratory of Advanced Electrical Engineering and Energy Technology, Tianjin polytechnic Univ.
Hongyu Wang Institute of Electronic Engineering and Automation, Tianjin Polytechnic Univ. Key Laboratory of Advanced Electrical Engineering and Energy Technology,Tianjin polytechnic Univ.
Xiaohong Wang Institute of Electronic Engineering and Automation, Tianjin Polytechnic Univ. Key Laboratory of Advanced Electrical Engineering and Energy Technology,Tianjin polytechnic Univ.

The positioning algorithm of unmanned aerial vehicle (UAV) is one of the key technologies in the field of unmanned aerial vehicle autonomous flight. In this paper, the absolute position of unmanned aerial vehicle is calculated without global positioning system (GPS) signals by using moving targets tracked by onboard camera and the relative position between it and UAV. The positioning method is presented by combined the Meanshift target tracking algorithm and camera calibration. According to obtained internal and external camera parameters, image pixel coordinates of moving targets and relative position between UAV and moving targets, the UAV world coordinates can be calculated. Multiple sets of experimental data verifies that the absolute error of calculating data is no more than 1.5% of the real data and the relative error is below 2%. Simulation results validate the feasibility of the proposed method in the field of UAV autonomous flight.

SunB04 **Room04**
Fractional Calculus and Fractional-order Systems (II) **16:20-18:20**
Chair: Junguo Lu Shanghai Jiaotong Univ.
CO-Chair: Hua Chen Hohai Univ.

16:20-16:40 **SunB04-1**

Realization of Fractional Order Controller for Electro-Hydraulic Servo System Based on Best-Rational Function Theory

Songtao Wang Tsinghua Univ.
Bin Liang Tsinghua Univ.
Xueqian Wang Tsinghua Univ.

Houde Liu Tsinghua Univ.
To improve the dynamic performance of the electro-hydraulic servo system, the best-rational controller is designed by realizing the fractional order PID controller based on the best-rational function theory. Firstly, in the frequency domain, the rational models of the fractional differential and integral operators are realized based on the best-rational function theory. Secondly, the fractional order controller are rationalized according to the rational models of the fractional differential and integral operators, then the best-rational controller can be obtained. Lastly, the numerical experiments of an electro-hydraulic servo system are carried out based on the best-rational controller and the common PID controller. The results of the numerical experiments show that the best-rational controller can effectively improve the transient response and steady accuracy of the electro-hydraulic servo system comparing with the common PID controllers.

16:40-17:00 **SunB04-2**

A Nyquist-Like Approach for Stability Analysis in Fractional-Order Systems: Related Issues and Case Studies

Jun Zhou Hohai Univ.
In this note, we consider a Nyquist-like criterion for stability analysis in linear dynamical systems that are described by fractional-order linear time-invariant (FOLTI) differential equations, associated with commensurate-order characteristic polynomials, by means of the argument principle. Based on some appropriately chosen integral contour for applying the argument principle, the stability conditions are necessary and sufficient, independent of zeros/poles distribution, which can be implemented as we do in using general Nyquist-like criteria graphically. Contour detouring and locus discontinuity are examined. Existing numerical examples are re-visited as case studies.

17:00-17:20 **SunB04-3**

The Benchmark Problems for the Assessment of Numerical Algorithms on Fractional-Order Differential Equations

Bai Lu Northeastern Univ.
Dingyu Xue Northeastern Univ.
There are many numerical algorithms for solving the fractional-order differential equations (FODEs). The numerical algorithms are very different, and it is difficult to compare their performances. To solve this problem, some different FODEs with the known analytical solution are designed and proposed, they could be used as the benchmark problems for testing the numerical algorithms. A Simulink block diagram scheme is proposed for solving these benchmark problems, and the computing errors and the running times are reported. These benchmark problems and the solutions are constituted as a framework, and the numerical algorithms for solving the FODEs could be compared in the same framework. The comparing result could assess which algorithm is better to a concrete FODE.

17:20-17:40 **SunB04-4**

An indirect Lyapunov approach of stability of fractional order linear system with and without time delay

Keyong Shao Northeast Petroleum Univ.
Xiaofeng Gu Northeast Petroleum Univ.
Feng Han Northeast Petroleum Univ.
Guangyuan Yang Northeast Petroleum Univ.
Wang Gao Northeast Petroleum Univ.
Yongfeng Zhang Daqing Oilfield Co.Ltd.
Lyapunov stability of fractional order linear system with time delay is addressed in this paper. The key concept is the frequency distributed fractional integrator model, which is the basis for a global state space model of FDEs. We give the sufficient condition of stability of fractional order system with time delay based on indirect Lyapunov approach, which is based on the continuous frequency distribution. No-memory and memory state feedback controller are designed to stabilized the fractional order system. The feasibility of the design method is verified by the examples.

17:40-18:00 **SunB04-5**

Research on Fractional Order PID Controller Applied to PEMFC Pre-stage Power Conversion

Di Hu Nanjing Univ. of Science anf Tech.
Zhidong Qi Nanjing Univ. of Science anf Tech.
Yinyin Tang Nanjing Univ. of Science anf Tech.
Yongkang He Nanjing Univ. of Science anf Tech.
The soft electrical properties are limiting Proton Exchange Membrane Fuel Cell (PEMFC) to be directly applied. To overcome such shortcoming, the high efficiency structure Four Switch Buck-Boost (FSBB) converter, which combines with Fractional Order PID (FOPID) controller, is used as pre-stage power converter of PEMFC to achieve regulated output. Also, Particle Swarm Optimization (PSO) based on the optimization of similar ITAE performance index is used to optimize FOPID controller parameters. And in order to reduce the probability of PSO falling into local optimum prematurely, the fitness variance is introduced to adjust the inertia weight change rule. Finally, compared with the traditional PID controller, the FOPID controller can make FSBB converter have a more excellent dynamic and steady performance, especially in the system parameters even the structural change, which shows a stronger robustness.

18:00-18:20 **SunB04-6**

Adaptive step size numerical algorithm for fractional order control systems

Yongkang He Nanjing Univ. of Science anf Tech.
Zhidong Qi Nanjing Univ. of Science anf Tech.
Yinyin Tang Nanjing Univ. of Science anf Tech.
Di Hu Nanjing Univ. of Science anf Tech.
For fractional order control systems, fast and accurate numerical algorithm is the key step in real-time control and simulation. Although the short memory method (SMM) and the constant weight memory method (CWMM) accelerate the computation speed through the choice and approximation of the historical information of the fractional differential operator, the computation precision decreases with the increase of time. The CWMM is affected by input function and the error range is large. Considering the limitation of fixed step size discretization (FSSD) of fractional differential operator, a variable step size discretization (VSSD) scheme is utilized. According to the local error obtained by the step-doubling technique, the iterative step size is adjusted adaptively. The algorithm not only can achieve good accuracy, uniform error, but also fast calculation speed, which provides a feasible way for the numerical calculation of state space description of fractional order control system. Finally, the reliability of the algorithm is verified by an example.

SunB05 Room05
IntelliSense and Advanced Sensing, Detection Technology (II) 16:20-18:20

Chair: Feng Dong Tianjin Univ.
CO-Chair: Yonghong Huang Jiangsu Univ.

16:20-16:40 **SunB05-1**

Ultrasound Modulated Electrical Impedance Tomography by Contrast Libraries of Measurements Variation

Shengnan Zhang Tianjin Univ.
Yanbin Xu Tianjin Univ.
Feng Dong Tianjin Univ.
Electrical impedance tomography (EIT) is a relatively new imaging technique developed in the recent years. However, due to the ill-poseness of the inverse problem, spatial resolution of the reconstructed image is not high. Acousto-electric effect depicts that focused ultrasound alters the conductivity in the focal region. Based on the acousto-electric effect, ultrasound modulated electrical impedance tomography (UMEIT) is proposed. Using location information related to the original conductivity in the focused ultrasound area, contrast libraries of the measurements variation from background to object have been established, then the point-wise data of the boundary measurement are compared with the contrast libraries, and image of conductivity distribution is reconstructed with binarization directly without resorting to inverse algorithm. Finally the simulation results validate the effectiveness of the proposed method by the contrast libraries of the measurements variation. This method can reduce the effect of electrode location on sensitivity to improve the resolution, especially in the center of the imaging object, and avoid the ill-poseness of inverse problem.

16:40-17:00 **SunB05-2**

Crack Detection Based on Support Vector Data Description

Weiguo Lin Beijing University of Chemical Tech.
Yaru Lin Beijing University of Chemical Tech.
Fang Wang Beijing University of Chemical Tech.
It is difficult to detect concrete cracks because of the existence of background interference. To solve this problem, some methods for crack detection on concrete surfaces are analyzed. According to shape features, a new concrete crack detection method is proposed. First of all, iteration method is applied to get the optimal threshold for image segmentation after grayscale transformation. Secondly, binary images are processed by morphological closing operation and deburring. Features including eccentricity, circularity and packing density are selected as input training vectors for Support Vector Data Description (SVDD). The experimental results show that crack detection method based on SVDD can accurately distinguish cracks from other kinds of defects (non-crack) and reduce the false negative detections

17:00-17:20 **SunB04-3**

Object Tracking with Convolutional Neural Networks and Kernelized Correlation Filters

Dongxuan Li Beijing Institute of Tech.
Wenjie Chen Beijing Institute of Tech.
Convolutional neural networks are widely used in object recognition and detection. In recent years, some researchers attempt to apply deep neural networks to visual object tracking. However, deep networks are extremely time-consuming and object tracking is not a classification problem essentially. In this paper, we present an online tracking framework which combines shallow convolutional neural networks with kernelized correlation filters (KCF). Different from offline training, our method successfully gets the convolution kernels by K-means clustering algorithm. Experimental results based on a representative visual tracker benchmark dataset show that the proposed method achieves excellent performance.

17:20-17:40 **SunB05-4**

Interactive Detection Method Applied in DVR

Jie Zhou Jiangsu Univ.
Yuxiang Huang Jiangsu Univ.

Hui Shi Jiangsu Univ.
Li Du Jiangsu Univ.
Yonghong Huang Jiangsu Univ.
To satisfy the real-time and accuracy requirements of voltage sag detection, an interactive Dynamic Voltage Restorer (DVR) combined generalized S-transform and RMS is proposed. Generalized S-transform is improved by time-frequency aggregation performance criteria, to obtain high time-frequency resolution, realizing the detection and localization of mutation signal. The generalized inverse S- transform is performed on the processed mode to get the effect of de-noising and filtering. Based on the effective value detection method, the value of voltage sag is calculated, and the interactive voltage sag detection is realized by isolating the switch. This method can improve the detection accuracy and response speed of DVR, and have good signal de-noising ability. Finally, the feasibility and timeliness are verified by simulation and experiment.

17:40-18:00 **SunB05-5**

A New Fast and Robust Template Matching with Randomness

Chang Liu Beijing Institute of Tech.
Yongqiang Bai Beijing Institute of Tech.
Yinyin Tang Beijing Institute of Tech.
Yongkang He Beijing Institute of Tech.
Template matching is one of the most important techniques in computer vision, where the algorithm should find the location of template image in scene image. The commonly used method of template matching is Normalized Cross Correlation which has a high matching accuracy while consuming a large amount of computational speed. In this paper, a novel, fast and robust template matching approach is proposed. The new algorithm randomly visits the pixels and locates local maxima by gradually moving to the regions with larger NCC values. To further improve the speed and accuracy of the algorithm, several additional rules are established. Theoretical analysis and experimental results show that the proposed algorithm maintains a high matching accuracy while providing a significant speedup.

18:00-18:20 **SunB05-6**

Effect of Electromagnetic Field Stimulation on Electrocardiogram of Rat

Xu Wang Northeastern Univ.
Zhe Long Northeastern Univ.
Dan Yang Northeastern Univ.
Make the magnetic field stimulation the heart of rat; record the electrocardiograms (ECG) of rat; analyze the RR interval, PR interval, QRS interval and R amplitude of the ECG. Compare the different effects of the Magnetic Stimulation on electrocardiogram of rat. Research shows that the RR interval and R amplitude of the ECG significantly changes after stimulated by uniform magnetic field, while, the PR interval and the QRS interval of the ECG has no change.

SunB06 Room06
Identification and estimation (II) 16:20-18:20

Chair: Hongbo Zhang National Univ. of Defense Tech.
CO-Chair: Yuxian Zhang Shenyang Univ. of Tech.

16:20-16:40 **SunB06-1**

Frequency Domain Identification for Linear Systems with Mixed Noises

Liqing Feng Univ. of Electronic Science and Tech. of China
Wen Mi Univ. of Electronic Science and Tech. of China
In this paper, a new method for frequency domain identification of discrete linear time invariant systems is proposed. A new model structure is used to get the solution of coefficients for mixed or unknown noises case. We applied the augmented Lagranian method in the numerical computation. Given examples show the efficiency of the presented method.

16:40-17:00 **SunB06-2**

Parameters Optimization of ANFIS using Quantum-inspired Evolutionary Algorithm

Xiaoyi Qian Shenyang Univ. of Tech.
Yuxian Zhang Shenyang Univ. of Tech.
Mohammed Altayeb Awad Shenyang Univ. of Tech.
Yong Li Shenyang Univ. of Tech.
For describing nonlinear system accurately and improving adaptive neuro-fuzzy inference system model, a quantum-inspired evolutionary algorithm is presented for optimizing parameters of adaptive neuro-fuzzy inference system. In this paper, an allele real-coded quantum evolutionary algorithm is introduced to optimize the premise and consequent parameters of adaptive neuro-fuzzy inference system. The real-coding method based on allele is adopted, and variable-scale updating strategy of parameter is employed. As a result, the parameter falling into local minimum is avoided. The model accuracy ofadaptive neuro-fuzzy inference system is improved. The simulation examples show the effectiveness of proposed method. The proposed improved algorithm is compared with the standard adaptive neuro-fuzzy inference system. Finally, the proposed adaptive neuro-fuzzy inference system model is applied to predict the quality index in textile slashing process.

17:00-17:20 **SunB06-3**

The Parameter Identification Method for the Over-Damping System Based on the Newton Iteration

Ling Xu Wuxi Vocational Inst. of Commerce
Jiangnan Univ.
Feng Ding Wuxi Vocational Inst. of Commerce
Feng Ding Jiangnan Univ.
Most industrial processes are represented by the second-order system. This paper studies the parameter estimation for the second-order system with over-damping. By means of the statistical identification method, the impulse response is adopted to generate the measurement data. Because the system impulse response is a highly nonlinear function with respect to the system parameters, the nonlinear optimization method based on the Newton iteration is used to derive the parameter estimation algorithm. Finally, some simulation examples are given to test the algorithm performance. The simulation results illustrate that the methods work efficiently.

17:20-17:40 **SunB06-4**

Radar Tracking for Hypersonic Glide Vehicle Based on Aerodynamic Model

Jingshuai Huang National Univ. of Defense Tech.
Hongbo Zhang National Univ. of Defense Tech.
Guojian Tang National Univ. of Defense Tech.
Weimin Bao National Univ. of Defense Tech.
China Aerospace Science and Tech. Corporation
In order to achieve hit-to-kill in terms of intercepting the hypersonic glide vehicle, the first task is to accurately track the flight state and predict the trajectory. In this paper, a radar tracking approach for hypersonic glide vehicles is proposed based on a novel aerodynamic model. The extended motion equations are derived on basis of the established aerodynamic acceleration, and the measurement equations of radar are given. In view of the nonlinearities, the extended and unscented Kalman filters are adopted to estimate the extended state, respectively. To examine the proposed method, two types of standard trajectories are designed and then tracked. Simulation results indicate that it can precisely track the hypersonic glide vehicle, which provides a guarantee of the following trajectory prediction.

17:40-18:00 **SunB06-5**

Online Identification of Missile in Frequency Domain Based on Chirp-Z Transform

Yuhang Wang Beijing Aerospace Automatic Control Inst.
Huiping Zhang Beijing Aerospace Automatic Control Inst.
Jiarun Liu Beijing Aerospace Automatic Control Inst.
Mengyu Liu Beijing Aerospace Automatic Control Inst.
Conventional methods face problems when dealing with attitude control in complex environment due to the lack of adaptive ability. Therefore, attention needs to be paid to obtain accurate system stability margin in real time and design an adaptive attitude controller. An online stability margin identification method based on Chirp-Z transform is proposed in this paper to identify amplitude and phase curves online and analyze uncertainty under noise. It has been verified that identification results are in good agreement with true values and have strong adaptability to noise. Besides, influences of several typical excitation signals are analyzed and compared to offer optimal signal. Finally, closed-loop simulation proves application to the missile in flight and can greatly support online attitude controller design.

18:00-18:20 **SunB06-6**

A Calculation Method of Braking Torque for Eddy Current Dynamometer Using Least Square Method Based on Assumption of Cylindrical Ring

Duo-yang Li Key Laboratory of Intelligent Control and Decision of Complex Systems Beijing Inst. of Tech.
Wei Shen Key Laboratory of Intelligent Control and Decision of Complex Systems Beijing Inst. of Tech.
Ying-hui Chen Key Laboratory of Intelligent Control and Decision of Complex Systems Beijing Inst. of Tech.
Jiang-bo Zhao Key Laboratory of Intelligent Control and Decision of Complex Systems Beijing Inst. of Tech.
Guan-rong Chen Key Laboratory of Intelligent Control and Decision of Complex Systems Beijing Inst. of Tech.
For engineering applications, the existing method of calculating the braking torque is more complex.Furthermore, the calculation method depends on the internal structure parameters which are often difficult to obtain.Hence, the calculational method of braking torque using least square method based on assumption of cylindrical ring (CR-LS) is proposed in this paper. Referring to calculation methods of eddy current braking devices, The CR-LS assumes that the eddy current is distributed as a cylindrical ring with the same width as the tooth tip of the inductor. Eddy current values are worked out by conversion coefficient. With the employ of LS, unknown internal structure parameters of dynamometer in formula are fitted. It makes the formula use in industrial control with easy. By experimental verification, the formula obtained by CR-LS was simple and available, and calculation results had minor errors in contrast with output values of actual system. Therefore CR-LS can be applied in actual engineering calculations of dynamometer.

SunB07 Room07
Intelligent systems (III) 16:20-18:20
Chair: Fuli Wang Northeastern Univ.
CO-Chair: Zhen Gao Northeastern Univ.

16:20-16:40 SunB07-1

The Abnormity Control Scheme for the Thickening Process of Gold Hydrometallurgy Based on Fuzzy Bayesian Network

Hui Li Northeastern Univ.
Fuli Wang Northeastern Univ.
State Key Laboratory of Synthetical Automatio n for Process Industries (Northeastern Univ.)
Hongru Li Northeastern Univ.

This paper develops an abnormity control scheme based on fuzzy Bayesian network (BN) for the thickening process of gold hydrometallurgy. By analyzing the causes and corresponding solutions of the abnormity, the operator experience of removing the abnormity is transformed to construct the BN. The BN combines the expert knowledge with quantitative data analysis to make decisions and remove the abnormity. The BN is established off-line and used to infer on-line. Because the observable variables extracted from sensors are continuous in practical application, we use fuzzy set theory to discretize the continuous variables. After receiving abnormal phenomena as soft evidences, the posterior probabilities of the decision variables with different grades can be obtained by BN reasoning, which provide real-time safety analysis. The application results show that the proposed approach can make effective decisions for the abnormity in the thickening process.

16:40-17:00 SunB07-2

Research of Automatic Batching System Based on Fuzzy Algorithm

Anna Wang Northeastern Univ.
Zhen Gao Northeastern Univ.
Zhiyuan Liu State Grid Shandong Electric Power Company

In general, the ingredients required time and the accuracy of ingredients is contradictory, reduce the time required for ingredients, ingredients will inevitably increase the error, if you want to reduce the error, then the time required for ingredients Corresponding increase. Firstly, the weighing part of the batching system is designed to complete the weighing process. Secondly, the accuracy and speed of ingredients to optimize and ensure the accuracy of ingredients. Then, the overshoot quantity produced at the end of the batching is adjusted and the whole system is optimized to increase the stability ofthe system and improve the batching speed ofthe batching system.

17:00-17:20 SunB07-3

Salient Object Detection via Harris Corner

Dongliang Jin Nanjing Univ. ofPosts and Telecommunications
Songhao Zhu Nanjing Univ. ofPosts and Telecommunications
Yanyun Cheng Nanjing Univ. ofPosts and Telecommunications

In this paper, a fast and effective image saliency detection based on Harris Corner method is proposed. Different from most previous methods that mainly concentrate on boundary prior, we take both background and foreground information into consideration. First, a novel method is proposed to approximately locate the foreground object by using the convex hull from Harris corner. Then, the original image is segmented into super-pixels regions and the saliency values of different regions are divided into two parts to generate the corresponding background and foreground cue maps which are combined into a unified map. Finally, the unified map and the convex hull center-biased algorithm are combined to be the saliency map, which is then optimized by Bayesian perspective and saliency diffusion to get the final result. Experiments on publicly available data sets demonstrate that the proposed algorithm performs favorably against the state-of-the-art methods.

17:20-17:40 SunB07-4

Locality Correlation Preserving Based One-Class Support Vector Machine

Jian-Di Chang Coll. of Mathematics and Information Science
Hong-Jie Xing Coll. of Mathematics and Information Science

In order to fully utilize the local geometric information of the given training set consisting of the normal data, locality correlation preserving (LCP) is introduced into the traditional one-class support vector machine (OCSVM). The proposed method, named as locality correlation preserving based one-class support vector machine (LCP-OCSVM), inherits the merits of LCP and OCSVM. It can keep locality correlation of the normal data and margin maximization between the normal data and the origin in the high-dimensional feature space. Experimental results on one synthetic data set and ten benchmark data sets demonstrate that the proposed method is superior to the traditional OCSVM and two related approaches.

17:40-18:00 SunB07-5

Design and Implementation of a Real-time Simulation Test System for Rectifying Devices

Zhuanyan Bai Xi'an Jiaotong Univ.
Tian Yan National Key Laborotary of Science and Tech. on Fuse and Dynamic Characteristics
Aimin Zhang Xi'an Jiaotong Univ.
Hang Zhang Xi'an Jiaotong Univ.
Zhigang Ren Xi'an Jiaotong Univ.
Jingjing Huang Xi'an Jiaotong Univ.

In order to reduce the development costs and shorten the development period of power electronic experiments, a real-time digital simulation test system for rectifying devices is presented in this paper. This system combines the traditional simulation software SIMULINK with high-performance industrial personal computer (IPC). SIMULINK is used to create system model and the interface module. The RTW toolbox provided by SIMULINK is used to convert the model to C code, which is then uploaded to the IPC. When the C code runs, the test signals required by the control board are output through the I/O or Ethernet port. What's more, the simulation model can be modified in real time according to the control signal fed back by the control board, and can also be used to carry on the hardware-in -loop simulation test. In this paper, many problems were solved or mitigated, such as numerical oscillation in the off-line simulation, the cumbersome process of the model converting to C code, and the real-time performance of the task scheduling strategy of the computing unit. At last, some experiments were done to show that the system has strong real-time performance and can be used in the experiment of rectifier.

18:00-18:20 SunB07-6

Design of Remote Irrigation System in Farmland based on the cloud platform

Fei Hu Tianjin Univ. of Tech.
Lei Shao Tianjin Univ. of Tech.

The traditional agricultural irrigation methods are often inefficient and consume a lot of manpower and water resources. In this paper, a lightweight remote irrigation system based on cloud platform technology is designed. With a networked computer, the user can control the irrigation machine through the network and view the field data. The system consists of host PC software, remote server software, intelligent controller and sensor components. The sensor collects parameters such as soil temperature, humidity, and carbon dioxide concentration and passes these parameters to the controller .The remote server software receives the collected data into the Ali cloud database and sends the data to the PC client software through the cloud platform technology. PC client software can control the parameters of the irrigation machine, irrigation equipment to the scene in time and effective remote operation, which can achieve water-saving, provincial, fertilizer, and other effects.

SunB08 Room08
Decision supporting system and production planning and scheduling (I) 16:20-18:20
Chair: Shuan Liu Northeastern Univ.
CO-Chair: Biao Zhang Huazhong Univ. of Science & Tech.

16:20-16:40 SunB08-1

Influence of Waiting Times on Customer Loyalty and Queueing Behavior in Call Centers

Shu-an Liu Northeastern Univ.
Jun Gong Northeastern Univ.
Luping Ma Northeastern Univ.
Miao Yu Shenyang Jianzhu Univ.

This paper mainly considers a queueing model with abandonment and recurrent consumption behavior for call centers. As a general rule, customers determine their behavior mainly based on their perception of waiting time. We explicitly take into account customer satisfaction with waiting experience, and model that queueing system with endogenous customer arriving processes. The profit of call centers is generated by serving customers and lost with abandonment. The goal of the model is to determine the economically optimal staffing level balancing the tradeoff between the revenue from customers and the cost from staffs. We show that all the main results carry through to different parameter settings.

16:40-17:00 SunB08-2

Simulation-based Optimization on Quay Crane Scheduling of Container Terminals

Haoyuan Li Dalian Neusoft Univ. of Information
Qi Sun Dalian Neusoft Univ. of Information

By applying the object-oriented simulation modeling method of discrete event system, this paper establishes an simulating model of container terminal operating system, including vessels, anchorages, berths, gantry cranes, internal and external container trucks and gate system. In order to solve the quay crane scheduling problem of container terminal, a lot of stochastic factors in the problem are taken into account. Simulation-based optimization (SBO) method is proposed to solve the problem. Genetic algorithm, particle swarm algorithm and simulated annealing algorithm are used respectively as the superior optimizer, and their application performance is compared and analyzed.

17:00-17:20 SunB08-3

A Modified Migrating Birds Optimization for Solving the Steelmaking-continuous Casting Problem with variable processing times

Biao Zhang Huazhong Univ. of Science & Tech.
Kunkun Peng Huazhong Univ. of Science & Tech.
Quanke Pan Huazhong Univ. of Science & Tech.
Qingda Chen Northeastern Univ.
Yuhao Dai Huazhong Univ. of Science & Tech.

In this paper, the steelmaking-continuous casting problem with variable processing times is addressed. We present a modified migrating birds

optimization (MMBO) to deal with this problem within a reasonable time. For the addressed problem, we use the job permutation to represent the solution and give a detailed decoding process. For the employed algorithm, we introduce a various neighborhood strategy to explore the solution space more widely. And the benefit mechanism is modified to take full advantage of the promising solutions. To evaluate the performance of our proposed algorithm, the other three meta-heuristics are compared and the computational results demonstrate the effectiveness of the MMBO.

17:20-17:40 **SunB08-4**

An Improved Method for Predicting Pulp Properties and Scheduling the Ratio of Waste Paper

Yin Liu South China Univ. of Tech.
Wenhao Shen South China Univ. of Tech.
Zhang Liu South China Univ. of Tech.

Focusing on the automatic production scheduling of the ratio of waste paper in a paper mill, the research target was minimizing the purchase cost of waste paper under multiple constraints. Having divided, the field data (mixing ratios of waste paper and pulp properties) into the training and validation data sets, the scheduling ratios of waste paper were optimized. Firstly, from the point of view of the average pulp properties and the variances, the predicted results proved that the BP-NN predicted model accuracies of the pulp properties with the mixing ratio of waste paper were better than those of SVM and GA-SVM. Secondly, the minimization of the purchasing costs of waste paper under some constraints were obtained with the BP-NN predicted model and the non-dominated sorting genetic algorithm (NSGAII), Comparing with the general GA in the previous study, the scheduling results improved the pulp brightness by 9.24%, and reduced the purchasing costs of waste paper by 2.16%.

17:40-18:00 **SunB08-5**

Research on Single Machine Scheduling Problem with Limited Waiting and Degenerate Maintenance

Yanhui Yu Univ. of Northeastern Univ. at Qinhuangdao

The scheduling problem based on degenerate maintenance is more practical than the case of fixed period maintenance. In this paper, based on the degradation of maintenance, consider the limited waiting constraint, there is a wider range of applications in the medical field. A mixed integer programming model is established. Since degenerate maintenance, there will be idle times per cycle. In order to reduce the idle time, use the SPT rule to generate the initial sort, and then determine whether the waiting time for each job exceeds the upper bound by the timetabling algorithm, if more than, need to adjust the starting time forward. The experimental results show that the algorithm is feasible and effective.

18:00-18:20 **SunB08-6**

A Hybrid Iterated Greedy Algorithm for The No-wait PFSP

Junxi Zheng Guangdong Mechanical&Electrical Coll.

This paper introduces a hybrid iterated greedy algorithm (HIGA) for the no-wait permutation flowshop scheduling problem (PFSP) with make-span criterion. Firstly, a NEH-based heuristic with a rare two-level construction method is presented. Moreover, the author introduces a block-based destructive strategy. And, a tabu-based reconstruction approach has been applied in the algorithm. Furthermore, An efficient local search that consists of insertion-move, double-insertion move and swap-move by hybridizing the strategies of variable neighborhood descent and variable neighborhood search is proposed. Finally, results from extensive experiment show the proposed one is the new state-of-the-art algorithm for the problem.

SunB09 Room09
Networked control systems (II) 16:20-18:20

Chair: Tao Ren Northeastern Univ.
CO-Chair: Haoping Wang Nanjing Univ. of Science & Tech.

16:20-16:40 **SunB09-1**

Event-triggered Control based on Observer for Active Queue Management

Huawei Yuan Northeastern Univ.
Yuanwei Jing Northeastern Univ.
Mengnan Lin Northeastern Univ.
Tao Ren Northeastern Univ.
Dongmei Wu Northeastern Univ.

With the increase of network scale and the continuous growth of network users and applications, the network congestion has become an important problem. In this paper, an observer-based AQM algorithm is proposed because the system state is not fully measurable. Considering the uncertainty and external disturbance of network, the robust event-triggering controller and event-triggering condition based on observer are designed and two methods to calculate the gain of the designed controller are given. The simulation results show that the algorithm is strongly robust and it can reduce the calculating frequency of controller.

16:40-17:00 **SunB09-2**

The Congestion Control for TCP Network based on Input/Output Saturation

Mengnan Lin Northeastern Univ.
Tao Ren Northeastern Univ.
Huawei Yuan Northeastern Univ.
Meng Li Northeastern Univ.

In this paper, for the nonlinear dynamic model of TCP network with both input saturation and output saturation, the Backstepping controller is proposed. Firstly, because the saturation function isn't derivable, the smooth differentiable function is chosen to replace it. Secondly, the restriction of output is transformed into states saturation. Meanwhile, taking the disturbance into consider, the disturbance observer is designed. Then, the Backstepping controller is proposed. Finally, the simulation results show that the disturbance can be observed effectively.

17:00-17:20 **SunB09-3**

2-Order Discrete-time Sliding-Mode Tracking Control for DC Motor in NCSs with Random Delay

Meng Li Univ. of Electronic Science and Tech. of China
Yong Chen Univ. of Electronic Science and Tech. of China
Xia Liu Xihua Univ.

Acorrding to tracking control of direct current (DC) motor in networked control systems (NCSs) with random delay and considering the controlled plant with disturbance. A 2-order discrete-time sliding-mode trancking control (2-DSMTC) is proposed. Firstly, a new discrete-time sliding-mode function is established on the tracking error and tracking error difference. Then, the 2-DSMTC is designed on the disturbance estimated value as weight factors, Furthermore, the networked predictive control (NPC) algorithm on 2-DSMTC is presented. Finally, a simulation experiment of DC motor verifies the effectiveness of the proposed method.

17:20-17:40 **SunB09-4**

New Continuous State Observer Design for Networked Visual Servo Control Systems with Variable Delayed and Sampled Output

Rui Gong Nanjing Univ. of Science & Tech.
Haoping Wang Nanjing Univ. of Science & Tech.
Yang Tian Nanjing Univ. of Science & Tech.

This paper deals with the problem of observer design for networked visual servo control systems with time varying delayed and sampled output. The proposed observer called new continuous state observer is motivated by the communication disturbance observer which is proposed to solve the time delay problem. Different from the current work, this paper aimed at improving the communication disturbance observer and making it suitable for the case of delayed and sampled output. The proposed continuous state observer has a very simple structure and can be easily implemented. The stability of this observer is also analyzed and demonstrated. Finally, some simulation results are sketched to demonstrate significant performance improvement of the proposed observer.

17:40-18:00 **SunB09-5**

Networked filtering for a dualrate sampled-data system

Weiwei Ma Shanxi Univ.
Xinchun Jia Shanxi Univ.
Dawei Zhang Shanxi Univ.
Xiaobo Chi Shanxi Univ.

This paper concerns with the networked H1 filtering for a class of nonlinear time-delay systems, where the measured output is classified into two sub-vectors and is sampled respectively by two sensor groups with different sampling periods (i.e., dualrate sampling or DRS). The sampled data are transmitted to a filter through multiple communication channels. Considering the asynchronous behavior of the DRS, we propose a matching mechanism to synchronize the successfully transmitted sampled data of the system and the sampled data of a filter. Using the matched sampled-data, a new filter is presented to estimate the objective signal of the nonlinear systems. The resulting filtering error system is modeled as a continuous time-delay nonlinear system. By a discontinuous Lyapunov-Krasovskii functional, a sufficient condition is presented to guarantee that the filtering error system is globally asymptotically stable with a prescribed H1 performance. Finally, the effectiveness of the proposed filter is illustrated by a numerical example.

18:00-18:20 **SunB09-6**

Delay Effect on Group Consensus Seeking of Second-order Multi-Agent Systems

Sufang Chen Jiangnan Univ.
Chenglin Liu Jiangnan Univ.
Fei Liu Jiangnan Univ.

Group consensus problem is investigated for the second-order multi-agent systems with communication delay under general directed topology, and stationary consensus protocols are proposed for two sub-groups. By using algebraic graph theory and matrix theory, consensus conditions are obtained for second-order multi-agent systems without time delay firstly. Based on frequency-domain analysis method, delay-dependent and delay-independent consensus conditions are gained for the agents with communication delay, respectively. Numerical simulations show the correctness of the results.

SunB10 Room10
Fault diagnosis and fault-tolerant control (II) 16:20-18:20

Chair: Bin Liang Tsinghua Univ.

CO-Chair: Qing Yang Shenyang Ligong Univ.

16:20-16:40 **SunB10-1**

Rolling Bearing Fault Prognosis Using Recurrent Neural Network

Qiangqiang Cui Tsinghua Univ.
Tsinghua National Laboratory for Informati on Science and Tech.
Zhiheng Li Tsinghua Univ.
Jun Yang Tsinghua Univ.
Tsinghua National Laboratory for Informati on Science and Tech.
Bin Liang Tsinghua National Laboratory for Informati on Science and Tech.
Tsinghua Univ.

Rolling bearing devices are widely used in almost all industries in the world, and play a very critical role. So that once this critical device fails, the whole system will have a very serious impact. It will not only affect the performance of the entire system, but also the system reliability, security, applicability and so on. Therefore, it is very important to predict the bearing failure. Because recurrent neural network is quite effective in dealing with sequence problems, it is often used to do prediction-related problems. And in recent years, recurrent neural network has been put into great attention, so here we choose to use RNN for rolling bearing fault prognosis. Afterwards, we use the actual rolling bearing fault data to verify the effectiveness of our method.

16:40-17:00 **SunB10-2**

Data-based Incipient Fault Detection and Prediction for Satellite's Attitude Control System

Min Liu Nanjing Univ. of Aeronautics and Astronautics
Ningyun Lu Nanjing Univ. of Aeronautics and Astronautics
Yuehua Cheng Nanjing Univ. of Aeronautics and Astronautics
Bin Jiang Nanjing Univ. of Aeronautics and Astronautics

Incipient fault detection (FD) and prediction are crucial for the safe operation of in-orbit satellite's attitude control system (ACS). In this paper, a locally linear embedding (LLE) model combined with exponentially weighted moving average (EWMA) technique is proposed in FD for ACS, which is more suitable when the magnitude of the fault is small. After that, fault trend prediction with multi variables is conducted. Firstly, a preprocessing for high-dimensional telemetry data from the satellite ACS is conducted. Considering that there exists non-linear correlation relationship among telemetry parameters in ACS, LLE is used for online FD, while EWMA is used to accumulate the fault value. Based on the results of fault detection, vector autoregressive integrated moving average model (VARMA) is used for tracking the trend of fault. The case study on a simulated satellite ACS demonstrates the effectiveness of the proposed method.

17:00-17:20 **SunB10-3**

A Test Sequencing Optimization Method for Fault Diagnosis of Engineering Systems

Dandan Huang Nanjing Univ. of Aeronautics and Astronautics
Ningyun Lu Nanjing Univ. of Aeronautics and Astronautics
Bin Jiang Nanjing Univ. of Aeronautics and Astronautics

In order to solve the test sequencing problem in fault diagnosis, an optimal test point selection and test sequencing optimization algorithm are proposed. Based on the improved multi-signal model and using the information entropy algorithm as the heuristic function, a test sequencing optimization algorithm with one step backtracking is proposed and validated on the multi-signal model of the hydraulic AGC system. The example shows that the algorithm can isolate the fault states with less test cost.

17:20-17:40 **SunB10-4**

A Weights Particle Filter for State Estimation

Chengyuan Sun Bohai Univ.
Xinrui Shen Bohai Univ.
Jian Hou Bohai Univ.
Zhiyong She Bohai Univ.
Beijing Aerospace Tech. Inst.

The particle filter (PF) is an effective technique for state estimation in the nonlinear and non-Gaussian systems. However, one serious problem of PF is resampling. In this study, a weights PF (WPF) is proposed to mitigate the particle impoverishment problem common in PF. The WPF is inspired by the selection operator of genetic algorithm (GA). The weights of WPF are divided into two parts, and the large weights are used to replace the small ones. In this strategy, more particles are able to participate in the approximation of the posterior distribution after the procedure of resampling. Consequently, the results of state estimation can be more accurate. Meanwhile, the WPF has fairly low computational burden. Finally, the effectiveness of the proposed technique is verified by two simulation examples.

17:40-18:00 **SunB10-5**

Anomaly Detection of Spacecraft Attitude Control System Based on Principal Component Analysis

Bingqing Feng Sichuan Univ.
China Xi'an Satellite Control Center
Shaolin Hu Sichuan Univ.
Chuan Li Xi'an Univ. of Tech.
Yangfan Miao Sichuan Univ.

Based on the high fault rate of the attitude control system in the process of spacecraft running, this paper analyzes the variation tendency, characteristics and regularities of different types of data generated by the attitude control system. In this paper, we construct the principal component analysis (PCA) model to express the correlations among the variables using the data collected with normal operation. Then we propose the algorithm of PCA-based anomaly detection of the attitude control system and judge the state of the system by monitoring multi-variable statistics which can implement the performance monitoring of the orbiting spacecraft. The experimental results indicate the feasibility and validity of the method to detect the abnormality of the spacecraft attitude control system based on multi-variable statistics of the PCA model.

18:00-18:20 **SunB10-6**

A Parallel Computing Method for Fault Diagnosis Based on Hadoop

Qing Yang Shenyang Ligong Univ.
Wang Zhou Shenyang Ligong Univ.
Guichang Ma Shenyang Ligong Univ.

To improve the efficiency and the speed of fault diagnosis for multimode process under big data environment, a new parallel computation fault diagnosis approach, called GFCM-VMD-HM, is proposed for multimodal TE process based on Hadoop platform. Firstly, the global fuzzy c-means (GFCM) clustering algorithm is applied to distinguish the operation modes. Then, Variational Mode Decomposition(VMD) algorithm is introduced for the sake of filtering. After that, the data are encoded string files and put to Hadoop Distributed File System (HDFS). Finally, character statistics program is written to output multiple files under MapReduce data frame to complete the fault feature extraction and diagnosis. An experimental study is carried out to evaluate the performance of the proposed algorithm. The results obtained show that the method saves fault diagnosis time by means of parallel computing.

SunB11 **Room11**
Neural networks (II) **16:20-18:20**

Chair: Jun Hu Southeast Univ.
CO-Chair: Hongjun Zhou Chongqing Univ.

16:20-16:40 **SunB11-1**

Prediction of Soil Moisture With Complex-Valued Neural Network

Ronghua Ji China Agricultural Univ.
Shulei Zhang China Agricultural Univ.
Lihua Zheng China Agricultural Univ.
Qiuxia Liu China Agricultural Univ.
Ahmed Saeed Iftikhar China Agricultural Univ.

Soil moisture is a critical state affecting a variety of land surface and subsurface processes. In this paper we report investigation results of multilayer neural network with multi-valued neurons (MLMVN), it is a distinct type of complex-valued neural network with derivative-free back-propagation algorithm. We examined the proposed method by using 4752 soil moisture data set at 30cm underground and environmental factors (rainfall, temperature and wind speed) collected respectively. Firstly, in order to smooth the data, outliers and missing values were replaced by the mean values of the neighbors. Meanwhile, from the autocorrelation and timing diagram can be seen that soil moisture was non-stationary nonlinear time series, and rainfall, temperature and wind speed had significant influence on soil moisture according to the correlation analysis. Secondly, principal component analysis (PCA) was used to eradicate the correlation of initial input parameters (soil moisture, rainfall, temperature and wind speed), and the first three principal components were nominated to restructure the samples into a lower dimensions, to reduce the scale of network and improve network performance. Finally, transformed the restructured samples into complex values as inputs and outputs of MLMVN network. The experimental results show that, in multi-step ahead soil moisture prediction, two hidden layers PCA_MLMVN network outperforms the MLMVN network in term of prediction accuracy with the average prediction accuracy reached 92.8%, enhanced 4.5% compared with the MLMVN network. The result shows that PCA_MLMVN comfirm a good performance in the long-term prediction of soil moisture and show little accumulating errors for multi-step ahead predictions.

16:40-17:00 **SunB11-2**

Time Series Prediction of Stock Price Using Deep Belief Networks With Intrinsic Plasticity

Xiumin Li Chongqing Univ.
Lin Yang Chongqing Univ.
Fangzheng Xue Chongqing Univ.
Hongjun Zhou Chongqing Univ.

In recent years, the stock market plays an important role, which has attracted more and more attentions. The key problem of the stock market prediction is how to design a method to improve the prediction performance. As we know, the biggest challenge is that the stock time series is essentially dynamic, nonlinear, complicated, nonparametric and chaotic. In this paper, we propose a novel method to predict the stock closing price based on the deep belief networks (DBNs) with intrinsic plasticity. In the experiments, the stock in S&P 500 is used to examine the performance. The back propagation algorithm is used for output training to make minor adjustments of structure parameters. The intrinsic plasticity (IP) is also applied into the network to make it have adaptive ability. It is believed that IP learning for adaptive adjustment of neuronal response to external inputs is beneficial for maximizing the input-output

mutual information. Our results show that the application of IP learning can remarkably improve the prediction performance. Moreover, the effects of two kinds of IP rules on the performance of prediction are examined. Compared with Triesch's IP and without IP, DBN with Li's IP learning has much better prediction performance than the others. These results may have important implications on the modeling of neural network for complex time series prediction.

17:00-17:20 **SunB11-3**

The Intelligent Liquid Indicator Design Based On Soft Measurement

Yuexin Song North China Electric Power Univ.
Jin Ma North China Electric Power Univ.
Weiguo Tong North China Electric Power Univ.
Lujie Zhou North China Electric Power Univ.

Level measurement is an important part of industrial sectors, and it plays an important role for the safe and stable operation of the production process. The traditional liquid level instrumentation and equipment has disadvantages of low accuracy and poor stability, and it is not suitable for level measurement under complicated conditions. With the development of industrial technology, the liquid indicator develops toward miniaturization and intelligent. The main text takes the single room balance container as an example to design the intelligent liquid indicator which based on soft measurement. By using the actual data for training and testing, calculating and analyzing errors, finally gets the conclusion that the model is applicable to the boiler drum lever measurement, and achieves a high accuracy.

17:20-17:40 **SunB11-4**

An Improved Belief Function Method for Path Planning of AUV

Mingzhi Chen Shanghai Maritime Univ.
Daqi Zhu Shanghai Maritime Univ.

Path planning of AUV is a research topic of great importance. And the velocity vector synthesis method and belief function method can be applied in this area. Though it can plan a straight way for AUV to reach the target under the influence of current, the velocity vector synthesis method cannot avoid obstacles. Then belief function method is proposed to avoid obstacles and prevent speed jump of AUV. But the method may have folding path and "dead point" problems sometimes. Therefore, it cannot be applied in practical circumstances. In this paper, a restricted velocity vector synthesis method combined with improved belief function is proposed to overcome these situations. The effectiveness of the proposed algorithm is proved through effectiveness simulation. And comparison simulation is carried out. It is demonstrated that the folding path and "dead point'' problems are solved by the improved method.

17:40-18:00 **SunB11-5**

Finite-time H_infty Bounded Estimation for Memristive Recurrent Neural Networks With Randomly Occurring Time-delay and Missing Measurements

Jun Hu Southeast Univ.
Yue Song Harbin Univ. of Science and Tech.
Dongyan Chen Harbin Univ. of Science and Tech.
Xiu Kan Shanghai Univ. of Engineering Science

In this paper, the finite-time H_infty state estimation problem is investigated for a class of discrete-time memristive recurrent neural networks (DMRNNs) subject to randomly occurring time-delay and missing measurements. Two random variables obeying the Bernoulli distribution are employed to characterize the randomly occurring time-delay and missing measurements, where the corresponding occurrence probabilities are assumed to be known. The main purpose of this paper is to design an H_infty state estimator such that the estimation error dynamics is finite-time bounded with respect to some prescribed parameters and the H_infty performance is achieved simultaneously. In view of the semi-definite programming approach, sufficient conditions are given to guarantee the existence of desired state estimator and provide the explicit form of the estimator gain. Finally, a numerical simulation example is given to verify the feasibility and effectiveness of the developed estimation approach.

18:00-18:20 **SunB11-6**

Study on the State Prediction of Electronic Device Based on the BP Neural Network of Genetic Algorithm

Ting An Linyi Univ.

The state prediction of electronic device is the foundation and the key of the fault prediction and health management (PHM), it used to use the neural network method. In order to improve the accuracy, the paper studied the problem of using genetic algorithm to improve the BP neural network. First, the genetic algorithm was used to optimize the thresholds and the weights of the BP neural network. Then, the network was trained to obtain optimal solution. In the end, the paper verified the effectiveness of the BP neural network of genetic algorithm by two examples. The results of the first example showed that the average value of relative error of the output voltage predicted by the BP neural network of genetic algorithm is 2.11%, but the BP neural network method is only 5.342%. This shows the genetic algorithm method is superior to the traditional method, and has higher prediction accuracy. The second example drew the similar conclusion.

SunB12 Room12
Motion control (II) 16:20-18:20

Chair: Tao Zhang Tsinghua Univ.
CO-Chair: Ming Li Beihang Univ.

16:20-16:40 **SunB12-1**

The Research and Error Analysis of Attitude Solution Algorithm for Guided Munitions Based on MR Sensor

Hongye Cao Beijing Inst. of Tech.
Chunlei Song Beijing Inst. of Tech.
Yongqiang Han Beijing Inst. of Tech.
Zhe Dong Beijing Inst. of Tech.

The attitude solution is a vital index in the research of guided munitions. In order to better understand the attitude solution algorithm, the initial alignment and the error analysis, we study the attitude parameters. For the initial alignment requirement of the guided munitions integrated navigation, we use the attitude solution algorithm based on using the MR sensor. This algorithm uses magnetic sensor to measure the magnetic field signal. And in the premise of knowing the head angle, we tend to calculate the other two attitude angles. In addition, this paper proposes three algorithm errors, and the result is showed with the simulation and analysis using MATLAB. The simulation results show the algorithm is advisable in the attitude solution. It can be considered using this algorithm for guided munitions.

16:40-17:00 **SunB12-2**

Attitude Control and Vibration Suppression of Flexible Spacecraft Based on Quintic Polynomial Path Planning

Jiawei Tao Tsinghua Univ.
Tao Zhang Tsinghua Univ.
Yong Wang Beijing Inst. of Control Engineering
Shuping Tan Beijing Inst. of Control Engineering

With the development of aerospace mission, more and more satellites adopt large scale flexible structures. However, rigid body motion of flexible spacecraft is strongly coupled with elastic vibration of flexible structure, which may lead to oscillation and overshoot of satellite attitude, and even instability. In order to meet the requirement of rapid maneuver capability of agile satellites, a novel trajectory planning scheme is proposed in this study based on quintic polynomial transition. The continuous and smooth maneuver path is planned to solve the conflict between swiftness and overshoot in traditional path planning as well as to suppress the vibration of flexible appendages. In addition, a hybrid steering law is adopted to avoid the singularity problem and provide precise torque output simultaneously using a Variable Speed Control Moment Gyroscope (VSCMGs) cluster. Moreover, based on Simulink, a simulation platform is designed, which is served as the test bed for trajectory planning and steering law designing of flexible satellites, providing good extensibility. Overall, the numerical simulation results, based on the well-established platform, clearly establish that the proposed trajectory planning scheme is significantly superior to the existing methods. It is illustrated sufficiently that the established platform is helpful for trajectory planning and VSCMG steering law designing of VSCMG-actuated flexible satellite.

17:00-17:20 **SunB12-3**

Relay Route Planning Based on Connectivity in Airborne Ad Hoc Networks

Zhaochen Zhang Science and Tech. on Information Systems Engineering Laboratory, Nanjing, Jiangsu
Jing Zhao Science and Tech. on Information Systems Engineering Laboratory, Nanjing, Jiangsu

For the problem of communication support for the aircraft formation mission, the network connectivity is ensured by the way of adding relay nodes. A relay route planning method of airborne ad hoc network is presented. By the spanning tree selection strategy based on connected component and the relay vector connection strategy based on subsequent vector in-degree, the method gets the smallest number of additional relay node routes, then the network topology is connected graph all along the task route time range. The spanning tree selection strategy avoids the number of relay nodes rising caused by the change of Minimum Spanning Tree (MST) between adjacent time periods. According to the subsequent vector in-degree, the relay vector connection strategy connects the most relay vectors into relay routes. Simulation demonstrates that the proposed method can achieve the reuse of relay nodes in time and space. Compared with the traditional algorithm, this method can effectively reduce the number of relay nodes, and achieve the optimization of relay routes.

17:20-17:40 **SunB12-4**

Modeling and Simulation for Z-axis Force/Position-servo System of Assembly Manipulator

Ming Li Beihang Univ.
Hang Feng Beihang Univ.
XiaoguangZhang Beihang Univ.

In this paper, the mathematical model of Z-axis force/position-servo system of assembly manipulator of precise assembly platform for optical lens is established, including the mathematical models of permanent magnet synchronous motor (PMSM) and ball screw of manipulator, and then the friction and gravity disturbance is analyzed and modeled. Finally, the simulation is established to demonstrate the validity of the proposed model. The results show that the jitter of servo system occurs due to the inertia of worktable. Meanwhile, the sliding and scrambling of worktable appear under the disturbance from both the factor friction and gravity.

17:40-18:00 **SunB12-5**

2D Plane Standoff Tracking Based on Chaos-Lyapunov Guidance Vector Field

Yi Zhang Naval Aeronautical and Astronautical Univ.
Qiyuan Meng Naval Aeronautical and Astronautical Univ.
Xiuxia Yang Naval Aeronautical and Astronautical Univ.

In order to solve the problem that when UAV converges to target circle in the process of tracking target based on existing Lyapunov vector field, the flight path is fixed and easy to be detected, an improved Lyapunov guidance vector field based on Chaos theory (CLGVF) is proposed. CLGVF can achieve the standoff tracking of static or dynamic target and meet UAV's flight dynamics constraint at the same time. The flight path generated overcomes the shortcoming of existing method and its feasibility is verified by simulation in the end.

18:00-18:20 **SunB12-6**

Circumnavigation by a Car-like vehicle Using Distance Measurements

Jianqun Wan Univ. of Electronic Science and Tech. of China
Yingjing Shi Univ. of Electronic Science and Tech. of China
Rui Li Univ. of Electronic Science and Tech. of China
Yimin Bao Univ. of Electronic Science and Tech. of China

This paper considers the problem of steering a car-like vehicle to achieve a circular motion around a target with an unknown position. We propose control schemes that require only distance measurements and deal with two situations that the target is stationary or moves slowly. We show that using the proposed control schemes, the vehicle can circle the unknown-position target at a desired radius only with the distance measurements. Meanwhile the control schemes can work efficiently when the target moves slowly. The validity of the proposed control schemes is supported by the experiments.

SunB13 **Room13**
Signal processing (II) **16:20-18:20**
Chair: Rao Zhang Nankai Univ.
CO-Chair: Wei Xie South China Univ. of Tech.

16:20-16:40 **SunB13-1**

Design and FPGA Implementation of DDS Based on Waveform Compression and Taylor Series

Jianxun Zhang Nankai Univ.
Rao Zhang Nankai Univ.
Yu Dai Nankai Univ.

Direct Digital Frequency Synthesis (DDS) or Numerically Controlled Oscillators (NCO) is an important functional blocks in digital communication systems. DDS is widely used in the fields of radar, communication and electronic warfare. It plays an important role in digital up-conversion, down-conversion, demodulation of phase and frequency. This paper brings out the FPGA implementation of one such DDS which has quadrature outputs. The proposed design, which is based on look-up table (LUT) using wave compression and Taylor series calculation, has considerable improvement in terms of spurious free dynamic range (SFDR) compared to other existing designs based on traditional LUT. The design is implemented on Xilinx Zynq XC7Z020-1CLG484 FPGA, fabricated in 28 nm process technology. The design has utilized 489 slice flip flops and 388 4-input LUTs as its hardware count. The SFDR of proposed DDS is 114 dBc, which has improved by 70dB than traditional DDS.

16:40-17:00 **SunB13-2**

The Application of Adaptive Fractional Differential Algorithm in Virtual Keyboard

Bo Li South China Univ. of Tech.
Wei Xie South China Univ. of Tech.
Xiaoyuan Yu South China Univ. of Tech.
Langwen Zhang South China Univ. of Tech.

The virtual keyboard applying image processing technology can collect the image of keyboard area via camera and identify which key is pressed after image processing. Virtual keyboard has the advantages like less hardware, small volume and easy portability. Because of the interference of light and noise, it is likely to lose pixel when extracting the edge of key image using traditional image processing method, which may lead to the decrease of key identification accuracy. As a result, this paper applies adaptive fractional differential in virtual keyboard, which not only enhances the edge of key image, but also retains the weak texture of the image. Therefore, the edge of key in the image is clearer and the discrete edge pixels decrease, which improves the accuracy of subsequent key position extraction.

17:00-17:20 **SunB13-3**

A Novel Data Preprocessing Method for DPD's Polynomial Modeling Based on Principal Component Analysis

Xia Zhao Tongji Univ.
Zhanning Li Tongji Univ.
Yingting Ni Tongji Univ.

Digital Pre-Distortion (DPD) is a cost-effective way to the linearization of a power amplifier (PA). The polynomial-based model is commonly used to characterize DPD. However, the number of coefficients in polynomialbased model becomes quite large when PA has high-order nonlinearity and deep memory. Moreover, the model often shows numerical problems, which make it unattractive in practical application. In this paper, a novel data preprocessing method using main idea of principal component analysis (PCA) is proposed. The method takes the polynomial terms as 'characteristics', and transforms those 'characteristics' to some new less 'characteristics' by a matrix made up of eigenvectors of a covariance matrix. PCA-based method has the following advantages: it extracts and uses main components to express high nonlinearity and deep memory effects, which decreases the number of coefficients in polynomial-based model and makes the implementation complexity reduce; it reduces the condition number and improves numerical stability; it does not need to know the distribution of input signal. Finally, simulation results indicate the effectiveness of PCA-based method.

17:20-17:40 **SunB13-4**

A New Adaptive Iterative Regularized Algorithm for Super-resolution Image Reconstruction

Chunli Wu Northeastern Univ.
Cuili Liu Northeastern Univ.
Xiaowan Li Northeastern Univ.
Baoqi Yu Liaoning Inst. of Science and Tech.

In order to further improve the reconstruction quality of super-resolution image, a new reconstruction algorithm of adaptive super-resolution image sequence is proposed. The algorithm could adaptively estimate the regularization coefficients for each low-resolution image, and self-adaptively update the iterative step size in the iterative process. In the process of super-resolution image reconstruction, the prior information of image are sufficiently utilized, thus the reconstruction effects would be better. In the conventional bilateral total variation (BTV) regularized algorithm, the regularization parameter can be selected adaptively, but the iterative step size is not adaptive. The simulation experiments are performed for Lena image and Fish image, which using the proposed algorithm and the conventional regularized algorithm. And the experimental results indicate that, compared with the conventional adaptive BTV algorithm, this proposed algorithm has a relatively higher peak signal-to-noise ratio (PSNR) and better visual reconstruction effects of image.

17:40-18:00 **SunB13-5**

New methods for solving the nuclear norm with random matrix and the application in Robust Principal Component Analysis

Zhen Wang Nanjing Univ. of Posts and Telecommunications
Min Yang Nanjing Univ. of Posts and Telecommunications

RPCA (Robust Principal Component Analysis) recovers sparse and low rank components from the original observation data, RPCA commonly uses ADM (Alternate Direction Method) for solving, the efficiency of algorithm depends on the nuclear norm optimization solution, that is SVD. And the application of RPCA in computer vision, image and video and so on, large amounts of data, such as images and video, make it difficult for large-scale data SVD. In this paper, we used the random matrix algorithm to improve the SVD, respectively the Count Sketch algorithm, the Prototype Randomized k-SVD algorithm and the Faster Randomized k-SVD algorithm, the main idea is to reduce the size of the original large-scale data matrix and sample randomly. Using the random projection algorithm to obtain an approximation of the original matrix, and operate QR decomposition of the approximate matrix, get the unitary matrix corresponding to the approximate matrix, and do the corresponding SVD, finally we can get the results which is similar to the original matrix calculation.Obtaining approximation of the original data matrix.But the cost time and space have been greatly optimized. Simulation experiments based on single image and video foreground detection show that the proposed methods can greatly improve the efficiency of RPCA iterative optimization.

18:00-18:20 **SunB13-6**

Anomaly detection based on Super-Pixels Time Context Feature

Dandan He Jiangnan Univ.
Ying Chen Jiangnan Univ.

To combine consistency of moving object with temporal motion information of objects, an anomaly detection method based on time context features of super-pixels is proposed. Firstly, the video frames are segmented into super-pixels and then super-pixels of foreground are then selected according to their pixel ratios of foreground. Secondly, to enhance the temporal relation of super-pixel features, the mean value of multi-scale histogram of optical flow of super-pixels among adjacent frames which matched with the current super-pixels based on the gray-level histogram is taken as the feature for detection. Finally, the sparse combination learning algorithm is adopted to detect abnormality in the videos. The experiments show that the algorithm can reliably detect and locate anomalies in UCSD and UMN video libraries.

SunB14 **Room14**
Data processing (II) **16:20-18:20**
Chair: Jiang Jiang National Univ. of Defense Tech.
CO-Chair: Mengyu Liu Beijing Aerospace Automatic Control Inst.

16:20-16:40 **SunB14-1**

Sleep Monitoring Approach based on Belief Rule-Based Systems with Pulse Oxygen Saturation and Heart Rate

Jianbin Sun National Univ. of Defense Tech.
Yanqing Ye National Univ. of Defense Tech.
Leilei Chang High-Tech Inst. of Xi'an

Jiang Jiang National Univ. of Defense Tech.
Xiaoxiao Ji National Univ. of Defense Tech.
This paper aims to propose a sleep and wake classification approach based on Belief Rule-Based (BRB) systems (called BRB classifier) to address the challenge of daily personal sleep monitoring at home. The BRB classifier infers sleep and wake states with two signals, pulse oxygen saturation and heart rate which can be obtained from wearable devices. The actual sleep datasets collected by Sleep Heart Health Study group are investigated to testify the efficiency of BRB classifier. In this case study, several experiments are conducted to determine the settings of BRB systems. By comparing with Linear Discriminate classifier and Neural Network classifier, the proposed BRB classifier has shown superior performance in sleep/wake classification with pulse oxygen saturation and heart rate.

16:40-17:00 **SunB14-2**

Dynamic Load Balancing Decision Algorithm for Domestic Data Processing System

Mengyu Liu Beijing Aerospace Automatic Control Inst.
Jie Zhang Beijing Aerospace Automatic Control Inst.
He Pang Beijing Aerospace Automatic Control Inst.
Longfei Wei Beijing Aerospace Automatic Control Inst.
Wei Zheng Beijing Aerospace Automatic Control Inst.
In this paper, a new dynamic load balancing decision algorithm is proposed based on the multi-core single-server of the domestic data processing system, and the data processing capability of the whole data processing system is improved by software algorithm. First, we set CPU affinity, which binds the process task on the CPU core to prevent inter-process migration. The weighted minimum join algorithm is then improved. According to the CPU occupancy of each CPU core, the load balancer set the weight of each CPU's processing power, the weight of the data packets are distributed to the task queue bound to the CPU with the largest weight, in order to achieve the load balance among different cores. Finally, the experiment proves that this dynamic load balancing decision algorithm can realize the load balance among the CPU cores of the system.

17:00-17:20 **SunB14-3**

An Algorithm for Automatic Recognition of Cluster Centers Based on Local Density Clustering

Xuanzuo Ye Zhejiang Univ. of Tech.
Dinghao Li Zhejiang Univ. of Tech.
Xiongxiong He Zhejiang Univ. of Tech.
Based on the local density clustering (LDC) algorithm, a new automatical local density clustering (ALDC) algorithm is proposed in this paper. Different from the existing LDC algorithm, the ALDC can capture the cluster center automatically. The new algorithm calculates the local density and the distance deviation of every point and expands the difference between the potential cluster center and other points by using these two features. The expansion of difference enables the machine automatically to recognize the cluster centers, and then assigns the remaining points by their closest neighbor of higher density. Experimental results on data sets show that the ALDC algorithm can achieve a accurate clustering and obtain a higher accuracy of clustering result than other two classical cluster algorithms.

17:20-17:40 **SunB14-4**

Planar Visibility Graph Network Algorithm For Two Dimensional Timeseries

Jie Liu Wuhan Textile Univ.
Qingqing Li Wuhan Textile Univ.
In this brief paper, a simple and fast computational method, the Planar Visibility Graph Networks Algorithm was proposed based on the famous Visibility Graph Algorithm, which can fulfill converting two dimensional timeseries into a planar graph. The constructed planar graph inherits several properties of the series in its structure. Thereby, periodic series, random series, and chaotic series convert into quite different networks with different average degree, characteristic path length, diameter, clustering coefficient, different degree distribution, and modularity, etc. By means of this new approach, with such different networks measures, one can characterize two dimensional timeseries from a new viewpoint of complex networks.

17:40-18:00 **SunB14-5**

The Study on Daily Variation Characteristics of PM 10 Concentration Based on the Attribute Partial Order Structure Diagragm

Yanyan Zhang Northeastern Univ. at Qinhuangdao
Xiaomin Wang Northeastern Univ. at Qinhuangdao
Jianbo Liu Northeastern Univ. at Qinhuangdao
Jing Liu Northeastern Univ.
As an important tool for data analysis and knowledge processing, formal concept analysis has been applied to many fields. In this paper, we introduce a new visualization method of a concept lattice and the attribute partial order structure diagram (APOSD), we obtain the analysis method of the daily variation characteristics of PM 10 concentration. Through in-depth analysis of the APOSD by granulating the PM 10 concentration data, it is confirmed the effectiveness and rapidity of the proposed method, to grasp the law in perspective and to discover new relationship. To provide scientific basis for improving the environment.

18:00-18:20 **SunB14-6**

Face Detection Based on Skin Color and AdaBoost Algorithm

Chongshan Lv Beijing Inst. of Tech.
Ting Zhang Beijing Inst. of Tech.
Cong Lin Beijing Inst. of Tech.
This paper proposes a face detection algorithm of combining skin color segmentation and AdaBoost algorithm .The algorithm set up the skin Gaussian model in YCbCr color space using skin color clustering characteristics. Then sort out the region of skin color, use AdaBoost algorithm to train a classifier to detect face in the image. Based on our experiments, the proposed method shows good results with significant improvements of low error detection rate and better detection speed in both simple and complex background.

SunB15 Room15
Factory modeling and simulation 16:20-18:20

Chair: Liang Chen Soochow Univ.
CO-Chair: Zhiwei Zhou Chinese Academy of Sciences

16:20-16:40 **SunB15-1**

Modeling and Simulation of a Novel HEV Automatic Transmission System for Heavy Duty Vehicles

Liang Chen Soochow Univ.
Chenlu Geng Soochow Univ.
Juanjuan Song Soochow Univ.
This paper designed a new type of hybrid structure of automatic transmission for the heavy duty vehicles. After determining the parameters for the core components according to the working principles of the hybrid vehicle and performance requirements, the mathematical model of hybrid electric vehicles has been completed by using the Simulink. For the purpose of the vehicle's fuel economy and power performance, the control strategy based on the rules of logic threshold has been studied in this paper. The New European Driving Cycle (NEDC) as a benchmark for simulation analysis was made on the heavy duty vehicle model. Compared the simulation results with those of a traditional vehicle, the new structure of the hybrid electric vehicle can improve fuel economy significantly while meeting the dynamic performances.

16:40-17:00 **SunB15-2**

Process Automation Study of a Helium Cryoplant Warm Compressor Station using Dynamic Simulation

Zhiwei Zhou Chinese Academy of Sciences
Qiang Yu Chinese Academy of Sciences
Univ. of Science and Tech. of China
Liangbing Hu Chinese Academy of Sciences
Ming Zhuang Chinese Academy of Sciences
Qiyong Zhang Chinese Academy of Sciences
Linhai Sheng Chinese Academy of Sciences
For the optimal control and full automatic operation, the process automation of a warm compressor station in a helium cryogenic system has been studied using dynamic simulation. The warm compressor station model was developed with a commercial modeling and simulation software EcosimPro. Based on this model, control strategies study and virtual commissioning of control system have been performed. This paper presents the modeling development and the process control design of the helium warm compressor station. Then the process automation operation including the compressors start and three stages of pressure control as well as the emergent stop process was simulated and analyzed. The simulation results prove the satisfied control performance during the entire process. And it shows that dynamic simulation for the complex helium cryoplant is the best way to design and test the new or improved control strategies without disturbing the real operation.

17:00-17:20 **SunB15-3**

Artificial Neural Networks Model for Predicting Oxygen Content In Flue Gas of Power Plant

Zhenhao Tang Northeast Electric Power Univ.
Haiyang Zhang Northeast Electric Power Univ.
Hui Yang Xinxiang Dream Power CO. LTD
The oxygen content in flue gas of power plant is one of the important variables for keeping the boiler combustion process stable and secure. Real-time monitoring and control for the oxygen content in flue gas of power plant is difficult at present. To address this problem, we propose a soft measurement method based on back-propagation neural network (BPNN) and genetic algorithm (GA) to predict the oxygen content in flue gas of power plant. In the algorithm, partial least squares (PLS) method is used to reduce dimensions of input variables. The model based on the data collected from the historical data of power plant is constructed by BP. The GA algorithm is utilized to optimize the parameters of BP for improving the accuracy of the model. The proposed method has been proved effective through iterative experiments.

17:20-17:40 **SunB15-4**

Research on Soft Sensor Based on Extreme Learning Machine

Zhili Xiong Huanggang Normal Univ.
Central China Normal Univ.
Shaocheng Qu Central China Normal Univ.
Zhigao Lan Huanggang Normal Univ.
The traditional ELM algorithm in the hidden layer part parameters when the data sets are determined randomly and outliers are present, using the least squares method often exaggerate the singular value influence, cause the system deviation, resulting in the results of ELM network

instability. In view of the above problems, an improved algorithm for extreme learning machine is proposed. By introducing the M estimation method, the specific idea is iterative weighted least squares estimation of regression coefficient, so as to optimize the residual sum of squares objective function to determine the weights of each sample to improve the robustness of traditional extreme learning machine. Finally, the data set is constructed to validate the proposed method, and the results show that the proposed method can reduce the impact of outliers and improve the prediction accuracy.

17:40-18:00 **SunB15-5**

Analysis of the transition process of ball valve close in vertical high lift pump station

Fangting Yang Beijing simulation center economic field system simulation technology application National Engineering Research Center
Lei Liu North China Univ. of Tech.
Yuntao Shi North China Univ. of Tech.
Wenyan Guan Beijing simulation center economic field system simulation technology application National Engineering Research Center

Aiming at the vertical high lift pumping station of hydraulic transient characteristics, especially in the emergency shutdown valve after the pump is pumping head and inlet pressure is too large, the characteristic line method, calculation model of the transition process of water hammer is established. At the same time, combined with the project general situation, established the setting model of two stage pumping station outlet valve, in order to reduce the model after the pump valve head and inlet pressure as the objective function, to close the angle valve two stage and slow closing time for setting variables, constraint conditions and corresponding to the setting of the two stage valve, determine the minimum value of the objective function, and then reduce the tuning step further tuning. The results show that when the 6s setting fast turn 72 degrees, 18 degrees 17s slow closing valve after the pump, the head pressure is 345.33m, inlet pressure is 88.0m, the maximum speed is 1.04 times of reverse pump rated speed, the best tuning results.

18:00-18:20 **SunB15-6**

On-line Monitoring of Ash Fouling for Air Pre-Heaters in Coal-fired Power Plant Boiler

Yuanhao Shi North Univ. of China
Jingcheng Wang Shanghai Jiao Tong Univ.
Jie Wen North Univ. of China

Air pre-heater of coal-fired power plant boiler is an important piece of engineering equipment, which is designed to heat air before combustion in furnace with the primary objective of increasing the thermal efficiency of the boiler. This paper presents a mathematical model of heat exchange, which allows for the on-line monitoring of ash fouling in air preheater. The model is built using dynamic heat balance method, in which the cleanliness factor is used to characterize the fouling level. The ash fouling model is validated by using the actual data of a 300MW power plant boiler. The validation results show the effectiveness of the proposed method. It can be used for the soot blowing optimization in most coal-fired power plant boiler with air preheaters, not requiring additional special instruments and complex computing systems.

SunB16 **Room16**
Smart grids (I) **16:20-18:20**

Chair: Jinkuan Wang Northeastern Univ.
CO-Chair: Hong Liu North China Electric Power Univ.

16:20-16:40 **SunB16-1**

A Multi-Objective Optimization Strategy for Combined Heat and Power Systems of the Energy Internet

Fangyuan Si Northeastern Univ.
Jinkuan Wang Northeastern Univ.
Qiang Zhao Northeastern Univ.
Northeastern Univ. at Qinhuangdao
YingHua Han Northeastern Univ. at Qinhuangdao

Energy Internet is a kind of novel interconnected multi-energy-grids, highly coupled with the information internet. Aiming at the problems of resource saving and environment protection, a multi-objective optimization strategy in primary energies of the Energy Internet considering economic and environmental aspects has been proposed. An optimization coordination model was presented for combined heat and power (CHP) system with complimentary generation of wind, photovoltaic cell (PV), gas and energy storage in different tariff structures. Typical load and the third order model of generator efficiency were selected in the proposed model to make the result more accurate. To avoid the premature convergence problem, the neighborhood re-dispatch particle swarm optimization (NR-PSO) algorithm was adopted, which re-dispatches in neighborhood of the iteration that could avoid falling into the local optimum. Finally, three operating modes are detailed and the result indicates it can reach an equilibrium point that can reduce the pollution gas without too much additional cost.

16:40-17:00 **SunB16-2**

Research on Impacts of the Electric Vehicles Charging and Discharging on Power Grid

Xuesong Zhou Tianjin Univ. of Tech.
Lei Zou Tianjin Univ. of Tech.
Youjie Ma Tianjin Univ. of Tech.
Zhiqiang Gao Tianjin Univ. of Tech.

In the present, more and more concerns have been paid to the world energy conservation and environmental protection, therefore, the development of electric vehicles(EVs) are speeding up. Electric vehicles have good environmental protection performance and can taking many kinds of energy as power the prominent characteristic, and electric vehicles are considered as green transportation for the 21st century.Automotive manufacturers, governments, and environmental organizations are taking more and more care about the electric vehicle. As zero emission vehicles, electric vehicles can radically decrease vehicles exhausting pollution to improve air environment and adjust the energy structure. So, the author assumes that electric vehicles should be developed vigorously in our country, but large-scale EVs charging has become a practical problem in the grid operation and planning of the distribution network. It might have great impacts on the system performance, such as overloading, reducing efficiency, deteriorating power quality and increasing power system losses.As the light vehicle fleet moves to electric drive (hybrid, battery, and fuel cell vehicles), an opportunity opens for “vehicle-to-grid” (V2G) power.V2G only makes sense if the vehicle and power market are matched.This paper briefly discusses the impact of the charging on the distribution system, the factors of causing the influence, the charging control methods that reduce the impacts on the distribution network and V2G techniques.Based on the current development status and problems, discuss the trend of EV.

17:00-17:20 **SunB16-3**

Voltage and Reactive Power Control of Microgrids Based on Distributed Consensus Algorithm

Lizhen Wu Lanzhou Univ. of Tech.
Aihu Lei Lanzhou Univ. of Tech.
Xiaohong Hao Lanzhou Univ. of Tech.

In a low-voltage microgrid system, due to the influence of property of line impedance and other factors, the reactive power supplied by distributed generations could not be shared accurately based on conventional droop control. To improve the power sharing accuracy, a voltage and reactive power control approach of microgrids (MGs) based on distributed consensus algorithm (DCA) is proposed in this paper. Based on the communication technology and hierarchical control theory, an architecture of distributed hierarchical control is introduced which consists of local control level and distributed secondary control level. The local control level involves droop control, virtual impedance control and proportional-resonance (PR) voltage and current control to achieve reactive power sharing. In secondary control level, an observer is designed based on DCA to get global average value, which restores the voltage deviation and improves the accuracy of reactive power sharing. Besides, the method not only can reduce the high bandwidth requirements, but also improve the reliability and extended flexibility of MGs. Finally, the simulation experiment platform is built based on Matlab/Simulink software and dSPACE1103. Real-time simulation results are shown to demonstrate the effectiveness and robustness endowed by the proposed method. The results indicate that the DCA is very robust with respect to communication impairments, such as packet delays and random packet losses.

17:20-17:40 **SunB16-4**

Research on Reactive Power Compensation Technology in Distribution Grid

Youjie Ma Tianjin Univ. of Tech.
Luwen Cao Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Zhiqiang Gao Tianjin Univ. of Tech.

The researches of reactive power compensation in distribution network mainly consist of two aspects: the research of reactive power compensation optimization theory and the research of reactive power compensation device. According to certain configuration principle and optimization principle, the mode and capacity of reactive power compensation can be optimized, which can effectively reduce the system loss and improve the power quality of distribution network. At present, reactive power compensation devices include shunt capacitor, static var compensator and static synchronous compensator (D-STATCOM). We could choose the appropriate reactive power compensation device to compensate the distribution network in the view of practice and economy. This article would introduce some aspects of reactive power compensation breifly, including several studies on compensation mode selection and capacity determination. In addition, we would also introduce the working principle and the reactive current detection technology of D-STATCOM which is the most advanced reactive power compensation device.

17:40-18:00 **SunB16-5**

Research on Seasonal Power Load Characteristics and Modeling of TOU Price

Taihua Chang North China Electric Power Univ.
Hong Liu North China Electric Power Univ.
Yang Hu North China Electric Power Univ.
Junlin Guo North China Electric Power Univ.

With the rapid development of economy, the proportion of cooling load and heating load grows into an important share of the total load. These loads formed the peak load and had great demand response potential.

The effective demand response strategy becomes greatly significant to achieve peak load shifting, load rate improving and electricity cost reducing, which is developed on studying users load characteristics in different seasons. Firstly, the daily load data in 2015 from Hainan power grid is divided into the different types according to the internal connection of the load curve by clustering algorithm, and the typical daily load curves are fitted out, which can represent the seasonal characteristics. Then the time-of-use (TOU) pricing model is established with the price demand elasticity coefficient to find the optimal price of different seasons. Finally, the users' power utilization under different TOU prices and different demand response strategies are compared. The result indicates that TOU price and incentive is significant for optimization, which is benefit for the development of intelligent power grid and demand response project.

18:00-18:20 **SunB16-6**

Study of Electricity Load Forecasting Based on Multiple Kernels Learning and Weighted Support Vector Regression Machine

Limei Liu Shenyang Inst. of Engineering
Xuan Hou Shenyang Inst. of Engineering

Electricity load forecasting research has become a hot spot. Accurate electricity load forecasting is of great practical significance to our lives. Support vector regression machine is suitable for data forecasting capabilities. Its merit of learning method is under the less and limited information condition to obtain much more ability. This paper presents a new algorithm that is a multi-kernel algorithm and a new weighted support vector regression machine that is applied in power system short-term load forecasting field. The algorithm can optimize the kernel functions of support vector regression machine. The simulation experimental results indicate that the new algorithm made a meaningful exploration on forecasting electricity load and it can shorten the prediction time with good generalization performance.

SunB17 **Room17**
Renewable energies (II) **16:20-18:20**
Chair: Haitao Liu Chinese Academy of Sciences
CO-Chair: Chang Sun North China Electric Power Univ.

16:20-16:40 **SunB17-1**

Evaluation of Risk and Benefit of Available Transfer Capability Decisions For Wind Farms Integration System

Lei Jia Lanzhou Univ. of Tech.
Xiaoying Zhang Lanzhou Univ. of Tech.
Labao Zhang Nanjing Univ.
Kun Wang State Grid Gansu Electric Power Company Electric Power Research Inst.
Wei Chen

Wind power integration has made a new demand on the calculation of available transfer capability (ATC) in the power system operation. How to accurately decide ATC considering the volatility and stochastic variation of wind power as well as improve the calculation efficiency and precision has become an urgent problem to be solved. An improved method based on Reflective slice sampling (RSS) is proposed in this paper and applied to risk-based ATC decisions for wind farms integration system. The optimal modeling for probability model of wind farm outputs is firstly constructed. Then the sample space is obtained by RSS from the probabilistic model of wind farm outputs. Finally, the samples from the sample space are calculated by load flow and the statistical analysis of ATC decisions index is finished, the results of Gibbs sampling methods and RSS method are compared in IEEE30-bus system. It is shown that the proposed method can reduce the computation time and ensures its accuracy, and further improve system transmission efficiency.

16:40-17:00 **SunB17-2**

Performance Ratio Measurement Method of Photovoltaic Modules under Natural Sunlight Condition

Haitao Liu Chinese Academy of Sciences
Guomin Zhou Tibet New Energy Research and Demonstration Centre
Shuai Zhou Chinese Academy of Sciences

Photovoltaic module is the key photo-electric conversion product in renewable energy field. To evaluate photovoltaic module electrical performance accurately, module performance ratio parameter is presented in this paper. On-site experiment for performance ratio is introduced and illustrated for performance ratio calculation and assessment of modules under natural outdoor condition. Compared with peak power and efficiency parameters of module, the performance ratio is more accurate and suitable for rating photovoltaic module electrical performance over long time period.

17:00-17:20 **SunB17-3**

Wind Turbine Spindle Condition Monitoring Based on Operational Data

Zhaoguang Wang North China Electric Power Univ.
Peng Guo North China Electric Power Univ.

Wind turbine spindle is the connecting part of impeller and gearbox. It has the function of transmitting torque and energy in the transmission chain of the unit. It needs to bear the bending moment and thrust of the wind wheel, so the failure rate of spindle is high. Therefore, the condition monitoring of the spindle is directly related to the stability of wind turbine and power generation. The spindle temperature model is established and used to predict by the nonlinear state estimate technology under the normal operating condition of the spindle. When the spindle fails, the observation vector of the model input changes obviously, resulting in a significant change of the prediction residual. In order to improve the sensitivity and reliability of the spindle anomaly early warning, using the double moving window calculate the statistic properties of the residual sequence based on the Lewitt criteria. If the residual mean or standard deviation exceeds the set fault alarm threshold, an alarm message will be issued. Using the actual operating data of wind turbine spindles verify the validity of this method.

17:20-17:40 **SunB17-4**

Data Preprocessing of Wind Turbine Based on Least Squares Support Vector Machine and Neighbor Model

Chang Sun North China Electric Power Univ.
Peng Guo North China Electric Power Univ.

Wind turbine data preprocessing is a key step in wind turbine equipment condition assessment, and it helps to improve data quality and data utilization. In this paper, a data preprocessing method has been proposed based on the neighbor model of least squares support vector machine, with the wind speed data as an example. There are strong similarities between the operating conditions of wind turbines with similar wind resources. In this paper, e use the normal data of multiple wind turbine anemometers and the least squares support vector machine（LS-SVM）method to establish the neighbor model between wind speed data of multiple wind turbines. This model reflects the similarity of the wind speed between neighbors. After the model established, the wind speed data containing the outliers will be input to the model. When the wind speed data of one unit is abnormal, the similarity relation between the data and its adjacent units data is destroyed. The prediction residual of the wind speed of this unit will be increased significantly by the neighbor model, indicating that the wind speed data is abnormal data. The method can realize the recognition of wind turbine abnormal data. Based on the actual operation data of a wind farm, the validity of the method is verified.

17:40-18:00 **SunB17-5**

Predictive Controller Design and Simulation for a 50kW Three-phase Grid-Tied Inverter

Guoan Qin Wuhan Univ. of Tech.
Xiaoru Luo Wuhan Univ. of Tech.
Qihong Chen Wuhan Univ. of Tech.
Liyan Zhang Wuhan Univ. of Tech.

This paper presents a method to design a predictive controller for a 50kW three-phase grid-tied inverter. A discrete-time model of the inverter is built in which duty ratios are modeled as continuous control variables. Then, introduce predictive control parameters P and M, and built a predictive model based on predictive controller parameters and discrete-time model. A cost function is employed as a criterion to optimize duty ratio. The simulation results are provided to validate the feasibility and effectiveness of the proposed algorithm.

18:00-18:20 **SunB17-6**

Prediction of Solar Radiation Intensity in Clear Sky Based on AOD Estimation Model

Yongjun Lin North China Electric Power Univ.
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Atmospheric aerosol is one of the most important factors that cause the random variation of solar radiation intensity. In view of the problem that the atmospheric aerosol optical depth (AOD) is difficult to obtain real-timely with high accuracy, BP neural network method is adopted to estimate the AOD based on PM2.5 concentration, PM10 concentration, air temperature and air relative humidity that from air quality monitoring station; then, take AOD and precipitable water as main change parameters, REST2 model is simplified to calculate direct solar radiation intensity and scattered radiation intensity in clear sky. Experimental results show that the proposed method for predicting solar radiation intensity in clear sky is of high precision and easy to be realized.

SunBIS **Room18**
Interactive Session **14:00-16:00**

SunBIS-01

Online-Rating Prediction Based On an Improved Opinion Spreading Approach

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Recommender systems are significantly useful to reduce information explosion nowadays. In order to design an optimized algorithm, we develop an improved opinion spreading approach to predict online rating of recommender systems. The proposed method provides a solution to zero-value problems of similarity results, which is ignored in existing publications. The proposed method could produce a more precise rating prediction for each unrated user-item pair. In our work, the similarity of items is defined as the number of corresponding reviews which a user has given and the differences between those viewpoints spreading in network model. Using Movie-lens data set, experiments confirm that the

presented algorithm has better performance than both collaborative filtering algorithm based on Pearson correlation coefficient and the original opinion spreading approach. Our approach produces a mean absolute error (MAE) 2.1% lower and root mean square error (RMSE) 2.5% lower than existing algorithms, which indicates a higher accuracy score.

SunBIS-02

Synchronization of Delayed Complex Networks with Hybrid Coupling Via Pinning Impulsive Control

Chengbo Yi Shenzhen Univ.
Jianwen Feng Shenzhen Univ.
Yi Zhao Shenzhen Univ.

This paper studies the synchronization problem of delayed complex networks with hybrid coupling, which is composed of current-state coupling and distributed time-varying delay coupling among the nodes of the complex networks. By means of pinning impulsive control, some conditions are derived to ensure global exponential synchronization of the complex networks through introducing pinning ratio. The main result of this letter has extended some existing related works. Numerical simulations are provided to illustrate the effectiveness of the theoretical analysis.

SunBIS-03

Two Controllable Canonical Forms for Single Input Complex Network

Lifu Wang Northeastern Univ. at Qinhuangdao
Liqian Wang State Grid Liaoning Information and Communi cation Company
Zhi Kong Northeastern Univ. at Qinhuangdao

The outstanding problem of controlling complex networks is relevant to many areas of science and engineering, and has the potential to generate technological breakthroughs as well. Despite the development of structural controllability theory, we continue to lack a framework to design controllable structure of complex networks. In this paper, we provide two canonical forms for controlling complex network. To fully control the canonical form structure, the minimum number of inputs (driver nodes) Nd = 1. The controllable canonical form provide a step forward from the current research on controllability toward ultimate control of complex networked dynamical systems.

SunBIS-04

State Estimation for Complex Network with One Step Induced Delay Based On Pinning Control

Wei Wang Nanjing Univ. of Posts and Telecommunications
Youhong Wan Nanjing Univ. of Posts and Telecommunications

In this paper, the state estimation of the complex network with one-step induced delay is studied.The state estimation system are designed that only need a part of the network node's output measurement. By using the Lyapunov stability theory and the stochastic analysis method, the sufficient conditions for the gain matrix of the state estimator are presented in the form of linear inequalities. The derived conclusions can also be used to obtain the minimum number of pinned nodes. Finally, the numerical simulation is given to illustrate the effectiveness of the results.

SunBIS-05

Nonnegative Edge Consensus of Complex Networks with Time Delay

Wanna Jia Shenzhen Univ.
Yi Zhao Shenzhen Univ.
Jianwen Feng Shenzhen Univ.
Jingyi Wang Shenzhen Univ.

Differing from the existing literature about nodes' consensus, this paper focus on consensus taking place on the edges of complex network. With time delay. Firstly, the coupling protocol with time delays is given. It's worth pointing out that considering about the physically meaning, the edges must be nonnegative to make sense of the world. Then we obtain some criteria for guaranteeing the edge consensus of the proposed complex dynamical network by using linear matrix inequality, algebraic graph theory and ordinary differential equations. Finally, several examples are presented to show the effectiveness and correction of the theoretical results.

SunBIS-06

Ranking the Key Nodes with Temporal Degree Deviation Centrality on Complex Networks

Zhiqiang Wang State Grid Zhejiang Electric Power Company Information & Telecommunication Branch
Xubin Pei State Grid Zhejiang Electric Power Company Information & Telecommunication Branch
Yanbo Wang State Grid Zhejiang Electric Power Company Information & Telecommunication Branch
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Records of time-stamped social interactions between pairs of individuals (e.g. the human contact networks involved in the transmission of disease, ad hoc radio networks between moving vehicles, and the transactions between principals in a market) constitute a so-called temporal network. A remarkable difference between temporal networks and conventional static networks is that time-stamped events rather than links are the unit elements generating the collective behavior of nodes. While we have good centralities to measure the importance of the nodes in static networks, so far these have been lacking for temporal cases. In this paper we propose a simple but powerful centrality, the degree deviation centrality, which calculates the deviation of temporal degree centrality. This enables us to extend network properties vertex degree centrality metrics in a very natural way to the temporal case. We then demonstrate how our centrality applies to identify the vital nodes in temporal networks by epidemic spreading dynamics based on SI (susceptible-infected) model. The numerical experiments on several real networks indicate that the temporal degree deviation centrality method outperforms some other indicators, and the results with different time window size show that the improvement is also robust.

SunBIS-07

Modeling and Analysis of Fuzzy Dynamic Boolean Network Control Systems

Yujing Song Shandong Jianzhu Univ.
Hongli Lyu Shandong Jianzhu Univ.
Peiyong Duan Shandong Jianzhu Univ.
Lingpu Song Shandong Jianzhu Univ.
Shaohua Wang Shandong Jianzhu Univ.
Zhen Zhang Shandong Jianzhu Univ.

In order to solve the problem of mathematical modeling and analysis of the nonlinear Boolean Networks, one modeling and design method of the fuzzy dynamic Boolean Network Control system is proposed in this paper. On base of the matrix Semi-Tensor Product theories, the logic operations of the Boolean Control Network are transformed into the algebraic operations. Using the fuzzy dynamic model, nonlinear fuzzy modeling of the Boolean Network are designed. For each rule of the dynamic fuzzy inference process, the Boolean Network control system is locally linear, while the controllability and observability of the local model are analyzed. For the dynamic fuzzy inference process, the nonlinear characteristics of the global model are analyzed. Finally, we simulated and analyzed one example of the single input and single output system. The local model and global model of the system are established. And the controllability, observability are analyzed in both local model and global model. We draw a conclusion that the nonlinear fuzzy dynamic modeling of the nonlinear Boolean Network Control system is valid, so that it has valid meanings in the further research.

SunBIS-08

Community-based Model Reduction of Networked Linear Systems

Minfeng Ruan Shanghai Jiao Tong Univ.

In this paper, we embed different community detection algorithms in the model reduction problem of networked linear systems. In addition, we propose a reference clustering algorithm, using the clustered model reduction theory based on controllability information. Through these algorithms, the states of the original networked system can be aggregated into small clusters which become the new states in the reduced system, and thus the system dimension is reduced. We compare the outcome of community detection algorithms with the result when applying the reference algorithm. Numerical tests are run on both synthetic and real-world networks. It can be concluded that when the network has a clear community structure, community detection algorithms have advantage over the reference clustering algorithm, i.e. the approximation error is smaller and the construction of clusters is more reasonable. When the node number of the reduced network exceeds the actual community number, this reference clustering algorithm has a better performance.

SunBIS-09

On Infectious Diseases Transmission Based on Traffic Network

Ming-sheng Hu Zhengzhou Normal Univ.
Xin-xin Liu Zhengzhou Normal Univ.
Chuan-feng Cai Zhengzhou Normal Univ.
Zhi-juan Jia Zhengzhou Normal Univ.

Aiming at the great impact of the complex transportation network on the spread of infectious diseases, a propagation model of infectious disease dynamics in complex social traffic network based on Markov chain model is proposed. The model is based on the common traffic network of highway, high-speed railway, self-driving and aviation as the breakthrough point of the study of infectious disease transmission model, and establishes the social traffic network topology under the real environment and constructs the infectious disease risk index model. In this paper, nearly a decade of new influenza virus infection as an example, the number of severe cases of infection to verify the number of validated standards. The experimental results show that the model has a positive correlation with the actual case data, so the model has a certain value in predicting the potential infectious risk degree of infectious diseases.

SunBIS-10

Leader-following Formation Control of Multi-agent Systems in Fixed and Switching Directed Networks with Time-varying Delays

Fen Zhang Xianyang Normal Univ.
Yanbang Zhang Xianyang Normal Univ.

This paper is concerned with leader-following formation problem for second-order multi-agent systems. A modified neighbor-based formation control algorithm with time-varying is constructed. Employing Lyapunov-Razumikhin theorem and linear matrix inequalities (LMIs) approach, respectively, the formation consensus conditions are derived

to guarantee the agents achieve and maintain the desired formation in a fixed directed network. Moreover, LMIs approach for a fixed directed network can be extended straightforwardly to switching directed networks. Finally, a numerical example is given to illustrate the effectiveness of the proposed results.

SunBIS-11

Adaptive Consensus of Multi-Agent Systems with Unknown Control Coefficients and Input Saturation

Ming-Can Fan Huizhou Univ.

This paper investigates the leaderless and leader-following consensus problem for a second-order multi-agent systems with input saturation, i.e., the control input is required to be priori bounded. Moreover, the control coefficients are unknown and cannot be lower or upper bounded by known constants. By virtue of adaptive control technique, Lyapunov theory, algebraic graph theory and Barbalat's lemma, it is proved that the states of the multi-agent systems can achieve consensus under the assumption that the interconnection topology is undirected and connected. Finally, two simulation examples are provided to illustrate the effectiveness of the theoretical results.

SunBIS-12

Two-Degree-of-Freedom Low-Order Control Scheme for Multi-Agent Systems

Linlin Ou Zhejiang Univ. of Tech.
Yanlin He Zhejiang Univ. of Tech.
Xinyi Yu Zhejiang Univ. of Tech.
Fan Yang Zhejiang Univ. of Tech.

Two-degree-of-freedom distributed low-order control scheme which can both realize the global tasks and provide good performance for the multi-agent systems is proposed in this paper. The two-degree-of-freedom control protocol which contains the individual controllers and the coupling controllers is firstly presented. The individual and coupling controllers are both of the proportion-integration-differentiation (PID) type. The two-degree-of-freedom multi-agent system is established according to the proposed protocol. Such the system is decoupled to several single-input-single-output (SISO) subsystems based on matrix theory. For each SISO subsystems, the PID stable region of the individual controllers satisfying H_∞ index is obtained based on the extended Hermite-Biehler theorem so as to improve the performance of each agent. Then, the control parameters of the coupling controllers that ensure the fast consensus of the whole system is determined by first deriving the stable region and then searching for the minimum of the real part of the roots of the characteristic equation in the obtained stable region. The simulation result verifies the effectiveness of the proposed method. The proposed two-degree-of-freedom low-order control scheme is applicable to the systems with arbitrary-order stable or unstable agents.

SunBIS-13

Cluster Consensus of Multi-Agent Systems with Heterogeneous Dynamics

Kairui Chen Faculty of Automation, Guangdong Univ. of Tech.
Junwei Wang Faculty of Automation, Guangdong Univ. of Tech.
Guangdong Univ. of Foreign Studies
Yun Zhang Faculty of Automation, Guangdong Univ. of Tech.
Frank L Lewis Univ. of Texas at Arlington
Northeastern Univ.

This paper studies the cluster consensus problem of heterogeneous linear multi-agent systems under fixed directed topology. Compared to existing results for cluster consensus problems, dynamics of all agents are allowed to be nonidentical, which promotes the application of the results. A state-feedback control protocol with a dynamic compensator is proposed to solve the problem. Output regulation technique is introduced to prove that the proposed control protocol is effective. A numerical simulations is provided to verify the effectiveness of the theoretical results.

SunBIS-14

An Improved Immune Algorithm for Optimization of Irrigational Water Distribution

Lei Bao Donghua Univ.
Xin Cai Donghua Univ.
Yongsheng Ding Donghua Univ.

This paper proposes a novel immune algorithm by integrating local search with multi-swarm immune optimization algorithm to solve the problem of cost optimization in water distribution systems. The objective of this study is to maximize the crop yields by coordinating the distribution of water amongst different kinds of crops, especially for the case of deficit irrigation. In order to prevent premature of the solution, the improved algorithm enhances the global search ability of the antibody groups and divides the swarm into two sub swarms. As verified by the experimental results, the proposed algorithm can coordinate water distribution and has better performance compared with the traditional immune algorithm.

SunBIS-15

Weighted Consensus of Multi-agent Systems with Communication Delay and Self-delay

Zhaoxia Wang Qilu Univ. of Tech.
Jinsong Zhang Shandong Jiaotong Univ.

For multi-agent systems (MASs), with the diversity of information about agents, especially the introduction of image information, the delay introduced by each agent for itself cannot be neglected. Then, under communication network, the communication delay and self-delay are in one unified MASs. To solve this problem, a new weighted consensus protocol with communication delay and self-delay is proposed firstly. Then, a reducing dimension system model is constructed, and some sufficient conditions for the weighted consensus are further achieved. Finally, the simulation results are presented to show the effectiveness of the main results.

SunBIS-16

Tracking Control Algorithms Design of Underactuated Vessels

Yuqing Chen Dalian Maritime Univ.
Zhipeng Shen Dalian Maritime Univ.
Chen Guo Dalian Maritime Univ.

The cooperative tracking control problem of autonomous vessels is analyzed in this paper. Firstly, we capture the properties of motion constraints of marine vessels. We relate these constraints to previous analysis to suggest ways that they can be bounded in practice. Then a feedback-linearization tracking method and a sliding mode controller are designed respectively to solve the consensus problem of underactuated vessels, and the stability of the system is discussed. Finally, simulation results demonstrate the tracking effectiveness of the marine vessels.

SunBIS-17

Distributed Robust Time-varying Formation Control for Multiple Unmanned Aerial Vehicles Systems with Time-delay

Ping Li Univ. of Electronic Science and Tech. of China
Kaiyu Qin Univ. of Electronic Science and Tech. of China
Hongping Pu Univ. of Electronic Science and Tech. of China

This paper investigates robust control problems of time-varying formation flight for multiple unmanned aerial vehicles (UAVs) systems with the external disturbances and time-delay. Firstly, the nonlinear kinematics and dynamics models of UAV are transformed into a linear time-invariant double-integrator model by employing the feedback linearization method. Then robust time-varying formation control is defined for multiple UAVs systems. Based on state feedback of neighbors, a distributed control protocol is designed. In order to decrease the difficulty of the analysis, the closed-loop dynamics is reduced-order and decoupled. Furthermore, the necessary and sufficient conditions are deduced for multiple UAVs system to achieve robust time-varying formation flight with the desired disturbance attenuation index. Finally, simulation results are provided to illustrate the effectiveness of our theoretical results.

SunBIS-18

Finite-Time Attitude Coordination Control for Formation Spacecraft

Liyuan Yang Heilongjiang Univ
Jianting Lyu Heilongjiang Univ
Yang Lin Heilongjiang Univ
Shujuan Chen Heilongjiang Univ

Fini-time attitude coordination control problem for formation spacecraft is investigated. Considering external disturbances, asideing mode attitude control law is first proposed to guarantee attitude synchronization. Then an adaptive control attitude law is given for formation spacecraft in the presence of external disturbances and model uncertainties, and which is robust to external disturbance and model uncertainties. Using graph theory and Lyapunov stability theory, it is shown that the control laws guarantee the finite-time stability of the closed-loop system. Finally, the simulation results show the feasibility of the proposed control laws.

SunBIS-19

Relative Navigation of Missile Formation and INS Error Correction Methods

Wenlei Liu Beijing Univ. of Aeronautics and Astronautics
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Xiaolong Wu Beijing Univ. of Aeronautics and Astronautics

Relative navigation of the missile formation is one of the key technologies for missile autonomous formation flight and cooperative detection. A relative navigation algorithm and an inertial navigation system (INS) error correction method based on mutual ranging and relative motion were proposed, using real-time ranging and data communication supported by the missile-borne data link in the global navigation satellite system (GNSS) free environment. Firstly, the measurement polygon with rotational ambiguity was obtained by the metric multidimensional scaling (MDS) method based on mutual ranging. Then the ambiguity was determined by the nodes' relative motions. Finally, the polygon translation method was applied to estimate INS errors according to the rank-defect network adjustment theory. Simulation results show that the proposed methods solve the rotational ambiguity problem for range-only relative navigation without inter-node angle measurements, as well as slow down the divergence trends of the INS position errors. For the formation of five missiles, the relative navigation accuracy is less than 30m when the ranging error is 20m and the INS accuracy is about three times of the original value.

SunBIS-20

A Step Response Model Estimation Method Based on Case-Based Reasoning

Ning Du China Aerodynamics Research and Developm
ent Center
Xingrui Yang China Aerodynamics Research and Developm

ent CenterUniv.
Fan Yi China Aerodynamics Research and Developm ent Center
Haoyu Pang Northeastern Univ.
Ping Yuan Northeastern Univ.
In the 2.4m×2.4m Transonic Wind Tunnel, dynamic matrix control can effectively improve the control accuracy of wind tunnel flow Mach number. To realize this control method, step response models are generally obtained through step response experiments executed in specific working conditions. A step response experiment requires a lot of time, energy and cost. An estimation method based on case-based reasoning is proposed in this paper, to estimate step response models under a new condition, with existing step response models acquired under different working conditions, and estimated models are applied to dynamic matrix control in wind tunnel. Actual control result verifies the usefulness of the estimated models.

SunBIS-21

Model Identification of a Hybrid Coaxial Rotors/Fixed Wing VTOL UAV in Hovering

Weisheng Kong Nanjing Univ. of Science and Tech.
In this paper, an unmanned aerial vehicle (UAV) is discussed which can achieve both fixed wing mode and vertical take-off and landing (VTOL) mode. In order to realize VTOL, coaxial rotors are used to offset the torque, while collective-cyclic pitch mixing (CCPM) is used to control the six degree of freedom. After reaching to a certain height, the UAV can switch from VTOL mode to fixed wing mode by controlling of the tail. CIFER is a frequency identification method based on the aircraft sweep frequency data. It includes several steps: preprocessing, Fourier transformation, multi-input process, multi-widows process, state-space identification, time domain verification. After processing sweep frequency data of each channel by CIFER, I got accurate relations of each input and output. Then, models in hover state are identified with CIFER for future works on autonomous flight control.

SunBIS-22

Modeling and Analysis of Unbalance for GyroWheel System

Xin Huo Harbin Inst. of Tech.
Haiyuan Liu Harbin Inst. of Tech.
Zhaosheng Guo Xi'an Flight Automatic Control Research Inst.
Sizhao Feng Harbin Inst. of Tech.
Hui Zhao Harbin Inst. of Tech.
For rotating machineries, unbalance of the rotor is widely existed which plays a bad role resulting in unexpected vibrations, uncertain dynamics and even unstable motions. The GyroWheel system, a typical rotating machine, is an innovative attitude determination and control device, which provides a varying amplitude and direction of the angular moment vector by using a spinning flex-gimbal suspension. In this paper, the uneven mass distribution of the GyroWheel rotor, called unbalance, is modeled and investigated by simulations and comparisons. The results can be utilized to reveal the operating properties, and to develop reasonable unbalance identification algorithm for the GyroWheel system.

SunBIS-23

Gradient-Based Iterative Algorithm for the Extended Coupled Sylvester Matrix Equations

Huamin Zhang Bengbu Univ.
A gradient-based iterative algorithm is established for solving the extended coupled Sylvester matrix equations $A_1XB_1+A_2YB_2=F_1$ and $C_1XD_1+C_2YD_2=F_2$ by using the hierarchical identification principle. We prove that the iterative solution converges fast to the exact one for any initial iterative value if the coupled matrix equations has a unique solution. A numerical example is offered to illustrate the efficiency of the proposed algorithm.

SunBIS-24

Online Modeling for Switched Reluctance Motors Using Adaptive Network Based Fuzzy Inference System

Xuelian Yao Jiangsu Univ. of Tech.
Yi Yang Jiangsu Univ. of Tech.
A novel online modeling scheme for the switched reluctance motor (SRM) using an adaptive network based fuzzy inference system (ANFIS) is proposed in this paper. The parameters of ANFIS are tuned through online supervised learning to improve the accuracy of the model, so it is robust toward parameter variations in the motor or any system disturbances. To eliminate the expensive torque sensor used in this model scheme, the improved online modeling scheme is proposed with a torque estimator replaces the sensor. It is suitable to apply the improved online modeling scheme to the torque control system design, which can be verified by the simulation of SRM torque control.

SunBIS-25

Multiple Fault Parameter Identification Based on Extremum Seeking for Multi-agent Systems

Wei rong Liu Central South Univ.
Dong yang Wang Central South Univ.
Xiao yong Zhang Central South Univ.
Kai Gao Changsha Univ. of Science & Tech.
Zheng Xu Central South Univ.
Zhi wu Huang Central South Univ.
In this paper, a multiple fault parameter identification method based on extremum seeking algorithm is proposed for the consensus of multi-agent systems. Firstly, a model for the cooperative consensus multi-agent systems is established based on the graph theory and linear system theory. Secondly, by using the proposed cooperative consensus model, an adaptive multiple fault parameter identification method based on extremum seeking algorithm is designed. Then, the multiple fault parameter identification problem is reformulated as an optimal input problem of multiple extremum seeking. Thirdly, the multiple fault closed-loop search framework based on gradient information is given and the extremum seeking cost function is designed. Finally, the performance of the multiple fault parameter identification algorithm using extremum seeking is rigorously evaluated through a series of simulations. In addition, the extremum searching performance under different excitation signals is discussed.

SunBIS-26

Adaptive Simulated Annealing Particle Swarm Optimization for Catalyst Protected Region Parameter Identification

Shu-ting Liu Northeastern Univ.
Xian-wen Gao Northeastern Univ.
Aiming at the parameter identification problem of catalyst protected region in the process of propylene oxidation, a novel parameter identification method has been proposed for catalyst protected region using an adaptive simulated annealing particle swarm optimization (ASAPSO) algorithm. Synchronous change learning factors and linear decrease progressively inertia weights are embedded in the simulated annealing particle swarm optimization algorithm. The information exchange capacity is enhanced by the synchronous change learning factors. The overall search ability and local improved ability are balanced by the linear decrease progressively inertia weights. The proposed algorithm has some advantages in the aspect of good stability, strong information exchange capacity and fast convergence. Meanwhile, the shortcoming of local minimum valve is solved by the proposed algorithm. Simulation results show that the algorithm is feasible and accurate. The catalyst protected region of propylene oxidation from 6.35% to 11.25% is determined. Finally, the proposed ASAPSO algorithm is efficient.

SunBIS-27

A Robust to Outliers Method for Estimating the Homography

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A novel method robust to outliers is proposed which integrates outliers rejection within the homography estimation pipeline with a negligible computational overhead. With a basis of algebraic criterion, the proposed method has a low level of computational time with an arbitrary large number of key-point correspondences. Given a set of 2D-to-2D matches, we formulate pose estimation problem as a low-rank homogeneous system where the solution lies on its 1D null space. Outlier correspondences are those rows of the linear system which perturb the null space and are progressively detected by projecting them on an iteratively estimated solution of the null space. Several simulations based on synthetic and real image demonstrate that the proposed method can achieve robust homography estimation to different ratios of outliers.

SunBIS-28

Modeling and Simulation of Indoor Environment Parameters Based on Least Squares

Deliang Zeng North China Electric Power Uni.
Yifan Jian North China Electric Power Uni.
Zhiguang Deng North China Electric Power Uni.
Yang Yang North China Electric Power Uni.
Indoor building environment for energy saving and human health has important significance and the main criterion for evaluating its quality is environmental comfort. An experimental scheme for obtaining the mathematical model of the main parameters is designed by analyzing the parameters that affect the environmental comfort. The scheme establishes a discrete bilinear model with parameters and control variables, and uses the the least squares method to obtain the model parameters based on the experimental data. The simulation results show that the experimental scheme of this paper has strong universality and adaptability, and the model with the deviation of the real system is small, which can be used as the model basis for optimizing the control of the indoor building environment.

SunBIS-29

Prediction of Ship Motion Attitude Based on BP Network

Yang Ge Harbin Engineering Univ.
Ming Jie Qin Harbin Engineering Univ.
Qing Tao Niu Harbin Engineering Univ.
When the disturbance of ship is compensated, it can't get the specific motion parameters in time. In order to solve this problem, the motion attitude needs to be predicted in advance, and the reliable data also needs to be provided for the wave compensation system. This paper introduces a method of motion attitude prediction based on BP neural network. The method solves the learning problem of hidden layer by selecting the BP neural network model, and the results show that using

such method can effectively improve the prediction speed and precision of motion attitude.

SunBIS-30

Diffusion Modeling for Contaminant Emission-Advection process in River Flow Regimes

Deng-Yin Jiang Shanghai Jiao Tong Univ.
Li-Sheng Hu Shanghai Jiao Tong Univ.

In this paper, the diffusion nonlinear modeling strategy based on time-space separation approach is proposed for contaminant concentration advection-diffusion process which described by partial differential equation with uncertain nonlinear distributed diffusion. The time-space separation approach is proposed to deal with the contaminant temporalspatial distribution characteristics, which the spatiotemporal contaminant concentration output is decomposed into the dominant spatial basis functions with related temporal coefficients. And, the data-driven time-varying sensitivity has been analyzed for contaminant diffusion process. The adaptive diffusion model construction strategy is proposed for nonlinear distributed diffusion process based on online adaptive tuning multiple model methods, which considers the variable environment process and the disturbance. The nonparametric approach is used for diffusion modeling to separate the linear time invariant part and dynamics part from the best linear approximation. Finally, based on analysis of the typical processes of contaminant concentration in river flow, the influence factors on contaminant concentration diffusion have been analyzed by using sensitivity analysis method, which analyzes the different regions contaminant concentration index at different times, which shows that the effects of contaminant emission conditions and flow in rivers as well as the impact of diffusion, the concentration condition is non-determining over time. The analysis of typical contaminant concentrations in flow river regimes shows the effectiveness of the proposed modeling method.

SunBIS-31

Model Identification of Coal Mill Control System Based on Genetic Algorithm

De-liang Zeng North China Electric Power Univ.
Gang Zhang North China Electric Power Univ.
Yan-qiao Chen National Inst. of Science and Tech.
Yan-qiu Zheng North China Electric Power Univ.

This paper is based on the experimental data of the coal mill control system of the full incentive simulator. The two - point method and the genetic algorithm are used to identify the experimental results. The results are compared with each other, and the transfer function is obtained. The study of the coal mill control system model is the basis for analyzing the boiler combustion control system, establish a precise coal mill control system model, can further enhance the boiler combustion efficiency and economic benefits, and better protection of the safe operation of the boiler unit.

SunBIS-32

Nonlinear L2 Disturbance Attenuation Control Design of Upfc for Power Flow Control

Xingyu Lv Guizhou Inst. of Tech.
Bangjun Lei Guizhou Inst. of Tech.
Shumin Fei Southeast Univ.

A nonlinear L_2 disturbance attenuation control (DAC) of unified power flow controller (UPFC) is investigated in power system by using Hamiltonian function method. First, the dissipative Hamiltonian structure of the UPFC system is established by means of variable transformation. Then, based on the obtained dissipative Hamiltonian structure, a nonlinear L_2 DAC is put forward. Simulation results on the two-area four-machine power system demonstrate the effectiveness and robustness of the nonlinear L_2 DAC in comparison with that of direct feedback linearization control (DFLC) and add-On self-tuning (ST) control and PI control. The research results show that the nonlinear L_2 DAC has better performance than the other controls.

SunBIS-33

Further Results on Stabilization for A Class of Stochastic High-order Nonlinear Systems with Unknown Control Directions

Jian Zhang Zhengzhou Univ.
Xiuming Zhao Zhengzhou Univ.
Xiaowu Mu Zhengzhou Univ.

This paper concerns the global stabilization for a class of stochastic high-order nonlinear systems which admit more general system form than those in the existing works. For details, except for the serious system nonlinearities which show that the considered system is the general of the strict-feedback systems, the most distinct feature of the systems is exhibited by the unknown control directions, that is, all the control coefficients of the virtual and actual control have unknown signs. By skillfully employing the Nussbaum function, and applying the method of adding a power integrator, an effective regulation control scheme is successfully provided for the considered systems. In particular, the presented controller can guarantee that all the closed-loop system states are bounded, and especially the original system states converge to the origin, both in the sense of probability one.

SunBIS-34

Neural Network Controller Design for Uncertain Nonlinear Systems Based On Backstepping Control Algorithm

Xiulan Zhang Huainan Normal Univ.
Xiaoxia Ma Huainan Normal Univ.
Hongqi Zhu Huainan Normal Univ.
Heng Liu Shaanxi Normal Univ.

This paper investigates the control problem for a class of nonlinear systems having strict feedback structure with system uncertainties by using adaptive neural network backstepping control technique. In order to solve the ”explosion of terms” problem that appears in backstepping design procedure, the derivative of the virtual control input signals and the unknown functions are approximated by neural networks. The controller proposed in this paper has a simple form. At last numerical simulations are given to confirm the results of this paper.

SunBIS-35

Relaxed Fuzzy Observer-Based Output Feedback Control with Multilateral Matrix Method

Hongxia Yu Northeastern Univ.
Shenyang Inst. of Engineering
Yuanwei Jing Northeastern Univ.
Xinli Chi Shenyang Inst. of Engineering

This work explores the development of observer-based output feedback control design of discrete-time nonlinear systems in the form of Takagi-Sugeno (T-S) fuzzy model adopting multilateral matrix method. Lately, previous results have been improved by introducing slacker matrix variables. From a technical point of view, more useful relaxed approach is further developed while the relative sizes among different normalized fuzzy weighting functions are utilized by introducing some additional matrix variables. As a result of this work, those main defects of the existing method can be redressed and a desired solution is provided for some special cases in aspect of conservatism reducing and the computation complexity alleviating. Moreover, the effectiveness of the proposed approach is shown by means of an illustrative example.

SunBIS-36

Rapid Longitudinal Trajectory Planning for RLVs in the Terminal Area

Min Zhou Northwestern Polytechnical Univ.
Jun Zhou Northwestern Polytechnical Univ.
Mingfei Lu Inst. Of Applied Optics

A rapid longitudinal trajectory palnning method has been developed for Reusable Launch Vehicles in the terminal area. It is based on existing research, which utilizes two continuous and smooth quadric curves to describe the reference altitude profile with respect to the groud range. In this study, the range-to-go at joint of thes two quadric curves is free to be adjusted. Thus, there’s one freedom of design variable for longitudinal trajectory design. A monotonic relation of the reference altitude and the design variable is found and proved theoretically. Consequently, the monotonic relation between the terminal velocity and the design variable is derived. The longitudinal trajectory palnning is translated to a one-parameter searching problem, which can be solved easily with a simple Newton iteration scheme. Afeasible reference trajectory can be determined in few iteration steps with a proper initial value interpolated from a one dimensional interpolation table, which is pre-estabilshed with different values of terminal velocity corresponding to changed design variable. Numerical simulations of tasks with different terminal flight-path angle and velocity constraints are conducted. The results show that reference trajectories, which are planned rapidly, can be tracked with small terminal errors under initial dispersions. It is indicated that the proposed trajectory palnning method is feasible and potential for on-line application.

SunBIS-37

Periodic Flows Analysis of a Nonlinear Power System Based on Discrete Implicit Mapping

Duyu Liu Southwest Univ. for Nationalities of China
Shanghai Jiao Tong Univ.
Gang Xiao Shanghai Jiao Tong Univ.
Xingwen Liu Southwest Univ. for Nationalities of China
Zhouyun Dai Shanghai Jiao Tong Univ.

This study focuses on the periodic solutions of single-machine-infinite-bus system under a periodic load disturbance. The qualitative behavior of this system is described by the well-known ‘swing equation’, which is a nonlinear second-order differential equation. Periodic solutions of the system are analytically predicted through discrete implicit mapping. The discrete implicit maps are obtained from the swing equation. From mapping structures, bifurcation trees of periodic solutions of the simple connection power system are predicted analytically, and the corresponding stability and bifurcation analysis of periodic solutions are carried out through eigenvalue analysis. Finally, from the analytical prediction, numerical results of periodic solutions are performed by numerical method of the differential equation to show good agreements.

SunBIS-38

Tracking Control for Underactuated VTOL Aircraft

Shunxiang Hou Nanchang Inst. of Science and Tech.
Rui Ling Chongqing Univ.

The position tracking problem of a vertical take-off and landing (VTOL) aircraft whose input has a coupling effect was studied, and a control strategy which has a two closed-loop was proposed. To simplify the controller design, a converted algorithm which aim to a underactuated

system is used to convert the input of the system, and the output tracking system was converted intu the control of out-loop which is position loop and the control of inner loop which is a angle loop. The position substem was controlled using the optimal controller and the angle error substem was controlled using the sliding mode controller. Simulation results indicate that the proposed control strategy has the better effectiveness to solve the VTOL aircraft trajectory tracking problem.

SunBIS-39

A Rate-Dependent Hysteresis Model for Giant Magnetostrictive Actuators Using the Dynamic Weight and Dynamic Threshold based Modified Prandtl-Ishlinskii Model

Xiaoxu Peng Ludong Univ.
Zhenkai Guo Ludong Univ.
Xinjiang Wei Ludong Univ.
Xiaohua Liu Ludong Univ.

The rate-dependent hysteresis in giant magnetostrictive actuators (GMA) is a major impediment to the engineering application. In this paper, a rate-dependent modified Prandtl-Ishlinskii (RDMPI) model is proposed to characterize the rate-dependent hysteresis nonlinearity of GMA. The new model is based on the modified PrandtlIshlinskii (MPI) model combined with the dynamic weight and dynamic threshold. Simulation results show that the proposed model effectively represents the characterization of the GMA's rate-dependent hysteresis nonlinearity within a range of frequency.

SunBIS-40

Synchronization for a class of Fractional Order Chaotic Systems with Uncertainties via Fractional Backstepping

Qiao Wang Zhejiang Univ.
Donglian Qi Zhejiang Univ.

The traditional backstepping method of controller design is generalized into chaos synchronization of fractional order systems.The master and slave systems are of fractional order, subject to both interferences and parameters undetermined. A novel synchronization strategy containing fractional order estimates adjustment rules is developed by use of the generalized fractional backstepping design for chaotic systems. Fractional candidate Lyapunov functionals designed in cooperation with fractional order power law inequalities are applied to analyze the Mittag-Leffler stability, and then the error system can realize global asymptotic convergence. The prior information of the upper bounds of undetermined interferences is not required in our proposed synchronization strategy.

SunBIS-41

Adaptive Backstepping Control of Block-Strict-Feedback Systems with Unknown Parameters

Chun Yin Univ. of Electronic Science and Tech. of China
Wei Wang Univ. of Electronic Science and Tech. of China
Xiuling Wei Univ. of Electronic Science and Tech. of China
Yuanyuan Li Univ. of Electronic Science and Tech. of China
Xuegang Huang China Aerodynamics Research and Developme nt Center
Binyang Hu Univ. of Electronic Science and Tech. of China
Jianhong Xue Univ. of Electronic Science and Tech. of China

In this paper, we establish the adaptive back stepping controller designed using the standard technique aiming at the class of block-strict-feedback nonlinear system subject to unknown constant parameters. We have given the tuning function at every step of the design which used for parameters estimation. An illustration example is proposed and then used in the intelligent lighting test platform to prove the practical application of the adaptive backstepping control method.

SunBIS-42

Further Results on Delay Dependent Stability for Cellular Neural Network with Time-Varying Delays

Haixia Wu Chongqing Univ.
Chongqing Univ. of Education
Wei Ran Chongqing Univ. of Education
Wei Feng Chongqing Univ. of Education

Delay dependent stability for cellular neural network with time-varying delays is studied. By using the differential inequality, employing some free-weighting matrices and introducing an appropriate type of Lyapunov functional, a delay dependent stability criterion is established to guarantee the delayed cellular neural network to be asymptotically stable. A numerical example is given to illustrate the effectiveness of the proposed criterion.

SunBIS-43

Asymptotic Tracking Control for an Underactuated Quadrotor via Immersion and Invariance Technology

Yuehui Ji Tianjin Univ. of Tech.
Hailiang Zhou Tianjin Inst. of Metrological Supervision and T esting (TIMST)
Xianggui Guo Tianjin Univ. of Tech.

A nonlinear tracking control based on Immersion and Invariance-based (I&I) technology, is addressed to achieve asymptotic tracking for 3-D position and yaw motion of an underactuated quadrotor. In the underlying control scheme, an inner/outer-loop construction is designed to handle the underactuated property. The I&I technology is constructed for stable tracking for the inner-loop and outer-loop. Lyapunov Theorem is exploited to guarantee the asymptotic tracking stability of resulting closed-loop system. Numerical simulations on Matlab/Simulink environment are included to illustrate the effectiveness of proposed I&I control scheme.

SunBIS-44

Finite-time Sliding Mode Coordination Control for Networked Euler-Lagrange Systems

Shujuan Chen Heilongjiang Univ.
Jianting Lv Heilongjiang Univ.
Dai Gao Harbin Inst. of Tech.
Wenyu Li Heilongjiang Univ.

Coordination control problem of networked Euler-Lagrange systems with external disturbance is addressed. The sliding mode surface and coordination control law of networked Euler-Lagrange systems with a dynamic leader under a directed graph is first proposed. It is shown that the followers can track the dynamic leader in finite time. Then leaderless consensus law for networked Euler-Lagrange systems is proposed. Based on algebraic graph theory and Lyapunov stability theory, finite-time stability of the closed-loop system is proven. The simulation results show the feasibility and effectiveness of the proposed control law.

SunBIS-45

A Novel Gaussian Nonlinear Iterated Update Filtering

Xin Lu Naval Univ. of Engineering
Zhong Liu Naval Univ. of Engineering
Hongxin Zhang Naval Univ. of Engineering

To solve the problem of performance degradation and divergence of the Gaussian nonlinear filter in the large initial deviation condition, a new nonlinear filtering method is proposed, which is the Iterated Update Extended Kalman Filter (IU-EKF). The new approach is carried out by introducing the current time measurement information gradually to the measurement update process in pseudo-time. The proposed algorithm has two advantages, one is that it increases the filtering accuracy substantially, compared with the Extended Kalman Filter, the other is that it is superior to the classical Gaussian hypothesis filter in large prior uncertainty condition. Simulation has been taken to compare the filtering performance among the EKF, IEKF, UKF, CKF and the proposed method. The simulation results demonstrate higher accuracy provided by the new filter than the classical Gaussian approximate filter mentioned above.

SunBIS-46

Bifurcation Analysis of Closed-loop System for a Fixed-trim Vehicle

Yafei Wang Jiangsu Automation Research Inst.

The dynamic of fixed-trim vehicle controlled by a single moving-mass is very complex due to its strong nonlinear and coupling characteristics. The relationship between the controller parameters and dynamic performance of the system is hardly obtained by traditional linear system theory. Since the controller has a significant impact on the stability and dynamic characteristics of the closed-loop system, bifurcation analysis is applied to the closed-loop roll autopilot system in this paper. Based on bifurcation analysis on the attitude dynamics, the equilibrium points of the closed-loop system are obtained, and then the bifurcation diagram is drawn by numerical methods. For the roll angle control and roll rate control model respectively, the influences of the autopilot parameters on the stabilities and dynamics of the closed-loop system are researched, and therefore the reasonable ranges of the autopilot feedback parameters are carried out. The result can be used as a basis for the design of roll autopilot.

SunBIS-47

Model Predictive Control for Discrete-time Nonlinear Quadratic Systems

Shanqiang Li Harbin Engineering Univ.
Harbin Univ. of Science and Tech.
Xiuyan Peng Harbin Engineering Univ.
Long Wang Harbin Univ. of Science and Tech.

In this paper, the problem of model predictive control is investigated for discrete-time non-linear quadratic systems. For a given polytopic initial feasible set, a state feedback model predictive controller is designed. Sufficient conditions for the closed-loop systems to be stable and cost function to be minimum are derived by using linear matrix inequalities. Based on Lyapunov theorem, the feasibility of the proposed model predictive control algorithm and the stability of the closed-loop systems are proved. Finally, a simulation example is employed to show the feasibility and effectiveness of the model predictive control method.

SunBIS-48

Modeling and Aerodynamic Characteristics Analysis of Morphing Aircraft

Lingpu Zhu Beihang Univ.
Zhenghua Liu Beihang Univ.
Luochuan Li Beihang Univ.

In recent years, military and civil aviation have put forward higher and higher requirements to the performance of the aircraft. The morphing aircraft can adapt to a variety of environments, perform a variety of tasks and meanwhile maintain excellent flight performance. This paper researches the dynamic modeling method, aerodynamic parameter analysis and the dynamic characteristic response of morphing aircraft. The physical model of a variable-span variable-sweep morphing aircraft was simplified so as to use Kane Equation modeling. In this paper, the software Datcom is used to analyze the aerodynamic parameters of the

morphing aircraft. Then the aircraft's longitudinal dynamic responses during the morphing process are simulated and analyzed. The simulation results show that the speed, height and pitch angle of the morphing aircraft will be greatly changed.

SunBIS-49

Long-memory Behavior Analysis of China Stock Market Based on Hurst Exponent

XiaoYue Wang Beijing Forestry Univ.
Ting Lei Beijing Forestry Univ.
Zhuo Liu Beijing Forestry Univ.
ZhaoBin Wang Beijing Tech. and Business Univ.

Previous mathematical models shown by empirical studies, such as Poisson model and Markov Process based on the hypothesis of short-dependence and independent arriving features of stocks data, failed to describe the stock market's behavioral characteristics with high accuracy. In this paper, we first offered thought for fractal theory and introduced an important index in this theory, Hurst exponent (H), to better depict stock movement in a more objective way. Then we selected 5 China's representative stocks in different years and applied R/S analysis on them to calculate the value of Hurst exponent. The result, Hurst exponent of the daily price of stocks is larger than 0.5, which implicates the rejection of previous models, proved that the stock market follows the Fractal Market Hypothesis (FMH), and stock tendency has the long-range dependent and fractal features. Thus, Hurst exponent provides a better measure with a new perspective to analyze the overall stock market and also gives useful guidance for investors.

SunBIS-50

On the Compactness and Continuity of Polytopes

Xiushan Cai Zhejiang Normal Univ.
Hai Wu Shanghai Jiaotong Univ.
Zhengzhi Han Shanghai Jiaotong Univ.

This paper considers the fundamental properties of polytopes in Banach space. A norm is defined for the polytopes and the preliminarily properties are then analyzed. It is proved that the linear summation of two polytopes is still a polytope. For a given compact set, its polytope is compact if and only if the supporting space is with finite dimension. If the dimension of its supporting space is infinite, the polytope is totally bounded. The continuities of the polytopes is analyzed. It is verified it is lower semi-continuous, and the null set of weak inverse is a linear subspace.

SunBIS-51

Research on Synchronization Control Method of Networked Multi - Agent System of Multiple Manipulator-motors

Anna Wang Northeastern Univ.
Yangyang Man Rizhao Power Supply Company
Qianqian Zhang Northeastern Univ.
Xiaoqiao Yan Northeastern Univ.

For coordination and cooperation among the four motors in the same position of four manipulators, in order to make the manipulator motors have the precision and same speed, the double-layer control strategy is adopted in this paper. In the lower control, only the single mechanical arm motor can be stably controlled, the multiple manipulator motors can be synchronized. Therefore, fuzzy PID is used as the control compensator. And the control strategy of single motor based on fuzzy PID is designed. In the high-level control, considering the four motors system in the same position of four manipulators needs to meet the requirements of rapidity in the reality. Based on the prediction mechanism, a multi-motor synchronous consistency control strategy based on network multi-agent prediction mechanism is proposed .To ensure that multiple manipulator system can quickly achieve the same synchronization. Respectively, simulation experiments are carried out to verify the effectiveness and practicability of the proposed control strategy as described above.

SunBIS-52

Comparison Analysis of Two Test Case Prioritization Approaches With the Core Idea of Adaptive

Jian Ding Avic Cheng Du Aircraft Industrial (Group) Co., Ltd
Xiao-Yi Zhang Beihang Univ.

Test case prioritization problem (TCP) has been widely discussed. It aims to controlling the test case execution sequence to improve the effectiveness of software testing. The key issue of TCP is to identify which test cases can provide useful information for failure detection and fault localization. So far, many TCP approaches have been proposed. Among them, Adaptive Random Testing (ART) and Dynamic Random Testing (DRT) are two of the most popular approaches to solve TCP with a basic idea borrowed from Cybernetics: adaptive. Both ART and DRT has been widely explored and observed with good performances in experimental studies. Nevertheless, although they are proposed by two related research groups, they are developed independently and in parallel. In fact, their mechanisms have many similarities and differences and, for the completeness of the domains of Adaptive Testing and Software Cybernetics, many issues concerning the comparison between these two approaches should be further explored. In this paper, we specifically explores the relationship between these two adaptive TCP approaches. Their mechanisms are described respectively with explorations of their distinctions, similarities, and respective characteristics. Moreover, based on these explorations, we analyse their advantages from the aspects of failure detection and fault understanding. During the analysis, a symbolic-graphic combination method is applied. Finally simulation based on real-life programs is conducted to observe our analysis. Our comparison analysis can support the selection of a proper testing approach according to various practical environments with different targets. Furthermore, the clarification of the two easily confused concepts is also a complement for the framework of Adaptive Testing and Software Cybernetics.

SunBIS-53

Formation Control for Nonlinear Multi-Agent Systems with Diverse Time-Varying Delays and Uncertain Topologies

Hefu Luo Guangdong Univ. of Tech.
Shiguo Peng Guangdong Univ. of Tech.

A leader-following distributed formation control problem for a class of second order nonlinear multi-agent systems (MAS) with diverse time-varying delays and uncertain topologies is discussed in this paper. By proposing a distributed protocol, employing Lyapunov-Krasovskii theory and introducing free-weighted matrix, several feasible linear matrix inequalities (LMIs) are presented to determine maximal allowable time-varying communication delays. We prove that all agents with a globally jointly-reachable leader can achieve expected formation. Finally, numerical examples are provided to illustrate the obtained results.

SunBIS-54

Visual Language Model for Keyword Spotting on Historical Mongolian Document Images

Hongxi Wei Inner Mongolia Univ.
Guanglai Gao Inner Mongolia Univ.

The Bag-of-Visual-Words (BoVW) approach has been attracted some attention in the field of keyword spotting. However, the BoVW approach discards the spatial relations of the visual words. Therefore, a visual language model is integrated into the BoVW framework in this study so as to add the spatial information. To accomplish the process of keyword spotting, two well-known retrieval schemes, including query likelihood model and KL divergence, have been adopted. The experimental results show that the visual language model can significantly improve the performance of keyword spotting on a collection of historical Mongolian document images than the original BoVW approach. Meanwhile, the influence of different codebook sizes on the performance has been analyzed in this paper. And the best appropriate size of the codebook has been determined.

SunBIS-55

A Nonlinearity-Based Genetic Algorithm for Ship Path Planning

Shengke Ni Dalian Maritime Univ.
Zhengjiang Liu Dalian Maritime Univ.
Yao Cai Dalian Maritime Univ.
Xin Wang Dalian Maritime Univ.

In this thesis, a nonlinearity-based genetic algorithm for ship path planning was proposed. This novel algorithm applied the nonlinear programming to compensate the inherent deficiency of genetic algorithm in local optimization. Meanwhile, problem-specific knowledge and heuristic knowledge were incorporated into encoding, evaluation and genetic operators of genetic algorithm. Furthermore, the application of minimum generation kept of the optimal fitness as the criterion of the termination condition reflected the knowledge accumulation in the optimal process which perfectly suited this nonlinearity-based genetic algorithm. Finally, the feasibility and effectiveness of this algorithm were evaluated with a set of test cases simulating various traffic scenarios.

SunBIS-56

Design and Implementation of Electrical Intelligent Detection System for Cab Body Based on CompactRIO

Wen Ji Xuzhou Inst. of Tech.
Jia-sheng Zhu Xuzhou Heavy Machinery Co., Ltd.
Xu-long Zhang Xuzhou Inst. of Tech.
Feng Wang Xuzhou Inst. of Tech.
Zi-long Li Xuzhou Inst. of Tech.

As the inspection requirement of engineering machinery cab is analyzed, the intelligent detection system for cab based on compactRIO (CRIO) is designed, which is combined with NI LabVIEW and embedded modules of CRIO. In engineering Machinery cab, the designed system can realize intelligent supervisory and networking management of testing data for electrical system. And then, a set of complete and systematic plan is established for the detection, diagnosis and data management of cab. The practical application demonstrates that the designed intelligent detection system has high accuracy in the fault diagnosis and detection. And, the system can run stably and reliably. That is, the system ensures the dependability of cab body electrical system and reduces the rate of failure.

SunBIS-57

Object Detection via Superpixel and 3D Self-Organizing Background Subtraction

Zheng Xu Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications

For moving targets with slow speed and temporary stationary, the detection performance of traditional methods via Gauss model and three-frame model is not so satisfactory. Therefore, a novel scheme is proposed to improve the detection performance. Specifically, the simple linear iterative clustering algorithm method is first utilized to complete the

superpixel segmentation; then, the 3D self-organizing background subtraction algorithm is utilized to achieve the background model; finally, the optimal weight decision strategy is utilized to detect moving targets. Experimental results conducted on MSA and PETS2009 datasets demonstrate that the proposed scheme can effectively improve the object detection performance.

SunBIS-58

Pedestrians Tracking Based On Least Squares Algorithm and Intelligent Collision Avoidance Model

Weicheng Sun Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Baoxiao Fu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications
Fang Fang Southeast Univ.

Target tracking is a hot topic in the field of computer vision and pattern recognition. The aim of target tracking is to achieve the location of moving targets and tracking trajectories of moving targets. A pedestrian tracking method based on the Least Squares algorithm and intelligent collision avoidance model is proposed in this paper. Specifically, the traditional Kalman algorithm is first utilized to realize the initial target tracking; then, to deal with the issue of target tracking caused by the traditional Kalman algorithm, the least square method is here utilized to fit the pedestrian moving curve and predict the location ofthe pedestrians in the next frame, which can be utilized as the initial moving object for the later search; finally, the intelligent collision avoidance algorithm is here proposed to improve the tracking accuracy in case ofobstacles.

SunBIS-59

Adaptive-weighted One-Class Support Vector Machine for Outlier Detection

Man Ji Hebei Univ.
Hong-Jie Xing Hebei Univ.

The classification performances of the traditional one-class support vector machine (OCSVM) and its variants are often not satisfying when outliers are complex. To deal with this case, assigning smaller weights to these outliers may alleviate their influence upon the classification boundary and enhance the robustness of OCSVM. In this paper, a novel adaptive-weighted one-class support vector machine (AWOCSVM) is proposed for dealing with the outlier detection problem. The appropriate weights are assigned to training samples by considering both their local densities and distances between them to their center. Experimental results on two synthetic data sets and eight benchmark data sets demonstrate that the proposed AWOCSVM achieves more compact classification boundary and superior performance in comparison with the traditional OCSVM and one related approach.

SunBIS-60

A Case Study on the MPC for Ozone Dosing Process Based on SVM

Dongsheng Wang Nanjing Univ. of Posts and Telecommunications
Yongjie Lu Nanjing Univ. of Posts and Telecommunications
Lei Zhang Nanjing Univ. of Posts and Telecommunications

Ozone is an important disinfectant in drinking water treatment. The ideal ozone dosage should be a good trade-off between the requirement of disinfection and the restriction of bromate formation. Additionally, the ozone dosing process should cope with the changes of raw water quality and maintain the treated water stable. However, ozone dosing process is very difficult to be controlled because of its complicated nonlinear behaviour. In this paper, model predictive control (MPC) scheme based on support vector machine (SVM) model is designed for the ozone dosing process. With the proposed control scheme, a SVM model is established which could be used for MPC. The control strategy of maintaining a constant ozone exposure is attempted for the requirement of more effective disinfection. The plant-scale experimental studies demonstrate the efficiency and effectiveness of proposed control scheme.

Monday, 29 May, 2017

MonA01 **Room01**
Adaptive control (II) **10:20-12:20**

Chair: Dafu Sheng School of Automation Science and Electrical Engineering, Beihang Univ.
CO-Chair: Qi Ouyang Chongqing Univ.

10:20-10:40 **MonA01-1**

Self-tuning fuzzy control for time-varying excitation vibration isolation system with magnetorheological elastomer actuator

Junjie Lai Chongqing Univ.
Jie Fu Chongqing Univ.
Guanyao Liao Chongqing Univ.
Miao Yu Chongqing Univ.

This paper investigates the design of a self-tuning fuzzy controller (STFC) for vibration isolation system with magnetorheological elastomer (MRE) actuator and variable sinusoidal excitations. Firstly, the silicone rubber matrix MRE is briefly introduced, and the performance of the actuator is evaluated by sweep frequency test. Then, based on the conventional fuzzy controller (FC), a STFC constructed on peak observer is proposed which is independent of excitation frequency. The quantification and scaling factors in STFC can be adjusted in real time according to the excitation characteristic. Finally, numerical simulations with variable sinusoidal excitations are conducted to verify the effectiveness of the designed controller. The STFC and FC are compared in control current and response acceleration to demonstrate the effectiveness and superiority of STFC.

10:40-11:00 **MonA01-2**

Research on Adaptive Backstepping Control Method for a Hex-rotor Unmanned Aerial Vehicle

Dafu Sheng School of Automation Science and Electrical Engineering, Beihang Univ. Science and Technology on Aircraft Control Laboratory, Beihang Univ.
Weihong Wang School of Automation Science and Electrical Engineering, Beihang Univ. Science and Technology on Aircraft Control Laboratory, Beihang Univ.
Miao Gu Beijing Inst. of Spacecraft Environment Engineering

This paper concentrates on attitude control and position control of the hex-rotor Unmanned Aerial Vehicle (UAV) to achieve fixed-point hover. First, based on the Newton-Euler equations, the equations of motion are established in the inertial coordinate system. Then according to the characteristics of the hex-rotor UAV model, adaptive backstepping mode controllers are designed to realize the attitude and position control. Using Lyapunov theory, the stability of system is proved. Finally, simulation results prove that the control system has strong robustness to both the disturbance and the parametric variation.

11:00-11:20 **MonA01-3**

Globally tracking control for a class of uncertain nonlinear MIMO systems with prescribed performance

Wenlei Qin Chongqing Univ.
Yangqi Ou Chongqing Univ.
Xiucai Huang Chongqing Univ.
Xiucai Huang Chongqing University of Tech.

This paper investigates the globally tracking control problem for a class of uncertain nonlinear MIMO systems with prescribed performance. Firstly, we import a compressed function to transform the tracking error into one that stays in a compact set. Secondly, we use the prescribed performance bounded (PPB) control method to prescribe the trajectory of the transformed error. As a result, for any given initial states, the tracking error will converge into a preset set at a conservatively well-defined speed within a pre-specified time, and then further reduce into a smaller and preassigned residual set. All internal signals in the closed-loop are ensured to be globally ultimately uniformly bounded. Both theoretical analysis and practical application to robot system verify the effectiveness and benefits of the proposed scheme.

11:20-11:40 **MonA01-4**

Quasi-Proportional Resonant Control of the LCL-Type Grid-Connected Inverter Based on Fuzzy Control and Self-Tuning of Fuzzy Parameters

Xiangjun Duan Nanjing College of Information Tech.
Hannian Zhang Nanjing College of Information Tech.

This paper proposes the quasi-proportional resonant (QPR) fuzzy control of the LCL-type grid-connected inverter, which is based on 1) the inner-loop feedback control of the capacitor current and 2) the outer-loop QPR control of the grid-side current. Also, in the controller, self-tuning of the fuzzy parameters is used in regulating the parameters of QPR controller. The advantages of our methods are that: easy implementation, low computational cost, fuzzy control that is not dependent on rigorous mathematical models. Experiments show that this method has more effectiveness, compared with the usual proportional-integration controller and the quasi-proportional resonant controller.

11:40-12:00 **MonA01-5**

Robust Adaptive Dynamic Surface Control for Receiver UAV During Boom Refueling in the Presence of Vortex

Ziquan Yu Northwestern Polytechnical Univ.
Yaohong Qu Northwestern Polytechnical Univ.
Youmin Zhang Concordia Univ.

This paper investigates the approaching control problem of a receiver unmanned aerial vehicle (UAV) in the presence of vortex induced by tanker aircraft/UAV during boom refueling. Sliding mode control and adaptive control are incorporated into the backstepping control architecture in each step to develop the controller for the attitude subsystem and velocity subsystem. The upper bounds of the vortex induced by the tanker aircraft are estimated with the adaptive law. To eliminate the inherent problem of “explosion of complexity” in the backstepping architecture, the dynamic surface control (DSC) is investigated to construct the controller. Furthermore, it is proved that the proposed controller can guarantee the uniform ultimate boundedness of all the signals in the closed-loop system. Finally, simulation results show the effectiveness of the proposed method.

12:00-12:20 **MonA01-6**

Landing Control of Unmanned Aerial Vehicle using continuous Model Predictive Control

Naila Qayyum National university of Science and Techn. Institute of space techn.
Aamer Iqbal Bhatti Capital university of Science and Tech.
Muwahida Liaquat National university of Science and Tech.

In this paper, landing control has been designed using Model Predictive control for autonomous landing of unmanned aerial vehicles (UAVs), along with associated path planning. An improved design and development of controller required for the autonomous landing of fixed wing unmanned aircraft is presented. Model Predictive controller using laguerre function is designed to ensure optimum performance of landing phase of UAV. MPC improves performance by giving superior control over MIMO controller of landing. A quadratic cost function minimization using cyclic co-ordinate search method is utilized in solving constraints imposed on inputs of the system. Numerical simulations are performed to verify feasibility of the proposed landing control law of aircraft under input constraints.

MonA02 **Room02**
Intelligent Building Control and Management (I) **10:20-12:20**
Chair: Yahui Wang Beijing Univ. of Civil Engineering and Architecture

10:20-10:35 **MonA02-1**

Design of Real-time Monitoring about Air-source Heat Pump Based on Kingview

Guihong Zhang Nantong Univ.
Yi Yang Nantong Univ.
Yuanpei Yang Nantong Univ.
Jianhan Wang Nantong Univ.
Haiqi Gu Nantong Univ.

This article designed a monitoring system about single unit for air-source heat pump water heater which is based on kingview as epigynous machine and Mitsubishi programmable logic controller (PLC) as hypogynous machine. In this system, the PID control algorithm as temperature control provides important protection for the stable operation of the water heater. This system realizes some important functions such as a user login, the real-time data-logging, alarming, printing of the parameter and data, record checking and so on.

10:35-10:50 **MonA02-2**

Research of Building Evacuation Path to Guide Based on BIM

Jun Ma Beijing Univ. of Civil Engineering and Architecture
Jia Wang Beijing Univ. of Civil Engineering and Architecture
Jingyan Zhang Beijing Univ. of Civil Engineering and Architecture

As building structure is more and more complex, confronting evacuation prone to retrograde and blockage phenomenon, traditional plain of evacuation schematic has been difficult to meet the demand guidance for fire evacuation. In this paper, we propose a building information model (BIM) for the guidance of the three-dimensional building within the evacuation path. Full integration of BIM Technology and virtual reality technology, timely updates to the daily information, form a management platform, through this platform, so that the fire evacuation path is more intuitive, evacuation drills more convenient and management personnel to direct the rescue more accurately. Article schematic through normal fire evacuation, evacuation typical fire scenarios indicate two aspects to exhibit a three-dimensional analysis of the command to evacuate the building evacuation path.

10:50-11:05 **MonA02-3**

Human Localization System Using 3D Two-dimension Code

Jianhong Zou Tsinghua Univ.
QianChuan Zhao Tsinghua Univ.
Chengjun Jia Tsinghua Univ.

Lack of intelligent service is nowadays a problem in the construction of smart community. Location-based service is a typical intelligent information service, but its application is limited by the low accuracy of localization technologies. This paper proposes a new human localization technique using 3D 2-dimensional code. Spatial units in smart community are uniformly modeled and encoded. The location code is converted into QR 2-dimensioanl code and made into identification card by 3D printer. The 3D 2-dimensional codes are mounted on walls, and location information server and intelligent application server are deployed for the smart community. User uses the APP on smart phone to scan and recognize the 3D code and obtains the location information. The servers fuse the location data and other heterogeneous data and big data mining may inspire potential intelligent service. The location data are encoded as the format of “zip code/institution code/building code/partition code/floor code/room code”. The location information database mainly consists of user information database, map node database and location characteristic database. This technique is used to design and implement a human location system for Tsinghua University. Students and staff use the system to localize themselves and the property management department collects their complaint on temperature or humidity to improve the comfortable level and save energy. This technique achieves a high localization accuracy of room level due to the lookup table strategy and has several advantages over the IC card technique.

11:05-11:20 **MonA02-4**

Study on interregional traffic coordination based on multi-objective optimization

Min Li North China Univ. of Tech.
Haibo zhang North China Univ. of Tech.
Li Wang North China Univ. of Tech.

Traffic control and route guidance is a common method for realizing area traffic coordination. Firstly, the travel time of local area network and intersection delay are selected as the optimization objective of the network system, meanwhile considering the constraints about capacity in boundary region. Furthermore, regional internal control, induced coordination effect and coordination with cross-sub segments are abstracted into a multi-objective optimization problem, simultaneously, introducing the weighted strength parameters to reflect the different preference information of transportation decision-maker for different traffic influence on cooperative system. Finally the paper gives a genetic algorithm solution to the problem, and then traffic simulation software Paramics is used to analyze the real-world road network in Wangjing district in Beijing. Simulation results show that the cooperative algorithm can effectively alleviate the local traffic congestion and improve traffic operation efficiency.

11:20-11:35 **MonA02-5**

Monitoring Platform of Energy Management System for Smart Community

Hui Li Shadong Jianzhu Univ.
Guirong Wang Shadong Jianzhu Univ.
Jianping Wei Shadong Jianzhu Univ.
Peiyong Duan Shadong Jianzhu Univ.

For the purposes of realizing energy-saving and emission reduction for smart community, this paper presents a monitoring platform of energy management system integrated supply energy and using energy for smart community. It monitors, records and analyzes the process data of energy production, energy transmission and energy consumption for smart community. The architecture of community energy system is divided into acquisition layer, transmission layer and management layer. The data communication between data acquisition devices and data center adopts Ethernet and TCP/IP protocol. The data communication between field instruments and data acquisition devices adopts RS-485 interface and Modbus communication protocol. The software system framework of data center is divided into data communication and processing layer, data display and analysis layer and information layer. The development of monitoring platform for smart community can not only improve the management level, but also reduce the energy consumption of community energy system.

11:35-11:50 **MonA02-6**

Device Control and Manage System in Military Barracks

Kaiwen Luo Logistic Engi. Univ.
Wei Zhong Logistic Engi. Univ.

In order to improve device management level and ensure device operation stabilization, a device control and manage system (DCMS) and its application method is proposed in this paper. The DCMS and its application method are made up of four essential parts: scheme design, data acquisition, data upload and transfer, applications. The details of each part have been illustrated comprehensively. Finally, a typical application is given to demonstrate that the DCMS can realize the field device controlling and management real time, improve control efficiency and reliability.

11:50-12:05 **MonA02-7**

Research on Intelligent Decision Making Technology of Fire Emergency Rescue

Ran Chu Beijing Univ.of Civil Engi. and Architecture
Huaixiu Wang Beijing Univ.of Civil Engi. and Architecture
Yahui Wang Beijing Univ.of Civil Engi. and Architecture
Conglei Zhang Beijing Univ.of Civil Engi. and Architecture

There is frequent fire accident in the city building, how to allocate fire resources reasonably and minimize the loss of accident need to be solved urgently. In order to solve these problems, this paper studies the intelligent decision making technology about emergency rescue, and put forward a kind of decision scheme based on case based reasoning technique.

12:05-12:20 **MonA02-8**

A Research on Smart Tourism-Oriented Big Data Real-time Processing Technology

Jin Wei Northwestern Polytechnical Univ.
Lei Ma Northwestern Polytechnical Univ.
Zhongqiu Zhang Northwestern Polytechnical Univ.

With the enrichment of human social life, tourism is becoming more and more popular. The development of cloud computing, big data, internet of things technology makes smart tourism gradually evolve from the concept to a technology which can thoroughly change people's lives. Through smart tourism, a large number of rich and comprehensive real-time data can be available, including source of tourists, travel information, travel routes and other data which can achieve real-time monitoring of the scenic spots and precision marketing to customers, thus promote the development of tourism services and improve tourism.
This paper will take smart tourism as the research object, and introduces large quantities of real-time data analysis and processing technology in smart tourism, and real-time processing data modeling methods. On this basis, scenic passenger flow monitoring model, scenic tourist analysis model and scenic passenger flow warning model will be established respectively. The technology presented in this paper has the characteristics of high real-time, high reliability, high accuracy of data processing, and has strong applicability, which be extended to other large data real-time processing scenarios.

MonA03 Room03
Optimal control and optimization (V) 10:20-12:20
Chair: Lizhen Shao University of Science and Techn.
CO-Chair: Xiaoming Tang Chongqing Univ.

10:20-10:40 MonA03-1

Application of Improved Gravitational Search Algorithm in PID Control for Boiler DrumWater Level

Le Wei North China Electric Power Univ.
Binbin Ma North China Electric Power Univ.

The boiler drum water level reflects the equilibrium relationship between the steam load and the water supply of the drum boiler, which is an important monitoring parameter in boiler operation. Its object has the characteristics of non-self-balancing and pure delay, and its control quality directly affects the safe operation of a boiler-turbine unit. Based on the improved gravitational search algorithm, the parameter optimization method of the main controller is put forward according to the wide-used cascade control structure of drum water level in power plant. The gravitational search algorithm has the advantages of simple process, little parameter setting, strong universality of the algorithm, but easy to fall into local optimum. Combining with the memory function of particle swarm optimization algorithm and the high precision of other improved algorithms, the formulas of position and velocity are improved, an improved gravitational search algorithm (IGSA) is obtained. By applying this method to the optimization control of the drum water level, and comparing with trial-and-error method (TEM), genetic algorithm (GA) and the standard algorithm (GSA), simulation tests are carried out to verify its effectiveness.

10:40-11:00 MonA03-2

Modeling and Optimal Tracking for Power and Rate in Wireless Communication Networks with Multiple Time Delays

Cunwu Han North China University of Tech.
Shurui Chang North China University of Tech.
Qi Diao North China University of Tech.
Song Bi North China University of Tech.
Lei Liu North China University of Tech.

This paper concerns multiple time delays in power and rate control for wireless communication networks with external disturbance. Based on the mathematical state-space model established for the wireless communication networks with state delay and input delay, a compensation algorithm for multiple time delays of general form model is researched and it can be applied into our model. An optimal tracking algorithm is given and the optimal control law can be obtained by solving the matrix Riccati algebraic equation. Finally, simulation results show that the proposed algorithm has good control performance.

17:00-17:20 TueD02-3

Output Feedback Predictive Control of Interval Type-2 T-S Fuzzy Systems with Markovian Packet Loss

Xiaoming Tang College of Automation, Chongqing University of Posts and Telecommunications, Key Laboratory of Industrial Internet of Things & Networked Control, Ministry of Education, Chon gqing University of Posts and Telecommunications
Li Deng College of Automation, Chongqing University of Posts and Telecommunications, Key Laboratory of Industrial Internet of Things & Networked Control, Ministry of Education, Chongqing University of Posts and Telecommunications
Jimin Yu College of Automation, Chongqing University of Posts and Telecommunications, Key Laboratory of Industrial Internet of Things & Networked Control, Ministry of Education, Chongqing University of Posts and Telecommunications
Jiaqi Chen College of Automation, Chongqing University of Posts and Telecommunications, Key Laboratory of Industrial Internet of Things & Networked Control, Ministry of Education, Chongqing University of Posts and Telecommunications

This paper is mainly concerned with the output feedback model predictive control (MPC) of nonlinear networked control systems (NCSs) with data quantization and packet loss. Affected by the parameter uncertainties, which can be captured with the lower and the upper membership functions, the nonlinear system is turned into the linear one by the interval type-2 (IT2) Takagi-Sugeno (T-S) fuzzy model. Stochastic variables with Markov jump linear model are exploited to represent the defective communication links with packet loss, and sector bound uncertainties are introduced to express the data quantization by applying the sector bound approach. The design of output feedback MPC scheme involves an off-line obtained state observer using the linear matrix inequality (LMI) technique and an on-line MPC optimization problem based on the designed estimation state. A new technique for refreshing the estimation error bound, which plays the key role of guaranteeing the recursive feasibility of optimization problem, is provided in this paper. A numerical example is given to demonstrate the effectiveness of the proposed output feedback MPC approach.

11:20-11:40 MonA03-4

Transfer Trajectory Optimum Design for Lunar Relay Satellite Based on Electric Thruster

Ran An Institute of Telecommunication Satellite
Min Wang Institute of Telecommunication Satellite
Xingang Liang Institute of Telecommunication Satellite
Qiang Li Institute of Telecommunication Satellite

During the optimal design process of low-thrust transfer trajectory to translunar Libration point, the governing variable such as pitching and yaw angle of satellite were considered. However, the consideration is not enough because the selection of initial orbit after satellite-rocket separation and the inlet point of invariant manifolds are also of great importance to the transition time and the fuel consumption, which influence optimal design. In this paper, the hybrid method in optimal control theory is adopted to calculate the optimal transfer orbit of Lunar Relay Satellite using electric thrusters based on the range of initial orbits according to the launch capacity of launch vehicle and the extinction selection of low-thrust transfer trajectory. Initial orbit parameters of low-thrust transfer trajectory and invariant manifold of Lunar Relay Satellite are optimized. The result shows the design rules and the algorithm is of great important engineering meaning.

11:40-12:00 MonA03-5

Approximating reachable sets of linear control system using multi-objective programming

Yangfan Zhang University of Science and Technology, Beijing
Lizhen Shao University of Science and Technology, Beijing
Guanda Hu Shanghai University
Boyu Li University of Science and Technology, Beijing

A continuous control system can be discretized into a discrete control system by numerical methods for ordinary differential equations. Studies have shown that the reachable set of a continuous control system can be approximated by its discrete counterpart. In this paper, utilizing the convex property of the reachable set of a linear control system, we propose a method to approximate the convex reachable set of a discrete control system with multiple MOP problems and the convex hull of the non-dominated sets of these MOPs is the reachable set. For each MOP the revised normal boundary intersection method is used to obtain non-dominated points. Finally, we use computational experiences to clearly illustrate the validity of this method.

12:00-12:20 MonA03-6

A Fuel Cell EIS Measurement Method Based on the Model Predictive Control Strategy

Rong Long Huazhong Agricultural Univ.
Weiyang Chen Wuhan University of Tech.
Liyan Zhang Wuhan University of Tech.
Qihong Chen Wuhan University of Tech.
Shuhai Quan Wuhan University of Tech.

Electrochemical impedance spectroscopy is one of the important indicators for the fuel cell performance, so its accurate measurement is necessary for the fuel cell system's efficient and reliable operation. In this paper, the fuel cell EIS measurement is to modulate DC/DC ripple which is introduced into the fuel cell as excitation source. In order to meet requirements of rapidity and stability in DC/DC controller, model predictive control algorithm is proposed. First of all, the linear state space equation is obtained by linearizing boost circuit model. The triangular wave disturbance is added in the reference voltage which is used to compute the optimal duty cycle by using explicit model predictive control algorithm. The duty cycle is used to control the IGBT of the circuit system, thereby achieve the rapidity and stability of the control. Finally, the simulation results and experimental results demonstrate the feasibility and effectiveness of the model predictive control.

MonA04 Room04
Fractional Calculus and Fractional-order Systems (III) 10:20-12:20
Chair: Dingyu Xue Northeastern Univ.
CO-Chair: Feng Pan Northeastern Univ.

10:20-10:40 MonA04-1

Observer Design for Fractional Order One-Sided Lipschitz Nonlinear Systems with Unknown Input

Tao Zhan Shandong Univ.
Shuping Ma Shandong Univ.

In this paper, we consider a method of designing the unknown input observers for fractional order one-sidedLipchitz nonlinear systems. By introducing a continuous frequency distributed equivalent model and using the matrixgeneralized inverse approach, sufficient conditions for asymptotic stability of the observer error dynamic systems arepresented, which guarantee the existence of the full-order unknown input observers. All the conditions are obtainedin terms of linear matrix inequality (LMI). Two numerical examples are given to demonstrate the applicability of the proposed approach.

10:40-11:00 MonA04-2

Some New Alternative Stability Conditions For Fractional Order Systems

Xuefeng Zhang Northeastern Univ.
Dengrui Sun Northeastern Univ.

Recently, fractional calculus has attracted much attention since it plays

an important role in many fields of science and engineering. Especially, the study on stability of fractional differential equations appears to be very important. This paper puts forward some new alternative stability conditions for fractional order systems based on existing stability conditions for fractional systems. And we propose some remarks about equivalent existing theorems. This paper shows that the two kinds of different situations, respectively are : $0 < \alpha < 1$ and $1 < \alpha < 2$. And we propose three theorems based on existing conclusions of fractional order systems. Finally, the numerical examples are given to illustrate the effects of conclusion.

11:00-11:20 **MonA04-3**

A MATLAB Toolbox for Multivariable Linear Fractional-order Control Systems

Dingyu Xue Northeastern Univ
Tingxue Li Northeastern Univ
Lu Liu Northeastern Univ

In this paper, an extended version of the FOTF Toolbox is presented which can be used to handle multivariable fractional-order transfer function matrices. A good interface is provided on top of the well-established MFD (Multivariable Frequency Design) Toolbox, which enables the users to perform frequency domain analysis and design of linear fractional-order systems. An illustrative example is also provided in the paper to show the applications of modeling, analysis and design of fractional-order systems with the proposed toolbox.

11:20-12:40 **MonA04-4**

Analysis of A Novel 4D Fractional-order Ferromagnetic Chaotic System

Chaojun Wu Xi'an Polytechnic Univ.
Ningning Yang Xi'an Univ.of Tech.
Cheng Xu Xi'an Univ.of Tech.
Rong Jia Xi'an Univ.of Tech.

In this paper, a novel four-dimensional (4D) fractional-order chaotic system is proposed deduced from the model of ferromagnetic resonance. The attractor is a three-dimensional (3D) torus like the Olympic nest in Beijing when the system is in stable state. Dynamic behaviors of the novel 4D ferromagnetic system are analyzed in detail, such as phase portrait, Poincare map, Lyapunov exponents and bifurcation diagram. Then the influence of the fractional-order on the dynamic behaviors of this system is analyzed. Numerical simulation results illustrate the feasibility of the novel system.

11:40-12:00 **MonA04-5**

PDα−Type Iterative Learning Control for Fractional-order Singular Time-delay System

Mihailo Lazarević Univ.of Belgrade
Nikola Đurović Univ.of Belgrade
Boško Cvetković Univ.of Belgrade
Petar Mandić Univ.of Belgrade
Milan Cajić Mathematical Institute of the SASA

In this paper a closed-loop PDα - type iterative learning control (ILC) of fractional order singular time-delay systemis considered. In particular, we discuss fractional order linear singular timed-delay systems in state space form. The sufficient conditions for the convergence in time domain of the proposed PD-alpha type ILC for a class of fractional order singular system are given by the corresponding theorem together with its proof. Finally, the validity of the proposed PDα ILC scheme for a class of fractional order singular time-delay system is verified by a numerical example.

12:00-12:20 **MonA04-6**

Stabilization of Double Inverted Pendulum System by Using a Fractional Differential Compensator

Petar D. Mandić Univ.of Belgrade
Mihailo P. Lazarević Univ.of Belgrade
Tomislav B. Šekara Univ.of Belgrade
Milan Cajić Mathematical Institute of the SASA
Ljubiša Bučanović Univ.of Belgrade

In this paper stability problem of double inverted pendulum controlled by a fractional differential compensator is investigated. Pendubot is an underactuated mechanical system, i.e. it has only one control input and two degrees of freedom. Detailed mathematical model of Pendubot is derived using the Rodriguez method and then fractional order lead compensator is introduced in order to stabilize it around unstable upright position. D-decomposition method is used to solve the problem of asymptotic stability of closed loop system. Stability regions in control parameters space are calculated using this technique, which allows tuning of the fractional differential compensator to be carried out.

MonA05 **Room05**
IntelliSense and Advanced Sensing, Detection Technology (III) **10:20-12:20**

Chair: Qi OuYang Chongqing Univ.
CO-Chair: Hongpeng Wang Shenyang Jianzhu Univ.

10:20-10:40 **MonA05-1**

A new harmonic measurement method based on VMD and STEKF

Lingyun Wang Huazhong Univ. of science and Tech.

With the extensive application of power electronic devices and nonlinear loads, harmonic inevitably exists in power systems. This paper proposes a new method for global harmonics measurement including integer harmonic and inter-harmonic under both stationary condition and dynamic condition. The new proposed method consisits in applying the Variational Mode Decomposition (VMD) for harmonic extraction, then using strong Tracking Extended Kalman Filter (STEKF) to calculate the instantaneous amplitude and frequency of harmonic. An adaptive algorithm for finding appropriate parameter K of VMD is used to ensure that there is no false mode in the VMD result. The performance of proposed method is compared with Fast Fourier Transform (FFT) based methods, Wavelet Transform (WT) based method and Hilbert-Huang Tranform (HHT) based method in different harmonic conditions. The result of simulation argues that the new proposed method is suitable for global harmonic measurement which contains inter-harmonic and dynamic harmonic.

10:40-11:00 **MonA05-2**

The Dynamic Impedance Matching Method for High Temperature Electromagnetic Acoustic Transducer

Yongming Zao Chongqing Univ.
Qi OuYang Chongqing Univ.
Xinglan Zhang Chongqing Univ.
Shuaicheng Hou Chongqing Univ.
Mi Fang Chongqing Univ.

Temperature fluctuation and lift-off form the sample had caused the resonant frequency shift and impedance variation of electromagnetic acoustic transducer (EMAT). They result in low power efficiency and unstable echo amplitude. To solve this problem, a dynamic impedance matching system has been developed to accurately achieve impedance match for high temperature EMAT at the broadband. It based on the linear model of an EMAT. The main advantage of the method is use the switch combination to changing parameter values of the LC network at the temperature fluctuation. The reasonable signal-to-noise ratios were to be achieved based on the most useful LC matching network for ultrasonic transducer. Furthermore, there is no need controller due to this method based on take turns to query coded values and which find the suitable switch combination of LC network. In this paper, the main influence of coil impedance is high temperature, and the change trends of coil parameters are analyzed in different temperature. The experimental results show that the dynamic impedance matching method can effectively improve the ultrasonic conversion efficiency of the transducer at the temperature fluctuation, and it verified the effectiveness of this method.

11:00-11:20 **MonA04-3**

Human Action Recognition Based on Improved CoHOG-LQC

Shiru Qu Northwestern Polytechnical Univ.
Tao Li Northwestern Polytechnical Univ.

In accordance with the miscalculation over the recognition of resemble objects in the process of human action recognition, and strong correlations between detection precision and description capability that local texture feature descriptors can achieve when acquiring the characteristics of image edge and direction, considering the defects that the low space efficiency as well as high spectral information loss of the pedestrian tracking algorithm which based on fusion among Local Binary Pattern (LBP) and Histograms of Oriented Gradient (HOG), we proposed a novel algorithm based on the fusion among Local Quantization Code (LQC) feature and Co-occurrence Histogram Oriented Gradient (CoHOG) feature for detecting passenger. Firstly, the spectral property of the image was extracted efficiently using LQC feature descriptor from image. Next, the calculation using integral image was established to withdraw edge characteristic and CoHOG features based on LQC character spectrums from the original image. For further procedure, the CoHOG edge feature are fused with them, then the fusion feature image is acquired. At last, Histogram Intersection Kernel Support Vector Machine (HIKSVM) classifiers were performed for detection and recognition. To validate the effectiveness of the algorithm, experiments are carried out on 3 public human action dataset including Weizmann, KTH and Hollywood2. The results demonstrate that the method is effective to raise accuracy and efficiency of clustering process.

11:20-12:40 **MonA05-4**

A Multi-Scale Kernel Correlation Filter Tracker with Feature Integration and Robust Model Updater

Fulai Xu NanKai Univ.
Hongpeng Wang NanKai Univ.
Yulin Song NanKai Univ.
Jingtai Liu NanKai Univ.

In recent years, the correlation filter-based trackers (CFTs) have shown to provide excellent results in different competitions and benchmarks, but there is still a need to improve the robustness of CFTs. Compared with the traditional kernel correlation filter tracker, the approach we present in this paper makes some significant improvements. The strong features including HOG and Color-naming are integrated to maintain a more powerful object representation, and PCA is applied to boost the computation speed. To deal with scale variation, a multiple scale adaptive method is adapted. Model updater is modified by considering all previous frames to update the discriminative classifier coefficients. Extensive evaluations are performed on 51 challenging benchmark sequences. The experiments results show that our approach outperforms state-of-the-art tracking methods. Additionally, the proposed approach is implemented in our practical project, and the results also prove the availability of our approach.

11:40-12:00 **MonA05-5**

The permanent magnet rotating (angular) acceleration sensor and a new method of mechanical rotating system torsional vibration measuring

Juanjuan Zhang Hangzhou Dianzi Univ.
Hao Feng Hangzhou Dianzi Univ.

According to the basis measurement problem of rotating machinery system in tangential vibration at present, this article presented 3 types of structure of the permanent magnet rotating (angular) acceleration sensor, and on the basis of introducing the operating principle of sensor, this article also analyzed the sensor error and introduced the thinking of sensor characteristics system parameter normalization. Because the sensor is based on the principle of electromagnetic induction, it is only sensitive to the rotation acceleration or rotation angle acceleration. Moreover, the sensor is simple in structure, convenient in use and different in structure, which can meet the measurement requirements of rotation (angle) acceleration of different rotating machinery systems. Finally, according to two practical application examples of the sensor in this article, the sensor proved the practicality and feasibility.

12:00-12:20 **MonA05-6**

Research on Pedestrian Navigation System Aided by Indoor Geomagnetic Matching

Xin Huang Nanjing Univ. of Aeronautics and Astronautics
Zhi Xiong Nanjing Univ. of Aeronautics and Astronautics
Jianxin Xu Nanjing Univ. of Aeronautics and Astronautics
Linlin Xu Nanjing Univ. of Aeronautics and Astronautics

Indoor pedestrian navigation technology is playing a more and more important role in our life. For low cost strap-down navigation system, error is large and spreads rapidly. Hence, this paper proposes a zero velocity update (ZUPT) detection algorithm based on acceleration magnitude square variance detector (AMSVD), angular rate magnitude square variance detector (ARMSVD), acceleration magnitude square detector (AMSD) and angular rate magnitude square detector (ARMSD) to distinguish pedestrian kinetic characteristics and restrain the divergence of errors. Meanwhile, this paper studies the pseudo measurement information in ZUPT and builds a kalman filter for optimal estimation of errors. Simultaneously, we study the indoor magnetic anomaly and put forward a kind of indoor geomagnetic matching algorithm based on k-nearest neighbor algorithm (KNN) and a multi-layer constraint which is suitable for engineering application. Finally, we construct an integrated navigation system to realize optimal fusion of MEMS pedestrian navigation system and geomagnetic matching model to improve accuracy and adaptation and provide continuous position information, besides, it weakens the effect of MEMS sensor over range. Tests show that the accuracy of the integrated navigation system is increased by more than 55% and the final position error is only 0.4%.

MonA06 **Room06**
Nonlinear systems (I) **10:20-12:20**
Chair: Zhitao Liu Zhejiang Univ.
CO-Chair: Jiamei Lin Jilin Univ.

10:20-10:40 **MonA06-1**

Terminal Guidance Law Based On Adding a Power Integrator Approach with Autopilot Lag

Zhao Wang China Univ. of Petroleum (East China)
Qing Cai China Univ. of Petroleum (East China)
Shurong Li China Univ. of Petroleum (East China)

In this paper, a guidance law is proposed based on adding a power integrator approach for intercepting maneuvering targets in the presence of autopilot lag. Considering the missile autopilot as the first-order system, a new robust finite-time terminal guidance law is designed which can handle the targets maneuvering. In the design procedure, assumed that the acceleration of the target is bounded. It is proved that the system state i.e. the line-of-sight (LOS) angular rate and LOS angular acceleration can converge to a small neighborhood of zero in finite time under the designed terminal guidance law. Simulation demonstrate that this paper proposed the guidance law has a better robust performance against the maneuvers and the dynamics of the missiles autopilot.

10:40-11:00 **MonA06-2**

Adaptive Cooperative Output Regulation of Multi-Agent Systems in Nonlinear Lower Triangular Form

Meichen Guo City Univ. of Hong Kong
Dabo Xu Nanjing Univ. of Science and Techn.
Lu Liu City Univ. of Hong Kong

This paper considers a global cooperative output regulation problem for a class of multi-agent systems in nonlinear lower triangular form. Specifically, we focus on the problem under three relaxed conditions: (i) the agents have non-identical arbitrary relative degrees, (ii) the control directions are unknown and non-identical, and (iii) the communication graph is directed. To overcome these challenges, we develop a novel dynamic compensator based distributed controller. Moreover, the proposed controller is applied to cooperative control of a group of Lorenz systems to show the effectiveness of the proposed control scheme.

11:00-11:20 **MonA06-3**

Control Lyapunov Function Based Control Strategy for Air Supply System of PEM Fuel Cells

Rong Yang Zhejiang Univ.
Zhitao Liu Zhejiang Univ.
Hongye Su Zhejiang Univ.

In order to achieve the desired net power sufficiently and rapidly, a control strategy based on control Lyapunov function is proposed to regulate the oxygen from the air supply system of PEM Fuel cells in this paper. Based on the popular nonlinear air supply model, exponential stability can be obtained by the proposed control strategy. Moreover, the convergence speed can also be tuned by the parameters in a range. Finally, the performance of the proposed strategy is shown by the simulation results.

11:20-11:40 **MonA06-4**

Integral Backstepping Adaptive H∞ Control for a Class of Switched Nonlinear Systems

Xiaolei Cheng Univ. of Science and Tech. Liaoning
Xiaohua Li Univ. of Science and Tech. Liaoning
Xiaoping Liu Univ. of Science and Tech. Liaoning
Lakehead Univ.

A control approach is proposed by using integral backstepping adaptive H controller for a class of switched nonlinear systems with unknown parameters and external disturbance in this paper. The backstepping technique is employed to design the adaptive controller step by step, and integral action is introduced in order to improve the robustness of controller and to ensure the convergence of tracking error to zero at steady state. The effect of external disturbances is attenuated by H performance. The proposed method can guarantee that the closed-loop system is stable and all signals of the closed-loop system are bounded. Finally, a simulation example shows the effectiveness of the proposed method.

11:40-12:00 **MonA06-5**

AFR Control of a Gasoline Engine Using Triple-Step Method

Jiamei Lin Jilin Univ.
Hong Chen Jilin Univ.
Ping Wang Jilin Univ.

Control of the air-fuel ratio (AFR) in gasoline engines is of imminent importance when aiming at minimizing calibration effort and meeting performance requirements. In this paper, this is achieved by employing triple-step method, which keeps the air-fuel ratio close to the stoichiometric value. The structure of the designed controller consists of three parts: steady-state control, feed-forward control concerning the reference variations and error feedback control. Based on engine speed, air mass flow through throttle and the exhaust gas oxygen (EGO) sensor, a straightforward design process is provided. Finally, the simulation results in the environment of en-DYNA with a reasonable common four-cylinder engine model show the efficiency of the proposed method.

12:00-12:20 **MonA06-6**

Study and Suggestions on R&D Competitiveness of China's GM Crops

Yuguang Wang Ningxia Univ.
Beijing Inst. of Tech.
Yanan Li Henan Polytechnic Univ.
Jinyang Cai Beijing Inst. of Tech.

In this paper, we study the commercialization dilemma of China's agriculture biotechnology from the the perspective of GM R&D capability. Firstly, we investigate government investment and the corresponding human capacity. Next, scientific papers&patents are analysised.Thirdly, we compare the R&D system between China and others and point out its disadvantages. Finally, we give some corresponding suggestions for healthy and sustainable development of China's agriculture biotechnology.

MonA07 **Room07**
Intelligent systems (I) **10:20-12:20**
Chair: Zhen-hao Tian Air Force Engineering Univ.
CO-Chair: Songhao Zhu Nanjing Univ. of Posts and Telecommunications

10:20-10:40 **MonA07-1**

Image Search via Semantic Hashing Learning

Weicheng Sun Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications

With the rapid proliferation of large-scale web images, recent years have witnessed more and more images labeled with user-provided tags, which leads to considerable effort made on hashing based image retrieval in huge databases. Current research efforts focus mostly on learning semantic hashing functions which designs compact binary codes to map semantically similar images to similar codes, and the visual similarity is not well explored for constructing semantic hashing functions. Here a novel approach is proposed to learn hashing functions that preserve semantic and visual similarity between images. Specifically, semantic hashing codes are first learned by leveraging the similarity between textual structure and visual structure; then, maximum entropy principle is exploited to achieve compact binary codes; finally, function decay principle is introduced to remove noisy visual attributes. Experimental results conducted on a widely-used image dataset demonstrate the proposed approach can effectively improve the performance in image retrieval.

10:40-11:00 **MonA07-2**

A Case-Similarity Computation Method of Anti-missile Operation

Zhen-hao Tian Air Force Engineering Univ.
Qing-hua Xing Air Force Engineering Univ.
Jia-le Gao Air Force Engineering Univ.

Case-Similarity Computation is an important process of the case-based reasoning (CBR). In this paper, we extended the CBR to anti-missile operation, and proposed a novel method of the anti-missile case similarity computation. Combining the characteristics of the anti-missile operation, we designed six kinds of algorithms corresponding to six attributes and improved the algorithms of margin attribute and general numerical attribute. The experiment result illustrates that the new method is logical and shows better performance in the resolution.

11:00-11:20 **MonA07-3**

Temporal-Spatial Coherence Based Abnormal Behavior Detection

Xian Sun Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications

To improve the accuracy and speed of the local abnormal detection, a novel method based on Temporal-Spatial Coherence model is proposed. Specifically, the video block is firstly extracted using the gradient histogram and optimized based on the temporal-spatial coherence. Then the normal behavior model and abnormal behavior model is learned via the tensor voting algorithm and the temporal-spatial coherence respectively. Finally, abnormal behavior is detected and labeled. The experiments conducted on the public UCSD and Subway datasets demonstrate the efficiency of the proposed method for local abnormal behavior detection.

11:20-11:40 **MonA07-4**

Object Detection via Optical Information and Background Information

Xian Sun Nanjing Univ. of Posts and Telecommunications
Songhao Zhu Nanjing Univ. of Posts and Telecommunications
Yanyun Cheng Nanjing Univ. of Posts and Telecommunications

This paper presents a novel method to detect salient objects by exploiting the optical information and background information. Specifically, each video image is first segmented into superpixels; then, the optical information and color information is utilized to obtain the initial result of each salient object; finally, the accurate result of each salient object is obtained by taking into consideration the background information. Experimental results conducted on the SegTrackv2 database demonstrate the the effectiveness of the proposed method.

11:40-12:00 **MonA07-5**

Dynamic Data Modeling Based on Multi-kernel Support Vector Machine with Immune Sliding Optimization

Ke Yin Donghua Univ.
Lei Chen Donghua Univ.
Yongsheng Ding Donghua Univ.

A novel dynamic modeling method based on multi-kernel support vector machine with immune sliding optimization (ISA-MKSVM) is proposed in this paper. Multi-kernel SVM is an effective tool to solve the diversity of data features, and the immune sliding algorithm optimizes the parameters of multi-kernel SVM. The proposed algorithm can obtain a good dynamic performance by re-defining the affinity of the antibody on a dynamic system. The proposed approach is applied for modeling the solvent concentration in forming of carbon fiber, and the experimental results show that ISA-MKSVM is accurate and has better generalization ability than single-kernel SVM, and the process of parameter optimization is faster than traditional algorithm.

12:00-12:20 **MonA07-6**

An adaptive genetic algorithm for monitoring Kiwifruit's Variant Seedlings in tissue culture

Qiang Zhang Kunming Univ. of Science and Tech.
Yong Li Kunming Univ. of Science and Tech.
Zhikun Zhang Kunming Univ. of Science and Tech.

For simulating dynamically monitoring the process of optimizing the genomic DNA polymorphism of subculture seedlings of kiwifruit, an adaptive genetic algorithm is proposed. Based on selected 8 primer pairs of kiwifruit subculture seedlings, the variations of the genomic DNAs with different fitness functions are evaluated by coding, selection, mutation and crossover operators. The results show kiwifruit's subculture seedlings can better maintain their genetic stability from the first to the ninth generation, but from the tenth generation, genetic variations appear. The results are in accord with the experimentation, which use optimized AFLP system for analyzing genetic diversity of 75 samples of 12 generations of kiwifruit.

MonA08 **Room08**
Hybrid systems (I) **10:20-12:20**
Chair: Yanming Fu Harbin Inst. of Tech.
CO-Chair: Rui Wang Dalian Univ. of Tech.

10:20-10:40 **MonA08-1**

Quadratic Stabilization and L2 Gain Analysis of Switched Affine Systems

Chi Huang Taiyuan Univ. of Tech.
Guisheng Zhai Shibaura Inst. of Tech.
Wenzhi Li Taiyuan Univ. of Tech.

We consider quadratic stabilization and L2 gain analysis for switched systems which are composed of a finite set of time-invariant affine subsystems. Both subsystem matrices and vectors are switched, and no single subsystem has desired quadratic stability or specific L2 gain property. We show that if a convex combination of subsystem matrices is Hurwitz and another convex combination of affine vectors is zero, then we can design a state-dependent switching law (state feedback) and an output-dependent switching law (output feedback) such that the entire switched system is quadratically stable. The result is also extended to L2 gain analysis under state feedback.

10:40-11:00 **MonA08-2**

Trajectory Tracking Problem Based-on Output Feedback Control for Linear Systems with Actuator Jumping Fault and Its Application in Orbit Maneuvering

Yang Lu Harbin Inst. of Tech.
Yanming Fu Harbin Inst. of Tech.
Maorui Zhang Harbin Inst. of Tech.

The trajectory tracking control problems for linear systems with actuator jumping fault is studied in this paper. The main contribution is that it is obtained the complete parametric expression of the controller for the systems. The existence condition of the controller is deduced based on the Lyapunov stability theory. A linear matrix inequality method is used for the output feedback control law which is synchronously switched with the ode of the fault that make the systems stochastically stable. Based on the theory of the generalized Sylvester equations, a parametric method is established for the output model reference tracking problem. The controller is simulated under the spacecrafts rendezvous task which is about the two spacecrafts running on a circular orbit. The simulation results show the effectiveness of the proposed approaches.

11:00-11:20 **MonA08-3**

Design of robust observer-based controller for Time-delay switched fuzzy systems with unmeasurable premise variables

Le Zhang Shenyang Univ.
Chunpeng Guo Shenyang Univ.
Jian Wang Shenyang Univ.
Hong Yang Shenyang Univ.

This paper addresses the problem of robust observer-based controller design for the time-delay switched fuzzy systems with unmeasurable premise variables. A switched fuzzy system, which integrates fuzzy and switching features, can describe continuous and discrete modes and complex nonlinear phenomena of objective reality as well as their coupling and interactions. The fuzzy observer with unmeasurable premise variables is designed to estimate the system states. The stability and the switching control law based on measured state of the dynamic errors system are then analyzed by multiple Lyapunov function approach. Then the estimated system states are used for the state-feedback control of switched fuzzy systems. In this study, the robust control problem of an uncertain time-delay switched fuzzy system is solvable, which some sub time-delay fuzzy systems are allowed to be unstable. The robust stability conditions in the form of linear matrix inequalities (LMIs) are derived. Two numerical simulations are provided to show the validity of the proposed method.

11:20-11:40 **MonA08-4**

Stability Analysis of Positive Switched T-S Fuzzy Systems Based on Fuzzy Clustering Sets

Hongwei Wang Dalian Univ. of Tech.
Jie Lian Dalian Univ. of Tech.

Based on Takagi–Sugeno (T–S) fuzzy modeling, we deal with the problem of stability analysis for continuous-time switched positive nonlinear systems under the mode-dependent average dwell time (MDADT) switching. In our study, a fuzzy clustering method is firstly used to build the positive switched fuzzy model. Fuzzy partition for the structure space of positive switched fuzzy model is obtained by the fuzzy clustering method. On this basis, the MDADT switching is extended to switched positive T–S fuzzy system consisting of stable and unstable subsystems. The MDADT is activated to sufficiently large and the total running of stable subsystems is relatively big compared with that of unstable subsystems, then exponential stability of switched positive T–S fuzzy systems is guaranteed. Finally, the effectiveness of the proposed method is demonstrated by the example of the positive nonlinear system.

11:40-12:00 **MonA08-5**

A Stability Criterion for Discrete-Time Switched Nonautonomous Nonlinear Systems with Delays

Xingwen Liu Southwest Univ. for Nationalities of China

Addressed in the present paper is the stability issues of a class of nonlinear switched systems. It is supposed that the considered systems are nonautonomous and with time-varying delays. By defining the Jacobian-like matrices of nonlinear vector field of the original system, a comparison system (which is a so-called positive system) of the original one is constructed. It is shown that the original system is stable, exponentially stable, asymptotically stable if the comparison system is stable, exponentially stable, asymptotically stable, respectively, both local and global cases are studied. Finally, a numerical example is presented to illustrate the main theoretical results.

12:00-12:20 **MonA08-6**

Finite-time Stabilization Control for the Flight Mode Transition of Tiltrotors Based on Switching Method

Zhen Sun Dalian Univ. of Tech.
Rui Wang Dalian Univ. of Tech.
Wenya Zhou Dalian Univ. of Tech.

This paper studies the control problem of tiltrotor transition mode, which requires the regulation of nacelle inclination from 0 to 90 degree based on a finite-time switching control technique. Because of the dynamic characteristic of tiltrotor conversion, a single system model can not meet the requirements for control precision. A switched system is used to characterize the multitudes of the system. Then, based on the average dwell time method, the sufficient condition for finite-time stabilization of the longitudinal motion flight control system is developed. Finally, Simulation studies are used to demonstrate that a smooth transition of tiltrotor transition modes can be implemented effectively by the proposed switching control strategy.

MonA09 Room09
Sensor network systems (I) 10:20-12:20

Chair: Yaqing Hou Tianjin Univ. of Tech.
CO-Chair: Yingdong Ma Inner Mongolian Univ.

10:20-10:40 **MonA09-1**

Research on Indoor Environment Monitoring System Based on ZigBee

Hong He Tianjin Univ. of Tech.
Yaqing Hou Tianjin Univ. of Tech.
Zhihong Zhang Tianjin Univ. of Tech. Tianjin Radio and TV Station

Indoor air quality is an important factor in people's health.In particular, as ward, office, classroom and other sealing effect is good, relatively small space.So it is very important to monitor the indoor air quality.The system real-time monitoring of indoor air quality in a number of physical quantities.Mainly CC2530 chip as the core processor.Through the Zigbee wireless communication module to form a wireless data communication network,upload the collected information.Using LabView designed PC monitoring software, according to the set value to effectively monitor and alarm.This system has raised people's concern for the indoor living environment quality and to consider the impact of the environment on our own health,which provides a new monitoring framework for indoor environment comfort system.

10:40-11:00 **MonA09-2**

Design of Improved Directional Routing Algorithm Based on Clustering Structure

Minkai Li Shanghai Inst. of Tech.
Yiqun Yang Shanghai Inst. of Tech.
Yiming Yao Shanghai Inst. of Tech.

Aiming at the problem of large amount of data and large number of nodes in wireless sensor network, this paper proposes an improved directional routing algorithm based on clustering structure. The algorithm combines the efficient energy consumption of the cluster routing algorithm with the optimal performance of the directed diffusion routing algorithm in the process of large data transmission. And the routing algorithm of directed diffusion needs to be broadcasted many times to lead to the long delay of network and the clustering routing algorithm needs to improve and optimize the characteristics of the topology structure. Finally, the paper integrated the improved clustering algorithm and the directed diffusion algorithm. The algorithm reduces the delay of network and improves the robustness of the system. For wireless sensor networks, network delay is one of the indexes to evaluate a routing algorithm. Ultimately, according to the simulation results and the actual system test results, the proposed algorithm is proved more effective.

11:00-11:20 **MonA09-3**

A Novel Path Planning of Mobile Charger in Wireless Rechargeable Sensor Networks

Chen Qin Hohai Univ.
Yonghui Sun Hohai Univ.
Yuhang Zhang Hohai Univ.
Mantong Ai Hohai Univ.

Wireless rechargeable sensor networks (WRSNs) have become an important approach to solve the energy constraint problems in traditional battery-powered systems. In WRSNs, one or more mobile chargers (MCs) can traverse the network to transfer energy to sensor nodes. The key issue of MC is to find an optimal charging path. In this paper, we study security monitoring WRSNs for disaster area built from the industrial wireless identification and sensing platform (WISP). By taking advantage of the strong coverage of equilateral triangle, a novel charging path named TRIANGLE is proposed as a static path planning method for a single MC. Comparing with S-CURVES(ad) which has been proved to be a superior charging path, simulation results demonstrate that the proposed charging path TRIANGLE has a better performance in terms of the number of alive nodes, the charging efficiency and the utilization rate of energy.

11:20-11:40 **MonA09-4**

Convolutional Neural NetWorks (CNN) for Indoor Human Activity Recognition using Ubisense System

Jun Li Inner Mongolian Univ.
Rongkai Wu Inner Mongolian Univ.
Jiaxiang Zhao Inner Mongolian Univ.
Yingdong Ma Inner Mongolian Univ.

In order to improve the accuracy of Indoor Human Activity Recognition based on the spatial location information, we proposed a recognition method using the convolutional neural network(CNN).We pre-process the raw spatial location data and transfer them into motion feature, frequency feature and statistic feature. These features are input into the CNN to do local feature analysis. After that, we got the characteristic output items, which have to be processed by the Softmax classifier, which can recognize six activities, including walking, sitting, lying, standing, jogging and jumping. By comparing the experimental results, the best recognition rate of different experimenters is 86.7%, which shows its feasibility.

11:40-12:00 **MonA09-5**

Aeromarine Reentry Vehicle Tracking Based on Asynchronous Data Fusion of Multi-airborne-platform Sensors

Lijia Zhao Zhejiang Univ.
Meiqin Liu Zhejiang Univ.
Zhen Fan Zhejiang Univ.
Yan He Zhejiang Univ.

Asynchronous multi-sensor data fusion is a significant and practical problem in multi-airborne-platform combat system. In this paper, the low-altitude-period reentry vehicle (RV) tracking problem based on multi-airborneplatform is considered. We propose two fusion tracking algorithms for asynchronous observations of airborne infrared devices. The first one is based on the time registration policy, which unifies the observations of different nodes at different time to the fusion instant by interpolation. The second one is a new method based on asynchronous sequential fusion, which fuses the sequential observations of different nodes by state prediction. For the strong nonlinearity of reentry vehicle motion model and infrared angle observation, we use the particle filter to estimate the target states. Simulation results show that the two policies are both effective, but the time registration algorithm has better tracking precision in the assuming circumstance. Further experiments illustrate that the fusion performance is related to the observation sample rate, and the asynchronous sequential fusion method is more flexible in application.

12:00-12:20 **MonA09-6**

A dynamic energy-saving routing strategy based on ant colony optimization

Wei Qu Shenyang Normal Univ.
Danli Wen Shenyang Normal Univ.
Xueshuai Feng Shenyang Normal Univ.

Focus on the problem of finding the optimal path in wireless sensor networks(WSN), considering energy saving requirement, a dynamic energy-saving routing strategy based on ant colony optimization (DERS-ACO) is proposed. Our strategy designs the optimization rule of dynamic state transformation, which increases the search probability of the new node, so as to achieve the purpose of searching the global optimal solution quickly and effectively; In addition, it introduces the mechanism of rewards and penalties which further saves the search time and increase the probability of optimal path search, and prolongs lifetime of network greatly. Simulation and theoretical analysis showed that the searching probability of a global for the optimal solution is increased by dynamic adjustment of the dynamic state transition rule and the mechanism of rewards and punishments, and the global optimal solution is obtained quickly and effectively, furthermore the energy consumption of the nodes is saved, which will prolong the lifetime of network greatly.

MonA10 Room10
Fault diagnosis and fault-tolerant control (III) 10:20-12:20

Chair: Xiukun Wei Beijing Jiaotong Univ.
CO-Chair: Zetao Li Guizhou Univ.

10:20-10:40 **MonA10-1**

Fault Isolation for Rail Vehicle Suspension Systems Based on PSD Distance Feature

Xiaozhong Zhang Beijing Jiaotong Univ.
Xiukun Wei Beijing Jiaotong Univ.
Guorui Zhai CRRC Changchun Railway Vehicles Co., LTD
Limin Jia Beijing Jiaotong Univ.

The Suspension system is crucial for safety and steady operation of high-speed vehicles, for which the research on fault diagnosis and isolation is necessary. In this paper, the PSD distance feature extraction method is presented. The vehicle dynamic model is built in SIMPACK and the external force models are built in SIMULINK. Different fault levels of the vehicle suspension components are simulated based on the co-simulation between SIMPACK and SIMULINK. The Fuzzy Possibilistic C-Means Clustering (FPCM) and BP neural network are combined for isolating different component faults. The simulation results show that the method proposed in this paper achieves sound performance.

10:40-11:00 **MonA10-2**

Weak Fault Detection of Rail Vehicle Suspension System Based on MPCA

Tengteng Wang Beijing Jiaotong Univ.
Xiukun Wei Beijing Jiaotong Univ.
Limin Jia Beijing Jiaotong Univ.
Guorui Zhai CRRC Changchun Railway Vehicles Co., LTD

Along with the rapid development of urban rail transit, the security and

reliability of rail transit vehicle system draws more and more attention. Suspension system plays a key role in supporting the car body, bogies and wheels, therefore it is vitally important to implement real-time performance monitoring and weak fault detection. This paper introduces a multilinear principle component analysis (MPCA) framework for weak fault feature extraction by using tensor data. The aim of the proposed framework is to determine a multilinear projection that captures most of the variation on the original tensor input. Experimental results show that MPCA discussed in this paper achieves better performance for weak fault detection and isolation compared with classical principle component analysis (PCA) and its extension algorithm dynamic principle component analysis (DPCA).

11:00-11:20 **MonA10-3**

RUL Prediction for Railway Vehicle Bearings Based on Fault Diagnosis

Dong Yan Beijing Jiaotong Univ.
Xiukun Wei Beijing Jiaotong Univ.
Guorui Zhai CRRC Changchun Railway Vehicles Co., LTD

In recent years remaining useful life prediction of metro bearing is paid much more attention. Different faults have different prediction models for bearings. In this paper, the remaining useful life prediction based on fault diagnosis is proposed. With the aid of the cyclic stability characteristic of the bearing signal, a spectral correlation density combination method is proposed and used to fault diagnosis and identify the fault scale. In order to ensure the accuracy of analysis and mixed fault, the variable predictive model is used to detect the fault type. As for the remaining useful life prediction, a semi supervised co-training based approach is used to solve the problem of lacking fault data. The effectiveness and better prediction accuracy of this method are demonstrated by a case study.

11:20-11:40 **MonA10-4**

Multi-Parameter Fault Isolation Using Trajectory-Based Envelope

Zetao Li Guizhou Univ.
Boutaieb Dahhou LAAS-CNRS, Universite de Toulouse

Parameter interval based fault isolation for single parameter fault has ideal isolation speed, the fault parameter value is estimated when fault is isolated. Analogous scheme can be built for multi-parameter fault isolation using envelope to replace scalar threshold for interval judgment. However wrapping effect should be considered when envelope is used. In this paper a multi-parameter fault isolation scheme is built using a trajectory-based envelope which is without of wrapping effect.

11:40-12:00 **MonA10-5**

Simultaneous Fault Detection and Controller Design for Networked-Based Discrete-time Switched Systems with Time-varying Delays

Shenquan Wang Changchun Univ. of Tech.
Yuenan Wang Changchun Univ. of Tech.
Jiyue Pang Changchun Univ. of Tech.
Keping Liu Changchun Univ. of Tech.

This paper studies the problem of simultaneous fault detection (FD) and control of discrete-time switched systems with time-varying delays under an arbitrary switching signal in a network communication. The missing phe-nomenon is assumed to occur, in the communication links for sensor-to-controller and controller-to-actuator, where the missing probability of packet dropouts is governed as two different mutually independent Bernoulli distributed white sequences with known conditional probability distributions. The main attention is focused on designing the robust fault detection filter (FDF) such that the estimation error between the residual and fault is minimized in an exponential way and at the same time the closed-loop networked switched system is exponentially stable in the mean-square sense. The simultaneous fault detection and controller design problem is converted into an exponential H_infty filtering problem. By a multiple Lyapunov-Krasovskii functional (LKF) and the average dwell-time scheme, a novel delay-dependent sufficient conditions are developed to ensure the resulting error system is exponentially stable with an optimized H_infty disturbance attenuation level. The solution of the parameters of the controllers and fault detection filters is characterized in terms of the feasibility of a convex optimization problem. A numerical example is given to illustrate the effectiveness of the obtained results.

12:00-12:20 **MonA10-6**

Machinery Fault Diagnosis Method of HV Circuit Breaker Based on EEMD and RBF Neural Network

Bing Li Heilongjiang Univ.
Mingliang Liu Heilongjiang Univ.
Ping Yang Heilongjiang Univ.
Yaowen Xing Heilongjiang Univ.
Quanwei Peng Heilongjiang Univ.

HV circuit break is a kind of important switching equipment in the field of power system. In order to improve safety and reliability of power system, studies about fault diagnosis of high-voltage circuit breaker are needed, especially for mechanical fault. In the study field of mechanical fault diagnosis of HV circuit breaker, the diagnosis process includes three steps: signal acquisition, feature extraction and fault identification. The methods of Fault identification mainly can be divided as three aspects, it is model identification, signal identification and knowledge identification. In this article, the ensemble empirical mode decomposition (EEMD) is used for feature extraction, then the EEMD-characteristic entropy can be obtained. However, the frequency of the mechanical action of high-voltage circuit breaker is very few, the experimental data about EEMD-characteristic entropy is precious and highly depends on the existing samples. For classification issues, in this study, radial basis function (RBF) neural network which act as a recognition tool were used to fault diagnosis. The whole process of this research included: signal acquisition, feature extraction, fault diagnosis.

MonA11 **Room11**
Neural networks (III) **10:20-12:20**
Chair: Ying Guo Beihang Univ.
CO-Chair: Yize Liu East China Normal Univ.

10:20-10:40 **MonA11-1**

A Fast RBM-Hidden-nodes based Extreme Learning Machine

Chen Li Lanzhou Univ.
Yang Ling Lanzhou Univ.
Sun Chao Lanzhou Univ.
HaiPeng Xi Lanzhou Univ.

In this paper, we propose an Extreme Learning Machine (ELM) approach for solving large and complex data problems. In contrast to existing approaches, we embed hidden nodes that are designed using Restricted Boltzmann machine (RBM) into the classical ELM, exhibiting excellent generalization performances. To overcome the high computational complexity involved especially on large datasets, hidden nodes are derived from RBM trained in turn by multiple random subsets of data sampled from the original datasets instead of the entire dataset in one time. The resultant algorithm proposed is labeled here as FRBM-H-ELM in short. Comprehensive experiments and comparisons are conducted to assess the FRBM-H-ELM against the traditional Extreme Learning Machine. The results obtained demonstrated the superior generalization performance and efficiency of FRBM-H-ELM.

10:40-11:00 **MonA11-2**

Hand Gesture Recognition Using Kinect via Deterministic Learning

Fenglin Liu Longyan Univ.
Bangxing Du Longyan Univ.
Qinghui Wang Longyan Univ.
Ying Wang Longyan Univ.
Wei Zeng Longyan Univ.

Hand gestures are spatio-temporal patterns which can be characterized by collections of spatio-temporal features. However, in real world scenarios, hand gesture recognition suffers from huge challenges with variations of illumination, poses and occlusions. The Microsoft Kinect device provides an effective way to solve the above issues and extract discriminative features for hand gesture recognition. The recognition approach consists of two stages: a training stage and a recognition stage. In the training stage, hand gesture features representing hand motion dynamics, including spatial position and direction of fingertips, are derived from Kinect. Hand motion dynamics underlying motion patterns of different gestures which represent Arabic numbers (0-9) are locally accurately modeled and approximated by radial basis function (RBF) neural networks. The obtained knowledge of approximated hand motion dynamics is stored in constant RBF networks. In the recognition stage, a bank of dynamical estimators is constructed for all the training patterns. Prior knowledge of hand motion dynamics represented by the constant RBF networks is embedded in the estimators. By comparing the set of estimators with a test gesture pattern to be recognized, a set of recognition errors are generated. The average L1 norms of the errors are taken as the recognition measure between the dynamics of the training gesture patterns and the dynamics of the test gesture pattern according to the smallest error principle. By using the 2-fold and 10-fold cross-validation styles, the correct recognition rates are reported to be 95.83% and 97.25%, respectively.

11:00-11:20 **MonA11-3**

Modeling of Magnetorheological Damper Using ANFIS

Xiaoying Xu Chongqing Univ.
Youxiang Peng Chongqing Univ.
Xiumei Du Chongqing Univ.
Miao Yu Chongqing Univ.
Jie Fu Chongqing Univ.

Magnetorheological (MR) damper is a semi-active actuator, it responds to a variable control signal very fast in the meanwhile it requires a very low power. Due to the highly nonlinear dynamic nature, it is difficult to characterize the behavior of this actuator. The existing parametric modeling methods require to identify so many parameters that are difficult to implement. So the paper puts forward an adaptive neuro-fuzzy inference system (ANFIS) to approximate the dynamic behaviors of magneto-rheological damper with the characteristics of nonlinearity and hysteresis. We built a vibration test system to obtain the experimental data of the MR damper, such as the displacement and the velocity, the input current and the MR damping force. One and a half cycle of the experimental data are used to train the forward model. And the rest of data are used for testing. It has been known that noise disturbance in measured inputs and output exists in real system. Therefore, it is important to study the robustness of ANFIS network model. The results of the network show that the proposed ANFIS network is more optimal than BP network.

11:20-11:40 **MonA11-4**

Recognition of Facial Expression Based on CNN-CBP Features
Yize Liu East China Normal Univ.
Yixiang Chen East China Normal Univ.
Automatical recognition of facial expression is an interesting and challenging problem, which has so many applications such as expression synthesis, human-robot interaction, metal state identification, intelligent tutoring systems, operator fatigue, music for mood, and clinical medicine. The vital step of a successful approach is deriving features from raw facial image. The existed methods of features extraction are the hand-crafted features based on geometric features or appearance features , and the auto-learned features. To utilize the benefit of low computation of hand-crafted features and the high-representation of auto-learned features, we firstly proposed the combined features CNN-CBP with putting together Centralized Binary Patterns (CBP) features and Convolutional Neural Network (CNN) features. And then, we classified the features using Support Vector Machine (SVM). With the help of the CNN-CBP features, we achieved average recognition accuracy of 97.6% on the Extended Cohn-Kanade datasets and 88.7% on the Japanese Femal Facial Expression datasets based on 10-cross validation.

11:40-12:00 **MonA11-5**

Research on Robot Path Planning Based on Fuzzy Neural Network and Particle Swarm Optimization
Ying Guo Beihang Univ.
Weihong Wang Beihang Univ.
Sentang Wu Beihang Univ.
In a certain evaluation standard, robot path planning is to find a collision-free path from the initial state to the target state in an environment with obstacles, which is one of the key research directions of intelligent mobile robots. The mathematical model of the surrounding environment is established by using the grid method. The obstacle avoidance strategy of the fuzzy neural network is proposed. The function of the obstacle avoidance is realized by searching the next feasible node by the fuzzy neural network. Aiming at the parameter optimization problem of fuzzy neural network, the improved particle swarm optimization algorithm is used to optimize the parameters of fuzzy neural network, which avoids the instability of the system caused by improper parameter selection. Simulation results verify the effectiveness of the method. The simulation results show that the path planning of mobile robot based on fuzzy neural network and particle swarm optimization achieves performance index of the minimum sum of the obstacle cost and the route cost.

12:00-12:20 **MonA11-6**

A Multi-Label Classification Model Using Convolutional Netural Networks
Guanglei Zhang Donghua Univ.
Lei Chen Donghua Univ.
Yongsheng Ding Donghua Univ.
In this paper, a novel multi-label classification model using convolutional neural networks (CNNs) is proposed. As one of the deep learning architectures, CNNs lead breakthrough in many fields of image processing especially the image classification. Since the applications of CNNs are more concentrating in the background of single-label samples, our model introduce the hidden semantic between different labels of the same sample to the existed CNNs to enhance the performance. In order to use the semantic of the multi-label, i.e. fine-label and coarse-label, a coarse-label classification part was built using the shared low features of the fine-label classification. We have compared our method with the CNNs using single label. Experimental results demonstrate that our model can achieve better classification performance on the multi-label dataset of CIFAR-100 than the CNNs using single label, our model improves the classification performance, by 2.3% increasing for the top-1 accuracy, while 2.7% for the top-5 on average.

MonA12 Room12
Control applications (I) 10:20-12:20

Chair: Jianfeng Liu Central South Univ.
CO-Chair: Jianqiao Yu Beijing Inst. of Tech.

10:20-10:40 **MonA12-1**

Trim Method of Impedance Matching for Magnetic Resonance Coupling System
Bo Zhai Beijing Information Tech. Coll.
Mingbo Yang North China Univ. of Tech.
Guihua Liu Civil Aviation Univ. of China
The working frequency of magnetic resonance coupling wireless power transmission (WPT) system can run to the range from several hundreds of thousands to a few megahertz, therefore, the dynamic impedance matching is the most effective way to keep the system transmission efficiency higher than the setting value. In this paper, we take coupling coefficient and working frequency as the focus of this WPT system and set up one transmission efficiency model, controlling parameter curve is built by solving optimization problems with maximum transmission efficiency and maximum transmission capacity as constraints, all points on this curve meet the transmission efficiency requirements, then available input parameter is extended from one point to the section of space curve. The proposed method makes the system able to dynamically follow the maximum transmission efficiency curve without changing the system topology or adding additional external matching circuits. Experimental results show that the proposed method can significantly improve the magnetic resonance WPT system's adaptability to variation of position and angle between transmit coil and receive coil.

10:40-11:00 **MonA12-2**

Design of the Nonlinear Controller for a Quadrotor Trajectory Tracking
Yunsheng Fan Dalian Maritime Univ.
Yabo Cao Dalian Maritime Univ.
Yongsheng Zhao Dalian Maritime Univ.
In order to solve the trajectory tracking of a quadrotor called QBall2 which is produced by Quanser Company of Canada, an integral backstepping controller is designed. A nonlinear mathematical model of QBall2 in the presence of external disturbances is obtained and a MATLAB/Simulink simulation system is built to validate the nonlinear trajectory tracking controller and compare the difference of PID and integral backstepping. The simulation results illustrate the good tracking performances of the designed nonlinear trajectory tracking controller.

11:00-11:20 **MonA12-3**

Steady State Controller Design for Aero-engine Based on Reinforcement Learning NNs
Hongmei Zhang Shenyang Aerospace Univ.
Shenna Wei Shenyang Aerospace Univ.
Guangyan Xu Shenyang Aerospace Univ.
An aero-engine optimal steady state controller based on reinforcement learning neural networks (NNs) was proposed in this paper. The presented reinforcement learning NNs can achieve the optimal control objective by constructing two interconnected modules (i.e. action module and critic module). For the state variable models of small perturbation on steady operating points, the double-variable control of an aero-engine is accomplished by two similar backing propagation (BP) NNs. The simulation results show that the presented controller has the perfect performance with the smooth transition process. It not only has strong anti-interference ability and adaptability, but also has excellent robustness to the change of aero-engine model parameters.

11:20-11:40 **MonA12-4**

Attitude Predictive Control for Reentry Vehicle Considering Two-order Actuator Dynamic Characteristic
Jianguo Guo Northwestern Polytechnical Univ.
Xiangyu Zheng Northwestern Polytechnical Univ.
Jun Zhou Northwestern Polytechnical Univ.
This paper investigates the attitude predictive control for reentry vehicle with two-order actuator dynamic system. In order to improve the performance of attitude control system for reentry vehicle, the predictive control strategy is derived from quadratic optimization method based on two-order actuator dynamic characteristic, at the same time the disturbance observer is introduced to compensate the predictive control system to eliminate the effect of the uncertainties and disturbance. The stability of the predictive control system is demonstrated by Lyapunov stability theory and the relationship among predictive step, observer error and the precision of control system is also obtained. Finally, numerical simulation shows that the performance of the attitude predictive control with two-order actuator system can achieve the desired performance.

11:40-12:00 **MonA12-5**

Development of a Modular Software System for Missile Trajectory Designing
Zhenxing Shi Beijing Inst. of Tech.
Jianqiao Yu Beijing Inst. of Tech.
Yuesong Mei Beijing Inst. of Tech.
In the background of a kind of tactical air missiles, a modular software system for trajectory designing is developed based on Visual Studio. This software system has some advantages: a. this software system can be tailored to a range of missiles; b. this software system includes five modules related to the missile movement, the user can freely combine each module and design parameters; c. this software system is convenient and flexible to operate; d. this software system can be extended easily. Simulation results show that the missile trajectory designed by this software system is correct.

12:00-12:20 **MonA12-6**

An EMPC Based Active Control for Pneumatic Pantograph System Using ON/OFF Valves
Linzhou Fu Central South Univ.
Jianfeng Liu Central South Univ.
Weirong Liu Central South Univ.
Zhiwu Huang Central South Univ.
Qing Peng Central South Univ.
Hongwei Cao Central South Univ.
The Pantograph-Catenary system (PAC) is the most crucial and vulnerable part in the high-speed train. During the high-speed movement of locomotive, the conventional passive control would cause various malfunction of the PAC system. Because the passive control does not have sufficient ability to avoid the dynamic variation of the contact force between carbon-plate and catenary wire. Therefore, this paper considers the optimal reference-tracking active control algorithm based on explicit model predictive control (EMPC) to stabilize the contact force of PAC and set it precisely for which there exists experimentally validated model. Firstly, the nonlinear model of pantograph with one pair of ON/OFF valves is deduced to describe the correspondence between cylinder pressure

and contact force. Secondly, the process of an offline computation for the state-space approximate optimal linear affine is presented. Finally, the EMPC based on the linear affine is designed. Then, the simulation and experiment result are illustrated to prove the effectiveness of the design.

MonA13 Room13
Signal processing (III) 10:20-12:20
Chair: Rui Ling Chongqing Univ.
CO-Chair: Zhuliang Yu South China Univ. of Tech.

10:20-10:40 MonA13-1

An Adaptive Fast Iterative Shrinkage Threshold Algorithm
Shaoli Chen Nanjing Univ. of Posts and Telecommunications
Min Yang Nanjing Univ. of Posts and Telecommunications
Fast iterative shrinkage threshold algorithm (FISTA) is an efficient first-order optimization algorithm for Linear inverse problems. However, the algorithm employed a fixed iterative step size which limits the speed of calculation, This paper proposes an adaptive fast iterative shrinkage threshold algorithm (FISTA) by using a BarzilaiBorwein (BB) operator. The proposed Algorithm uses the previous iteration information to update the step size which can speed up the rate of the iteration. The numerical experimental results of Compressed Sensing and Image Denoising demonstrate that the proposed algorithm has a faster convergence rate and improves the efficiency of the calculation.

10:40-11:00 MonA13-2

Block RLS Algorithm for Surveillance Video Processing Based on Image Sparse Representation
Donghai Bao Zhejiang Univ. of Tech.
Fang Yang Zhejiang Univ. of Tech.
Qianru Jiang Zhejiang Univ. of Tech.
Sheng Li Zhejiang Univ. of Tech.
Xiongxiong He Zhejiang Univ. of Tech.
Block recursive least square (BRLS) algorithm for dictionary learning in compressed sensing system is developed for surveillance video processing. The new method uses image blocks directly and iteratively to train dictionaries via BRLS algorithm, which is different from classical methods that require to transform blocks to columns first and then giving all training blocks at one time. Since the background in surveillance video is almost fixed, the residual of foreground can be represented sparsely and reconstructed with background subtraction directly. The new method and framework are applied in real image and surveillance video processing. Simulation results show that the new method achieves better representation performance than classical ones in both image and surveillance video.

11:00-11:20 MonA13-3

Gender Identification Based on the Fusion of Adaboost and SVM
Yujuan Hao Beijing Univ. of Civil Engineering and Architecture
Liquan Zhang Beijing Univ. of Civil Engineering and Architecture
Jie Gao Beijing Univ. of Civil Engineering and Architecture
Face gender classification plays an important role in pattern recognition, and it is a challenging research direction, but the current research is not perfect. We use the MB-LBP operator to extract the facial texture feature, which can be used as the training sample of the gender classifier, and it reduces the influence of the noise in the complex facial image. In addition, we propose the method of gender recognition by fusing Adaboost and SVM classifiers, which extracts the facial texture features as the input samples, and reduces the impact of the environment on the recognition, then enhances the robustness of the recognition.

11:20-11:40 MonA13-4

Classification recognition of anchor rod based on PSO-SVM
Haiqing Zheng Shijiazhuang Tiedao Univ.
Shilei Zhang Shijiazhuang Tiedao Univ.
Xiaoyun Sun Shijiazhuang Tiedao Univ.
Based on learning principle of support vector machine (SVM), damage detection of bolt anchorage is studied in this paper. Characteristic matrix is composed of 17 time domain or frequency domain characteristic properties including mean value, peak value of the denoised signal, etc. Principle component analysis (PCA) is used for feature extraction and several main components with higher cumulative contribution rate are chosen for SVM classifier training and testing. Particle swarm optimization (PSO) method is used to optimize the penalty parameter C and kernel function radius g of SVM. In experiments, choose 90 groups of data for three different types of anchor as the sample set, respectively. Select the first 70 samples as the SVM training set of each type anchor, and the remaining as the test set. The experimental results show that the proposed method is effective in identification of anchor, and the highest prediction accuracy can reach 93.333%.

11:40-12:00 MonA13-5

A Sleep Spindle Detection Algorithm based on SVM and WT
Silin Zhou South China Univ. of Tech.
Xichun Zhang South China Univ. of Tech.
Zhuliang Yu South China Univ. of Tech.
Sleep spindles play an important role in assessing sleep pathphysiological. Recently, many researches also indicated some differences in spindle characteristics for different neurological disorders. However, it is a tough task to detect sleep spindles because of the unclear definition of sleep spindle characteristics. The detection is usually done through visual inspection of electroencephalogram (EEG) signals by experts, which has the weaknesses of time-consuming and great subjectivity. This paper proposes a novel sleep spindle detection algorithm, in which we use wavelet transform (WT) to extract the spectrum information of EEG in range from 8 to 25 Hz. Gaussian function is used to normalize the power spectrum and preserve the significant spectrum information. The probability of having a spindle at a given sample is calculated by summing the power spectrum of frequency corresponding to spindle range. After using a smoothing algorithm on the probabilities, we apply Support Vector Machine (SVM) in order to obtain the threshold of probability of spindle candidate. The results of experiment on the public DREAMS sleep spindle database demonstrate the efficiency of the proposed algorithm.

12:00-12:20 MonA13-6

An Effective DOA Estimation Method of Coherent Signals Based on Reconstruct Weighted Noise Subspace
Xiaozhi Liu Northeastern Univ.
Muye Song Northeastern Univ.
Yinghua Yang Northeastern Univ.
For the problem that traditional DOA (Direction Of Arrival) estimation algorithms often fail to deal with coherent signals, a new high accuracy DOA estimation method based on weighted noise subspace is proposed. Considering the received data matrix obtained by uniform liner array, the proposed method makes full use of the cross-covariance information of it to construct an augmented matrix and performs singular value decomposition on it. In order to obtain more accurate signal vectors, a new weighted noise subspace is reconstructed, and the weighted factor matrix is designed to maintain the consistency of eigenvectors. Finally, combined the new noise subspace and weighted factor matrix completes the DOA estimation of coherent signals. Simulation results are presented to demonstrate the effectiveness of the proposed method, especially in low signal-to-noise ratio (SNR) and small number of snapshots. And without losing the aperture of array, the new method can estimate the DOA of coherent signals successfully.

MonA14 Room14
Data processing (III) 10:20-12:20
Chair: Haiyan Jin Xi'an Univ. of Tech.
CO-Chair: Qiduo Liu Beijing Inst. of Tech.

10:20-10:40 MonA14-1

The Design of Portable ECG Health Monitoring System
Bo Liu Shenyang Inst. of Automation Chinese Academy of Sciences
Gang Shi Shenyang Inst. of Automation Chinese Academy of Sciences
Wei Zhao Shenyang Inst. of Automation Chinese Academy of Sciences
According to the problem of the rising sub-health people and the potential undetectable chronic diseases, this paper researches and develops a kind of portable ECG health monitoring system, which can make real-time acquisition about ECG information in the high degree of portable, reduce the patients' psychological pressure with not to be restricted on the use scene, and implement a daily ECG healthy monitoring. Thus, the current situation of primary medical resources shortage can be alleviated and the purpose of health care and disease prevention can be achieved.

10:40-11:00 MonA14-2

Fuzzy Multiclass Support Vector Machines for Unbalanced Data
Yuanyuan Wu Univ. of Chinese Academy of Sciences
Liyong Shen Univ. of Chinese Academy of Sciences
Hubei Collaborative Innovation Center for Early Warning and Emergency Response Tech.
Sanguo Zhang Univ. of Chinese Academy of Sciences
Traditional support vector machines have low classification performance on unbalanced datasets and are more influenced by dataset noise, which can lead to a deviation of the classification results. To address this problem, other studies have proposed fuzzy support vector machines for unbalanced datasets. However, most of these algorithms are directed to the second-class classification problem and their fuzzy membership functions typically only consider the distance factor, failing to accurately reflect the importance of training sample points. In this paper, a fuzzy multiclass support vector machine algorithm for unbalanced data is proposed. The algorithm uses the distance from the training sample point to the center of its class and a weighted class-overlap method to design the sample fuzzy membership function. Corresponding membership values are assigned according to the importance of the sample points: the weight of the support vector points is increased and the weight of noise is decreased. The latest unbalanced adjustment factors are used to reduce the influence of the unbalanced data on the classification results. Experimental results confirm that, compared with traditional fuzzy support vector machines, the proposed algorithm can address unbalanced data and noise more effectively in multi-classification problems.

11:00-11:20 MonA14-3

A Nearest Neighbor Sort Algorithm Based on Cluster Index for Flight Support Task
Haiyan Jin Xi'an Univ. of Tech.
Juanjuan Qin Xi'an Univ. of Tech.

There are various forms of disturbance records in airport task set. In order to apply those important information effectively, we need to carry on data cleaning, such as attribute value and abnormal clean, similar duplicate record detection. In this article, we designed the corresponding clean rules for different records. At the same time, a nearest neighbor sort algorithm based on cluster index is presented in detection of likeness duplicate records. In this algorithm, we adopted the combination of keywords, the cluster index, the slide window of real-time changes, the field weights and the similarity thresholds, which has increased the detection efficiency for alike records. Finally, the load speed of after data cleaning is compared with before , which showed the validity of the data cleaning.The comprehensive evaluation is used to determine the size of variable slide window, which improved the detection efficiency for repeated records.

11:20-11:40 **MonA14-4**

Modelling and Analysis of a Typical Short-term Event Induced Evolution Social Network

Hui Zhou Wuhan Textile Univ.

In this paper, a typical short-term event induced evolution social network is proposed via real relationship evolution process data selecting. Discussions on two aspects of related data set are carried out via both visualization method and numerical quantity analysis method. From the discussion of both cases, some basic characteristics of such a short term event induced social network are proposed. It is founded that, for a short term event induced evolution social network, the scheme network choosing (the initial state of the mini-social network, or bases of the evolution relationship network) and critical member assigning affect the final social structure mostly. Also, the event induced evolution social network will certainly become stable after a very short term during the evolution process of the source event in both cases. In other words, the numerical investigation reveals that the afore-designing of the event organizer plays the most important influence on the final structure of this mini-social evolution network. It is also found that, under both possible initial states of the mini-social network, the network states evolution to similar final states and both of them behave sensitively to the modularity parameter (Communities parameter).

11:40-12:00 **MonA14-5**

Research on Particle Filter Algorithm for Improving Particle Diversity

Qiduo Liu Beijing Inst. of Tech.
Yongqiang Bai Beijing Inst. of Tech.

The particle filter has been applied widely for non-linear filtering since it can relax the linear and Gaussian assumptions. However, the traditional particle filter will cause particle depletion, losing the particle diversity. Aiming at this problem, an improved particle filter based on adaptive chaos immune genetic resampling is proposed. The interval of chaotic traversal changes adaptively to further speed up the local search. A novel selection mechanism considering the antibody concentration and affinity is proposed to increase the population diversity by replicating particles with high weights and low concentration dynamically. Experimental results show that the improved method has higher filtering precision and faster running speed than conventional filtering algorithm and common resampling method based on chaos immune genetic algorithm, and the diversity of the population is improved remarkably.

12:00-12:20 **MonA14-6**

Keyword Extraction Based on Statistical Information for Cyrillic Mongolian script

Bat-Erdene Nyandag Inner Mongolia Univ.
Ru Li Inner Mongolia Univ.
Mongolia Univ. of Life Sciences
Orgil Demberel Inner Mongolia Univ.
Mongolia Univ. of Life Sciences

We present a keyword extraction system for Mongolian documents using word co-occurrence statistical information which used in for English, Chinese and other languages.This method based on extracting top frequent words and building the co-occurrence matrix showing the occurrence of each frequent word. The biasness degree of the words and the set of frequent words are measured using CHI-Square Method (χ2). Also, the weight of the words and the set of frequent words are measured using word frequency-inverted word frequency (WF-IWF). Therefore words with high χ2 values and high WF-IWF values are likely to be keywords. The adopted χ2 method in this study is compared with another one method based on WF-IWF which tested for Mongolian. Two different documents were used to evaluate the system performance. We evaluate the effectiveness of χ2 method and WF-IWF method. Results show that the χ2 method is better than WF-IWF.

MonA15 Room15
Network-based systems 10:20-12:20

Chair: Haiyang Sun Northwestern Polytechnical Univ.
CO-Chair: Zilei Wang Univ. of Science and Tech. of China

10:20-10:40 **MonA15-1**

Wireless Channel Modeling and Performance Analysis Based on Markov Chain

Xiaoyang Liu Chongqing Univ. of Tech.
Chongqing Univ.
Chao Liu Chongqing Univ. of Tech.
Wanping Liu Chongqing Univ. of Tech.
Xiaoping Zeng Chongqing Univ.

High altitude platform station (HAPS) is a new means of wireless communication,which operate in stratosphere whose altitude is about 20km.The wirless communication network of HAPS are researched Markov chain model is proposed in the HAPS wireless channel model.The performance of the wireless communication channel and channel model are analyzed.The simulation results shows that the performance of coded HAPS wireless channel is better than the uncoded channel.The signal level is different when the radio spacing distance is different.

10:40-11:00 **MonA15-2**

Design of Image Acquisition System Based on Embedded Linux

Hong He Tianjin Univ. of Tech.
Yang Li Tianjin Univ. of Tech.
Zhihong Zhang Tianjin Univ. of Tech.
Tianjin Radio and TV Station

Based on the requirements of miniaturization, stability and definition of the image acquisition device, an embedded Linux image acquisition and display system based on embedded system is designed. The system hardware using ARM core S3C2440 microprocessor, USB camera and LCD display to build image acquisition and display system; the software system placed Linux system as the core is built. Build hardware platform and transplant Linux operating system and related drivers, to achieve the image acquisition and display system miniaturization and stability and image quality have reached the people's requirements.

11:00-11:20 **MonA15-3**

Situation Awareness in Cloud Cooperation

Haiyang Sun Northwestern Polytechnical Univ.
An Zhang Northwestern Polytechnical Univ.
Renjun Zhao Northwestern Polytechnical Univ.

In this paper, we presented the concept of situation awareness in cloud cooperation. It is realized by cloud cooperation providing a situation awareness background information (SABI) service. The SABI service fuses all data in battlespace into a common operational picture (COP) and provides it to every echelon of commanders. In the end, we put forward key technologies of realizing SABI service.

11:20-11:40 **MonA15-4**

Multi-step prediction for the network traffic based on echo state network optimized by quantum-behaved fruit fly optimization algorithm

Ying Han Northeastern Univ.
Yuanwei Jing Northeastern Univ.
Kun Li Bohai Univ.

The network traffic is a very important parameter to evaluate the network load and running state, and realization of the accurate prediction can be an important method to improve the network management. In this paper, a multi-step prediction method for the network traffic based on echo state network (ESN) optimized by quantum-behaved fruit fly optimization algorithm (QFOA) is proposed. First, the phase-space reconstruction technology is used to reconstruct the original network traffic data series, and then the ESN method is used to build the prediction model, and meanwhile four model parameters are optimized by the QFOA to improve the model prediction accuracy. Through the simulation experiments on the public network traffic data set, the results prove that the proposed method has better prediction effects.

11:40-12:00 **MonA15-5**

Control System for Granary Ventilation Based on Embedded Networking and Qt Technolog

Kang Peng Zhejiang Univ.
Wei Yao Zhejiang Univ.
Wei Zhang Zhejiang Univ.

Aiming at realizing intellectualized control of granary ventilation and eliminating the flaws such as low efficiency, technological obsolescence and structural incompleteness in traditional system, this paper brings forward a new control system for granary ventilation with advanced embedded Linux technology, embedded networking technology, and Qt technology. This system uses BeagleBone Black platform as the core communication server, deploys the Modbus embedded network as sensing unit for fetching sensor data and the CAN open embedded network as execution unit for controlling fan devices, and adopts JSON-RPC service as remote communication mechanism. It fully realizes functions of intelligent detection of grain condition, automatic control ventilation, local visualized monitoring and remote centralized monitoring.

12:00-12:20 **MonA15-6**

A Dynamic Two-Phase Schedule Strategy for Streaming Media Edge Cloud

Zewei Chen Univ. of Science and Tech. of China
Zilei Wang Univ. of Science and Tech. of China
Hongsheng Xi Univ. of Science and Tech. of China

For streaming media systems based on cloud service, an efficient and adaptive resource scheduling is strongly required. In this paper, we aim to make the small-scale streaming edge cloud admit more requests such that lower per-stream operation cost is achieved. Traditionally, the video deployment and session migration is solely executed on the cloud.

However, such a simple strategy can hardly guarantee the good trade-off between performance and cost since the popularity of user requests is highly varying, especially for the edge clouds closer to users. In this work, we propose a joint optimization algorithm of session migration and video deployment, i.e., both strategies are smoothly involved to obtain a better trade-off. Consequently, the proposed strategy is more adaptive to dynamic fluctuation of video popularity, and thus gains a flexible balance between service cost and quality. The trace-driven experiment verified the effectiveness of the proposed method, and the results show that our proposed method has better adaptation to popularity than other comparable methods.

MonA16 **Room16**
Smart grids (II) **10:20-12:20**
Chair: Xin Tao Zhejiang Univ.
CO-Chair: Xin Tong Tianjin Univ. of Tech.

10:20-10:40 **MonA16-1**

Summary of Power System Harmonics
Zhiqiang Gao Tianjin Univ. of Tech.
Hongjian Zhao Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Youjie Ma Tianjin Univ. of Tech.
Due to the large number of power electronic devices in the power system, the harm caused by harmonic has become more and more serious. This paper comprehensively expounds the main causes of harmonic generation and the main methods of harmonic detection and control. The accuracy of harmonic detection and the speed of response are determined by the method of harmonic detection. For harmonic control, there are active harmonic control technology and passive harmonic control technology. In this paper, the basic harmonic current detection method and the compensation current tracking control strategy are discussed, and the main development trend of harmonic detection and harmonic control is analyzed.

10:40-11:00 **MonA16-2**

The Review on Distribution Network Reconfiguration
Youjie Ma Tianjin Univ. of Tech.
Xin Tong Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Zhiqiang Gao Tianjin Univ. of Tech.
Power distribution network reconfiguration is the main measure for distribution network optimization. It can reduce network loss and enhance the system reliability effectively. The essence is mixed multiple target and non-linear optimization problem. This paper primary introduces the current research hot spots and optimization algorithm of reconstruction, including tabu search algorithm, simulated annealing algorithm,genetic algorithm and artificial neural network. Then the paper discuss the advantage and weak points of those algorithms.

11:00-11:20 **MonA16-3**

Summary of Photo Voltaic and Maximum Power Point Tracking
Youjie Ma Tianjin Univ. of Tech.
Tianqi Bai Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Zhiqiang Gao Tianjin Univ. of Tech.
Introduced the basic principle of photovoltaic,,and describes the development significance that photovoltaic brings to each field such as technology,industry,domestic and foreign.The development of PV technology at home and abroad are mainly demonstrated.Due to the radomness and discontinuity of the output of photovoltaic generation,maximum power point tracking (MPPT) has always been the hot topic.At last,point out that futher study the new algorithm and combine the traditional algorithm with the intelligent algorithm,will be the most important tendency in future.

11:20-11:40 **MonA16-4**

Path Planning Algorithms for Power Transmission Line Inspection Using Unmanned Aerial Vehicles
Jingkui Cui Xi'an Univ. of Tech.
Youmin Zhang Xi'an Univ. of Tech.
Sha Ma Xi'an Univ. of Tech.
Yingmin Yi Xi'an Univ. of Tech.
Jing Xin Xi'an Univ. of Tech.
Ding Liu Xi'an Univ. of Tech.
The effectiveness and efficiency of using unmanned aerial vehicle (UAV) for automated power transmission line inspection is tightly related to the inspection paths designed for UAV. Different types of UAV are suitable for different inspection tasks and have different requirements for path planning. Based on the contents of the transmission line inspection, it can be divided into tower monitoring and line corridor monitoring. First, according to the characteristics of the tower monitoring, the multi-rotor UAV is used for the tower inspection. By considering the safe distance bewteen UAV and the tower and the features of the camera, the genetic algorithm (GA) is used to design a rational inspection path. Then, according to the requirements of the line corridor monitoring mission, the fixed-wing UAV is used for long distance inspection and the path planning mathematical model and objective function are established. Polar coordinate coding is used to overcome the restrictions of the maximum path deflection angle, the minimum step length and the number of the maximum path nodes. The GA and genetic simulated annealing (GSA) algorithms are used to obtain effective inspection paths. Simulation results show that the proposed optimization scheme in this paper can find the optimal inspection paths.

11:40-12:00 **MonA16-5**

Long Term Intelligent Load Forecasting Method Considering the Expectation of Power Market Transaction
Weiting Xu State Grid Sichuan Power Economic Research Inst.
Yunling Wang State Grid Sichuan Power Economic Research Inst.
Ting Li State Grid Sichuan Power Economic Research Inst.
Quan Tang State Grid Sichuan Power Economic Research Inst.
Jinfang Zhang State Grid Energy Research Inst.
Li Shen State Grid Sichuan Power Economic Research Inst.
Mi Zhu State Grid Sichuan Power Economic Research Inst.
In the power market, the power generation and consumption behavior will be more difficult to capture and predict than in the environment of monopolistic buying and selling model. Smart grid planning and operation is going to be challenged. In order to adapt to the new situation, it is necessary to actively explore some innovative load forecasting methods. The improved method of intelligent load forecasting was put forward on the two aspects. Firstly, the power price response was added into the long term load forecasting method. Secondly, the most probable market transactions were simulated based on the forecasting results of load distribution, power plant planning and marginal price, thus the power balance and transaction prices ofthe long term power market could be captured, and then the trading results could conversely corrects the load forecasting results. Shown as the case study, the intelligent method took full account of the market participants' elastic response to the expected trading behavior, and brought a certain reference to the smart grid planning in the power market environment.

12:00-12:20 **MonA16-6**

Impedance Modeling and Analysis of AC-DC Modular Cascade System
Xin Tao Zhejiang Univ.
Ji Xiang Zhejiang Univ.
Wei Wei Zhejiang Univ.
With the extensive development of hybrid AC-DC micro-grid, stability issues in hybrid AC-DC micro-grid are the major concern. As the core module of AC-DC micro-grid, the stability analysis of AC-DC modular cascade system also has drawn more attention. This paper presents the stability analysis of AC-DC modular cascade system based on the impedance analysis method, which has been proved to be an effective tool for the stability assessment of power systems. In this paper, AC-DC cascade system is modeled as Z + Y type system and the impedance ratio type criterion is applied to analyse the system stability. Experiment on a real time digital simulator (RT-LAB) verifies the impedance-based stability criterion for cascade system.

MonA17 **Room17**
Renewable energies (III) **10:20-12:20**
Chair: Yi Yang Nantong Univ.
CO-Chair: Ying Wang Wuhan Univ. of Tech.

10:20-10:40 **MonA17-1**

Research on Multi-peak Output Characteristics of Photovoltaic (PV) System Based on Piecewise Model
Yuanpei yang Nantong Univ.
Yi Yang Nantong Univ.
Jianshan Wang Nantong Univ.
Guihong Zhang Nantong Univ.
Shuiqin Huang Nantong Univ.
In view of the problems that the local shadow to the photovoltaic (PV) power generation system, which reduces the output power and generates multiple peaks on output power curve, the paper studies the influence of local shadow on the output characteristics of the PV array. Based on the engineering model of the PV array, the piecewise model of the PV array under local shadow is established by the theoretical analysis and the experimental verification is carried out. By using the piecewise model, the output characteristics of PV arrays under different light intensities, occlusion modes, shadow distributions and array patterns are analyzed, which will lay a good foundation for studying the maximum power tracking method of PV system under local shadow.

10:40-11:00 **MonA17-2**

Multi-degree of Freedom Optimization Control for Large Inertia Wind Energy Conversion System using Model Predictive Approach
Hongmin Meng North China Electric Power Univ.
Pengfei Li Aalborg Univ.
Zhongwei Lin North China Electric Power Univ.
Yang Hu North China Electric Power Univ.
Smoothing output power and alleviating mechanical loads are two main control objectives for wind energy conversion system (WECS) above rated wind speed. Conventional control methods, such as PID, cannot

handle and balance multi-objective control problems. This paper presented a multi-degree of freedom, multi-objective optimization control method using model predictive approach to solve these problems. Power smoothing and mechanical loads alleviating were both given consideration in objective function. Simplified linear model was established reasonably to reduce the calculated amount. The proposed control system had good dynamic performance, fluctuations of generator power and drive train transient loads are both reduced. Simulation studies were carried out to verify the effectiveness of proposed method. The proposed method is beneficial to lifetime of wind turbine and reliability of power system.

11:00-11:20 **MonA17-3**

A Design of Differential Decoupling Phase-Locked Loop for Unbalanced Power Systems

Ying Wang Wuhan Univ. of Tech.
Shuhai Quan Wuhan Univ. of Tech.
Kang Yang Wuhan Univ. of Tech.

Aiming at unbalanced three-phase power grid voltage, traditional phase locked loop was not able to restrain the negative sequence component in unbalanced grid voltage, which led to the poor accuracy of phase. Based on the traditional three-phase software phase locked loop model, the paper proposed a design of differential decoupling phase-locked loop. Through differential decoupling algorithm, the positive sequence component could be extracted from the unbalanced voltage. By this way, the ability of three phase software phase locked loop to resist unbalanced voltage had been improved. In Matlab, the improved software phase-locked loop was simulated. Compared with the traditional phase locked loop, the differential decoupling phase-locked loop was not only able to track the phase of grid voltage unbalance accurately without delay, but had excellent dynamic phase tracking performance.

11:20-11:40 **MonA17-4**

Research on Distributed Multi-peak Maximum Power Tracking Control

Jianshan Wang Nantong Univ.
Yang Yi Nantong Univ.
Yuanpei Yang Nantong Univ.
Guihong Zhang Nantong Univ.
Shuiqin Huang Nantong Univ.

When the photovoltaic(PV) array in partial shadow occlusion, the output characteristic curve will become more complex, the P-V curve showed multi peak, I-V curve into a step shape, making the output power of the PV array decreased. For realization of PV array maximum power tracking control technique for optimization, the first of different temperature, illumination, occlusion model of PV array are modeled and analyzed, the output characteristic curve, in-depth analysis of the block pattern of global location of the maximum power point, proposes a distributed maximum power tracking method, qualitative to solve the fall into the local maximum and makes the tracking failure problem and improve the PV array Output power, which provides a new idea for the research of the maximum power point tracking technology under multiple peaks.

11:40-12:00 **MonA17-5**

Grid-connected Current Control of Micro Inverter based on ANN inverse Model

Yongjun Lin North China Electric Power Univ.
Shun Wang North China Electric Power Univ.
Jing Li North China Electric Power Univ.
Chen Chen Hebei Energy Coll. of Vocation and Tech.
Weiliang Liu North China Electric Power Univ.

The flyback type grid-connected micro inverter has received much attention because of its simple structure and electrical isolation characteristics. However, due to the nonlinear characteristics of the flyback converter, a large amount of harmonic currents are generated during the operation process. In this paper, an inverse control method is proposed to improve the grid current quality of flyback type micro inverter. The mathematical model of the inverter is established by small signal method, and the major factors affecting the grid-connected current are discussed. Then inverse model of the system is established by ANN method and the inverse control method is proposed. Simulation results indicate that compared with conventional PID control method, the presented method could effectively reduce the harmonic content of grid-connected current.

12:00-12:20 **MonA17-6**

Photovoltaic Array MPPT Based on Improved Variable Step Size Incremental Conductance Algorithm

Yang Liu Changchun Inst. of Tech.
Yunbo Zhang Changchun Inst. of Tech.
Shengzhu Li Changchun Electric Supply Company Dispatching Inst.
Hong Zhang Changchun Inst. of Tech.

According to analyze the output characteristics of photovoltaic (PV) array and the advantages and disadvantages of the traditional maximum power point tracking (MPPT) method, an improved increment conductance (INC) method was proposed. Using MATLAB/Simulink modeling and simulating the boost DC/ DC convert system, apply the improved method and the traditional INC to control the system respectively. The simulation results show that the improved method in the premise of ensuring stability ofthe system, make the PV array tracking the maximum power point more quickly and exactly under the change of circumstance.

MonAIS **Room18**
Interactive Session **10:20-12:20**

MonAIS-01

Game Analysis on the Cooperative Mining of Coalbed Methane under the Discerption of Mining Right

Jun Tu Liaoning Technical Univ.
Chang Su Liaoning Technical Univ.

Coalbed methane is not only a valuable clean resource, but also a major hazard in coal mine safety production. The discerption of mining right leads to the contradiction between the coal enterprise and the coalbed methane enterprise, which hinders the healthy development of coal and coalbed methane industry. Based on Game Theory, this paper studies the coalbed methane cooperative mining under the discerption of mining right. The strategy set and income function of the coalbed methane enterprise and the coal enterprise are given respectively. The game model is established and solved, and the results are analyzed. The results show that the realization of coalbed methane cooperative mining relies on the ratio of income distribution and the charge to transfer right of gas mining. The influence of system parameters on the game equilibrium results is shown by numerical experiments.

MonAIS-02

Application of Fuzzy Set Pair Analysis on Evaluation of Seafarers' Competency

Yang Ou Bohai Univ.
Ying Tian Bohai Univ.
Ying Jie Dai Bohai Univ.

In order to evaluate and analyze the seafarer's competence scientifically and objectively, an evaluation model of seafarers' competency based on fuzzy set pair analysis is proposed. By considering both definition of 'marine resource management' by IMO and the current research status of crew assessment in China, the evaluation index systems are established for the two kinds of seafarer. In the evaluation process, to bring the uncertainty of evaluation data, the fuzzy connection degree is used to express the fuzzy relationship of similarities and differences between the evaluation object and the evaluation standard. The evaluation results show that the model can evaluate the seafarer's competence for different grades of crew reasonably, and find the main factors affecting the competency. By comparing with the comprehensive evaluation method, the fuzzy set pair analysis is more accurate and scientific.

MonAIS-03

3PL Inventory Pledge Decision Analysis under the Unified Credit Logistics Model

Jun Shi Northeastern univ.
Xintian Zhuang Northeastern univ.
Congcong Liu Northeastern univ.
Weiping Zhang Northeastern univ.

Based on supply chain inventory pledge financing, under the unified credit model, the research object is supply chain that consists of third-party logistics companies, financial institutions, manufacturers, small and medium retail businesses, research the TPL inventory credit decision problem when the market demand is random. The credit decision model of the third party logistics enterprises is constructed, and the supervision degree and the regulatory cost function are introduced into the expected return model of logistics enterprises. This paper discussed the problem of the retailer credit risk and the service decision of the logistics enterprise, and gives the corresponding countermeasures and suggestions.

MonAIS-04

A Model for the Visual Effect Evaluation of a Urban Road Indicating Device

Guangyu Zhu Beijing Jiaotong Univ. Center of Cooperative Innovation for Beijing Metropolitan Transportation
Xinming Yu Beijing Jiaotong Univ.
Lei Zhao Beijing Jiaotong Univ.
Li Wang Beijing Jiaotong Univ.
Peng Zhang Beijing Municipality Key Laboratory o f Urban Traffic Operation Simulation and Decision Support

For an urban road indicating device, Variable Message Signs (VMS) screen system is used to publish and display all kinds of traffic information, including the condition of current and nearby roads and the useful travel advice, which leads to the topic that the VMS screen visual effect is a crucial issue. Therefore, a model for the visual effect evaluation of VMS screen with the simulation method is studied in this paper. Firstly, establish a reasonable evaluation index system; secondly, build a VMS screen dynamic evaluation model based on Analytic Hierarchy Process (AHP) method and two-level fuzzy comprehensive evaluation method; in addition, select one VMS screen in Beijing as an example, then evaluate the visual effect comprehensively by simulation. Finally, optimize simulation parameters by field driving, which makes the model more effective and more practical. It provides an innovative way to improve VMS design standards.

MonAIS-05

IInterval-valued intuitionistic hesitant fuzzy Quasi-Choquet geometric operators based TOPSIS method for multi-criteria group decision making

Lijia Liu Shenyang Univ. of Tech.
Chen Yan Shenyang Univ. of Tech.

In this paper, we define the interval-valued intuitionistic hesitant fuzzy Quasi-Choquet geometric (IVIHFQCG) operators, then some desirable properties are proposed. Then we show the family of IVIHFQCG operators. Further, the compromise ratio method ,the extended Euclidean distance and the extended technique for order preference by similarity to ideal solution (TOPSIS) method are used for these interval-valued intuitionistic hesitant multi-criteria group decision making (MCGDM) problems. A numerical example is given by using the operators of the IVIHFQCG family.

MonAIS-06

Research of international infectious diseases in frontier domains in visualized information

Mingsheng Hu Zhengzhou Normal Univ.
Shan Kong Zhengzhou Normal Univ.
Zhijuan Jia Zhengzhou Normal Univ.
Weiqing Yuan Zhengzhou Normal Univ.

This paper analyzed the temporal and spatial distribution of the CNKI database to infectious diseases as the theme of the literature; then using information visualization software CiteSpace to draw the main research institutions in the field of infectious disease research, knowledge mapping representatives, and detailed analysis of its last words as hot words; sources of infectious disease research that is used to determine the field and development trend of infectious disease research. Hope the result of this study can help to understand the academic research resources of infectious disease research and future direction.

MonAIS-07

The Research on Fraud Group Mining Which Based on Social Network Analysis

Zhijuan Jia Zhengzhou Normal Univ.
Liang Zhao Zhengzhou Normal Univ.
Na Zhou Zhengzhou Normal Univ.

In recent years, microblogging as an important social way, and gradually integrated into life, users can express personal feelings anytime and anywhere, sharing information, etc on the platform. Weibo brings convenience of message for people at the same time, also brings a lot of criminals using weibo for fraud. The fraud groups use weibo to set the language trap, in order to cheat money of others, taking the interests of others. This study tried to use the method of social network analysis and data mining Tech, analyze the fraud group, thus define the organizational structure, the characteristics of the group, in order to develop potential fraud group in weibo, help users identify fraud, avoid being deceived.

MonAIS-08

Duck pack algorithm—A new swarm intelligence algorithm for route planning based on imprinting behavior

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In this paper, by studying the foraging behavior of ducks, a new bionic clustering intelligent algorithm - duck pack algorithm (DPA) is proposed and applied to route planning. The foraging behavior of the duck pack is dependent on imprinting behavior and food orientation, and this is why the ducks are different from other kinds of packs. To obtain the duck pack algorithm, the imprinting behavior and food orientation are abstracted into two operators and then the two operators are merged into an iterative process. Then the DPA is applied to route planning, and it can be found that DPA converges more quickly and the path generated by the DPA algorithm is smoother than that generated by the standard DE. This shows the reasonableness of the algorithm, and proves that the DPA algorithm is superior to the standard DE algorithm in stability and superiority.

MonAIS-09

Based on Dynamic Evaluation Research Procedural Examination Gain Incentive Method

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Stage evaluation model as a comprehensive evaluation model is gradually being introduced into the course of the examination. In order to improve the actual effect of the process of evaluation, aiming at the problems in the process of evaluation with dynamic evaluation incentive characteristics, be evaluated in different periods of gain as the basis, taking into account the evaluation of dual information, this paper puts forward a kind of information aggregation method based on time sequence gain incentive. In the first three different reward situation, determine the different levels of punishment by gain, on the basis of the assessment and preference information to determine the incentive coefficient; and then use the difference factor and ideal proximity correction gain value, according to the evaluation results obtained with the feature of reward and punishment. This method reflects the evaluation of incentive demand, by incentives, is the overall evaluation of the gap between the object and the expectations of the benign development of students or class to play a guiding role. Finally, a numerical example is given to demonstrate the effectiveness of the method.

MonAIS-10

Research on Civil-Military Integration Degree of Weapon Equipment Research and Production by System Dynamics Model

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The scientific analysis about Civil-military integration degree is foundation for Civil-military integration of weapon equipment research and production system. This paper defined concept about Civil-military integration degree, analyzed the model of Civil-military integration degree , designed causal relationship diagram of Civil-military integration degree , gave seven main variables to describe causal relationship diagram of Civil-military integration degree, the main variables included Market Concentration Rate, Efficiency of Resource Allocation, Market Access, Economies of Scale, Technological Innovation, Risk and Effectiveness , get six feedback loop for causal relationship diagram of Civil-military integration degree , established flowchart of System Dynamics model for Civil-military integration degree, constructed System Dynamics model of Civil-military integration degree .On this basis, simulated and analyzed Civil-military integration degree for three fields of weapon equipment research and production, get the optimal Civil-military integration degree for three fields of weapon equipment research and production . The conclusion will have definitely meaning to set up Civil-military integration of weapon equipment research and production system which have Chinese characteristics.

MonAIS-11

Logistic Command System Framework for Earthquake Relief based on Big Data

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The big data management is to mine effective information from huge data for assisting customers in the decision-making based on data analysis method. First, the general framework of earthquake relief logistics command based on big data management is studied by analyzing the shortcomings of traditional logistics method. Then, the logistics command method of using big data Tech in the earthquake relief operations is discussed. Finally, the case of earthquake relief in southwest China is introduced to display the application of the method.

MonAIS-12

Dynamic Fault detection and Optimization of Assignment for Decision-makers in C2-Organization

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The Command and Control (C2) organization plays an indispensable role on planning of military operation. Nowadays the plan oriented more uncertainty battlefield environment is the hot area. Many studies highlight how to rapidly make or change the plans with detecting advance information. One of the solutions is based the time-domain metric model to evaluate C2 organizational decision-making capability. We develop an improved simulated annealing algorithm to facilitate this model implementation. In order to discretize the time-domain, we propose a horizon partition that is based on the task dynamic state. Finally, the optimization for a case of multi-force joint operation is numerically conducted to obtain simulation results. The results are compared with the ones from traditional models Computational. It shows the proposed model has better outcomes in accurately estimating C2-organization capability.

MonAIS-13

Optimal control for region of the city traffic signal based on APSOWM

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Intelligent transportation system of the urban is the basis of modern urban development. In order to improve traffic efficiency of urban transport and ease traffic pressure. First, taking the average vehicle run time of traffic road net is the shortest as target, it established the model of regional traffic of urban through the analysis for urban road network to control of coordination traffic flow. Second, it got the coordinated timing plan of traffic signal of each of intersections in area through the particle swarm optimization algorithm modified by the strategy of adaptive inertia weight with a variation. Last, compared with the basic PSO algorithm and traditional way of timing control, the results of the analysis according to optimal simulation shows that proposed method in that increase about 22.6 percent and 24.1 percent for the average running time of all vehicle of region, and reduce about 17.2 percent and 30.1 percent for the average delay time of all intersection through a typical road network by

established and the use of MATLAB software and VISSIM5. 20 software validated that established and improved traffic models and algorithms. In a certain extent, it improves the efficiency and applicability of regional transit passage.

MonAIS-14

New Robust Single Machine Scheduling to Hedge against Processing Time Uncertainty

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This paper focuses on the single machine scheduling problem with uncertain processing times described via a set of scenarios. Rather than the traditional worst-case model, a new robust model is proposed based on two-bad-scenario set and the new problem is proved NP-complete. The proposed solution method is based on a branch-and-bound algorithm, in which a pruning rule and a method to get the upper bound and lower bound values are designed. The extensive computational results demonstrate the effectiveness of the branch-and-bound algorithm and the advantages of the new model.

MonAIS-15

Improved DE algorithm for multipurpose multistage batch scheduling problems

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This paper introduces an improved differential evolution algorithm for solving short-term multipurpose multistage batch scheduling problems (MMBSP) with the objective of minimizing the maximum completion time of all batches. A novel individual encoding and decoding scheme is designed for representing a scheduling solution for MMBSP. To improve the performance of DE further, a local search mechanism is introduced to exploit more latitude of search space to anchor the global optimum. In addition, the proposed DE is combined with a position bound disturbance strategy to add population diversity. Using those strategies, the proposed DE algorithm can get good balance between exploitation and exploration. The experimental results on some random generated problem instances demonstrate the good performance of the proposed DE.

MonAIS-16

An Improved NSGA-II for the Multi-Objective Operation Optimization of Continuous Annealing

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In the continuous production process of iron & steel enterprises, the key control parameters are generally determined based on expert's experience, which often causes problems such as frequent quality fluctuations, huge energy consumption, and low production efficiency. To handle these problems, a multi-objective operation optimization model for the continuous production process is constructed and an improved NSGA-II algorithm is proposed to solve this model. In this algorithm, a new crowding distance based on distributions of solutions is presented through taking into account the crowding between adjacent Pareto fronts. Then based on it a new construction method is designed to construct the new population, which can help to overcome the insufficient search diversity of canonical NSGA-II, in which the crowding distance is considered in the selection of solutions in only the last Pareto front. Computational results based on benchmark multi-objective optimization problems and practical continuous annealing process data illustrates the efficiency of the proposed algorithm.

MonAIS-17

Application of Extremal Optimization Approach to the Integrated Scheduling Problem of Continuous Casting and Hot Rolling Process

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Making an integrated schedule on both continues casting (CC) and hot rolling (HR) process in steel-making lines is a difficult problem since the balance of material flow, the continuity of production, the hot charge rate as well as the coupling between successive stages should be taken into consideration together. Therefore, few approaches have been published to solve the multistage integrated scheduling problem and applied to the real systems in practice. In this study, a novel modified Extremal Optimization (EO) algorithm combining exact mathematical model on CC stage and a heuristic algorithm on HR stage is proposed to solve the scheduling problem with less computational effort, and has been successfully applied to a real plant. The industrial application results show that compared with manual scheduling, considerable improvement in hot charge rate is achieved, leading to large energy-saving for the steel maker.

MonAIS-18

Model Researching on Daily Peak Load and Climate Factors of Hubei Grid in Summer

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Short-term load prediction is an important part of power grid dispatching, which is effective to unit commitment, economic dispatching and optimal power flow. With electrification level higher and higher, especially improvement of air conditioning ownership and usage, peak load fluctuation is more obvious for cooling in summer. In view of the typical characteristics of summer climate in Hubei, the model of daily peak load prediction based on climate factors is built and applied for actual production, which includes the historical factors of load, temperature and holidays. The relation and correlation between climate and load have been mined deeply. After evaluation, the goodness of fit highly reaches 95% and the mean relative error is only 4.40%. The model could be used for prediction of daily peak load in summer. This model has been used to predict peak load significantly in Hubei grid for 3 years.

MonAIS-19

Stabilization for discrete-time LPV systems with Markovian switching under partially known transition probabilities

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This paper investigates the stabilization problem for a class of discrete-time linear parameter-varying (LPV) systems with Markovian switching by using a parameter-dependent Lyapunov function method. A key point of this work relaxes discrete-time Markovian jump systems whose subsystems are described by discrete-time linear time-invariant (LTI) dynamics to discrete-time LPV systems with Markovian switching whose subsystems are described by discrete-time LPV dynamics. Meanwhile, the special assumption of completely known transition probability is relaxed to more general case that transition probability are partly known. Moreover, the proposed control technique for the discrete-time LPV systems with Markovian switching is used to solve the stabilization problem of turbofan-engine. Firstly, a state- feedback controller is designed, and the design problem can be reduced to a set of linear matrix inequalities (LMIs) feasibility problem. Then, a turbofan-engine example is given to demonstrate the applicability of the main results.

MonAIS-20

Stabilization Design for One-Sided Lipschitz Uncertain Nonlinear Systems with Time-Delay

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Stabilization design for a class of uncertain nonlinear systems with time-delay is devoted in this paper. Based on the theory of differential inclusion systems, sufficient conditions for stabilization the closed-loop system are acquired with the help of the convex hull Lyapunov-Krasovskii functional. Next, the interval observer for system is designed, and a control law is acquired based on the states of interval observer. Then, we prove that the closed-loop system is asymptotically stable under the control law. Finally, an example is given to illustrate the effectiveness of the proposed method.

MonAIS-21

Multiple Linear Models Tracking Control via Switching Strategy and the Application to Aero-engine

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For the linearized models based on the multiple operating points, this paper studies the switching control problem of the switching process from the initial point to the target point. First, the problem is described as a switching tracking problem with state constraints and basic controller, regulating controller and protecting controller are designed respectively. Second, in order to ensure that each controller works within the effective range of the respective models, the basic controller and the regulating controller switch in a rational way. The sufficient conditions of the switching strategy are proposed. Third, based on the safety margin, an efficient switching rule for the subsystems is proposed to make the output finally stabilized to the target point. Fourth, in the protection based scheme, accelerating loop and protecting loop work in turn to ensure that the output tracks to the target point in a safe way. Finally, the proposed method is applied to the safety protection system of the engine, and the simulation results verify the effectiveness of the proposed method.

MonAIS-22

Robust Stabilization for Constrained Switched Positive Linear Systems with Uncertainties and Delays

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This paper is concerned with robust stabilization problem by constrained state feedback control of switched linear systems with uncertainties and time delays. The synthesis of nonnegative state feedback controllers while imposing positivity and stability on closed-loop system is firstly addressed for systems with interval uncertainty description. Then this result is extended to the robust stabilization issue by bounded controls

and constrained states. Also the synthesis of bounded controls is solved for systems with polytopic uncertainties. The proposed conditions are formulated as linear programming form. An example is employed to illustrate the effectiveness of the established results.

MonAIS-23

Stabilization of Sector-Bounded Switched Nonlinear Systems with All Unstable Modes

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This paper will study the global stabilization for a class of sector-bounded switched nonlinear systems with features: (i) all subsystems are allowed to be unstable; (ii) the nonlinear functions belong to sector sets with arbitrary boundaries, which cover the most general case since the sector boundaries can have positive and/or negative slopes; (iii) systems matrices are constant ones without any restrictions. The stabilization criteria for switched nonlinear systems with mode-dependent dwell time are firstly derived. Then, for a class of sector-bounded switched nonlinear systems, sufftcient conditions for stabilization are presented to guarantee that the switched system can be globally stabilized by designing stabilizing switching signal in the framework of mode-dependent dwell time scheme.

MonAIS-24

Almost Exponential Stabilization for Stochastic Dynamical Systems under Event-Triggered Impulsive Control

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This paper studies the issue of the almost exponential stabilization for stochastic dynamical systems (SDS) by using event-triggered impulsive control (ETIC) . The ETIC scheme is designed by setting three levels of event conditions. The criteria on almost exponential stabilization are derived for the controlled SDS. Thus the almost exponential stabilization is achieved for SDS under the designed ETIC. Finally, one example is given for illustration.

MonAIS-25

Energy Decay Rate for a Thermoelastic Transmission Problem with Frictional Dissipation

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The asymptotic behavior of a mixed thermoelastic system of type II, type III and type II with frictional damping is considered. These three components are connected with certain geometrical topological structures (chaintype, tree-type). By frequency domain analysis, we obtain two classes of decay rates for these systems: if these three components are connected with chain-type structure and the thermoelastic component of type III is not in the middle of these components, the system can achieve exponential stability. However, the systems with other chain-type or tree-type structures are all lack of exponential decay rate. The polynomial decay rate is further obtained for those systems.

MonAIS-26

Feedback Control Design of Crowd Evacuation System Based on the Diffusion Model

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Xuyang Lou Jiangnan Univ.

This paper pertains to the study of feedback control design for the crowd evacuation in the framework of 1D and 2D models, respectively. The models representing crowd dynamics are based on the conservation law of mass with the density and velocity relationship given by a diffusion model. The feedback controllers taking care of control saturation are designed by using the method of feedback linearization for partial differential equations, which can keep the pedestrians evacuating in specific direction and fixed speed. By constructing the corresponding Lyapunov functional, the stability of the closed-loop system under the designed distributed feedback controller is proved. Finally, an example is given to illustrate the results.

MonAIS-27

Global dissipativity in the mean square of stochastic Cohen-Grossberg neural networks with time delays

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In this paper, the problem of global dissipativity in the mean square is discussed for stochastic Cohen-Grossberg neural networks with time delays. By constructing general Lyapunov functions, combining with Itˆo's formula, several sufficient conditions for the global dissipativity in the mean square are derived. Moreover, we give out the estimations of globally attractive sets. Finally, one example is given to show the effectiveness of the proposed criteria.

MonAIS-28

Study on Series Repairable System Reliability Model Based on PH Distribution

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Jing Yang Naval Univ. of Engineering

This paper studies a series repairable system with a single repair facility in which the component lifetime and repair time are subject to general distribution that can be represented as Phase-type (PH) distribution. Based on the basic assumption, the proposed model is more suitable to characterize the real situation. The process of solving system steady-state probability is provided, and the analytical expressions for system stationary availability, mean time between failures (MTBF), mean down time (MDT), reliability and failure rate functions are expressed. Finally, the validity and applicability of the model are illustrated with a numerical example.

MonAIS-29

Multi-state System Reliability Analysis Combined PH Distribution with Universal Generating Function

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To make multi-state system reliability model reveal the randomness of component or system state changes more authentically, reduce the number of system states effectively and simplify the solution of model, this paper employs continuous phase type (PH) distribution to improve universal generating function. It is firstly assumed that a multi-state component's residence time in different states is subject to general distribution, which is presented in the PH distribution. A procedure for solving Instantaneous probability of each state is provided to construct the improved universal generating function for multi-state component. Subsequently, this paper describes how to construct the improved universal generating function for serial, parallel and complex systems, and obtains the reliability measures, such as the system instantaneous availability, average performance and mean performance deficiency measures. Finally, an example is used to verify the improvements of the model descriptive and state dimension control capability, and the algorithm effectiveness is illustrated demonstrated simultaneously.

MonAIS-30

Adaptive output feedback stabilization of a class of stochastic feedforward nonlinear systems with uncertainties

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This paper considers the adaptive output feedback control problem for a class of stochastic nonlinear systems dominated by a upper-triangular condition. The distinguishing feature of the investigated system is the presence of unmeasured states growth multiplying an unknown constant. To address serious uncertainties in the growth rate, a dynamic gain approach combing with a linear observer is employed to construct a linear-like output feedback controller for stochastic feedforward nonlinear systems. By the general stochastic convergence theorem, it is proven that the proposed controller renders the boundedness and stochastic convergence of the resulting closed-loop system.

MonAIS-31

Distributed Event-Triggered Control with Dynamic Triggering Mechanisms for Multi-Agent Systems

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Lun Wang Anhui Univ.
Yuan Fan Anhui Univ.

In this paper, a new event-triggered mechanism for distributed control system is presented. This control protocol is governed by an a trigger defined based on internal dynamic variable. The triggering condition of an agent is not only affected by its own measurement error and the relative states of its neighbors but also the current state measurement error and those previous ones. A candidate Lyapunov function is proposed to illustrate the asymptotic convergence of the closed-loop system. Simulation results are provided for illustration of the theoretical claims at the end.

MonAIS-32

Distributed Control Algorithm and Experiment of Multi-agents in a Non-rectangular Bounded Space

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In this paper, we consider coordinated motion and cooperative control of multi-agents in a non-rectangular bounded space, and present a velocity consensus algorithm for the agents with double-integrator dynamics. The traditional consensus algorithm for bounded space is only applied to rectangular bouncing boundaries, not suitable for non-rectangular space. Therefore, we introduce the concept of the mirrored velocity that not only can convert the discontinuous real velocity into the continuous mirrored velocity, but also can expand a bounded space into an infinite space, and eventually the velocity of multi-agents asymptotically converge to the same values, respectively. Finally, the effectiveness of the proposed consensus algorithm is examined by numerical simulations. Moreover,

we pave the way from theoretical design to practical implementation by performing an experiment in a real multi-robot system.

MonAIS-33

An Impact-time-control guidance law for cooperative attack of multiple missiles

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In this paper, a new guidance problem with the impact time constraint for cooperative attack of multiple missiles is investigated, which can be applied to salvo attack of anti-ship missiles. It can be used to guide multiple missiles to hit a stationary target simultaneously at a desirable impact time. The considered impact time control problem can be transformed into a range tracking problem. Then the range tracking problem can be viewed a consensus problem of multi-missile systems. As the application of the distributed consensus controller of multi-agent systems, several distributed protocols are given to solve the cooperative attack problem for the advantages such as reducing cost, improving system efficiency, flexibility, reliability of distributed control. Nonlinear simulation demonstrates the performance and feasibility of the given protocols.

MonAIS-34

Decentralized Tracking An Event Using Optimal Coverage Sensor Networks

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A variety of distributed cooperative strategies of mobiles agents are discovered to perform covering and tracking tasks. However, energy is a challenge for them. Energy-out may cause the failure of the mission. In this paper, a decentralized tracking problem of some events is considered by using the optimal coverage sensor networks. We emphasize that the occurrence of the events do not have a uniform probability distribution, so we can design a preferred fixed sensor configuration which can help to maximize the probability of detecting the event. That is to say, we deploy the sensors to the positions which can achieve the optimal coverage corresponding to the probability density function obtained from the statistical data in history, which may minimize the energy consumption. Then the tracking method by using the standard Luenberger observer will be shown under the condition that the events really happen in the considered environment. The novelty of our algorithm is that we use the properties of Voronoi partition to achieve decentralized estimation of the position of the events. In fact, the sensor technical reflected on the quantitative effect of the signal, and the quantitative results of position error indirectly affect the performance of the tracking system. So, what is more significant is that we take the sensor quantitative effect on the system into consideration. Simulation results are provided to demonstrate the validity of the algorithm.

MonAIS-35

Specified-Time Containment Tracking For Multi-Agent Systems: An Optimal Control Approach

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In this paper, for single-integrator multi-agent systems, specified-time containment tracking problem is studied under undirected topologies. By utilizing specified-time optimal control approaches, a class of novel containment tracking algorithms are proposed. In order to solve the containment control problem in a settling time specified in advance, a sampling time sequence, which converges to the specified time, is designed. During each time interval of the sampling time sequence, the proposed algorithm is used for single-integrator multi-agent systems. Thus, the proposed algorithm is a sampling-data-based specified-time containment tracking algorithm. Due to the settling time can be specified in advance, this algorithm is very meaningful and consistent with practical requirements. Finally, we propose a numerical simulation to show the effectiveness of the theoretical results.

MonAIS-36

Consensus of Lur'e-type Nonlinear Multi-Agent Systems with a Class of Directed Switching Topologies

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Wei Liu Naval Aeronautical and Astronautical Univ.

This paper addresses the consensus problem of Lur'e-type nonlinear multi-agent systems with directed switching topologies. A special class of directed topologies containing a directed spanning tree is characterized. Distributed consensus controllers are constructed based on relative states information of neighbor agents. A special property of the graph Laplacian matrix is used to convert the consensus problem with switching topologies into a stabilization problem of a switched system with lower dimensions. Common Lyapunov function based approach is employed for analysis. A bright feature of this paper is that the consensus of Lur'e-type nonlinear multi-agent systems can be achieved with directed and arbitrarily fast switching topologies. There is also no any constrains on the dwell time or the averaging dwell time of the switching topologies. Finally, a numerical simulation is provided to illustrate the effectiveness of the theoretical results.

MonAIS-37

A Fault-Tolerant Scheduling Algorithm for Distributed Control System Based on Backward Non-Preemptive RM

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Distributed control systems (DCSs) have been widely applied in many fields in recent years. With the increase of the number of processors, a DCS is subject to hardware and software failures. Therefore, a fault-tolerant scheduling algorithm based on backward non-preemptive RM (BNPRMFT), which can tolerate both hardware faults and software faults, is presented in this paper. Each task has two independent copies named primary copy and backup copy that are assigned on different processors. The backup copy of a task is executed only when its corresponding primary copy fails due to a fault. In order to decrease the number of preemptions and lower the runtime overhead of the algorithm, non-preemptive RM is applied to schedule primary copies which are assigned to the same processor, and the backward non-preemptive RM is applied to schedule backup copies and to calculate notification times of tasks. Simulation results show that BNPRMFT can obtain a higher success rate in executing primary copies and lower the runtime overhead of BPRMFT.

MonAIS-38

Guaranteed cost control of networked control systems with bounded packet loss

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This paper investigates the guaranteed cost control of quantized feedback systems over networks with bounded packet loss. The model of the networked control systems, which appropriately incorporates the quantized feedback, is established on the standpoint of robust control which transforms the problem of stabilization of the networked control systems with packet loss into the robust stabilization of a class of subsystems. Unlike the common Lyapunov function in the quadratic framework which is normally used in analyzing the networked control systems, this paper presents a new approach that can significantly reduce the conservativeness by taking the quantization dependent Lyapunov function. Based on the provided Lyapunov function, a guaranteed cost state feedback controller is derived which explicitly considers the packet loss process. A numerical example illustrates the effectiveness of the proposed method.

MonAIS-39

Prediction of Networked Control System Time-delay based on Grey Model and Elman Neural Network

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In order to improve the time-delay prediction accuracy, this paper proposes a network time-delay prediction method based on grey model and Elman neural network. Grey model can weaken the randomness of the time-delay sequence, and the Elman neural network has good prediction ability for nonlinear sequence. The advantages of these two methods are combined. The final predictive time-delay is obtained by grey model and Elman neural network multiplied by their weighting coefficients. The optimal model weighting coefficients are determined by principle of minimum variance. The simulation results show that this combination prediction method has higher prediction accuracy with smaller predictive error.

MonAIS-40

The Real-time Constraint Semantics of Events-driven State Transition for Embedded Control Systems

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Jun Sun Kunming Univ. of Science and Tech.
Hongbo Fan Kunming Univ. of Science and Tech.

In this paper, we study the process of physical state transition in the embedded system. The key to dramatically increase the efficiency of system is important to meet the deadline and the quality of task process for actors which were released the real-time events and were driven to transfer the state of the system. To address these two goals at the same time, we defined a real-time events label of the value constraint and clock constraint conditions, and established a super dense time model contained constraint conditions. Based on partial order model to simulate the state time sequence order, we proposed a real-time semantics of the state transition for embedded control systems. The embedded system state transition constraint while supporting the value constraint was proposed, and this model validation under the clock constraint of events, was ensured real-time operation in the process of execution sequence what has a certain event and state. An example of laser gyroscope blocking threshold test system is performed to evaluate the performance of the feedback controller in-depth research which has the effect of value constraint for the state transition of systems.

MonAIS-41

A Time Delay System Approach to Synchronization Control of Bilateral Teleoperators

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Shengquan He Zhejiang Univ. of Tech.
This paper investigates the synchronization problem of bilateral teleoperators in the presence of time-delay. Compared with previous work, a new controller with specific structure is designed. In this paper, the robot teleoperation system is converted to a linear time-delay system model by using feedback linearization method. Then, a memoryless state feedback controller with specific structure is applied to tackle the delay-dependent stabilization problem. Finally, delay-dependent criteria for the stability analysis are derived. A simulation example is provided to show the effectiveness and superiority of this method.

MonAIS-42

Event-triggered mechanism based dynamic quantized output feedback controller for networked control systems

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Jian Guo Nanjing Univ. of Science and Tech.
Chuan Zhou Nanjing Univ. of Science and Tech.
A co-design strategy of optimal event-triggered mechanism and dynamic output feedback controller for a class of networked control system with resource-constrained and random time delay is proposed based on the mode-dependent quantizer. Firstly, an adaptive event-triggered mechanism is designed according to the output error in order to reduce the number of information transmission and the occupation of network bandwidth while ensuring the stability of networked control system. Secondly, a mode-dependent quantizer is used for seeking the balance between network congestion and quantized error, which can improve the quality of control of NCS in a certain extent. Next, the co-design scheme of event-triggered mechanism and the dynamic output feedback controller(DOFC) is given to ensure the stability and minimum quadratic performance index of the closed-loop system based on Lyapunov function and linear matrix inequality technique. Finally, a simulation example illustrates the efficiency of the proposed method.

MonAIS-43

Excel under the information Tech application in financial management research

Jinping Liu Bohai Univ.
Under the condition of information technology，Excel As a professional spreadsheet software, In accounting, financial management, finance, finance and securities such as widely used areas of the economy, For accurate economic forecasting and decision-making plays an important role， Improve the quality of the enterprise financial management under the environment of informatization。n this paper, the application of Excel function in the financial management under the environment of informatization situation analysis and research.

MonAIS-44

Under the IT environment inventory accounting and management studies

Jinping Liu Bohai Univ.
The content of the inventory accounting and management is very complicated, The difficulty of the traditional environment accounting and inventory management is very big, Especially when there are many different kinds of enterprise inventory, Warehouse more cases, The difficulty of manual management, Under the IT environment, The organic fusion of information Tech and inventory management, Set up under the environment of informatization inventory management system, To improve the accuracy of inventory accounting and the validity of the inventory management has important practical significance.

MonAIS-45

An Inter-Domain Routing Scheme for Software-Defined Optical Network

Yunshan Liu Guidaojiaotong Polytechnic Inst.
Northeastern Univ.
Software-Defined Optical Network (SDON) incorporates the technologies of Software-Defined Network (SDN) into the comprehensive solutions of traditional optical network, which greatly improves the weaknesses of the traditional optical network, including inadequate enforcement of control, inefficient utilization of resource and so on. Based on the improved SDON architecture, this paper did lots of research and experiments on the inter-domain routing technologies of multi-domain SDON. Results show that the SDON architecture can effectively solve the routing problems among the traditional multi-domain optical networks.

MonAIS-46

Bounded Real Lemma for a Class of Linear Discrete-time Networked Control Systems

Chaochao Tang Hangzhou Dianzi Univ.
Xiefu Jiang Hangzhou Dianzi Univ.
Meichen Wang Hangzhou Dianzi Univ.
Li Yao Hangzhou Dianzi Univ.
Meidan Zhang Hangzhou Dianzi Univ.
This paper studies the problem of bounded real lemma for a class of linear discrete-time networked control systems. By introducing an augmented matrix, the Lyapunov-Krasovskii functional of some existing literatures is improved and the discrete Wirtinger-based inequality is used to deal with the finite-sum term. Combining the discrete Wirtinger-based inequality and the reciprocally convex approach, we obtain a less conservative bounded real lemma for networked control systems. Finally, the numerical simulations by LMI toolbox in MATLAB are compared with the existing literatures and the validity of the used method is verified.

MonAIS-47

Synergetic Robust Fault Detection and Fault Tolerant Control for Flight Vehicles with Time-varying Delay

Aojia Ma China Academy of Launch Vehicle Tech.
Feng Gao China Academy of Launch Vehicle Tech.
Yahui Li China Academy of Launch Vehicle Tech.
Lei Zhang China Academy of Launch Vehicle Tech.
Chenlin Wang China Academy of Launch Vehicle Tech.
Fugui Li China Academy of Launch Vehicle Tech.
This paper is concerned with the fault detection and fault tolerant tracking control problem for flight control system connected over a digital communication network with time-varying delay. The fault detector and fault tolerant tracking controller are designed synergistically using the delayed state and output feedback signals. A delay-dependent stability criterion is presented to handle with the adverse effects of the delays. The asymptotic stability and desired H∞ performance of the system are guaranteed by combing Lyapunov-Krasovskii functional method with linear matrix inequality technique. A numerical example based on the HiMAT vehicle demonstrates the merits of the proposed method.

MonAIS-48

Event-triggered Control of Physically Interconnected Systems

Muhammad Imran Shahid Univ. of Science and Tech. of China
Qiang Ling Univ. of Science and Tech. of China
This paper presents a survey on the event-triggered control of a class of distributed networked control systems called physically interconnected systems. Conservation of shared communication and computational resources is a fundamental challenge in the development of these systems especially when the number of interconnected subsystems becomes large. In recent years, event-triggered control schemes have been proved to be a highly efficient choice to improve the communication and control efficiencies in resource-constrained systems. We provide a comprehensive survey on event-triggering mechanisms employed in the control of physically interconnected systems with an emphasis on the theoretical results. An overview of the existing literature in this area leads to a number of potential research directions which have been pointed out at the end.

MonAIS-49

Fault Detection of Networked Multi-rate Systems with Probabilistic Sensor Failures

Yong Zhang Wuhan Univ. of Science and Tech.
Weijia Huang Wuhan Univ. of Science and Tech.
Luyang Tang Wuhan Univ. of Science and Tech.
Zhenxing Liu Wuhan Univ. of Science and Tech.
Min Zhao Wuhan Univ. of Science and Tech.
In this paper, the fault detection problem is investigated for a class of networked multi-rate systems (NMSs) with network-induced probabilistic sensor failures. By applying the lifting technique, the system model for the observer-based fault detection is established. With the aid of the stochastic analysis approach, sufficient conditions are established under which the stochastic stability of the error dynamics is guaranteed and the prescribed H1 performance constraint is achieved. Based on the established conditions, the addressed fault detection problem of NMSs is recast as a convex optimization one that can be solved via the semi-definite program method, and the explicit expression of the desired fault detection filter is derived by means of the feasibility of certain matrix inequalities. Finally, an simulation example is utilized to illustrate the effectiveness of the proposed fault detection method.

MonAIS-50

Research Progress of Simulation Platform for Networked Control Systems

Baoran An China Academy of Engineering Physics
Gang Chen China Academy of Engineering Physics
Guoping Liu Harbin Inst. of Tech.
Networked control technology integrates with microelectronic technology, communication technology and control technology so that networked control systems have some attractive advantages such as convenient installation, high reliability and flexibility, and low-cost maintenance. These advantages have promoted wide application into large-scale distributed control systems. Focusing on the control dynamics of the physical system and the communication performance in the critical network information mode, the research of simulation technology has been carried out by scholars at home and abroad. Combined with the relationship between the physical system and communication network in the networked control systems, the paper reviews the physical simulator, network simulator and physical simulator research dynamics. Finally, the existed problems and application challenges in the field of network control system simulation are discussed.

MonAIS-51

A UDP-based Way to Improve Data Transmission Reliability

Xinhong Hei Xi'an Univ. of Tech.
Jia Chen Xi'an Univ. of Tech.
Hongtao Lu Xi'an Univ. of Tech.
Guo Xie Xi'an Univ. of Tech.

Haining Meng Xi'an Univ. of Tech.
In real-time control systems, a fast and reliable data transmission mechanism is necessary. This paper analyzes the advantages and disadvantages of the existing data transmission protocol and proposes a data transmission protocol called Deque-ERUDP (Deque Efficient and Reliable Protocol Based on UDP) which can guarantee data transmission reliability and efficiency. The proposed protocol uses double sub-queue data transmission and acknowledgment mechanism. This protocol controls TIQ (Timeout Interval of Queue) and TIP (Timeout Interval of Packet) dynamically to avoid network congestion. By comparing the results of simulation experiment, it really verifies the feasibility of Deque-ERUDP and improves the reliability of data transmission very well.

MonAIS-52

Remote monitoring system based on Zigbee wireless sensor network

Aijuan Song Northeastern Univ. at Qinhuangdao
Guangyuan Si Northeastern Univ. at Qinhuangdao
This paper deals with the monitoring system based on Zigbee wireless sensor network technique in details. The system adopts single-chipped microprocessor ZIC2410 radio frequency chip. By the upper computer software and programs of various physiological data acquisition, the physiological data of warded people, such as the pulse, blood pressure, blood oxygen saturation and electrocardiogram, are gathered by the PC software in real time, and then the collected data are transmitted to the remote medical monitoring center through the wireless sensor network. The data information of each node, including the location and health status of the warded people, can be displayed by the monitoring center software. It makes timely and effective medical guidance possible. The system is small- sized, low-power-dissipated and strongly compatible and can be connected to network with different hardware platforms. The author mainly introduces hardware circuit design of processor module, data acquisition module, and wireless communication module. The monitoring software of the host computer is developed by LabVIEW. Experiments prove that the system has good stability and security. It has very high practical value and promoting function in telemetrically monitoring field in the future.

MonAIS-53

Time Synchronization of Wireless Sensor Networks Under Random Environment

Haian Yin Southeast Univ.
Peijun Wang Southeast Univ.
Wen Xie Nanjing Housing Provident Fund Manage ment Center
Tingwen Huang Texas A&M Univ. at Qatar
Xinping Gui Southeast Univ.
This technical note addresses the distributed time synchronization problem for wireless sensor network (WSN) and personal area network (PAN) under randomly switching topologies, respectively. The coordination goal here is to make the clock speed of each sensor asymptotically converges to a same value and the clock offset of each sensor vanishes asymptotically. To achieve this goal, several distributed algorithms based on some updating laws are proposed, while we do not focus on the convergence analysis. Finally, some simulation examples are given to show the effectiveness of the proposed algorithms.

MonAIS-54

Delaunay triangulation based localization scheme

Zixiao Guan Beijing Inst. of Tech.
Baihai Zhang Beijing Inst. of Tech.
Yu Zhang Beijing Inst. of Tech.
Shi Zhang Beijing Inst. of Tech.
Feifan Wang Beijing Inst. of Tech.
Geometry-based localization algorithms come to the forefront with its unique superiority. This paper proposes a Delaunay triangulation based localization scheme (DBLS), which takes use of received signal strength indicator (RSSI) from anchor nodes. Based on RSSI, the Delaunay area is generated. The unknown node determines which Delaunay area it belongs to and then record it down. After several iteration, the overlapping region of all Delaunay areas is identified as the possible region where sensor resides in. By fixing the Delaunay area, we restrains the influence of noise on the result. The simulation result shows that DBLS has a better performance than Voronoi diagrams based localization scheme (VBLS) and centroid algorithm.

MonAIS-55

An Energy-Efficient Routing Strategy Based on Mobile Agent for Wireless Sensor Network

Jing Yang Guizhou Univ.
Heng Zhang Guizhou Univ.
Xiao Wang Guizhou Univ.
Yuzhi Zhan Guizhou Univ.
Ping Yang Guizhou Univ.
Xuemei Luo Guizhou Univ.
Yuefang Sun Guizhou Industry Polytechinc Coll.
Zetao Li Guizhou Univ.
The access sequence and the number of nodes have a significant impact on the performance of agent-based data gathering in a network. This paper proposes an energy-efficient routing strategy for mobile agent (ERS) in wireless sensor networks (WSNs). ERS integrates the advantages of clustering and the mobile agent. By constructing a cost function, an optimal route for a mobile agent between the sink and the cluster is obtained. An improved ant colony algorithm (ACA) is presented to form the route for the mobile agent in a cluster. Moreover, a simple scheme that turns off redundant nodes according to the measurement requirement is designed to improve the energy efficacy. Simulation results show that the proposed strategy can provide less energy consumption and network delay compared to the traditional algorithms.

MonAIS-56

A Historical Harvested Energy Assigning Mechanism for Multi-hop Multi-relay Energy Harvesting Wireless Sensor Networks

Yuanchang Zhong Chongqing Univ.
Zunzhao Wang Chongqing Univ.
Xiaofan Zhang Chongqing Univ.
The load imbalance of sensor node is a severe problem for Wireless Sensor Networks (WSNs). In this paper, we firstly propose a Multi-hop Multi-relay Network Model (MMNM) with Relaying Head (RH) to balance the load among sensor nodes. And the emergence of energy harvesting techniques brings us the Energy Harvesting Wireless Sensor Networks (EH-WSNs). Due to the indeterminacy of energy that can be harvested in ambient environment, study on energy management mechanism to achieve energy neutral is significant. We proposed a novel Sensor Nodes Pair (SNP) policy dividing all the sensor nodes into two groups GSN and GSN'. With the function rotation of GSN and GSN', we achieve continuous data transmission avoiding time delay. Also a Historical Harvested Energy Assigning Mechanism (H-HEAM) is proposed to ensure the energy neutral constrains and perpetual network operation. Extensive simulation results verify that our MMNM and H-HEAM are indeed able to improve the network overall performance on throughput, energy utilization efficiency and time delay.

MonAIS-57

Self-sorted D2D Discovery for Alleviating In-band Emission in LTE Networks

Fei Dong Shanghai Jiao Tong Univ.
Jing Wu Shanghai Jiao Tong Univ.
Chengnian Long Shanghai Jiao Tong Univ.
Proximity service (ProSe) enables the adjacent mobile devices communicate with each other on device to device (D2D) links in the Long Term Evolution Advanced (LTE-A) system. Device neighbor discovery is the first step to the D2D communication. In LTE-A networks, D2D discovery beacons are multiplexed with cellular signal, it will lead to in-band emission interference (IBEI). IBEI will lead to considerable interference to cell UEs uplink control signal. Therefore, reducing the IBEI caused by D2D discovery signal and keeping a high discovery ratio are the objective of discovery algorithm designing. In this paper, we propose a new distributed discovery algorithm named self-sorted (SS) discovery algorithm. First, SS algorithm is motivated by greedy resource block (RB) selection method for keeping a higher discovery ratio. Second, we use self-sorted method for converging the D2D user equipments (DUEs) who will cause severe IBEI transmit discovery beacons in minimum sub-frames such that reducing the impact of IBEI to eNB. Through simulation results, our proposed algorithm is proven to be better than existing distributed D2D discovery algorithm.

MonAIS-58

Modelling and Simulation on Wireless Communication Positioning Tech in the Mall

Huijuan Bian school of Beijing Univ. of civil engineering and architecture
Jiabin Xu school of Beijing Univ. of civil engineering and architecture
Chuncheng Liu school of Beijing Univ. of civil engineering and architecture
With the emergence of Internet shopping, the mall wilted in the face of fierce competition increasingly. So it should find a way of new Tech for a change, in order to build a more sophisticated services. Indeed, Indoor Positioning Tech is the key. A kind of positioning Tech is use mobile phones and base stations to determine the location of the mobile. The holder's trajectory can get through the statistics of large-scale location about anonymous user. Even in the special position the mall can push information keywords and make the service management more intelligent. When mobile phones become an indispensable things step by step, it can help the mall to reflect the location of the holder and to push the information of goods to improve the promotion of goods. In this paper, using the Time Of arrivals (shortened form TOA) positioning for 3 D Indoor Positioning, which is the classic of indoor positioning Tech. In view of the variety and complexity of the indoor environment, we build a more optimized mathematical model to solve those problem.

MonAIS-59

Implementation of Indoor Fingerprint Positioning Based on ZigBee

Dong Zhe North China Univ. of Tech.
Mengjiao Chen North China Univ. of Tech.
Wenjuan Liu North China Univ. of Tech.
Human's demand for location-based services is more and more strong, and getting the location of the indoor service object is the core problem. ZigBee Tech has the characteristics of low power consumption, small throughput and so on. This paper studies the indoor fingerprint identification positioning method based on ZigBee, the process is mainly

divided into two phases: the first phase is to establish a fingerprint database, the second is real-time positioning phases. In phase one, RSSI data was collected point by point in the positioning area, then filtered the data and stored them to form the fingerprint database. In the positioning stage, experiment was carried out by using nearest neighbor method, weighted K neighbor method, and the specific area weighted K neighbor method, respectively. In the end, online tracking process in the simulated indoor environment was completed by using the map matching method combined with fingerprint identification positioning method.

MonAIS-60

The Design and Implementation of the Visual Location System Based on Beeline Detection

Weisi Gong Naval Aeronautical Engineering Inst.
Xiuzhen Wu Naval Aeronautical Engineering Inst.
Shaolei Zhou Naval Aeronautical Engineering Inst.
Shi Yan Naval Aeronautical Engineering Inst.

In order to solve the problem of localization of indoor mobile robot, the visual location method of indoor mobile robot based on beeline detection is put forward. Through the four rotor UAV to set up the indoor mobile robot hardware platform. Using the Robot Operating System(ROS) to set up the software platform. Using camera to collect ground grid image to detect the image of the beeline in order to obtain real-time coordinates. Test shows that the algorithm is feasible, real-time, high accuracy position and strong robustness. The problem of indoor mobile robot localization can be a good solution.

MonB01 Room01
Robust control (I) 14:00-16:00

Chair: Xiangbing Liu Beijing Jiaotong Univ.
CO-Chair: Nanyu Chen Beihang Univ.

14:00-14:20 **MonB01-1**

Robust control for asymmetric saturated systems based on gain scheduling

Qian Wang Hangzhou Dianzi Univ.
Guoda Chen Hangzhou Dianzi Univ.

The paper proposed a gain scheduling control for the systems with asymmetric saturation and parameter uncertainties. The main contributions of the proposed method are transforming the control problem of the asymmetric saturated system to the symmetric one and increasing the state convergent speed of the closed-loop system by introducing a parameter. The controller can be computed by the linear matrix inequalities (LMIs). The simulation results show the usefulness of the designed controller.

14:20-14:40 **MonB01-2**

Research On Self-Healing Strategy Of Smart Distribution Grid Based On Improved Ant Colony Algorithm

Nanyu Chen Beihang Univ.
Jun Huang Beihang Univ.
Yaoming Zhou Beihang Univ.

This paper aims to address the robust control problem of the unmanned helicopter during a path-following task in the presence of inertia uncertainty and external disturbance. A combination of the adaptive sliding mode control method and a nonlinear disturbance observer is proposed as a solution, where the upper bounds of the parametric uncertainty and disturbance are not required in advance. Firstly, according to the force of the flight system, the dynamic model is established by using the Newton-Euler equation and simplified properly. Then an adaptive sliding mode variable structure control method is proposed to combine with adaptive control method, nonlinear disturbance observer (NDO) and sliding mode control techniques which is used to obtain the position controller and attitude controller, respectively. On the premise of sliding mode control to ensure the control robustness, the adaptive control variables are used to compensate the parameter uncertainty and extern disturbance. Base on the Lyapunov theory, the global asymptotic stability is validated. Finally, the algorithm is verified by Matlab simulation experiment and the result is analyzed. It can be seen that the adaptive sliding mode control method has invariance to parameter perturbation and external disturbances and is feasible.

14:40-15:00 **MonB01-3**

Fractional-order PID and Active Disturbance Rejection Control for Active Power Filter

Nixuan Liu Hohai Univ.
Juntao Fei Hohai Univ.

This paper proposed a fractional-Order PID controller and Active Disturbance Rejection Control (ADRC) method for current compensation of Active Power Filter (APF). The control method consists of two closed loop. One is a reference current tracking loop based on the ADRC controller, which can treat the internal and external uncertainties of the system as a whole for the convenient control. The other is the voltage controlling loop with the Fractional Order PID controller for more flexibility. By comparing with other control method, simulation results verify that the presented control method has excellent dynamic performance and strong robustness in the presence of model uncertainty as well as external disturbances.

15:00-15:20 **MonB01-4**

Robust State Estimation for Delayed Genetic Regulatory Networks Using Sampled-Data

Weilu Chen Harbin University of Science and Tech.
Dongyan Chen Harbin University of Science and Tech.
Xiu Kan Shanghai University of Engineering Science
Yanfeng Zhao Shanghai University of Engineering Science
Harbin University of Science and Tech.

In this paper, we investigate the robust state estimation problem for a class of genetic regulatory networks (GRNs) subject to time-varying delays and parameter uncertainties via utilizing sampled-data method. By substituting the continuous measurements, we use the sampled measurements to estimate the concentrations of mRNAs and proteins. Based on the extended Wirtinger inequality, a new discontinuous Lyapunov functional is constructed. Via using Jensen inequality and the Lower bounds theorem, a sufficient criterion is derived, which guarantees the globally robustly asymptotic stability of the augmented system. Further, the required state estimators can be designed by solving a set of linear matrix inequalities (LMIs). Finally, two numerical examples are provided to demonstrate the effectiveness and less conservatism of the obtained results.

15:20-15:40 **MonB01-5**

Comparative Study on H∞ Robust Control Based on Dynamic State Feedback and Static State Feedback

Xiaohua Li University of Science and Tech.
Zhe Ma University of Science and Tech.
Xiaolin Wang University of Science and Tech.

Aiming at a triple Inverted pendulum model, the H∞ robust control problem based on dynamic state feedback and static state feedback is studied in this paper. First, the sufficient condition for H∞ robust stability based on dynamic state feedback is obtained by employing the linear matrix inequality (LMI) approach. And the design method of the H∞ dynamic state feedback controller is given. Then, the comparison with H∞ robust control method based on static state feedback is studied by the simulations. The results show that the dynamic-state-feedback-based H∞ controller is equally effective as the one based on static state feedback. The former has more flexibility and less conservatism than the other, but the latter has better performance on dynamic stationarity and disturbance attenuation capability.

15:40-16:00 **MonB01-6**

Robust Control for Missile with Lateral Jet and Aerodynamic Surfaces

Xiangfei Deng Beijing Jiaotong Univ.
Xiangbin Liu Beijing Jiaotong Univ.
Jinpeng Zhang Luoyang Electro-Optics Technology Development Center

In this paper, a robust blending control algorithm of tail fin and reaction jet of autopilot is proposed for the pitch control of a missile. The missile dynamic is a nonlinear system with uncertainties, which is existed in both aerodynamic force and moment generation terms in the equations of motion. The bound of the uncertainties are known, which is used to attenuate uncertainties by robust part in the control law, which guarantees the whole missile system with satisfying control performance both in transient state and steady state. The dual control allocator is designed to manipulate the tail fin and reaction jet of the missile work cooperatively when the deflection of aerodynamic rudder is in its limitation deflection and cannot supply enough torque via attitude deflection system. The stability analyses is provided for the closed-loop system in this paper. Finally, numerical simulations are given to illustrate the effectiveness of the proposed robust control law.

MonB02 Room02
Intelligent Building Control and Management (II) 14:00-16:00

Chair: Yahui Wang Beijing Univ. of Civil Engineering and Architecture

14:00-14:15 **MonB02-1**

Research on Fault Diagnosis Algorithm of Gas Pressure Regulator Based on Compressed Sensing Theory

Yinxing Dong Beijing Univ.of Civil Engi. and Architecture
Huaixiu Wang Beijing Univ.of Civil Engi. and Architecture
Yahui Wang Beijing Univ.of Civil Engi. and Architecture
Fangwen Chen Beijing Univ.of Civil Engi. and Architecture

In order to diagnose a fault in gas pressure regulator, this paper presents a new fault diagnosis method based on the compressed sensing theory. The key is to boil down the fault classification into a problem of representing a testing sample as a sparse linear combination of the training samples, and the diagnosis algorithm based on the compressed sensing theory is applied to the gas pressure regulator. Four different fault statuses of the gas pressure regulator were diagnosed by using the l classifier. The experimental results showed that the method of using sparse representation can achieve good diagnostic results. The accuracy rate of the classification was 92.8%, the operation time of the diagnosis was 0.5924s, the method is appropriate for the diagnosis of a gas pressure regulator fault with small specimen data.

14:15-14:30 **MonB02-2**

A New Flame Segmentation Algorithm Based Color Space Model

Liu Yang Beijing Univ. of Civil Engi. and Architecture
De Zhang Beijing Univ. of Civil Engi. and Architecture

Yahui Wang Beijing Univ. of Civil Engi. and Architecture
Flame image segmentation is an important prerequisite for fire characteristics and recognition, the segmentation results will affect the accuracy of fire identification. This paper proposes a flame segmentation algorithm merging 2-dimension Otst and seed region growth on HSI color space. After many texts it confirmed that the new flame segmentation algorithm doesn't only overcome interference the light source reflection area and smoke area in fire image, but also quickly segment the relatively complete suspected fire area.

14:30-14:45 **MonB02-3**

Smart City Construction Practices in BFSP

Qiacai Chen Beijing Future Science Park
Wei Zhang Beijing Future Science Park
Rong Zhou Beijing Future Science Park
As a national smart city pilot zones, BFSP (Beijing Future Science Park) promote urban development and modernization through the smart city construction. The construction of smart BFSP city is based on the city information infrastructures and resources, and incorporates the new ICT technologies to meet the demands of government, enterprises and citizens in the park.

14:45-15:00 **MonB02-4**

Simulation Design of Stereo Garage

Kaikai Yan Beijing Univ. of Civil Engi. and Architecture
Yahui Wang Beijing Univ. of Civil Engi. and Architecture
At present, with the increasing number of vehicles in the city parking problem becomes more and more prominent. Therefore, people propose the design of stereo garage based on PLC control. The main principle of stereo garage is by PLC in all kinds of sensor switch control linkage and controls the comb type mechanical carts and carrier plate to complete a series of actions. Users only need to drive into the entrance, through the operation board to issue instructions to complete the parking. It has a high efficiency, safe and convenient advantages also greatly improve the space utilization, in solving the problem of urban parking difficult to have a great role in promoting.

15:00-15:15 **MonB02-5**

Intelligent Gas Pressure Regulator Control System

Chao Lu Beijing Public Utility Science Institute
Lisheng Chen Beijing Public Utility Science Institute
Beijing Gas Group Institute
Jinfeng Liang Beijing Gas Group Institute
Guanjuan Peng Beijing Public Utility Science Institute
Ruizhi Zhou Beijing Public Utility Science Institute
Intelligent gas regulator control system is an innovation in the situation of constantly enhancing the precision and management requirement of gas equipment control system, which integrates and optimizes production and operation information-based system and improve production management "cloud platform". Control platform can realize real-time acquisition of field data, monitor the field operation state, remote control, diagnose, analyze the fault and give an alarm. In addition, through statistics of historical data, the control platform can integrate the system data and enhance the efficiency of production and operation, and thus effectively saves the manpower, material and financial resources required by maintaining the field.

15:15-15:30 **MonB02-6**

Design and Simulation of Building Fire Protection System Based on BIM Technology

Yang Gao Beijing Univ.of Civil Engi. and Architecture
Huijie Xue Beijing Univ.of Civil Engi. and Architecture
This paper is aimed at discussing the BIM technology application in the field of fire protection system. The application has solved the problem of repetitive modeling for fire system simulation. Through the IFC standard to achieve the purpose of multi-platform information exchange and sharing, and improve the quality and efficiency of the building fire all the work.

15:30-15:45 **MonB02-7**

Research on BIM Database Based on Point Cloud Model

Nanxin Huang Beijing Univ.of Civil Engi. and Architecture
Jia Wang Beijing Univ.of Civil Engi. and Architecture
With the high demand, the increasing demand for large-scale construction projects, people seeking to build BIM database to achieve the conversion and sharing of building information. In this paper, based on the point cloud model BIM database, based on the point cloud model BIM database development ideas and obstacles, which can improve the accuracy of model information and make the information model more convenient.

15:45-16:00 **MonB02-8**

A Preprocessing Method of AdaBoost for Mislabeled Data Classification

Xiangyang Liu Shandong Zaozhuang Experimental High School
Yaping Dai Shandong Zaozhuang Experimental High School
Yan Zhang Shandong Zaozhuang Experimental High School
QiaoYuan Shandong Zaozhuang Experimental High School
Liuhui Zhao Beijing Union Univ.
AdaBoost is one of the most popular algorithm for classification and has been successfully used for text classification, face detection and tracking. However noise sensitivity is regarded as a major disadvantage and previous works show that AdaBoost will be overfitting when dealing with the data sets with noisy data. To improve the noise tolerance of conventional AdaBoost, this paper proposed a preprocessing method of AdaBoost for mislabeled data to find the noisy data and correct it. Further decision stump is selected as the weak learner of the AdaBoost algorithm for classification. The comparison of simulation results between conventional AdaBoost and the method proposed in this paper shows that the proposed algorithm has improved testing accuracy of the data sets with the noisy data.

MonB03 Room03
Optimal control and optimization (VI) 14:00-16:00

Chair: Chong Lin Qingdao Univ.
CO-Chair: Lizhen Shao University of Science and Tech.

14:00-14:20 **MonB03-1**

Computing reachable sets for linear discrete systems with bounded input

Chao Wang University of Science and Technology Beijing
Lizhen Shao University of Science and Technology Beijing
Guanda Hu Shanghai Univ.
Yadong Xu University of Science and Technology Beijing
In this paper, an approximation method of reachable sets for linear discrete systems with bounded input is proposed. The method finds boundary points of reachable sets by solving finite convex optimization problems. It not only constructs an inner approximation bounding but also an outer approximation bounding. Two numerical examples are used to demonstrate the validity of the algorithm. Compared to a recent Lyapunov-Krasovskii functional based approach, our method obtains much tighter bounding sets.

14:20-14:40 **MonB03-2**

Study on Interception Control Strategies with Zero Effort Miss

ZhongCheng Mu ShangHai Engineering Center for Microsatellite
JinLing Qi ShangHai Engineering Center for Microsatellite
Dong Ye Harbin Institute of Tech.
Keke Zhang ShangHai Engineering Center for Microsatellite
in the present paper the terminal orbital control in the satellite pursuit-evasion game was studied, where the orbital maneuver with using limited magnitude continuous thrust was involved for both the interceptor and target. Since considering the terminal application scenario the high nonlinear interception dynamics could be reduced to the CW equations. Based on the reduced CW equation, zero effort miss was proposed to obtain the orbit control strategy. And with adding the fuel consumption the controller was built. Finally, the proposed method was validated by the numerical simulation, and the advantage and weakness of the proposed control strategy was analyzed.

14:40-15:00 **MonB03-3**

The Optimal investment Strategies for University Endowment Funds Based on Principle Component Analysis

Haochen Zou Shenyang Jianzhu Univ.
Weiwei Liu Shenyang Sport Univ.
Dexin Zou Shenyang Sport Univ.
The paper is to establish a feasible evaluating indicator system for university endowment funds based on principle component analysis. According to information provided by the reference index system from nearly 8000 schools were selected, the 16 indicators were proposed and 1340 schools were selected as the alternative school for investment objectives. By using data envelopment analysis (DEA), 30 schools were selected to invest from 1340 schools, and the optimal investment strategies of those 30 schools in the next five years were given. For the non DEA effective decision-making units in data envelopment analysis, T projection transformation in the efficiency frontier were used, which made the point input and output combined to be data envelopment analysis efficiency. The model was applied to the investment for University Endowment Funds, which verified effectiveness and advantage.

15:00-15:20 **MonB03-4**

Midcourse Trajectory Optimization Method with Strong Velocity Constraint for Hypersonic Target Interceptor

Danxu Zhang Air Force Engineering Univ.
Yangwang Fang Air Force Engineering Univ.
Pengfei Yang Air Force Engineering Univ.
For intercepting the hypersonic target head on, the velocity of the hypersonic target interceptor besides angle, and attitude, are the key points at hand-over time. Trajectory optimization is a practical method to provide satisfied states for the interceptor. To decrease the large relative velocity at the hand-over time, and satisfy the angle and attitude constraints, this paper presented the hp-adaptive pseudospectral method to obtain the optimal trajectory of the interceptor. Firstly, specifically longitudinal plane motion equations for the interception are established, including the constraints on path parameters and terminal conditions are modeled. Secondly, using the hp-adaptive pseudospectral method, the optimal problem is converted to a nonlinear programming problem with a series of algebraic constraints. Then the hp-adaptive strategy and algorithm flow are presented. Simulation shows that the midcourse trajectory optimization method obtains the satisfied trajectory and terminal states. On the other hand, the results approach to the fact that the hp-adaptive pseudospectral method is more efficiency and accuracy

than conventional optimization method. The paper's work provides a solid basis for breaking through the difficulty of the HTI intercepting the hypersonic target head on.

15:20-15:40 **MonB03-5**

Research on Optimization Control of the Hovercraft-Engine-Propeller Matching

Yuanhui Wang Harbin Engineering Univ.
Fang Zhang Harbin Engineering Univ.
Chenglong Wang Harbin Engineering Univ.

The hovercraft usually consumes a large amount of fuel in navigation, so this paper will analyze engine-propeller matching problem of dynamic hovercraft to achieve the purpose of saving energy. By using the method of predictive control, the fuel quantity of gas turbine and the pitch of controllable-pitch propeller for the hovercraft have been jointly controlled. Through adjusting engine and propeller operation parameters reasonably, it can achieve engine-propeller matching and optimization control of dynamic working condition of hovercraft. Finally, dynamic working condition matching process and optimization control simulation of hovercraft has been carried out and receive satisfying simulation results.

15:40-16:00 **MonB03-6**

Hybrid Path-following Method for Solving Static Output Feedback Problems

Jian Chen Qingdao Univ.
Qingdao Technological Univ.
Chong Lin Qingdao Univ.
Bing Chen Qingdao Univ.
Ying Guo Zaozhuang Univ.

This paper studies the path-following method for solving static output feedback (SOF) problems. In order to find initial values for the method, a new linear matrix inequality (LMI) based iterative algorithm is given by a new stabilization criterion. Then, the convergence of the improved path-following method (IPFM) is proved. Based on the above two parts, a hybrid path-following method (HPFM) is proposed and it is extended to solve the SOF H∞ controller design problems. The effectiveness and merits of the proposed method are shown through several examples.

MonB04 **Room04**
Fractional Calculus and Fractional-order Systems (IV) **14:00-16:00**

Chair: Yong Wang Univ. of Science and Tech. of China
CO-Chair: Yiheng Wei Univ. of Science and Tech. of China

14:00-14:20 **MonB04-1**

Fractional Order L'Hopital's Rule

Yiheng Wei Univ. of Science and Tech. of China
Songsong Cheng Univ. of Science and Tech. of China
Yuquan Chen Univ. of Science and Tech. of China
Yong Wang Univ. of Science and Tech. of China

Inspired by the birth of fractional calculus, this paper ties fractional calculus to L'Hopital's rule. This yields ˆ augmentations of L'Hopital's rule, for the indeterminate form of type ˆ 0/0 and ∞/∞ cases. By mean of the $\varepsilon-\delta$ language, an instructive proof is provided, which can treat the 0/0 and ∞/∞ cases in a parallel fashion. The presented results may evoke a deeper understanding of the limit concept.

14:20-14:40 **MonB04-2**

An Improved Image Denoising Algorithm Based on Adaptive Fractional Integral

Jingxue Sun Changchun Univ. of Science and Tech.
Chunyang Wang Changchun Univ. of Science and Tech.
Xuelian Liu Changchun Univ. of Science and Tech.
Huanhuan Xi , CSIC Shenyang LIAOHAI lift Co.,Ltd

In order to improve the effect of image denoising, in the background of the salt and pepper noise, we proposed an improved adaptive image denoising algorithm based on adaptive fractional integral in this paper. First of all, the noise points was detected by the method that detect salt & pepper noise based on the number, the noise image is divided into the flat area, the image edge and the noise points in three parts. Then use the discriminate function of "noise-edge" to do the second detection to the noise points and edge points which is detected in the first step. At the same time, adaptive fractional order was constructed according to the local statistical information and the structural characteristics. In the end, do the denoising to those suspicious noise points with the fractional integral mask. Compared with the traditional fractional integral denoising algorithm, MATLAB experiments show that the proposed adaptive algorithm effectively preserve the noise points and edge points that are misjudged and and realize adaptive the fractional integral order. The adaptive algorithm can not only remove the noises largely but also keep the edges and texture details well.

14:40-15:00 **MonB04-3**

Decentralized robust H∞ controller design for fractional order interconnected systems with element-bounded uncertainties

Fuzheng Chen Shanghai Jiao Tong Univ.
Junguo Lu Shanghai Jiao Tong Univ.
Yubin Miao Shanghai Jiao Tong Univ.

In this paper, the decentralized H∞ control problem for the fractional order interconnected systems with element-bounded uncertainties is investigated. A sufficient condition for designing the decentralized state feedback controllers, which guarantees that the fractional order closed loop interconnected systems are asymptotically stable and satisfy a prescribed H∞ performance, is derived and transformed into the solvability problem of linear matrix inequalities. Furthermore, the gains of the decentralized state feedback controllers are optimized as low as possible by solving the convex optimization problem with linear matrix inequality constraints. A simulation example is given to demonstrate the validity of the proposed approach.

15:00-15:20 **MonB04-4**

Fault detection observer design for fractional-order systems

Wei Zhong Shanghai Jiao Tong Univ.
Junguo Lu Shanghai Jiao Tong Univ.
Yubin Miao Shanghai Jiao Tong Univ.

The aim of this paper is to investigate the fault detection observer design problem for fractional-order systems. Firstly, the performance index H−/H∞ of integer-order systems is generalized to fractional-order systems, and the fault detection problem is formulated as designing a fault detection observer subject to three conditions: system stability condition, fault sensitivity condition and disturbance robustness condition. Secondly, two theorems about the performance index H−/H∞ are given and then the sufficient condition for designing the fault detection observer subject to the above three conditions is derived in terms of linear matrix inequalities. Finally, an illustrative example demonstrates the validity of the proposed theoretical results.

15:20-15:40 **MonB04-5**

Robust H-infty Analysis and Control of Fractional-order Systems with Convex Polytopic Uncertainties

Fengming Xie Shanghai Jiao Tong Univ.
Junguo Lu Shanghai Jiao Tong Univ.
Yunan Zhao Shanghai Jiao Tong Univ.
Yubin Miao Shanghai Jiao Tong Univ.

In this paper, the problem of robust H∞ analysis and control of fractional-order linear time-invariant systems subjected to polytopic uncertainties are investigated. A sufficient condition for the H∞ performance analysis of fractional-order polytopic systems is established in terms of linear matrix inequalities via the H∞ bounded real lemma for commensurate fractional-order systems. Based on this condition, a LMI method for the design of robust H∞ controller is obtained. Next, a less conservative condition for the H∞ performance analysis of such systems is introduced. Finally, two different numerical examples are provided to demonstrate the effectiveness of the proposed approaches.

15:40-16:00 **MonB04-6**

Fractional Order Controller Design for a Semi-Active Suspension System using Nelder-Mead Optimization

Waqas Mehmood Baig Tsinghua Univ.
Zhichao Hou Tsinghua Univ.
Salman Ijaz Beihang Univ.

This paper presents application of a fractional order controller for a semi-active suspension system integrated with magnetorheological fluid damper. A quarter-car model is used in this research and only vertical motion of the vehicle is considered. In order to control the nonlinear behavior of the magnetorheological fluid damper (MRD) to achieve the optimal suspension performance, two controllers are designed for the whole system, namely a system controller and a damper controller. A fractional order proportional integral derivative (PID) controller is used as the system controller and a continuous state controller is employed as the damper controller. The Nelder-Mead optimization is adapted to tune the controller parameters according to the desire performance criteria. Simulation results clearly show effectiveness of the proposed controllers as compared to a passive system and a traditional PID controlled MRD suspension system.

MonB05 **Room05**
IntelliSense and Advanced Sensing, Detection Technology (IV) (Chinese) **14:00-16:00**

Chair: Dihua Sun Chongqing Univ.
CO-Chair: Yanan Zhang Northeastern Univ.

14:00-14:20 **MonB05-1**

Traffic Congestion Pattern Detection Using an Improved McMaster Algorithm

Dihua Sun Chongqing Univ.
Cheng Zhang Chongqing Univ.
Min Zhao Chongqing Univ.
Linjiang Zheng Chongqing Univ.
Weining Liu Chongqing Univ.

Traffic congestion has been an important problem all over the world. Advanced transportation management system (ATMS) that provides information for traffic control and management addresses this problem. McMaster Algorithm, one of the most classical congestion detection algorithms, has been widely used in practice. However, it still has some limitations such as difficulty of determining its parameters which are lower bound of uncongested data (LUD), critical occupancy (Ocrit) and critical volume (Vcrit). This paper transforms this problem to be an optimization problem and presents a new method that integrates gradient descent algorithm and particle swarm optimization algorithm (GPSO), with which parameters of McMaster Algorithm are extracted from the occupancy and volume of the detector. Thus it can determine the parameters of

McMaster Algorithm more quickly and precisely. The parameters of McMaster algorithm are validated with real data from Yuwu Expressway in Chongqing. The results show that GPSO can help operators find the best parameters more effectively and make McMaster Algorithm yield a higher accuracy rate and recall rate.

14:20-14:40 **MonB05-2**

Leakage Detection of Pipeline Based on Weighted-Permutation Entropy

Jinfeng Gao Zhejiang Sci-Tech Univ.
Keyu Chen Zhejiang Sci-Tech Univ.
Ping Wu Zhejiang Sci-Tech Univ.
Liang Chen Zhejiang Sci-Tech Univ.
Peifeng Lin Zhejiang Sci-Tech Univ.

The recognition of abnormal dynamic pressure wave signal is key to pipeline leakage detection. Permutation entropy algorithm can effectively amplify slight changes of time series data and has advantages of easily computing and good performance in change detection. The weighted-permutation entropy which is based on the permutation entropy considers the amplitude information. In this study, the weighted-permutation entropy is utilized to detect the pipeline leakage. To prove the effectiveness of the method, typical experiments are performed on the test platform. Results show that the weighted-permutation entropy method can successfully detect the pipeline leakage.

14:40-15:00 **MonB05-3**

Highway Traffic Abnormal State Detection Based on PCA-GA-SVM Algorithm

Zhao Min Chongqing Univ.
Liu Yanlei Chongqing Univ.
Sun Dihua Chongqing Univ.
Cheng Senlin Chongqing Univ.

In the highway traffic abnormal state detection, Support Vector Machine (SVM) algorithm is widely researched in recent years, but it still has some limitations. Aiming at the problem of improper selection of feature vector, the space and time characteristics of highway traffic abnormal state data is summarized, and the feature vectors of SVM are selected by Principal Component Analysis (PCA) properly. To solve the model parameters selection problem, the theory of Genetic algorithm (GA) is used to select SVM model parameters effectively. Also two-class SVM classification is extended to multi-class SVM classification which has a better command of the traffic running state on highway. According to the severity of the traffic incident, the traffic is divided into the state of no event, the state of mild congestion and severe congestion. The test software of SVM algorithm and the improved one are developed by using MATLAB and LIBSVM tool. The experimental result shows that the improved algorithm has a higher accuracy and a higher detection rate.

15:00-15:20 **MonB05-4**

Perpendicularity Identification Method of Image-based Welding of Components

Rongbao Chen Hefei Univ. of Tech.
Tianze Fei Hefei Univ. of Tech.
Honghui Jiang Hefei Univ. of Tech.

For the purpose of accurately inspecting and measuring perpendicularity of column elements on circuit board, a sub-pixel position technology-based perpendicularity identification method which combines centroid registration of edge contour is proposed. This method, first obtains element's pixel edge of pre-treated pictures using improved Canny algorithm, then rejects noise point and interference edge through edge track method and numbers the elements at last. The element's sub-pixel edge is obtained at the edge subject to crude extraction with the aid of Zernike moment algorithm. On the basis of this, the minimum circumscribed rectangle of the element's contour is obtained to correct the edge and get the areal coordinate. Perform registration between the centroid of the element on PCB board for test purpose and the standard centroid, so as to inspect and measure perpendicularity of each element according to displacement of the centroid. Experience has shown that the method mentioned herein can not only measure the welding skew but also is complete with high identification accuracy.

15:20-15:40 **MonB05-5**

Color Recognition and Dynamic Decision-making Model of 6 Axis of Industrial Robot Based on Embedded System

Ligang Cai Beijing Univ.
Yingjie Liu Beijing Univ.
Zhifeng Liu Beijing Univ.
Congbin Yang Beijing Univ.

For the problem that industrial robot has a poor ability to perceive external environment, and not able to change the way of operation and path of transformation timely as working condition changes. This paper selects color sensor as the medium of recognition, introduces the embedded system Raspberry Pi to 6 axis industrial robot grabbing assignments, and puts forward a six axis industrial robot intelligent recognition model with color perception, dynamic decision-making and other multi-function. In the model, the color sensor signal will be resolved by color processing algorithm in embedded system, and consequently color information of material on the conveyor can be obtained. The color information after processing by the embedded system will be converted to digital signals. Then input the digital signal into robot controller. Finally, robot controller chooses corresponding motion path according to the input signal. The experimental results show that the six axis industrial robot intelligent recognition system can distinguish colors of material with almost 100% accuracy , and adjust operation way and path in 0.72 s time rapidly. Efficiency could be improved by more than 75%.

15:40-16:00 **MonB05-6**

Predicting Protein Subcellular Localization by Approximate Nearest Neighbor Searching

Wei Xue Nanjing Agricultural Univ.
Xiaoyu Hong Nanjing Agricultural Univ.
Rongli Yang Nanjing Agricultural Univ.
Nan Zhao Nanjing Agricultural Univ.
Liang Zhang Jiangnan Univ.

Protein subcellular location prediction is an important problem in bioinformatics. It is highly desirable to predict a protein's subcellular location from its sequence. We propose a novel prediction model combined with locality-sensitive hashing (LSH)-based approximate nearest neighbor searching (ANNS) and a global alignment dynamic programming algorithm. LSH was used to hash map protein sequence amino acid composition vector features, where sequences with similar features were placed into a hash bucket of corresponding key values in a hash table. Then, we determined similar sequences to the target sequence in the hash table, and compared them to the sequence of the closest Euclidean distance using the global alignment dynamic programming algorithm to predict the protein subcellular localization. Compared with other algorithms, this prediction model recorded relatively high overall accuracies on two benchmark datasets via jackknife testing, and it predicted target sequences quickly and effectively.

MonB06 Room06
Nonlinear systems (II) 14:00-16:00

Chair: Kang Wu Southeast Univ.
CO-Chair: Meng Li Central South Univ.

14:00-14:20 **MonB06-1**

Nonlinear Optimal Internal Model Control for AUVs under Wave Disturbances

Qing Yang Ocean Univ. of China
Hao Su Ocean Univ. of China
Jian Zhang Ocean Univ. of China
Gong-you Tang Ocean Univ. of China

A nonlinear optimal internal model control (NOIMC) for autonomous underwater vehicles (AUVs) under wave disturbances is designed. Firstly, nonlinear model of AUVs in vertical plane is obtained, and an exosystem model of wave disturbance is generated based on Hirom approximate formula. Secondly, a disturbances compensator is constructed based on the internal model principle such that the AUVs system with wave disturbances is transformed into an augmented system. Then, a NOIMC law with a compensation term is designed by the maximum principle and the successive approximation approach, which can realize the optimal control when the system has none disturbances; While the wave disturbance exists, this obtained NOIMC law can reject the disturbance with zero steady-state error because of the existence of the internal model. Finally, the effectiveness and feasibility of the NOIMC law is demonstrated by a numerical example of the Remote Environmental Unit (REMUS) AUV.

14:20-14:40 **MonB06-2**

A New Order Reduction Approach for Multidimensional Roesser Model Based on Real Eigenvalues

Dongdong Zhao Akita Prefectural Univ.
Shi Yan Lanzhou Univ.
Shinya Matsushita Akita Prefectural Univ.
Li Xu Akita Prefectural Univ.

In this paper, a new order reduction approach based on real eigenvalues will be proposed for Roesser statespace model of multidimensional (n-D) system. Compare with the existing order reduction approaches, the new order reduction approach can generate the Roesser model with a lower order. Moreover, corresponding examples are given to illustrate the details as well as the effectiveness of the proposed approach.

14:40-15:00 **MonB06-3**

Output Feedback Control Based on Extended State Observer for Nonholonomic Systems

Kang Wu Southeast Univ.
Changyin Sun Qufu Normal Univ.

The adaptive output feedback controller is proposed for nonholonomic systems with nonlinear uncertainties and external disturbances. The disturbance is as the generalized system state. An extended state observer is designed for the uncertain external disturbance in order to ensure the global asymptotical stability of the closed loop system. A novel observer/estimator is introduced for state and unknown parameter estimates. The integrator backstepping technique based on a constructive recursive is applied to the design of the output feedback adaptive controller. The numeric simulation example validates the effectiveness of the proposed method.

15:00-15:20 **MonB06-4**

Output Feedback Stabilization Design of PVTOL Aircraft Based on a Finite-time Observer

Juan Zhang Central South Univ.
Meng Li Central South Univ.
This note considers output feedback stabilization design of PVTOL aircraft without velocity measurements. When the model states are recovered by the observer, a saturation technique is used to construct the controller. Without using backstepping, the controller is simple and the global convergence analysis is straightforward. The effectiveness of the algorithm is illustrated by simulation results.

15:20-15:40 **MonB06-5**

The Design of Delay-Dependent Wide-Area Reduced-Order Dofc with Prescribed Stability Degree for Damping Inter-Area Low-Frequency Oscillations in Power System

Miaoping Sun Central South Univ.
Jun Zhang Central South Univ. of Forestry and Tech.
Xiaohong Nian Central South Univ.
Wenyan Tang Hunan Univ. of Tech.
In this paper, the delay-dependent reduced-order wide-area dynamic output feedback controller (DOFC) with prescribed stability degree is put forward for interconnected power system to damp inter-area low-frequency oscillations. Here, the concept of prescribed stability degree □ is applied to maintain all the poles on the left of □ = −□ in the complex plane. The participation factor method is adopted to select input-output control signals and the Schur model-reduction method is used to obtain the equivalent low-order power system model. The sufficient conditions of asymptotic stability for closed-loop power system with prescribed stability degree are derived based on Lyapunov stability theory and transformation operation in complex plane. In addition, a novel and relatively simple LMI-based method is presented to obtain the parameters of wide-area reduced-order DOFC and calculate the upper bound of transmission delay in wide-area signals. Case studies are carried out on the two-area four-machine system and the effectiveness and advantages of the proposed method are verified by the simulation results under different operating conditions.

15:40-16:00 **MonB06-6**

Exact Regulation for Disturbed Nonlinear Systems with Unfixed Output and Uncontrollable/Unobservable Linearisations

Chuanlin Zhang Shanghai Univ. of Electric Power
Pengfei Song Shanghai Univ. of Electric Power
Jun Yang Southeast Univ.
Xitong Niu Shanghai Univ. of Electric Power
The problem of exact regulation control for a class of disturbed higher-order nonlinear systems with unfixed single output and uncontrollable/unobservable linearisations is investigated in this paper. A general composite controller is proposed by integrating the homogeneous domination technique with an observation process of the unmatched disturbances. Inheriting a recursive dsign procedure and a delicate way of handling the non-vanishing nonlinearities, it is shown that unmatched disturbances in every channel can be compensated in a series of composite virtual controllers design while a state assigned as the system output can be regulated to exact tracking its desired value. A rigorous Lyapunov function based stability analysis and numerical simulations assure the effectiveness of the proposed strategy.

MonB07 **Room07**
Discrete event systems (I) **14:00-16:00**
Chair: Fuchun Liu Guangdong Univ. of Tech.
CO-Chair: Lijun Sun Qingdao Univ. of Science and Techn.

14:00-14:20 **MonB07-1**

A Decision-Tree-Based Approach for Correctability of Stochastic Discrete-Event Systems

Fuchun Liu Guangdong Univ. of Tech.
Rixiang Mo Guangdong Univ. of Tech.
This paper aims to investigate the correctability of stochastic discrete-event systems (DESs) equipped with a probabilistic structure to estimate the likelihood of events occurring. The notion of $k$step corrective probability is formalized by using the representation of decision trees to describe the possibility that the stochastic system may recover to accepted states from the current state within k steps. By introducing the strategy of adjusting the transition probability of the current state, a correction mechanism is presented for stochastic systems to achieve the maximal $k$step corrective probability. In addition, an approach for the computation of supremal corrective probability is developed by constructing the decision tree after introducing the infinitely expandable states. Finally, an illustrative example is provided.

14:20-14:40 **MonB07-2**

Solving Ordinary Differential Equations by ZFD Formula 4NgSFD

Yunong Zhang Sun Yat-sen Univ.
Huanchang Huang Sun Yat-sen Univ.
Penghao He Sun Yat-sen Univ.
Min Yang Sun Yat-sen Univ.
Jianfeng Wen Sun Yat-sen Univ.
Guangdong Polytechnic Normal Univ.
In this paper, a new Zhang finite difference (ZFD) formula with higher accuracy, termed 4-node g-square finite difference (4NgSFD), is presented and applied to solving ordinary differential equations (ODEs). Such a method is thus considered as ZFD 4NgSFD method. For comparison, the conventional Euler method is also presented. In addition, numerical experiments are carried out, of which the results substantiate that the accuracy of ZFD 4NgSFD method is indeed higher than that of Euler method for solving ODEs. Note that the presented ZFD 4NgSFD method can be applied in ODE numerical solver software.

14:40-15:00 **MonB07-3**

New ZFD (Zhang Finite Difference) Formula 4IgSFD_L for Time-Varying Reciprocal and Inverse Computation

Yunong Zhang Sun Yat-sen Univ.
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SYSU-CMU Shunde International Joint Researc h Inst.
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Time-varying reciprocal and inverse computation are considered as fundamental problems in scientific and engineering fields, which are more complicated than static computation. Continuous-time Zhang dynamics (CTZD) model is a powerful method for such complicated situations. To obtain a discrete-time Zhang dynamics (DTZD) model, a new formula of 4-instant g-square finite difference (4IgSFD L) is proposed in this paper. Note that the formula has a truncation error of $O(g^2)$, where g denotes the sampling gap. With the aid of the formula 4IgSFD L, the 4IgSFD L-type DTZD model is obtained. The 4IgSFD L-type DTZD model has a high calculative precision with truncation error of $O(g^3)$. Through numerical experiments, the convergence and stability of 4IgSFD L-type DTZD model are illustrated via time-varying reciprocal and inverse computation.

15:00-15:20 **MonB07-4**

A Hybrid Petri Nets Approach for Railway Systems

Liewei Wang Anhui Provincial Key Laboratory of Public Safety Emergency Information Tech
Yuyin Wang 92270 Naval Forces Command
Gang Liu Dongfang Electronics Co., Ltd.
Xu Wang Univ. of Zaragoza
Railway systems are usually hybrid, huge and complex, composed by both discrete events and continuous properties. Therefore, we need a compact and effective method to model and analyze them. In this work we propose a hybrid Petri nets approach. We first provide the method of modelling the basic elements such as segments, switches; then, a bottom-up procedure is proposed to build a complete railway system. Enumerative analysis is performed and algorithms for constructing the reachability graph are provided. Different from previous works that mostly only consider discrete states of the model, we also emphasize continuous parameters, such as speeds, times and positions. Segment agents and connection agents are introduced to manage the state evolvement of the system, and ensure that the railway network is in a safe condition.

15:20-15:40 **MonB07-5**

Analysis of Type III System Model with Failed Service in Hybrid Star Sensor Networks

Lijun Sun Qingdao Univ. of Science and Techn.
Sha Li Qingdao Univ. of Science and Techn.
In recent years, wireless sensor networks have been applied in many application areas. For some fields that have special timing requirement, only wireless sensor networks can not satisfy the needs of high speed communication. We propose a hybrid wired-cum-wireless sensor network by introducing the Contention-Collision Cancellation (C-CC) access control mode, which is an important access control mode in star network. As the backbone network, C-CC star network has good scalability and apt to achieve high speed communication by connecting fiber. C-CC access control mode is divided into six system models, whose mathematical modeling have been almost finished for star network with one server. However, due to the difficulty and complexity of the type III system model, its analysis was based on a simplified model, in which all services were considered as error free. In this paper, the considerate type III system model under general circumstances including failed service is discussed. The customer state transfer probability, average queue length, and the average service time are given. At last, we evaluate the performance of this system through the numerical calculation. The conclusion not only consummates the mathematical modeling for single-star network, but also provides the overall reliable theoretical foundation to the application of star network.

15:40-16:00 **MonB07-6**

Decentralized Predictability of Discrete Event Systems

Fuchun Liu Guangdong Univ. of Tech.

In this paper, the decentralized predictability of discrete event systems (DESs) is investigated. The notion of copredictability of DESs is formalized under the decentralized framework to capture the feature of copredictable DESs that the occurrences of failure events can be predicted in advance based on at least one local observation. The relationships with the notions of predictability and codiagnosability of DESs are analyzed. It is deducted that copredictability is weaker than predictability but stronger than codiagnosability. In order to achieve the performance of the prediction, the copredictor is constructed from a given decentralized system, in which a family of local prediction components are employed to deal with the local observations. In particular, a necessary and sufficient condition for the copredictability of DESs is presented, which generalizes the main results of predictability of DESs from the centralized framework to the decentralized case.

MonB08 Room08
Hybrid systems (II) 14:00-16:00

Chair: Enchang Cui Northeastern Univ.
CO-Chair: Le Zhang Shenyang Univ.

14:00-14:20 **MonB08-1**

Backstepping Design for Adaptive Control of A Class of Switched Nonlinear System

Enchang Cui Northeastern Univ.
Yuanwei Jing Northeastern Univ.
Xiaoting Gao Northeastern Univ.

In this paper, the tracking control problem of nonlinear switched system under arbitrary switched signals is resolved. Adaptive backstepping control technique is introduced and its control effect with accurateness and speedability is attained, in order to deal with nonlinear lower triangular switched system with uncertain parameters. First, adaptive law and the corresponding tracking controller is provided under arbitrary switched signals, the proof of stability is presented as well. Then, the mathematical model of motor in form of lower triangular is established based on asymptotic tracking control method, simulation case of BLDCM is given in the meantime. Finally, simulations and analyses of adaptive law and the corresponding controller have verified the proposed method.

14:20-14:40 **MonB08-2**

Stability Analysis for Continuous-Time Descriptor Semi-Markov Jump Systems Subject to Actuator Saturation

Yi Zhou Shandong Univ.
Shuping Ma Shandong Univ.

In this paper, the stability of the continuous-time descriptor semi-Markov jump systems with actuator saturation is discussed. First, with the infinitesimal generator for stochastic Lyapunov function of descriptor semi-Markiov jump systems, lower and upper bounds of the time-varying transition probability, and the singular value decomposition approach, two sufficient conditions are obtained to guarantee this kind of systems are stochastically admissible. Then, based on the above conditions, the design of state feedback controller is developed by solving the linear matrix inequalities (LMIs) optimization problem. Last, a numerical example is given to illustrate the effectiveness of the proposed methods.

14:40-15:00 **MonB08-3**

State Feedback Reliable Control for a Class of Switched Fuzzy Time-delay systems

Le Zhang Shenyang Univ.
Chen Guan Shenyang Univ.
Xuejia Shi Shenyang Univ.
Zhi Li Shenyang Univ.

The reliable control of a class of switched fuzzy (SF) time-delay systems containing faulted actuator is presented. A switched fuzzy system with a Takagi and Sugeno (T-S) fuzzy model, which differs from existing ones, is employed to describe a nonlinear system. The actuator is serious failure and the residual part of actuator cannot make original system stable, state feedback reliable controller of each subsystem is built to ensure the relevant closed-loop switched fuzzy time-delay system is asymptotic stability by using switching technique and Lyapunov function method. Using switching technique depend on the states of SF time-delay systems , the conditions for asymptotic stability of closed-loop switched fuzzy systems are obtained in terms of linear matrix inequality. A Simulation result shows the feasibility and the effectiveness of the design method.

15:00-15:20 **MonB08-4**

Optimal Control of Switching Time in Discrete-Time Switched Autonomous System with Different Costs

Xiaomei Liu Shandong Normal Univ.
Shengtao Li Shandong Normal Univ.
Chuan Ji Shandong Jiaotong Univ.

This paper considers the optimal switching time control problem for discrete-time switched autonomous systems. The controlled parameter consists of the switching times, and the cost functional is defined on the state and performance cost functions are different in different time-intervals. Based on calculus of variations, an approach to finding the optimal switching times is proposed. Firstly, we derive the difference of the cost with respect to the switching time for one switching time case. Then, we propose an approach to deal with the problem with multi-switching times case. The obtained difference formulas have an especially simple form and can be directly used to locate the optimal switching instants. Finally, the validity of the proposed method is demonstrated by a numerical example.

15:20-15:40 **MonB08-5**

Switching Control for a Class of Discrete-time Switched Fuzzy Systems

Hong Yang Shenyang Univ.
Yanting Chen Shenyang Univ.
Kai Ji Shenyang Univ.
Wenyu Shen Shenyang Univ.
Yang Chen Shenyang Univ.

In this paper, a new stabilization criterion for discrete-time switched fuzzy (DTSF) systems is proposed. DTSF system, which differs from existing ones, can often more precisely describe continuous dynamics and discrete dynamics as well as their interactions in complex real-world systems. In the beginning, the operation state space of every switched subsystem for this class of systems is divided into several subregions, and then, the interactions among the switched subsystem in each subregion ir S_{ir} are presented by one matrix ir X_{ir}. So the feasible solutions of the inequalities in the criteria are much easier to be found. In other words, the criteria are much more relaxed than the existing criteria proposed in other literature. Moreover switching techniques are used to derive the criteria, some subsystems are allowed to be unstable. Finally, the elaborated illustrative examples and the respective simulation experiments demonstrate the effectiveness of the proposed method.

15:40-16:00 **MonB08-6**

Stability of A Semi-linear Stochastic Differential System with Switching and Impulse

Xingcheng Pu Chongqing Univ. of Posts and Telecommunications
Yuling Zhang Chongqing Univ. of Posts and Telecommunications
Xuegang Tan Chongqing Univ. of Posts and Telecommunications

This paper formulates and studies a kind of semi-linear stochastic differential systems with switching and impulse. By using switching Lyapunov function approach、Ito formula、impulsive differential inequality method and linear matrix equality techniques, we obtain pth moment globally asymptotically stability, pth moment globally exponentially stability and mean square stability criteria for such system. Numerical examples show the validity of the obtained results.

MonB09 Room09
Sensor network systems (II) 14:00-16:00

Chair: Wei Gao Jilin Univ.
CO-Chair: Quanbo Ge Hangzhou Dianzi Univ.

14:00-14:20 **MonB09-1**

An Improved DV-Hop Algorithm Based on Average Hop Distance and Estimated Coordinates

Wei Gao Jilin Univ.
Yue Sun Jilin Univ.
Wenjun Li Jilin Univ.
Wenqiang Wang Jilin Univ.

There is a big error in the classic DV-Hop localization algorithm in average hop distance and unknown point coordinates. We propose an improved DV-Hop location algorithm, by improving the average hop distance and introducing a checkout algorithm in the second and third stages of the classic DV-Hop localization algorithm, to improve the position accuracy. The MATLAB simulation shows that in the same test situation, without significantly increasing calculating complexity and requiring additional hardware, the performance of the improved DV-Hop algorithm in wireless sensor network is better compared with the classic algorithm.

14:20-14:40 **MonB09-2**

A Novel Sensing Matrix Design Applied to Distributed Compressed Estimation in WSN

Fang Yang Zhejiang Univ. of Tech.
Donghai Bao Zhejiang Univ. of Tech.
Qianru Jiang Zhejiang Univ. of Tech.
Sheng Li Zhejiang Univ. of Tech.
Huang Bai Zhejiang Univ. of Tech.
Shuqin Guo Zhejiang Univ. of Tech.

We proposed a novel sensing matrix for compressed sensing (CS) based distributed compressed estimation (DCE) scheme. In traditional approaches for sensing matrix design, normalization of the column vectors is independent from optimizing mutual coherence. The proposed algorithm integrates these two processes into one framework, which gives the cost function a profound physical meaning. Applying this new sensing matrix design algorithm results in a higher reconstruction accuracy and a better realtime performance on channel estimation for a wireless sensor network (WSN), which is a development of DCE scheme via CS. Simulations show the higher reconstruction accuracy and shorter running time of DCE related to the new sensing matrix compared to the analysis existing approaches.

14:40-15:00 **MonB09-3**

Performance Indexes Analysis for Multi-Observation Platform System

Tianxiang Chen Hangzhou Dianzi Univ.
Quanbo Ge Hangzhou Dianzi Univ.
Weifeng Liu Hangzhou Dianzi Univ.
Zhuyun Niu North Automatic Control Tech. Inst. Taiyuan
Jinyan Ma Hangzhou Dianzi Univ.

Because of the more and more complex requirements of tracking environment, single-observation platform is difficult to deal with the challenges of the future war. Compare with it, the multi-observation platform can overcome the uncertainty and limitation through coordination and complementarity between the platforms. How to optimize the allocation of the limited sensor resources is a key problem in the platform management system. The existing evaluation indexes of multi-observation platform are based on its operating parameters and are designed under the precondition of given network topology. There is less research on the optimal allocation of multi-observation platform. In this paper we put forward three kinds including four evaluation indexes, for example the time-spatial coverage(time coverage and spatial coverage), the observation completeness and the platform security. The performance evaluation of the platform is obtained, by defining and relationship analysis of platform parameters. We try to provide some thoughts and ideas for the performance evaluation, construction and optimization of the multi-platform observation system.

15:00-15:20 **MonB09-4**

Transmission Performance Analysis ofWireless Sensor Networks under Complex Railway Environment

Ruifeng Chen China Academy of Railway Sciences
Tianyun Shi China Academy of Railway Sciences
Xiaojun Lv China Academy of Railway Sciences

Wireless sensor networks (WSNs) can be widely applied to the environmental monitoring and control systems in railway transportation industry. In this paper, an analytical framework is proposed to study the transmission performance of one-dimensional WSNs under complex railway environment. Specifically, the WSNs along the railway are comprised by two types of sensor nodes: the ordinary sensors and the powerful ones, of which the distributions both follow Poisson Point Process. Analytical results are obtained for the successful reception probabilities of both single-hop communication and end-to-end transmission under the composite channel model, which is the superposition of largescale fading and Nakagami fading channel. To be specific, we also derive the closed-form expression of successful reception probability in condition of the free space propagation with the path loss exponent $\alpha = 2$. A simulation platform is established to evaluate the impact of different factors on the transmission performance, and the analysis results are validated to be consistent with the simulations. The results in this paper can be applied to evaluate the transmission performance of WSNs and provide useful guidance for the network design under the railway scenarios.

15:20-15:40 **MonB09-5**

Networks Energy-Efficient Clustering Algorithm Based on Fuzzy Inference System

Ying Zhang Shanghai Maritime Univ.
Rundong Zhou Shanghai Maritime Univ.

Clustering routing algorithms have been widely used in Wireless Sensor Networks (WSNs) recently. However, relaying node with closer distance to cluster head will involve in higher data traffic and consume energy more quickly than the farther nodes, which may result in bad influence on load balancing in network system. Therefore, we proposed a fuzzy Logic based distributed energy-efficient clustering algorithm (FLDEEC). During cluster head (CH) election, we take nodes' energy, nodes' degree and neighbor nodes' residual energy into consideration as input parameters. Through fuzzy inference system, node uses its own information and its neighbor nodes' information to make a judgment to decide whether it fits to be a CH or not in a distributed way. FLDEEC algorithm can solve hot spot problem caused by communication in cluster, improve the efficiency of data transmission and extend the lifetime of the whole network by screening out nodes with bad conditions. The experimental results indicated that the FLDEEC algorithm is better than CHEF algorithm and DEEC algorithm in the aspects of data transmission, energy consumption and the number of living nodes.

15:40-16:00 **MonB09-6**

Networks Connectivity Recovery Method based on Finite State Machine

Ying Zhang Shanghai Maritime Univ.
Guan Hao Shanghai Maritime Univ.

The networks connectivity is a crucial factor to relay data among nodes, exchange data for collaboration and aggregation in wireless sensor networks (WSNs). However, in unattended and harsh environment, the connectivity is prone to be lost due to the failure of nodes. The network self-healing and fault-tolerance have increasingly become important. In this paper, aiming at decreasing the movement overhead, we propose a Distributed Connectivity Recovery Method on Finite state machine (DCRMF). The idea is that firstly we identify whether a node is a critical node, and then update the connected dominating set. If a failure node is critical, the nearest uncritical node will be relocated to replace the failure node. The simulation results indicate that this algorithm has better performance in the total moving distance and the number of the total relocate nodes compared with other connectivity recovery algorithms.

MonB10 Room10
Fault diagnosis and fault-tolerant control (IV) 14:00-16:00

Chair: Qingyu Yang Xi'an Jiaotong Univ.
CO-Chair: Lingya Meng China Univ. of Petroleum

14:00-14:20 **MonB10-1**

ELM-Based Adaptive Neural Estimation for Actuator Faults Detection and Diagnosis of Nonlinear Uncertain Systems

Qingyu Yang Xi'an Jiaotong Univ.
Yongqiang Nai Xi'an Jiaotong Univ.

Actuator, as a key component of control system, whose faults detection and diagnosis (FDD) is a complex problem due to system modeling uncertainty, so it is essential to propose advanced FDD scheme that accurately detects the faults. In this paper, we develop an actuator FDD scheme for a class of uncertain nonlinear systems based on extreme learning machine (ELM). In ELM, all parameters of hidden layer nodes need not be adjusted during learning, which may simply be assigned with random values, and the output weights only need to be adjusted. Within this scheme, two ELMs are employed to learn the unknown system function and unknown fault function. Firstly, a stable adaptive observer is designed to monitor faults in an online manner. Secondly, adaptive threshold is designed to make the fault detection, and deviation between the actual and the estimated system is known as residual. If the residual exceeds threshold at finite time denotes a fault occurrence. Different from the existing schemes, online computational efficiency and learning speed are improved considerably because ELM is introduced in this FDD scheme. Finally, a single-link robotic arm will be employed in simulation to illustrate the effectiveness of the proposed FDD scheme.

14:20-14:40 **MonB10-2**

Research on Fault-Tolerant Control Problem for Suspension System of Medium Speed Maglev Train

Le Jin National Univ. of Defense Tech.
Zhiqiang Long National Univ. of Defense Tech.
Jiewei Zeng National Univ. of Defense Tech.

With suspension control of the medium speed maglev train as the research background, a new suspension joint structure is proposed and an active fault-tolerant control algorithm based on state gain refactoring is designed by referring to the joint structure of high speed maglev train of German and the patent from Japan. The new structure connects the two adjacent bogies by mechanical structure, which not only increases the redundancy degree of the system but also takes the fault-tolerant control problem of the end bogie into account. Simulation demonstrates that the joint structure and its active fault-tolerant control method can increase significantly the fault-tolerant performance of suspension system, which can contribute greatly to engineering application.

14:40-15:00 **MonB10-3**

Integrated Active and Passive Fault-Tolerant Control for A Class of Non-linear Uncertain Systems with Time-varying Delay

Xuelian Yu China Univ. of Petroleum
Lingya Meng China Univ. of Petroleum

For a class of non-linear uncertain systems with time-varying delay, fault-tolerant controller design is investigated for the actuator faults, where the actuator faults including the cases of loss of effectiveness, bias faults, outage, and stuck faults. For more general consideration, the bias/stuck faults are assumed to be a state-dependent time-varying part and a constant part. The controller design combines the advantages of the active approach and passive approach. Designing the adaptive law, the actuator fault value is estimated on-line and the controller is designed to compensate the fault. Meanwhile, a fixed controller is designed to dealing with other stability effect factors. Based on the Lyapunov stability theory and linear matrix inequality (LMI), the stability of the closed-loop system is proved. The proposed methods have solved the stability decrease of the system that caused by the actuator faults, system uncertainties and time-varying delay of the state. Finally, the developed design techniques have been applied to an annealing furnace. The validity of this approach is also been demonstrated by simulation results.

15:00-15:20 **MonB10-4**

An Energy-based Nonlinear Pressure Observer for Electronically Controlled Pneumatic Brake Fault Diagnosis

Yingze Yang Central South Univ.
Lu Xiong Central South Univ.
Zhiwu Huang Central South Univ.
Kuo-Chi Lin Univ. of Central Florida

As widely used in the heavy-haul combined trains, electronically controlled pneumatic(ECP) brake is a highly nonlinear system. Heavy-haul combined train consists of variant freight trucks with different types and different load weights. When operating with brake mode, inconsistent braking forces will aggravate impacts of collisions between adjacent freight cars, especially uncertainty faults occur and the trucks in rigid connection mode. Therefore, it is necessary to conduct online fault diagnosis for ECP brakes. In this paper, an Lyapunov-based globally stable pressure observer for ECP brake is proposed. Firstly, according to the output value of the observer, a residual generator is designed and residual signals are evaluated with the Generalized Likelihood Ratio(GLR) method. Secondly, fault diagnosis can be achieved by GLR when system's faults happened. Finally, experimental results demonstrate and validate effectiveness of the proposed observer and algorithm.

15:20-15:40 **MonB10-5**

A Modified PCA-Based Approach for Process Monitoring

Jingxin Zhang Chinese Academy of Science
Hao Chen Chinese Academy of Science
Pinlong Cai Chinese Academy of Science

Principal component analysis (PCA) has been widely utilized for process monitoring owing to its simplicity, easy understanding and high efficiency in dealing with large numbers of process variables. Aimed at its disadvantages including relatively low detectability, this paper mainly presents a modified PCA (MPCA) approach based on the combination of the two test statistics for process monitoring. Thus, the monitoring chart will be reduced to one and the fault detectability will be improved. Then, several other PCA-based approaches are described briefly. Besides, theoretical discussions are made among these schemes to demonstrate the virtues of MPCA. The results of theoretical analysis indicate that MPCA-based approach has lower computational complexity and higher fault detection rate. An industrial benchmark of Tennessee Eastman (TE) process is employed to demonstrate the effectiveness of MPCA-based approach according to the comparison of simulation consequences.

15:40-16:00 **MonB10-6**

Research on Implementation Modes of Test and Launch Control Technology

Feng Ou R&D Center, China Academy of Launch Vehicle Tech.

The ground test and launch control system is the important part of the space system engineering. With the development of the science and technology, and the urgent need of the high-density launch, rapid test and low costing operating, the space nation in the world is successively carrying out the follow-up study on technology and application of related systems for satisfying the design objective of reliability, facilitation, integration, automation and intelligence. According to the technical research and present demanding, the paper analyzed the development of test and launch control technology in the space field at home and abroad, put forward the implementation modes of health management and rapid test. In this paper, the intelligent, efficient, economical and integrated ground test and launch control system was building by applying wireless network, cloud platform and so on. This system will shorten task cycle, reduce the labor and offer the high-quality launching service.

MonB11 **Room11**
Fuzzy systems (I) **14:00-16:00**
Chair: Haoping She Beijing Inst. of Tech.
CO-Chair: Piyu Li Northeastern Univ. at Qinhuangdao

14:00-14:20 **MonB11-1**

Fuzzy PID Controller for UAV Tracking Moving Target

Weiyong Si Beijing Inst. of Tech.
Haoping She Beijing Inst. of Tech.
Zhanglong Wang Beijing Inst. of Tech.

During the Vision-based Unmanned Aerial Vehicle (UAV) tracking mobile vehicle, the speed of vehicle is different and variation with the time, so the conventional PID controller with single fixed parameters is difficult to track the mobile vehicle precisely. For the question, designing the Fuzzy PID controller, which can adjust the parameters of the PID controller according to different conditions, is necessary. In this paper, describing its characteristics and the rules of adjusting the parameters, it can meet the requirement of tracking the mobile vehicle precisely. The simulation results demonstrate that, under different vehicle speed and variation with time, the Fuzzy PID controller response is fast, small overshoot, high robustness and high tracking accuracy.

14:20-14:40 **MonB11-2**

A New Stabilization Criterion for T-S Fuzzy Time-delay Systems

Kun Zhou Southwest Jiaotong Univ.
Tianmin Huang Southwest Jiaotong Univ.
Fenghua Gao Southwest Jiaotong Univ.

This study is concerned with stabilization of Takagi–Sugeno (T–S) fuzzy time-delay systems. By selecting a new integral inequality, less conservative delay-dependent stability criteria are obtained. The border character of the membership functions is considered, and then the new membership-function-dependent (MFD) stabilization conditions with linear matrix inequalities (LMIs) are derived. The fuzzy controllers under the non-parallel distributed compensation (non-PDC) design technique are proposed, one in which the fuzzy controllers are not demanded to apply the uniform membership functions as the fuzzy models. In addition, some relaxation factors are introduced to decrease conservatism. Simulation example illustrates the feasibility of the presented approach.

14:40-15:00 **MonB11-3**

Stability Analysis of Networked Time-Delay Fuzzy Systems With Data Dropout and Quantization Based on Non-PDC and a Novel Piecewise Lyapunov Function

Jimin Yu Chongqing Univ. of Posts and Telecommunications
Tingting Fu Chongqing Univ. of Posts and Telecommunications
Xiaoming Tang Chongqing Univ. of Posts and Telecommunications

In this paper, the problem of stabilization for networked stochastic time-delay systems with data dropout and control input quantization is studied. The plant in the networked control system (NCS) under consideration is a nonlinear discrete time-delay stochastic system represented by a Takagi-Sugeno (T-S) fuzzy model. Control input is quantized by a class of logarithmic quantizers, which are represented by the sector-bound method. By using piecewise quadratic Lyapunov function (PQLF), the stabilization criteria of the NCS are developed. Non-parallel distributed compensation (Non-PDC) controller with convergence rate constraint is designed by solving a set of linear matrix inequalities (LMIs). A practical example is provided to illustrate the effectiveness of the proposed method.

15:00-15:20 **MonB11-4**

Performance Analysis of Multi-Constellation GNSS in Urban Canyons Based on Fuzzy Comprehensive Evaluation

Xi Cai DFH Satellite Co. Ltd.
Chengdong Xu Beijing Inst. of Tech.

The satellite signals are always blocked by obstructions in urban canyons, therefore multi-constellation global navigation satellite system (GNSS) performs poor. Quantitative comparison of the performance of different satellite navigation systems can provide a basis to analyze their advantages and disadvantages. This paper proposes a fuzzy comprehensive evaluation (FCE) theory to quantitatively evaluate the performance of GNSS, and systematically puts forward how to quantitatively analyze precision, availability, continuity and integrity. A simulation was conducted to emulate the environment of urban canyons. Evaluation results show the performance of BDS is neck and neck with GPS, and much better than GLONASS. A multisystem has better performance than a single system. GPS+GLONASS+BDS has the best performance and gets a high FCE result of 0.3268, while the FCE result of GPS, BDS and GLONASS are 0.1722, 0.1570 and 0.0970 respectively.

15:20-15:40 **MonB11-5**

On Rough Multi-granularity Soft Sets and Its Application in Decision Making

Xiaomin Wang Northeastern Univ. at Qinhuangdao
Chenxi Guo Northeastern Univ.
Piyu Li Northeastern Univ. at Qinhuangdao
Jianbo Liu Northeastern Univ. at Qinhuangdao
Jing Liu Northeastern Univ.
Yanyan Zhang Northeastern Univ. at Qinhuangdao

In this paper we proposed the concept of optimistic rough multi-granularity soft set and pessimistic rough multigranularity soft set. Basic properties of rough multi-granularity soft sets are presented. Furthermore, we compared the difference between rough multi-granularity soft sets and rough soft sets showed by some illustrative examples. Finally, an algorithm for decision making problem is proposed. We also give an example to illustrate the validity of this kind of method.

15:40-16:00 **MonB11-6**

On Multi-soft Rough Sets

Piyu Li Northeastern Univ. at Qinhuangdao
Zhi Kong Northeastern Univ. at Qinhuangdao
Wenli Liu Anshan Normal Univ.
Changtao Xue Northeastern Univ. at Qinhuangdao

In this paper, we presented a possible fusion of rough sets and multi-soft sets. Based on the soft rough sets we proposed the concept of multi-soft rough sets. We proposed multi-soft approximation space. And based on the multi-soft approximation space W, we define the multi-soft rough approximations. Basic properties of multi-soft rough approximations are presented and showed by some illustrative examples. We also define the jointly full soft set and study some relevant proposition. Finally, we study the multi-soft W-rough equal relation that is equivalence relations.

MonB12 **Room12**
Control applications (II) **14:00-16:00**
Chair: Hongguang Xu Harbin Inst. of Tech.
CO-Chair: Haokun Wang Hangzhou Dianzi Univ.

14:00-14:20 **MonB12-1**

Inerter-based Passive Structural Control for Load Mitigation of Wind Turbines

Yinlong Hu Hohai Univ.
Michael Z. Q. Chen The Univ. of Hong Kong

This paper investigates inerter-based passive structural control problem for wind turbines to reduce the wind-induced loads, where the inerter-based dynamic vibration absorber (IDVA) is employed. The IDVA in this paper is composed of a passive spring and a parallel-connected passive network, where all networks with first-order and second-order admittances are considered and the specific structure for the passive network is obtained by using network synthesis methods. The wind turbine system is modelled as a discrete parameter multi-degree-of-freedom system, where an interaction between the tower and blades is included. Numerical simulations are conducted to show the effectiveness and the performance benefits of the proposed inerter-based passive structural control method.

14:20-14:40 **MonB12-2**

A novel Control Method for Single-phase Power Inverter Systems Based on Hilbert Transform and DQ Transform

Cui Li Wuhan Univ. of Science and Tech.
Zhenxing Liu Wuhan Univ. of Science and Tech.
Chai Li Wuhan Univ. of Science and Tech.
Jiying Wang Wuhan Univ. of Tech.

In the control of 400Hz power inverter systems, a new method based on Hilbert transform and DQ transform is proposed. The αβ coordinate is structured according to actual measured voltage and its Hilbert transform. Then the DC quantities under the rotating coordinate is obtained by the DQ transform, followed which the double closed loop control model can be structured. Compared with the conventional method which the BETA data is structured by the 90° delay, the good performance of the proposed method is verified in the simulation results. In addition, on the circumstance of the sudden load adding to the system, the method eliminates the secondary subsidence of output voltage problems, which cannot be solved by the conventional 90°delay method.

14:40-15:00 **MonB12-3**

Offset-Free MPC with Zone Control for An Air Source Floor Heating System

Haokun Wang Hangzhou Dianzi Univ.
Aipeng Jiang Hangzhou Dianzi Univ.
Jian Wang Hangzhou Dianzi Univ.

In this study, an offset-free model predictive control (MPC) with zone control is proposed for an air source heat pump connected to a residential floor heating system. First, both the building model and the heat pump model are developed. A model transformation strategy is presented to transform the system nonlinearity into linear system with input uncertainties. Then an offset-free MPC is adopted to handle system uncertainties. Zone control target is achieved based on the proposed offset-free MPC to keep the room temperature within a specified range. This strategy enables the control system more freedom to reduce the energy consumption. Simulation results demonstrate that the proposed approach can provide an improved air conditioning performance and energy efficiency over conventional PI controllers.

15:00-15:20 **MonB12-4**

Nonlinear Adaptive Backstepping Control of a Friction Based Electrohydraulic Load Simulator Using Chebyshev Neural Networks

Dake Zheng Harbin Inst. of Tech.
Hongguang Xu Harbin Inst. of Tech.

This paper deals with the output torque tracking control of a friction based electro-hydraulic load simulator (FEHLS) with time-varying spring stiffness and bearing friction. Although the FEHLS has no extra torque, the friction of the bearings will cause uncertain friction torque. Besides, due to the special mechanical structure of the FEHLS, the spring stiffness will vary near the zero position of the hydraulic cylinder and also cause uncertain torque. To compensate for the uncertain torque and improve the torque tracking accuracy of the FEHLS, an adaptive backstepping controller based on Chebyshev neural network (CNN) is proposed. First, the nonlinear control model of the FEHLS is established where the uncertain torque is lumped into unknown disturbance. Then, the CNN is used to approximate the lumped unknown distrubance. Based on the CNN approximation, an adaptive backstepping controller is designed. Finally, simulation studies are carried out to show the effectiveness of the proposed controller.

15:20-15:40 **MonB12-5**

Practical Guidance Considering Filtering Performance for Attacking Maneuvering Targets

Wen Li Beijing Aerospace Automatic Control Inst.
Ke Yi System Engineering Research Inst.
Tao Yan Beihang Univ.

For missiles with passive seeker, they are usually little observable because only the line of sight (LOS) information is obtained without distance information. It's difficult to take both aspects that the observability of filtering model and hit accuracy of the maneuvering target, into account at the same time. For this problem, the motion tracking sliding mode guidance law is adopted in this paper, and the specified form of LOS rate and the method to determine value of its parameters are given. Firstly, the relative motion model and the conclusion that it is necessary to reduce the LOS rate to improve the accuracy of the guidance, are given. Then, features of standard PNG (Proportional Navigation Guidance), MAPNG (Modified Augmented Proportional Navigation Guidance) and MTSMG (Motion Tracking Sliding Mode Guidance) are analyzed. With regard to MTSMG, a LOS rate curve form is designed, which can both improve the observability and hit accuracy. Finally, the relationship between the upper limit of LOS rate and the relative distance is deduced, and the method to select parameters is given in order to determine the final value of the expected LOS rate. Simulation results show that, compared with the standard PNG and MAPNG method, the hit accuracy of improve method in is paper is higher and the filtering performance is good.

15:40-16:00 **MonB12-6**

Feedforward DMC-PID Cascade Strategy for Main Steam Temperature Control System in Fossil-Fired Power Plant

Huaizhong Hu Xi'an Jiaotong Univ.
Jianbo Zhang Xi'an Jiaotong Univ.
Qingyu Yang Xi'an Jiaotong Univ.
Yuanli Cai Xi'an Jiaotong Univ.

Main steam temperature system has the characteristics of nonlinear, large inertia and time delay. Thus, traditional PID cascade control usually could not provide satisfied performance. As a most widely used model predictive control (MPC) algorithm, dynamic matrix control (DMC) is especially suitable for large inertia controlled object. However, DMC is vulnerable to be influenced by uncontrollable disturbances. In this paper, a new DMC control strategy based on the combination of cascade structure and feedforward compensation is proposed in main steam temperature control system. The disturbances of the load and the spray attemperator inlet temperature can be compensated by feedforward model. And the cascade structure can suppress the disturbances of spray attemperator water. Simulation results show that the novel feedforward DMC-PID cascade control strategy has remarkable dynamic performance and strong disturbance rejection ability.

MonB13 Room13
Signal processing (IV) 14:00-16:00

Chair: Dawei Li Donghua Univ.
CO-Chair: Hanyu Shao Nanjing Univ. of Posts and Telecommunications

14:00-14:20 **MonB13-1**

Adaptive Waveform Design for Through-the-Wall Radar Using Compressed Sensing Based Randomized Step Frequency

Xiongjun Wu National Defense Key Laboratory of Science and Tech. on Electromagnetic Scattering
Yan Zhang National Defense Key Laboratory of Science and Tech. on Electromagnetic Scattering
Liang Ma National Defense Key Laboratory of Science and Tech. on Electromagnetic Scattering
Xinfan Xia National Defense Key Laboratory of Science and Tech. on Electromagnetic Scattering
Tao Yang Univ. of North Texas
Xue Zhang National Defense Key Laboratory of Science and Tech. on Electromagnetic Scattering

The through-the-wall radar systems with microwave techniques enable us to detect some specific targets through typical kinds of obstacles such as bricks, concrete, and trees. In the through-the-wall radar application, the performance is prone to degrade due to the interference of the ground multipath reflection. The traditional way to recover the range and velocity joint estimating of the targets requires large amount of sampling numbers, which is not available in many cases. In this paper, a novel randomized step frequency radar that combines the adaptive waveform design and the off-grid point effect simultaneously is proposed. The range and velocity joint estimating are recovered by exploiting sparseness of the targets and by invoking the compressed sensing (CS) theory, which reduces the sampling burden efficiently. In this new mechanism, each of the dictionary matrix element is first extended by adopting a Taylor expansion to an arbitrary precise off-grid point, instead of only the points in a discrete form. Then by adding the new generated information into the dictionary matrix adaptively, an updated time-varying new dictionary matrix is yielded. The proposed waveform design approach has the potential to achieve much higher estimation accuracy, a faster convergence speed and stronger robustness against unpredictable perturbations.

14:20-14:40 **MonB13-2**

Piecewise affine warp based frontal face synthesizing and application on face recognition

Shanshan Wang Jiangnan Univ.
Xiaobin Yi Jiangnan Univ.
Ying Chen Jiangnan Univ.

In this paper, a frontal face synthesizing strategy based on Poisson image fusion and piecewise affine warp (PAW) is proposed to solve the problem of large-scale computation cost or transformation distortion in general synthesizing methods. The multiple non-frontal input images are warped to the frontal face template with PAW. The corresponding weight matrixes are calculated according to the magnitude of deformation which can be used to obtain the foreground mask for Poisson fusion. Iterative fusion strategy is designed to synthesize one frontal image from multiple non-frontal images. In each step, the PAW image is used as foreground image, the deformation mask is used as foreground mask, and the fusion image of the previous step is used as background. Experiments show that the synthesized frontal image can perfectly preserve personal facial details and outperforms others in both subjective and objective evaluations, and the synthesizing strategy can greatly improve the accuracy of face recognition.

14:40-15:00 **MonB13-3**

Sunspot Umbral Oscillation Analysis Using Wavelet Transform

Zeyuan Du Kunming Univ. of Science and Tech.
Song Feng Kunming Univ. of Science and Tech.

Umbral oscillation is one kind of basic phenomena appearing in sunspots. Accurate measurement the oscillation period is quiet important for understanding the structure and evolution of sunspot. A long line of work indicates that there are two kinds of typical oscillations in sunspot umbral area: 3–minute oscillations and 5–minute oscillations. The high quality observational sunspot data set obtained with the HINODE/Solar Optical Telescope in the Ca II H line on 20 August 2013 was employed to study the oscillation period of the chromosphere above a sunspot. In this paper, we used two kinds of wavelet transform methods to analyze sunspot umbral oscillation. One method based on continuous wavelet transform (CWT) was applied to analyze umbral oscillation period and frequency changing over time. The other method based on cross wavelet transform (XWT) was used to analyze phase relationship between the two time series. The outcomes demonstrate the viability and efficiency of the wavelet transform as a analyzing tool by accurately calculating period

and studying phase difference.

15:00-15:20 **MonB13-4**

Wheel Overheat Detection via Incorporation of Scattering Brightness Difference and Texture Representation

Rixing Zhu Chang'an Univ.
Jianwu Fang Chang'an Univ.
Hongke Xu Chang'an Univ.
Xiaohong Wang Chang'an Univ.

Wheel overheat is easy to cause spontaneous combustion, and makes severe traffic accidents. To this end, this paper contributes a novel wheel overheat detection system based on far-infrared video analysis. With effective frame selection of wheel video, we propose a scattering brightness difference descriptor (SBDD) to represent the brightness distribution of wheel infrared image. In addition, the traditional and superior texture features, such as histogram of oriented gradient (HOG) and local binary patterns (LBP), are integrated to make a more powerful representation of wheel image. The extracted low-dimensional feature set is projected into high-dimensional space by RBF kernel, and the support vector machine is utilized to judge the wheel overheat. To restrain the influence of image border and background, wheel feature region is selected by a Gaussian kernel. Experimental results show that the proposed system can accurately find the wheel overheat, and has important significance to reduce the traffic accidents.

15:20-15:40 **MonB13-5**

Motion Artifact Detection and Reduction in PPG Signals Based on Statistics Analysis

Hanyu Shao Nanjing Univ. of Posts and Telecommunications
Xiaohui Chen Nanjing Univ. of Posts and Telecommunications

The performance of pulse oximeters is highly influenced by motion artifacts (MA) in photoplethysmographic (PPG) signals. MA can't be eliminated completely by using the traditional filtering algorithms, which results in the error in the measurement of blood oxygen, so this paper presents a new method to detect and remove MA in PPG signals. The statistics of the segmented signals are detected by setting a threshold and high-quality signal segments will be extracted with MA segments eliminated. By using high-quality signal segments to calculate the saturation of blood oxygen instead of the whole signal, accuracy of blood oxygen estimation can be improved. Research results show that quality of the signals can be distinguished by applying the proposed algorithm and high-quality signal segments can be correctly extracted despite the large MA.

15:40-16:00 **MonB13-6**

Improved CAMShift Object Tracking Based on Epanechnikov Kernel Density Estimation and Kalman Filter

Dawei Li Donghua Univ.
Lihong Xu Tongji Univ.
Yang Wu Tongji Univ.

This paper first chooses Epanechnikov Kernel Density Estimation for moving foreground detection. Targets are extracted by labeling connected regions in the detected binary image. Kalman filter is then employed to proffer initial searching window for CAMShift algorithm to track targets and predict the future position of the targets. Meanwhile, the histogram of target is updated by the color information in the region obtained by periodical detection of Epanechnikov Kernel Density Estimation. This paper also addresses the occlusion problem in tracking. Experimental results show that the strategy which combines the KDE foreground detection, Kalman filter and CAMShift, can realize automatic and efficient tracking of moving target. The reliable performance of this algorithm satisfies the real-time requirement, and is robust against the effects of unstable scene illumination, and object occlusion.

MonB14 Room14
Data processing (IV) 14:00-16:00

Chair: Yunong Zhang Sun Yat-sen Univ. SYSU-CMU Shunde International Joint Research Inst.
CO-Chair: Jianxun Li Shanghai Jiao Tong Univ.

14:00-14:20 **MonB14-1**

A content-based image retrieval scheme for identifying lung nodule malignancy levels

Guohui Wei Northeastern Univ.
He Ma Northeastern Univ. Key Laboratory of Medical Image Computing Ministry of Education
Wei Qian Northeastern Unive. Univ. of Texas at El Paso
Xinzhuo Zhao Northeastern Univ.

Discriminating the lung nodules benign or malignant is an important task for computer aided diagnosis of lung cancer. The malignancy of the nodules is divided into five levels in Lung Image Database Consortium (LIDC) database. In this study, a new content-based image retrieval (CBIR) scheme is proposed for classification of the lung nodules with different ratings. A lung nodule dataset is assembled from LIDC lung CT database. Two nodule density dependent features are calculated to depict each nodule. For each queried nodule, a CBIR scheme is used to search for ten most similar reference nodules. A malignancy probability is computed to predict the malignancy of the lung nodules. The results show that accuracy and the area under the curve (AUC) are 0.6655 and 0.6901 when classifying nodules moderately suspicious for cancer (rating 4) and highly suspicious (rating 5). The ACC and AUC are 0.9231 and 0.8659 when testing our scheme on differentiating benign and malignant cases.

14:20-14:40 **MonB14-2**

Potential Mw8.1-or-above Japan earthquake around 4 May 2030 numerically predicted via addition-subtraction frequency method

Yunong Zhang Sun Yat-sen Univ. SYSU-CMU Shunde International Joint Research Inst.
Jiadi Wang Sun Yat-sen Univ. SYSU-CMU Shunde International Joint Research Inst.
Yaqiong Ding Sun Yat-sen Univ. SYSU-CMU Shunde International Joint Research Inst.
JianfengWen Sun Yat-sen Univ. SYSU-CMU Shunde International Joint Research Inst. Guangdong Polytechnic Normal Univ.
Wan Li Sun Yat-sen Univ. SYSU-CMU Shunde International Joint Research Inst.

Japan is located in Pacific volcanic seismic belt, and lies at the junction of the Pacific plate and the Eurasian plate. This makes Japan one of the most seismically active regions in the world. Earthquake prediction, and especially huge earthquake prediction for Japan is necessary to take disaster preparedness and mitigation measures. In this paper, addition-subtraction frequency (ASF) method with three inputs is presented for predicting a potential Mw8.1-or-above earthquake in Japan after year 2020. The date data of earthquakes which this paper uses are Japan's real seismic data in the past. Meanwhile, three forms of initial date data [i.e., m/d/y (month/day/year), m/y (month/year), and y (year)] are used as the inputs of numerical experiments. Thus, possible occurrence dates of Mw8.1-or-above earthquakes in Japan can be identified via ASF method. Finally, via consistency analysis of these possible dates, the date 4 May 2030 is the one with the highest possibility.

14:40-15:00 **MonB14-3**

Design and Implementation of Detecting and Tracking System of Moving Target Based on BF533

Hang Li Guidaojiaotong Polytechnic Inst.

With the intensive study in the fields of video surveillance system, robot navigation and smart home appliances etc., moving target detection and tracking is raised to a new height. BF533 development board which has a dedicated video processing hardware can solve the problem of large data and real time in image processing. The difference multiplication method, the matching difference method, and the improved Camshift algorithm are adopted in this paper. Meanwhile, these approaches are implemented on a net vision tracking system based on BF533. The result shows that the proposed method can detect and track moving target accurately and has high practical value in reality.

15:00-15:20 **MonB14-4**

Improved Saliency Detection Based on Manifold Ranking Algorithm

Liang Yao Shanghai Jiao Tong Univ.
Hongliang Chen Luoyang Inst. of Electro-optical Equipment
Jianxun Li Shanghai Jiao Tong Univ.

Saliency detection is a fundamental problem in computational and cognitive sciences. Nowadays, graph-based methods are widely applied to saliency detection including manifold ranking (MR) method, which is shown to be fast and effective. However, because of only using a single feature and imperfect selection strategy for background seeds, MR has a poor performance in some circumstances. In order to complete more challenging saliency detection, an improved method based on manifold ranking algorithm is proposed in this paper. The adopted parallel architecture enables the final detection results generated with the combination of calculations from background seeds and foreground seeds. These seeds are quickly obtained by using priori information and the graph structure is optimized with adding threeconstraints. Moreover, the graph edge weights are computed by utilizing an adaptive local width parameter and measuring multi-features distance. Three-stage strategy is used to calculate the final saliency map. Experiment results on two large famous datasets demonstrate that the proposed method performs better comparing with MR and other state-of-the-art methods.

15:20-15:40 **MonB14-5**

Motion Blurred Star Image Centroid Optimized Extraction Based on Prior Gaussian Distribution

Dingbang Peng Shanghai Jiao Tong Univ. Key Laboratory of System Control and Information Processing, Ministry of Education of China
Hao Chen Shanghai Inst. of Spaceflight Control Tech. Shanghai Key Laboratory of Aerospace Intelligent Control Tech.
Xiaochong Sang Shanghai Inst. of Spaceflight Control Tech. Shanghai Key Laboratory of Aerospace Intelligent Control Tech.

Jianxun Li Shanghai Jiao Tong Univ.
Key Laboratory of System Control and Information Processing, Ministry of Education of China

Star centroid extraction is the precondition of star recognition in star navigation system. Star image will be motion blurred under high dynamic conditions. Conventional methods such as Wiener filter method, restore the blurred star image with an estimated PSF to calculate the star centroids. The unique characteristic of star images different from general images is ignored in conventional methods. In addition, the error of motion blur parameters estimation and the approximate linear motion model can decrease the accuracy of star centroids calculation. This paper proposes a method utilizing the prior Gaussian distribution information of star energy to deal with the motion blurred star images .The experimental results demonstrate that the proposed method gets smaller error in star centroids calculation compared with the conventional estimation method.

15:40-16:00 **MonB14-6**

Control-oriented credibility assessment of air-breathing hypersonic vehicle model

Haoliang Wang Beihang Univ.
Qingdong Li Beihang Univ.
Zhang Ren Beihang Univ.

A new control-oriented credibility assessment method of air-breathing hypersonic vehicle model is presented in this paper. As the actual aerodynamic parameters are few, a new method of obtaining linear systems of the Model Awaiting Assessment (MAA) and the Actual Model (AM) is presented to comprehensively evaluate the changing trends of flight conditions. In order to assess the credibility of hypersonic vehicle, the B type association degree is proposed to assess the distinctions between the simulation results of the two corresponding linear systems which are calculated from MAA and the AM. The application is provided to demonstrate the effectiveness of the creditability evaluation method.

MonB15 Room15
Instrumentation systems 14:00-16:00

Chair: Kui Li Beihang Univ.
CO-Chair: Xue Bao Nanjing Univ. of Aeronautics & Astronautics

14:00-14:20 **MonB15-1**

Dynamic Bowtie Filter Design with Monte Carlo Simulation for Cone-Beam CT

Huijie Zhu Chongqing Univ.
Fuqiang Gao Chongqing Univ.
Weiwen Wu Chongqing Univ.
Fenglin Liu Chongqing Univ.

Bowtie filter, as a beam shaping attenuator placed between X-ray source and scanned object in computed tomography system, can effectively reduce radiation dose. In addition, the bowtie filter is expected to be able to compress the dynamic range which could limit the application of some detectors. In this paper, we propose a methodology for dynamic bowtie which can balance the photon flux on a detector array in real time. Our goal is to determine the shape of dynamic bowtie filter for modulating detector reading in the target angle of 20° with a reflected target. Monte Carlo simulation has been employed. The results demonstrate the designed high-attenuation bowtie filter has a unique advantage in terms of balancing photon flux data on a detector array.

14:20-14:40 **MonB15-2**

Barometer Measurement Error Modeling and Correction for UAH Altitude Tracking

Xue Bao Nanjing Univ. of Aeronautics & Astronautics
Zhi Xiong Nanjing Univ. of Aeronautics & Astronautics
Shouzhao Sheng Nanjing Univ. of Aeronautics & Astronautics
Yijie Dai Nanjing Univ. of Aeronautics & Astronautics
Sheng Bao Nanjing Univ. of Aeronautics & Astronautics
Jianye Liu Nanjing Univ. of Aeronautics & Astronautics

Altitude is a significant flight parameter for Unmanned Aerial Helicopters (UAH). Traditional vertical damping loop has been used to improve stability of vertical channel of the INS(inertial navigation system) with auxiliary altitude information. Barometer is a common and popular altimeter which can provide the continuous and reliable altitude information, however the measurement performance is rather poor due to several factors, including principle error, drifting behavior and sensitivity to environment changes in pressure uncorrelated with altitude. In this paper, the characteristics of the barometer measurement errors have been thoroughly investigated and we decomposed the barometer measurement errors into three components: principle error, drift error and external disturbance error. We proposed a scheme to estimate and correct the barometer measurement errors. GPS has been utilized in this paper as an auxiliary altimeter. A method has been proposed to estimate and correct the drift error by introducing a factor to change the measurement noise covariance. A serial experiments have been performed to validate the accuracy of the models and illustrate that the proposed method has better performance than normal Kalman filter.

14:40-15:00 **MonB15-3**

Control Implementation for the Single-axis Rotation and Motion-insulated Inertial Navigation System

Lingcao Wang Beihang Univ.
Kui Li Beihang Univ.
Yuanpei Chen Beihang Univ.
Rong Guo Beihang Univ.

The navigation accuracy could be improved in the rotation inertial navigation system (INS) compared to strapdown INS. However, the effectiveness of the rotation modulation could be decreased owing to the carrier motion, which is necessary to be insulated. This study analyses the motion influence on the accuracy for the single-axis rotation inertial navigation system (RINS) and designs a control implementation to isolate the azimuth angular motion and modulate the inertial sensors errors simultaneously. This control implementation is constructed by using dual DSP processor, the encoder and direct-drive motor. Its algorithm is PID with the feedforward compensation. The simulation and experimental results show that the proposed implementation can accomplish the rotation modulation and azimuth motion insulation, which can improve the navigation accuracy further.

15:00-15:20 **MonB15-4**

The Multiple coils to Perform Autonomous Rendezvous & Docking of CubeSat/micro-satellite

Wenwen Chen Shanghai Engineering Center for Microsatellites
Zhongcheng Mu Shanghai Engineering Center for Microsatellites
Wei Wang Shanghai Engineering Center for Microsatellites
Guowen Sun Shanghai Engineering Center for Microsatellites
Hongyu Chen Shanghai Engineering Center for Microsatellites

This paper proposes a docking device by using only magnetic force with multi-dipole for CubeSat/micro-satellite. An innovative electromagnetic capture device was recently proposed to increase the reliability and simplify rendezvous operations. The device could be implemented in the re-configurable space structures that architect large structure or reconstruct themselves by assembling basic structural units. The joining mechanism is designed to combine in a simple way of probe-drogue configurations, through the docking ports of auto attraction capabilities, avoiding the need of a large amount of actuators usually employed in larger docking ports. The paper presents the design and control aspects of this magnetic capture device. One remarkable benefit of this device is that it does not require attitude controls for final rendezvous stage and doesn't require propulsion. The final contact is secured thanks to a current control of passive magnet. The performance of magnetic force is analyzed, and test results are presented.

15:20-15:40 **MonB15-5**

Design of Infrared Oil Measuring Instrument Based on STM32

Chunjie Wang Key Research Laboratory for Control Theory & Applications in Complicated Systems Tianjin Univ. of Tech.
Lei Zhao Key Research Laboratory for Control Theory & Applications in Complicated Systems Tianjin Univ. of Tech.

The water pollution caused by oil substances become more and more serious. In order to facilitate the monitoring of oil substances in water, an infrared measuring instrument based on the principles of infrared spectrophotometry, was developed from STM32F103RC processor. Main components of the hardware are light source system ; signal acquisition and processing system ;STM32-configuration industrial serial port screen (touch screen) control system. Touch screen is designed for the host computer interface. Through the operation of the touch screen interface, the functions of various modules of the instrument can be achieved. The absorbance, concentration, and draw the standard curve can be automatically calculated. The test is simple, high precision and intelligent.

15:40-16:00 **MonB15-6**

ABB Freelance Control System Application Program Interface Communication Technology Research and Application

Li Su Harbin Engineering Univ.
Qian Xiang Harbin Engineering Univ.
Chengtao Cai Harbin Engineering Univ.

In the ABB Freelance process control system, it is difficult to compose the complex intelligent control algorithm using industrial programming language. In order to realize the intelligent control algorithm applied in ABB Freelance quickly, Proposed the use of the system application interface to achieve VC + +, MATLAB and other environmental development of customer applications directly with the ABB Freelance system communication, making VC++, MATLAB and other environmental development intelligent control algorithm can be quickly and easily applied in the ABB Freelance control system.

MonB16 Room16
Smart grids (III) 14:00-16:00

Chair: Qiang Yang Zhejiang Univ.
CO-Chair: Haiyang Zhang Northeastern Univ.

14:00-14:20 **MonB16-1**

Residential Thermostatically Controlled Appliances for Smoothing Tie Line Power Based on Multiple State-Queueing Model

Lingxiao Wang Zhejiang Univ.
Qiang Yang Zhejiang Univ.
Wenjun Yan Zhejiang Univ.

Currently renewable energy including wind and solar power has been widely applied in microgrid. But its intermittency and randomness bring obvious challenge for the control of microgrid. Being different from the

high cost of energy storage system, demand response (DR) aiming at changing the user's electricity consumption behaviors is considered as an efficient tool for energy management. This paper proposes a multiple state-queueing method using three types of residential thermostatically controlled appliances (TCAs) to respond the target of tie line power smoothing. Different types of TCAs are aggregated and managed through different queues, and masses of TCAs switch status is controlled using multiple state-queueing (MSQ) model. Based on a reliable bi-directional communication system, a new weighted fair queueing (WFQ) allocation algorithm is proposed to achieve real time resource allocation. The proposed approach of thermostatically controlled appliances for smoothing the tie line power is assessed through a set of simulation experiments and the numerical result demonstrates its effectiveness.

14:20-14:40 **MonB16-2**

A Power Flow Solution for Meshed Network by Incidence Matrix

Jie Yu State Grid Shaoxing Power Supply Company
Tao Shen Zhejiang Univ. City Coll.
Zhejiang Univ.
Yanjun Li Zhejiang Univ. City Coll.
Yan Zhang Zhejiang Electric Power Company Research Inst.

This paper describes a new power flow solution based on graph theory for solving distribution systems. The method proposed to deal with both radial and meshed networks is a kind of forward/backward sweep method, which is used to solve radial networks only. We fully depict the topological characteristic of a radial or meshed structure by a nodebranch incidence matrix. Without breaking meshes or loop-analysis like previous studies, our method can directly solve meshed structure by finding the basis of the null space of the incidence matrix. In addition, we also give a convergence analysis by using of the Banach fixed-point theorem.

14:40-15:00 **MonB16-3**

Research on Power Customer Segmentation Based on Big Data of Intelligent City

Xizhong Li State Grid Yingkou Electric Power Supply Company
Haiyang Zhang Northeastern Univ.
Qinghe Hu Northeastern Univ.
Xiancui Huang Northeastern Univ.

With the vigorous development of intelligent city, it has been an important task that we need to consistently revitalize owned information, make full use of the incremental data, to provide unified data service for intelligent application in various fields. This paper proposes an improved power customer segmentation model, which uses an optimized algorithm that is based on the basic data of the intelligent city and the internal data of the electric power enterprise. This model attach importance to the customer's change tendency on the basis of maintaining the original clustering distance, making the result of clustered classification more detailed and more advanced. At the same time, the quality of clustering center is improved and the convergence rate of clustering is improved by using the pre-clustering and average clustering center linear prediction. The simulation results show that this model provide a better classification way for power customers, which has higher classification quality and faster speed.

15:00-15:20 **MonB16-4**

Equilibrium Analysis of Electricity Market Considering Demand Response in Smart Grid

Xuena An Shanghai Univ.
Shaohua Zhang Shanghai Univ.
Xue Li Shanghai Univ.

Development of smart grid provides the opportunity for demand side to participate in the electricity market competition. Firstly, based on the oligopolistic competition theory, a novel equilibrium model is proposed to address the interaction between the supply and demand sides, in which the flexible consumers are allowed to take part in the electricity market competition in the form of demand response (DR) aggregators. In this model, all generation firms behave a la supply function competition mode in the electricity wholesale market, while DR aggregators behave a la Cournot mode in the electricity wholesale market. Load shifting and curtailing programs are considered, and the strategic behaviors of DR aggregators with different DR programs are examined. Secondly, the nonlinear complementarity approach is used to solve this equilibrium problem. Finally, numerical examples are presented to verify the effectiveness of the method. Simulation results show the superior performance of the proposed DR model in encouraging flexible consumers to shift the load from peak-period to off-peak-period, flattening the load demand and electricity price curves, and DR aggregators with load shifting and curtailing programs are more competitive and have the ability to grab more DR share, thus improve their profits.

15:20-15:40 **MonB16-5**

Effect of voltage sag phase factors on the performance of asynchronous motor

Voltage sag has serious impact on the safe and stable operation of induction motor, which has been attracting more and more people's attention. In order to study the influence of voltage sag phase-angle factor on operation performance of asynchronous motor, this paper established the simulation model of asynchronous motor which can simulate different voltage sags. Taking 5.5kW,55kW and 135kW motor as examples, the influence of phase jump and starting point of voltage sag on stator current peak, torque peak, speed loss and critical clearing time are respectively discussed. The simulation results show that stator current peak and torque peak increase obviously, speed drops apparently and critical clearing time also decreases under the consideration of phase shift, while different starting points have little influence on these operation indicators. Experimental results of a 5.5kW induction motor agree well with those obtained by simulation.

15:40-16:00 **MonB16-6**

Coordinate optimization for grid-connected microgrid considering uncertainties of renewable energy sources and electric vehicles

Xiaodong Yang Zhejiang Univ. of Tech.
Youbing Zhang Zhejiang Univ. of Tech.
Guofeng Wang Zhejiang Univ. of Tech.
Shuaijie Ren Zhejiang Univ. of Tech.
Weiwei Shan Zhejiang Univ. of Tech.
Junjie Lu Zhejiang Univ. of Tech.

The output of solar and wind energy has the characteristics of uncontrollable and volatile, and electric vehicles (EVs) also have a high randomness, the randomness of both greatly increases the difficulty of power grid control. In this paper, the wind turbine (WT) output is processed by point estimation method, the output of the two border scenarios is obtained, while the three typical weather scenarios of the photovoltaic (PV) output and the randomness of EVs are considered. On this basis, the microgrid optimal operation model is built with the goal of minimizing the running cost of the system, considering the interests of the power supply side and the demand side, for the grid-connected microgrid with EVs and high permeability WT and PV. In the case study, the optimization results under different energy storage capacity allocation and number of accessed EVs are analyzed. The results show that the EVs with a certain travel pattern has a good synergistic effect with the renewable energy, which can reduce the operating cost of the system and increase the utilization rate of renewable energy effectively

MonB17 **Room17**
Renewable energies (IV) **14:00-16:00**
Chair: Xiaojie Su Chongqing Univ.
CO-Chair: Gang Chen Chongqing Univ.

14:00-14:20 **MonB17-1**

A Control Strategy for Suppressing Harmonics and Circulation in Islanded Microgrid

Yan Li Central south Univ.
Xiangyue Shi Central south Univ.
Xiaoping Fan Central south Univ.

An inverter control strategy which can suppress harmonic and circulation is proposed for the paralleled multi-inverter system with non-linear loads in islanded microgrid in this paper. The proposed strategy does not require any active or reactive power calculations. Instead, a phase-locked loop (PLL) is used. The virtual impedance is set to contain the virtual negative impedance, the fundamental virtual inductance and the harmonic virtual resistance. The virtual negative impedance is set to offset the resistance component of the line impedance and reduce the system voltage drop caused by line resistance. The fundamental virtual inductance and harmonic virtual resistance is set to be put into the voltage feedback loop in fundamental domain and harmonic domain, respectively. Simulation and experimental results verify the validity of the control strategy. The control strategy improves the quality of output voltage and output current of each inverter and suppresses the circulation.

14:20-14:40 **MonB17-2**

Robust H∞ Control for Wind Energy Conversion System in Linear Parameter Varying Framework

Jianwei Zhang Chongqing Univ.
Xinxin Liu Chongqing Univ.
Xiaojie Su Chongqing Univ.

A robust control approach depending on delay is designed for the pitch-controlled variable-speed wind energy conversion system (WECS) above the rated wind speed range under the impact of time-delays. H ∞ performance index is adopted to test the effect of the disturbance on the controlled output. A state feedback controller with time delay is designed such that the wind output power can be maintained at near rated power above the rated wind speed. In addition, the H ∞ performance analysis of WECS is proposed based on Lyapunov functions and sufficient conditions are presented based on linear matrix inequalities (LMIs).

14:40-15:00 **MonB17-3**

A Variable Step-Size MPP Tracking Algorithm Based o n D ifferential Characteristic Curves o f Power versus Duty Cycle

Ziye Liu Chongqing Univ.
Gang Chen Chongqing Univ.

To make photovoltaic generation systems track the maximum power point (MPP), the MPP tracking algorithms have been extensively investigated. In this work, based on the differential characteristic curves of power versus duty cycle, we introduce a new threshold function and propose a novel variable step-size MPP tracking algorithm. Compared with the existing MPP tracking schemes, our proposed scheme is very simple for implementation. Moreover, the proposed scheme can guarantee a fast respond speed and achieve a good accurate tracking control. Numerical simulations are provided to justify the effectiveness of the proposed MPP

tracking scheme.

15:00-15:20 **MonB17-4**

Modeling and Simulation of Heliostats Field in Solar Power Tower

Weijie Ding Nanjing Normal Univ.
Xuemei Zhu Nanjing Normal Univ.

With the widespread use and preliminary mature of solar energy generation technology, the improvement of generating efficiency has become a vital technical target. For the tower-solar thermal generation system, the design and optimization of the heliostats field is of great significance for improving generating efficiency, rationalizing the energy dispatching and seizing the distribution and variation trend of the whole power plant. Firstly, in this paper, an energy model of the tower-solar thermal generation system is established and the parameters are analyzed. Then, the reflection model of a single heliostat is established and the mechanical characteristics and cosine effect are analyzed. Finally, the energy distribution and scheduling solution are obtained. Proved by simulation, analysis based on this model has certain guiding significance on actual production.

15:20-15:40 **MonB17-5**

MPPT Control Strategy Based on CVT and Variable Step Hysteresis Comparison Method

Xiangping Meng Changchun Inst. of Tech.
Miao Leng Changchun Univ. of Tech.
Hong Zhang Changchun Inst. of Tech.
Ting Xu Changchun Univ. of Tech.

Aiming at the contradiction between the speed and precision of traditional photovoltaic MPPT (maximum power point tracking) algorithm, an algorithm based on CVT (constant voltage tracking) and variable step size hysteresis comparison method is proposed. It avoids the problem of false judgment which is easy to appear in the perturbation and observation method, and the oscillation in the vicinity of the maximum power point is suppressed, and the steady-state accuracy of the conventional hysteresis comparison method is improved. Based on MATLAB/SIMULINK simulation platform, MPPT simulation model based on this algorithm is built. The simulation results show that the algorithm obviously improves the tracking speed and precision, and when the environment changes, the system can quickly and accurately track the maximum power point, the conversion efficiency of the photovoltaic power generation system has been improved.

15:40-16:00 **MonB17-6**

Electrical Performance Comparison of a Rooftop Photovoltaic System and an Open-rack Photovoltaic System

Xu Zheng Instrumentation Tech. and Economy Inst.
Xijing Zou Chinese Academy of Sciences
Haitao Liu Chinese Academy of Sciences

This paper analyses the performance of a rooftop photovoltaic (PV) system installed in south China and an open rack photovoltaic system in remote desert in northwest China. A subsystem of the rooftop system and a subsystem of the desert PV system are monitored by a movable monitoring system. The results showed that the performance ratio (PR) of the rooftop subsystem and the open rack PV subsystem is 0.88 and 0.80 respectively. The analysis showed that PR is not influenced by Yr except Yr lower than 1.0 h/d. The final yield Yf increased with the increasing of reference yield Yr. The Loss Ratio (LRc) of the open rack PV subsystem is 15.51% and it is much higher than 15.51% of the rooftop subsystem. The main reason is considered as much higher dirt losses and line losses of the open rack PV subsystem in rainy and humid region in south China than that of the rooftop subsystem in dry, windy and dusty region in northwest China. The Balance of System Loss Ratio (LRBOS) of the rooftop subsystem is a little higher than that of the open rack PV subsystem. The main losses of the rooftop subsystem is LRBOS while the main losses of the open rack PV subsystem is LRc.

MonBIS **Room18**
Interactive Session **14:00-16:00**

MonBIS-01

Analysis of Parameter Sensitivity for the NSS Model of Term Structure Based on the Genetic Algorithm

Rongxi Zhou University of International Business and Economics
Hanzhang Liu University of International Business and Economics
Lin Zou Renmin University of China

The term structure of interest rate is an important foundation for studies such as asset pricing and risk management. In this paper, the sensitivity of parameters in the NSS model of the yield curve is studied with the help of genetic algorithm, and the impact of the relevant parameter setting on the fitting precision of the model is also discussed. Based on the positive analysis of Chinese Treasury Bonds data, it is found that the parameter setting in the model has a significant effect on the fitting precision, but the effect varies due to different parameters. It also leads methodological support to precisely and conveniently employ the NSS model.

MonBIS-02

An Efficient Method of White Blood Cells Detection Based on Artificial Bee Colony Algorithm

Zheng Fu Nanjing University of Posts and Telecommunications
Ye Liu Nanjing University of Posts and Telecommunications
Haidong Hu Beijing Institute of Control Engineering
Dongmei Wu Nanjing University of Posts and Telecommunications
Hao Gao Nanjing University of Posts and Telecommunications

The form and content of the white blood cells are the important manifestations of human body health indicators. In color blood cell images, segmentation and recognition are two essential issues in the automatic white blood cells (WBC) identification system. Since WBC can be approximately regarded as elliptic shape, so using the ellipse detection method can successfully recognize such elements. Whether segmentation problems or ellipse detection problems are time-consuming and error-prone, in view of the white blood cells segmentation and detection problem this paper introduced an efficient optimization method. Based on comparing some optimization methods, paper present an artificial bee colony (ABC) algorithm for automatic detection of WBC in color blood cell images, by transforms the detection into an optimization problem. Experimental results validate the reasonable of our proposed technique in terms of its accuracy and efficiency.

MonBIS-03

Optimal Control Method for Runtime System Maintenance

Haining Meng Xi' an University of Tech.
Yichuan Wang Xi' an University of Tech.
Huaijun Wang Xi' an University of Tech.
Feng Wang Xi' an University of Tech.
Jianjun Liu Aeronautics Computing Technique Research Inst.

Long-running software systems are suffering performance degradation due to steady accumulation of error conditions in the internal state and the external operating environment of the runtime system. To solve this problem, a proactive and preventive maintenance method called software rejuvenation has been proposed. Aiming at the long-running system, we put forward an optimal maintenance control method, by which software system is rejuvenated prior to system failure to achieve high availability and low maintenance cost. First we formulate the optimization method and obtain the system cost rate function. Then the optimal rejuvenation interval is derived to minimize the cost rate, and the boundary condition of our maintenance method is achieved based on its closed-form solution. Finally, the Experiment results demonstrate the effectiveness of the proposed method.

MonBIS-04

Steel Surface Defects Recognition Based on Multi-label Classifier with Hyper-sphere Support Vector Machine

Maoxiang Chu State Key Laboratory of Robotics and System (HIT)
Univ. of Science and Tech. Liaoning
Jie Zhao State Key Laboratory of Robotics and System (HIT)
Rongfen Gong Univ. of Science and Tech. Liaoning
Liming Liu Univ. of Science and Tech. Liaoning

Aiming at steel surface defects recognition, this paper proposed a multi-label classifier with hyper-sphere support vector machine (HSVM-MC). Firstly, in order to describe steel surface defects well, a new set of edge distance statistical features are proposed. Then, based on twin-hypersphere support vector machine (THSVM), HSVM-MC is built by introducing binary relevance (BR) idea. This novel classifier has merits of THSVM and BR. Moreover, it can make up the shortcomings of BR method. Experimental resuslts show that the novel multi-label classificatin method has superior accuracy and efficiency for steel surface defects recognition.

MonBIS-05

A Comprehensive Survey on Recent Developments in Iterative LearningControl Algorithms and Applications

Haris Anwaar Univ. of Science and Tech.
Yi-Xin Yin Univ. of Science and Tech.
Salman Ijaz Beihang Univ.

Iterative learning control (ILC) has evolved with the time after Arimoto's first paper, ILC was designed to cope the problems associated with the processes which involve repetitions. ILC involves dynamics along two dimensions i.e., iteration domain and time domain, which makes it different from other control techniques. In this paper, a comprehensive insight is given for the evolution of different areas for ILC, i.e., other control design techniques which when combined with ILC, provide improvement in robustness, performance, convergence of ILC. Moreover, by these combinations, ILC can address more broad applications and system dynamics.

MonBIS-06

Nonlinear Control of Triple Inverted Pendulum Based on T-S Cloud Inference Network

Xiu-ling Zhang Yanshan Univ.
Jing-huan Dai Yanshan Univ.
Yan-tao Cheng Yanshan Univ.
Shuang Hao Yanshan Univ.
Jia-huan Li Yanshan Univ.

The triple inverted pendulum is a nonlinear, dynamic and unsteady system. The traditional control methods of triple inverted pendulum have limited control accuracy and slow responding. This kind of pendulum system is difficult to control due to the inherent instability and nonlinear behavior. In this paper, GA-RBF-ARX model is applied to model triple inverted pendulum based on its input/output data. According to the

nonlinear identification model, a novel method via T-S cloud inference network controller optimized by genetic algorithm (GA) is proposed. T-S cloud inference network is constituted by T-S fuzzy neural network and the cloud model. Therefore, the rapid of fuzzy logic and the uncertain of cloud model for processing data are both taken into account. What's more, GA possesses global optimization characteristics and good parallel design structure. Compared with the simulation recognition results of T-S fuzzy neural network controller, T-S cloud reference network controller has strong robust and fast calculate speed. So, T-S cloud inference network by GA is an effective method in control.

MonBIS-07

Input-to-state Stability of Discrete-Time Switched Nonlinear Systems

Guiyuan Li Univ. of Jinan
Ping Zhao Univ. of Jinan

In this paper, global asymptotic stability (GAS) and input-to-state stability (ISS) for discrete-time switched nonlinear systems are investigated. Using multiple Lyapunov function method, some sufficient criteria on GAS and ISS are provided for discrete-time switched nonlinear systems. By the average dwell-time method, a sufficient condition on ISS is also obtained. Finally corresponding example is provided to illustrate the effectiveness of our results.

MonBIS-08

Observability of Boolean Control Networks with state-dependent input constraints

Xiaoyong Ma Central South Univ.
Yong Ding Central South Univ.
Rongpei Zhou Central South Univ.
Yuqian Guo Central South Univ.

In this paper, under the framework of the semi-tensor product of matrices, the observability of Boolean control networks (BCNs) with state-dependent input constraints is investigated. In order to avoid unnecessary repeated computation, an algorithm is proposed to check the observability. Furthermore, more effective necessary and sufficient conditions for the observability of Boolean control networks with state-dependent input constraints have been derived. Finally, an example is given to illustrate the effectiveness of the obtained results.

MonBIS-09

Attitude Estimation for UAV Using Extended Kalman Filter

Xiaofei Jing Univ. of Science and Tech. Beijing
Jiarui Cui Univ. of Science and Tech. Beijing
Hongtai He Beijing State Grid Fuda Science and Tech. Development Limited Liability Company
Bo Zhang China Electric Power Research Inst.
Dawei Ding Univ. of Science and Tech. Beijing
Yue Yang Univ. of Science and Tech. Beijing

A novel attitude estimation algorithm is proposed for unmanned aerial vehicles(UAV) in this paper. It uses attitude quaternion to represent the attitude of UAV, and uses extended Kalman filter(EKF) to fuse the merits of magnetic, angular rate, and gravity(MARG) sensors. First, attitude quaternion and drift bias of gyroscope are selected to construct the state vector, and the state equation is established based on the kinematics model of gyroscope. Then, an orthogonalization method is utilized to obtain the unit attitude quaternion from the outputs of accelerometer and magnetometer, it makes the magnetic field vector perpendicular to the measured gravity vector, which avoids the geomagnetic disturbance. And the unit attitude quaternion is used for the measurements for the EKF. Finally, the EKF update equation is used to determine the attitude of UAV. Experiments are provided on a real-world data set and the results show that the algorithm can precisely represents the orientation of UAV in both static and dynamic situation.

MonBIS-10

Natural landmarks based localization algorithm for indoor robot with binocular vision

Wei Hong Jilin Univ.
Hua Xia Jilin Univ.
Xuecheng An Jilin Univ.
Xiaocheng Liu Jilin Univ.

Self-localization in unknown environment is one of the most fundamental tasks for mobile robot. In this paper, a novel natural landmarks based localization method is proposed for indoor robot equipped with binocular vision, ceiling corner is taken as natural landmarks. The absolute location of the robot is determined according to the principle of triangular localization. The ceiling corner feature extraction is very importance for localization. Firstly, FAST with adaptive double threshold is proposed to extract feature points, which is described by 32- dimension SIFT descriptor. Then the absolute location is determined by matching feature points with landmarks database based on SIFT. Finally, the feasibility and effectiveness of proposed localization method is demonstrated.

MonBIS-11

ORB-SLAM-based Tracing and 3D Reconstruction for Robot using Kinect 2.0

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We aim to track robot location and provide dense 3D reconstruction while exploring environment in real time, based on one of the best SLAM algorithm called ORB-SLAM, which accurately estimate the camera poses and sparse 3D map of the environment based on images. However, the sparse map can't be applied to obstacle avoidance and navigation. We base on octrees and use probabilistic occupancy estimation, extending the mapping technique of ORB-SLAM and builds 3D reconstruction which can be used in robot field, the validity of this method is verified via benchmark datasets. Finally, the extended SLAM system is applied to a handheld Kinect 2.0, experiments show that the camera pose is accurately tracked and octomap is completed in real time.

MonBIS-12

Research on Indoor Robot SLAM of RBPF Improved with Geometrical Characteristic Localization

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LIDAR and odometer are used as the main sensors in this paper, with the two-wheeled self-balancing robot as the research and experiment platform, this topic has researched the way to SLAM when the robot is in unfamiliar environment with uncertain position and orientation. On the issue of setting the dynamic threshold value to zone the LIDAR scanning points in the process of constructing the geometry map, with the consideration of the character of RPLIDAR which is used in our research, this paper has analyzed and proposed the specific dynamic threshold values, which make the zoning of LIDAR scanning points more reasonable. In order to improve the robustness of SLAM, we have used regular particle filter (RPF) as the location algorithm. In order to solve the problem of unable to add auxiliary information under the traditional MCL framework, we have taken full use of the high accuracy character of the geometry matching and locating, and have used the result of it to improve the importance density function of RPF. Based on the idea of Rao-Blackwellization, the improved RBPF-SLAM has been proposed. The validity and feasibility of the improved RBPF-SLAM have been proved with simulations and experiments.

MonBIS-13

Circulant Structures Based Moving Object Detection

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Zimei Tu Shanghai Second Polytechnic Univ.

Background modeling and subtraction, the task to detect moving objects in a scene, is a fundamental and critical step for many high level computer vision tasks. However, background subtraction modeling is still an open and challenge problem particularly in practical scenarios with drastic illumination changes and dynamic backgrounds. In this paper, we present a novel background modeling method focused on dealing with complex environments based on circular shift operator. Firstly, the neighborhood of each pixel forming a region as a basis unit, performing circular shift on this unit to construct the background model. Then subtract the established background from the current frame to obtain the distance map. Thirdly, adopt the graph-cut on the distance map to perform foreground detection. The background model is updated with an adaptive update rate. Experimental results on indoor and outdoor videos demonstrate the efficiency of our proposed method.

MonBIS-14

Robust Edit Propagation Based On Hessian Local Linear Embedding

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Edit propagation is a technique that can propagate various image edits (e.g., colorization and recoloring) performed via user strokes to the entire image based on similarity of image features. Although manifold preserving has been used for edit propagation, there is still much room for improvement. To this end, this paper proposes an edit propagation method based on Hessian Local Linear Embedding which is a modification of locally-linear embedding, with the distributed field descriptor as the image features. We demonstrate the proposed edit propagation approach can achieve better results than previous work.

MonBIS-15

Research on Lending Decision and Optimization of Supply Chain Finance for Commercial Banks Based on Financial Constraint

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He Huang Jinzhou Medical Univ.

Supply chain finance is the integration of logistics, fund flow and information flow. Previous researches mostly analyzed the problem of financing decision in a cash-constrained supply chain from the point of financing companies in the supply chain. The paper studies a cash-constrained and two-stage supply chain system including a single manufacturer and a retailer from a new perspective of commercial banks and other lenders, aimed at commercial banks and other financial institutions to provide financing services to the upstream and downstream enterprises in the supply chain. The problem of commercial banks' financing decision is studied through establishing mathematic optimizes models under the framework of the newsvendor model. Then the results

of analog simulation show that the proposed model is feasible and accurate. The main contents and results are as follows: the numerical study indicates that if one of the firms in the supply chain has sufficiently low cash, joint decision referred to supply chain financing may be better not only for the lender but for the retailer and manufacturer as well. It is an important guiding significance in the practical operation of commercial banks' financing services for cash-constrained supply chains.

MonBIS-16

The Comprehensive Appraisement of the New Urbanization Level Based on Eight Ethnic Provinces in China

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Gansu Province Bureau of Statistics
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Jian Zhou Northwest Univ. For Nationalities

This paper discusses the views of New urbanization based on Eight Ethnic Provinces in China. It has built a six-dimensional indicator system involving 52 detailed indicators that can comprehensively measure the level of new urbanization on the basis of ethnic minority areas and has used Entropy Evaluation method to measure new urbanization levels in 2014 across the nation. According to the study, the development of new urbanization in areas inhabited by minority groups is extremely imbalanced, thus new urbanizations in different areas should be boost on the basis of local conditions.

MonBIS-17

Insider Trading, Internal Capital Market Efficiency and SEO Announcement Returns--An Empirical Research on A-Share Market of China Shanghai Stock Exchanges

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Kong Wei Xi'an Univ. of Tech.

This paper studies 3 relationship, first relationship is between insider trading profits and the efficiency of internal capital market, made conclusion that the insider trading profit which made by director, supervisor, senior and the staff and relatives can effectively improve the efficiency of internal capital market; secondly, empirical evidence shows that the internal capital market efficiency effectively alleviate the uncertainty of SEO announcement return, from two perspective: directional add-issuance and public security issuance market; finally, with the additional join of the concept of insider trading---insider trading scale which found it has positive impact on the efficiency of internal capital market, that the insider trading scale and internal capital market efficiency can effectively improve the SEO market return. Therefore, allowing appropriate insider trading profit stimulate the executives nostalgia for the position, leaving return as ability and cleverness ``incentive mechanism'' can effectively mobilize the enthusiasm of the management of the enterprise, has a positive impact on the SEO announcement return.

MonBIS-18

Application of Pattern Recognition Based on Rough Set and Optimized BP Neural Network

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In this paper, rough set, genetic algorithm and BP neural network are combined together in pattern recognition. The neural network, rough set, and genetic algorithms are described in details. The wine dada in UCI database is considered and is dealt with by the above combination approach. The result shows that the accuracy of pattern recognition is improved and the cost of input is decreased. The proposed method has a high value of application. The approach presented in the paper is significant both in theory and practice.

MonBIS-19

Option Pricing Based on HMM and GARCH Model

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This paper aims to improve the accuracy of option pricing by using the hidden Markov model(HMM) incorporated into Black-Scholes option pricing(BS). Considering that volatility forecast is a key issue for option pricing, we firstly use historical time series of the underlying asset to train a two-state HMM. Then we apply the model to recognize the hidden states behind the observable time series, dividing the entire time series into two regimes with different volatility levels. Within each regime, we train the corresponding generalized autoregressive conditional heteroskedasticity (GARCH) model with different parameters. Finally we can predict the hidden state of next time by the HMM and use the corresponding GARCH model to forecast the volatility. After obtaining the volatility sequence during the life of the option, we can further make the forecast on option price based on BS model. The empirical analysis shows that our method is superior to traditional historical volatility and GARCH methods.

MonBIS-20

Online Context-based Person Re-identification and Biometric-based Action Recognition for Service Robots

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In this paper, we address the problem of person re-identification and action recognition for service robots, which undergoes lack of training dataset for model learning, reduction of feature set discriminative power in changing scenarios, and high complexity of the algorithm computation. An online context-based person re-identification algorithm is proposed, which learns the person model online without pre-collect dataset and adjusts the weight of features according to the context information. An online biometric-based action recognition algorithm is proposed, actions are recognized by simply matching the skeleton vectors extracted from five linkage mechanisms of human body. The proposed algorithms are evaluated on a service robot system, extensive experimental results show that they performs efficiently and effectively in various real-life scenarios.

MonBIS-21

A Wireless Evaluation System for In-home Physical Rehabilitation

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This paper describes an evaluation system, which can visually display and evaluate the user' s performance in his physical rehabilitation. The system is composed of a body sensor network with low cost MEMS inertial measurement units (IMUs), which is capable of measuring the orientations of all body joints. Every joints orientation is represented relative to its parent joint according to human skeleton and they are used as features to evaluate. The system uses OGRE (object-Oriented Graphics Rendering Engine) to reconstruct and display the three-dimensional motion of a human body in virtual scenes on computers. To evaluate the user's performance of rehabilitation, the body motion sequences data are analyzed with Dynamic Time Warping (DTW) algorithm, and are compared with the standard motion sequences from health experts. The DTW algorithm can measure the distance between sequences of varying speed, and avoid the problem of different speed of doing a same motion.

MonBIS-22

Design of Public Health Management System Based on SOA Architecture

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The public health management system (PHMS) becomes the bottleneck of the development of public health, which is the basis to design a set of information system in accord with Chinese universal health or health insurance, it adopts SDO/SCA/BPEL techniques of SOA system to connect all the modules seamlessly, and releases to the outside through a Web service. The design of the system is advanced technology, flexible, easy to expand, practical, safe and reliable.This paper provides a solution to the applying of SOA frame in large scales service system, through analysis and design of public health management system.

MonBIS-23

The Collaborative Decision of Profit Distribution in Retail Supply Chain under Emergency

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Aiming at the profit optimization distribution problem of retail supply chain under emergencies, the retail price and revenue sharing proportion are set as the floating parameters. The profit distribution multi-objective programming model of retail supply chain is created based on revenue sharing contract under the emergency. Cooperation intentions are concluded by the dynamic negotiation. This paper presents a collaborative decision algorithm of retail supply chain profit distribution based on multi-objective symbiotic co-evolutionary genetic algorithm. The multi-objective evolutionary optimization problems of retail supply chain are well studied under emergency, by which the intelligence and precision of multi-objective collaborative decision-making are improved. The numerical experiment results show that the profit distribution multi-objective programming model of retail supply chain under emergency makes profits into balance for both sides and the entire supply chain profit loss into minimization. The feasibility of the collaborative decision algorithm for retail supply chain profit distribution is verified under emergency.

MonBIS-24

Lean Implementation Through Value Stream Mapping: A Case Study of A Footwear Manufacturer

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Lean production is one of the initiatives that are applied by many manufacturers to obtain the competitive advantages in the increasingly competitive global market. Value Stream Mapping (VSM) is one of the key lean tools to identify the opportunities for other lean approaches and for waste elimination in the production system. Since the performance of the supply chain would significantly influence that of individual partners, the implementation of lean thinking should also extend beyond the boundary of the manufacturing plant to the whole value chain. This paper introduces the VSM and the extended VSM used for description, analysis

and identification of improvement initiatives internally and externally in the context of a footwear manufacturing enterprise. It can be seen from the analysis of the "initial state", "current state" and "future state" VSM that the inventory and other non-value added activities within the manufacturing plant can be reduced by the launch of lean initiatives internally. However, the market responsiveness and competitiveness would not be enhanced substantially unless the extended VSM is taken into the implementation of lean.

MonBIS-25

Trade Credit Policy of Supply Chain with Oversupply

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Trade credit arises when a buyer delays payment for purchased goods or services. In order to explore the trade credit policy when the supplier is produce surplus under deterministic linear demand, based on the wholesale price contract, we establish a two-echelon financial supply chain game model with a supplier and a retailer under the condition of excess supplying, and obtain the decisions and the profits of supply chain which credit trade is considered. Both the participants' decision objective is return maximization, then we obtain the equilibrium solution. We find, based on the wholesale price contract, the supplier suffers from oversupply but the retailer benefits from oversupply, and supply chain efficiency is impaired by oversupply. Trade credit for retailers cannot improve both supply chain sales quantity and mutual benefits. Additionally, trade credit is a useful tool available for supplier to stabilize the wholesale price on overcapacity.

MonBIS-26

Research on Game of Fresh Agriculture Products Distribution Scheme in the Supermarket-oriented Mode

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The distribution of fresh agricultural products in our country is restricted by the ability of distribution, which causes too many intermediate links in the supply chain, so that the income of both ends in the supply chain (the suppliers of agricultural products and the final consumers) are seriously damaged. In this paper, with the help of matrix model analysis, we design a differentiated distribution mode for different suppliers. By using the method of dynamic game, we get the Nash equilibrium solution of the pricing and distribution time between the supermarket and the cooperatives in the Supermarket-oriented farm-supermarket direct purchase mode, and the conclusion is verified by an example. Finally, this paper also analyzes the change regularity of Nash equilibrium solution with the consumer demand for fresh agricultural products quality becoming more and more high, and puts forward the coordination mechanism in the development of distribution plan by the cooperatives and the supermarket to help the development of their core competitiveness.

MonBIS-27

Travel Time Analysis of the Single and Dual Command of AS/RS

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Multi aisle automated storage and retrieval systems correspond to multiple picking aisles served by a single storage and retrieval machine. We use this system for saving the initial investment costs due to single aisle systems. The objective of the presented study is to develop analytical travel time models for multi aisle automated storage and retrieval systems considering the operating characteristics of the storage and retrieval machine. Acceleration and deceleration of the storage and retrieval machine is considered in this paper instead of uniform speed, and there are curve channels in the warehouse. Based on the above hypothesis, the time function and distance function are studied in this paper. The distribution function of the distance and time is given. On this basis, the expected travel time of the automated storage and retrieval system is studied. Finally, a numerical example is given. The results show that proposed analytical travel time models perform satisfactory according to the results and could be very useful tools for designing of multi aisle automated storage and retrieval systems in real-world applications.

MonBIS-28

Optimizing Logistic Distribution Routing Problem Based on Wavelet Chaotic Neural Network

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A mathematical logistic distribution model with constraints was constructed and a wavelet chaotic neural network model was proposed to solve the route optimization problem of logistic distribution. In order to escape the local minima, a new chaotic neural network model called Shannon wavelet chaotic neural network was presented. The activation function of the new model is non-monotonous, which is composed of sigmoid and Shannon wavelet. The figures of the reversed bifurcation and the maximal Lyapunov exponents of single neural unit were given. And the new model is applied to solve several function optimization problems. The new model can solve the logistic distribution routing more effectively because of the Shannon wavelet being a kind of basic function. Seen from the simulation results, the new model is powerful.

MonBIS-29

The Revenue-sharing Contract Coordination of Supply Chain Under Asymmetric Information

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This paper considers the revenue-sharing contract coordination of supply chain under the asymmetric information with one retailer and one supplier. We present an approach by a function which can constraint the reported sales volume of the retailer. The optimal profits of the supply chain are obtained with this approach. A numerical example is given to show the effectiveness of the proposed approach.

MonBIS-30

Impact of Loss Aversion on Supply Chain Coordination with the Combined Contract

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This paper investigates a single-period two-echelon supply chain with random demand, where the lossaverse preference is adopted to describe the retailer's decision-making behavior. By combining the revenue sharing (RS) contract and the buy-back (BB) contract, a new combined contract is introduced. It is shown that the combined contract could mitigate the risk-aversion effect, and coordinate the supply chain. Moreover, the effects of retailer's risk preference on agents' decision-making and profit allocation are studied. In terms of coordination and profit allocation, the combined contract presents more advantages than the RS contract and the BB contract. The numerical experiments are conducted to validate our theoretical results.

MonBIS-31

Newsvendor Problem with VaR and CVaR Criteria under Random Demand and Supply

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This paper studies the effect of random supply on the inventory decision of a newsvendor. For risk-neutral newsvendor, we find that the optimal order quantity is affected by random yield and the combination of random yield and capacity, but not affected by capacity uncertainty. For risk-averse newsvendor, we consider the newsvendor problem with a Value-at-Risk (VaR) constraint and the newsvendor model with Conditional Value-at-Risk (CVaR) measure. Under the VaR constraint, we find that random supply may lead to an increase or decrease in the optimal order quantity. However, under the CVaR criterion, random supply decreases the order quantity.

MonBIS-32

Discussion on the Problems and Countermeasures of Smart City Logistics System

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The development of new smart city has promoted the innovation of information technology, made the industrialization and informatization highly integrated. The construction of smart city relies on the intelligent transformation of the various fields of urban operation, among them, the urban circulation situation is the focus of developing new smart city. The article first puts forward the concept of the smart city logistics system so as to strengthen the soft power of city, promote the industrialization upgrading of the high-tech, and promote the operation efficiency of the smart city. The article establishes the framework of the smart city logistics platform system, carries on the detailed analysis of smart city logistics system development issues in the future. It is suggested that the construction of the smart urban logistics system in China should upgrade the industrial flexibility mainly, take the market demands as the traction and take the geographical advantages as the opportunity to improve the logistics service system.

MonBIS-33

The Data Mining Method Based on Support Vector Machine Applied to Predict Tool Life of TBM

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The tool life prediction model of tunnel boring machine (TBM) can well reflect the influence of geological structure and machine operation on tool

life. In this paper, basing on big data to modeling is the innovation rather than traditional model of analytical dynamics. The author firstly introduces the principle of support vector machine, then the author perfectly integrates both normal and non-normal tool damage, and make them combine with the dynamic factors influence tool life. From the data gaining from mining a city subway line 4 point of view, because the support vector machine has the advantages of small dimension, transduction reasoning and so on, the author chose this way. First of all, the author uses the gray correlation method to select driving factors to form information matrix which includes daily digging mileage, rock rank, number of tool damage, thrust of the cutter, cutter speed, speed of boring. The second the author use k-cross-check and grid search to find the optimal parameters and the author select the optimal kernel function is Gaussian kernel function. At last the author use structural model calculated to predict life of the tool from subway line 5, at the same time the author obtain the prediction accuracy is 94.52%. It is shown that the regression model based on SVM can predict the life of tool in the next working interval, which can provide guidance for scheduling tools and intelligent use of shield machine.

MonBIS-34

Data-Driven Adaptive Dynamic Programming for Two-Player Nonzero-Sum Game

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In this paper, we propose a data-driven adaptive dynamic programming approach to solve the Hamilton-Jacobi (HJ) equations for the two-player nonzero-sum (NZS) game with completely unknown dynamics. First, the model-based policy iteration (PI) algorithm is given, where the knowledge of system dynamics is required. To relax this requirement, a data-driven adaptive dynamic programming (ADP) is proposed in this paper to solve the unknown nonlinear NZS game with only online data. Neural network approximators are constructed to approach the solution of the HJ equations. The online data is collected under the two initial admissible control policies. Then, the NN weights are updated based on the least-squares method using the collected online data repeatedly, which is a kind of the off-policy learning scheme. Finally, a simulation example is provided to demonstrate the effectiveness of the proposed control scheme.

MonBIS-35

Multimode analysis and online monitoring for injection molding processes

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Injection molding process is a typical batch processing technique to manufacture plastic products. In such process, plastic particles are heated to melt, injected to a mold with a certain configuration, and cooled down to solid state. In recent years, because of the more pressing market demand for modern multi-species, multi-standard and high-quality products, more attention have been paid on batch processes which can produce small-quantity, high-added-value products. In order to improve the safety of multimode production process, inter-mode analysis is an urgent need to establish monitoring for multimode production process. Besides inherent process variation along the time direction within each batch, multimode characteristic along the batch direction widely exists in injection molding processes. Different operation modes along the batch direction may not be well captured by a single model. In this work, multiple modes are modeled separately for online process monitoring along the batch direction. First, after a batch cycle is divided into multiple phases, normality test is conducted to analyze the data characteristic. Then, ICA-PCA models are constructed for each mode within each phase according to their different characteristic considering both the Gaussian and non-Gaussian information of the process data. Then online monitoring model is properly chosen by identifying which mode the new sample point belongs to. The application to a real injection molding process illustrates the feasibility and performance of the proposed algorithm.

MonBIS-36

High efficient operation for a DPGS-HES system using dynamic programming

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This paper proposed an operational strategy for a distributed power generation system with hybrid energy storage (DPGS-HES) under dynamic programming (DP). The system, consisting of a generator, batteries and super-capacitors, was primarily designed to satisfy electricity needs in domestic sectors. DP aimed to instantaneously split the power to the multi- source in the DPGS-HES when load demands fluctuated. Simulation results validated its effectiveness where the system had virtuous dynamic performance when the constraints and objectives were met. The overall energy efficiencies were also dramatically improved from 3.84%, 3.67%, 5.15%, 4.14% to 19.69%, 17.47%, 21.48%, 17.75%, respectively in case studies.

MonBIS-37

Research on the System Technology for Automated Container Terminal

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This paper carries out research on handling technology, foreword handling equipment and handling efficiency prediction of intelligent container terminal, puts forward advanced and reasonable intelligent handling working system and foreword handling equipment plan, promotes the development of automated terminal technology in China, lays foundation for further application, provides technical support, lays foundation for further detailed research on intelligent container terminal, promotes the development of container terminal in the direction of environmental protection, energy conservation, automation, informatization, intellectualization and realizes true full-automatic terminal system.

MonBIS-38

The Analysis of Bidding Strategies in Multi-attribute Reverse Auction with Risk-averse Suppliers

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In this paper, a generalized multi-attribute reverse auction model is introduced and the equilibrium bidding strategies of the risk-averse suppliers are analyzed. In the proposed models, the procured item includes multiple quality attributes and several cost parameters. There is not a linear restriction on the form of the cost function any longer, thus it is adapt to a more complex situation. The equilibrium qualities are only affected by suppliers' cost parameters and the equilibrium price decreases with the risk attitude. In order to reduce the computational complexity of equilibrium price, two concrete formulas are given for the convenience of application in the special cases. At last, three numerical examples are calculated to verify the advised models.

MonBIS-39

Brand and Channel Competition under Different Dominant Structure

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This paper is based on the two-stage supply chain, considering the situation that manufacturer opens direct sale channel and retailer provides private products. According to the fact that different ownership has a great influence on the supply chain structure,we establish the mathematical model, and analyze the impact of supply chain structure on supply chain members' profit and pricing strategies when there are the competition between direct channel and retail channel ,and the competition between manufacturer's brand products and power retailer's private products under different dominant structure.The result shows that,when manufacturer as the leader of supply chain opens direct sale channel,retailers can reduce loss by providing their private products.When channel competition intensity is small,providing private products is not conducive to manufacturer;In the case that dominant retailer provides provide products,when brand competition intensity is very small,it is unprofitable for manufacturer to open direct channel.And when brand competition intensity is larger,opening direct channel is beneficial for manufacturers. With the increase of brand competition intensity, retailers should reduce brand products' and their own products' retail price.

MonBIS-40

Dynamic and Interactive Gesture Recognition Algorithm Based on Kinect

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Lei Yu Soochow Univ.
Jun Huang Soochow Univ.

With the constant development of smart devices, Gesture recognition is applied on more and more fields. Gesture recognition devices currently on the market are inconvenient and expensive. A gesture recognition method based on Kinect is proposed in this paper. The camera of Kinect is used to get gesture images and then a hidden Markov model is established to recognize dynamic gesture so that the operation is simple. The assessment, decoding algorithms and training issues of hidden Markov model in gesture recognition is focused in this paper. Viterbi algorithm and Baum-Welch algorithm are used to solve the problems above. After simulation experiments, it is discovered that the gesture recognition algorithm based on Kinect proposed in this paper has a high accuracy rate for a variety of gestures, simultaneously the naturalness of human-computer interaction has been greatly improved.

MonBIS-41

Travel Distance Characteristics Analysis Using Call Detail Record Data

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With the development of growing number of China's mobile phone users and mobile Internet, intelligent transportation has become an effective way to solve the traffic problems. Many studies based on GPS data analysis are available. However, high costs lead to insufficient number of samples, the small number of studies based on call detail record (CDR) data analysis only apply a small range of short data sample. The study covers 27604 base stations in Beijing’ s Sixth Ring Road, collecting millions of data for research. By analyzing the location update of mobile communication network and mechanism of data and targeting, 75 zones are defined based on land use categories. The case study demonstrates CDR data for traffic characteristics analysis were practical. Travel distance consistent with the law of power law of Traffic zone. For different traffic zones (working or residential) travel mode choice, and improve the traffic situation provides a theoretical basis.

MonBIS-42

Exploring Traffic Accident Locations from Natural Language Based on Spatial Information Retrieval

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Exploring traffic accident locations is essential for making prevention strategy in order to improve traffic safety proactively. Quite a number of methods have been developed to acquire accident spatial data, by various detectors in roads. However, plenty of locations information is contained in textual alarm information transformed from telephone calls of 122 Alarm Reception. This paper, aims to obtain spatial data, longitude and latitude, of traffic accident locations based on textual alarm information. Natural language processing, database system and Geographic Information System (GIS) are used to get traffic accident spatial data. The proposed method involves three processes, location name identification, spatial information retrieval and information matching respectively. Validation results show that the method is of reasonably high accuracy for exploring traffic accident locations.

MonBIS-43

A Real-time Traffic Signal Control for Single Intersection in Incomplete Connected Vehicles Environment

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Xiangdong Chen Zhejiang Univ.

It will stay in incomplete connected vehicles environment for a long time before all cars are connected. The purpose of this paper is to take full use of incomplete connected vehicles information to improve intersection efficiency. In order to estimate the state of unconnected vehicles and construct arriving table, an estimation algorithm is proposed. A real-time signal control algorithm is presented to optimize phase sequence and duration with dynamic programming. An objective function is considered: minimization of the total vehicle delay. This method has been tested in TransModeler. The result shows that the proposed method outperforms actuated control by reducing vehicle delay by 17.25% and reducing queuing length by 20.19% under 100% penetration rate. The method always achieves better performance than actuated control when penetration rate above 30%.

MonBIS-44

Digital Modeling Analysis of Urban Road Traffic Capacity Under the Condition of Traffic Accidents

Qicheng Xu Shenyang Jianzhu Univ.
Jianing Zheng Shenyang Jianzhu Univ.
Changchun Sun Shenyang Jianzhu Univ.

Traffic capacity in an accident site of the lane is investigated by analyzing the urban road traffic accident. The accident is caused by the vehicles in the upstream intersection traffic jam time. A hypothesis model is established to describe a relationship between the vehicle queue length and the cross-sectional actual capacity in the accident. In order to verify the rationality of the assumptions and the structural equation model, an appropriate index model is analyzed by means of the calculation. The last VISSIM traffic microscopic simulation system model is constructed to simulate the change of the queue length under the influence of various factors. The specific values and corresponding time of the queue length can be predicted by utilizing the data of the VISSIM output queue length.

MonBIS-45

Response and control of a levitation module under track irregularities when the maglev train is traveling

Danfeng Zhou National Univ. of Defense Tech.
Peichang Yu National Univ. of Defense Tech.
Jie Li National Univ. of Defense Tech.
Lianchun Wang National Univ. of Defense Tech.

The EMS (Electro-Magnetic Suspension) maglev train uses attractive magnetic forces to neutralize its weight, which puts a rather high requirement on the smoothness of the track since the levitation gap is generally 8~10 mm. It has been observed that in a traveling urban maglev train, the levitation gap error of the rear levitation unit in a levitation module is generally more prominent than that of the front levitation units; and under poor track conditions, the rear electromagnet of the levitation unit is more likely to clash with the track and to cause a levitation failure. However, this phenomenon has not yet been well interpreted. In this paper, a model of the levitation module in a maglev train is built to study the responses of the levitation gaps under different vehicle speed and track conditions, and results show that the levitation module is sensitive to some specified wavelengths ofthe track irregularities, and the analysis well interprets the reason that causes the difference of the response for the front and the rear levitation unit under track irregularities. A control strategy is also proposed to reduce the rear gap fluctuation.

MonBIS-46

Characteristic of Transportation Network with LOGIT Model

Zaisheng Pan Zhejiang Univ.
Xuanhao Zhou Zhejiang SUPCON Research CO.,LTD.
Peng Chen Zhejiang SUPCON Research CO.,LTD.

In this research, we employ LOGIT model, which is widely used in statistical field, to describe the individual decision-making process instead of shortest path rule in transportation network models. With the idea of congestion effects, we can derive a stationary flow distribution solution analytically under any given network structure which is solved by a numeric iterative approach approximately. Based on that, simulations are made to compare the cumulative the difference of load distribution under shortest path law and our LOGIT law. Meanwhile, four different classes of networks are tested to uncover the relationship between traffic flow and topological structures under LOGIT law. The results indicated that random network and scale-free network outperform than the others two in the measurement of TSC.

MonBIS-47

Numerical investigation of transport aircraft cabin environment control in initial stages of fire

Zhuohuan Hu Univ. of Shanghai for Science and Tech.
Lina Zhang Univ. of Shanghai for Science and Tech.
Lulu Wang Univ. of Shanghai for Science and Tech.

The mathematic models were established to study the distribution of the flow field and movement rule of the smoke in a transport aircraft cabin with environment control system when fires broke out. Based on the interaction of forced convection and natural convection, this article simulated and analyzed the changes of temperature fields and concentration fields of combustion product in initial stages of fire under different boundary conditions. Regularities of the propagation of harmful gases are provided by analyzing the concentration distribution of carbon dioxide. According to this article research results, we can upgrade and optimize the corresponding measures to tackle a fire. Namely, when a fire break out, the staff should be far away from the fire source, stay away

from the cabin wall and increase the ventilation rate in low temperature to expand the living environment in space and time.

MonBIS-48

A Shadow Resistant Tracking Method for Outdoor Scene

Linlin Zhu Shenyang Aerospace Univ.
Jiandong Tian Shenyang Inst. of Automation CAS
Mingyue Li Shenyang Aerospace Univ.
Guanglei Meng Shenyang Aerospace Univ.

Shadows bring many problems in object tracking because of the appearance's change caused by illumination variation. In this paper, we present a shadow-resistant tracking method for the objects in outdoor scene based on a new shadow invariant transformation. Our method includes 3 steps: shadow detection and verification, shadow invariant transformation for image sequence and shadow resistant tracking. Our method can be applied in both the still background scene and the dynamic scene; the experiment results validate the performance of our method.

MonBIS-49

Visual Servo Control of Unmanned Aerial Vehicles: An Object Tracking-based Approach

Jia Yang Bohai Univ.
Xing Huo Bohai Univ.
Bing Xiao Bohai Univ.
Zhenzhou Fu Bohai Univ.
Chaofan Wu Bohai Univ.
Yiran Wei Bohai Univ.

This paper investigates the object following control problem for a low-cost quadrotor unmanned aerial vehicle (UAV). An object tracking-based approach is proposed. In this approach, the techniques of object tracking and visual servo control are efficiently combined to achieve the control objectives. To eliminate the impact of tracking target rotation during tracking model, an online learning method is proposed by learning the object size over different view at the desired distance. On the basis of this, an image-based visual servo control law is then designed to ensure that the quadrotor can track the moving target in real-time and keep the desired distance away from the object. The applicability of the proposed scheme is verified by flight experiments. It is demonstrated that the proposed algorithm is robust to rotary movement.

MonBIS-50

Improved CamShift Tracking Method Based on the Edge Suppression

Chunbo Xiu Tianjin Polytechnic Univ.
Zuohong Chai Tianjin Polytechnic Univ.
Huiyao He Tianjin Polytechnic Univ.
Jianguo Hou Tianjin Polytechnic Univ.

In order to improve the tracking performance of the target in complex background, a novel Camshift tracking method based on the edge suppression is proposed. Because the edge of the target is probably most vulnerable to the background, the gray value of the target edge in the back projection image is suppressed by the weighted method according to the position and size in the previous frame. Thus, the disturbance information from the background can be prevented from involving the target tracking. The method is applied to track the actual target and the target in the video of the standard test libraries. Experimental results show that the accuracy and stability of the target recognition and tracking can be improved by suppressing the information of the edge of the tracking target in the back projection image. And the method can also meet the real time tracking requirement of the TV tracking system.

MonBIS-51

Dynamic Performance Adjusting Control of DC Motor Double Closed Loop Speed Regulating System

Shengmeng Duan Chongqing Univ.
Niu Wang Chongqing Univ.

Aiming at the dynamic performance control problem of DC motor speed regulation system, the characteristics of DC motor double closed-loop speed regulation system are analyzed, and the dynamic performance of double closed-loop speed regulation system of DC motor can be adjusted by controlling the armature current. The method of adjusting the dynamic performance of the system is introduced in this paper. This method introduces the current dynamic control adjusting link in the DC motor double closed-loop speed regulating system, which adjusts the current feedback coefficient so that the current is outputted according to the given value, so as to regulate the motor acceleration process dynamic performance tuning purposes. Experiments show that the proposed control method is effective.

MonBIS-52

Speech Recognition Based Building Semantic Map Method on Aldebaran Nao

Shuhua Liu Northeast Normal Univ.
Qiwei Xing Northeast Normal Univ.
Yuanyuan Han Northeast Normal Univ.
Yu Zhao Northeast Normal Univ.
Runmin Li Northeast Normal Univ.

Shallow domain knowledge, such as labels attached to objects and places is necessary for task planning of mobile robots. In order to save energy and protect environment for robots, a fast and effective semantic building map method based on sonars, vision and audio is proposed. Firstly, humanoid robot Nao builds the border map of an unknown environment by its sonars. And then Nao follows a red ball that controlled by a person to close to an obstacle in the environment. After that, Nao builds the border of the obstacle by its sonars autonomously. When finishing an obstacle border, Nao will get the name of obstacle by speech recognition. In this way, Nao builds the border map of all obstacles one by one until the map of the unknown environment is built. As illustrated in experimental results, the proposed algorithm is very fast and effective, and easy to implement.

MonBIS-53

Dynamic Localization of Mobile Robot Based on Triangulation Centroid Estimation

Shuhua Liu Northeast Normal Univ.
Qiwei Xing Northeast Normal Univ.
Yuanyuan Han Northeast Normal Univ.
Yu Zhao Northeast Normal Univ.
Runmin Li Northeast Normal Univ.

According to the inbuilding disaster rescue system failure in network blind spots, a self-dynamic localization system of mobile robot, which can dynamically choose beacon node and determine centroid of intersection based on circles of three beacon nodes, was proposed. This method can apply Received Signal Strength Indication (RSSI) for distance measurement. Geometric Contraints-based Triangle Centroid Estimation (GCTCE) fulfilled the localization. Kalman filter was integrated with the proposed localization to realize the error-correct. The errors caused by the interference of the environmental noises can be minimized efficiently. Especially in network blind spots, the Kalman filter provides optimal data. Simulation and experimental results showed the accuracy and adaptivity of the self-dynamic localization of mobile robots.

MonBIS-54

Adaptive Distributed Estimation for Mobile Sensor Networks Based on Cubature Kalman Filtering

Tan Qingke Beihang Univ.
Dong Xiwang Beihang Univ.
Li Qingdong Beihang Univ.
Ren Zhang Beihang Univ.

To deal with the nonlinearity in the target tracking and distributed estimation in mobile sensor networks, an algorithm of adaptive distributed estimation for mobile sensor networks based on cubature Kalman filtering is proposed by combining the advantages of the cubature Kalman filtering and consensus algorithm. The weight matrix in the consensus iteration changes dynamically according to the error between the node and its neighbors to improve the convergence rate of consensus iteration. Besides, the estimation error of the algorithm is proved to be bounded in mean square. A simulation example of mobile sensors in the sky tracking target on the ground is given to validate the effectiveness of the proposed adaptive distributed estimation.

MonBIS-55

An Extrinsic Calibration Method for Binocular Cameras and Swing 2D Laser Rangefinder

Wenkai Chang Chinese Academy of Sci.
Guodong Yang Chinese Academy of Sci.
Zize Liang Chinese Academy of Sci.

In this paper a novel method is proposed to calibrate the extrinsic parameters of the swing 2D laser rangefinder (LRF) and binocular cameras system. Target object that need special processing is abandoned. Extrinsic calibration is completed with one observation of three planes that posted with checkboard-like posters. The procedure is simplified. Superior to the monocular vision, stereo vision can obtain more information of scene. 3D virtual points and lines are deduced by analyzing the intersected 3D planes and they are used as inputs to an optimization problem which estimating the relative pose between camera and LRF. Moreover, we build geometric model of swing LRF and estimate the two important parameters with Levenberg-Marquardt (LM) individually. Thus, the distortion of point cloud that caused by mechanical structure is corrected as pretreatment of relative pose calculation. Experimental results demonstrate the validity of the proposed calibration and correction methods.

MonBIS-56

A Fast Segmentation Method of Sparse Point Clouds

Mengjie Li Beihang Univ.
Dong Yin Beihang Univ.

In this paper, we present a fast segmentation algorithm based on the geometric characteristics of the objects and the attribute of medium. This algorithm is not only suitable for sparse point clouds, but also for dense point clouds. It is built up of three stages: First, the range image is established from the Velodyne VLP-16 laser scanner data, which changes the sparse characteristic of data in the original space and determines the close relationship between the data points. Then, according to the geometric relation of the adjacent data points and point clouds edges distribution analysis, a region growing method is used to complete the fast segmentation of point clouds data, obtaining a series of mutually disjoint subsets. Finally, based on the laser intensity, refined segmentation of the under-segmentation subset is addressed using the K-means clustering method. The point clouds of an indoor corridor scene are used to verify the superiority of our method and compared with three

typical algorithms. Experimental results prove that our method can fastly and accurately segment objects in the scene, and is not sensitive to noise and satisfactory in anti-noise performance.

MonBIS-57

A Crime Scene Reconstruction Method Based on Omni-directional Catadioptric Cameras

Mai Jiang National Police Univ. of China
Liqu Song National Police Univ. of China
Shunli Qiao National Police Univ. of China

This paper describes a method for omni-directional 3D reconstruction with a hyperbolic mirror and a regular camera. Omni-directional images are becoming increasingly famous in computer vision and other fields. Despite there some related research in omni-directional vision system applications during last two decades, however, omni-directional perception system have not ever been applied in crime scene reconstruction. The main advantages of the catadioptric vision system are robustness because of no needing mechanical moving units and single effective viewpoint constraint which allow the next feature detection. Firstly, we provide the transformation mapping method from the omni-directional images into the cylindrical panoramic images. Secondly, we use the SIFT Method to yield the scenario features. Subsequently, we tackle this matching and disparity estimation problem by proposing Markov random field (MRF) model. Finally with some experiment and we show the 3D clouds actually results.

MonBIS-58

Path Planning of Mobile Robot Based on Improved A* Algorithm

Mingxiu Lin Northeastern Univ.
Kai Yuan Northeastern Univ.
Chenzhi Shi Northeastern Univ.
Yutong Wang Northeastern Univ.

Aiming at the problem of path planning algorithm of autonomous parade robot in the indoor environment, this paper, based on Dijkstra algorithm and A* algorithm, introduces the influence of the current node's parent node to the heuristic function in A* algorithm, and seeks the optimal weight of the heuristic function to optimize the path planning algorithm. In the MATLAB environment, different scenarios were simulated, and compared with the non-improved situation in terms of path searching consumption time, path cost and traversed grid number and other indexes. After using the more reasonable heuristic function and changing the weight appropriately, the poor real-time capacity of the A* algorithm was improved at the expense of a small path cost.

MonBIS-59

Modeling and Enactment of Control Flow Specifications Based on ECA Rules and Process Decomposition

Gang Chen China Academy of Engi. Physics
Harbin Institute of Tech.
Baoran An China Academy of Engi. Physics
Jin Liu China Academy of Engi. Physics

Because of inherent variability and uncertainty in modern industrial control system, the control system software framework pays more and more attention to the design and re-construction of industrial control flow. Establishing a reasonable control flow model is essential to carry out control flow component re-engineering, which can describe control business-related information and relationship. In order to ensure that the model can be interpreted and executed by the control system software framework, we propose a novel control flow model based on ECA rules and process decomposition. The model mainly focuses on the execution dependencies between control flow activities and proposes the concepts of sequence dependency, data dependency, trigger dependency and resource dependency. In addition, process decomposition is proposed to support hierarchy control flow modeling and management. The successful application of this model in large laser facility indicates its reliability and effectiveness.

MonBIS-60

Long distance slurry pipeline transportation slurry arrival time prediction based on multi-sensor data fusion

Xuyi Yuan Kunming Univ. of Sci. and Tech.
Xiaodong Wang Kunming Univ. of Sci. and Tech.
Xiaonan Zhang Yunnan Tianlang Energy Saving & Environmental Protection Group Co.,Ltd

For the slurry arrival time calculation problem in Long distance slurry pipeline transportation process, a multi sensor data fusion method based on SCADA system is proposed, which can predict the arrival time of slurry. Due to high cost, difficult accurate flow measurement, large maintenance with supporting facilities in slurry pipeline concentration meters and flow meters, in this paper, through the research of multi-sensor data fusion technology, by using the least square weighted data fusion algorithm based on self-learning, comprehensive transportation equipment operation data, flow meter, pressure gauge, concentration sensor data transmission flow detection of slurry pipeline, calculate mean velocity, realizing the slurry arrival time prediction. The results show that the method has high accuracy, and the validity of the method is proved.

MonBIS-61

Tensor product model transformation based fractional decoupled sliding-mode control for cart-pole system with time-varying sliding surfaces and Dahl friction model

Guoliang Zhao Dalian Univ. of Tech.
Sharina Huang Heilongjiang Univ. of Sci. and Tech.
Yajiang Zhang Heilongjiang Univ. of Sci. and Tech.
Taifa Zhang Heilongjiang Univ. of Sci. and Tech.
Yaping Zhang Heilongjiang Univ. of Sci. and Tech.

This article proposes a tensor product model transformation based fractional order decoupled sliding mode control (TPFrDSMC) scheme for cart-pole system with friction model. In the design of TPFrDSMC, the fractional order sliding surface is incorporated into the main sliding surface, and the number of tuning the sliding surface slopes is reduced to 5. Based on fuzzy logic, parameters auto-tuning laws for the sliding surface slopes are implemented. Finally, control law of the proposed TPFrDSMC is designed according to Lyapunov stability theorem. The proposal is validated through a simulated cart-pole system with Dahl's friction model. The robustness has been evaluated through simulation in the presence of frictions and disturbances, and comparisons are performed with respect to classical approach show a better performance of the newly proposed method

MonC02 Room02
Intelligent Building Control and Management (III) (Chinese)
16:20-18:20

Chair: Yahui Wang Beijing Univ. of Civil Engineering and Architecture

16:20-16:40 **MonC02-1**

Modeling of the Renewable Energy System of an Net Zero Energy Community

Dong He Chongqing Univ.
Qingyu Xiong Chongqing Univ.
Xin Shi Chongqing Univ.

This paper introduces our research in modeling the renewable energy system of Historic Green Village, which is a real-world net zero energy community (NZEC) in Florida. We will first introduce the renewable energy system that serves the Historic Green Village and the design of our modeling framework. Then we show the implementation of Modelica models for the renewable energy network, including the renewable energy generation by the photovoltaic (PV) panel, energy consumption of buildings, and the interface between the power grid and the NZEC. After that, we will present simulation results and compare them with the onsite measure data from the Historic Green Village. The results show that the Modelica models are able to reveal the dynamic behaviors in renewable energy network in NZEC. That information can be used for future research in the optimization of NZEC operations.

16:40-17:00 **MonC02-2**

Design of Intelligent Parking Lot System Based on Wireless Network

Chen Yuan Beijing Univ. of Civil Engi. and Architecture
LiPing Qian Beijing Univ. of Civil Engi. and Architecture

The number of private cars is growing with each passing day in recent years. The problem of parking is becoming more and more serious. In view of this problem, the intelligent control and management strategy of the underground parking lot based on ZigBee wireless network technology is given. The method of underground intelligent parking lot management system's structure and establishment of the network that utilizes ZigBee wireless network technology is studied. The wireless network nodes are designed and developed based on the CC2530 chip. These nodes that combine with infrared detector can detect the vehicle and environmental information when these nodes are combined with temperature, humidity, and smoke sensor. Besides, it can raise alarm about potential security risks. The module of display can transmit timely garage's overall information to the LED display, provide the information of vehicle and environment to drivers and guide parking. Eventually, the problem of parking is solved.

17:00-17:20 **MonC02-3**

Simulation of Pedestrian Behaviors Based on an Improved Floor Field Cellular Automaton Model under Attractive Incidents

Min Zhao Chongqing Univ.
Linglin Wang Chongqing Univ.
Linjiang Zheng Chongqing Univ.
Dihua Sun Chongqing Univ.

The study of pedestrian dynamics is very significant for promoting pedestrian traffic management and optimizing the layout of public facility in comprehensive transportation hubs, markets, theaters etc. In order to simulate and reproduce pedestrian behaviors under attractive incidents, an improved floor field model is proposed in this paper. This improved model is composed of static floor field, dynamic floor field and the new proposed attractive field, which takes into account the attractive degree of incident, view distance of onlooker, and pedestrian's safe psychological distance. The transition probability of pedestrian is decided by the interaction of static floor field, dynamic floor field and attractive field. Besides, pedestrian movement state is divided into three types under attractive incidents: walking, staying, and leaving, which can depict the pedestrian behaviors of gathering, looking and dissipation. The experiment results show that our proposed model can reproduce the onlooking processes and capture the typical characteristics of torus-shaped phenomenon under attractive incidents.

17:20-17:40 **MonC02-4**

Audio data compression based on AVS-P10

Deliang Zeng North China Electric Power Univ.
Zhiguang Deng North China Electric Power Univ.
Yifan Jian North China Electric Power Univ.
Yue Sun North China Electric Power Univ.

AVS-P10 is the first national standard for mobile audio codec with completely independent intellectual property rights.In view of the current situation of the explosive growth of network audio data,According to the principle of AVS-P10 coding and based on AVS-P10 core encoder to make the algorithm compile.And the algorithm is optimized by the self search cycle optimization scheme.Finally, the third National Graduate smart city technology and creative design contest organized by the audio data to do the experiment.And the experimental results show that the algorithm has achieved some results.At the same time, the compression ratio of the optimized algorithm increases with the same code rate.

17:40-18:00 **MonC02-5**

Fuzzy Evaluation of Traffic Flow Stability Based on the Discreteness of Traffic Parameters

Xiaoyong Liao Chongqing Univ.
Aiangyuan Chen Chongqing Univ.
Dihua Sun Chongqing Univ.
Min Zhao Chongqing Univ.
Senlin Cheng Chongqing Univ.

The microscopic traffic flow stability is difficult to describe the influences of the dynamic relationship between vehicles on traffic conditions. In order to solve the problem, from the perspective of macroscopic and microscopic parameters of traffic flow and considering the discreteness of velocity and following distance, the paper selected average velocity, average following distance, the variation coefficient of velocity and following distance as the traffic flow stability indices. And a stability evaluation model was constructed based on fuzzy theory. Using VISSIM simulation software, simulation experiment was carried out. The influences of traffic volume, traffic incident, traffic signals and GPS permeability on traffic flow stability evaluation were analyzed. Results show that traffic flow stability decreases gradually with the increase of volume. When there is a traffic incident, traffic flow stability decreases at the upstream section, while it is contrary to the downstream section. With the decrease of GPS permeability, the differences of the four indices and traffic flow stability at these GPS permeability with that of full permeability are becoming bigger and bigger. So the behavior described by the model is consistent with the actual state of the traffic system, proving that the model is real and effective. Thus it can be used to evaluate urban traffic flow stability macroscopically.

18:00-18:20 **MonC02-6**

The research of twin support vector machine based on radius interval

Feng Jin Beijing Univ. of Civil Engi. and Architecture
De Zhang Beijing Univ. of Civil Engi. and Architecture

Support vector machine has good generalization ability to the small sample problem, and it has become a hot spot in domestic and foreign scholars in recent years. The support vector machine based on the radius of the support vector machine and the twin support vector machine are extensions of the support vector machine, which has better performance. The main research of the thesis is combined with support vector machine based on the radius of the support vector machine (SVM) and Gemini, selected jointly determined by the kernel function and data sample interval radius (radius margin) circles as a selection kernel function determination indexes. In this paper, the kernel function selection algorithm is different from the traditional method which was used by the former scholars, and the optimization strategy is adopted in this paper. The first step is still the traditional support vector machine training, after calculated kernel functions corresponding to the kernel parameters and the optimal interval (m) is introduced, and then the prediction samples, combined with the optimal kernel parameters calculated include samples for training and predicting the feature space minimum super hemisphere.

MonC03 **Room03**
Optimal control and optimization (VII) **16:20-18:20**
Chair: Werong Liu Central South Univ.
CO-Chair: JInle Li Anhui University Of Tech.

16:20-16:40 **MonC03-1**

INS/BDS integrated navigation filter algorithm based on Unscented Kalman Filter

Jie Lei Guangzhou Maritime Univ.
Ming Bai Guangzhou Maritime Univ.
Zhipeng Chen Guangzhou Maritime Univ.
Linfeng Wu Guangzhou Maritime Univ.
Yiyi Zhan Guangzhou Maritime Univ.
Xinhai Xia Guangzhou Maritime Univ.
Zexin Wu Guangzhou Maritime Univ.
Jielin Zheng Guangzhou Maritime Univ.

The inertial navigation system (INS) can continuously provide position information, with high precision in short time, but the positioning error accumulates over time. The BeiDou navigation satellite system (BDS) has long term stability, but susceptible to interference, data update frequency is low. INS and BDS constitute the integrated navigation system, it can learn from each other. In this paper, the INS / BDS tightly integrated navigation method is described, and the algorithm steps and characteristics of Unscented Kalman Filter (UKF) are introduced in details. The mathematical model of the integrated navigation system was established, and the error equation of the integrated navigation system was deduced, the application of unscented Kalman filter in INS / BDS tightly integrated navigation was studied, and compared with Extended Kalman Filter (EKF) algorithm. The experimental results showed that UKF filter can provide higher filtering accuracy than EKF in INS / BDS tight combination.

16:40-17:00 **MonC03-2**

Application of Velocity Adaptive Shuffled Frog Leaping Bat Algorithm in ICS Intrusion Detection

Jinle Li Anhui University Of Tech.
Huazhong Wang Steel Plant Of Meishan Iron And Steel Cooperation Of Baosteel Group.
Bingyong Yan Anhui University Of Tech.

In this paper, a velocity adaptive shuffled frog leaping bat algorithm (VASFLBA) is proposed to solve the problem that the bat algorithm (BA) is easy to fall into local optimum and a lack of deep local search ability. Firstly, the influence of the current stochastic local optimal solution on the search of the algorithm is considered. Two adaptive proportional regulation factors are introduced to balance global and local search. Then, the locally deep search ability is enhanced by using the meme transfer mechanism of shuffled frog leaping algorithm (SFLA). In addition, stochastic population competition is introduced to improve the global search ability and when the algorithm trapped in the local optimum, differential mutation operation is performed on the current global optimal bat so that the algorithm can jump out of the local optimum. The superiority of VASFLBA is verified by benchmark test functions. On this basis, VASFLBA is used to optimize the parameters of support vector machine (SVM) in intrusion detection of industrial control system (ICS), and the standard dataset for ICS intrusion detection is used for simulation. The results show that, compared with BA, SFLA and other algorithms, VASFLBA can better solve the problem of SVM parameters selection.

17:00-17:20 **MonC03-3**

Prediction of CCPP Output Based on Improved Fuzzy Analytical Hierarchy Process

Fei Chu China University of Mining and Tech.
Jie Wang China University of Mining and Tech.
Nannan Lu China University of Mining and Tech.
Tian Tan Southwest Jiaotong Univ.
Fuli Wang Northeastern Univ.

For the lack of process data of the Gas-Steam combined cycle power plant in initial operating stage, this article presents a method for the output power prediction of CCPP using the Fuzzy Analytical Hierarchy Process (FAHP). Firstly, based on the analysis of the main factors that affect the CCPP output, a hierarchical structure for the prediction of CCPP output is established by combining with Analytical Hierarchy Process and calculating weight vectors according to experts' experience. Then, analyze and correct the operating characteristic curves of CCPP, which will be taken as the input and output membership functions. Finally, the output prediction model can be established, and the effectiveness of output prediction model of CCPP based on improved FAHP is demonstrated by the data set from a real case.

17:20-17:40 **MonC03-4**

Optimal Operation of High-Speed Train Using Hybrid Model Predictive Control

Zheng Xu Central South Univ.
Zhiwu Huang Central South Univ.
Kai Gao Changsha University of Science & Tech.
Shuo Li Changsha University of Science & Tech.
Rui Zhang Central South Univ.
Weirong Liu Central South Univ.

The train operation process is highly nonlinear and has multiple constraints and objectives, which lead to higher requirements for the automatic train operation (ATO) system of high-speed train. In this paper, a hybrid Model Predictive Control (MPC) framework is proposed for the controller design of the ATO system. Firstly, a piecewise linear system with state and input constraints is constructed though piecewise linearization of the high-speed train's nonlinear dynamics. Secondly, the piecewise linear system is transformed into a mixed logical dynamical (MLD) system by introducing the auxiliary binary variables. For the transformed MLD system, a hybrid MPC controller is designed to realize the precise control under hard constraints. To reduce the online computation complexity, the explicit control law is computed offline by employing the multi-parametric mixed-integer linear programming (mp-MILP) techniques. Simulations results validate the effectiveness of the proposed method.

17:40-18:00 **MonC03-5**

Development of intellectual fuel supplies planning system

Aksyonov K.A. Ural Federal Univ.
Nevolina A.L. Ural Federal Univ.
Ayvazyan H.L. Ural Federal Univ.
Yerevan State Univ.
Aksyonova O.P. Ural Federal Univ.

The thesis contains results of development of intellectual fuel supplies

planning system. Besides, there have been made an analysis of transportation problem. As basis it was suggested to use all three methods (transportation algorithm, expert and multi-agent imitation modeling) for taking into account main features of fuel supplies planning problem. Frame approach has been used as basic tool of subject area formalization. Supposed method of decision-making for supplies planning problem and intellectual system are currently implementing on fuel stations in Yekaterinburg.

18:00-18:20 **MonC03-6**

Nonlinear Model Reduction for Direct Expansion Air Conditioning and MPC Control of Indoor Climate and Energy Efficiency

Jun Mei University of Pretoria
Xiaohua Xia University of Pretoria

This paper presents a hierarchical control for a direct expansion (DX) air conditioning (A/C) system to reduce energy consumption, while maintaining both indoor thermal comfort and air quality within an acceptable range. The hierarchical control method consists of two layers. The upper layer includes an open loop controller to optimize the energy consumption of the DX A/C system and predicted mean vote (PMV) index to obtain tradeoff steady states. On the other hand, the lower layer is a model predictive control (MPC) for tracking the tradeoff steady states calculated by the upper layer. In [1], the DX A/C system is modeled into a seventh order model, whereas a reduced order model is derived in this paper. It is shown that the energy-optimised open loop controller and the closed-loop regulation of the multi-input-multi-output (MIMO) MPC scheme based on the reduced model are equally effective to improve both indoor thermal comfort and air quality, while minimizing energy consumption. The performance of the proposed control approach is verified and compared with [1] by simulation results.

MonC04 Room04
Fractional Calculus and Fractional-order Systems (V) (Chinese) 16:20-18:20

Chair: Ning Chen Nanjing Agricultural Univ.
CO-Chair: Lu Liu Northeastern Univ.

16:20-16:40 **MonC04-1**

Fractional Order Modeling and Residual Vibration Suppression for Flexible Two-Mass Syste

Shidong Xu Harbin Institute of Tech.
Guanghui Sun Harbin Institute of Tech.
Zhihao Chengi Harbin Institute of Tech.

This paper develops a novel fractional order model for a flexible two-mass system and proposes a fractional order controller to suppress residual vibration of this system. Based on fractional order constitutive law of viscoelastic material, a generic fractional order dynamic model has been derived for a flexible two-mass system, ranging from the pure elastic solids to the pure viscous materials. To suppress the residual vibration, a fractional order PD^{α} controller is proposed. Simulation results show that the proposed fractional order controller is effective and robust in achieving control requirements.

16:40-17:00 **MonC04-2**

Observability of Fractional Linear Systems with Singularity

Dengguo Xu Beijing Institute of Tech.
Chuxiong Normal Univ.
Qinglin Wang Beijing Institute of Tech.
Yuan Li Beijing Institute of Tech.

In this paper, the state observability of fractional linear systems with singularity is considered. State response and output response of the systems are obtained by using Laplace transformation and convolution formula. Based on the output response of the subsystems, observability Grammian matrices of slow subsystem and the fast subsystem are presented for the first time. We demonstrate that the sufficient and necessary conditions for observability of the subsystems are reversibility of the observability Grammian matrix. The results obtained will be useful in the analysis and synthesis of fractional descriptor systems.

17:00-17:20 **MonC04-3**

Spectral and pseudospectral schemes for the distributed order time fractional reaction-diffusion equation with Neumann boundary conditions

Haiyu Liu Beihang Univ.
Shujuan Lu Beihang Univ.
Wenping Chen Beihang Univ.

In this paper, two efficient numerical algorithms for the distributed order time fractional reaction-diffusion equation with Neumann boundary conditions are proposed, combining the finite difference method in time with Legendre spectral and Gauss-Lobatto-Legendre-Birkhoff (GLLB) pseudospectral method in space, respectively. It is proved that both of the schemes are unconditionally stable and have the same convergent order $o(\tau^2 + \alpha^2 + N^{1-m})$, where τ, α, N and m are the temporal step, step size in distributed-order variable, polynomial degree and spatial regularity of the exact solution. Numerical results are presented to support the theoretical analysis.

17:20-17:40 **MonC02-4**

A new Barbalat's Lemma and Lyapunov stability theorem for Fractional order Systems

Ruoxun Zhang North China Electric Power Univ.
Yongli Liu North China Electric Power Univ.

This paper presents a new version of Barbalat's lemma to fractional order integrals. Based on this result, a Lyapunov stability theory is established, which allows proving the stability and adaptive control/synchronization of many fractional-order nonlinear, time-delay and uncertain systems. An example shows the usefulness of our results.

17:40-18:00 **MonC04-5**

Controller Design for A Class of Switched Nonlinear Systems Based on Fractional Order Backstepping

Yuhan Zhao Nanjing Forestry Univ.
Xin Lu Nanjing Forestry Univ.
Jun Xu Nanjing Forestry Univ.
Ning Chen Nanjing Forestry Univ.

A fractional order control strategy for the switched nonlinear systems is presented in this paper. The fractional calculus is applied in the Backstepping control method. By constructing a virtual feedback variable, a fractional order feedback control law is proposed, and the switching law is established based on multi-Lyapunov functions. The state feedback controllers and switching law can guarantee the system's asymptotic stability. The simulation result shows the effectiveness of the proposed control strategy.

18:00-18:20 **MonC04-6**

Fractional Order Control of Dissimilar Redundant Actuating System used in Large Air Craft

Salman Ijaz Beihang Univ.
Lin Yan Beihang Univ.
Nabeel Shahzad Beihang Univ.
Mirza Tariq Humayun COMSATs Lahore.
Umair Javaid Beihang Univ.

The paper proposed a strategy to address the issue of dynamical force fighting and to provide precise tracking of actuator control surface driven by two dissimilar actuators. To solve this issue, a fractional order control strategy is adopted and its performance is compared with conventional PID controller. The control strategy includes the design of two fractional order PID controllers in position feedback configuration. In order to keep the actuator dynamics at similar pursuit, a third fractional order PID controller is added in such a way as to feed force compensation signal in position feedback loop of both actuators. To optimally tune the controller parameters, Nelder-Mead optimization technique is employed based on specified performance criteria. The objective function is defined by assigning weights to each time domain and frequency domain performance parameters. To check the robustness of proposed scheme, an external disturbance is applied at the control input of both actuators. Simulation results illustrated that proposed controller is able to reduce the force fighting problem as well as precisely track commanded input as compared to PID controller.

MonC05 Room05
Complex networks and systems (III) 14:00-16:00

Chair: Xin-yang Wu National Univ. of Defense Tech.
CO-Chair: Guoping Jiang Nanjing Univ. of Posts and Telecommunications

14:00-14:20 **MonC05-1**

Local Load Redistribution Strategy based on Maximum Residual Capacity of Nodes in Complex Networks

Tianjie Zhou Nanjing Univ. of Posts and Telecommunications
Guoping Jiang Nanjing Univ. of Posts and Telecommunications
Xiao Tu Nanjing Univ. of Posts and Telecommunications
Lingling Xia Nanjing Univ. of Posts and Telecommunications
Yurong Song Nanjing Univ. of Posts and Telecommunications

In this paper, we investigate the load redistribution strategy, to explore the issue of cascading failures in complex networks with nodes being failure. Aiming on attaining the load balancing and improving the network robustness, we propose a novel local load redistribution strategy by choosing candidate nodes with its maximum residual capacity. The modeling process is derived from the nearest neighbor load redistribution strategy. Moreover, we verify the superiority of the proposed load redistribution strategy by simulations on small world network, scale free network and real power grid, respectively.

14:20-14:40 **MonC05-2**

Nominal Boolean Networks

Xingbang Cui Shandong Univ.
Jun-e Feng Shandong Univ.
Sen Wang Shandong Univ.

Nominal Boolean network is a kind of Boolean network, which is obtained from a Boolean control network with all controls disconnected. In this paper, the relationship between the transition matrix of the original Boolean control network and the transition matrix of the corresponding nominal Boolean control network is investigated. Due to the fact that transition matrices can be derived from structure matrices, the relationship between structure matrices of the original Boolean control network and structure matrices of the nominal Boolean network is studied. Via constant values corresponding to disconnected controls, structure matrices of the nominal Boolean network can be derived from structure matrices of the original Boolean control network. Finally, a concrete algorithm is presented to derive transition matrices of nominal Boolean networks.

14:40-15:00 **MonC05-3**

Derivative–Based Component Global Importance Measure for Phased Mission Systems

Xin-yang Wu National Univ. of Defense Tech.
Xiao-yue Wu National Univ. of Defense Tech.

Importance measures for system reliability analysis are used to estimate the relative importance of components to the system reliability, and further to provide useful information to improve system performance. Components in phased mission systems (PMS) may have unequal structural importance working in different phases with different reliability logics, and their reliability parameters also may vary from phase to phase caused by different phase environment. Thus, traditional importance measure based on fixed component structural importance and component nominal reliability are not suitable to be applied in these situations. This paper presents a derivative–based global sensitivity measure to evaluate the component importance of PMS. The proposed method can consider component with different structural logic in different phase task profiles, and variational reliability parameter caused by different work environment. Finally, a PMS example is given for illustration the effectiveness of the provided measure. Additionally, compared with the Birnbaum structural importance, the results show that the proposed measure displays reasonable component importance by considering component various reliability parameters and structural logics.

15:00-15:20 **MonC05-4**

A Kind of University HPC Platform Security Balance Method Based on the Barrel Theory

Yuanyuan Chen Information Center of Chongqing Univ. of Tech.
Qin Zheng State Office of State Asset Management of Ch ongqing Univ. of Tech.
Huijie Yang Information Center of Chongqing Univ. of Tech.

With the rapid development of HPC, more and more attention is paid to the security of HPC. In this paper, a new hierarchical barrel model based on the traditional barrel model is proposed, which is used in two aspects: Firstly, the HPC overall security architecture is a hierarchical barrel, divided by value size and difficulty of offensive and defensive, supplemented with safety measures; Secondly, the security association between layers, different degree of safety protection, follow short board principle. Aiming at the security problem of HPC platform in University design risk indicators, scan two sets of vulnerabilities in different time periods. Use the security balance algorithm to calculate the sample mean and the overall mean, deduce multiple risk points, reference mean to do security optimization. Finally scan the third set vulnerability value and compared with the previous two sets. Experiment results show that the new barrel model has the function of security balance, and can pinpoint the system's short board, effective protection, reduce cost and improve the overall security performance.

15:20-15:40 **MonC05-5**

Discrimination and Compensation of Abnormal Values of Magnetic Flux Leakage in Oil Pipeline Based on BP Neural Network

Lin Jiang Northeastern Univ.
Jinhai Liu Northeastern Univ.
Huaguang Zhang Northeastern Univ.
Mingrui Fu Northeastern Univ.
Li Zheng Beijing Huahang Radio Measurement & Rese arch Inst.
Jun Yang Northeastern Univ.

In the submarine oil pipeline inspection, the magnetic flux leakage data may exist some abnormal values. In order to obtain the true value, the magnetic flux leakage data should be preprocessed. One of the important parts of data preprocessing is to discriminate the abnormal values, and predict and compensate its true value reasonably and effectively. In this paper, it combines threshold segmentation with 3s-criterion to discriminate the abnormal values of the single-channel MFL data firstly. And then, analyzing the neural network theory and the characteristics of MFL data, it presents a method of compensating the abnormal value which is based on BP neural network. Lastly, it simulates the methods of discrimination and compensation with the abnormal value which is collected from single-channel of magnetic flux leakage detection. The results show that this method is feasible and effective.

15:40-16:00 **MonC05-6**

Improved LFM Algorithm in Weighted Network Based on Rand Walk

Xiaobo Yang The Information Engineering Univ.
Chuxiang Chen The Information Engineering Univ.
Zhiwan Wang Henan Univ. of Chinese Medicine

Because of randomly selection of seed nodes, the result of traditional LFM algorithm is full of instability. What's more, with underused weight information in network, the accuracy of LFM decreases apparently in network with fuzzing community structure. In order to solve the problems, LFMs algorithm is presented in this paper. First, the random walk method was used to select seed nodes to avoid the instability of LFM. Then, with cosine similarity to calculate vertex similarity, weight information in network was fully used, and the precision of community division was also raised. To validate the algorithm, LFMs was compared with traditional LFM in LFR benchmark and real network. Results showed that, both in LFR network and real network, LFMs gets higher precision than LFM.

MonC06 Room06
Nonlinear systems (III) 16:20-18:20

Chair: Qian Wang Shenyang Inst. of Automation Chinese Aca demy of Sciences
CO-Chair: Zhenning Yu Beijing Normal Univ. Zhuhai

16:20-16:40 **MonC06-1**

Three-State Space Reformulation and Control of MD-Included One-Link Robot System Using Direct-Derivative and Zhang-Dynamics Methods

Yunong Zhang Sun Yat-sen Univ.
Ministry of Education
SYSU-CMU Shunde International Joint Research Inst.
Wan Li Sun Yat-sen Univ.
Ministry of Education
SYSU-CMU Shunde International Joint Research Inst.
Binbin Qiu Sun Yat-sen Univ.
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Yaqiong Ding Sun Yat-sen Univ.
Ministry of Education
SYSU-CMU Shunde International Joint Research Inst.
Deyang Zhang

Tracking control of nonlinear systems is a hot topic in various fields, especially in robotics. In this paper, a nonlinear one-link (1L) robot system with motor dynamics (MD) included is investigated, and a novel method, i.e., Zhang-dynamics (ZD) method, is applied to solve the tracking control problem of this nonlinear system. A ZD controller of the nonlinear MD-included 1L robot system is designed. The simpleness and effectiveness of ZD method are proved through theoretical analysis. Moreover, computer-simulation results substantiate the high performance of the ZD controller. It is worth pointing out that our research provides the feasibility of applying ZD method in more and more practical fields.

16:40-17:00 **MonC06-2**

Damping Control for Power Systems Using Energy Storage

Yongli Zhu Univ. of Tennessee
Bin Wang Univ. of Tennessee
Kai Sun Univ. of Tennessee

This paper proposes a controller for energy storage (ES) to improve damping of power system oscillation. The controller manages charge and discharge of an ES device to respond to the real-time frequency deviation measured locally to provide positive damping effects. The expected damping ratio improvement from an ES equipped with this controller is derived mathematically from a single-machine-infinite-bus system considering different placements of the ES. Then, the ES with this new controller is tested on both the Kundur's two-area power system and the WECC 179-bus system to damp a targeted oscillation mode. Simulation results verify the effectiveness of the proposed controller.

17:00-17:20 **MonC06-3**

Robust Stabilization of a Class of Time-Delay Nonlinear Systems with Markovian Jump

Qian Wang Shenyang Inst. of Automation Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Zhongfeng Wang Shenyang Inst. of Automation Chinese Acade my of Sciences
Ligang Li Shenyang Inst. of Automation Chinese Acade my of Sciences
Jianlong Huang Shenyang Inst. of Automation Chinese Acade my of Sciences
Fudong Wang Shenyang Inst. of Automation Chinese Acade my of Sciences

The problem of robust stabilization of time-delay nonlinear systems with Markovian jump with a triangular structure is studied. Based on backstepping method, we prove that the closed system is almost surely asymptotically stable and the controller and the associated Lyapunov function is independent of the generator of the Markov process.

17:20-17:40 **MonC06-4**

Adaptive Nonlinear Control of Wheelchair with Independent Active Suspension System

Zhenning Yu Beijing Normal Univ. Zhuhai
Seng Fat Wong Univ. of Macau

The growing number of elder people is a huge problem in Macau, China, especially, the elder people who loss living ability. In medical area, the complicating disease, such as press sore is one of the most dangerous reason to cause disabled people death. Therefore, some relative research projects are still developing. This paper address the problem of driving a smart wheelchair with independent active suspension system to follow a desired path. Based on a practical wheelchair, Krama KM5000.2, the suspension was a nonlinear system. The solution consists of a Lyapunovbased trajectory tracking control law and an active force for correcting vehicle running attitude. When the wheelchair is working, active suspension generates an active force to against vehicle attitude error. In detail, the paper demonstrates how Lyapunov based techniques

yield a control structure includes i) active force against vehicle attitude error, i) saturation on position error and iii) nonlinear damping disturbance.

17:40-18:00 **MonC06-5**

Semi-Global Stabilization of Nonlinear Time-Delay Systems Based on Dynamic Gain Approach

Na Duan Jiangsu Normal Univ.
Huifang Min Jiangsu Normal Univ.
Nanjing Univ. of Science and Tech.
Hongxu Chu Jiangsu Normal Univ.
Xiaoyan Qin Zaozhuang Univ.

This paper investigates the adaptive state-feedback control problem of a two-stage chemical reactor system. Firstly, by using a direct radial basis function neural network (RBF NN) approximation approach, the nonlinear terms are handled under much weaker conditions. Then, with the help of a novel dynamic gain-based backstepping technique and appropriate Lyapunov-Krasovskii functionals, a smooth controller with only one adaptive parameter is constructed, which successfully overcomes the obstacles generated by time delay, control coefficients and nonlinear restrictions. It is proven that the constructed controller can render the closed-loop system semi-globally uniformly ultimately bounded. Finally, the simulation results of the chemical reactor system are shown to demonstrate the effectiveness of the control scheme.

18:00-18:20 **MonC06-6**

Mathematical Modeling of Electrical Controlled Pneumatic Brake

Yingze Yang Central South Univ.
Lu Xiong Central South Univ.
Zhiwu Huang Central South Univ.
Kuo-Chi Lin Univ. of Central Florida

Inconsistent brake forces will aggravate impacts of collision between adjacent freight cars with different car types and load weights, especially in rigid connection mode which is widely used in Chinese freight lines. As it's designed with complex components and various operation modes the pneumatic brake system is a highly nonlinear one, it is hard to model and analyze its instantaneous state. In this paper, a mathematic model of the pneumatic brake is proposed. According to real-time operation mode of ECP system and brake stage of freight train, tracking object is dynamically adjusted to fit complex railway conditions. Finally, simulation results verify the astringency of this proposed algorithm, and shows collisions of ECP brake are decreased and real-time performance is improved.

MonC07 **Room07**
Game theory (I) **16:20-18:20**
Chair: Chunyan Zhang Nankai Univ.
CO-Chair: Xiaoyong Zhang Central South Univ.

16:20-16:40 **MonC07-1**

A Coalitional Game Based Mechanism for Resource Sharing in Geo-Distributed Mobile Cloud Computing

Yeru Zhao Central South Univ.
Zhiwu Huang Central South Univ.
Xiaoyong Zhang Central South Univ.
Weirong Liu Central South Univ.
Qianqian Zhang Central South Univ.
Zhengfa Zhu Central South Univ.

Geo-distributed mobile cloud computing takes location information into consideration in mobile cloud computing. Users can access cloud resources that are geographically close to their mobile devices in Geo-distributed mobile cloud computing to reduce communication delay. Considering the uncertainty requirement of mobile users, in this paper, we focus on resource sharing through cooperation among cloud providers. A coalitional game based mechanism is proposed for resource sharing to optimize the resources usage and reduce the cost of cloud service providers. The coalition game is adopted to form the coalition of cloud service providers and the stability of its structure is guaranteed. The cost distribution of resource usage by cloud service providers participating in coalition game is analyzed according to Shapley value method. Besides, the coalition resource sharing problem is transformed into the problem of resource cost minimization in the coalition, and the solution is obtained by the dual decomposition and the subgradient method. Simulation results validate the effectiveness of the proposed mechanism.

16:40-17:00 **MonC07-2**

Payoff Measurement Noise in Risk-Sensitive Mean-Field-Type Games

Hamidou Tembine New York Univ.

Payoff measurement noise constitutes a major problem in practical interactive decision making scenarios. When agent's payoff is erroneously perceived or observed with a noise functional, the response is highly impacted. In this paper, a risk-sensitive approach is proposed for capturing players' behaviors in presence of measurement randomness in mean-field-type games. Equilibrium and optimal strategy systems are established using stochastic maximum principle and dynamic programming principle in infinite dimensions.

17:00-17:20 **MonC07-3**

Dynamic Shapley Value for 2-stage cost sharing game with perishable products

Yin Li St. Peterburg State Univ.

The dynamic Shapley Value for N-person 2-stage minimum cost spanning tree game is considered. The cooperative behaviour of players is defined. Selecting strategies, players build a minimum cost spanning tree at each stage. The total cost consists of costs defined by minimal cost spanning tree and the lost values of perishable products. Before the second stage a particular player m may leave the game with probability p that depends on the previous behaviour of players. As optimality principle, the modified Shapley Value is proposed. Computation of the Shapley Value along different cooperative path scenarios shows its subgame inconsistency.

17:20-17:40 **MonC07-4**

Evolutionary Games with Different Time Scales of Strategy Updating

Jianlei Zhang Nankai Univ.
Yuying Zhu Nankai Univ.
Chunyan Zhang Nankai Univ.

Variation in learning rates within populations suggests that evolutionary game theory may not necessarily be restricted to uniform time scales associated with the game interaction and strategy adaption evolution. Using agent-based evolutionary simulation in the framework of prisoner's dilemma game, we demonstrate the sustainability of cooperation and the emergence of different macro-effects, when equipping agents with non-uniform time scale preferences. We employ a spatial random regular grid to describe the social interactions among agents. We conclude that the cooperation level has a strong dependence on the population composition, and the suitable fraction of the fast-updating players in the system which is associated with the maximal cooperation frequency has been found out. Besides, the extent of the promotive effect of diversifying time scales is also closely related with the payoff adoption rules in strategy updating, especially when we invent a past history for each agent. Summing up the gained results, a general conclusion can be drawn, saying that the combination of these factors (e.g. time scales and memory) gives rise to rich dynamic behavior of the system.

17:40-18:00 **MonC07-5**

Novel Global Harmony Search Algorithm for Computing Nash Equilibrium of Bimatrix Games

Longquan Yong Shaanxi Univ. of Tech.
Shouheng Tuo Shaanxi Univ. of Tech.
Jiarong Shi Xi'an Univ. of Architecture and Tech.
Quanxi Feng Guilin Univ. of Tech.

In this paper a new method is proposed for computing Nash Equilibrium of bimatrix games. Firstly, bimatrix games were reformed as non-monotonic linear complementarity problem (LCP).Then, the non-monotonic LCP is formulated as absolute value equation (AVE), and solved by recently proposed algorithm named novel global harmony search (NGHS). Numerical experiment shows that the NGHS algorithm can achieve as many as possible equilibrium pair of strategies.

18:00-18:20 **MonC07-6**

A Fractional order Game Model of Multiple Stakeholders in Colliery Safety Management

Rongwu Lu Shandong Univ. of Science and Tech.
Xinhua Wang Shandong Univ. of Science and Tech.
Hao Yu Shandong Univ. of Science and Tech.
Dan Li Shandong Univ. of Science and Tech.

In this paper, a game model of multiple stakeholders in colliery safety management is built firstly. Then, we utilize the theory of fractional order calculus to set up the fractional game model. The Adams-Bashforth-Moulton (ABM) predictor-corrector method is used to solve the fractional model, and the phase diagram and time series graph are used to simulate and analyze the dynamic process of the fractional order game model.

MonC08 **Room08**
Stochastic systems (I) **14:20-16:20**
Chair: Dongliang Yin Naval Univ. of Engineering
CO-Chair: Weihai Zhang Shandong Univ. of Science and Tech.

16:20-16:40 **MonC08-1**

Stochastic control of semi-active suspension system

Liangchao Geng Yantai Univ.
Mingyue Cui Yantai Univ.
Zhaojing Wu Yantai Univ.

In this paper, for automobile semi-active suspension in rough road, the problems of random modeling and control are considered. First, dynamics model is constructed assuming the road being flat. According to the dynamicstatic method and the relative-motion principle, the road irregularities is transformed to disturbance to the control. Thus, the random dynamic model of the system is established. Second, the system is transformed into a lower triangular system by an appropriate transform. Using backstepping method and Lyapunov theory, a controller is designed such that the closed-loop system is noise-to-state stability in probability(NSS-P) and the mean square of the state converges to an arbitrarily small neighborhood of zero, which means that the passengers feel much comfortable. Finally, the simulation experiment is carried out by matlab. The simulation results show the effectiveness of the control strategy.

16:40-17:00 **MonC08-2**

Pareto Optimality in Finite Horizon LQ Stochastic Differential Games

Yaning Lin Shandong Univ. of Science and Tech.
Weihai Zhang Shandong Univ. of Science and Tech.

This paper is concerned with the linear quadratic (LQ) Pareto optimal control of the continuous-time stochastic systems in finite horizon. First, based on the necessary and sufficient characterization of the Pareto optimality, we reformulate the Pareto optimality problem as a set of finite horizon optimal control problems with a specific constraint
structure. Next, in the spirit of the Lagrange multiplier theorem, we present a necessary condition for a control to be Pareto efficient which is consistent with those of a weighted sum optimal control problem, and give the expressions of all Pareto efficient strategies.

17:00-17:20 **MonC08-3**

Disordered stabilization of stochastic delay systems: The disorder-dependent approach

Guoliang Wang Liaoning Shihua Univ.
Hongyang Cai Liaoning Shihua Univ.

In this paper, a general stabilization problem of stochastic delay systems is realized by a disordered controller and studied by exploiting the disorder-dependent approach. Different from the traditional results, the stabilizing controller here experiences a disorder between control gains and system states. Firstly, the above disorder is described by the robust method, whose probability distribution is embodied by a Markov process with two modes. Then, by exploiting a disorder-dependent Lyapunouv functional, two respective conditions for the existence of such a disordered controller are provided with LMIs. Finally, a numerical example is exploited to demonstrate the effectiveness and superiority of the proposed methods.

17:20-17:40 **MonC08-4**

Stability and Hopf bifurcation for an epidemic disease model with time delay

Yuguang Wang Ningxia Univ.
Beijing Inst. of Tech.
Yanan Li Henan Polytechnic Univ.
Wenshuai Wang Ningxia Univ.

The conditions for stability and Hopf bifurcation of a SIR disease model with survival probability and time delay are analysed. Firstly, the conditions of the existence and local stability of disease-free and endemic equilibrium are investigated. Secondly, we found that there are stability switches, and Hopf bifurcation occur for endemic equilibrium when the time delay τ passed through a sequence of critical values. Finally, we verify the analytic results by module Simulink in Matlab.

17:40-18:00 **MonC08-5**

Robust Weighted Fusion Kalman Predictor for Multisensor Systems with Multiplicative Noises and Uncertain Noise Variances

Wenqiang Liu Heilongjiang Univ.
Heilongjiang Univ. of Science and Tech.
Zili Deng Heilongjiang Univ.

This paper addresses the design of robust weighted fusion Kalman predictor for a class of linear discrete-time multisensor systems with multiplicative noises in the state and measurement matrices, and with the uncertain noise variances. By introducing two fictitious noises, the considered system is converted into one with only uncertain noise variances. According to the minimax robust estimation principle, based on the worst-case system with the conservative upper bounds of the noise variances, using the optimal fusion criterion with scalar weights, the robust scalars-weighted fusion time-varying Kalman predictor is presented. By use of the Lyapunov equation approach, its robustness is proved such that its actual prediction error variance is guaranteed to have the corresponding minimal upper bound for all admissible noise variance uncertainties. The accuracy relations between the robust local and fused time-varying Kalman predictors are proved. Simulation results show the effectiveness and correctness of the proposed results.

18:00-18:20 **MonC08-6**

Reliability Analysis of Series System with a Repairman Taking Single Vacation

Dongliang Yin Naval Univ. of Engineering
Tao Hu Naval Univ. of Engineering
Tong Chen Naval Univ. of Engineering

Considering that full-time repairman is often assigned to key equipment in series, the policy of a repairman taking single vacation is introduced. This paper studies the series system containing n identical components. For too stringent constraints of model caused by exponential distribution and other typical distributions in the past studies, this paper assumes that lifetime of online components, repairman's vacation time, idle time and repair time are all subject to Phase-type distribution, builds a more applicable interpretive model for system reliability, gives the reliability features including system reliability, steady-state failure frequency and system mean time between failure (MTBF), etc., and takes a numerical application to verify the applicability of the model and analyze the influence of whether the repairman takes a vacation on the system reliability.

MonC09 **Room09**
Robot sensing and data fusion (I) **16:20-18:20**
Chair: Yang Liu Beihang Univ.
CO-Chair: Lei Yang Inst. of Automation Chinese Academy of Sciences Beijing

16:20-16:40 **MonC09-1**

A Threat Modeling Method based on Kalman Filter for UAV Path Planning

Minyang Kang Science and Tech. on Avionics Integration La boratory, Shanghai
Yang Liu Beihang Univ.
Yijing Zhao Beihang Univ.

For low altitude penetration task, unmanned aerial vehicles (UAVs) need to accomplish its task with collision free. However, due to the uncertainties in the flight environment, the application of UAV is undoubtedly affected in the actual complex flight environment. This paper presents a method based on Kalman filter to evaluate the risk of UAVs under the precondition of distance sensor noise, GPS sensor noise and model estimation noise, aiming to provide the security flight space. Meanwhile, experimental results verify the correctness of the algorithm.

16:40-17:00 **MonC09-2**

Design of Three-dimensional Reconstruction and Robot Path Planning Based on Kinect System

Binquan Wang Univ. of Science Tech. of China
Lingcheng Kong Inst. of Advanced Manufacturing Tech., Hefei Inst. of Physical Science
Jianghai Zhao Inst. of Advanced Manufacturing Tech., Hefei Inst. of Physical Science
Haiwei Huang Inst. of Advanced Manufacturing Tech., Hefei Inst. of Physical Science

This paper addressed the problem of three-dimensional reconstruction using the Kinect system and robot path planning based on the improved ant colony algorithm(IACA). Firstly, we established a three-dimensional model by means of Kinect equipment, in light of which, the information of the obstacles was extracted. Then, we utilized the IACA to solve the problem of path planing as the changing pheromone evaporation coefficient ρ can dramatically enhance the convergence of algorithm. A simulation example was finally carried out to illustrate the effectiveness of the system and the optimal path was visually displayed in the three-dimensional model.

17:00-17:20 **MonC09-3**

A Novel 3D Measurement Method of welding workpiece for Robot off-line Programming

Lei Yang Inst. of Automation Chinese Academy of Scienc es Beijing
Univ. of Chinese Academy of Sciences, Beijing
En Li Inst. of Automation Chinese Academy of Scienc es Beijing
Yijian Mao Inst. of Automation Chinese Academy of Scienc es Beijing
Univ. of Chinese Academy of Sciences, Beijing
Zize Liang Inst. of Automation Chinese Academy of Scienc es Beijing

In the narrow and dangerous working environment, the welding robot is an important way to guarantee the welding quality and improve the welding efficiency. During the process of the welding, the robotic abilities of environment perception and 3D measurement are the premise of robotic automatic planning and automatic control, especially in the narrow environment. Because the laser sensor has the characteristics of compact structure, non-contact measurement and high precision, the laser sensor is used to design a new 3D measurement system of welding workpiece combined with the practical application requirements of aluminum electrolytic cell. This system combines off-line programming mode of the special welding robot in the virtual environment to achieve semi-automatic batch welding tasks. At the same time, a calibration method based on monocular vision is designed to calibrate the laser sensor. Through the experimental verification, the system can well realize the 3D measurement of welding workpiece. Meanwhile, the angle measurement error is lower than 0.5 degree. And the results meet the actual welding demand through the actual welding experiment verification.

17:20-17:40 **MonC09-4**

Obstacle avoidance for outdoor flight of a quadrotor based on computer vision

Xiaodong Yan Univ. of Electronic Science and Tech. of China
Rui Li Univ. of Electronic Science and Tech. of China
Yingjing Shi Univ. of Electronic Science and Tech. of China
Xiang Cheng Univ. of Electronic Science and Tech. of China

This paper presents a system of obstacle avoidance based on computer vision for a quadrotor in the outdoor environment. The system first acquires video stream from the camera and obtains the 3D information of specific obstacle by Harris Corner detector method. Based on the 3D information of obstacle, we can design the modeling of the flight environment and plan the flight path by the A* algorithm in the 3D space. Finally, simulations and series of experiments are carried out which show that the system is effective in avoiding obstacles for a quadrotor helicopter in the outdoor environment.

17:40-18:00 **MonC09-5**

A Series-Wound EKF Algorithm for Attitude Estimation

Hong Jiang Univ. of Electronic Science and Tech. of China
Rui Li Univ. of Electronic Science and Tech. of China
Yingjing Shi Univ. of Electronic Science and Tech. of China
Guo Ye Univ. of Electronic Science and Tech. of China
In this paper, we introduce a series-wound extended Kalman filter (EKF) algorithm for attitude estimation using Inertial Measurement Unit (IMU). An EKF algorithm is proposed to reduce the noise of acceleration and magnetism data, and then the three-axis attitude determination (TRIAD) algorithm is used to get the Direction Cosine Matrix (DCM). Finally we propose other EKF algorithm using three elements of DCM as measurement vector in order to optimize the Euler angles. This paper presents field experiments for a small quadrotor, and the results show good performance.

18:00-18:20 **MonC09-6**

Sensor Fusion: A Review of Methods and Applications

Man Lok Fung Univ. of Hong Kong
Michael Z. Q. Chen Univ. of Hong Kong
Yong Hua Chen Univ. of Hong Kong
This paper aims to present a brief overview of the development of sensor fusion in various application in recent years, and to understand the challenges and ability of sensor fusion. Various algorithms that are typically employed are covered to comprehend the complexity of usage in different scenarios.

MonC10 Room10
Fault diagnosis and fault-tolerant control (V) 16:20-18:20

Chair: Jing Wang Beijing Univ. of Chemical Tech.
CO-Chair: Dong Yue Nanjing Univ. of Posts and Telecommunications

16:20-16:40 **MonC10-1**

Feature Extraction Based on DWT and CNN for Rotating Machinery Fault Diagnosis

Yuan Xie Tsinghua Univ.
Tao Zhang Tsinghua Univ.
Fault diagnosis technique and condition monitoring for rotating machinery have become important issues as the development of modern industry. A novel fault diagnosis feature extraction approach is presented for rolling bearing signals based on discrete wavelet transform (DWT) and convolutional neural network (CNN) in this paper. Vibration signals of rolling bearings usually carry dynamic information of the rotating system, therefore are very useful for fault feature extraction. Wavelet analysis is an effective tool for signal processing and feature extraction. However classic fault diagnosis methods based on wavelet analysis only use statistic features or transformation of the decomposed signals as fault feature, there are still rich information contained in the signal yet to explore. In this paper, a two-level DWT is applied on the vibration signals and four components of the signal are acquired. A CNN structure is designed and trained on the frequency spectrums of the four components after Fourier-transform. The extracted features can reflect the characteristic of the original signals and are trained in a softmax classifier for rotating machine fault diagnosis. Experiments are carried out using vibration signals under 52 different machine working conditions. The experiment results indicate that our proposed approach has better accuracy and efficiency than traditional fault diagnose approaches.

16:40-17:00 **MonC10-2**

Autoencoder-based Fault Diagnosis for Grinding System

Xingyu Qu Shenyang Inst. of Automation Chinese Academy of Sciences
Northern Heavy Industries Group Co. ltd
Peng Zeng Shenyang Inst. of Automation Chinese Academy of Sciences
Dongdong Fu Northeastern Univ.
Chengcheng Xu Northeastern Univ.
At present, most fault diagnosis for grinding system is based on artificial judgments, which is inefficient, low accurate, high cost and easy to cause casualties. The traditional neural network has an unsatisfying performance to predict on high dimensional dataset, and is hard to extract crucial features, which brings about terrible classification results. To solve the above problems, the paper present a deep learning based on autoencoder to realize the intelligent diagnosis for grinding system. The algorithm applies autoencoder to extract features from fault dataset, and transit the non-linearized features to Softmax classification to recognize the fault category. This paper compares autoencoder-based deep learning networks and the traditional BP neural networks in experiments, and it is concluded that the autoencoderbased deep learning outperforms BP networks in the unbalanced classification. The classification precision is up to 92.4% by using the proposed method.

17:00-17:20 **MonC10-3**

Fault Diagnosis of Nonlinear System via Hybrid Observer-Based and Homogeneous Polynomial Techniques

Hui Ge Nanjing Univ. of Posts and Telecommunications
Dong Yue Nanjing Univ. of Posts and Telecommunications
Xiangpeng Xie Nanjing Univ. of Posts and Telecommunications
The problem of fault diagnosis for a class of nonlinear system is investigated via the hybrid method of observer-based approach and homogeneous polynomials technique. In the design of the estimator, a new structure with homogeneous polynomial form has been proposed, which is able to deal with the fault diagnosis issue for multi-instant case. A quintessential tunnel diode circuit example is given to demonstrate that i) more relaxed conditions can be obtained under the novel designed observer; ii) faults have been successfully distinguished during only a few steps after their occurrence.

17:20-17:40 **MonC10-4**

Comprehensive Evaluation of Maglev Train Risk Based on Fuzzy Theory

Zhiqiang Long National Univ. of Defense Tech. Mechatronic Engineering and Automation Coll.
Jingfang Ding National Univ. of Defense Tech. Mechatronic Engineering and Automation Coll.
Chengxin Fan National Univ. of Defense Tech. Mechatronic Engineering and Automation Coll.
The process of risk-based maintenance not only considers the probability of the malfunctions of the system components, but also considers many risk factors integrally such as personal safety, parking loss, maintenance costs, environmental impact and so on. These risk factors are often with uncertainty and ambiguity. Based on the above problems, this paper puts forward a comprehensive evaluation method of equipment risk based on fuzzy theory. The method uses fuzzy analytic hierarchy process and fuzzy comprehensive evaluation method to establish a fuzzy evaluation method which supports the expert opinion. Combined with the severity of the consequences of the malfunctions, the method of the risk level evaluation is proposed. Maintenance decisions become more practical, by giving the appropriate maintenance recommendations.

17:40-18:00 **MonC10-5**

Infrared Image Segmentation of Aircraft Skin Damage Based on the Game between MRF and Improved GVF Snake

Kun Wang Civil Aviation Univ. of China
Momo Guo Civil Aviation Univ. of China
Yanxiao Lee Civil Aviation Univ. of China
Li Wang Civil Aviation Univ. of China
Jingchang Zhuge Civil Aviation Univ. of China
Infrared image possess the characteristics of large noises, concentrated intensity, blurring target edge, and poor contrast between target and background, which causing the segmentation of damage targets in aircraft skin infrared thermal image become difficult. Aiming at this problem, a method of infrared image segmentation based on the game between Markov Random Field (MRF) and improved Gradient Vector Flow (GVF) Snake is proposed in this paper. On the basis of wavelet transform denoising, the infrared image is firstly classified into target and background domain by Maximum Between-Class Variance. Secondly, region-based MRF image segmentation model and edge-based improved GVF Snake image segmentation model are established, respectively. These two algorithms are executed in parallel and independently, and the iteration stops when convergence condition is reached. Finally, Game theory is applied to fuse the segmentation results of the above two models. When the game reaches the Nash equilibrium, the optimal solution of segmentation is acquired. The experimental results show that the proposed method can successfully segment the defect targets from the infrared images of aircraft aluminum skin specimens and effectively improve the accuracy of infrared image segmentation.

18:00-18:20 **MonC10-6**

DKPCA Based Fault Detection of Cold Bending Forming Process in Torque Tube Manufacture

Bo Qu Beijing Univ. of Chemical Tech.
CNOOC EnerTech Equipment Tech. Co.Ltd
Jing Wang Beijing Univ. of Chemical Tech.
Jinglin Zhou Beijing Univ. of Chemical Tech.
Haiyan Wu Beijing Univ. of Chemical Tech.
Torque tube is widely used on the offshore platform, and its quality plays an important role on the security of offshore platform. The cold bending forming process for torque tube production is nonlinear and dynamic seriously, with the fault types varied and complex, so the traditional PCA cannot get a good effect in the fault detection of cold bending forming. In this paper, a fault detection method based on dynamic kernel principal component analysis (DKPCA) algorithm is introduced to detect the faults of the cold bending forming. Eleven process variables were sampled from the actual manufacture process and used for fault diagnosis. PCA and DKPCA are used to carry out fault detection on the cold bending forming process, and the results show that the effect of DKPCA for fault detection is better than that of PCA. DKPCA can improve the detection effect greatly due to its advantage in nonlinear and dynamic characteristics, which can be applied widely in actual process.

MonC11 Room11
Social economy systems (I) 16:20-18:20

Chair: Xin Tong Northeastern Univ.
CO-Chair: Huichen Jiang Beihang Univ.

16:20-16:40 **MonC11-1**

An Empirical study on Spatial Spillover of carbon emissions and Financial Development based on Provinces Data and Spatial Panel Econometrics Model

Xin Tong Northeastern Univ.
Central Univ. of Finance and Economics
Yuming Wu East China Univ. of Science and Tech.

Xuesen Li Shenyang Polytechnic Coll.
Lin Tong Dalian Inst. of Science and Tech.
The paper explores the spatial spillover of carbon emissions and financial development based on spatial econometric model using panel series data in China. The results show that carbon emissions have spatial dependence, spatial spillover effects of provincial carbon emissions and financial development are obvious; local correlation exhibits the characteristics of spatial agglomeration, spatial spillover effect is significant; the elasticity modulus of financial development on carbon emissions is significantly positive; Chinese government promotes the development of low-carbon finance, carbon finance role in the development of monetary policy taking into account the mechanism of action space on carbon emissions, the paper opens up new insights for China decrease China's carbon emissions from financial development visual threshold.

16:40-17:00 **MonC11-2**

Gray Correlative Empirical Research on Carbon Emissions and Influencing Factors in Hebei Province

Xin Tong Central Univ. of Finance and Economics
Northeastern Univ.
Xuesen Li Shenyang Polytechnic Coll.
Lin Tong Dalian Inst. of Science and Tech.
In this paper, the gray relational analysis model was used to analyze the correlation between carbon emission and influencing factors in Hebei Province based on historical data from 2000 to 2012. It was found that economic growth was the main factor leading to the increase of carbon emissions in Hebei Province And the gray correlation between carbon emission and technological progress has a positive effect. Finally, on the basis of the research results, this paper discusses the carbon emission reduction strategy of Hebei province, and puts forward the countermeasures and suggestions for the low carbon economy development. Hebei Province would control of carbon emission factors to reduce carbon emissions through a reasonable, thereby reducing the Beijing-Tianjin-Hebei and the country's total carbon emissions.

17:00-17:20 **MonC11-3**

The Principle of Urbanization Promoting the China's Economic Growth and It's Empirical Research

Huirong Jing Yunnan Univ. of Nationalities
This paper uses the data of the urban and rural populations in China Statistical Yearbook to reveal the status of China’s economic structure. This article from the perspective of affecting economic output production, builds the production function model of urbanization development which promotes economic growth. increases urbanization development elements in the Cobb-Douglas production function, modifies the production function which contains the technical progress, Further, selects the section data of China's 31 provinces, autonomous regions and municipalities directly under the Central Government in 2011, uses the Eviews6.0 software, changes the production function model into the econometric model to empirical test theoretical model of the urbanization development to promote economic growth and it’s related the theoretical conclusions. At the significance level of 1%, the urbanization rate increasing 1%, the output GDP increasing 0.66 percent, while the output elasticity of capital and labor are 0.71 and 0.37 respectively.

17:20-17:40 **MonC11-4**

Empirical Study on the Effect of Asset Price Bubbles on Investment

Wenxiu Hu Xi'an Univ. of Tech.
Qiang Fu Xi'an Univ. of Tech.
Tingting Wu Xi'an Univ. of Tech.
Gang Liu Xi'an Univ. of Tech.
This paper make a comparison of the elasticity coefficient of fixed assets investment to the U.S. stock market index (house price index) in the period in which they have bubbles and don’t have bubbles, to study the effect of asset price bubbles on investment demand. Our empirical results show that: (i) compared to the non-bubble period, the elasticity coefficient of investment to stock price (house price) changes from -0.088 (0.402) to 0.094 (0.945) in the bubble period, which indicates there are significant positive effect of stock price and house price on investment when they are both in bubbles; (ii) the elasticity of investment to house price is much larger than that of stock price when they are both in bubbles, which indicates that asset price bubbles, especially the real estate price bubble can significantly stimulate investment demand.

17:40-18:00 **MonC11-5**

Review on the Theories of Auction Corruption

Huirong Jing Yunnan Univ. of Nationalities
This paper systematically reviews the literatures on the theories of auction corruption at domestic and overseas.The auction corruption is divided into simple corrupt and complex auction corruption. According to the differences of the way which auction rules is distorted, The simple auction corrupt is divided into special care type corruption, limited corruption and rebate Agreement type of corruption. It is given that the relationship between simple auction corruption and complex auction corruption. System compared to the different conclusions what the auction corruption impact on the efficiency of resource allocation.Summarized the difference of the auction corruption come into being.The relationship between auction corruption and competition is summarized.Finally, the systematically gives the existing problems of the existing research about the auction ,corruption, and the future of studies in this field is also predicted.

18:00-18:20 **MonC11-6**

Efficiency Research on China Listed Securities Companies

Huichen Jiang Beihang Univ.
Recently, China economy has entered the stage of "new normal", series of reforms and the steady growth of economy boost the rapid development of China securities industry. In this paper, we designed a Data Envelopment Analysis (DEA) Model with multi inputs and outputs, and statically and dynamically evaluated the firms and the industry. Our findings indicated that in the period of "new normal", there had been a significant rise of the total factor productivity of the industry, and there were more efficient growths of firms than in the past according to the prior studies and our evaluations. Additionally, differences in the pure technical efficiency were not as significant as in the scale efficiency. Suggestions were offered based on the evaluations and actual development of securities firms. By using DEA, this paper shed light on the operating efficiency of China securities companies from 2012 to 2015, which was of positive significance to the healthy development of China securities industry in the period of "new normal".

MonC12 Room12
Control applications (III) 16:20-18:20

Chair: Bin Zhou Harbin Inst. of Tech.
CO-Chair: Yijian Mao Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences

16:20-16:40 **MonC12-1**

Magnetic Attitude Control of Bias Momentum Spacecraft by Bounded Linear Feedback

Weiwei Luo Harbin Inst. of Tech.
Bin Zhou Harbin Inst. of Tech.
This paper addresses the three-axis magnetic attitude control of small spacecraft with momentum bias configuration by bounded linear feedback. Necessary and sufficient conditions are derived to guarantee that the linearized dynamics and kinematics are stable in the Lyapunov sense. Explicit solutions to some Lyapunov equations associated with the considered open-loop system are obtained. Based on the explicit solutions to the Lyapunov equation, an explicit saturated linear state feedback controller is designed. Globally asymptotic stability of the closed-loop systems is proved by constructing the explicit Lyapunov function. Simulations show the effectiveness of the proposed approach.

16:40-17:00 **MonC12-2**

A Dynamic-decoupling Controller of Current for Permanent Magnet Synchronous Motor

Mingxing Zhao Jilin Univ.
Haiyan Zhao Jilin Univ.
Hong Chen Jilin Univ.
The problem of current coupling in permanent magnet synchronous motor (PMSM) will affect control performance of the motor. The id = 0 control in the field-oriented control (FOC) can realize the static decoupling of current and improve the steady-state performance of the system. But this method does not solve the dynamic coupling problem of current, which will reduce the dynamic performance of the motor. Therefore, aiming at the problem of current dynamic coupling in PMSM system, a dynamic-decoupling controller of current based on Lyapunov stability theory is proposed in this paper. In order to solve the problem of controller gain selection in engineering, a random algorithm is adopted to narrow the range of controller gain. Compared with PID controller, the proposed controller can greatly decrease the number of controller gain and reduce the burden of controller gain selection simultaneously. Finally, the validity of proposed controller is verified by the model of PMSM system established in MATLAB/Simulink.

17:00-17:20 **MonC12-3**

Servo System to Control Arc length for Electro-Gas Welding Equipment

Yijian Mao Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Lei Yang Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Fengshui Jing Chinese Academy of Sciences
Zize Liang Chinese Academy of Sciences
Weiqing Zhao Chinese Academy of Sciences
Automatic welding equipment with arc length control for electrolytic aluminum plant is designed. The servo system is composed of AC servo motor, ball screw, electro-gas (EGW) power, base material to be welded and servo controller. The welding power is installed of numerical communication port of welding current, providing information of velocity error between welding pool and gun. MIMO model of welding process is simplified into a linear error amplified. Dynamics of AC servo motor and ball screw with external load are analyzed. And a list of parameters is provided for further controlled design. The system is essentially a multi-loop control system. The internal loop of PID controller is tuned first. And then the whole system with PD controlled is tuned, so that the overshoot (σ%) and stabilization time (ts) is comfortable. At last, with the help of Simulink, arc control performance test is conducted. It proves that the system can keep arc length almost constant. This method is practical and easy to be realized for industrial application.

17:20-17:40 **MonC12-4**

Design and Implementation of Active Disturbance Rejection Control for the Ship-borne Photoelectric Tracking Servo System

Dongyang Zhang Beijing Inst. of Tech.
Qinghe Wu Beijing Inst. of Tech.
Xiaolan Yao Beijing Inst. of Tech.
Dongdong Xie Beijing Inst. of Tech.
Luliang Jiao Beijing Inst. of Tech.

The critical design for the control system of the ship-borne photoelectric tracking equipment is how to isolate the internal uncertainty and external disturbance. To obtain the stabilization and tracking of the target, servo control system of the photoelectric tracker becomes the key of the new designing measurement and control system. In this paper, the coordinate transformation technology is used to conduct the real-time compensation to the attitude angle caused by ship-swaying. And the multi-loop (double speed loop and a position loop) structure of servo system was modeled, and linear active disturbance rejection controller is designed to improve the anti-disturbance ability and control performance. The simulation results show that the proposed method is effective and it has better control effect and stronger antidisturbance ability compared with traditional control method.

17:40-18:00 **MonC12-5**

Light Intensity Intelligent Control System Research and Design Based on Automobile Sun Visor of BH1750

Jing Gao Shenyang Inst. of Engineering
Jinming Luo Shenyang Inst. of Engineering
Aoran Xu Shenyang Inst. of Engineering
Jia Yu Shenyang Inst. of Engineering

This article investigates variable optical characteristics of Liquid Crystal Display (LCD). The main function of light intensity intelligent control system is to adjust the brightness of the LCD screen of automotive sun visors according to the light intensity of external environment. The working process starts sending a processed analog signal to single chip microcomputer by collecting data of environmental light through a sensor of BH1750, and then analyzes and computes through processing units, adjusts driving voltage and changes the brightness of LCD screen so that the drivers can fit the light intensity outside and drive safely.

18:00-18:20 **MonC12-6**

Robust H ∞ control of a friction based electrohydraulic load simulator

Dake Zheng Harbin Inst. of Tech.
Hongguang Xu Harbin Inst. of Tech.

In order to improve the torque tracking performance of a friction based electrohydraulic load simulator (FEHLS), first, the linear mathematical control model of the FEHLS is established according to its working principle. As an electrohydraulic servo system (EHSS), the FEHLS always has parameter uncertainties, measurement noise, external shock, etc. Besides, in practical applications, most of the state variables of the controlled EHSSs cannot be measured. In order to compensate for the aforementioned factors of the FEHLS and avoid the use of full-state feedback, a robust H∞ controller is designed to meet the requirements of highly accurate and highly dynamic torque tracking control. As compared with the proportionintegration-differentiation (PID) controller, the effectiveness of the robust H ∞ controller is verified by the experimental results.

MonC13 **Room13**
Signal processing (V) **16:20-18:20**
Chair: Xibin Sun Beijing Inst. of Tech.
CO-Chair: Zhao Wang China Univ. of Petroleum

16:20-16:40 **MonC13-1**

An Ensemble Method for Multiple Source Images Fusion in Smart City

Xibin Sun Beijing Inst. of Tech.
Shaoxun Li Beijing Inst. of Tech.
Jiangang Lei Beijing Inst. of Tech.

Facing to the huge amount of data in the construction of smart city, it is a severe challenge for image fusion technology to acquire the fast information processing ability. How to optimize computation process and ensure the calculation accuracy is one of problems to be solved for massive image data fusion of the smart city. In this paper, it is proposed that image fusion and image stitching technology are combined together to build the big data computing platform of urban images. It is known that there are more data to be dealt for the image pixels-level fusion compared to feature fusion. Urban data are existed in the variation modes and shortage of content correlation. The data are sparse for city global information, but there may be redundant information for local urban region. So, the urban image fusion must meet the requirement of getting requisite and accurate information for the big data computing platform. The improved simple SIFT image registration algorithm (called S-SIFT algorithm) uses SIFT feature extraction method for getting feature point location and scale information, and some of feature point pairs are randomly selected out. The improvement of S-SIFT algorithm is reflected in reducing the time consumed by the feature description, thereby speeding up the image registration process. The ensemble method provides technical support for low cost image big data platform with high reliability operation.

16:40-17:00 **MonC13-2**

Frequency Characteristic Test of Electro-hydraulic Servo Mechanism Based on ADSTK

Fan Gu Xi'an High-Tech Research Inst.
Ruihua Yue Xi'an High-Tech Research Inst.
Qingliang Ma Xi'an High-Tech Research Inst.
Jianhua Wang Xi'an High-Tech Research Inst.
Ben Wang Xi'an High-Tech Research Inst.

Electro-hydraulic servo mechanism is the actuator of the missile to adjust the implementing agencies, the frequency characteristic test is important content in the test. In order to reduce the dependency of the filter on the statistical characteristics of the noise during the testing process, an improved adaptive strong tracking filter (ADSTK) is proposed to suppress the noise in the frequency characteristic test. With ADSTK, the time-varying process noise and measurement noise were estimated online and filtered, and dependence of noise prior statistical properties was reduced. By the simulation, anti-interference ability of the system was improved and the effectiveness of the algorithm was verified.

17:00-17:20 **MonC13-3**

An applied research of improving Kalman filter in dual mode navigation

Zexin Wu Guangzhou Maritime Univ.
Ming Bai Guangzhou Maritime Univ.
Jieling Zheng Guangzhou Maritime Univ.
Yiyi Zhan Guangzhou Maritime Univ.
Xin hai Xia Guangzhou Maritime Univ.
Jie Lei Guangzhou Maritime Univ.
Zhipeng Chen Guangzhou Maritime Univ.

Aiming at the improvement the low accuracy of conventional Kalman filter, this paper puts forwards a modified Kalman filter to construct a nonlinear regression model based on M estimation, adopts Unscented Kalman Filter (UKF) filtering, and then applies this algorithm to research of dual mode navigation. Experimental results show that the algorithm can improve the navigation accuracy compared with UKF and Extended Kalman Filter (EKF). It retains the high accuracy while the robustness is ensured, it has certain practical application value in dual mode navigation, also has extensive application and broad prospects.

17:20-17:40 **MonC13-4**

Simulation Analysis of Inrush Current of Three Phase Transformer Based on MATLAB

Yundong Song State Grid Liaoning Electric Power Co., Ltd.
Hongde Jia Shenyang Inst. of Engineering
Xiaofeng Xu Shenyang Inst. of Engineering
Li Yu Shenyang Inst. of Engineering

This paper presents a phenomenon of inrush current in three-phase transformer closing switch without load, a simulation model of three-phase transformer no-load switching inrush current was built by using the SimPowerSystems software package of simulink in Matlab software, and the simulation result was analyzed by Fourier transform analysis, which directly showing the characteristics of the three-phase transformer inrush current waveform.

17:40-18:00 **MonC13-5**

Applications of An Improved EMD Method in Signal Denoising of Oil Pipeline

Longtao Ma China Univ. of Petroleum
Zhao Wang China Univ. of Petroleum
Peng Liu China Univ. of Petroleum
Shurong Li China Univ. of Petroleum

The long-distance pipeline leakage signal is disturbed by the outside world and the signal-to-noise ratio is low. It needs to deal with the leaking signal to improve the detection precision of pipeline leakage. In this paper, the advantages and disadvantages of several common denoising methods are analyzed. Emphasis is placed on the analysis of empirical mode decomposition (EMD). In order to solve the problem of end effect, the EMD algorithm of the nearest similar distance is analyzed and validated with the data collected in the field. The denoising results show that the proposed algorithm can effectively suppress the end effect in denoising decomposition, suppress the random noise in the leakage signal, and improve the signal - to - noise ratio of the pipeline monitoring signal.

18:00-18:20 **MonC13-6**

Jointed Method of Diagonal Interacting Multiple Model Algorithm and Distributed Kalman Consensus Filter for Intermittent Measurement

Shiqi Cao Chongqing Univ. of Posts and Telecommunications
Ming Cen Chongqing Univ. of Posts and Telecommunications

Intermittent measurements generally are inevitable for networked multisensor system. To improve the state estimation performance of multisensor system with measurements loss, a jointed method of DIMM (Diagonal Interacting Multiple Model) and distributed KCF (Kalman Consensus Filter) is presented. By the method, the intermittent measurement is modeled by a Bernoulli binary stochastic variable, and two different structures of jointed method are discussed. The one used the consensus filter after fusion of filters of each model, and the other used the consensus filter on each model. The equivalence of accuracy of two structures is proved. Simulation results show that the accuracy of two methods is equal, and the calculational cost of former is superior to that

of latter.

MonC14 Room14
Intelligent automation (II) 16:20-18:20
Chair: Qiliang Du South China Univ. of Tech.
CO-Chair: Kun Wang Chongqing Univ.

16:20-16:40 MonC14-1

An improved background modeling algorithm based on the codebook model

Bin Zhu South China Univ. of Tech.
Lianfang Tian South China Univ. of Tech.
Qiliang Du South China Univ. of Tech.
Lubin Yu South China Univ. of Tech.
LiXin Shi Shenzhen

As an effective background subtraction algorithm, the basic codebook model algorithm has many disadvantages. Such as too many parameters、background was mismatched as foreground、the slow speed of the background model updating、affected by noises. An improved codebook model algorithm is proposed in this article. The mean and variance cubic (MVC) of the pixel value in RGB color space was applied to judge whether the input matches one of the codewords or not; the mean and variance of codeword is updated by dynamic learning rate which is correlated to the frequency of the codeword has occurred; Layered modeling technique was proposed to update codebook adaptively; meanwhile the frequency of the codeword has occurred was also used as one of the criteria to judge whether absorbing a codeword into the codebook model. Experiment results show that the algorithm proposed can segment moving objects under complicated scenes which could include dynamic background and illumination change, can absorb variations into the background model quickly, can be used to real-time foreground-background segmentation.

16:40-17:00 MonC14-2

Multi-view Images of Time-sensitive Targets Simulation Method Based on Geometric Deformation

Xiaopei Tang Xi'an Research Inst. of High-Tech
Xiaogang Yang Xi'an Research Inst. of High-Tech
Yunfeng Liu The 209th Research Inst. of Weapon Industry
Naixin Qi Xi'an Research Inst. of High-Tech

Time-sensitive targets strike is a hot and difficult topic in the research of targets attack system, however, the acquisition of reference images of time-sensitive targets are high-cost and data is scarce. Aiming at the problem, a simulation method of generating multi-view images of time-sensitive targets is proposed. Firstly, the imaging model of the aircraft viewpoints transformation is established, and the coordinate transformation is deduced in detail; Secondly, a multi-view images generation algorithm is designed, and the implementation of the algorithm is introduced in detail. Simulation result shows that the method is effective for the simulation of multi-view images with high value of time-sensitive targets.

17:00-17:20 MonC14-3

The Research on Energy Conservation Controller for Asynchronous Motor Based on ADRC

Xuesong Zhou Tianjin Univ. of Tech.
Haobo Cui Tianjin Univ. of Tech.
Youjie Ma Tianjin Univ. of Tech.
Zhiqiang Gao Tianjin Univ. of Tech.

Asynchronous motors are widely applied in industry, agriculture production and daily life, but in practical application, asynchronous motor often works in empty or light load because of various factors, leading to a low power factor and efficiency, which cause a great waste of energy. Therefore, it is of important practical significance to research of asynchronous motor energy conservation issue. This paper analyzes the energy-saving principle of asynchronous motor, mainly studies under the condition of light load or no load, according to a certain control rules to reduce the motor input voltage to achieve energy saving purposes. ADRC (Active Disturbance Rejection Control) technology is proposed to achieve energy-saving, and use the MATLAB simulation software to study the control system of energy-saving.

17:20-17:40 MonC14-4

Research on Asynchronous Motor Energy-saving Technology

Xuesong Zhou Tianjin Univ. of Techn.
Mingpeng Sun Tianjin Univ. of Techn.
Youjie Ma Tianjin Univ. of Techn.
Zhiqiang Gao Tianjin Univ. of Techn.

With the social and economic development, human demand for energy is more and more essential. How to achieve energy conservation and emissions reduction effectively has become a worldwide concern. Asynchronous motor in daily life, especially in the industrial production plays a very important role. Asynchronous motor is the main energy consumer. In practice, due to various reasons, the asynchronous motor run frequently under the condition of no load or light load, the condition of motor power factor and the efficiency is low, even the large electric energy waste. If the energy saving of asynchronous motor is in control and the efficiency of the motor is improved, the considerable electricity quantity for increasingly energy conservation will have extremely great significance for our society, nowadays. From the perspective of energy-saving of asynchronous motor, this paper introduces the new situation of the asynchronous motor energy-saving's background, significance and research status at home and abroad. This paper mainly discussed the key technology of asynchronous motor energy-saving and its existing problems and briefly introduced its future development trend.

17:40-18:00 MonC14-5

Research on Tightening Control of Solid Rocket Engine Based on Expert Prediction

Jingdong Lin Chongqing Univ.
Kun Wang Chongqing Univ.

The torque control model was established based on the analysis of the mechanical properties of the screw.Aiming at the precision control of the compression ratio of the rubber sealing ring, an improved torque angle control method based on the zero point identification of the seal was put forward by using the torque angle control idea. It was difficult to directly observe and detect the initial deformation point of the sealing ring in the tightening process .The authors use the model prediction and expert control technology to establish the dynamic prediction model ,and combine the experts' reasoning to estimate the torque value of the zero point of the sealing ring on-line, and establish the zero-point recognition control algorithm based on expert estimation.

18:00-18:20 MonC14-6

SVM ensemble method based on improved iteration process of Adaboost algorithm

Yiming Tian Hebei Univ. of Tech.
Xitai Wang Hebei Univ. of Tech.

In order to improve the performance of the base classifier in the process of AdaBoost algorithm and simplify the complexity of the whole ensemble learning system, this paper presents a SVM ensemble method based on an improved iteration process of Adaboost algorithm.The improved Adaboost algorithm is added with methods of adding sample selection and feature selection in its iterative process in order to solve the problem that Adaboost is susceptible to noise and has long training time. First of all, the samples subsets are selected by means of mean nearest neighbor algorithm. Secondly, the feature subset is obtained using the method of relative entropy. Lastly, the individual SVM classifiers are trained by the resulting optimal feature samples subset in each cycle and combined via majority vote to generate the final decision system. The simulation results of UCI datasets show that this algorithm can achieve a higher recognition accuracy on the basis of fewer samples and features compared with the traditional Adaboost support vector machine ensemble algorithm.

MonC15 Room15
Robot control (I) 16:20-18:20
Chair: Pinghai Gao National Univ. of Defence Tech.
CO-Chair: Haoping Wang Nanjing Univ. of Science and Tech.

16:20-16:40 MonC15-1

Obstacle Avoidance for Micro Quadrotor Based on Optical Flow

Pinghai Gao National Univ. of Defence Tech.
Daibing Zhang National Univ. of Defence Tech.
Qiang Fang National Univ. of Defence Tech.
Shaogang Jin National Univ. of Defence Tech.

In recent years, UAV has attracted a lot of attention and is being used widely. However, in order to complete missions successfully, the ability to sense and avoid obstacles is essential for UAV. In this paper, a method for micro quadrotor to detect obstacles based on optical flow is proposed. Based on the ROS framework, a controller is developed to avoid the detected obstacles and is successfully experienced on the Ar.Drone. Experiments show that the proposed method is robust and effective for micro quadrotor to avoid obstacles.

16:40-17:00 MonC15-2

Regressor-Free Adaptive Control of Flexible Joint Robot Manipulators with Reduced Number of Estimators

An-Chyau Huang National Taiwan Univ. of Science and Tech.
Peng Liu National Taiwan Univ. of Science and Tech.

In this paper, an adaptive controller is proposed for controlling flexible joint robots containing time-varying uncertainties. The controller is free from the computation of the regressor matrix which largely simplifies its implementation. The feedback of link accelerations and their higher derivations are avoided without the support of Slotine and Li's modification. The number of update laws in the estimation of uncertainties by using the function approximation technique is significantly reduced in this new design which further improves its applicability. The closed loop stability and boundedness of internal signals are proved by the Lyapunov-like theory. Computer simulations are performed to verify its effectiveness.

17:00-17:20 MonC15-3

Developing an Identity Recognition Low-cost Home Service Robot Based on Turtlebot and ROS

Chengguang Xu Nankai Univ.
Wenyu Li Nankai Univ.
Jeffrey Too Chuan TAN Univ. of Tokyo
Zengqiang Chen Nankai Univ.

Han Zhang Nankai Univ.
Feng Duan Nankai Univ.
Aging population and disabled assistance have become serious social problems these years. However, it is impossible to make sure that every old people has a caregiver. Therefore, the home service robot is a good method to mitigate these issues. Although current robotic technology is mature, service robots with advanced functions are very expensive. In this paper, we developed an identity recognition low-cost home service robot based on Turtlebot and Robot Operating System (ROS). In order to verify the performance of the service robot, we designed a series of experiments in a simulated home environment. The average successful rates of the designed experiments were all above 90%. The results confirmed that the low-cost service robot satisfied our design target.

17:20-17:40 **MonC15-4**

A Genetic Algorithm-based Surface Segmentation method for Spray Painting Robotics

Zhenzhou Fu Bohai Univ.
Bing Xiao Bohai Univ.
Chaofan Wu Bohai Univ.
Jia Yang Bohai Univ.
Two novel methods of complex surface segmentation in robot spray trajectory planning are developed. It is designed by using genetic algorithm. The first method is able to separate the largest patch from the surface, while the second approach is capable of dividing the surface with the smallest number of slices. Moreover, different initial triangles are selected to produce different segmentation results. This will inevitably affect the result of trajectory planning. Simulation results with the proposed approaches applied to the part of car's front are further presented to validate effectiveness of the proposed methods.

17:40-18:00 **MonC15-5**

Integral Backstepping Based Computed Torque Control for A 6 DOF Arm Robot

Shuaishuai Han Nanjing Univ. of Science and Tech.
Haoping Wang Nanjing Univ. of Science and Tech.
Yang Tian Nanjing Univ. of Science and Tech.
The focus of this survey is the modeling and control of a 6 DOF arm robot. Based on Lagrangian dynamics, a 6 DOF(degree of freedom) arm robot model is built. The computed torque control (CTC) is applied to the position tracking control and a planned trajectory is given. Furthermore, to improve the tracking speed and achieve the velocity tracking, a nonlinear integral backstepping (NIB) technique is combined with CTC. The final control scheme is proposed, in the name of CTC-NIB. Simulation results show the effectiveness of the proposed control method. Compared with traditional CTC, the CTC-NIB absolutely improve the tracking performance.

18:00-18:20 **MonC15-6**

Research on mechanical arms trajectory-planning using different order B-splines

Meng Zhu Beijing Inst. of Tech.
Feng Pan Beijing Inst. of Tech.
Kunming –BIT Industry Tech. Research Inst. INC
Chao Pan Kunming Inst. of Physics
Weixing Li Beijing Inst. of Tech.
Kunming –BIT Industry Tech. Research Inst. INC
Gao Qi Beijing Inst. of Tech.
Kunming –BIT Industry Tech. Research Inst. INC
In order to ensure the smoothness of joint motion and the accurateness of the target position estimate, B-spline has been widely used in joint trajectory planning for mechanical arms. In this paper, the base functions of the third order, fifth order, and seventh order of uniform B-splines are given. Comparison between piecewise polynomial and B-splines on trajectory planning is presented to show the differences in computational complexity. The trajectories planned in using three different order B-splines are shown and discussed. Detailed analysis of the planning with virtual points is described in this paper.

MonC16 **Room16**
Electric vehicles and intelligent transportation (I) **16:20-18:20**
Chair: Guodong Yin Southeast Univ.
Jilin Univ.
CO-Chair: Jingxin Yuan Jilin Univ.

16:20-16:40 **MonC16-1**

Takagi-Sugeno Fuzzy Model Predictive Controller Design for Combining Lane Keeping and Speed Tracking of Four Wheels Steering and Four Wheels Drive Electric Vehicle

Chentong Bian Southeast Univ.
Guodong Yin Southeast Univ.
Jilin Univ.
Ning Zhang Southeast Univ.
Liwei Xu Southeast Univ.
Most of the previous lane keeping algorithms are designed for the vehicle lateral control without considering the longitudinal dynamic characteristic. In this paper a new controller for combining lane keeping and speed tracking of four wheels steering and four wheels drive electric vehicle is presented. Firstly, the nonlinear system model is constructed considering the vehicle longitudinal and lateral dynamic behaviors. Then, the Takagi-Sugeno (T-S) fuzzy model is built to approximate the nonlinear model by local linear models with fuzzy rules. Finally, the vehicle controller is devised via fuzzy model predictive control (FMPC) to cope with the physical actuator limit and ensure the control performance. Simulations of Simulink and Carsim suggest that the proposed controller is competent for lane keeping and speed tracking on curve road with varying desired speed.

16:40-17:00 **MonC16-2**

AHS_BP Algorithm and Application in Traffic Parameters Prediction

Qiong Wu Chang'an Univ.
Shenyang Univ.
Xiangmo Zhao Chang'an Univ.
In order to avoid the low stability of memory and the uncertainty of global minimum point, a new algorithm based on harmony search that optimizes the weights and the thresholds of BP neural net is proposed to predict the traffic parameters. Then the algorithm is improved to increase the running speed. The other advantage is that the algorithm combines the nonlinear fitting capability of BP neural net with the searching ability of global optimal solution of HS. And in this paper, the single parameter and the multiple parameters of traffic information are simulated to predict their tendencies. The results show that the proposed method has strong robustness, adaptability and global searching ability.

17:00-17:20 **MonC16-3**

Attribute-based Authenticated Protocol for Secure Communication of VANET

Yiliang Han Northwest Univ.
Engineering Univ. of PAP
Xi Lin Engineering Univ. of PAP
Di Jiang Engineering Univ. of PAP
Dingyi Fang Northwest Univ.
VANET (Vehicular Ad hoc Network) is prone to attack of safety and leakage of privacy, because of the large scale of networks, openness of the wireless communication channel and easy tracking of mobile vehicles. Motivated by the security requirements, an attribute-based authenticated protocol for secure communication of VANET was proposed, in which attribute-based signcryption and signature were used to help vehicles to securely receive a secret key and message from an RSU or other vehicles, and then the vehicles could anonymously receive different service with different attributes on behalf of the group, moreover attributes scheme was employed to accelerate the verification. The results showed that the scheme achieves confidentiality and authentication, at the same time, the maneuverability and efficiency of the communication and authentication are raised, and which is more suitable for the practical applications.

17:20-17:40 **MonC16-4**

Study on the Framework of Surveillance and Management System for High-Speed Railway System

Yuqiang Liu China Academy of Railway Sciences
Tianyun Shi China Academy of Railway Sciences
Xiaojun Lv China Academy of Railway Sciences
Fenghua Zhu Chinese Academy of Sciences
For most people, the high-speed railway has become an important and preferred way to travel. In order to improve the safety, it is of great importance to effectively monitor natural disasters, man-made destruction, and draw up reasonable emergency plan. However, we have great challenges to achieve effective surveillance and management for high-speed railway system, as it is a complex giant system. In order to solve this problem, we employ the theory of parallel system and the technology of big data. In this paper, we put forward the research frame of surveillance and management system for high-speed railway system so as to satisfy the practical requirements of monitoring and management. Firstly, the basic model of the artificial system is set up from the actual system, and then the design method of the computational experiment is given. Finally, the parallel execution of real and artificial systems is described in detail. The research framework proposed in this paper will provide reasonable solutions and suggestions for the parallel control and management of high-speed railway.

17:40-18:00 **MonC16-5**

TransModeler based implementation of autonomous vehicular platoon control

Yongfu Li Chongqing Univ.of Posts and Telecommunications
Yu Song Chongqing Univ.of Posts and Telecommunications
Taixiong Zheng Chongqing Univ.of Posts and Telecommunications
Huizong Feng Chongqing Univ.of Posts and Telecommunications
This study develops a vehicular platoon control system (VPCS) based on the combination of car-following model and leader-follower model under connected environment. In particular, first, a three-level framework including information collection, information processing and information release is proposed to design the control strategy. Then, the car-following model is used to capture the characteristics of vehicular platoon movement; while the leader-follower model is used to describe the vehicle dynamics of vehicle merging into the platoon. Finally, the TransModeler based platform is developed to validate the effectiveness of the proposed method with respect to vehicle speed and position trajectory.

18:00-18:20 **MonC16-6**

Gain-Scheduled Fault Diagnosis of In-Wheel Motor Electric Vehicles

Jingxin Yuan Jilin Univ.
Yulei Wang Jilin Univ.
Shuyou Yu Jilin Univ.
Hong Chen Jilin Univ.

This paper presents a gain-scheduled fault diagnosis approach for in-wheel motor (IWM) driven electric vehicles. The dynamics of vehicle slip ratio, which is usually used for vehicle stability and torque allocation, is modeled to monitor the motor torque and evaluate the loss of effectiveness. A gain-scheduled extended state observer (GSESO) is investigated to estimate the fault in each of in-wheel motors. With the aid of gain-scheduled techniques, the formulation of fault diagnosis for IWM electric vehicles is transformed to an output feedback gain-scheduled robust control problem. Simulation results using a high-fidelity full-vehicle model in VeDYNA validate the effectiveness of the proposed approach.

MonC17 **Room17**
Energy management systems (I) **16:20-18:20**
Chair: Gang Chen Chongqing Univ.
CO-Chair: Xu Yang Univ. of Science and Tech. Beijing

16:20-16:40 **MonC17-1**

Design of A Energy Monitoring System Based on WebAccess

Yu Liu Tianjin Univ. of Tech.
Jianwei Leng Tianjin Univ. of Tech.
Baiyang Sun Tianjin Univ. of Tech.

Energy monitoring system is based on computer network, automation control and communication technology comprehensive application. To design energy monitoring system should not only in the monitoring data to real-time and accuracy and in maintaining rapid and convenient arrived on the requirements. The design for the above requirements, with centralized management, decentralized control and remote monitoring of the guiding ideology, the design of a remote monitoring system based on energy WebAccess.The system layer is the meter water, electricity, oil and other energy, we have to solve problems through the use of on-site communication totalizer; monitoring layer of the whole system need to be carried out using WebAccess software development to realize emergency scene cannot at the scene, and the realization of Web network for the whole project.

16:40-17:00 **MonC17-2**

Consensus Based Distributed Finite-Time Economic Dispatch in Smart Grid With Jointly Connected Topology

Gang Chen Chongqing Univ.
Zhiyong Li Chongqing Univ.

The plug-and-play function is one of the features of future smart grid. Distributed economic dispatch algorithm will pave the way for the achievement of this function. Most existing distributed economic dispatch algorithms only achieve asymptotic or exponential convergence and work under time-invariant communication topology. In this work, a consensus based distributed economic dispatch algorithm, which achieves finite-time convergence under jointly connected topology condition, is proposed to calculate the optimal active power for each generator. By virtue of Lyapunov theory, LaSalle's invariance principle and homogeneous property, the convergence and optimality of the proposed algorithm are proved. Several case studies are performed to illustrate the effectiveness of the proposed algorithm.

17:00-17:20 **MonC17-3**

A battery management system with two-stage equalization

Shengping Hong Huazhong Univ. of Science & Tech.
Jianhua Jiang Huazhong Univ. of Science & Tech.
Xi Li Huazhong Univ. of Science & Tech.

This paper presents a lithium-ion battery pack equalization system and method. The batteries are divided into several groups, which are connected in parallel with the bidirectional DC-DC converters respectively, and the output of DC-DC converters ends are connected in series with each other as a DC bus. The scheme divides equalization of the cells into two stages: intra-group equalization and inter-group equalization, and the two stages are respectively realized by battery time-sharing-access structure and stack energy-sharing structure. Then equalization strategy of the distributed battery energy storage system under two stages is proposed, especially the Single Cell Battery Access Timing Algorithm and MPC Algorithm. The simulation results show that the proposed battery management structure and control strategy can realize fast and accurate SOC equalization.

17:20-17:40 **MonC17-4**

Energy Consumption Optimization of Air Conditioning Based on Building Monitoring System

Liu Gu Univ. of Science and Tech. Beijing
Xu Yang Univ. of Science and Tech. Beijing
Dawei Ding Univ. of Science and Tech. Beijing
Lei Zhang Univ. of Science and Tech. Beijing
Jiarui Cui Univ. of Science and Tech. Beijing
Zhiwen Chen Central South Univ.
Chaonan Tong Univ. of Science and Tech. Beijing

This paper proposes building monitoring system and optimization scheme about energy consumption of air conditioning. At first, building monitoring system is introduced in detail, which consists ofnode group, concentrator and upper computer. Large amounts of data including environmental parameters and air conditioning energy consumption data are collected, transmitted, stored, and displayed through the proposed system in real time. According to it, optimal performance index of air conditioning is defined. Optimization scheme of air conditioning is put forward based on this index, under which the use pattern ofair conditioning is adjusted by the system. The reduction of air conditioning energy consumption is demonstrated its effectiveness through a case study.

17:40-18:00 **MonC17-5**

An energy sentient service brokering strategy in cloud computing

Fang Ma Yunnan Univ. of Finance and Economics
Ying Yang Yunnan Univ. of Finance and Economics

With the development of cloud computing, on-demand resource provision has become a key feature of it. However, most cloud service providers have their own interface type, energy consumption level and other service features. A service broker in cloud computing plays an intermediate role between providers and users. It is designed to find out the suitable services from the various service providers and meet the user' s requests. Maximizing the energy efficiency is not only good for the environment protection but also could benefit the providers. This paper proposed an energy sentient service brokering strategy, which try to find a suitable trade-off between energy consumption and user's satisfaction. Simulation results show that our proposed strategy could effectively reduce the energy consumption and maintain user's satisfaction in a reasonable level at the same time.

18:00-18:20 **MonC17-6**

An economic dispatching and stability control approach for demand side management

Xu Han Chongqing Univ.
Zhou Wu Chongqing Univ.
Yongduan Song Chongqing Univ.

The wind-solar-battery hybrid system is widely used in modern communities. As the wind and solar resources could compensate each others power output, continuous energy generation can be used to supply the demand-side loads, and its surplus can be stored in the battery. In the paper, a switching wind-solar-battery hybrid system with grid connection is studied. The hybrid system model is simplified in the form of power flow, and use the Lyapunov theory to do the stability analysis. Optimal switching control is used to control power flows from wind/ solar/battery to the loads for minimizing the electricity cost under the time-of-use program. The results show that the promising cost savings can be achieved via optimal operation of the hybrid system.

MonCIS **Room18**
Interactive Session **16:20-18:20**

MonCIS-01

Parameter Fault Diagnosis on Analog Circuits with Tolerance

Haidi Dong High-Tech Inst. of Xi'an
Bing He High-Tech Inst. of Xi'an
Gang Liu High-Tech Inst. of Xi'an
Huafeng He High-Tech Inst. of Xi'an
Jianfei Zheng High-Tech Inst. of Xi'an
Hongzeng Li High-Tech Inst. of Xi'an

This brief deals with soft-fault diagnosis of analog circuits with tolerance and limited test points. Node-voltage-ratio under different current excitation is deduced to establish a fault dictionary and fault eigenvalues of circuit with tolerance are manifested to be the same as that with nominal parameters. It is proved that multiple-fault eigenvalue equation of analog circuits with tolerance holds when node voltage with nominal parameters are adopted. Three numerical examples illustrate diagnosis accuracy and effectiveness of proposed approach.

MonCIS-02

Restraining EMD End Effect of Vibration Signal Based on Homotopy Least Squares Support Vector Double Regression

Bo Xu Wuhan Univ. of Science and Tech.
Fengxing Zhou Wuhan Univ. of Science and Tech.
Yajie Ma Wuhan Univ. of Science and Tech.
Baokang Yan Wuhan Univ. of Science and Tech.

Aiming at the end effect in Empirical Mode Decomposition (EMD) of vibration signals, Shape-Preserving Piecewise Cubic Spline (SPPCS) interpolation method and Homotopy Least Squares Support Vector Double-Regression (HLSSVDR) algorithm is proposed in this paper which can restrain the end effect. In order to obtain valid upper and lower envelopes, based on the studies of end effect mechanism and the existing research results, the SPPCS used to eliminate the fitting overshoot/undershoot problems by structuring the upper and lower envelope curves of the signal. Then the HLSSVDR algorithm is introduced to predict and replace the left and right values at both ends of the mean values of the upper and lower envelopes. The proposed method is analyzed and tested using the actual rolling bearing vibration signals. The experimental results indicate that the proposed method can effectively inhibit the fitting overshoot and undershoot, as well as the end effect, with higher accuracy and less distortion decomposition.

MonCIS-03

Fault Diagnosis Method of HV Circuit Breaker Based on Wavelet Packet Time-frequency Entropy and BP Neural Network

Yaowen Xing Heilongjiang Univ.

Mingliang Liu Heilongjiang Univ.
Ping Yang Heilongjiang Univ.
Quanwei Peng Heilongjiang Univ.
Bin Li Heilongjiang Univ.

High-voltage High-voltage circuit breakers are the most important control and protection equipment in power systems and their reliable operation is critical to power systems.However, the mechanical failure of high-voltage circuit breakers occurs frequently. The vibration signals of high-voltage circuit breakers contain abundant fault information. The change of vibration signals reflects the mechanical state of the circuit breakers. The extraction and classification of vibration signals are very important for fault diagnosis of HV circuit Breaker. In this paper, the packet time-frequency entropy is used to extract the characteristic of the vibration signal of the circuit breaker and BP neural network is used to identify the various types of fault vibration signals. Specially, the vibration signal is decomposed by wavelet packet, then construct the time-frequency entropy of the vibration signal, which is used to the feature vector of fault vibration signals. Finally, we use the BP neural network to judge the working state and fault type of the circuit breaker. The experimental results show that the combination of wavelet packet time-frequency entropy and BP neural network can effectively judge the mechanical failure of the circuit breaker.

MonCIS-04

Anomaly Detection Algorithm for Telemetry Data of Spacecraft Based on Fusing Multiple Weighted Distribution Features

Ying Du 63758 Unit of PLA
Fei Wang 63758 Unit of PLA
Chao Sun 63758 Unit of PLA
Wei Wu 63758 Unit of PLA
Shaolin Hu Xi'an Satellite Control Center

Single feature is difficult to achieve a comprehensive description of the complex orbiting spacecraft telemetry data characteristics and is easy to lose telemetry data information, but the statistical distribution operators can fully reflect the characteristics of statistical distribution information. Aiming at the orbiting telemetry data which meets the character of local stability, we propose an anomaly detection algorithm which is based on the characteristics of concentration, discrete characteristic, shape and boundary in the statistical distribution. Four kinds of statistical features are represented by the distribution characteristic operator, and the different distribution features of abnormal patterns are weighted to construct an efficient model for the anomaly detection of multidimensional feature vectors, which can effectively detect the abnormal changes of the local stationary telemetry data of the spacecraft on orbit in the complex space environment. The experiment results of a satellite power system telemetry sequence anomaly detection indicate that the algorithm can effectively detect the change of amplitude, trend and periodic and complex mutation of telemetry data, and the detection effect is robust.

MonCIS-05

A New Method of Bearing Fault Diagnosis Based on LMD and Wavelet Denoising

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The Ministry of Education P.R.C. Engineering Rese arch Center of Digital Community
Beijing Laboratory for Urban Mass Transit
Beijing Key Laboratory of Computational Intelligenc e and Intelligent System
Huanran Wen Beijing Univ. of Tech.
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The impulse feature from an early diagnosis of bearing fault is often drowned by the noise background, and is usually very difficult to extract. To solve the problem, a new method was presented here, which was based on the Local Mean Decomposition (LMD) and wavelet de-noising. The LMD was used to decompose the original signal of the bearing into serval PF components which were retained using the principle of maximum kurtosis and cross-correlation coefficients to keep only the reasonable ones. Compared to the traditional PF component selection process, our new method captured more fault impulse features in the selected PF components. For these retained PF components were first de-noised by a db10 wavelet of 5 layers, and then were used to reconstruct the high frequency signal of each component layer by the method of superposition. Finally, the envelope spectrum analysis was applied to the derived the spectral kurtosis to give the result of rolling bearing fault diagnosis. A test experiment was conducted with our bearing fault simulation platform. The collected data, including signal from bearing outer ring, inner ring and ball, was analyzed using the method proposed in this paper. The result shown that the new method can effectively enhance the impulse features in the signal, also improve the fault diagnosis efficiency.

MonCIS-06

Quality-related Fault Detection Based on Mutual Information Principal Component Analysis

Shuai Zhao East China Univ. of Science and Tech.
Bing Song East China Univ. of Science and Tech.
Hongbo Shi East China Univ. of Science and Tech.

Quality-related fault detection has received extensive attention in recent years. It requires an appropriate supervisory relationship between process variables and quality variables. While the traditional principal component analysis (PCA) doesn’t consider the relationships between them. Thus we proposed the mutual information principal component analysis (MIPCA) to detect the quality-related faults. MIPCA fully integrates the advantages of mutual information (MI) and PCA. With MIPCA, process variables can be utilized to monitor the process under the supervision of quality variables and judge a fault is whether related to the quality or not. Finally, the feasibility and effectiveness of the MIPCA are verified in Tennessee Eastman Process (TEP).

MonCIS-07

Fault Detection for Dissipative Nonlinear Systems: An Energy Balance Method

Jia Zhang Univ. of Science and Tech. Beijing
Dawei Ding Univ. of Science and Tech. Beijing
Yingying Ren Univ. of Science and Tech. Beijing
Xiaoqian Fan Univ. of Science and Tech. Beijing

This paper addresses the problem of fault detection for dissipative nonlinear systems. A new method based on energy balance is proposed for dissipative nonlinear systems. The nonlinear system is described by the T-S fuzzy model. Based on the dissipation of the T-S fuzzy model, the energy balance is constructed. Then faults can be detected by judging whether the energy balance of system construction is established. The effectiveness of the proposed scheme is illustrated by a numerical example.

MonCIS-08

Robust Fault Detection Filter Design for Interconnected Systems

Jian Li Northeast Electric Power Univ.
Chunyu Wu Northeast Electric Power Univ.

This paper deals with the problem of robust fault detection for interconnected systems. The outputs of the interconnected systems serve as inputs of the filter which is used as the residual generator. Therefore, whichever subsystem the fault comes from, by comparison with the change of residual in normal and faulty situations, the occurrence of the faults can be detected. The linear matrix inequality optimization approach and the Bounded Real lemma are used to solve the H_infty problem, and sufficient conditions for the design of the fault detection filter is formulated by linear matrix inequalities. A simulation example is presented to demonstrate the effectiveness of the proposed theory.

MonCIS-09

An intelligent fault diagnosis method for rotating machinery based on genetic algorithm and classifier ensemble

Dongyang Dou China Univ. of Mining and Tech.
Bin Xue China Univ. of Mining and Tech.
Min He Xuzhou Inst. of Tech.
Jian Jiang China Univ. of Mining and Tech.

On the basis of extracting six time-domain features and five frequency-domain ones from vibration signals processed by empirical mode decomposition, an intelligent method to construct a rule-based classifier ensemble for fault diagnosis of rolling bearings was presented. The candidate reducts which could be used to build the base classifiers were found by applying a genetic algorithm for feature reduction on the decision table, and then the other genetic algorithm for diversity evaluation was used to search an optimal ensemble of base classifiers. Based on the results above and the improved weighted voting strategy, the final classifier ensemble for fault recognition could be set up. It was proved by the diagnosis experiment including normal condition, inner race fault, outer race fault and rolling element fault of SKF 6203 bearings that the method proposed in this paper was valid due to the satisfactory accuracy of classification.

MonCIS-10

Fault-tolerant control of delta operator switched linear systems with sensor faults based on dynamic output feedback

Hao Hu Najing Univ. of Finance and Econnomics
Jinliang Liu Najing Univ. of Finance and Econnomics

This paper focuses on dynamic output feedback fault-tolerant control design of a class of delta operator linear systems with sensor faults. A full order dynamic output switching control law and a state switching law are jointly designed to guarantee the closed-loop asymptotical stability in the presence of all admissible sensor faults. A flight control switched system is employed to illustrate the efficiency of the proposed approach.

MonCIS-11

Fault detection using mutual information based decentralized variable-weighted dynamic PCA method

Likang Shi Ningbo Univ.
Chudong Tong Ningbo Univ.
Ting Lan Ningbo Univ.
Xuhua Shi Ningbo Univ.

With respect to the complicated dynamics in the modern large-scale industrial processes, different measured variables have different serial

correlations, and the cross-correlation among process variables would be more appropriately described on the basis of different time-delays. It is easy to imagine that the fault detection performance would be greatly improved if the difference in dynamic process data could be taken into account. Therefore, from a purely data-based aspect, a mutual information based variable-weighted dynamic process monitoring method is presented here. First, each observation is augmented with its previous observations so as to obtain an augmented matrix. The proposed method then utilizes the mutual information to define the relationship between each measured variable and different time-delayed measurements, the columns in the augmented matrix can thus be weighted according to the degrees of relationship. As a result, multiple variable-weighted augmented matrices are formed, and the principal component analysis can then be adopted for modeling purposes. This sort of modeling and monitoring approach can not only distinguish the difference in dynamic process data, which handle the dynamic problem in a much more clear way, but also take full advantages of decentralized modeling technique, which ensure the generality of the resulted monitoring model. Finally, the feasibility and effectiveness of the proposed method are validated by a well-known chemical process.

MonCIS-12

A Novel Process Monitoring Method Based on Improved DTW-MKECA

Yinghua Yang Northeastern Univ.
Xiang Shi Northeastern Univ.
Shuang Yi Northeastern Univ.
Xiaobo Chen Northeastern Univ.
Shukai Qin Northeastern Univ.

Aiming at the features that modem industrial processes always have some characteristics of complexity and non-linearity, an integration of improved dynamic time warping (DTW) and multi-way kernel entropy component analysis (MKECA) is proposed in this paper. DTW-MKECA applies DTW method at first to process unequal-length data, which ensures that the original data distribution can be preserved. Then it employs MKECA method to make data from the input space map to high dimensional feature space and analysis these data. MKECA ensures that little information of the original data is lost during the dimensionality reduction, meanwhile, a monitoring model can be established. The proposed process monitoring method combines the advantages of DTW and MKECA. The simulation results of monitoring between modeling data and online data of reheating furnace demonstrate the availability of proposed method in this paper.

MonCIS-13

Research on Identifying Drainage Pipeline Blockage based on Multi-Feature Fusion

Jing Yan Kunming Univ. of Science and Tech. Engineering Research Center for Mineral Pipeline Transportation
Zao Feng Kunming Univ. of Science and Tech. Engineering Research Center for Mineral Pipeline Transportation
Jiande Wu Kunming Univ. of Science and Tech. Engineering Research Center for Mineral Pipeline Transportation
Jun Ma Kunming Univ. of Science and Tech.

In order to solve the difficulties of detecting partial blockage in urban drainage pipeline and to determine the degree of blocking, a novel method based on multi-feature fusion technique of recognizing pipe blockage is proposed in this paper. Firstly, the acoustic response signal collected from a section of working sewer pipe is decomposed by 3 levels wavelet packet decomposition, and the high-energy wavelet packet nodes are selected to reconstruct the signal to establish feature components. Then the characteristics of wavelet energy entropy, approximate entropy and fractal box dimension of the feature components are extracted respectively, so that the classification feature sets can be constructed. Finally, the particle swarm optimization algorithm is used to optimize the parameters of the SVM classifier to identify the blockage fault signal. The results from the experiments have shown that the method can not only effectively identify the different degrees of blocking failure, but also eliminate the impact of the lateral connection from fault identification. As a result, the accuracy rate of pipeline blockage identification is improved, and the method also provided a research foundation for early fault detection of working pipeline.

MonCIS-14

Rapid Fault Isolation for a Class of Nonlinear Lipschitz Systems via Deterministic Learning

Tianrui Chen Guangdong Univ. of Tech.
Cong Wang South China Univ. of Tech.

Early isolation of small faults is an important issue in the literature of fault diagnosis. In this paper, for a class of nonlinear lipschitz systems with output measurements, an approach for rapid isolation of small oscillation faults is presented. By utilizing the knowledge obtained through the deterministic learning, a bank of estimators is constructed for the training normal mode and oscillation faults. The occurrence of a fault can be isolated if all the residual norms associated with the matched fault estimator become smaller than the ones associated with the other estimators in a finite time. Finally, based on the concept of fault mismatched function, rigorous analysis of the performance of the isolation schemes is given. The attractions of the paper lie in that the sensitivity to small faults is enhanced through using the learned knowledge of modeling uncertainty and nonlinear faults with output measurements.

MonCIS-15

Fault diagnosis of rail turnout system based on Case-based reasoning with compound distance methods

Hui Zhao Tsinghua Univ.
Hua Chen Tsinghua Univ.
Wei Dong Tsinghua Univ.
Xinya Sun Tsinghua Univ.
Yindong Ji Tsinghua Univ.

With the rapid development of the high-speed railway, the safety and reliability problem of the railway bring more rigid requirement to the high-speed railway industry. This paper focuses on the diagnosis problem of railway turnout system, which is the most important infrastructure elements of the rail system. According to the characteristics of the turnout mechanism and in order to improve the diagnosis performance, CBR method with compound distance metrics is proposed. First, different distance metrics (Euclidean metric, dynamic time warping metric) are calculated in the CBR to get the single result; then a group decision making strategy is adopted to combine the two metrics to get the final result. The experimental results indicate that the proposed method achieves a better performance, which prove that the proposed could improve the diagnosis performance, and guarantee the operation safety of high-speed rail way.

MonCIS-16

Slight Fault Diagnosis of Rolling Bearings Based on Improved LMD and Multifractal Theory

Lan Wu Kunming Energy Conservation and Supervision corps
Jing Yan Kunming Univ. of Science and Tech.

Aiming at the problem that the early slight fault of rolling bearing is difficult to be detected, a new diagnosis method based on improved local mean decomposition (LMD) and multifractal theory is proposed. Firstly, the original time domain signal of bearing is decomposed by LMD, and spectral analysis is carried out on the decomposed PF components, and the mask signal is constructed subsequently. In order to obtain the PF components of the overlapped mode, then the original signal and mask signal are decomposed by the dual LMD decomposition. Finally, the time-frequency distribution of the PF components is obtained by the Hilbert transform, and the multifractal dimension of the PF components are obtained, so the classification feature sets can be constructed. The experimental results show that the proposed method can be more accurate and effective in diagnosis of slight fault diagnosis of bearing.

MonCIS-17

A Robust Quality-Related Fault Detection Method for Nonlinear Processes

Wei Sun Bohai Univ.
Guang Wang Bohai Univ.
Shen Yin Harbin Inst. of Tech.

Quality-related fault detection method is quite significant for the process industry in recent years. One of the most effective nonlinear quality-related fault detection methods is MKPLS. It can achieve the purpose of monitoring the process performance. However, it is sensitive to outliers. When a certain number of outliers occurs, MKPLS can not work well to build model precisely. To overcome this drawback, this paper proposes a revised version of MKPLS, which can be used in chemical plant for fault detection. The algorithm introduces a spherical strategy to ensure system robustness against outliers. In the fault detection part, the new gained regression coefficient are decomposed thoroughly into quality-related subspace and quality-unrelated subspace. Then, Hotelling’s statistic is employed to monitor process. In the case study, a nonlinear numerical case and an industrial process simulator are applied to demonstrate the performance of the proposed method.

MonCIS-18

Robust H_infty fault-tolerant control for nonlinear networked control systems under event-triggered sparse data transmission

Yajie Li Lanzhou Univ. of Tech. Automation Inst. of Lanzhou Petrochemical of Petro Chi na
Wei Li Lanzhou Univ. of Tech.

Based on discrete event-triggered communication scheme (DETCS) with sparse transmission characteristic and Takagi-Sugeno fuzzy method, the problem of robust H_infty fault-tolerant event-triggered control is investigated for nonlinear networked control systems (NNCS) with actuator failure and actuator saturation. Firstly, a new fuzzy closed-loop fault model with actuator saturation is established under the background of sparse data transmission. Secondly, based on Lyapunov-Krasovskii stability theory, a sufficient condition is derived for NNCS with α-safety degree and disturbance rejection performance, which is the contractively invariant set of fault-tolerance with α-safety degree. And the integrated method between robust H_infty fault-tolerant controller and event-triggered matrices is given out by linear matrix inequality (LMI) under event-triggered sparse data transmission. Lastly, the simulation example demonstrates the effectiveness of the method proposed. Furthermore, the study of compatibility analysis among disturbance rejection level, safety degree and network communication resource

occupancy is also presented.

MonCIS-19

Axle Fault Prognostics of Electric Multiple Units based on Improved Apriori Algorithm

Li Li China Academy of Railway Science Lanzhou jiao tong Univ.
Tianyun Shi China Academy of Railway Science
Weijiao Zhang China Academy of Railway Science

To effectively reduce the occurrence rate of axle faults of electric multiple units (EMUs), in this study, classical Apriori algorithm is improved based on Apache Hadoop big data and applied to prediction studies of axle faults of EMUs. First, for deficiencies of the classical Apriori algorithm, the improved Apriori algorithm that is constrained by business experience is proposed under the MapReduce framework. Second, based on the improved Apriori algorithm put forward in this paper, in-depth data mining of information of one of the railway bureaus, such as EMU status, fault warning, and maintenance history, is conducted. The axle fault of the EMUs is then predicted through the obtained association rules. Finally, experimental results indicate that the proposed algorithm reaches an accuracy of 67% and its operation efficiency in experimental environments is improved by 50% when compared with the operation efficiency of the classical Apriori algorithm.

MonCIS-20

New delay-dependent stability criteria using improved double integral inequality for singular systems

Nan Zhao Qingdao Univ.
Chong Lin Qingdao Univ.
Bing Chen Qingdao Univ.

This paper deals with the problem of delay-dependent stability for singular time-delay systems. By applying Wirtinger-based integral inequalities and a tighter double integral inequality and using augmented Lyapunov-Krasovskii functional, a sufficient delay-dependent criterion is derived on the basis of linear matrix equalities(LMIs). Numerical examples are computed to obtain the upper bound of the maximum time-delay and illustrate the strength and less conservativeness of method proposed in this study.

MonCIS-21

IMC-Dahlin Temperature Regulator for Thermostat

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Zhong Zhao Beijing Univ. of Chemical Tech.

In this work, an IMC (Internal Model Control)-Dahlin temperature control method based on relay feedback self-tuning identification is proposed. The proposed method is based on relay feedback self-tuning identification and has double-loop control structure. According to the time delay and large time constant features of thermostat regulation, Dahlin control algorithm is applied to the inner loop to stabilize the process. To compensate the ringing response of Dahlin control and improve the robustness of the overall system, IMC control algorithm is applied to the outer loop. The parameters of Dahlin controller and IMC controller are optimized with LQR (Linear Quadratic Regulator) algorithm. The proposed method has been applied to develop a temperature regulator based on C2B8SNFA MCU (Micro Controller Unit) for thermostat. The real application results have verified the feasibility and effectiveness of the proposed method and the developed temperature regulator for thermostat.

MonCIS-22

New Results on Stability of Discrete-time Systems with Time-varying Delays

Lili Liu Shanxi Normal Univ.
Baowei Wu Shanxi Normal Univ.

This paper presents a new insight into the stability of discrete-time systems with time-varying delays. New stability criteria are obtained in terms of linear matrix inequalities. The novelties of the paper come from two aspects. First, this newly presented criterion does not require all the symmetric matrices involved in the employed quadratic Lyapnov-Krasovskii functional to be positive definite. Second, a new summation inequality based on discrete Wirtingerbased inequality is obtained to reduce the conservation of the stability criterion. The effectiveness of the proposed result is illustrated by classical examples from the literature.

MonCIS-23

Stochastic Finite-time L1-gain Control for Positive Markov Jump Linear Systems with Interval Time-Varying Delay

Lang Ma Shandong Univ.
Shuqian Zhu Shandong Univ.

This paper is concerned with the stochastic finite-time L1-gain control problem for positive Markov jump linear systems with interval time-varying delay and partly known transition rates. By constructing an appropriate linear co-positive stochastic Lyapunov functional, some delay-dependent sufficient conditions of the stochastic finite-time boundedness and finite-time L1-gain performance are developed, respectively. Then a stochastic finite-time state feedback L1-gain controller is designed by means of linear programming such that the closed-loop system is positive and stochastically finite-time bounded with finite-time L1-gain performance. The effectiveness of the method is verified by an example.

MonCIS-24

Improved stability condition for systems with discrete distributed delay

Lianglin Xiong Yunnan Minzu Univ.
Tao Wu Yunnan Minzu Univ.

In this article, two new integral inequalities are provided that are tighter than existing ones. Based on the constructed Lyapunov functional, two new integral inequalities are used to investigate the delay-dependent stability of linear systems with a discrete distributed delay, and a new stability condition is established. Two numerical examples demonstrate the effectiveness and the less conservatism of the method.

MonCIS-25

New Delay-dependent Criteria with Fewer Decisive Variables for Linear Systems with Interval Time-varying Delays

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Shuxia Wang Beijing Inst. of Petro-chemical Tech.
Chen Xu Beijing Inst. of Petro-chemical Tech.

This note deals with the stability problem of linear system with time-varying delay in a given range. In order to analyze its stability, a new type of Lyapunov functional (LF) which incorporates more information on the delay and some triple-integral terms is constructed. By combining Jensen's integral inequality with a delay division technique, upper bound of LF derivative has been estimated more tightly and expressed as a convex combination with respect to a tuning parameter. New stability criteria with fewer decisive variables but less conservatism are derived in terms of linear matrix inequalities (LMIs). Numerical examples authenticate the effectiveness of the proposed method.

MonCIS-26

Multi-sensor Sequential Fusion for Random Delay Systems

Lin Yuan Univ. of Jinan
Chunyan Han Univ. of Jinan
Jun Wei Univ. of Jinan

This note is concerned with the multi-sensor information fusion problems from discrete-time systems with random delayed observations where the random delay is time-stamped. The measurement reorganization technique is employed in this paper, and then the random delayed observation is reconstructed as an equivalent delay-free one for each sensor. Based on the altered system, the state fusion estimation is developed by applying the projection formula and the sequential fusion method. The fusion filter gain is derived by solving a set of difference Riccati equations which have the same dimension as the original system. The number of the Riccati equations is equation to rN, where r is the maximum delay and N is the number of the sensor. Finally, an example is presented to illustrate the efficiency of proposed estimator.

MonCIS-27

Second-order reciprocally convex approach for stability of neural networks with interval time-varying delays

Chunxia Li Binzhou Univ.
Fang Qiu Binzhou Univ.

This paper investigates the asymptotical stability problems for neural networks with interval time-varying delays. The second-order reciprocally convex approach is introduced in the Lyapunov-Krasovskii functional combined with the triple integral terms. By using the second-order reciprocally convex approach to handle the linear combination of positive functions arising from the manipulation of the triple terms, several novel asymptotical stability criteria with less conservatism are proposed. Finally, two numerical examples are given to demonstrate the improvement of the proposed methods.

MonCIS-28

The Instability Phenomenon in the Numerical Implementation of Delayed Output Feedback

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This paper studies the instability phenomenon in the numerical implementation of delayed output feedback (DOF) by using a characteristic root based method. As one control method for time-delay systems, the DOF controller contains distributed delay terms, which need to be implemented by numerical integration in practice. However, we find that the numerical implementation method may lead to instability of the closed-loop system, which can be verified by the distribution of the characteristic roots of a neutral time-delay system. In view of the fact that the existing tools are not good at solving the characteristic roots of a neutral time-delay system, in this paper, a new approach is provided to seek the characteristic roots in any specified area. It is shown that the proposed method is very effective for the analysis of the instability phenomenon in the numerical implementation of DOF.

MonCIS-29

Discrete free-matrix-based integral inequality and its application

Linxing Xu Northeastern Univ.
Hongjun Ma Northeastern Univ.
Shenping Xiao Hunan Univ. of Tech.

This paper is concerned with the stability problems for discrete linear systems with time-varying delays. A new summation inequality is presented in this paper, which is less conservative than other existing summation inequalities. This inequality is a discrete-time counterpart of

the free-matrix-based (FMB) integral inequality. Using it to investigate the stability problem for discrete-time systems, some novel stability criteria are established. The advantage of the derived condition is illustrated by some numerical examples, while a practical example demonstrates the applicability of the method.

MonCIS-30

Delay-variation-dependent stability for Markovian jump systems with time-varying delay and partial information on transition probabilities

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Yanbang Zhang Xianyang Normal Univ.

The delay-variation-dependent robust stability problem is investigated for uncertain Markovian jump systems (UMJSs) with time-varying delay and partial information on transition probabilities. The time-varying delay and its time variation respectively, are assumed to belong to respective bounded intervals. An augmented Lyapunov-Krasovskii functional (LKF) is constructed by introducing a newly delay decomposition method. Also, some novel sufficient criteria are derived to guarantee MJSs to be robustly asymptotically stable in the mean square for all admissible uncertainties by combing the Wirtinger integral inequality and the reciprocally convex technique. All the stability criteria are formulated in the form of linear matrix inequalities (LMIs), which are fully dependent upon the bounds of the time-varying delay and its time variation. Some numerical examples are given to show the effectiveness and less conservatism of the proposed method.

MonCIS-31

Predictive Study of Forest Fires Based on MIVBP-SVM

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Shuangquan Zhang Changchun Univ. of Tech.
Yude He Changchun Univ. of Tech.
Ziyi Liu Univ. of Waterloo

In this paper, we take the average impact value method as the evaluation of neural network variable correlation indicators, analysis the data provided by Professor P.Cortez and A. Morais from University of Minho (Portugal) using the MIVBP algorithm to filtrate 13 characterization factors to get 7 characterization parameters affect forest fires, construct the simulation model of the prediction of forest fires based on the support vector machine algorithm, using a test set for testing, the accuracy rate reached 91.89%.

MonCIS-32

Simulation of Micro-grid Energy Storage Inverter with Neural Network Control

Huaqing Zeng North China Electric Power Univ.
Changliang Liu North China Electric Power Univ.

The study for inverter control was researched under the simulation system of single deviation-grid micro-grid energy storage inverter, the inverter output voltage and current waveforms under various conditions were obtained. The inverse model of the micro-grid energy storage inverter was identified based on the algorithm of back-propagation artificial neural network, and then the neural network internal model control scheme based on the design of inverse system was adopted to improve the power quality of the inverter output. The control scheme of the micro-grid energy storage inverter was realized by the Matlab/simulink platform, a simulation study was carried out. Results show that the neural network internal model control scheme based on the design of the inverse system has a better effect on controlling inverter compared to the conventional PI controller, and can be applied in the control system design of the micro-grid energy storage inverter.

MonCIS-33

Improved Garson Algorithm based on Neural Network Model

Maozhun Sun East China Univ. of Science and Tech.
Ji Liu East China Univ. of Science and Tech.

The evaluation of input factors of complex system is a hot and difficult point in the sensitivity analysis. In this paper, the Garson algorithm based on artificial intelligence is studied and the original Garson algorithm accuracy is not high. Therefore, an improved Garson algorithm is proposed and the input factors are introduced into the Garson algorithm. At the same time, the original local sensitivity analysis algorithm is improved as the global sensitivity analysis algorithm and it increases the accuracy and stability of the Garson algorithm. Through the typical benchmark test function simulation, the experimental results show that the improved Garson algorithm has higher accuracy and stability in the evaluation of sensitivity coefficient. Finally, the improved Garson algorithm is applied to evaluate the input factors of the plate-fin heat exchangers. It shows that the IGarson algorithm is more feasibility and effectiveness.

MonCIS-34

The Detection of Typical Targets Under the Background of Land War

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Wenjie Chen Beijing Inst. of Tech.
Yingying Qin Beijing Inst. of Tech.

This paper investigates whether advanced neural network techniques can be applied to the detection and identification of typical targets in the context of land warfare. We collected 13 typical targets and built a detection data set. Based on the Faster R-CNN framework, we improve the detection accuracy by two ways. First, we design a neural network model with strong local modeling capabilities. Second, we combine middle layers and the last layer of feature maps as the detection features to enhance the detection ability and improve the detection accuracy.

MonCIS-35

Global Lagrange Stability of Complex-Valued Neural Networks with Time-Varying Delays

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Qiankun Song Chongqing Jiaotong Univ.

In this article, the global exponential stability in Lagrange sense for complex-valued neural networks (CVNNs) with time-varying delays is investigated under the condition that the activation functions are assumed to satisfy the globally Lipschitz condition in the complex domain. By constructing appropriate Lyapunov-Krasovskii functionals, a delay-dependent sufficient condition is provided to ascertain the considered CVNNs to be globally exponentially stable in Lagrange sense.

MonCIS-36

Research on Thermal Effect of Power LED Devices Based on PCA and Neural Network

Qiyan Yan Guangdong Univ. of Science and Tech.

This paper proposes a method to predict the thermal effect of the power LED based on principal component analysis (PCA) and BP neural network. This method adopts PCA for processing the sample data of the power LED, and then the processed data samples are considered as the input of BP neural network. Through this data processing the number of the input variables can be reduced and the BP network structure is simplified. The predicting experiment show that this method has strong adaptability and robustness. The method is used to predict the thermal effect of the power LED devices produced by APT Electronics LTD., and the prediction error is less than 5%.

MonCIS-37

Fixed-time stabilization control of reaction-diffusion Cohen-Grossberg neural networks

Ruoxia Li Southeast Univ.
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This paper focus on the fixed-time stabilization control strategy of delayed Cohen-Grossberg neural networks with reaction-diffusion terms. By a new agency of Hardy-Poincar`e inequality and some analysis techniques, some testable results on the fixed-time stabilization control of the target model were summarized, which depend on the system parameters, reaction-diffusion coefficients as well as the regional feature. The results obtained in this paper presented a more precise estimation compared to many known results. Finally, an example and its simulations are exhibited to explain our findings.

MonCIS-38

Modeling Method Based on Iterative UKFNN Pumping Oil Production Process

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Xiaohua Gu Chongqing Univ. of Science and Tech.

It is difficult to use the static modeling methods to describe pumping machine mining process because of multi-variable nonlinear and time-varying characteristics. This paper proposes a new modeling method based on Iterated Unscented Kalman Filter Neural Networks. Firstly the algorithm uses the input data to predict state variables and the covariance matrix. Secondly using the previous estimate data to resample sigma points and do unscented transforming in order to obtain the latest sampling points. Lastly the machine mining process model with a good precision is obtained by updating state. A comparison analysis has been done between Genetic Algorithm Back Propagation Neural Network (GABP), UKFNN and IUKFNN, by doing experiment on actual production data of a certain oilfield. The results show that the proposed method has a stronger generalization ability and stronger real-time tracking ability, and the precision of the model is IUKFNN>GABP>UKFNN. Therefore, the proposed method is a good choice for pumping machine mining process.

MonCIS-39

An Architecture of Interval Random Vector Function-link Networks and Its Numerical Analysis

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Yanru Niu Northeastern Univ.
Xiuyuan Peng Northeastern Univ.
Chuang Lu Northeastern Univ.

This paper extends the random vector functional-link (RVFL) networks with single-hidden-layer to interval ones (IRVFLNs) with interval model parameters. The analytic solutions are derived for the interval network parameters using the well-known least square methods, which can overcome the problems such as local minimal, slow convergence. In order to evaluate the performance of IRVFLNs, we choose two data sets in different levels of complexity to be modeled, and compare the aspects of generalization and train time with the interval feed-forward BP neural networks (IBPNNs). The simulation results show that the proposed IRVFLNs have the better properties than the IBPNNs in the network converging and approximating.

MonCIS-40

Advanced Pattern Recognition Based on Neural Network Applied in Coal Structure

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The coal and gas outburst disasters could be forecasted in time by recognizing the coal structure types. In order to classify the coal structure, an advanced pattern recognition that combined ultrasonic reflection with BP neural network was put forward. The patterns were sorted and recognised based on a reasonable consideration of ultrasonic speed, ultrasonic attenuation coefficient, characteristics of ultrasonic transmitting, ruggedness coefficient and other parameters relating to types of coal structure. Results demonstrate that the advanced coal structure pattern classification can distinguish coal structure types effectively. It is significant for the advanced coal structure pattern classification to forecast disaster of coal and gas outburst.

MonCIS-41

A Modified Echo State Network in Chaotic Time Series Prediction

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Fu Liu Jilin Univ.
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Rong Li Beijing Vocational Coll. of Agriculture

Echo state network (ESN) is one of the most well-known types of reservoir computing because of its outstanding performance when chaotic time series prediction is conducted. However, sometimes it works poorly because the reservoir connectivity and weight structure are created randomly. To solve this problem, we propose a modified ESN based on contribution rate algorithm. By pruning uninmportant connections without loss of majoy information, the proposed method can not only optimize the network structure, but also improve the generalization performance of network. Experimental results and performance comparisons demonstrate that the modified ESN outperforms the ESN without optimization.

MonCIS-42

Fuzzy adaptive PID control for VAV air-condition system

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This paper focuses on design a adaptive fuzzy PID controller which applied in the VAV air-conditioning system.The task is to control the temperature of supply air and the return air close to their respective targets. This paper adopt parameter auto-tuning technique that could adjust the PID parameters on real time to ensure good quality of control system. The control system has two respective close loops. In the first circuit, the valve of the cooling coil was adjusted to control the temperature of supply air. In the second one, the frequency is modulated to control the rotate speed of the electromotor, up to the temperature of return air. The supply air temperature and the return air temperature (indoor temperature) are controlled online by fuzzy PID controller. The test result shows that the design of fuzzy adaptive PID controller is reasonable and the effect of fuzzy PID control is well.

MonCIS-43

l_1-gain Fuzzy Control for A Class of Discrete-time Positive Fuzzy Markov Jump Systems

Fengwei Pan Shandong Univ.
Shuqian Zhu Shandong Univ.

This paper deals with the l_1-gain performance analysis and fuzzy state feedback controller design for discretetime positive fuzzy Markov jump systems (FMJSs). The definitions of the positive FMJSs, stochastic stability and l_1-gain performance are firstly provided. Then some sufficient conditions for stochastic stability and l_1-gain performance are derived in terms of linear programming (LP) by using a mode-dependent linear co-positive Lyapunov function, respectively. The derived conditions can cover several existing results as special cases and the fuzzy state feedback controller design of the positive FMJSs is converted into a standard and solvable LP problem. A numerical example is provided to illustrate the feasibility of the obtained conditions.

MonCIS-44

Selection of Fuzzy Time Series model based on autocorrelation theory

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The choice of the order of Fuzzy Time Series model has, to some extent, an influence on the accuracy of the forecasted result. This paper establishes relationship between Autoregressive Model and Fuzzy Time series model so as to apply autocorrelation theory to the selection of the order of Fuzzy Time Series Model (FTSM). Therefore, instead of listing the forecasted results generated by Nth order model respectively, we can choose the order of FTSM with a simpler method. In order to verify the effectiveness of the proposed method, the data of macula from 1701 to 1722 has been used in the experiment. It turns out the new method is an effective way to select the order of FTSM.

MonCIS-45

Output-feedback control for MIMO nonlinear systems with input Saturations

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Bing Chen Qingdao Univ.
Chong Lin Qingdao Univ.
Yumei Sun Qingdao Univ.

The fuzzy adaptive output-feedback control is considered for a class of multi-input and multi-output (MIMO) nonlinear systems with input saturations. Because only the output is measurable, an observer is structured at first to estimate the unmeasurable state variables. With the nonlinearities unavailable, the fuzzy logic systems (FLSs) are applied as approximators and observer-based adaptive controllers are derived. By combing Lyapunov stability theory, backstepping technique and adaptive technology, we can prove that the resulting closed-loop systems are stable in the sense of semi-global uniform ultimate boundedness. At last, the simulations are performed and simulating results exhibit the effectiveness of the presented control method.

MonCIS-46

Fuzzy Feedback Network Scheduling and Control for Multi-motor NMCS

Qiang Wang Univ. of Jinan
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Renquan Sun Univ. of Jinan

The networked motion control system (NMCS), has been more and more applied for integrated manufacturing in industrial enterprise, such as numerical control equipments, industrial robots, and other manufacturing equipments. It is necessary to apply appropriate network scheduling and control strategy to reduce the bad influence from conflict of network data transmission on the performance of motion control system. The situation get seriously especially for multi-motor NMCS. This paper focuses on applying the dynamic network scheduling on the network application layer for multi-motor NMCS. According to ideas of priority, a kind of feedback fuzzy network dynamic scheduling strategy is proposed to allocate the priority of data transmission for each speed closed loop control system. The design of the fuzzy feedback network dynamic scheduler based on the speed error and its rate is presented. In order to realize collaborative design of network schedule and control, an adaptive fuzzy PID controller is design to play a role of the controller of each speed closed loop control system. The simulation model of NMCS with three motors is established using TrueTime software. The related simulation research and analysis is presented. The simulation results show that the proposed method can achieve quick adjustment to system, effective improve global control performance of NMCS.

MonCIS-47

Robust Fault Estimation for T-S Fuzzy Systems with Unmeasurable Premise Variables and Random Time Delays

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Fuli Wang Northeastern Univ.
Xiqin He Univ. of Science and Tech. Liaoning
Suhuan Yi Univ. of Science and Tech. Liaoning

This paper studies the problem of actuator fault estimation (FE) for a class of T-S fuzzy systems with unmeasurable premise variables, which is subject to random time-varying delay and norm-bounded external disturbance. By taking the unmeasurable premise variables and actuator fault as auxiliary disturbance signal, the robust FE observer based on n-steps iterative learning algorithm is constructed to guarantee the error dynamic system to be asymptotically stable with a prescribed H_infty performance. An improved sufficient condition of such observer is presented in terms of linear matrix inequality, which includes the information of the upper and lower bounds of time delay. Finally, a numerical example is given to illustrate the effectiveness of the proposed method.

MonCIS-48

Adaptive Fuzzy Time-varying Sliding Mode Control for Quadrotor UAV Attitude System with Prescribed Performance

Shaoping Chang Tianjin Polytechnic Univ.
Wuxi Shi Tianjin Polytechnic Univ.

This paper presents an adaptive fuzzy time-varying sliding mode control scheme for quadrotor unmanned aerial vehicle (UAV) attitude system with prescribed performance. A performance function is used and an error
transformation is provided to transform the original constrained nonlinear system into an equivalent unconstrained one. Fuzzy systems are used to approximate unknown nonlinear functions of the attitude system. To eliminate the reaching phase which can make the control is robust with respect to external disturbances and parameter uncertainties from the very beginning, a time-varying fast terminal sliding mode surface is designed by the transformed error and a tracking differentiator. Then by using the sliding mode surface, the controller is developed. The proposed scheme guarantees that all the signals in the resulting closed-loop system are bounded and that the tracking errors converge to a small residual set with the prescribed performance bounds in finite time. Simulation results are used to demonstrate the effectiveness of the proposed scheme.

MonCIS-49

H_infty UIF Design for T-S Fuzzy System

Xiaokun Du Bohai Univ.

This paper researches the state estimation problem for a class of T-S fuzzy system which subject to unknown input. By employing unknown

input filter, the paper does a smooth estimation not only to the system states, but also the estimate signals and unknown disturbance inputs. Continuous-time system and discrete-time system are both studied to design the UIF for the T-S fuzzy system, and a converted system is constructed to solve the inequalities insolubility problem because of the exit of the unknown input. At last, a simulation result is used to illustrate the effectiveness of the proposed filter.

MonCIS-50

Research on control strategy of constant current charging power supply

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Long Che Nanjing Univ. of Science and Tech.

The high voltage constant current charging power supply with high charging efficiency and good stability is developed. The power supply has the advantages of small volume, low cost, etc. Design index is that the charging constant current is 0.34A, the charging voltage is 60kV, the power is 20kW. Simulation analysis of the original system using Pspice simulation software, in the light of the average charging current of the original system is difficult to maintain stability and disadvantages of affecting the output performance of the system, and the fuzzy PI charging control strategy is proposed, this way makes the current stable output is 0.34A, the stable time is 15ms, the overshoot is 3%. Finally, experimental results verify the stability of the simulation system is improved by adding the fuzzy PI charge control method, and the system can meet the requirements of the actual system.

MonCIS-51

A novel weights generating approach for multiple attribute decision making under interval-valued intuitionistic fuzzy environment

Lishi Zhang Dalian Ocean Univ.
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The aim of this paper is to investigate the multiple attribute decision making problems with interval-valued intuitionistic fuzzy information,in which the information about experts weights and attribute weights are completely unknown,and the attribute values take the form of interval-valued intuitionistic fuzzy number.We developed a multiple attribute decision making method by computing the scores of all alternatives in interval-valued intuitionistic fuzzy setting, by which the attribute weights and experts weights can be determined.A new score function is constructed to evaluate the alternatives. Finally,an example is presented to highlight the procedure of the proposed algorithm.

MonCIS-52

An application of weighted OWA operator under interval-valued intuitionistic fuzzy settings

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In this paper, a new operator,an interval-valued intuitionistic fuzzy weighted OWA (IFWOWA) operator, is defined to aggregate intuitionistic interval-valued fuzzy information. The newly proposed operator integrate the weights of experts and attributes together, the two weights of experts and attributes are not completely unknown in advance, we derive the weights only from the information expressed in the form of interval-valued intuitionistic fuzzy sets. Then, we use the developed weighted averaging(IVIFWA)operator to solve multi-attribute group decision making problem under interval-valued intuitionistic fuzzy settings.

MonCIS-53

Double Fuzzy Decision Based Artillery Battlefield Target Value Sequencing

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In order to arrange the target attacking sequence and strength reasonably, and provide objective and reliable suggestions on attacking sequence for commanders, a double fuzzy decision based artillery battlefield target value sequencing method is proposed in this paper. According to the fuzzy decision theory, multi-factor fuzzy decision method is applied to determine the rough sequence for individual decision-maker, and the fuzzy group decision method is used to further determine the final sequencing result for top decision-makers. Then it draws the most reasonable results on target value sequencing based on double fuzzy decision method. The simulation results show that the method above can avoid the subjective judgment, which is quite conducive to assistant decision for artillery, and long-distance artillery combat especially.

MonCIS-54

Dispensable parameter set in fuzzy soft set based on score method

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Fuzzy soft set theory is a new mathematical tool in decision making problems. Score method is one of evaluation criterion of fuzzy soft set in decision making problems. In this paper, we discuss the dispensable parameter set based on score method in fuzzy soft set. Some results are given. The dispensable parameter set is related to the parameter reduction in fuzzy soft set.

MonCIS-55

T-S Fuzzy Controller Design for a Descriptor Chaotic System

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Lihua Sun Shenyang Jianzhu Univ.
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A four-dimensional descriptor chaotic system with six nonlinearities is put forward in this paper. A novel chaotic attractor can be generated from the nonlinear descriptor system. The system can be described as an appropriate T-S fuzzy system by analyzing a common state variable in all nonlinearities. By employing a linear matrix inequality approach, the closed-loop descriptor system is asymptotically stable by designing a T-S fuzzy controller. Corresponding numerical simulations illustrate the effectiveness of the T-S fuzzy control approach.

MonCIS-56

Research on the impact of information sharing on the ``Supply-side Structural Reform"

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For enterprises, achieving the objectives of supply chain performances is consistent with achieving the objectives of ``Supply-side Structural Reform". The ``dislocation between supply and demand" is the main influence factor for the objectives to be achieved, which is actually caused by information's dislocation between supply-side and demand-side. The realization of information sharing between business partners affects the achievement of supply-side structure reform by affecting achievement of supply chain performance objectives. And the realization of information sharing is also affected by influence factor, which contains products characteristic, transaction dependence, information sharing willingness, information readability, corporate credibility. So this paper, taking resource-type enterprises as the research objects, expounded what is the influence factors of information sharing, how do the factors affect the realization of information sharing, how do the influence factors affect each other, how does the information sharing affect the achievement of the supply chain performances objectives and the ``Supply-side Structural Reform" objectives. The final purpose of this paper is to provide the necessary reference for the resource-type enterprises which are carrying on the ``Supply-side Structural Reform".

MonCIS-57

A Study on Micro-blog Sentiment Analysis of Public Emergencies under the Environment of Big Data

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In the environment of big data, We-media data which was produced on the public emergencies has presented the characteristics such as mass data, complex structure, various types, and so on. The analysis and guidance of public sentiment is very important to the healthy development of public events. This paper focuses on the micro-blog data of Tianjin explosion event. After the micro-blog contents collection using the crawler tools, the word frequencies, hot topics and the tendency of the different emotions behind the micro-blog were analyzed by software and tools. And some discussions of the influence by diffident emotions are given at the end of the article.

MonCIS-58

The Civil-military Integration Development of Equipment Construction Based on SWOT Quantitative Method

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Doing research on civil-military integration development of equipment construction could promote civil-military integration deep development. The paper introduces the process of SWOT quantitative method, and analyzes the Strengths, Weaknesses, Opportunities and Threats that affect civil-military integration development of equipment construction. Then it builds strategic intensity spectrum coordinate, and gives out strategic judgment. Based on these, the paper suggests that civil-military integration development of equipment construction should take SO strategy.

MonCIS-59

Optimization Model and Algorithm for Separable Linear Guideway Cutting Problem

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Lu Liu Northeastern Univ.
Qing Wang Northeastern Univ.

The problem of make a proper cutting program can significantly affect enterprises performance on material usages and production costs. In this paper, the practical features in an actual production environment are analyzed with regard to material stick length, holes distance, edges distance, cutting scrap, cutting direction, scrap usage, etc. Particularly, considering the standard stick shorter than customer requirement or having to be separated, an optimization model of multiobjective nonlinear integer programming is designed to make a cutting program to minimize both the number of sticks and cutting wastage. Considering the model complicatedness and the features of separable linear guideway and cuttings, a dedicated Genetic Algorithm is designed to solve the proposed model. The chromesomes are coded with two-segment genes which denote the separations and cuttings. With the defined wastage preference rate, the optimization objectives are converted to single objective such that provides an adjusting method for decision maker to achieve the desired cutting programs. The simulation computation is conducted with practical data from actual company, which testifies the effectiveness and efficiency of the designated problem model and algorithm.

MonCIS-60

On the Financial Instruments Applicable to Civil-Military Integrated Industry

Beibei Zhuang Company of Postgraduate Management, the Academy of Equipment

Finance is the blood of modern economy and an important force driving the construction of modern national defense. By virtue of the utilization of financial instruments, the speed and quality of the intensified development of civil-military integration, and the effectiveness of national defense and military construction can be enhanced. From the perspective of the financing pattern of civil-military integrated industry, financial instruments applicable to civil-military integrated industry are analyzed, including such direct financial instruments as the development of loan with discounted interest, investment subsidy, credit guarantee of financial support, insurance and financial leasing, as well as such indirect financial instruments as the establishment of national and local investment fund for civil-military integrated industry and the innovation of PPP pattern, etc.

Tuesday, 30 May, 2017

TueA01 **Room01**
Adaptive control (III) (Chinese) **08:00-10:00**
Chair: Chenliang Wang Beihang Univ.
CO-Chair: Mingxuan Chen Zhejiang University of Tech.

08:00-08:20 **TueA01-1**

Nonlinear Controller Design of Switched Reluctance Motor Based on Adaptive Fuzzy System

Yan Li Dalian Maritiome Univ.
Guofeng Wang Dalian Maritiome Univ.
Cunhe Li Dalian Maritiome Univ.
Aide Xu Dalian Maritiome Univ.

In this paper, the speed and torque dual-loop control for switched reluctance motor (SRM) is developed to extend the range of speed and reduce the ripple of toruqe. Firstly, a novel adaptive fuzzy controller is proposed for high performance speed control of the SRM. The proposed speed controller has not only the adaptability to parameter variations, but also the robustness against external load disturbance. The parameters of adaptive fuzzy controller are adjusted online according to adaptive rules, which are derived from Lyapunov stability theory, so that both the stability of the control system and error convergence can be guaranteed. Secondly, the direct instantaneous torque control (DITC) method is employed in the inner loop to minimize the torque ripple. Finally, the prposed method is verified by simulations with a 60KW three-phase 6/4-pole SRM. The simulation results show that the proposed scheme can effectively improve the accuracy of speed control with a wide speed range and low-ripple torque.

08:20-08:40 **TueA01-2**

L1 Adaptive Control Augmentation for the Lateral Dynamics of a Transport Aircraft for Ultra-low Altitude Airdrop

Jinyong Chang Air Force Engineering Univ.
Jiahai Zhu Air Force Engineering Univ.
Wenhan Dong Air Force Engineering Univ.
Ri Liu Air Force Engineering Univ.
Bingqian Li Air Force Engineering Univ.

For the problem that the airdrop of inner equipment coupled with the crosswind affects the flight safety and completion of the airdrop mission, a novel controller based on the L1 adaptive control was designed. State feedback control signals were produced by the optimal control and the matched reference model was determined. On this basis, we transformed the system nonlinearity into the matched and unmatched uncertainty of L1 control system. Combing with the outer loop PID control for lateral deviation, we completed the lateral flight control system. Simulation results show that the controllers have strong robustness and suppress the undesirable high frequency dynamics with high adaptive gain.

08:40-09:00 **TueA01-3**

Fuzzy distributed adaptive consensus of multi-agent systems with imprecise communication topology structure

Jiaxi Chen Xidian Univ.
Junmin Li Xidian Univ.
Jinsha Li Xidian Univ.

This paper investigates the adaptive consensus problem of first-order linearly parameterized multi-agent systems with imprecise communication topology structure. T-S fuzzy models are presented to describe leader-followers protocol is proposed. With the dynamic of leader unknown to any of the agent, the proposed protocol guarantees that the follower agents can track the leader. A sufficient condition of the consensus for the closed-loop multi-agent system (MAS) is given based on Lyaounov stability. Finally, simulation example is given to illustrate the effectiveness of the proposed method in this study.

09:00-09:20 **TueA01-4**

Adaptive Tracking Control for Air-breathing Hypersonic Vehicles with Attack Angle Constraints

Yun Li Beihang Univ.
Chenliang Wang Beihang Univ.
Wei Wang Beihang Univ.

The design of the attack angle constrained control for hypersonic vehicles is important to ensure the scramjet engine run normally in practice, and is not taken into account in many existing results. In this paper, an adaptive neural control scheme is proposed for the longitudinal model of a class of hypersonic vehicles. Based on the backstepping technique and barrier Lyapunov functions, the attack angle can be confined in a predefined set. Besides, with the aid of the minimal learning parameter technique, there is only one parameter needs to be estimated at each design step. The proposed scheme is able to guarantee that all closed-loop signals are bounded and all tracking errors converge to some small residue sets. Simulation studies are presented to illustrate the effectiveness of the proposed control scheme.

09:20-09:40 **TueA01-5**

Learning Control for Systems Subject to Fractional Uncertainties

Mingxuan Sun Zhejiang University of Tech.
Yanwei Li Zhejiang University of Tech.
He Li Zhejiang University of Tech.

This paper presents a Lyapunov-based design of repetitive learning controllers for uncertain systems. The controller design is unified due to the use of the parametrization and norm-bounding technique, and the novelty lies in the less requirement for the knowledge about the system undertaken. In addition, this design can handle fractional uncertainties involved in the dynamics effectively. The estimation for the fractional uncertainties is performed to facilitate the controller design and property analysis. Unsaturated- and saturated-learning algorithms are characterized, through rigorous analysis, for the establishment of the boundednesss of the variables in the closed-loop system and the the asymptotical convergence of the tracking error. Numerical examples are provided to verify effectiveness of the proposed learning control scheme.

09:40-10:00 **TueA01-6**

A novel neural network adaptive control for a uncertain nonlinear systems with prescribed performance

Rui Zhang Xidian Univ.
Baoji University of Arts and Sciences
Junmin Li Xidian Univ.
Jianmin Jiao Baoji University of Arts and Sciences

This paper addresses the problem of adaptive neural networks (NNs) prescribed performance control for a class of unknown nonlinear systems. A neural network is used as feedforward compensator to approximate the unknown function that help us determine the NN approximation domain a priori via the bound of the reference signal. A novel adaptive prescribed performance control (PPC) scheme is proposed. The predetermined approximation domain can be used to choose centers and widths of the radial basis function neural networks. The advantage of the proposed control scheme is that the prescribed performance of the closed-loop systems can be obtained not only a compact set, but also on the outside of the approximation domain, without violation the predefined bounds. The simulation is performed to demonstrate the effectiveness of the proposed control scheme.

TueA02 **Room02**
Process control (II) (Chinese) **08:00-10:00**
Chair: Chunhui Zhao Zhejiang Univ.
CO-Chair: Lan Yang Zhejiang Sci-Tech Univ.

08:00-08:20 **TueA02-1**

Research on the Control System of Heat Exchanger based on PCS7

Zaiying Wang Xi'an University of science and tech.
Chenchen ZOU Xi'an University of science and tech.
Gaoyuan Lin Xi'an University of science and tech.

According to the present self-circulation boiler,the problem is that the heat exchanger unit has the low ability of cooling and the instability in the practical application.The characteristics of the heat exchanger unit are analyzed and the optimization parameters are selected.The multi-function control training system SMPT1000 are used to testify the feasibility of the control system of the heat exchanger, and achieve the monitoring by SIMATIC PCS7.The optimized control system can realize the process requirements of the system and can ensure stability of the system,and significantly improve the existing problems in the heat exchanger system.It has important meanings in theory and practical engineering.

08:20-08:40 **TueA02-2**

A Direct Adaptive Neural Control with Voltage Traverse for Maximum Power Point Tracking of Photovoltaic System

Xiaoqiang Zhang Southwest Jiaotong Univ.
Ke Chen Southwest Jiaotong Univ.
Yingquan Zhou Southwest Jiaotong Univ.
Cuifang Zhang Southwest Jiaotong Univ.
Guang-chao Ren Southwest Jiaotong Univ.

In view of the 3x3 PV array and a DC-DC circuit connection of the photovoltaic system maximum power tracking (MPPT) problem, according to the output characteristics of photovoltaic array under partially shadowing conditions(PSC) , this paper proposes a new algorithm of adaptive neural network control with the feedback load voltage traverse. First, the feedback load voltage traversal method is used to quickly reach the reference voltage, and then the DANC online learning algorithm is used to stabilize the peak value, and finally through the comparison of the peak value , the global optimal solution is obtained. The simulation results show that the proposed method can track the global maximum power point (GMPP) of the PV array before and after under PSC. Compared with other traditional algorithms, the algorithm is simple and has better tracking accuracy, rapidity and stability.

08:40-09:00 **TueA02-3**

Automatic Control System of Blast Furnace TRT

Rongfu Zhou PanZhiHua Univ.
Ji Zeng PanZhiHua Univ.
Chunju Tang PanZhiHua Univ.

This paper briefly introduces the application of DCS in a blast furnace TRT. The process basic scheme, configuration of the control system and its main functions are described. The master, controller and control net are reduplicated on purpose to improve the reliability of the control system, When TRT trips, one of the valves group for reducing gas pressure is opened fast to avoid the increase of blast furnace top pressure rapidly. In order to stabilize the roof pressure of the blast furnace during TRT operation, an initial feedback control loop is used in the regulative static blade control and a perfect control result is achieved in practical application.

09:00-09:20 **TueA02-4**

Comprehensive Optimization of Batch Process based on Particle Swarm Optimization Algorithm

Lan Yang Zhejiang Sci-Tech Univ.
Haipeng Pan Zhejiang Sci-Tech Univ.
Yibo Zhang Zhejiang Sci-Tech Univ.

Based on Iterative Particle Swarm Optimization (PSO) Algorithm, comprehensive optimization problem of batch process is discussed in this paper. Batch process optimization problems in general to product concentration as optimization goal, if optimization object is changed to the sum of the product concentration, the reciprocal of reaction time and the reciprocal of energy loss and then optimization method will be more complex. Based on the iterative particle swarm optimization algorithm, optimal solution is obtained by searching for optimal trajectory. Results of study are applied to classical chemical reaction cases. Simulation results show that this algorithm is better than single objective algorithm in speed of optimization and efficient use of energy.

09:20-09:40 **TueA02-5**

Sparse analysis based fault deviations modeling and its application to fault diagnosis

Chunhui Zhao Zhejiang Univ.
Youxian Sun Zhejiang Univ.
Youxian Sun Zhejiang Univ.

In the fault process, some specific variables will be disturbed significantly and cover much fault information, while some irresponsible variables still keep similar relations with those of normal condition. Therefore, this paper proposes a sparse relative discriminant fault deviations (SRDFD) modeling algorithm which can extract fault directions and isolate faulty variables simultaneously to improve fault diagnosis performance. In the proposed algorithm, a sparse objective function is formulated by bringing an L1 penalization to the objective function of fault degradation oriented FDA (FDFDA) algorithm, which improved the traditional FDA algorithm by further considering the relative variations of variance between fault data and normal data. The proposed objective function is not convex, so that the minorization-maximization approach is used to efficiently optimize it. Then soft threshold operator is performed for analytic solutions. The extracted sparse directions and the corresponding loadings are used as reconstruction models to eliminate fault deviations. Online fault diagnosis is then conducted by finding the correct reconstruction models which can best eliminate the out-of-control monitoring statistics. The performance is verified by the pre-programmed faults of Tennessee Eastman (TE) benchmark process.

09:40-10:00 **TueA02-6**

A phase division strategy for multiphase batch process monitoring based on Particle Swarm Optimizer (PSO)

Xuanhong Chen Zhejiang Univ.
Chunhui Zhao Zhejiang Univ.
Youxian Sun Zhejiang Univ.

Batch process generally consists of multiple stages of operation. In view of such characteristic, multi-phase modeling and analysis help to improve monitoring performance and enhance understanding of the process. Although many partition algorithms have been put forward, these is no quantification index to evaluate the performance of phase model. Besides, the results may be affected by human factors since they have many tunable parameters. In order to overcome the above problems, an optimization based phase division algorithm is presented in this work. In the algorithm, a quantization index (the cumulative control limit error, CCLE) is first defined to evaluate the performance of the phase model. Then, the PSO-based optimization algorithm is used to search the optimal phase partition results for a given target phase number. Through the percentage of performance improvement threshold, the proposed algorithm achieves the compromise between modeling complexity and monitoring performance, and ultimately gets the number of phases. A chip packaging process are conducted to demonstrate the feasibility and effectiveness of the proposed algorithm.

TueA03 Room03
Optimal control and optimization(VIII) (Chinese) 08:00-10:00

Chair: Derui Chen Chongqing Univ.
CO-Chair: Jiani Zhu Northeastern Univ.

08:00-08:20 **TueA03-1**

A New Switching Signal Optimizing Control for Buck PFC Converter with LC Filter

Derui Chen Chongqing Univ.
Bin Li Chongqing Univ.
Min Zhao Chongqing Univ.
Senlin Cheng Chongqing Univ.
Yankun Xie Chongqing Univ.

Buck converter with LC input filter has the inherent PFC properties when operating in discontinuous capacitor voltage mode (DCVM). Due to the continuous capacitor voltage mode (CCVM) cannot be fully eliminated in power cycle, a good PFC effect also cannot be guaranteed which is the key for the application of Buck PFC. In this paper, the DCVM model for Buck PFC converter with LC filter has been constructed. Then, a dual-model switch passivity-based control is proposed to optimize the PFC based on the DCVM model and the CCVM model. Simulation results show the validity of DCVM model and a better PFC performance that has been achieved by proposed control method.

08:20-08:40 **TueA03-2**

Pursuit and Evasion Conflict for Three Players Based on Differential Game Theory

Qilong Sun Harbin Institute of Techn.
Zhenpeng Chen Air Force Aviation Univ.
Naiming Qi Harbin Institute of Techn.
Haiqi Lin Harbin Institute of Techn.

A conflict of three players including an Attacker, a Defender and a Target with bounded controls is discussed based on the differential game theories in which the Target and Defender use optimal pursuit strategy. The current approach singles out the miss distance as the outcome of the conflict. In order to guarantee the Attacker accomplish the evasion and pursuit task, a new optimal guidance law is derived and the feasible conditions are analyzed. Before the engagement time between the Defender and Attacker, the Attacker uses the derived control effort to guarantee that the evasion distance from the Defender is safe and the ZEM distance between the Attacker and the Target is the smallest value within the permitted control range for the Attacker successfully reaching to a safety area at the interception time. After that engagement time, the Attacker uses the optimal one-to-one guidance law to accomplish the pursuit task.

08:40-09:00 **TueA03-3**

Multi - objective Optimization of Continuous Casting Secondary Cooling Water Based on Differential Evolution Algorithm

Zhenping Ji School of Automation and Electrical Engineering Shenyang Ligong Univ.
Shuai Liu School of Automation and Electrical Engineering Shenyang Ligong Univ.

The secondary cooling water has a considerable influence on cracks and other internal defects of the billets. This research aims to develop an optimization algorithm used for solving the optimal secondary cooling water flowrate under different casting speeds. An multi-objective optimization algorithm based on differential evolution (DE) algorithm was developed for Pareto-optimal solutions for solving an optimal control of secondary cooling water distribution. The optimization method consists of the solidification heat transfer mathematical model, DE algorithm linked with three conflicting objective functions according to certain metallurgical criteria and some technological constraints. The Pareto-optimal solutions were controlled by crowding distance to improve the diversity of solutions. The application of the developed optimization algorithm for determining optimal setting of cooling parameters demonstrate that better results can be obtained in improving the product quality.

09:00-09:20 **TueA03-4**

Optimal portfolio selection under minimax criterion with short-selling

Chunyan Sun University of Chinese Academy of Sciences
Minhong Zhang University of Chinese Academy of Sciences

The paper mainly considers an extend version of Mean-Maximum Absolute Deviation model, which adds the transaction cost and the limitation of the amount of capital invested (sold short from) in each

security when short-selling is permitted in security market. It was proposed that a minimax portfolio selection model using absolute deviation function L as the risk measure. The model is bi-objective nonlinear programming problem. Then it was reformulated into a single-objective non-convex programming problem by introduction a risk tolerance factor. Furthermore, attempting to solve the problem by using Difference of Convex function (DC) programming and DC algorithms. Here, a numerical example was given to show the validity of the method.

09:20-09:40 **TueA03-5**

Modeling and Analysis of Optimal Scheme for Submarine Breaking Through the Double Surface Ships Blockade Region

Mingjie Wang Armored Force Institute of PLA
Zheng Zhang Armored Force Institute of PLA

Aiming at solving the submarine breaking through double surface ships patrol blockade region problem, the “safety margin” idea is put forward based on analysis, the optimal scheme decision-making model of submarine breaking through the blockade region of double surface ships is established and the algorithm is proposed. Combined with an example, the program composition with MATLAB is used to calculate the initial result of optimal submarine and enemy ships relative position, velocity of submarine and corresponding safety margin, the effects of blockade region area size, ships speed and active sonar on the results is analyzed, which is valuable to the tactics study and tactical application research of submarine breaking through double surface ships patrol blockade region for reference.

09:40-10:00 **TueA03-6**

A New Weight Vectors Generation Method for R2 Indicator Based Evolutionary Multiobjective Optimization Algorithm

Jiani Zhu Northeastern Univ.
Jianchang Liu Northeastern Univ.
Fei Li Northeastern Univ.
Peiqiu Huang Northeastern Univ.

In multi-objective optimization problems (MOPs), set-based performance indicators are commonly used to assess the convergence and diversity of Pareto front approximation. Performance indicators can be used as the selection strategies. The selection strategy of indicator based evolutionary multi-objective algorithms (EMOAs) is guided by a general preference information, which maps objectives into a single contribution value by means of a set of utility functions. R2-EMOA is one of the most important indicator-based algorithms to solve MOPs. We use fast R2-ranking to rank the individuals of EMOAs. This paper suggests a new weight generator strategy, which is based on direction angles, for MOPs. Our main purpose is to explore the relationship among direction angles, weight vectors and direction vectors. Our proposed weight generator scheme is incorporated to two different search engines, resulting in two new EMOAs, named IR2-MOGA and IR2-MODE. The performance of our proposed method is validated and compared with other R2-EMOAs on a number of unconstraint benchmark problems. Experimental results demonstrate that our algorithms can significantly improve the convergence and diversity of R2-EMOA.

TueA04 **Room04**
Perception systems **8:00-10:00**
Chair: Haiyang Meng Xi'an Univ. of Tech.
CO-Chair: Bin Wang Harbin Engi.Tech. Univ.

8:00-8:20 **TueA04-1**

Monocular Visual Odometry Based on Optical Flow and Feature Matching

Chuanqi Cheng Information Engi. Univ.
Xiangyang Hao Information Engi. Univ.
Zhenjie Zhang Information Engi. Univ.
Mandan Zhao Information Engi. Univ.

To solve the problem of real-time precise localization in CPS-denied places, a monocular visual odometry method based on optical flow tracking and feature matching is proposed. To speed up traditional pose estimation algorithm, the image sequences are classified into key frames and non-key frames. The conventional pipeline of feature detection and matching is utilized to process key frames, while utilizing Lucas Kanade optical flow to track the correspondences in non-key frames. To improve the robustness of the visual odometry method, a RANSAC-based outlier rejection scheme is applied in the phase of pose estimation. Moreover, a Kalman Filter based on the dynamic equation is designed to optimize the pose estimation. Experimental results demonstrate that proposed method can acquire the high accuracy of feature matching, while highlighting the real-time performance of optical flow tracking, which can meet the needs of real-time accurate localization in cities.

8:20-8:40 **TueA04-2**

Circuit Breaker Movement Characteristics Analysis Based on Predetermined Template

Chengtao Cai Harbin Engi.Tech. Univ.
Haiyang Meng Harbin Engi.Tech. Univ.

Circuit breaker is the essential electrical equipment of power plants and substations in distribution equipment. It shoulders the dual task of control and protection in Power System. Breaker as the power system is an important switching equipment, the merits of its motion feature has an important impact on the safety of the grid. Due to the motion characteristics of a conventional circuit breaker testing methods has low efficiency, poor accuracy, consumption of labor and other shortcomings, so its poor detection reliability and quality. Therefore, we introduce the computer vision to the analysis of circuit breaker movement characteristics, in order to visual analysis of the circuit breaker. In this paper, we adopt the analytical methods which based on predetermined template to analysis the movement characteristics of circuit breaker, and utilize the sliding window filtering methods to its motion parameters denoising and filtering, so that the result is closer to the actual movement characteristics of the circuit breaker. Predetermined template is captured from the source image in general, which is similar to the target that it can be found in the source image. This algorithm solves many shortcomings of the current motion characteristics of the circuit breaker testing.

8:40-9:00 **TueA04-3**

Adaptive Fragment Multi-Target Tracking in Occlusion Scene

Faliang Chang Shandong Univ.
Hongbin Liu Shandong Univ.
Xiude Bie Shandong Univ.

Multi-target tracking in occlusion scene is a challenging task. This paper proposes a multi-target tracking method based on adaptive fragment to complete it. The method adaptively divides each target into a few of fragments on the basis of its multi-channel gray projection. The similarity between each fragment and its model is calculated by weighted Bhattacharyya coefficient. Fuzzy C-means method is used to cluster the particle sets of each target, and the optimal state estimation of the target is obtained from these sets. By updating fragment weight of target model, the method can dynamically deal with occlusion problem. Experiments show that the proposed method can improve the accuracy and robustness of multi-target tracking in occlusion scene.

9:00-9:20 **TueA04-4**

A Novel Multi-Object Tracking Method Based on Main-Parts Model

Hongbin Liu Shandong Univ.
Faliang Chang Shandong Univ.

Multi-object tracking is often hindered by difficulties such as occlusion and illumination change. In this paper, we propose a novel multi-object tracking method based on main-parts model. Main-parts model is formulated by segmenting parts of object and accumulating variations of appearance from previous frames. We assume that parts with weaker appearance variations are main-parts of an object. By using main-parts model, data association between tracklets and detections can be more accurately. Experiments with challenging public datasets verify that the proposed method can improve tracking accuracy.

9:20-9:40 **TueA04-5**

Recovering the Manhattan Frame from A Single RGB-D Image by Using Orientation Relevance

Zhiqiu Wu Beijing Univ. of Tech.
Liang Wang Beijing Univ. of Tech.

Most man-made indoor and urban scenes are composed of a set of orthogonal and parallel planes. In robotics and computer vision, these scenes typically represented by the Manhattan-World model. The accurate estimation of the Manhattan Frame, which consists of three orthogonal directions being used to represent the Manhattan-World, plays an important role in many applications, such as SLAM, scene understanding and 3D reconstruction. In this paper, a new method for accurately recovering the Manhattan frame from a single RGB-D image by using the orientation relevance is proposed. It first extracts planes from the input single RGB-D image. Then three orthogonal dominant planes are determined by introducing the concept of orientation relevance. Finally, the Manhattan Frame can be easily recovered from the obtained three orthogonal dominant planes. Experiments with open dataset validate the proposed method. The overall performance of the proposed method, which takes both accuracy and speed into account, is superior to that of the state-of-the-art methods. It is also applied on the application of scene annotation to confirm its applicability.

9:40-10:00 **TueA04-6**

An Improved Integrated Fingerprint Location Algorithm Based on WKNN

Bin Wang Xi'an Univ. of Tech.
Yinqun Zhao Xi'an Univ. of Tech.
Tong Zhang Xi'an Univ. of Tech.
Xinhong Hei Xi'an Univ. of Tech.

Fingerprint location algorithm is often used in process of indoor location. But the complex environment will cause fluctuations in signal strength and this fluctuation will lead to positioning errors. In order to correct the error we use Gaussian filtering to preprocess the location data and adopt based on voting region decision policy and based on maximum signal strength AP selection policy. SSCM-WKNN algorithm that integrates these policies and the WKNN algorithm of K-value optimized are implemented in a simulation environment, and experiments show that it is effective to reduce the positioning error.

TueA05 **Room05**
Complex networks and systems (II) **8:00-10:00**
Chair: Shi Yan Lanzhou Univ.
CO-Chair: Bin Sun Tianjin Univ. of Tech.

8:00-8:20 **TueA05-1**

Route Optimization of Container Multi-Modal Transportation Based On Reliability under the Three-Dimensional Network

Endi Zhao Tianjin Univ. of Tech.
Bin Sun Tianjin Univ. of Tech.
Peng Yang Tianjin Univ. of Tech.
Junqing Sun Tianjin Univ. of Tech.

To deal with the uncertainty of container multi-modal transport, a container multi-modal transport route optimization model based on the reliability is proposed. To deal with the problem that network has multiplicity and that node has weights in multi-modal transport, the paper pre-processes the multi-modal transport network to three-dimensional graph based on the transport mode, and uses the improved Dijkstra algorithm to get the K-th shortest path set which take transport time and transport cost as the main target. On this basis, we find out the reliability of the common paths, and figure out the path which has higher reliability. The simulation experiments take sea routes of China to Australia as the main route, prove the model and method can improve the reliability of transport, to a certain extent, can also reduce the loss of the consignor.

8:20-8:40 **TueA05-2**

Quasi-Synchronization of Coupled Heterogeneous Duffing-type Oscillator Complex Networks with Parameter Mismatches

Mengmeng Hu Shenzhen Univ.
Jianwen Feng Shenzhen Univ.
Yi Zhao Shenzhen Univ.

This paper investigates the quasi-synchronization of heterogeneous Duffing-type oscillator networks with parameter mismatches without any external controller. To achieve quasi-synchronization of the network, a virtual target of Duffing-type oscillator is introduced. Some sufficient conditions for achieving the quasi-synchronization of heterogeneous complex networks are obtained based on the Lyapunov stability theory and strict mathematical analysis. Subsequently, we present a numerical example to illustrate the effectiveness of the theoretical results.

8:40-9:00 **TueA05-3**

Order Reduction for Roesser State-Space Model Based on Real Jordan Transformation

Xiaodong Du Lanzhou Univ.
Shi Yan Lanzhou Univ.
Gang Cheng Lanzhou Univ.
Dongdong Zhao Akita Prefectural Univ.
Li Xu Akita Prefectural Univ.

This paper is concerned with the problem of an order reduction approach for Roesser state-space model of multidimensional (n-D) systems based on real Jordan transformation. It will be shown that even if the eigenvalues of main block diagonal matrices of coefficient matrix A are not all real, it is still possible to reduce the order of the given Roesser model based on a real n-D Jordan canonical form obtained by using a well-defined real similarity transformation or intermediate matrix. As a consequence, the limitation of the existing elementary operation order reduction approach with Jordan transformation can be overcome so that it can be viewed as a special case of the new proposed approach. Moreover, a basic order reduction procedure is presented and corresponding examples are provided to illustrate the details as well as the effectiveness of the proposed approach.

9:00-9:20 **TueA05-4**

A New Method for Identifying Influential Nodes Based on D-S Evendence Theory

Langwen Zhang HuBei Univ. for Nationalities
Zhixuan Wang HuBei Univ. for Nationalities
Ningkui Wang HuBei Univ. for Nationalities
Daijun Wei HuBei Univ. for Nationalities

In complex networks, how to identify influential nodes in complex networks is a hot topic. Recently, weights of nodes and degree of nodes are combined for identifying influential nodes in the weighted networks. Degree centrality, closeness centrality and betweenness centrality are the most basic measures for describing the influence of nodes. In this paper, degree centrality, closeness centrality and betweenness centrality are considered. The three measures are built three basic probability assignment (BPAs) based on evidence theory, respectively. Then, a final measure, which is used to identify influence of nodes, is obtained by combining the three BPAs. Numerical examples are used to illustrate the effectiveness of the proposed method.

9:20-9:40 **TueA05-5**

Adaptive Impulsive Consensus of Multi-Agent Systems with Control Gain Error

Liuyang Zhang Chongqing Univ.
Teng Li Chongqing Univ.
Tao Huang Chongqing Univ.
Junhao Huang Chongqing Univ.
Tiedong Ma Chongqing Univ.

This paper studies the consensus problem of multi-agent nonlinear systems with or without uncertain parameters and control gain error. Based on the theory of impulsive differential equations, adaptive control technique and Lyapunov stability theory, some novel adaptive impulsive consensus conditions are given to realize the consensus of a class of multi-agent nonlinear systems. Compared with the existing investigations of impulsive consensus of multi-agent systems, the proposed impulsive control protocol with uncertain parameters and control gain error is more rigorous and effective in practical systems. Two numerical simulations are verified to confirm the effectiveness of the proposed methods.

9:40-10:00 **TueA05-6**

Research on Computer Virus Source Modeling with Immune Characteristics

Zhi-juan Jia Zhengzhou Normal Univ.
Yan-yan Yang Zhengzhou Normal Univ.
Na Guo Zhengzhou Normal Univ.

Existing computer virus direction of the study focused on the characteristics of virus propagation, and few people study the problem of computer virus source, but the source of computer virus can eliminate the source of the virus to quickly inhibit the spread of computer viruses. Therefore, the article mainly on the source of the virus problem modeling, by observing the status of each node network to achieve the source of the virus location. First, according to the actual network connection, to build a computer virus source model based on complex network. Secondly, the network timing state matrix is used to simulate the state of network nodes caused by computer virus propagation. And taking into account the computer node immune characteristics. Through analysis, the network state transition process is obtained, and the initial state of the virus node is the computer virus source. Finally, the paper gives the simulation experiment, the experiment proved that the above model is correct and effective, for the future effective control of computer virus propagation to help.

TueA06 Room06
Nonlinear systems (IV) 8:00-10:00

Chair: Yanli Du Nanjing Univ. of Aeronautics and Astronautics
CO-Chair: Xiaobing Kong North China Electiric Power Univ.

8:00-8:20 **TueA06-1**

ZG Tracking Controllers of Types z3g0 and z3g1 for Handling Fractional Power Systems

Yunong Zhang Sun Yat-sen Univ.
Penghao He Sun Yat-sen Univ.
Fangzheng Lai Sun Yat-sen Univ.
Jianfeng Wen Sun Yat-sen Univ.
Guangdong Polytechnic Normal Univ.
Liangyu He Sun Yat-sen Univ.

Tracking control of fractional power systems is a hot topic in many fields. The controller for a fractional power system generally needs to not only stabilize all the states but also drive the outputs of the system to track the pre-defined trajectories. Our paper aims at tackling this output tracking control problem with the aid of a novel Zhanggradient (ZG) method (e.g., type z3g0 and type z3g1), a smart combination of Zhang dynamics (ZD) method and gradient dynamics (GD) method. More specifically, we compare the performance of the z3g0 controller and the z3g1 controller in addition to several simulations so as to exemplify the method feasibility and effectiveness of type z3g1.

8:20-8:40 **TueA06-2**

Disturbance Observer Based Backstepping Control for a Hypersonic Vehicle

Yao Lu Beihang Univ.
Chaoyang Dong Beihang Univ.
Yang Liu Beihang Univ.
Qing Wang Beihang Univ.

Considering the longitudinal nonlinear model of a hypersonic vehicle including uncertain disturbances, a nonlinear controller based on backstepping method and dynamic inversion method is proposed for solving the tracking control problem. In order to facilitate the control design, the flight vehicle model is decomposed as velocity subsystem and flight path angle subsystem. The command filter is utilized to avoid the problem of “explosion of complexity” which occurs in backstepping method. In order to suppress the disturbances, a novel disturbance observer is proposed for estimating them during the tracking process. A Lyapunov-based stability analysis indicates that the tracking errors are uniformly bounded. Finally, the simulation results demonstrate that the proposed method can achieve superior tracking of velocity and flight path angle references in the presence of uncertainty of the general and aerodynamic parameters.

8:40-9:00 **TueA06-3**

The Nonlinear Anti-Windup Control of Hypersonic Glide Vehicles with Input Saturation and Uncertainties

Ping Sun Nanjing Univ. of Aeronautics and Astronautics
Yanli Du Nanjing Univ. of Aeronautics and Astronautics
Peng Zhang Nanjing Univ. of Aeronautics and Astronautics
Kai Xiang Nanjing Univ. of Aeronautics and Astronautics

The control of the hypersonic glide vehicle (HGV) during re-entry is confronted with the input saturation and unknown dynamical uncertainty problem. A nonlinear anti-windup (AW) compensation control method is designed to deal with the nonlinear control problem caused by the saturation of the control surfaces of the HGV. The scheme transforms the problem of saturation control into the optimization problem through nonlinear matrix inequality (NMIL) constraints, which is solved by particle swarm optimization (PSO). The saturation situation can be relieved within a short time and the satisfactory control performance is attained by the method. Then, a novel sigmoid function tracking differentiator based

disturbance observer (STDDO) is proposed to estimate parameter uncertainties and external disturbances for the problem of dynamical uncertainties. This method does not need the priori information about the bounds of disturbances and has global fast convergence property. Finally, the simulation results show the effectiveness and robustness of the proposed control scheme.

9:00-9:20 **TueA06-4**

Exact Feedback Linearization of General Four-Level Buck DC-DC Converters

Pei Cai Northwestern Polytechnical Univ.
Xiaohua Wu Northwestern Polytechnical Univ.
Runyu Sun Northwestern Polytechnical Univ.
Yanzhe Wu Univ. of Electronic Science and Techn. of China

Four-level buck DC-DC converters (FLB), as strongly coupled, multi-input multi-output and under-actuated 4th -order nonlinear systems, require relatively complex control to meet desired demand. Traditional control methods such as proportional-integral (PI) with linear decoupling either have slow dynamic response and incomplete decoupling, which means a conflict in performance among the output voltage and several flying-capacitor (FC) voltages, or need to degrade the circuit, losing the generality. Considering all state variables of general FLB and thus building the 4th –order affine average model, this paper proposes a full-state exact feedback linearization (EFL) nonlinear control method based on differential geometry. Besides, the stability of internal dynamics caused by under-actuated characteristics is concisely analyzed when different output functions are selected. Simulation results show that proposed method has better transient and steady-state performance than PI with linear decoupling when there is a step change in input voltage or load.

9:20-9:40 **TueA06-5**

Efficient Nonlinear MPC on Permanent Magnet Synchronous Motor

Xiaobing Kong North China Electiric Power Univ.
Xiangjie Liu North China Electiric Power Univ.

Reliable control of the permanent magnet synchronous motor (PMSM) is necessary to ensure high speed-following capability and robustness under model parameter and load torque variation. This is often difficult to achieve using conventional linear controllers, as PMSM is a nonlinear and high coupling system containing many uncertainties. This paper proposes a nonlinear model predictive controller (MPC) for a speed control of PMSM. The nonlinear PMSM decouples into a new linear system via the input-output feddback linearization (IOFL) scheme. To guarantee its feasibility, a quadratic program (QP) routine is proposed to slve the linear MPC problem with nonlinear constraints approximately linearized. Experimental results show the proposed controller has good dynamic and static performance while reducing computational burden.

9:40-10:00 **TueA06-6**

Path Following Control of Discrete-time AUV with Input-delay

Jiemei Zhao Wuhan Polytechnic Univ.
Zhonghui Hu 709th Research Inst. of China Shipbuilding Industry Corporation

A path following control problem of discrete-time autonomous underwater vehicle (AUV) with input delay is studied. For solving the time-delay in control system, a neural network (NN) predictive control method is introduced. Since the velocities are very difficult to be accurately measured, here output feedback method is employed to overcome this problem. The stability analysis is given by Lyapunov theorem. Simulation results show the effectiveness of the proposed control strategy.

TueA07 Room07
Decision-making theory and method (II) (Chinese) 8:00-10:00

Chair: Yonggang Li Dalian Univ. of Tech.
CO-Chair: Yongmei Liu Business School of Central South Univ.

8:00-8:20 **TueA07-1**

Pricing and Channel Structures Selection Considering Free-riding Behavior

Yongmei Liu Business School of Central South Univ.
Chen Fan Business School of Central South Univ.
Chunjie Ding Business School of Central South Univ.
Xiaohong Chen Business School of Central South Univ.

Online and offline marketplaces (dual-channel) have seen rapid growth recently. Online marketplaces serve as intermediary to match buyers with sellers, where consumers take a free-ride in channel services and have an impact on supply chain operations. We consider a manufacturer to operate only a traditional offline marketplace, an online channel (a direct channel), or a dual-channel structure, and model the consumer utility and demand function considering free-riding behavior in the above conditions, to find what structure the manufacturer should choose and at what price she should maximize her profits. The impact of service and free-riding behavior on the manufacturer's pricing decision and performance are evaluated numerically. We find that in the dual-channel structure with free-riding behavior, the improvement of traditional service is beneficial to the traditional channel and rapidly increases the online revenue, making up for the service cost and bringing benefits in both channels. What's more, a dual-channel structure makes the manufacturer more advantageous in channel pricing.

8:20-8:40 **TueA07-2**

CrowdSensing Games

Hamidou Tembine New York Univ.

Crowd sensing pertains to the monitoring of large-scale phenomena that cannot be easily measured by a single individual. For example, intelligent transportation systems may require traffic congestion monitoring and air pollution level monitoring. These phenomena can be measured accurately only when many individuals provide speed and air quality information from their daily commutes, which are then aggregated spatio-temporally to determine congestion and pollution levels in smart cities. In this paper we study three classes of a network game where each user decides its level of participation to the crowdsensing: (i) public good, (ii) information sharing, (iii) resource sharing. We examine the contribution level of users via Bayesian game models, where we have analyzed the equilibrium strategies, equilibrium payoff and the role of user-centric information on their behavior in terms of participation to the cloud. We also analyzed the possibility for users with power-hungry devices to serve the cloud by means of throughput sharing strategies from other users.

8:40-9:00 **TueA07-3**

Using AMPL/CPLEX to Model and Solve the Electric Vehicle Routing Problem (EVRP) with Heterogeneous Mixed Fleet

Xiaorong Zuo Beihang Univ.
Chuan Zhu Beihang Univ.
Changhao Huang Beihang Univ.
Yiyong Xiao Beihang Univ.

Vehicle Routing Problem(VRP) is one of the most important and classical issues in the logistics distribution field. However, the excessive consumption of oil resources makes a dramatic increase in emissions of carbon dioxide in the atmosphere which causes a deterioration of the environment around us for the past few years. The electric vehicle(EV) is a better alternative which operates with batteries instead of using gasoline.In this paper, we present the Electric Vehicle Problem(EVRP) and describe it with a mathematical programming model. Then, we verity the model via the mathematic program software called AMPL/CPLEX and the mathematic instances are extracted from the Solomon's instances. We propose a programming algorithm as an exact solution approach for the EVRP. Problem examples and numerical calculation have been provided to evaluate the solution approach and the optimality.

9:00-9:20 **TueA07-4**

Supplier evaluation in TSC based on fuzzy linguistic term sets and QFD

Ming Liu Qingdao Univ.
Qisheng Gao Qingdao Univ.

Supplier evaluation in tourism supply chain (TSC) is a typical multi-criteria group decision problem. An evaluation approach that makes use of 2-tupple linguistic model, quality function deployment (QFD), and fuzzy information aggregation is proposed. The establishment process of assessment criteria based on fuzzy linguistic term sets has been discussed, and house of quality (HOQ) based on 2-tuple linguistic model is constructed to compute the weights of suppliers' factors and the rank order. By using of ordered weighted averaging (OWA), the aggregation approach of multi-granularity linguistic term can manage non-homogenous decision information problem successfully. At last a case study on a travel operator's evaluation of suppliers solved by the proposed approach is illustrated.

9:20-9:40 **TueA07-5**

Individual Consumption-Investment Decision Making Model Based on the Focus Points

Yonggang Li Dalian Univ. of Tech.
Xiangpei Hu Dalian Univ. of Tech.

In this paper we consider a single decision period consumption-investment problem with the consumption targets for an individual. The rate of return is uncertain and the portfolio preference order is influenced by the investor's social status, wealth, psychology and so on. We emphasize that the individual investor has one and only one chance to allocate the wealth into consumption and a portfolio for investment. In this case, we argue the investor will make decision based on particular scenario which she/he focuses on. The chosen scenario is called a focus point of the consumption-investment strategy. We propose new decision-making model for consumption-investment problem. Based on the new model we discuss the relationships between consumption targets and consumption-investment behavior.

9:40-10:00 **TueA07-6**

Reliability Analysis of Wind Turbine Gear Box Based on Fault Tree and Bayesian Network

Haofan Jin North China Electric Power Univ. (Baoding)
Changliang Liu North China Electric Power Univ. (Baoding)

Gear box is a key component of wind turbine, its reliability improvement directly affects the reliability of the whole wind turbine. In this paper, two main failure modes of the wind turbine gear transmission system are analyzed based on the fault tree and Bayesian network. They are tooth surface contact fatigue pitting and tooth root bending fatigue fracture. The reliability index of the gear drive system was derived and its weaknesses were obtained through two - way reasoning ability of Bayesian network. Provide a theoretical basis and reference for the rational design and reliability of the gearbox.

TueA08 **Room08**
Decision supporting system and production planning and scheduling (II) (Chinese) **8:00-10:00**
Chair: Yingchun Jiang Shenyang Agricultural Univ.
CO-Chair: Kanjian Zhang Southeast Univ.

8:00-8:20 **TueA08-1**

An Enhanced Migrating Birds Optimization for a Lot-streaming Flow Shop Scheduling Problem

Tao Meng Shanghai Univ.
Liaocheng Univ.
Junhua Duan Shanghai Univ.
Quanke Pan Shanghai Univ.
Qingda Chen Northeastern Univ.

Migrating birds optimization (MBO) is a newly reported metaheuristic that has been proved effective in dealing with combinatorial optimization problems. In this paper, we propose an enhanced MBO (EMBO) to solve a lot-streaming flow shop scheduling problem with setup times, in which job-splitting and job scheduling are considered simultaneously. The objective is to minimize the makespan. In EMBO, a two-stage vector is employed to represent solutions in the swarm. Borrowing idea from artificial bee colony, a special neighbor structure is designed to create new candidates. Moreover, attempting to jump out of the local best, a new solution update scheme is introduced. Numerical tests are conducted and comparisons with other recent algorithms show the superiority of the proposed EMBO.

8:20-8:40 **TueA08-2**

Fault Diagnosis Algorithm for Storage and Transportation Equipment Based On Fault Tree

Chenxi Li Southeast Univ.
Chenglong Zhu Southeast Univ.
Kanjian Zhang Southeast Univ.
Haikun Wei Southeast Univ.

This paper investigates a fault diagnosis scheme to detect whether a system is in normal or fault condition, and further diagnose the type and location of the fault. A complicated storage and transportation equipment system is proposed to experiment the presented fault diagnosis strategy. The fault tree technique is used to overcome the difficult to detect system states and huge consume for arranging large numbers of information collection points. In this paper, the established fault diagnosis algorithm which based on the fault tree can achieve diagnosing the equipment intelligently. Firstly, we build fault tree for every fault code based on the system structure and past working data. Once a fault is detected, the fault tree analysis will be performed to find out possible broken-down components automatically with the help of written MATLAB software. Under the guidance of provided reasonable diagnostic sequence, the users can maintain the equipment effectively without the help of professionals.

8:40-9:00 **TueA08-3**

An Improved Migrating Birds Optimization for Solving the Multidimensional Knapsack Problem

Tao Meng Shanghai Univ.
Liaocheng Univ.
Junhua Duan Shanghai Univ.
Quanke Pan Liaocheng Univ.
Qingda Chen Northeastern Univ.

The multidimensional knapsack problem (MKP) is a famous NP-hard combinatorial optimization problem with strong engineering backgrounds. In this paper, we propose an improved migrating birds optimization (IMBO) to solve the MKP. In IMBO, to guarantee the initial swarm with a certain level of quality and diversity, we generate some meaningful solutions while other individuals are constructed randomly. In addition, considering the characteristics of MBO and MKP, an effective sharing scheme (NSS) is designed to deliver useful information to the following individual. Numerical experiments are performed and comparisons with state-of-the-art algorithms demonstrate the effectiveness of the proposed IMBO for solving the MKP.

9:00-9:20 **TueA08-4**

Brain Storming Optimization Algorithm for Heating Dispatch Scheduling of Thermal Power Plant

Lu Kang Xi'an Univ. of Tech.
Shannxi Province Key Laboratory of Complex System Control and Intelligent Information Processing
Yali Wu Xi'an Univ. of Tech.
Shannxi Province Key Laboratory of Complex System Control and Intelligent Information Processing
Xinrui Wang Xi'an Univ. of Tech.
Shannxi Province Key Laboratory of Complex System Control and Intelligent Information Processing
Xiaohua Feng Northwestern Polytechnical Univ.

In the traditional scheduling mode of the current thermal power plants, only the power load distribution of the unit was considered. And there was no enough guidance to the heat source scheduling. This can not meet the current energy-saving and emission-reduction requirements. In this paper, an optimal heat load dispatching model is set up under the premise of power load distribution of thermal power plant. Three kinds of heat loads including to high-pressure, medium-pressure and low-pressure are taken into account in the scheduling model. According to the characteristics of the problem, Brain Storming Optimization (BSO) algorithm is used to get the optimal distribution strategy. The comparison with the original scheme shows the correctness of the model and the optimization algorithm. Moreover, the optimization ability and effectiveness of brain storming optimization algorithm in solving complex optimization problems are verified by comparing the proposed algorithm with the other different optimization algorithms, such as Particle Swarm Optimization(PSO) and Differential Evolution (DE) algorithm.

9:20-9:40 **TueA08-5**

Dynamic Scheduling System for Steelmaking-Refining-Continuous Casting Production

Xinfu Pang Shenyang Inst. of Engineering
Huazhong Univ. of Science and Tech.
Yingchun Jiang Shenyang Agricultural Univ.
Liang Gao Huazhong Univ. of Science and Tech.
Bo Tang Shenyang Inst. of Engineering
Haibo Li Shenyang Inst. of Engineering
Northeastern Univ.
Shengping Yu Northeastern Univ.
Wei Liu Northeastern Univ.

Because of different refining route of every charge, it's difficult to make a static scheduling plan for steelmaking-refining-continuous casting (SRCC) production. There are many types of disturbances that upset the scheduling plan including processing time variation, temperature variation, quality variation, flow speed variation of cater, machine failures, and which could cause the static scheduling to become inefficient and even infeasible. It is necessary to adjust the schedule or generate a new executable schedule upon the occurrence of unanticipated disruptions and changes. An optimization scheduling strategy framework is proposed including static scheduling, dynamic scheduling, assistant equipment scheduling. The static scheduling plan is made by using expert systems, programming method, fuzzy evaluation. The dynamic scheduling is including the partial rescheduling and complete rescheduling by using heuristic and programming methods. The assistant equipment scheduling plan is made based on heuristic method. The dynamic intelligent scheduling system was developed with the optimization scheduling strategy, and has been applied to a large steel enterprise steelmaking-refining-continuous casting production.

9:40-10:00 **TueA08-6**

Optimization model for non-bulk material unloading of storage and retrieval in hydropower railway transportation

Yunlei Xiao Huazhong Univ. of Science and Tech.
Zhenyuan Liu Huazhong Univ. of Science and Tech.
Yige Zhang Huazhong Univ. of Science and Tech.

The construction effectiveness of hydropower development project, which is a large construction project, depends largely on the effective operation of material supply chain. And transfer reserve system is a supply hub which makes a crucial part in the material supply chain. Basing on supply chain management in the Development Program of Hydropower, this article analyzes the operation process and characteristics of the railway transit reserve system which is an important intermediate logistics node of engineering materials supply chain, and focuses on the unloading operation of non-bulk materials in transfer station and its optimization. A scheduling optimization model is developed to minimize the makespan of unloading tasks. The article also designed an IGA method considering the characteristics of the problem, and then the effectiveness of the optimization model and solving method is verified by experiments. The experimental results show that using the IGA to solve the cooperative scheduling model can obtain good quality solutions.

TueA09 **Room09**
Neural networks (I) **8:00-10:00**
Chair: Zhihong Guan Huazhong Univ. of Science and Tech.
CO-Chair: Jihong Chen Huazhong Univ. of Science and Tech.

8:00-8:20 **TueA09-1**

The IT2FNN Synchronous Control for H-Type Gantry Stage Driven by Dual Linear Motors

Limei Wang Shenyang Univ. of Tech.
Zongxue Zhang Shenyang Univ. of Tech.
Xiaoying Li Shenyang Univ. of Tech.

An interval type-2 fuzzy neural network(IT2FNN) control method is presented for H-type gantry stage driven by dual linear motors. The synchronous motion of the dual linear motors is the main factor affecting the accuracy and robustness of the servo system. Thus, the proposed method sets the position error of the both side motors as input, the powerful self -learning ability of neural network is used to guarantee the synchronous error converge to zero to achieve synchronous control. From the simulation results, the synchronous performance of the two-axis motion is significantly improved, and the robustness can be obtained as well using the proposed IT2FNN control method.

8:20-8:40 **TueA09-2**

A DIVA-based Method for the Phonation of the Chinese Diphthongs

Shaobai Zhang Nanjing Univ. of Posts and Telecommunications
Teng Zhang Nanjing Univ. of Posts and Telecommunications
Ningning Zhou Nanjing Univ. of Posts and Telecommunications
Mainly used to simulate and describe the brain involved in speech production and speech comprehension relevant functional areas, the DIVA model simulates channel activity by a neural network model of adaptive words, syllables or phonemes, and it depends on the background of the language are 29 basic English phonemes. Since that the pronunciation of Chinese and English is very different, the basic phoneme of more than 70, while the process is completely different from the brain mechanism. If you want to "read" the Chinese brain thinking process, the need for specialized research on China's background to adapt to the DIVA model. This paper based on the DIVA model can simulate and describe the function of language generation and acquisition of relevant brain areas. By means of linear prediction and cepstrum Mel combination (LPMCC), the double vowel resonance peak frequency was extracted by fitting polynomial, and the DIVA 9 typical Chinese double vowels were simulated. The simulation results show that the model is very effective in distinguishing the vowels of Chinese vowels and the sounds of speech by adjusting the function of the resonance peaks and the corresponding parameters of the vocal organs of the vocal organs. This work provides a great theoretical and practical basis for the widespread use of intelligent robots in society.

8:40-9:00 **TueA09-3**

Image Recognition Method Based on Deep Learning

Xin Jia Tianjin Univ. of Tech.
Deep learning algorithms are a subset of the machine learning algorithms, which aim at discovering multiple levels of distributed representations. Recently, numerous deep learning algorithms have been proposed to solve traditional artificial intelligence problems.This work aims to review the state-of-the-art in deep learning algorithms in computer vision by highlighting the contributions and challenges from recent research papers. It first gives an overview of various deep learning approaches and their recent developments, and then briefly describes their applications in diverse vision tasks. Finally,the paper summarizes the future trends and challenges in designing and training deep neural networks.

9:00-9:20 **TueA09-4**

Improved Multiple Kernel Extreme Learning Machine Based on AdaBoost.RT

Lihua Shen Huazhong Univ. of Science and Tech.
Jihong Chen Huazhong Univ. of Science and Tech.
Zhaocheng Ge Huazhong Univ. of Science and Tech.
Jian Jin Huazhong Univ. of Science and Tech.
Jianzhong Yang Huazhong Univ. of Science and Tech.
Hangjun Zhang Reliability Tech., Wuhan Huazhong Numerical Control Co., LTD
In this paper, an improved multiple kernel extreme learning machine is proposed for multivariate time series prediction. The time series is first phase-space reconstructed to form the input and output samples and then an ensemble of multiple kernel extreme learning machine is proposed based on AdaBoost.RT to achieve an improved model. In the process of model training, the weights of the training samples are adjusted according to their training error and the training samples with greater error would obtain heavier weights and be focused on to be learned. The final proposed model is a weighted ensemble of the multiple kernel extreme learning machine. The experimental results of Lorenz chaotic multivariate dynamic system and the annual runoff and sunspot multivariate dynamic system demonstrate that the proposed model has better prediction performance.

9:20-9:40 **TueA09-5**

Global Exponential Synchronization of Nonlinearly Coupled Reaction-Diffusion Neural Networks

Yanli Huang Tianjin Polytechnic Univ.
Beibei Xu Tianjin Polytechnic Univ.
Shunyan Ren Tianjin Polytechnic Univ.
Jinliang Wang Tianjin Polytechnic Univ.
Weizhong Chen Tianjin Polytechnic Univ.
This paper investigates the synchronization problem of nonlinearly coupled reaction-diffusion neural networks (NCRDNNs). By utilizing Lyapunov functional combined with several inequality techniques, a criterion for synchronization of NCRDNNs is presented. With designed pinning scheme, the synchronization problem of NCRDNNs is further discussed and a sufficient condition for pinning synchronization is also established. Finally, two numerical examples are given to verify the correctness and effectiveness of the theoretical results.

9:40-10:00 **TueA09-6**

On Memristor-Based Impulsive Neural Networks with Time-Delay

Bin Hu Huazhong Univ. of Science and Tech.
Zhihong Guan Huazhong Univ. of Science and Tech.
Zhiwei Liu Huazhong Univ. of Science and Tech.
Xiaowei Jiang Huazhong Univ. of Science and Tech.
This paper studies a group of interconnected memristor-based impulsive neural networks (MINNs) with time-delay and its synchronization mechanism. Due to the impulsive and switching mode, interconnected MINNs are mathematically elaborated in the form of impulsive differential inclusions. Based on theories of Lyapunov functions and impulsive differential equations, asymptotic convergence of synchronization is evaluated for the interconnected MINNs, where the relationship of impulse to convergence rate are specified. It is shown that in addition to the Laplacian coupling, the impulse plays an essential role in the pursuit of synchronization. Simulation work is provided to verify the developed theoretical results.

TueA10 **Room10**
Fault diagnosis and fault-tolerant control (VI) **8:00-10:00**
Chair: Guoxing Lan Tsinghua Univ.
CO-Chair: Xuemin Tian China Univ. of Petroleum

8:00-8:20 **TueA10-1**

Comparison and Fusion of Various Classification Methods Applied to Aero-engine Fault Diagnosis

Guoxing Lan Tsinghua Univ.
AECC China Aero-Engine Control System Inst.
Nong Cheng Tsinghua Univ.
Qing Li Tsinghua Univ.
Aero-engine fault diagnosis plays a crucial role in safe operation and cost-effective maintenance. Early detection and isolation of component faults prior to failure of aero-engines is of utmost importance. This paper applied various classification methods, including Support Vector Machine (SVM), Decision Tree (DT), K-Nearest Neighbors (K-NN) and Linear Discriminant Analysis (LDA), to aero-engine component fault detection and isolation. These 4 various methods were tested under different circumstances involving large training samples, small training samples, few features, and noisy data. Comparison of accuracy and time efficiency was made among those methods, and a fusion algorithm of these 4 classification methods was proposed based on their training classification accuracy. The experiment results show that SVM has excellent accuracy performance but poor time efficiency while LDA performs well in both accuracy and time efficiency, and the fusion algorithm has higher accuracy than any single method.

8:20-8:40 **TueA10-2**

Robust Fault Estimation and Fault Tolerant Control for Lipschitz Nonlinear Brownian Systems

Xiaoxu Liu Northumbria Univ.
Zhiwei Gao Northumbria Univ.
Aihua Zhang Bohai Univ.
This paper investigates robust fault estimation and fault tolerant control problems for stochastic Lipschitz nonlinear systems subject to Brownian motions, unexpected faults and unknown inputs. Augmented system approach and unknown input observer are integrated to produce robust estimates of the means of the faults and the full system states simultaneously. Based on the well-designed fault estimation scheme, a robust fault tolerant control strategy is proposed to compensate faults, stabilize the closed loop system, and eliminate the effects of unknown inputs. Sufficient conditions are presented in terms of linear matrix inequalities for the overall closed-loop system composed of both states and error dynamics to guarantee the stability and robustness of the system. Furthermore, the systematic design procedure for the robust fault estimation and fault tolerant control scheme is addressed. Finally, simulation on a single joint robotic model is illustrated to validate the suggested methodologies.

8:40-9:00 **TueA10-3**

Sensitive Measuring Points Analysis of Fault Vibration Signal of Wind Turbine Gearboxes Based on Resonance-Based Sparse Signal Decomposition

Wentao Huang Harbin Inst. of Tech.
Zhiqiang Li Harbin Inst. of Tech.
Hongjian Sun Harbin Inst. of Tech.
Hongyin Dou Harbin Inst. of Tech.
Weijie Wang Harbin Inst. of Tech.
Wind turbine gearboxes, as the key components of current wind power equipment, are crucial hubs connecting the main shaft to the generator. The internal structure and force of wind turbine gearboxes are complex especially when they are working under various conditions and alternating loads, which can easily result in fault. Therefore, condition monitoring and fault diagnosis of wind power gearboxes are very important to ensure the reliability of the wind power equipment operation. Currently, the structure of wind turbine gearboxes is mainly composed of primary planet transmission and secondary parallel shaft gear transmission. Therefore, once faults occur in planetary gears, transfer paths of the fault vibration signals are time-variant, imposing great challenges to fault diagnosis of wind turbine gearboxes. Meanwhile, due to the influence of transfer paths, the signal sensitivities of diverse measuring points are different, so research on the sensitive measuring points in favor of obtaining fault information is critical to improve the accuracy of fault diagnosis based on vibration signals. Firstly, this paper utilizes the adaptive resonance-based sparse signal decomposition to decompose vibration signals of wind turbine gearboxes, and extracts high-resonance components, low-resonance components and redundant components. The fault feature information obtained from the study is mainly contained in the high-resonance components. Then, the paper uses the relative kurtosis index to analyze and evaluate the high-resonance components of each measuring point. And the concept of relative kurtosis which is used to evaluate the sensitivity of measuring points is proposed. Finally, the locations of sensitive measuring points are

determined. The method is applied to the diagnosis of planet carrier bearing outer fault and planetary gear localized spalling fault in a planetary speed-increasing gearbox, which indicates the validity of the research results.

9:00-9:20 **TueA10-4**

Batch Process Monitoring Based on Batch Dynamic Kernel Slow Feature Analysis

Hanyuan Zhang China Univ. of Petroleum
Xuemin Tian China Univ. of Petroleum

The traditional nonlinear dynamic batch process monitoring approaches are unable to extract the underlying driving forces of batch process. In this paper, a novel batch process monitoring method based on batch dynamic kernel slow feature analysis (BDKSFA) is proposed not only to capture nonlinear and dynamic characteristics but also to extract the underlying driving forces. The three-way data matrix is first unfolded and normalized and then rearranged into three-way matrix again. In order to contain stochastic variations and deviations among batches, the total average kernel matrix is computed as an average of I batch average kernel matrixes, each of which is also an average of I kernel matrixes for each batch. Based on the slow features extracted from BDKSFA model, two monitoring statistics are constructed to detect batch process fault. The simulation results obtained from the benchmark fed-batch penicillin fermentation process demonstrate the superiority of the developed method in terms of fault detection performance.

9:20-9:40 **TueA10-5**

Fire Detection Method of Mine Belt Conveyor Based on Artificial Bee Colony Algorithm

Yuxin Liu Xi'an Univ. of Science and Tech.
Xianmin Ma Xi'an Univ. of Science and Tech.

The detection of fire on mine belt conveyor is very difficult in traditional image processing method, a novel image processing method is proposed in this paper, which integrates Artificial Bee Colony algorithm, gray scale morphology and information entropy. In Artificial Bee Colony algorithm the best threshold is approached in parallel via the division of labor,cooperation and information sharing of employed bees,onlookers and scouts. The fitness function of Artificial Bee Colony algorithm is designed by 2D maximum entropy method and fire image thresholds are regarded as nectar source. In order to reduce image noise the close operation is applied based on gray scale morphology. Theory analysis and simulation experimental results indicate that the proposed method is useful to detect fire of mine belt conveyor in complex coal under ground environment.

9:40-10:00 **TueA10-6**

Observer-based Scheme for Robust Fault Estimation of a Class of Nonlinear Discrete Systems

Guannan He Beijing Univ. of Chemical Tech.
Yang Liu Beijing Automatic Engineering School
Jing Zhang Beijing Univ. of Chemical Tech.

In this paper, we investigate the problem of robust fault estimation for a class of nonlinear discrete-time Lipschitz systems. A new fault estimation strategy is proposed based on the unknown input observer frameworks and the prescribed robust disturbance attenuation level is achieved to guarantee the convergence of the estimation error systems. Sufficient conditions for the existence of robust fault estimation observer is derived in terms of linear matrix inequalities (LMIs), which can be solved using the convex optimization techniques. Finally, a numerical example is given to demonstrate the effectiveness of the proposed approach.

TueA11 Room11
Neural networks (IV) 8:00-10:00

Chair: Shejie Lu Univ. of Science and Tech.
CO-Chair: Gang Chen Hunan Univ. of Tech.

8:00-8:20 **TueA11-1**

Visual Attention Based on Long-Short Term Memory Model for Image Caption Generation

Shiru Qu Northwestern Polytechnical Univ.
Yuling Xi Northwestern Polytechnical Univ.
Songtao Ding Northwestern Polytechnical Univ.

Image caption generation becomes a raising topic in computer vision and artificial intelligence. In order to solve the problem of stiff description, we intend to extract richer features using convolutional neural network (CNN). A neural and probabilistic framework has been proposed consequently which combines CNN with a special form of recurrent neural network (RNN) to produce an end-to-end image captioning. We use a model that takes advantage of word to vector to encode the variable length input into a fixed dimensional vector. Considering the description of the object in an image is not specific enough, we introduce an attention mechanism through visualization to show how the model is able to fix its gaze on salient objects. We validate our model on three benchmark datasets and get great performance by using standard evaluation metrics.

8:20-8:40 **TueA11-2**

Sufficient and Necessary Conditions for globally stability of the trivial solutions of Genetic Regulator Networks with mixed time-delays

Fengxia Tian Hubei Univ. of Science and Tech.
Huazhong Univ. of Science and Tech.
Shejie Lu Hubei Univ. of Science and Tech.
Xiaoxin Liao Hubei Univ. of Science and Tech.
Guopeng Zhou Hubei Univ. of Science and Tech.

In the paper, the globally stability for Genetic Regulator Networks with mixed time-delays is studied. By using derivative mean value theorem, two sufficient and necessary conditions for globally unformly asymptotic stability and global exponential stability of the trivial solutions of the GRNs with mixed time-delays are proposed. Finally, a simple example is given to demonstrate the correctness of the proposed results.

8:40-9:00 **TueA11-3**

The Difference Learning of Hidden Layer between Autoencoder and Variational Autoencoder

Qingyang Xu Shandong Univ.
Zhe Wu Shandong Univ.
Yiqin Yang Shandong Univ.
Li Zhang Shandong Univ.

Autoencoder is an excellent unsupervised learning algorithm. However, it can not generate kinds of sample data in the decoding process. Variational autoencoder is a typical generative adversarial net which can generate various data to augment the sample data. In this paper, we want to do some research about the information learning in hidden layer. In the simulation, we compare the hidden layer learning of hidden layer in conventional autoencoder and variational autoencoder.

9:00-9:20 **TueA11-4**

Improved Results on Passivity Analysis of Neural Networks with Time-varying Discrete and Distributed Delays

Xin Wang Hunan Univ. of Tech.
Key Laboratory for Electric Drive Control and Intelligent Equipment of Hunan Province
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Changsheng Luo Hunan Univ. of Tech.
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This paper focus on the problem of passivity of neural networks in the presence of time-varying discrete and distributed delays.By constructing a novel and suitable augment Lyapunov-Krasovskii functional(ALKF) and employing some useful inequality formula, especially generalized free-weighting-matrix(GFWM) approach, improved sufficient conditions for checking the passivity of the neural networks are established. Based on three numerical examples, the advantages of our results are illustrated through the comparison of maximal admissible delay bounds.

9:20-9:40 **TueA11-5**

Pixel-based Airplanes Segmentation in Remote Sensing Image

Mingjian Liu Beijing Inst. of Tech.
Zhifeng Gao Beijing Inst. of Tech.
Sun Li Beijing Inst. of Tech.
Zhiqiang Zhou Beijing Inst. of Tech.
Bo Wang Beijing Inst. of Tech.

In this paper, we present a novel pixel-based airplane segmentation method from remote sensing images by combining Single Shot MultiBox Detector (SSD) and Single-layer Cellular Automata (SCA). SSD is a kind of deep ConvNet for object detection while SCA is a saliency detection method via Cellular Automata. First, we obtain detection result where every airplane is boxed by a rectangle through the SSD model. The last two conventional layers in original SSD are removed in order to fit the small objects of remote sensing (RS) image. Then the result is processed via singlelayer Cellular Automata to achieve pixel-based segmentation. The experiments demonstrate that our approach is efficient and works well for automatic airplane segmentation in RS image.

9:40-10:00 **TueA11-6**

A New Feedback-Added Obstacle Avoidance Scheme for Motion Planning of Redundant Robot Manipulators

Dongsheng Guo Huaqiao Univ.
Zhaozhu Su Huaqiao Univ.
Sibo Sun Huaqiao Univ.
Xinjie Lin Huaqiao Univ.
Qingping Liu Huaqiao Univ.

How to avoid obstacle is one of the fundamental issues in motion planning of redundant robot manipulators. In this paper, a new scheme based on the pseudoinverse-type formulation is developed and investigated for obstacle avoidance of redundant robot manipulators. For this obstacle avoidance scheme, the feedback is added to guarantee the precision of Cartesian error. Theoretical results are then given to show its excellent property. Simulation results based on the PA10 robot manipulator with point and window-shaped obstacles are illustrated to further substantiate the efficacy of the presented feedback-added obstacle avoidance scheme for motion planning of redundant robot manipulators.

TueA12 Room12
Signal processing (VII) (Chinese) 8:00-10:00

Chair: Jiawei Chen Chongqing Univ.
CO-Chair: Xiaoping Shi Harbin Inst. of Tech.

8:00-8:20 **TueA12-1**

Bearings-Only Tracking with a Gaussian-Sum Based Ensemble Kalman Filter

Haonan Jiang Xi'an Jiaotong Univ.
Yuanli Cai Xi'an Jiaotong Univ.

The paper presents a novel nonlinear filtering algorithm called the Gaussian-sum ensemble Kalman filter (GSEnKF) for the bearings-only tracking problem. It extends the ensemble Kalman filter within a Gaussian-sum framework by using range-parameterized strategy. As a sequential Monte Carlo algorithm, it is not quite computationally demanding, whilst demonstrating better performance than conventional algorithms. Simulation results validate the effectiveness and robustness of the proposed algorithm.

8:20-8:40 **TueA12-2**

Research on heart sound digital water-marking based on heart sound wavelet

Xie-feng Cheng Jiangsu Province Engineering Lab of RF Integration & Micropackag
Nanjing Univ. of Posts and Telecommunications
You-xun Zhang Nanjing Univ. of Posts and Telecommunications
Pei-xi Gao Nanjing Univ. of Posts and Telecommunications
Bin Jiang Nanjing Univ. of Posts and Telecommunications
Chen-jun She Nanjing Univ. of Posts and Telecommunications

In the aspect of heart sound signal processing, the heart sound database copyright protection is very important. As a kind of special audio signal, there is no deep research on the heart sound watermark processing. This article first studies some basic characteristics of heart sound signal and the theory of digital watermarking technology , and then combined with the characteristics of heart sound signal, respectively using db5 wavelet and self-constructed heart sound wavelet embed three different watermarking (image, voice, and four corner code) into the heart sound signal. Based on the transparency, robustness and invisibility test experiment of the embedded watermark information and extracted watermark information, each type of watermarking are compared and analyzed quantitatively and qualitatively. The experimental results show that the four corner code watermarking of heart sound based on wavelet is more suitable for heart sound signal, the effective implementation of heart sound digital watermarking embedding and extraction. The embedded watermark information is not only better imperceptibility, but also larger energy, with strong practical value.

8:40-9:00 **TueA12-3**

Improved Iterative Contourlet Algorithm for Astronomical Image Denoising

Xiaoping Shi Harbin Inst. of Tech.
Jie Zhang Harbin Inst. of Tech.
Yi Zhu Harbin Inst. of Tech.

Research on compressed sensing (CS) reconstruction algorithm. To slove the problem of lower convergence speed in compressed sensing iterative algorittm (ICWF) based on contourlet wiener filtering, a Dai-Yuan linear search step size is used to adjust the convergence speed in this paper, and then an improved ICWF algorithm is proposed. At the same time, the proposed algorithm is applied for astronomical image denoising. Number experimental results demonstrate taht the proposed algorithm is superior to the traditional ICWF algorithm in terms of convergence speed and visual quality, meanwhile which can effectively protect the astronomical image detail information.

9:00-9:20 **TueA12-4**

Study on Multi-pulse Long Range Laser Ranging System

Chunyang Wang Changchun Univ. of Science and Tech.
Li Yu Changchun Univ. of Science and Tech.
Hongwei Shi Changchun Univ. of Science and Tech.
Yanxin Yu Changchun Univ. of Science and Tech.
Xuelian Liu Changchun Univ. of Science and Tech.
Longmin Li Changchun Univ. of Science and Tech.

In order to extract the weak signal in the long distance pulsed laser ranging, this paper uses the AD sampling rate of 1GHZ sampling rate to digitally collect the echo signal. According to the non - correlation of the noise, using the multi - pulse coherent superposition method, the useful signal strength is and then the signal-to-noise ratio can be improved. At the same time, the method of wavelet singular value filtering is used to process the accumulated signal to improve the measurement precision and realize the control system by FPGA and other hardware. In this paper, the measurement targets at different distances are tested, and the results show that the method can greatly improve the measurement accuracy of the laser ranging system.

9:20-9:40 **TueA12-5**

Research on Feature Extraction and Pattern Recognition of Acoustic Signals Based on MEMD and Approximate Entropy

Hao Zhang Kunming Univ. of Science and Tech. Measurement Control and Optimization Laboratory
Zao Feng Kunming Univ. of Science and Tech. Measurement Control and Optimization Laboratory
Jinhui Zou Kunming Univ. of Science and Tech. Measurement Control and Optimization Laboratory

The non-stationary character of the acoustic signals and the overlapping issue of blockage features can be challenging for condition detection of the underground water supply pipes. Aiming to solve the above problems, a method including feature extraction and pattern recognition based on multivariate empirical mode decomposition (MEMD) and approximate entropy was proposed in this paper. Firstly, the multichannel acoustic signals which were collected from water supply pipes under working conditions were decomposed by using MEMD, a series of intrinsic mode function (IMF) of each signal are obtained. Then, according to the criterions combining correlation coefficient and the variance contribution rate, the IMF components which comprise the main information of the pipe condition are selected; the approximate entropy of the selected IMF components are calculated to construct the feature vectors. Finally, the support vector machine (SVM) is used to classify and identify the pipe conditions. Experimental results have shown that the proposed method is superior to the EMD method in processing multichannel data, and it is more accurate in detecting the degree of blocking.

9:40-10:00 **TueA12-6**

Asynchronous Motor Imagery Detection Based on a Target Guided Sub-band Filter Using Wavelet Packets

Yujuan Sun Xi'an Jiaotong Univ.
Zuren Feng Xi'an Jiaotong Univ.
Jun Zhang Xi'an Jiaotong Univ.
Qing Zhou Xi'an Jiaotong Univ.
Jing Luo Xi'an Jiaotong Univ.

For an asynchronous system based on brain-computer interface (BCI), detecting the occurrence of motor imagery by electroencephalogram (EEG) signals is the basis but also a challenge, due to the complex and non-stationary characteristics of EEG signals. This paper employs a filtering method which uses a the target guided sub-band filter combined with an energy detector for asynchronous motor imagery detection. The proposed filter in the wavelet packet transform domain uses a prior knowledge of the motor imagery and also applies the idea of background suppressing. It can pass the frequency bands that are more significant in the motor imagery signal than in the noise. Experiment demonstrated that the proposed method was reliable for practical use with an equal error rate (EER) of about 9% and a mean response time of 4.36s.

TueA13 **Room13**
Signal processing (VI) **8:00-10:00**

Chair: Yanan Tian Northeastern Univ.
CO-Chair: Hongwei Lei Northeastern Univ.

8:00-8:20 **TueA13-1**

Sparse Target Detection of Pulse Doppler Radar Based on Two Dimensional Iterative Hard Thresholding Algorithm

Beiyi Liu Akita Prefectural Univ.
Guan Gui Nanjing Univ. of Posts and Telecommunications
Shin-ya Matsushita Akita Prefectural Univ.
Li Xu Akita Prefectural Univ.

One-dimensional (1D) compressive sensing is often adopted in traditional sparse target detection of pulse Doppler radar. However, the 1D sparse target detection problem often requires large computational memory due to large measurement matrix. To solve this problem, this paper proposes a two-dimensional iterative hard thresholding algorithm (2D-IHT) for CS-based pulse Doppler radar to directly detect sparse targets. Compared with 1D CS frame algorithm, our proposed method can significantly reduce the memory requirement. Simulation results are provided to confirm the performance of the proposed method.

8:20-8:40 **TueA13-2**

Adaptive Equalization for Logging Telemetry Based on OFDM

Yuntao Sun Chinese Academy of Sciences
Qingyun Di Chinese Academy of Sciences
Wenxuan Chen Chinese Academy of Sciences
Wenxiu Zhang Chinese Academy of Sciences
Yongyou Yang Chinese Academy of Sciences

In order to solve the equalization of the logging telemetry based on the Orthogonal Frequency Division Multiplexing, a self-adaptive channel equalization method is proposed and realized. After analysis of telemetry system, through transform of the system structure, according to the characteristics of frame operation, the channel Signal Noise Ratio measurement and real-time dynamic update method are realized, it ensure the logging telemetry no interruption of the premise and real-time dynamic adjustment of the rate according to the channel change. This method enhances the reliability and stability of the system, and improves the efficiency of logging operation.

8:40-9:00 **TueA13-3**

A Blind Guidance System Based on GCADSF Image Enhancement and Music Display

Yanan Tian Northeastern Univ.
Hongwei Lei Northeastern Univ.
Jinghong Li Northeastern Univ.

There are some problems in the conventional blind guidance systems, such as massive mapping data, low mapping efficiency and simple sound coding. And they are easily affected by noise. These make the blind difficult to use the system. To solve these problems, a system is presented based on GCADSF image enhancement and music display.

GCADSF model uses an exponential function which monotonically decreases with the gradient module to control the diffusion in the vertical direction of the image gradient. So it protects the image details as the edges are enhanced and the noise is filtered. The enhanced image is mapped into electronic music. Experimental results showed that the system has higher recognition rates for the blind's recognizing the image contents.

9:00-9:20 **TueA13-4**

Design and Implementation of Bus Lane Video Image Monitor System Based on FPGA

Jinghong Li Northeastern Univ.
Yanan Tian Northeastern Univ.
Xiujian Xu Northeastern Univ.

With the development of social economy, there are more vehicles per person in China. So traffic congestions and jams are becoming serious. The priorities of development for bus lane can relieve the traffic pressure to a certain extent. But social vehicles illegal occupation of the bus lane has become a new traffic problem. To solve this problem, a bus lane video image monitor system based on FPGA is presented in this paper. The system uses Genesys development board of Digilent as the hardware platform to monitor the road environment with CMOS image sensor. VGA monitor displays the environment. When social vehicles drive into the bus lane, we will label the illegal invasion of vehicles with the rectangle on the monitor in order to prompt monitoring staff to deal with it.

9:20-9:40 **TueA13-5**

Multi-model Robust Weighted Fusion Steady-state Kalman Estimators with Uncertain-covariance Linearly Correlated White Noises

Xuemei Wang Heilongjiang Univ.
Heilongjiang Coll. of Business and Tech.
Zili Deng Heilongjiang Univ.

For multi-model multisensor systems with uncertain covariance linearly correlated white noises, the design problems of the robust weighted fusion steady-state Kalman estimators (predictor, filter, smoother) are addressed. According to the minimax robust estimation principle, applying Lyapunov equation approach, a unified direct design approach to obtain the local and three weighted fusion robust steady-state Kalman estimators of the common state is presented based on the steady-state Kalman filtering theory, where the robust Kalman filter and smoother are designed based on the robust Kalman predictor. The three weighted fusers include that the fusers weighted by matrices, scalar and diagonal matrices. It is proved that their actual estimation error variances are guaranteed to have the corresponding minimal upper bounds. Their accuracy relations are also proved. Simulation results are given to verify the robustness and robust accuracy relations.

9:40-10:00 **TueA13-6**

The Design and Implementation of a New Magnetic Field Stimulation Device

Hongwei Lei Northeastern Univ.
Yanan Tian Northeastern Univ.
Xu Wang Northeastern Univ.

We have developed a new type of magnetic field generation and stimulation device based on the principle of electromagnetic induction for the needs of the research on biological signals base on some magnetic field stimulation in our laboratory. The design can output a single or continuous low frequency pulse magnetic signals, the maximum magnetic induction intensity in the magnetic stimulation coil center can reach more than 10T. The biological cells produce real-time response with the stimulating of themag+netic induced curren.

TueA14 **Room14**
Robot control (II) **8:00-10:00**
Chair: Lianzheng Ge State Key Laboratory of Robotics and System (HIT)
CO-Chair: Changyou Li National Univ. of Defense Tech.

8:00-8:20 **TueA14-1**

Local Passing-ball Tactics Based on a Keepaway Algorithm

Qian Zhao Nanjing Univ. of Posts and Telecommunications
Zhiwei Liang Nanjing Univ. of Posts and Telecommunications
Fang Fang Nanjing Univ. of Posts and Telecommunications
Chenxi Xia Nanjing Univ. of Posts and Telecommunications
Zhoufeng Huang Nanjing Univ. of Posts and Telecommunications
Zhouwu Xu Nanjing Univ. of Posts and Telecommunications

This paper proposes a passing method based on reinforcement learning to realize multi.agent cooperation strategy under the platform of Keepaway. In this paper, a Keepaway model is built in Robocup3D simulation game using the Sarsa(λ) algorithm based on a linear function approximation. We set the time to keep the ball as the reward, and keep training to get the action, making the team hold the ball as long as possible. In this training model, the strategy of soccer robots is implemented in team collaboration mechanism, include PASS and GETOPEN strategy. The experimental results demonstrate the effectiveness of our methods.

8:20-8:40 **TuA14-2**

Feedforward Control Based on Fourier Series Trajectory Fitting Method for Industrial Robot

Lianzheng Ge State Key Laboratory of Robotics and System (HIT)
Jian Chen Wuhu Robot Tech. Research Inst. CO.LTD
Ruifeng Li State Key Laboratory of Robotics and System (HIT)

Feedforward control is widely used in industrial robot as a valid control method. High speed motion will bring the vibration for robot with flexible joints, which will affect the dynamic performance of robot. The residual vibration character is analyzed for palletizing robot using feedforward control method in this paper. Considering the vibration suppression constraints polynomials fitting method is used to compute the discrete data of trajectory. Meanwhile, the discrete trajectory points are fitted based on Fourier series function. The trajectory fitted model is optimized using genetic algorithm, and the high frequency harmonics included in feedforward drive torque is decreased under the premise of guaranteeing fitting precision and boundary continuity. Simulation results verified the rightness of the proposed trajectory planning algorithm.

8:40-9:00 **TuA14-3**

Decoupling Control for Parallel Robot Based on Equivalent-Input-Disturbance Approach

Pingping Lin Central South Univ.
Jinhua She China Univ. of Geosciences
Hubei Key Laboratory of Advanced Control and Intelligent Automation
Tokyo Univ. of Tech.
Min Wu China Univ. of Geosciences
Hubei Key Laboratory of Advanced Control and Intelligent Automation
Qianqiu Li Central South Univ.

This paper discusses the problem of posture control for a parallel robot. The parallel robot features multiple variables and large nonlinearities. The control accuracy is strongly affected by the parameters which are coupled with each other, and by exogenous disturbances. A decoupling control strategy is presented based on the equivalent-input-disturbance (EID) approach to improve control performance. First, decoupling control is used to eliminate the main coupling effect between multiple variables. Then, the EID method is used to further improve decoupling effect and suppress the external disturbances. Simulation results show that the control strategy is effective for the decoupling control of parallel robot.

9:00-9:20 **TueA14-4**

Active Compliance Control for a Hydraulically-Actuated Articulated Robotic Leg

Changyou Li National Univ. of Defense Tech.
Honglei An National Univ. of Defense Tech.
Hongxu Ma National Univ. of Defense Tech.
Qing Wei National Univ. of Defense Tech.

This paper focus on the modelling and control of a hydraulically-actuated biologically-inspired articulated robotic leg. The leg has two hydraulically-actuated degrees of freedom (DoF), the hip and knee joints, and a passive spring DoF, the ankle joint. After a brief description of the prototype leg, the paper developed a nonlinear model of the leg, including its kinematics and dynamics. Subsequently, an actively compliant control architecture based on outer virtual compliant leg model and inner torque controller was designed to achieve a spring-damper like touchdown dynamics behavior. Lastly, both a Pushdown experiment and a Dropdown experiment were carried to verify the designed controller. The result confirmed that a hydraulically-actuated robot articulated leg can successfully emulate virtual passive components through proper mechanical design and actively compliant control under dynamic situations.

9:20-9:40 **TueA14-5**

Variable Stiffness Force Tracking Impedance Control Using Differential-less Method

Weifeng Lu Tsinghua Univ.
Houde Liu Tsinghua Univ.
Xiaojun Zhu Beijing Univ. of Posts and Telecommunications
Xueqian Wang Tsinghua Univ.
Bin Liang Tsinghua Univ.

As robot manipulators are widely used in contact with the environment, force tracking control is becoming more and more important. Variable stiffness impedance control can achieve force tracking by adjusting the stiffness of robot manipulators to get adapted to various environments just like human control to contact force. Most of the variable stiffness forces tracking impedance control methods need to obtain contact force differential information, but in fact there are high-frequency noise interferences in force sensor resulting in a big error of force differential. In order to make the strategy more feasible in practice, this paper proposes a differential-less method of variable stiffness force tracking impedance control. Analogously, the proposed control scheme achieves a contact force regulation control without force differential information. Moreover, the stability of the proposed control scheme is proved with a quadratic Lyapunov function. Extensive simulation studies with a two-degree-of-freedom robot manipulator are conducted to demonstrate the validity of the proposed method.

9:40-10:00 **TueA14-6**

A Program about Power Management System for Service Robot

Dehong Cong Northeastern Univ.
Xingang Yan Northeastern Univ.
Jia Chen Northeastern Univ.

This paper comes up with a program of power management system for service robot. Based on the structure of service robot, the power management system could be divided into seven parts: power path selector, BMS, wireless power receiver, power protection, four-switch Buck-Boost convert, Buck to DC +5V, LDO to DC+3.3V. A diagram is given to show the relationship between the various parts. Besides the diagram of the structure of power management system, concrete description of each part is given to make it easy to understand all functions the power management system should have.

TueA15 **Room15**
Robot control (III) **8:00-10:00**
Chair: Wei Gao Jilin Univ.
CO-Chair: Yao Yao Shanghai Jiao Tong Univ.

8:00-8:20 **TueA15-1**

Aircraft Longitudinal Decoupling: a Singular Perturbation Approach

Shangqiu Shan National Univ. of Defense Tech.
Zhongxi Hou National Univ. of Defense Tech.
Wenkai Wang National Univ. of Defense Tech.

Aircraft longitudinal dynamics is approximated by short-time mode and phugoid mode from experience. This paper provides a rigorous mathematical method based on the singular perturbation theory to deal with this decoupling problem. The longitudinal decoupling and singular perturbation are firstly introduced. The longitudinal equations are normalized and transformed into a canonical form to extract the perturbation coefficient. Thus the entire dynamics model is partitioned into boundary-layer equations and slow equations according to singular perturbation theory, which presents a proof to the experience method. The simulation results show that the proposed decoupling approach is sufficiently excellent to approximate the underlying model both in time domain and frequency domain.

8:20-8:40 **TueA15-2**

Configuration Dependent Vibration Controllability of Flexible Base Mounted Robot Manipulators

Zhaohui Jiang Hiroshima Inst. of Tech.

This paper addresses the issues of base vibration control of flexible base mounted robot systems. The system is considered as that the flexible base is not equipped with actuators, whereas the manipulator is fully actuated. The only way to suppress vibration of the base is by using the actuators of the manipulator. In order to evaluate controllability and further investigate the easiness and hardness for the control of base vibration, a controllability matrix is defined using a nominal state equation of the system, and controllability measure is proposed based on the controllability Gramian and state equation. Case studies are presented to demonstrate configuration dependent controllability. Uncontrollable configurations in the joint space are identified. Base vibration control simulations are carried out on a system consisting of a two-link robot manipulator mounted on a 2 DOF flexible base to illustrate different control performances of the system at different configurations of the manipulator.

8:40-9:00 **TueA15-3**

Kinematic accuracy analysis of robot based on Local POE

Sheng Wang Nanjing Univ. of Posts and Telecommunications
Jingjin Shen Nanjing Univ. of Posts and Telecommunications
Fengyu Xu Nanjing Univ. of Posts and Telecommunications
Guoping Jiang Nanjing Univ. of Posts and Telecommunications

Linear kinematics model based on POE formula has been widely applied to the error compensation of robot. In this paper, we employed a calibration model in the Local POE frame where all the joint axes are repressed in their respective local frames. The major advantage of this formula is that the local coordinate frames can be arbitrarily assigned onto their corresponding links. For analyzing the applicability of linear model, this paper builds envelope model of error distribution using linear and second-order error model. Meanwhile, this paper analyzes Kuka Youbot robot's error distribution through the established model. The results show that the second-order model could be neglected in comparison with first-order model, when nominal error values of the joint angles are less than 0.1 degree. Hence, linear error model is enough precise in most real applicable environments.

9:00-9:20 **TueA15-4**

Extension of Virtual Decomposition Control to Cooperative Carrying of Dual-arm Robots in Free Motion

Xueqian Wang Tsinghua Univ.
Shenzhen Key Lab of Space Robotic Tech. and Telescience
Bo Xia Shenzhen Key Lab of Space Robotic Tech. and Telescience
Gang Li Tsinghua Univ.
Houde Liu Shenzhen Key Lab of Space Robotic Tech. and Telescience
Bin Liang Tsinghua Univ.

This investigation is to deal with the internal force control issue for cooperative carrying of dual-arm robots in free motion using virtual decomposition control. According to the virtual decomposition control principle, the entire system of the dual-arm robot in free motion for cooperative carrying is virtually decomposed into two chain subsystems and an object subsystem. The motion control problem of this entire system is converted into that of subsystems in which the internal force control of the object is performed. On the basis of establishing the mathematical model of the entire system, kinematics and dynamics of every subsystem are calculated. A virtual decomposition controller of each subsystem is designed, and this controller and the corresponding subsystem structure a control subsystem of this robot. All subsystem controllers constitute the controller of the entire robot system, and the combination of this controller and the robot system is the virtual decomposition control system of this robot. Stability analysis of the devised robot virtual decomposition control system is accomplished analyzing the virtual stability of each control subsystem by way of the virtual power flow related to the products of velocities errors and force errors. Finally, the virtual decomposition control system of the dual-arm robot to carry an object in free motion is simulated. Simulation results show that the virtual decomposition control system is stable and effective.

9:20-9:40 **TueA15-5**

Research on Sliding Mode Control for Robotic Manipulator Based on RBF Neural Network

Wei Gao Jilin Univ.
Jianbo Shi Jilin Univ.
Wenqiang Wang Jilin Univ.
Yue Sun Jilin Univ.

In this paper, a new RBF based sliding mode controller is proposed for the joint trajectory tracking of robotic manipulators with uncertainties and disturbances. A RBF neural network is employed to approximate the nonlinear uncertainties in the mode, adaptive laws of the parameters are established, and the approximation error is compensated by designing a sliding mode controller, in which a generalized error factor is introduced. As a result, the chattering is eliminated and error performance is improved. The stability of closed-loop system and the asymptotic convergence of tracking error are guaranteed based on the Lyapunov theory. Simulation results demonstrate the effectiveness and robustness of the proposed control strategy.

9:40-10:00 **TueA15-6**

A motion simulation for Dual-arm robot based on the state-space method

Yao Yao Shanghai Jiao Tong Univ.
Zhengxin Weng Shanghai Jiao Tong Univ.

The research and development of dual-arm robot is a new direction of the robot industry development. Relative to the single arm robot, it not only can greatly enhance the adaptability for complex work, but also can improve the efficiency of work space [1] . In this paper, the kinematics equation of the end of the arm is deduced using the D-H method. Then the control algorithm based on the state space method is used to prevent movement interference in the process of arm movement. Finally, the displacement curve of end of arm can be got through the simulation of MATLAB using control algorithm. The effectiveness of the control algorithm can be judged.

TueA16 **Room16**
Electric vehicles and intelligent transportation (II) **8:00-10:00**
Chair: Rong Long Huazhong Agricultural Univ.
CO-Chair: Xiaomin Zhao Hefei Univ. of Tech.

8:00-8:20 **TueA16-1**

Design of Power Allocation Strategy and Passivity Based Controller for Multiple Module Fuel Cell Hybrid Power System

Rong Long Huazhong Agricultural Univ.
Zhangwen Yin Wuhan Univ. of Tech.
Liyan Zhang Wuhan Univ. of Tech.
Qihong Chen Wuhan Univ. of Tech.
Shuhai Quan Wuhan Univ. of Tech.

In order to improve reliability and efficiency of single fuel cell hybrid power system, a system composed of multiple fuel cell modules and supercapacitor is proposed, and the power allocation strategy based on passive control is developed according to the efficiency curve of the fuel cell. In this control strategy the multiple working modes are analyzed and the output powers of fuel cell and supercapacitor are allocated. So this hybrid power system can follow the requested load power rapidly and work in high efficiency area as far as possible. The simulation results demonstrate that the fuel cells of the hybrid power system can work in high efficiency area, and the complex and variable load power can be satisfied rapidly.

8:20-8:40 **TueA16-2**

Analysis of the chaotic characteristics of traffic flow under congested traffic condition

Yongfu Li Chongqing Univ. of Posts and Telecommunications
Yadong Liu Chongqing Univ. of Posts and Telecommunications
Hao Zhu Chongqing Univ. of Posts and Telecommunications

In this paper, the chaotic characteristics of traffic flow under congested traffic condition are analyzed quantitatively based on the measured data of urban expressway. To this end, multiple measures, i.e., speed, occupancy, and flow, are used to evaluate the state of traffic flow. Then, the chaotic characteristics of traffic flow associated with the speed,

occupancy, and flow are identified using the maximum Lyapunov exponent. In addition, the phase space of speed, occupancy, and flow are reconstructed based on the C-C algorithm, respectively. Numerical experiments are conducted using the data from PeMS system. Results from numerical experiments verify the chaotic characteristics of congested traffic flow in terms of the local features among the speed, occupancy, and flow in phase space.

8:40-9:00 **TueA16-3**

Collision Avoidance Adaptive Robust Control for Autonomous Vehicles: Motivated by Swarm Properties

Xiaomin Zhao Hefei Univ. of Tech.
Han Zhao Hefei Univ. of Tech.
Ye-Hwa Chen Georgia Inst. of Tech.
Fangfang Dong Hefei Univ. of Tech.

The control design problem for uncertain autonomous vehicle platoon system is considered. The uncertainty is possibly nonlinear and time-varying. Subject to the condition of collision avoidance, the original dynamical model for autonomous vehicle platoon system is designed with bounded state. After a state transformation, the bounded state is converted into a globally unbounded one. The swarm properties are incorporated into the system as ideal platoon performance. By treating the performance as constraint, the closed-form expression of the constraint force is obtained. An adaptive law is proposed to estimate the unknown parameters. Based on the constraint force and adaptive law, a class of adaptive robust control for each following vehicle in the platoon is proposed. Three major system performances are guaranteed: (i) collision avoidance, (ii) stable formation and (iii) global behavior.

9:00-9:20 **TueA16-4**

State of Charge and parameters estimation for Lithium-ion battery using Dual Adaptive Unscented Kalman Filter

Hongzhen Guo Univ. of Jinan
Zhonghua Wang Univ. of Jinan
Yueyang Li Univ. of Jinan
Dongxue Wang Univ. of Jinan
Guangying Wang Univ. of Jinan

In this paper, a novel method to estimate SOC of the vehicles and parameters of the equivalent model based on the dual adaptive unscented Kalman filter(DAUKF)is proposed. The UKF is used to estimate parameters of the battery model while another AUKF is used to estimate SOC of the battery through the real-time measurement data. The proposed approach is verified by simulation and experiments operated on the battery, the result shows that the proposed method can improve the accuracy as well as it has better robustness.

9:20-9:40 **TueA16-5**

Nonlinear Model Predictive Slip Control Based on Vertical Suspension System for An In-Wheel-Motored Electric Vehicle

Yan Ma Jilin Univ.
Chao Lu Jilin Univ.
Haiyan Zhao Jilin Univ.
Ming Hao The Chinese People's Liberation Army 93175 Troops

In order to improve the safety and dynamic performance of electric vehicles, prevent the wheel from getting locked or slipped when braking or accelerating, and maximize the longitudinal force on low-friction coefficient roads, it is necessary to control slip ratio of each wheel in the stable region. Combining the theory of the nonlinear model predictive control (NMPC), this paper presented a slip controller based on vertical suspension system for the electric vehicle equipped with four in-wheel motors. The model of vertical suspension system, which is established by adding the vertical force analysis on basis of the longitudinal motion model, is a four degrees of freedom model. By making the slip ratio of each tire individually converge to the optimal longitudinal slip ratio within a very short response time, the proposed controller can keep the traction or braking torque of each wheel in a reasonable level, by considering constraints of the In-wheel motor and the slip ratio. The effectiveness of the proposed controller is verified in the environment of Simulink, and the longitudinal slip ratio of each tire can catch the optimal longitudinal slip ratio in short time.

9:40-10:00 **TueA16-6**

Study on GNSS/DR Integrated Navigation

Jingsen Wang Guangzhou Maritime Univ.
Ming Bai Guangzhou Maritime Univ.
Yuping Huang Guangzhou Maritime Univ.
Zhenchao Chen Guangzhou Maritime Univ.
YiyiZhan Guangzhou Maritime Univ.
Xinhai Xia Guangzhou Maritime Univ.

When a vehicle passes through a blind area such as a high-rise building, a tunnel or an overpass, it is prone to satellite signals being poor or interrupted, and DR (Dead Reckoning) has autonomous navigation capability and is not influenced by the environment. However, DR navigation accuracy is rather low, due to the error will increase with time. Therefore, the GNSS(Global Navigation Satellite System) / DR integrated navigation system was studied. The integrated navigation can improve the navigation precision in the blind area of the satellite. The experimental results show that GNSS/DR integrated navigation is effective for improvement of accuracy compares to DR in the blind area of satellite.

TueA17 **Room17**

Modeling control and simulations of biological systems(I) **8:00-10:00**

Chair: Chao Liu Northeastern Univ.
CO-Chair: Sheng Hu Northeastern Univ. at Qinhuangdao

8:00-8:20 **TueA17-1**

EEG-based mild depression detection using multi-objective particle swarm optimization

Yan Guo Zhejiang Univ.
Haolan Zhang Zhejiang Univ.
Chaoyi Pang Zhejiang Univ.

This paper describes a mild depression detection method based on the EEG. Firstly, we present a comprehensible function to categorize volunteers by linear discriminant analysis (LDA). Then, a novel multi-objective particle swarm optimization (MOPSO) for depression detection is proposed, minimum the number of misclassification, minimize the internal distance and maximize the external distance are all included in the objectives of our model. Finally, the results of the experiment with 6 volunteers indicate that accuracies achieve 100%, and our method maybe good candidates for usage in portable systems for mild depression detection.

8:20-8:40 **TueA17-2**

Research on key Quality of Sausage with SVM and Hyperspectral Imaging Full Scale Features

Peiyuan Guo Beijing Tech. and Business Univ.
Hongbing Xiao Beijing Tech. and Business Univ.
Suxia Xing Beijing Tech. and Business Univ.
Mei Sun Beijing Tech. and Business Univ.
Man Bao Beijing Tech. and Business Univ.

In this paper a quick and accurate detection method is proposed, which can identify whether the sausage contains excessive acid value, peroxide value and area of colony. By using hyperspectral image measurement and multi-information fusion based on support vector machine (SVM), the sausage content model is established. In order to improve the accuracy of hyperspectral image measurement predicted model and to reduce the measurement turbulence,the image information and the NIR value data that are input as the parameters of the hyperspectral image content model are introduced. The detection model's RMSECV and r2 of the research are 0.251 and 0.972. The study concludes that the theory and method can be further extended to the detection of other related meat agricultural products.

8:40-9:00 **TueA17-3**

Research on Higher-order Dielectrophresis of Erythrocytes in Optoelectronic Tweezers

Sheng Hu Northeastern Univ. at Qinhuangdao
Jiangtao Lv Northeastern Univ. at Qinhuangdao
Guangyuan Si Northeastern Univ. at Qinhuangdao

During the last decades, optoelectronic tweezers (OET), which combines flexibility of optical tweezers (OT) with locally large electrokinetic force generated by dielectrophoresis (DEP), plays an important role in manipulating and assembling biological cells. Since classic Pohl's expression as effective dipole moment is simple and understandable form, many non-spherical cells such as erythrocyte and leukocyte are approximated to regular sphere so that optically induced dielectrophoretic forces can be calculated in the most experiments. In this paper, three different erythrocytes have been theoretically built to study the higher-order effects in the non-uniform electric field from projected light pattern. Towards this end, effective higher-order moment method is used to extract directly from induced electrical potential. Comparing with Maxwall stress tensor, accuracy of the higher-order forces should take into adequate account in the experimental observation.

9:00-9:20 **TueA17-4**

Position Tracking Control of Mass Spring Damper System with Time-Varying Coefficients

Zhan Li Univ. of Electronic Science and Tech. of China
Ziguang Yin Univ. of Electronic Science and Tech. of China
Dennis S. Bernstein Univ. of Electronic Science and Tech. of China

In robotics, to ensure safe physical interactions between robots and environment for protecting actuators from being damaged by abrupt dynamics changes, compliance strategies are often preferred to be used to make their dynamic process to be more soft by following some natural features observed from humans. Mass-spring-damper (MSD) system is frequently encountered in many compliant robotics systems as a basic architecture. The actuator(s) of robots can be designed based on the form of MSD in order to achieve desired compliant properties. The conventional MSD model is with constant/static coefficients and has appeared in most compliant robots. However, in numerous application scenarios, the coefficients associated with MSD are time variant, making the traditional control strategies (e.g., PID control) hard to deal with. This paper propose a novel control approach for tracking control of MSD model with time-varying coefficients. Simulation results illustrate efficiency of the proposed method.

9:20-9:40 **TueA17-5**

Dynamical Analysis in a Stage Structured Prey Predator System with Modified Leslie-Gower Scheme and Double Time Delays

Luping Wang Northeastern Univ.
Chao Liu Northeastern Univ.
Longfei Yu Northeastern Univ.
Na Lu Northeastern Univ.

A stage structured prey predator system with modified Leslie-Gower scheme is presented, where both maturation delay for prey and gestation delay for predator are considered. Positivity and boundedness of solutions are discussed. By analyzing the associated characteristic transcendental equation, combined dynamic effects of stage structure and double time delays on population dynamics are discussed, and regions of local stability around interior equilibrium are studied. According to Hopf bifurcation theorem for functional differential equations, existence of Hopf bifurcation around interior equilibrium is investigated as local stability switches. Numerical simulations are carried out to show consistency with theoretical analysis in this paper.

9:40-10:00 **TueA17-6**

An Improved Total Variation Regularized SENSE Reconstruction for MRI Images

Chunli Wu Northeastern Univ.
Xiaowan Li Northeastern Univ.
Cuili Liu Northeastern Univ.
Shuo Li Northeastern Univ.

In parallel magnetic resonance imaging (MRI), the quality of image reconstruction is very important. The signal to noise ratio (SNR) of reconstruction image would be obviously reduced with the increase of the acceleration factors because of the ill-posed problem in the sensitivity encoding (SENSE) reconstruction. Through in-depth analysis of the total variation (TV) regularized SENSE reconstruction model, an efficient Bregman iteration algorithm was introduced to obtain the optimal solution and improve the image reconstruction quality. In this paper, the simulation experiments were performed on the real cardiac data and brain data of MRI, respectively. The experimental results demonstrated that the proposed algorithm can alleviate the aliasing artifacts and has a better image reconstruction effect. Compared with the conventional TV regularized SENSE reconstruction algorithm, under the condition of the higher acceleration factors, the SNR has also been improved and the normalized mean squared error (NMSE) of reconstruction image is also decreased. This shows that the proposed iteration TV SENSE image reconstruction algorithm is effective and feasible.

TueAIS Room18
Interactive Session 8:00-10:00

TueAIS-01

Trajectory Based Motion Synchronization in a Dissimilar Redundant Actuation System for a Large Civil Aircraft

Waheed Ur Rehman Chongqing Univ.
Beihang Univ.
Haq Nawaz Beihang Univ.
Shaoping Wang Beihang Univ.
Xingjian Wang Beihang Univ.
Yuanxin Luo Chongqing Univ.
Xu Yun Chongqing Univ.
Muhammad Nadeem Iqbal Chongqing Univ.
Mansoor Ali Zaheer Chongqing Univ.
Irfan Azhar Koc Univ.
Hassan Elahi Sapienza Univ. of Rome

With the passage of time, the aircraft industry is moving towards more electric aircraft. This creates an opportunity to introduce dissimilar redundant actuation system in the primary flight control system. The problem arises, such as a force fighting (force difference between the outputs of actuators) in using dissimilar redundant actuation system. This paper presents a strategy to reduce force fighting for redundant actuation system of hydraulic actuator (HA) and electro hydrostatic actuator (EHA). A trajectory is designed on the basis of dynamic characteristics of the EHA. The feedback controller is used to improve load rejection performance and the two feed forward controllers to remove the initial force fighting between HA and EHA.

TueAIS-02

Dynamic Inclination Measurement At-Bit Based on MEMS Accelerometer

Yuntao Sun Chinese Academy of Sciences
Qingyun Di Chinese Academy of Sciences
Wenxiu Zhang Chinese Academy of Sciences
Wenxuan Chen Chinese Academy of Sciences
Yongyou Yang Chinese Academy of Sciences
Jian Zheng Chinese Academy of Sciences

Geo-Steering Drilling technology is one brand oil field engineering technology, which integrates well drilling, well logging and reservoir engineering technology. The measurement of At-Bit geology parameters and At-Bit drilling parameters are the core of down hole measurement technology. The trajectory information of drilling is indicated by the angle of the well in the measurement of the drilling parameters. Traditional instruments that measures the deviation of drilling, and other drilling parameters sensor probe distance is far from the bit, although here the measurement environment compared with near bit is good. But it cannot reflect the trajectory timely that is a big problem, especially in thin reservoir of directional drilling operation. The closer distance of the measuring sensor is, the worse the influence of vibration, shock, temperature and so on, which puts forward a very high demand for the development of the At-Bit Geo-Steering Drilling tools. The dynamic inclination measurement unit at At-Bit based on MEMS acceleration is using five axis MEMS accelerometer and four compartments Geological Steering tool. The sensor is near by the bit less than one meter and it can be real-time measurement of drill attitude and trajectory information. In order to meet the dynamic situation of inclination measurement ,the image measuring and compensating for dynamic filtering method are used, makes the dynamic measuring precision of hole deviation control in less than 0.5 degrees, static measuring accuracy within 0.3 degrees. This Unit meets the demand of LWD logging in high precision Geo-Steering Drilling.

TueAIS-03

Balance Control of Quadruped Robot Under Lateral Impact

Chuang-feng Huai East China Jiaotong Univ.
Xue-yan Jia East China Jiaotong Univ.
Ying-jiang Shu East China Jiaotong Univ.

Focusing on sudden instability of quadruped robots in practice that results from lateral impact, this paper designs a balance recovery basic algorithm based on roll compensated by the support leg's stretch and foothold searched by the swing leg's step, and then three balance recovery strategies are proposed: the strategy of the support leg adjusting attitude, the strategy of the swing leg stepping and the strategy of two kinds of legs combined. In the end the rationality and viability of the proposed strategies are verified by the results of the Adams simulation experiments.

TueAIS-04

A control method to prevent falling from a treadmill based on STM32 microcontroller and ultrasonic transducer

Tianyu Bai Chang'an Univ.

A treadmill is widely used at home or health entertainment centers, its safety is essential. If the body gait is not appropriate or the inclination degree of the body is too large, movement instability may be caused or even be fallen down from a treadmill. This paper presents an intelligent electronic control method based on STM32 microcontroller and ultrasonic transducer, which can real-time automatically control the treadmill velocity through detection of the upper body position or the tilt angle of human body. Control components are mainly STM32 microcontroller, signal detection unit and motor control unit. The STM32 microcontroller accepts ultrasonic signals of detection unit from input port and digitally processes these signals, and then drives the motor control unit to adjust the operating state and speed of motor through output port. The emitting and receiving of signals are realized by using the ultrasonic T/R module. The main control method is using multiple ultrasonic transducers to measure the interval time between the emitting signals and receiving signals to detect the distance between the subject's position and treadmill or the tilt angle of the body. These collected measurement data are digitally processed by some correlation calculation algorithm, in which some noise and interference signals can be excluded to avoid false judgments. The preliminary test results show that the upper limit of the distance error is less than 8 mm for a 43 kHz ultrasonic wave, and the tilt angular error of human body is approximately 1 to 5 degrees. Therefore the proposed control method and correlation calculation are effective and feasible.

TueAIS-05

The Variable Structure PI Speed Controller for AC Servo System

Hao Lu Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Yunkuan Wang Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Yong Yuan Chinese Academy of Sciences
Univ.of Chinese Academy of Sciences
Jianhua Hu Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Yubin Cai Huludao Especial Equipment Supervise Test Inst.
Bo He Bohai Shipyard Group Co., Ltd.
Jin He Bohai Shipyard Group Co., Ltd.

The high performance AC servo system is required to achieve fast response without overshoot. The traditional proportional-integral (PI) controller which utilizes fixed parameters, however, cannot well guarantee the requirement for both response and overshoot at the same time. Thus a variable structure PI(VSPI) controller is proposed in this paper, and the stability conditions of the closed-loop system based on which is given according to Lyapunov stability criterion. When the absolute value of speed error is smaller than the threshold value, the proportional gain and integral gain are regulated adaptively by a linear function; Otherwise, the proportional gain and the integral gain remain the fixed value. Experiment results show that compared with the traditional PI controller, the VSPI controller under a speed step input can achieve fast response with effectively reduced overshoot.

TueAIS-06

Application of Terminal Sliding Mode Control in Electronic Throttle Valve System

Yonggang Huang Southeast Univ.
Shihua Li Southeast Univ.
Jingwen Fan Southeast Univ.

Songqing Gong Nanjing Weifu Jinning Co.Ltd.
Hao Jiang Nanjing Weifu Jinning Co.Ltd.
This paper investigates the application of terminal sliding mode control in electronic throttle valve system. By introducing a non-singular terminal sliding mode manifold, the system states will converge to the equilibrium point in finite time after reaching the manifold. The controller could make the opening angle of the throttle plate track the reference angle in finite time, obtaining a faster convergence and a better precision. Meanwhile, considering that high switching gains will cause a large chattering phenomenon, a disturbance observer based terminal sliding mode controller is developed. The disturbance is estimated and feedforward compensated so that the switching gain could be selected smaller, then the chattering phenomenon will be reduced. The simulation is provided to show the effectiveness of this method.

TueAIS-07

Research on Compound Control Algorithm for Motion Control System

Yu Zhang Southeast Univ.
Chao Wu Southeast Univ.
Shihua Li Southeast Univ.
Force of friction, which blocks tendency of object's motion or relative motion can easily lead to low tracking accuracy of manipulator arm driven by PMSM at low speed or in back-and-forth movement. During the robot positioning, the gravity torque changes all the time. The variation of it is difficult to measure, Which have influence on the control accuracy of the manipulator arm. The traditional friction compensation algorithm does not take the gravity torque of mechanical arm into account, so the friction model lacks accuracy. For those previous methods which treat friction as disturbance and use disturbance observer to estimate it, it is difficult to estimate the friction precisely in low speed due to the existence of strong nonlinearity at this stage. In this paper, to eliminate the effects of friction and disturbance on the system, a Stribeck friction model is used to eliminate the influence of friction on the system. At first, the q-axis current and rotation speed are sampled. Then the friction model parameters are identified via Lagrange interpolation polynomial and least square method after the gravity and friction torques are separated. Considering the heavy torque of mechanical arm, the deviation of friction model when conditions are changing and the load torque as lumped disturbance, a sliding mode disturbance observer is designed for disturbance estimation. The estimate of friction and the observation of lumped disturbances are employed as feedforward compensation. Then combining the proportion feedback together, a composite speed controller is obtained. Simulation results indicate that the composite control method in this paper can effectively ameliorate “flat-top” phenomenon of position tracking and “chattering” phenomenon of speed tracking of the servo system, and improve the anti-disturbance ability of servo system.

TueAIS-08

Modeling and Control of Quadrotor with Tethered Payload

Zhiping Liu Xian Technological Univ.
This paper addresses the modeling and control of a quadrotor unmanned aerial vehicle (UAV) with a payload that is connected through a flexible rope. The calculation of the tension force and induced moments are derived, and position tracking and attitude control law were proposed based on some assumption. The simulation architecture was structured under the MATLAB environment, simulation results were analyzed and future research work were proposed finally.

TueAIS-09

An Optimal Direct Torque Control System of PMSM Based on Backstepping Model

Jianying Xu Univ. of Science and Tech. Liaoning
Junjie Zhao Univ. of Science and Tech. Liaoning
Liaoning Inst. of Science and Engineering
Weizhi Gu Univ. of Science and Tech. Liaoning
Jinan Meide Casting Company Limited
Ying Wang Univ. of Science and Tech. Liaoning
In this paper, an optimal direct torque control system of permanent magnet synchronous motor based on backstepping model is proposed. The actual model and the reference model equations of permanent magnet synchronous motor are established. The control rate is derived reversely with the error vector, and then the stator flux and torque values are predicted. The stability of the system is proved by using Lyapunov stability theorem. Evaluation function of direct torque controller and the current state of the constraints are designed. It can make direct torque controller select the appropriate control vectors according to the results of backstepping model controller. The simulation experiment is carried out in the Matlab/Simulink simulation environment, the results show that the method can reduce the speed and torque fluctuations obviously and has a better dynamic and static control performance.

TueAIS-10

A New Position Control Method for Lift Motors

Nian Liu Shenyang Ligong Univ.
Feng Wang Party School of The Liaoning Committee of CPC
This paper proposes a precise position control method for lifting motors through a control system of a sapphire crystal orientation device to meet industrial processing requirements. Both the Bang-Bang control and the proportional derivative negative feedback Proportion Integration Differentiation (PID) control are employed in the variable structure controller. For the nonlinear saturation problem, a trajectory planning technique is also introduced in the design to achieve rapid and precise motor position controlling without overshooting. As a proof-of-concept, the proposed method is tested with a Simulink simulation system.

TueAIS-11

Design and Simulation Analysis for An Internal Model Controller of Speed Loop

Nian Liu Shenyang Ligong Univ.
Feng Wang Party School of The Liaoning Committee of CPC
Yu Yang Shenyang Ligong Univ.
This paper focuses on the problem of servo control for automatic adhesive crystal orientation instrument. A three-loop cascade control structure is proposed based on the vector control theory. According to the process requirements of the equipment, PI controllers are employed in a current loop and a position loop. For a speed loop, an internal model controller is designed based on the internal model control theory to solve load variation problems. Compared with a simulation test by the PID control, the one tested by the internal model controller shows excellent robustness and anti-interference ability, which is preferred in the variable load control of this system.

TueAIS-12

Control Strategy Using Fuzzy PID for Waterjet Propulsion Ships

Yufan Wang Shanghai Jiao Tong Univ.
Wen Xiong Laboratory of Science and Tech. on Waterjet Propulsion
Fuxing Ru Changzhou FRP Boatbuilding co. ,LTD
Junzhou Li Laboratory of Science and Tech. on Waterjet Propulsion
Zhenhua Gong Laboratory of Science and Tech. on Waterjet Propulsion
Gangqiang Li Laboratory of Science and Tech. on Waterjet Propulsion
Jingqi Yuan Shanghai Jiao Tong Univ.
In recent years, waterjet propulsion achieves wide applications. This article focuses upon the asynchronous control of dual waterjets to meet specific motion mode. A three degree of freedom motion control model for vector propulsion ship is established based on MMG maneuverability equations. The relationship between thrust and its rotation rate is described by a model of waterjet presented by dynamic balance of energy and momentum. Based on above models, simulation environment is established and the fuzzy PID controller is designed to control the rotation rate of the diesel engine, the steer and reverse angle of two waterjets asynchronously, so as to meet specific positioning tasks. Compared with traditional PID, it is demonstrated that the vector control strategy using Fuzzy-PID is superior both in response time and disturbance rejection ability.

TueAIS-13

Research on Astronomical Trajectory Planning Algorithm for FAST

Sai Deng Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Fengshui Jing Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
Guodong Yang Chinese Academy of Sciences
Zize Liang Chinese Academy of Sciences
Univ. of Chinese Academy of Sciences
This paper addresses astronomical trajectory planning algorithms for tracking and basket-weaving for Five-hundred-meter Aperture Spherical Radio Telescope (FAST). In order to achieve stable operation at feed receiver of FAST and to ease difficulties of trajectory planning in 3-D space, the observed trajectories were planned in celestial coordinate system. Firstly, the characteristics of tracking and basket-weaving were analyzed, and the involved parameters for tracking and basket-weaving were extracted. Secondly, the constraint conditions for planning parameters corresponding to the practical motion were obtained; besides trajectory planning algorithms based on double S velocity profile for tracking and basket-weaving were proposed. Finally, the numerical results indicated that the planned trajectories are guaranteed to be continuous in position, velocity and acceleration, as well as respect the given motion constraint conditions. And the proposed algorithm cost less planning time than the algorithm plans in 3-D space.

TueAIS-14

Servo control method based on neural network and disturbance observation

Jiong Ma Southeast Univ.
Zhenxing Sun Southeast Univ.
Shihua Li Southeast Univ.
In this paper, the method of improving the performance of permanent magnet synchronous motor in the presence of disturbance and friction is studied. First, collected data are used to train BP neural network to get an accurate friction model. Friction model is used to compensate the friction. Considering the influence of friction over-compensation or less-compensation and external disturbance, the disturbance observer is used to compensate the disturbance. Finally, the simulation analysis of the proposed compensation method shows that the proposed method based on the neural network and the disturbance observer can improve the position and velocity tracking accuracy.

TueAIS-15

Control of an Oil Film Thickness in a Hydrostatic Journal Bearing Under Different Dynamic Conditions

Waheed Ur Rehman Chongqing Univ.
Yuanxin Luo Chongqing Univ.
Guiyun Jiang Chongqing Univ.
Yongqin Wang Chongqing Univ.
Yun Xu Chongqing Univ.
Muhammad Nadeem Iqbal Chongqing Univ.
Mansoor Ali Zaheer Chongqing Univ.
Irfan Azhar Koc Univ.
Hassan Elahi Sapienza Univ. of Rome
Xiaogao Yang Chongqing Univ.

In order to meet the requirements of supporting heavy loads, high stiffness, and precise movement, the hydrostatic journal bearings are getting popularity from day to day. The efficiency of hydrostatic bearing for supporting the external load, depends upon the external source of pressure, which is responsible for supplying fluid at a certain pressure. Normally pump is used to supply fluid at a certain pressure, which has poor performance and low efficiency. This paper presents servo valve with a feedback control algorithm to achieve uniform oil thickness for positioning of a shaft in a hydrostatic journal bearing. To check the effectiveness of a proposed strategy, a number of experiments have been done in Matlab/Simulink using different conditions of external load and viscosity. It is found that proposed strategy not only has good results under the different value of viscosity but also has a linear relationship between external load and change in oil film thickness under a wide range of external load.

TueAIS-16

Non-Connection Bluetooth Scanning and Location Technology for Energy-Saving Control System

Zhiming Chen Huizhou Univ.
Tong Liu Huizhou Univ.
Zhongliang Luo Huizhou Univ.
Xiaohui Wei Huizhou Univ.

To realize energy saving and intelligent control of classroom lighting, a control system based on the non-connection Bluetooth scanning and location technology is designed in this paper. Through scanning the Bluetooth devices without establishing a connection, the amount of the Bluetooth devices is obtained. A new weighted barycenter location method is also proposed to locate the cell-phones indoor. With the light sensation and distance parameters, the on or off of the lights in the classroom is controlled intelligently. It is proved by practice that the proposed system can precisely control the lights in the classroom according to the number of the people and their distribution, saving up to 40% electricity energy.

TueAIS-17

Tracking Filter for Nonballistic Targets in the Near Space Based on Modified Variable Structure Interacting Multiple Model

Lei Qin Beijing Inst. of Electronic System Engineering
Harbin Institute of Tech.
Di Zhou Beijing Inst. of Electronic System Engineering
Harbin Institute of Tech.
Jun-long Li Beijing Inst. of Electronic System Engineering
Harbin Institute of Tech.

As the representative of hypersonic vehicles in the near space, X-51A and HTV-2 with high speed and irregular acceleration often adopt nonballistic maneuver flight motion, which is hard to be accurately estimated. This paper focuses on three typical nonballistic maneuver models of near space targets, and proposes a new Modified Variable Structure Interacting Multiple Model (MVSIMM) algorithm. For the three nonballistic maneuver models, simulation results show that the MVSIMM algorithm is better than Fixed-Structure Interacting Multiple Model (FSIMM) filter algorithms.

TueAIS-18

On a Novel Current Control Method for Matrix Converter

Bin Wang Northwest Univ. for Nationalities
Da-Qing Gao Inst. of Modern Physics
Chen Diao Northwest Univ. for Nationalities
Ning Cai Northwest Univ. for Nationalities
Ling Guo Northwest Univ. for Nationalities

As one type of general power converter, matrix converter can realize n phase to m phase voltage conversion, the control strategy of which is now a research hotspot. For three input and one output phase matrix converter (31MC), in view of the insufficiency of normal strategies, a control strategy is adopted based on the hysteresis current control technology. Moreover, aimed at the contradiction between the constant switching frequency of present current control mode and the control speediness, a novel hysteresis current control method is introduced with frequency feedback included. On the condition of relax the rigid requirement to the switching frequency, the current control speed is highly improved without its reliability drop. The proposed technology of MC is proved by theory analysis and computer simulation in the paper.

TueAIS-19

Correction of Step Response Curve in Wind Tunnel Test

Feng Yu Northeastern Univ.
Ping Yuan Northeastern Univ.
Tingfeng Zhang Northeastern Univ.
Zhizhong Mao Northeastern Univ.
Fan Yi China Aerodynamics Research and Development Center
Ning Du China Aerodynamics Research and Development Center

Dynamic matrix control has been proved to be an effective wind tunnel control method. However, the estimation may be biased if the step response curve between input and output is unknown, which leads to the reducing of control effect. In this paper, the estimated step response curve is corrected using area method by the data measured from the wind tunnel test. First, the step response curve is transformed into a discrete transfer function model by using area method. By comparing the response curves under different operating conditions, the conclusion is obtained that there is only one gain difference between the curves. Based on this, the model of the condition without the response curve is parameterized by unknown gains. And then least square method is used to estimate the unknown gain so that the correction of the response curve is realized. The effectiveness of the proposed method is verified by real wind tunnel test results.

TueAIS-20

Partial Integrated Guidance and Control for Missiles Considering Actuator Fault and Saturation

Xianghua Wang Shandong Univ. of Science and Tech.
Xiao Lu Shandong Univ. of Science and Tech.

In this paper, we propose a partial integrated guidance and control (PIGC) scheme for missiles. Firstly, the model including the outer and inner loop models is derived. Then the outer controller where the pitch rate is regarded as the virtual control input is designed to send the line-of-sight angle tracking error and its derivatives to zero (hence the missile will be on a desired collision course). Next, the inner loop controller is proposed to make the actual pitch rate track the pitch rate command from the outer loop, which is robust to the actuator fault. More importantly, by the introduction of the auxiliary dynamic, the outer and inner loop commands are both within the reasonable limits. Finally, a simulation example is presented to illustrate the effectiveness of the proposed method.

TueAIS-21

Interception of Hypersonic Vehicle Based on Integrated Guidance and Control

Liqun Ma Luoyang Optoelectro Tech. Development Center
Chaoyang Duan Luoyang Optoelectro Tech. Development Center
Gongping Zhang Luoyang Optoelectro Tech. Development Center

Hypersonic vehicle weapons have the characteristics of high speed and large flight envelope. In order to make an effective interception, the guidance and control systems of the interceptor need faster response and higher tracking accuracy. This paper presents an integrated guidance and control algorithm based on integral backstepping method which introduces integral control to backstepping control borrowing the thought of PI control. The system designed has the enhanced capability of anti-jamming. High order differential of the line of sight can be achieved by constructing high order sliding mode differentiator, while ensuring the convergence speed and accuracy of the observed value. An additional control is designed in order to eliminate the target maneuver on the miss distance. Lateral jets are controlled based on fuzzy logic and the amount of line of sight. Simulation results show that integrated guidance and control can implement a hit-to-kill to the target, inhibit the adverse effects of target maneuver, and improve the robustness of the system.

TueAIS-22

Stochastic Air-Fuel Ratio MPC of Spark Ignition Engines

Jun Yang Shandong Jiaotong Univ.
Fengyan Yi Shandong Jiaotong Univ.

The problem of the stochastic model predictive control (MPC) of the air-fuel ratio is considered in this paper. A discrete-time dynamic model with residual gas fraction (RGF) which contains the dynamic equations of the air path and the fuel path is established. By the MPC theory of the Markovian jump linear systems, a stochastic model predictive controller is designed based on the dynamic model. Two results can be obtained from the numerical simulation: firstly, the performance of the stochastic model predictive controller is better than the one of the open-loop controller. Secondly, the stochastic model predictive controller with longer state horizon and control horizon has better performance than the one with shorter state horizon and control horizon.

TueAIS-23

Optimal Control System for Pressurizer in Nuclear Power Plant Based on NMGSA

Yongling Li State Grid Jibei Electric Power Co. Ltd. Skill Training Center

The pressurizer of nuclear power plant is a nonlinear, time-varying system. It is difficult for the conventional PID to get better control effect in the pressure control system. The application of the internal model control (IMC) PID method in the pressurizer control system can compensate the internal and external disturbances of the object model dynamically. However, the multitudinous IMC-PID parameters without uniform adjustment specification are very difficult to be tuned, especially hard to gain the internal model parameters. In order to solve the problem, a gravitational search algorithm based on NM simplex search has been set up in this paper. In this algorithm, the search and replace mechanism in NM simplex is integrated into the particle updating of the gravitational

search algorithm. Simplex method has strong local search ability, which can make the particles falling into local oscillation jump out in time to avoid from falling into local optimum. At first, it used the typical test functions to verify the effectiveness of the proposed algorithm, and then it was utilized to optimize IMC-PID controller parameters. The simulation results show that the proposed control system has better control effect.

TueAIS-24

Design of the UAV Normal Acceleration RSLQR-L1 Controller

Chenyuan Xu China Academy of Aerospace Aerodynamics
Qing Lin China Academy of Aerospace Aerodynamics
Pengcheng Dong China Academy of Aerospace Aerodynamics
Yongxin Yin China Academy of Aerospace Aerodynamics

The Robust Servomechanism LQR (RSLQR) is one of the modern control methods, it has the advantages of good control accuracy and less response time. However, the control effect of RSLQR controller will drop when the UAV is under large uncertain disturbance. In this paper, an RSLQR-L1 normal acceleration control method was proposed. The RSLQR-L1 controller takes RSLQR controller as main controller and takes L1 adaptive controller as assistant controller to compensate the control quality decline that caused by the uncertainties and restrain the high frequency disturbance that caused by the adaptive rate. The simulation shows the RSLQR-L1 controller can track the normal acceleration signal accurate while under the uncertain disturbance.

TueAIS-25

Surplus Torque Research on Electric Motor Loading Simulator Using Active Disturbance Rejection Controller

Yadong Chen Nanjing Univ. of Science and Tech.
Liang Shan Nanjing Univ. of Science and Tech.
Jiafeng Sun Nanjing Univ. of Science and Tech.
Zhidong Qi Nanjing Univ. of Science and Tech.

In order to enhance the control performance and loading precision of motor loading simulator, eliminating surplus torque becomes one of the keys. In this paper, according to mathematical model, the electric loading simulator is established and the causes of surplus torque are analyzed, and then the controller based on Active Disturbance Rejection Controller (ADRC) is designed. The experimental results indicate that the surplus torque is suppressed under 0.002 N·m, and the errors are smaller than 0.05 N·m when unit step, unit ramp and torque signal of sin(2πt) N·m· are tracked. These results mean that the performance of ADRC controller is better than those of traditional method.

TueAIS-26

Air-to-Air Missile Bank-to-Turn Autopilot Based on L1 Adaptive Control

Liqun Ma Luoyang Optoelectro Tech. Development Center
Chaoyang Duan Luoyang Optoelectro Tech. Development Center
Gongping Zhang Luoyang Optoelectro Tech. Development Center

Compared with skid-to-turn (STT) control, bank-to-turn (BTT) control has good compatibility with ramjet and is widely used in the long range air-to-air missile design. In this paper, the mathematical model of air-to-air missile is established while the coupling relationship is analyzed in three control channels respectively. The optimal state feedback control is designed by robust servo LQR without regard to the coupling relationship. It can be proved that the ability of the anti-disturbance of the system is improved with using the integral control of error. Subsequently, the coupling between different channels is regarded as non-matching uncertainty which is compensated by an L1 adaptive control design. Finally, simulation is realized and the results show that coordination control of the three channels can be achieved with improvement of control quality and robustness of the system by the robust optimal BTT control based on L1 adaptive control.

TueAIS-27

Attitude controller design for quadrotors based on the controlled Hamiltonian system

Kaijian Hu Dalian Univ. of Tech.
Yuhu Wu Dalian Univ. of Tech.
Xi-Ming Sun Dalian Univ. of Tech.

In this paper, a new mathematical model of quadrotor is proposed by using Hamiltonian approach, which has more advantages than Newtonian and Lagrangian approaches in some aspects, such as compactness, easiness to design controller and having symplectic structure. The Hamiltonian model of quadrotor is the first-order differential equations, whose states are generalized position including North-East-Down (NED) position, Euler-degrees and generalized momenta which are obtained by Legendre transformation from Lagrangian function. A novel nonlinear attitude controller is proposed based on the model. Furthermore, the stability analysis of both of the designed controllers is verified by Lyapunov stability theory. The effectiveness of the proposed model and the designed controller are demonstrated by simulations.

TueAIS-28

Finite-time Control of Chaos for Permanent Magnet Synchronous Motor Systems with Unknown Parameters

Fengjie Zhang Guidaojiaotong Polytechnic Inst.

This paper proposes a novel active finite-time stability controller for permanent magnet synchronous motor chaotic system considering parameters uncertain. The proposed controller can shorten the response time of the system according to adjust the parameters of terminal attractor. The robustness of the system is also strengthened. Finally, simulation study is carried out to verify the effectiveness of the proposed controller.

TueAIS-29

The Design of the Four Rotor Unmanned Aircraft Control Algorithm

Yimei Chen Tianjin Polytechnic Univ.
Yue Zhao Tianjin Polytechnic Univ.

For Qball-X4 four-rotor unmanned aircraft with its own characteristics, creating nonlinear model of system and adopting double closed-loop control algorithm with inner and outer loop are controlled by attitude and position respectively. Linear quadratic regulator is easy to solve state feedback control rate quickly， and has good robustness, thus LQR is utilized to design attitude inner loop controller. Due to the PID control algorithm has simple structure, strong robustness, thus PID is utilized to design position loop controller.Utilize Matlab/Simulink and flight test to verify control algorithm， and the result shows that the control algorithm can successfully achieve the hovering control, and achieve good control effect.

TueAIS-30

NanoSats/CubeSats ADCS Survey

Xiwang Xia Chinese Academy of Sciences
Guowen Sun Chinese Academy of Sciences
Keke Zhang Chinese Academy of Sciences
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From 2013 till the end of 2016, more than 552 NanoSats (500 CubeSats among them), weighing less than 10kg, have been launched successfully in total. With the explosive growth of NanoSats/CubeSats, Attitude Determination and Control System (ADCS) of NanoSats/CubeSats has undergone a profound transform and has changed from the initial passive attitude stabilization to active and precise attitude control. This paper summarizes the current state of the art in NanoSats/CubeSats technology for ADCS, based on an available data base of 377 sample ADCS systems from publically reported Nano/CubeSats missions. The advancement of NanoSat/CubeSat missions and their ADCS requirements are first summarized, a discussion on various ADCS sensors, attitude determination algorithms, actuators, and control schemes is then conducted. Further analyses on the various ADCS schemes versus their achievable performances are provided. This survey shows, NanoSat-compatible attitude actuators, miniaturized attitude sensors, GPS receivers and various attitude determination algorithms were widely adopted to achieve different pointing requirements. The reported attitude pointing accuracy has seen a range from being above 10 deg down to below 1 deg (according to different control schemes). Statistics indicates that almost every successfully launched NanoSat/CubeSat employs magnetometer, Sun sensors and magnetic coils; about 23% of the NanoSats/CubeSats had adopted passive attitude control strategies while more than 50% of them had adopted the advanced reaction wheels-based attitude control strategies, which would provide precise pointing.

TueAIS-31

TTEthernet for Launch Vehicle Communication Network

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Min Xu North sichuan nitrocellulose co., LTD
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In the paper, we research on the application of TTEthernet in the launch vehicle control system. Firstly, the communication network requirements of next generation launch vehicle is proposed in this paper. Then, we introduce the TTEthernet in the view of the mechanism of network communication, clock synchronization and fault-tolerant performance. And further, we analyze the application advantages of TTEthernet. Lastly, we design a dual redundant communication network topology for launch vehicle based on TTEthernet, studying the dataflow of the communication network during the process of vehicle launching. The results can not only show the TTEthernet exploration in launch vehicle, but also provide a guideline for TTEthernet research in the field of space application.

TueAIS-32

Research on the Wind Turbine Yaw System Based on PLC

Feng Guo Northeastern Univ. at Qinhuangdao
Wenyu Jiang Northeastern Univ. at Qinhuangdao
Hongjun Shao Northeastern Univ. at Qinhuangdao
Ying Du Northeastern Univ. at Qinhuangdao
Jianshu She Northeastern Univ. at Qinhuangdao

In this paper, the wind turbine yaw system is used as research object and Siemens SIMATIC S7-1200 control system is adopted as a wind controller. The process of yaw control is deeply studied. In order to ensure the safe and reliable operation of wind turbine, the overall operation plan is designed with combining the algorithms of automatic unmooring and automatic yawing. The control algorithm based on vane and the hill-climbing algorithm based on power detection are integrated.

Therefore the different wind direction can be tracked by system in shortest time, and the utilization efficiency of the wind energy is improved. Step7 TIA Portal is used to write control program running on PLC.

TueAIS-33

Cramér-Rao Bounds for Multiple Near Field Sources Location under Unknown Gain/Phase Response

Han Cui Huizhou Univ.
Wenjuan Peng Huizhou Univ.
Tong Liu Huizhou Univ.
Xiaohui Wei Huizhou Univ.

In this paper the Cramer-Rao bound (CRB) for the estimation of nearfield source location under unknown gain/phase responses is analyzed. We first derive the CRB under the special case of single source and then extend to more general case of multiple sources. For single-source scenario we show that the CRB can be segmented into two parts, which separately corresponds to gain responses and phase responses. For multiple-sources scenario, we show that the CRB can be recursively calculated based on the single-source CRB expressions. The CRB expressions of multiple-sources scenario are in closed-form and only involve matrix multiplications. We show that with the increase in the number of incident sources, CRB increases.

TueAIS-34

Identification and analysis of gas liquid two phase flow pattern

Chunling Fan Qingdao Univ. of Science and Tech.
Jianjun Cui Qingdao Univ. of Science and Tech.
Lichao Fan Qingdao Univ. of Science and Tech.

In this paper, we present a discrete fractional Hilbert transform. This method analyzes the mutation signal in detail according to the order of P. We also can analyze and extract the local information of the signal according to it. We know the difference between the square wave signal and the sine signal by the way of fractional Hilbert transform. And this method is applied to the identification of gas-liquid two-phase flow. We analyze the variation of the marginal spectrum under different orders of the two phase flow signals, and get a better performance of flow pattern recognition.

TueAIS-35

A Blind Guidance System Based on ICA Edge Detection and MIDI Music Display

Yanan Tian Northeastern Univ.

The conventional blind guidance systems have some problems such as massive mapping data, low mapping efficiency and simple sound coding. These make the blind difficult to use the system. To solve these problems, a system is presented based on ICA edge detection and MIDI music display. In this system image edges that accord with visual characteristics are mapped into MIDI music by ICA edge basis functions' reconstruction. Experimental results showed that the system has higher recognition rates for the blind's recognizing the image contents.

TueAIS-36

A Fusion Method for Visible Light and Infrared Images Based on FFST and Compressed Sensing

Yajie Wang Shenyang Aerospace Univ.
Quanbo Pan Shenyang Aerospace Univ.
Yanyan Wu Shenyang Aerospace Univ.
Zhoufeng Yang Shenyang Aerospace Univ.

In order to enhance the efficiency in the process of image fusion, a novel fusion algorithm of infrared and visible images is proposed. First of all, fast finite shearlet transform (FFST) on both the infrared image and the visible image is performed to get a low frequency sub-band and a certain amount of high frequency sub-bands. Then, the Sum Modified Laplacian (SML) fusion algorithm is used for the low frequency sub-band. For the each directional high frequency sub-bands, the compressive measurements are obtained by the block Compressed Sensing (CS). And the measurements are fused with the rule of maximum variance. The fused measurements are reconstructed through the Smoothed Projected Landweber (SPL) algorithm. Finally, the fused image is reconstructed by using inverse FFST. Experimental results demonstrate that the proposed algorithm can obtain better fusion effect and improve the operation efficiency.

TueAIS-37

A Medical Image Fusion Method based on SIST and Adaptive PCNN

Yulin Xiong Shenyang Aerospace Univ.
Yanyan Wu Shenyang Aerospace Univ.
Yajie Wang Shenyang Aerospace Univ.
Yi Wang Shenyang Aerospace Univ.

In order to improve the performance of medical image fusion, a novel medical image fusion method is proposed based on Shift-invariant Shearlet Transform (SIST) and adaptive Pulse coupled neural network (PCNN). Firstly, SIST is employed to decompose source images respectively, to get one low-pass sub-image and some band-pass directional sub-band images, which have the same size as source images. Secondly, the fusion rule based on the local energy and the local variance is used to fuse low frequency coefficients, meanwhile, the fusion rule based on adaptive PCNN is used to fuse band-pass directional sub-band coefficients, here, the improved spatial frequency (SF) in SIST domain is used as the input of PCNN model, and the gradient energy (EOG) is used as the link strength of the PCNN model. Finally, the final fused image is obtained by the inverse SIST. Compared with other methods, this proposed can not only well preserve the useful information from the source images, but also improve the accuracy of the fusion image effectively.

TueAIS-38

The Passenger Flow Counting Research of Subway Video based on Image Processing

Qian Xiao Shenyang Univ.
Yu Xiao Shenyang Univ.
Fa Chen Shenyang Univ.

In view of the traditional transportation passenger flow statistics methods are rough statistics on passenger flow, and it can't get statistical data of passenger flow in a certain period of time immediately, so the passenger flow counting method of subway video based on image processing is proposed. Firstly take the characters obtained by the background subtraction method in the video as the statistical target, and then extract of the human figure outline and do the morphology processing, finally use the method of the connected domain to achieve the statistical effect of the intelligent number. Experimental results show that, the number of statistics is very accurate.

TueAIS-39

An Improved Block Matching Motion Estimation Algorithm Based on Adaptive Rood Pattern Search

Ziwei Lu Northeastern Univ.
Liaoning Shihua Univ.
Chengdong Wu Northeastern Univ.
Dongyue Chen Northeastern Univ.
Shasha Luan Liaoning Entry-Exit Inspection and Quarantine Bureau
Xiaosheng Yu Northeastern Univ.

Block matching motion estimation is a significant issue in image and video super resolution reconstruction. In order to decrease the number of search locations, the amount of computations, and enhance the prediction accuracy, an improved block matching motion estimation algorithm based on adaptive rood pattern search (ARPS) is proposed. Firstly, we use spatial correlation characteristic to predict motion vector (MV) of the current macro-block in the algorithm. Secondly, we consider to eliminate the influence of neighborhood macro-blocks having low relevance to the current macro-block in the prediction process. Finally, we utilize the weighted average MV of two macro-blocks with the smaller matching error in the neighborhood macro-blocks to calculate the predictive MV of current macro-block, instead of using the fixed single macro-block forecast pattern in ARPS. Experimental results show that our algorithm provides the better performance in terms of the computational complexity and the prediction precision in comparison with APRS and other block matching algorithms.

TueAIS-40

Time-Frequency Analysis of Sunspot Numbers Using Synchrosqueezing Transform

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Yu Cao Yunnan Land and Resources Vocational Coll.
Song Feng Kunming Univ. of Science and Tech.

An accurate time-frequency representation can provide important physical information about solar oscillation and quasi-periodic signal. The traditional methods, such as fast Fourier transform, short-time Fourier transform and continuous wavelet transform, have limitations when distinguishing the instantaneous frequencies of the solar oscillation and quasi-periodic signal. The Synchrosqueezing transform (SST) is a promising tool that provide a more accurate time frequency representation. We used two synthetic signals to illustrate that the SST is more efficient and accurate than those traditional methods in time-frequency representation. Subsequently, the period of the sunspot numbers were analyzed using the SST. The result demonstrates that the SST differentiates more accurate frequency components to the continuous wavelet transform.

TueAIS-41

Extracting defect signal from the MFL signal of seamless pipeline

Senxiang Lu Northeastern Univ.
Jian Feng Northeastern Univ.
Fangming Li Northeastern Univ.
Jinhai Liu Northeastern Univ.
Huaguang Zhang Northeastern Univ.

Seamless pipes are widely used in oil and gas transportation. The manufacturing processes associated with the production of seamless pipes contribute to a helical variation in the grain properties of the pipe. It introduces seamless pipe noise in the magnetic flux leakage (MFL) inspection. This paper presents a new approach to extract defect signals based on chaotic time series and random forests prediction. Compared with the predicted signal estimated by this approach, the defect signal can be extracted from seamless pipe noise. The algorithm effectiveness is tested by using experiment data obtained from seamless pipes. The results demonstrate that the proposed method can improve the accuracy rate of extracting defects and reduce the false alarm rate and miss rate.

TueAIS-42

A novel MUSIC algorithm based on cyclic correntropy in impulsive nosie

Guohong You Bohai Univ.
Hongwei Qin Bohai Univ.
Zhaofeng Wang Bohai Univ.
Ying Tian Bohai Univ.
Since the DOA estimation based on second-order cyclic statistics degrades seriously in an a-stable distribution noise environment, and the fractional lower-order statistics based methods depend on apriori knowledge of non-Gaussiannoise. In this paper, by exploiting both the cyslic correlation and correntropy, a novel DOA algorithms based on cyclic correntropy is proposed to deal with cyclostationary signals and to ignore interferences in communication system which suppresses the interferences of the same frequency band. Simulation results strongly verify the effectiveness of this method.

TueAIS-43

Improved Particle Swarm Optimization Algorithm Based NonLinear Calibration of Camera

Wei Guan Shenyang Inst. of Aeronautical Engineering
Wentao Li Shenyang Inst. of Aeronautical Engineering
Jianhui Xi Shenyang Inst. of Aeronautical Engineering
Camera calibration has been a very important problem for 3D objects measurement technique, because it will have a impact on the measurement accuracy. Plane-based camera calibration is usually used in camera calibration. In order to solve the nonlinear optimization problem during the process of plane-based camera calibration,a new method is proposed in this paper.Firstly, the intrinsic and extrinsic parameters of linear camera model are obtained by direct linear transformation (DLT).Then, the intrinsic parameters are used as the initial values of the Particle Swarm Optimization (PSO) algorithm to calculate the optimal values of intrinsic, in addition, the camera nonlinear model is used to obtain the extrinsic parameters. Finally the accurate parameters values are given. An example is given to show that the method can improve the calibration precision obviously compared with existing method.

TueAIS-44

Design of Multiple Orthogonal Pulses for UWB Radios Using an Iterative Convex Constrained l1 Minimization Method

Jiangli Niu Hangzhou Dianzi Univ.
Qiong Wu Hangzhou Dianzi Univ.
Xiaoping Lai Hangzhou Dianzi Univ.
Considering the limitation of the U.S Federal Communications Commission (FCC)'s spectral masks and the coexistence with other wireless services, design of the pulse shape is vital to ultra-wideband (UWB) radios. Based on the classical Gaussian monocycle pulse which poorly fits the FCC spectral mask, this paper uses a digital finite impulse response (FIR) filter to synthesize a set of orthogonal pulses. The pulse design problem is then converted into the design of the FIR filter, which is highly nonconvex and thus hard to solve for its optimal solution. This paper extends the iterative constrained lp elliptic error minimization method for a single pulse design to the case of multiple orthogonal pulses design by incorporating with the orthogonality conditions in the design. Examples are provided to demonstrate the effectiveness of the proposed method and to compare with existing methods in the literature. Results show that the proposed method has obtained higher spectrum utilization efficiencies for almost all the designed orthogonal waveforms.

TueAIS-45

Active Noise Control by a Modified Filtered-xLMS Algorithm with Bandpass Filters

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Chunrong Huang Fujian Inst. of Special Equipment Inspection and Research
Dayong Zhang Univ. of Science and Tech. of China
Feng Li Univ. of Science and Tech. of China
Qiang Ling Univ. of Science and Tech. of China
This paper presents an improved FxLMS algorithm to accomplish the active noise control (ANC) task. In many situations, there may exist some unwanted acoustic noise whose frequency falls into in a certain band. In order to cancel such noise in the given frequency band, we introduce bandpass filters into the original FxLMS structure. Because the introduced bandpass filters can only allow the noise in that given band to pass, the cancellation performance can be significantly improved for such noise. Simulation were done to confirm the effectiveness of our ANC method.

TueAIS-46

An OMP-based T2 spectrum estimation algorithm for NMR logging data

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This paper proposes a T2 spectrum estimation algorithm for low SNR nuclear magnetic resonance (NMR) logging data with strong Gaussian and/or non-Gaussian noise. It have two key contributions. The first contribution is the introduction of the Tikhonov regularization method which provides an initial feasible solution for the SVD non-negative iteration process and can improve the accuracy of the final solution under white Gaussian noise. The second contribution is the implementation of the orthogonal matching pursuit (OMP) algorithm which can calculate the range of the non zero T2 spectrum and can resolve the iteration divergence issue in the existence of non-Gaussian noise. To verify the effectiveness of our algorithm, multiple groups of NMR logging data are used to test its estimation performance. The estimation results confirm that our algorithm can yield good performance even under very low SNR.

TueAIS-47

A method of calculating the mean life-time of solar granules

Jianshu Wang Univ. of Science and Tech.
Song Feng Univ. of Science and Tech.
Solar granulation is a kind of morphological characteristics of solar photosphere caused by convective motion. Because of the mechanism of convective motion, when we calculated the mean life-time of solar granules, we can get the time of convective motion. There are many methods based on the classification of solar granules and tracking solar granules to calculate the mean life-time of solar granules. As a result of the existence time of solar granules is very short and the evolution is more complex, identifying the fragmentation and merging of solar granules will get us into trouble. In this paper, we present a power spectrum analysis based on periodic analysis method to calculate the mean life-time of solar granules. First, we use the κ−w filter to remove the 5-minute oscillations. Only removing the 5-minute oscillations can we more accurately calculate the mean life-time of solar granules. Next, we use gradient transformation to remove the direct current component (DC component) and reduce spectral energy leakage with the Hamming Window. Finally, using the function of Periodogram calculates the mean life-time of solar granules. In order to verify the accuracy of the method, we set three data to calculate the mean life-time of solar granules. The final results of calculating the mean life-time of solar granules are 9.24 min, 9.04 min and 10.67 min respectively. So our method is effective and accurate compared with the results of other literature.

TueAIS-48

Image Registration through Self-correcting Based on Line Segments

Changqing Li Beijing Inst. of Tech.
Bo Wang Beijing Inst. of Tech.
Zhiqiang Zhou Beijing Inst. of Tech.
Sun Li Beijing Inst. of Tech.
Jinlei Ma Beijing Inst. of Tech.
Shi Tang Beijing Inst. of Tech.
Image registration system is able to judge whether images are taken from the same scene in aerospace field especially for the aerial work. The traditional related work has some problems in registration accuracy and robustness to image distortion. To tackle these problems, a novel self-correcting scheme for image registration based on line segments is proposed. We use the line feature instead of traditional point feature to determine the accurate correspondence between images and this brings in strong robustness to image distortion. The paper introduces two algorithms containing a rough registration algorithm and an accurate registration algorithm to improve registration accuracy. In order to search optimal registration correspondence in the appropriate candidate lines, a novel optimization algorithm called line segment length histogram method is proposed. Rough registration can obtain an approximate registration according to the candidate lines and it indeed improves the efficiency. In accurate registration algorithm, the line feature is expressed in a different form and can avoid more drawbacks in registration. Then the accurate algorithm can find all the corresponding line segments in images and their numbers can reflect the quality of our registration work. We have tested many images and all of them can match accurately with each other by the computed optimal correspondence. The experimental results demonstrate the high accuracy and strong robustness of our algorithm on various images.

TueAIS-49

Snapshot Imaging Radar for Moving Target Detection Based on Distributed Compression Sensing

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Snapshot radar is microwave imaging technique based on antenna array signal processing, which can realize both of spatial resolution and temporal resolution of the observed scene. It has the characteristics of all-day, all-weather and fast imaging, therefore, it has wide application prospect in helicopter navigation, traffic monitoring, bridge building deformation detection and other fields. In this paper, distributed compression sensing signal processing technology is applied to snapshot imaging radar for moving target detection, and imaging model and method are deduced. Then, snapshot radar sequence experimental images focused via traditional algorithm and distributed compression sensing algorithm are analyzed, which shows that the algorithm of this

paper requires only one fifth of echo data compared with the traditional algorithm.

TueAIS-50

Research on Cycle Slip Detection Based on Difference Morphology Filter and Singular Value Entropy

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Jiande Wu Kunming Univ. of Science and Tech. Engineering Research Center for Mineral Pipeline Transportation
Guoyong Huang Kunming Univ. of Science and Tech. Engineering Research Center for Mineral Pipeline Transportation
Jun Ma Kunming Univ. of Science and Tech.

In order to solve the problem of Beidou cycle slip detection during Beidou navigation process, a method based on a morphological filter and singular value entropy is proposed to detect the cycle slip in this paper. Firstly, the difference morphological filter is used to denoise the cycle slip signal. Then, the singular value decomposition (SVD) is used to decompose the de-noising signal and obtain several feature sets. Finally, the singular value entropy is obtained for the original feature set to reflect the state of cycle slip. The experimental results show that the proposed method can effectively detect cycle slip information.

TueAIS-51

Studies on Structure of Product Design Information Flow Based on Information Measurement

Yi Gan Univ. of Shanghai for Science and Tech. Chuo Univ.
Zheng Lu Univ. of Shanghai for Science and Tech.
Fu-jia Sun Univ. of Shanghai for Science and Tech.
Wei-ming He Univ. of Shanghai for Science and Tech. Chuo Univ.
Tohru Ihara Chuo Univ.
Peng-ju Zhang MSP/DRILEX (SHANGHAI) CO, LTD

In order to qualitatively and quantitatively describe the information state of each link in PLM design stage, through information entropy analyzes the uncertainty of information state of each link in design stage, through information distance analyzes the size of obstacles encountered for each link to achieve a certain state. Then TBS method had been used for establishing, the three-dimensional model of product and analyze its information state. The results show that when the customer demand increases, the needed information of product will increase in state's transition. To provide information basis for the development process of design stage in PLM by analyzing the information status.

TueAIS-52

Research on the relationship between strategic alliance's characteristics, inter-organizational learning and organizational performance

Xue Deng Bohai Univ.

The strategic alliance is an important platform of inter-organizational learning between the enterprises.The purpose of this paper is to analysis if inter-organizational learning in strategic alliance will help to improve organizational performance.And which characteristics of strategic alliance will affect the relationship between the two. Based on the related research of scholars both at home and abroad, this paper puts forward the model of the strategic alliance's characteristics, inter-organizational learning and organizational performance. In the model, the independent variable is inter-organizational learning. The dependent variable is organizational performance. At the same time, introducing alliance form and alliance scope are control variables. Then the paper put forward relevant assumptions. Through the questionnaire survey, altogether collected 195 valid sample data, we validate that the inter-organizational learning has positive correlation with the organizational performance and moderate action of the moderating variables. The conclusion will play an effective role in guiding our country enterprises in forming the strategic alliance and relevant decisions.

TueAIS-53

A Team's Internal Complex Scientific Research Networks and Its Research Performance

Limei Zhao Heilongjiang Univ.

In view of social capital theory and network embeddedness theory, the theory model and the concept model are constructed, representing the relationships between a team's internal complex scientific research networks and its research performance. On the basis of scientific research networks establishing and networks structure analysis, the hypothesis model expressing the correlations between a team's internal research networks and its performance is made. And then the pragmatic studies about the relationships between a team's internal research networks and its research performance, are processed using PLS Structure Equation Modeling method. The conclusion is that efficient scientific research networks in a team can promote its research performance, so it is the key for a team to devise an efficient incentive and beneficial guarantee mechanism to form and sustain those efficient research networks.

TueAIS-54

Medical community expert classification based on potential semantic feature transfer learning

Guang Fang Kunming Univ. of Science and Tech.
Lei Su Kunming Univ. of Science and Tech.
Qian Wang Kunming Univ. of Science and Tech.
JunFeng Wang Kunming Univ. of Science and Tech.

Nowadays, the mobile medical community, providing a communication platform for medical, medical treatment, pharmacy, life science as well as other related domains, acts as a professional social network for doctors, medical institutions, healthcare practitioners and life science. In the medical community, users can ask questions and receive the response from a professional doctor. It is possible to push the user's question to the specific doctor via classifying medical experts in the community, Therefore, the user's question can be answered in time. In the training of classification model of medical experts, the general approach is supervised learning. However, several different domains, including respiratory and chest diseases, first aid and critical illness and neuroscience, could be found in the medical community. Classical supervised learning algorithms find good classifiers for a given learning task using labeled input-output pair and require a large number of labeled training samples, when labeled data is limited and expensive to obtain. However, the original classification model can not obtain the optimal effects n the new domain. Moreover, trace number of categories or unclassified need to be re-labelled, leading to a higher price. In order to address the problem of cross-domain expert classification model in medical community, we combine user's inherent information as the keyword together with user's potential information, thereby improving the cross-domain model of medical community expert classification. Through the data collected in the medical community, our experimental results suggest that the method can be used to achieve better classification effect in small or unlabeled new domains.

TueAIS-55

Research On Information Security Management Mechanism Of The Industry Cloud In Manufacturing Enterprise

Ping Ma Beifang Univ. of Nationalities
Qiang Han Beifang Univ. of Nationalities

The industry cloud's development is important basis of to foster large datas industry and stimulate the manufacturing service transformation, is also the information center of implemented intelligent manufacturing and industry interconnection in the future development of advanced manufacturing. In the process of the construction and application of the industry cloud, formed a new generation of industry software architecture in the digital workshop of small and medium discrete manufacturing enterprises, at the same time, in terms of ability to improve security, analyses the industry cloud services security risks, cloud service providers has relationship with users and industry cloud's information safety inspection, supervision and evaluation, cloud information security framework design is brought forward.

TueAIS-56

The Improvement of Authentication Mechanisms

Shuo Li Univ. of Science and Tech. Liaoning Northeastern Univ.
Chong Sun China Mobile Liaoning branch company

In this paper, a new authentication protocols is proposed based on asymmetric key encryption functions. Through analysis, the improved protocol not only meets to security requirement of the third generation mobile communication, but also improve the insufficient security of the published authentication protocol.

TueAIS-57

On Fuzzy Hegelsman-Krause Opinion Dynamics

Tian Tao Univ. of Electronic Science and Tech. of China
Yiyi Zhao Southwestern Univ. of Finance and Economics
Jiangping Hu Univ. of Electronic Science and Tech. of China

In this paper, a fuzzy model of opinion dynamics is built to extend the classical Hegelsman-Krause model. The new model takes into account the factors of the uncertainty of agents' opinions and describes the interaction mechanism for the social group by using fuzzy set theory. The confidence levels of social agents are also modeled by a fuzzy variable. The evolution of fuzzy opinions of the social group is analyzed through numerical simulations. The analytical results show that the opinions of the majority of the population converge on the intermediate opinion as time goes. The proposed model effectively explains the interaction and evolution of group opinion in real society when opinions are uncertain.

TueAIS-58

Design of Online Acquisition And Monitoring System of Locomotive Comprehensive Information

Wei-di Zheng Univ. of Science and Tech. LiaoNing
Zhi-gang Li Univ. of Science and Tech. LiaoNing
Chuang Gao Univ. of Science and Tech. LiaoNing

Due to the existing problems of locomotives in the transportation department of domestic large-scale iron and steel metallurgy enterprise, such as bad real time performance of offline acquisition, expensive maintenance cost and difficult performance evaluation, an online acquisition and monitoring system of locomotive comprehensive information is designed based on 3G platform. The status information of locomotives can be collected, transmitted, received and processed by the system to realize the reasonable determination of maintenance time

point, the assisted observation of risk alarm and the performance evaluation of driver. The system has been applied into Anshan iron and steel metallurgy plant, the practice results show that the system improves the operation security of locomotives, reduces the maintenance cost, enhances the evaluation management for drivers and improves the production efficiency.

TueAIS-59

Research on XBRL's Improvement of Quality of Accounting Information in the New Accounting Standards

Guangqiang Han BoHai Univ.
Wenli Chen BoHai Univ.
Duo Li BoHai Univ.

The new accounting standards put forward higher request to the quality of accounting information, but do not change the traditional model of financial report and the disclosure of accounting information, which causes the accounting information provided by enterprise lags behind, users'cost of accounting information heightens, data input duplicates, and accuracy drops . And the implementation of new accounting standards under the background of XBRL (eXtensible Business Reporting Language) as the enterprises' financial report preparation, storage, transmission, application methods and technical means, can reform the traditional financial report mode and enhance the quality of accounting of information disclosure.

TueAIS-60

The Implementation of Clinical Data Management and Statistics System

Heming Ma South China Univ. of Tech.
Muqing Deng South China Univ. of Tech.
Cong Wang South China Univ. of Tech.
Key Laboratory of Biomedical Engineering in Guangdong

In this paper, a clinical data management and statistic system is implemented for authorized users such as doctors and medical researchers to manage clinical data. The system is able to inquiry patient particulars, diagnostic results, CT (Computerized Tomography) data and electrocardiogram (ECG) data, and it implements comparison function of Cardiodynamicsgram (CDG) data and statistic function for further analysis of medical research. The paper builds a stable and simple operating system based on GUI with MATLAB and SQL Server. The three-tier model which includes the storage platform of the system, abstract business logic layer and the operating interface, is utilized in this application. This system is very helpful for clinicians, as well as for researchers to do research on cardiovascular disease with the cardiovascular clinical data.

TueB01 Room01
Adaptive control (IV) (Chinese) 10:20-12:20

Chair: Min Wang South China University of Tech.
CO-Chair: Mengmeng Li Capital Normal Univ

10:20-10:40 **TueB01-1**

Adaptive sliding mode control with linear matrix inequality based on a DEAP Flexible Actuator

Mengmeng Li Capital Normal Univ.
Dehui Qiu Capital Normal Univ.
Yuan Li Beijing Institute of Tech.
Qinglin Wang Beijing Institute of Tech.

To address the problem of an actuated system based on the Dielectric Electro-active Polymer (DEAP) material with strong hysteresis, the nonlinearity and uncertainty, this paper proposes a linear matrix inequality (LMI) algorithm to design an adaptive sliding mode controller for DEAP flexible actuators. For this method, an inverse compensation operator of a Prandtl-Ishlinskii (P-I) model is applied to mitigate the hysteresis effect of DEAP materials. Then, the LMI algorithm is utilized to optimize the sliding mode surface and combined with a general adaptive sliding mode control for designing a DEAP system controller. A comparison of the simulation results indicates that the control method makes the system have better adaptability (or tracking reference) and stronger global robustness, can overcome the uncertainty disturbance of the external environment, and the chattering phenomenon of the system has been effectively eliminated at the same time.

10:40-11:00 **TueB01-2**

Adaptive Neural Dynamic Surface Control for Flexible Joint Manipulator with Prescribed Performance

Min Wang South China University of Tech.
Huiping Ye South China University of Tech.

This paper focuses on adaptive neural control for a class of flexible joint manipulator with unknown dynamics under the output tracking error constraint. To facilitate the design of control law, the constrained tracking error is transformed into unconstrained variable by introducing a performance function, the unknown dynamics of manipulator are accurately approximated by radial basis function(RBF) neural network(NN). Then, a novel adaptive neural control scheme is proposed using the derivative of the filter' s output as the input of NN instead of traditional intermediate variables. Due to structure features of the considered flexible joint manipulator, the proposed control scheme not only decreases the dimension of NN inputs, but also reduces the number of NN approximators. Moreover, it can be verified that all the signals in the closed-loop system are uniformly ultimately bounded and the constrained tracking error converges to a small neighborhood around zero with the prescribed performance. Simulation results on a single-link flexible joint manipulator are given to illustrate the effectiveness of the proposed scheme.

11:00-11:20 **TueB01-3**

Low-complexity adaptive tracking control forWheeled Mobile Robot with actuator dynamics and unknown parameters

Zhixi Shen The Key Laboratory of Dependable Service Computing in Cyber Physical Society of Ministry of Education, Chongqing Univ.
Institute of Smart Engineering, School of Automation, C hongqing Univ.
Yaping Ma The Key Laboratory of Dependable Service Computing in Cyber Physical Society of Ministry of Education, Chongqing Univ.
Institute of Smart Engineering, School of Automation, C hongqing Univ.

This paper presents a simple adaptive tracking control approach for wheeled mobile robot(WMR) with unknown parameters, as well as actuator dynamics. A robust adaptive controller is developed for WMR, which can not only compensate uncertainties in kinematic and dynamic model as well as actuator dynamics uncertainties, but also make WMR have a better performance of tracking desired trajectory. Moreover, this controller is structurally simple and computationally inexpensive. From Lyapunov-stability analysis, it is shown that all signals of the controlled closed-loop system are uniformly ultimately bounded. The effectiveness of the proposed control strategy is confirmed by systematic stability analysis and numerical simulation.

11:20-11:40 **TueB01-4**

L1 Adaptive Block Backstepping Control of MIMO Nonlinear System with Uncertainty

Hongtao Zhen Machine Engineering Coll.
Yanmei Lv Machine Engineering Coll.
Dong Zhang Machine Engineering Coll.

Based on L1 adaptive control theory, a novel block backstepping control for a class of uncertain multiple-input–multiple-output nonlinear system is proposed. The matched system parametric uncertainty and unmatched general uncertainty including modeling error and external disturbance are considered in the design. The L1 adaptive control is integrated with block backstepping to improve the transient performance in addition to stable tracking. The low-pass filter is adopted to guarantee fast adaptive rate without generating high-frequency oscillations in control signal and ensure its smoothness. A reference system is introduced to prove the stability of the closed-loop system via L1 adaptive theory and Lyapunov theorem. Finally, numeral simulation results show the transient performance and feasibility of the proposed adaptive control.

11:40-12:00 **TueB01-5**

Neuroadaptive PI Control With Prescribed Performance for a Class of Nonaffine Systems With Non-smooth Input Saturation

Yuanchang Zhong The Key Laboratory of Dependable Service C omputing in Cyber physical Society of Ministr y of Education, Chongqing Univ.
College of Automation, Chongqing Univ.
Xiaofan Zhang The Key Laboratory of Dependable Service C omputing in Cyber physical Society of Ministr y of Education, Chongqing Univ.
College of Automation, Chongqing Univ.
Tianzhi Ma College of Communication Engineering, Chongqing Univ.
Min Xu College of Communication Engineering, Chongqing Univ.

A neuroadaptive PI controller is developed for a class of nonaffine systems with bounded external disturbance and a symmetric non-smooth input saturation. Neural networks's (NNs's) capability of nonlinear function approximation and the use of exponentially decaying and hyperbolic functions in solving prescribed performance (PP) problems. Then, a transformed filtered error is designed to facilitate the control design and analysis. A stability analysis based on Lyapunov method guarantees uniformly ultimate bounded (UUB). Simulations are carried out to verify and clarify the theoretical findings.

12:00-12:20 **TueB01-6**

Synchronization controller design for triangular fractional-order chaotic systems based on state observer

Guanjun Li Huainan Normal Univ.
Hongqi Zhu Huainan Normal Univ.
Heng Liu Huainan Normal Univ.

Synchronization of a class of fractional-order chaotic triangular systems is studied through observer in this paper. Based on the fractional Lyapunov stability theory, a robust observer is designed. The proposed method can guarantee the stability of the closed-loop system as well as the convergence of the synchronization errors. Finally, the effectiveness of the proposed method is confirmed by a simulation study.

TueB02 Room02
Variable structure control (I) 10:20-12:20

Chair: Jingwei Dong Zhejiang Univ.

CO-Chair: Yibo Ding Harbin Institute of Tech.

10:20-10:40 **TueB02-1**

Fixed-Time Nonsingular Terminal Sliding Mode Control for Spacecraft Rendezvous

Jingwei Dong Harbin Institute of Tech.
Chuanjiang Li Harbin Institute of Tech.
Boyan Jiang Harbin Institute of Tech.
Yanchao Sun Harbin Institute of Tech.

This paper presents a fixed-time nonsingular terminal sliding mode control methodology for spacecraft rendezvous in the presence of nonlinearity and external disturbance. A nonsingular terminal sliding surface is constructed and a continuous sinusoidal function is introduced into the controller to solve the inherent singularity problem. Under the proposed controller, the relative position of the chaser spacecraft can rendezvous with the target within fixed time, which is demonstrated by Lyapunov theorem. The simulation results show that the proposed controller enables rapid convergence rate, high precision and strong robustness in the presence of nonlinearity and external disturbance.

10:40-11:00 **TueB02-2**

Robust Disturbance Rejection Guidance Law for Autonomous Rendezvous with Tumbling Non-Cooperative Spacecraft

Yibo Ding Harbin Institute of Tech.
Yingzi Guan Harbin Institute of Tech.
Naigang Cui Harbin Institute of Tech.
Feng Yang Harbin Institute of Tech.

A robust disturbance rejection guidance law for autonomous rendezvous with non-cooperative target is studied using generalized super-twisting algorithm (GSTA) and homogeneous high order sliding mode observer (HHOSMO). The proposed method is able to ensure a service spacecraft subject to modeling uncertainties, external disturbances and actuator/thruster failures accomplishes the rendezvous mission without collision. Considering the restriction of Clohessy-Wiltshire (C-W) equations, a coupled relative motion model is established in line of sight coordinate frame. The GSTA is used as a robust continuous guidance law while the HHOSMO is able to observe and compensate the lumped disturbances in a finite time to enhance the ability of disturbance rejection. The stability of the closed-loop system is analyzed using Lyapunov stability criteria. Results obtained from numerical simulations demonstrate the validity of the method formulated in this paper.

11:00-11:20 **TueB02-3**

Research on Sliding Mode Control of DC-DC Converter for Vehicle

Yongzhuang Liu Guangxi University of Science and Tech.
Wenguang Luo Guangxi University of Science and Tech.
Hongli Lan Guangxi University of Science and Tech.
Shengyong Liu Guangxi University of Science and Tech.

The control problem of vehicle DC-DC converter is the key problem of the new energy vehicle power system. In this study, Averaged state space method is used to develop converter model. the new global fast terminal sliding mode control scheme is proposed as a new approach for the voltage tracking control, a new control design method is developed to obviate the DC-DC converter disturbances. In order to evaluate the accuracy and effectiveness of proposed method, designed controller is simulated using MATLAB/Simulink S-function. The time reaching the sliding surface and equilibrium point are precisely calculated, system stability is analyzed. Simulation results show that the new sliding mode variable structure controller compared with the traditional sliding mode control method has the advantages of controllable convergence time, fast convergence speed and controllable precision, and more stronger robustness.

11:20-11:40 **TueB02-4**

Position and Attitude Tracking Control for a Quadrotor UAV via Double-loop Controller

Hairong Yin School of Automation, Southeast Univ. Key Lab of Measurement and Control of Complex Systems of Engineering, Ministry of Education, Southeast Univ.
Qingling Wang School of Automation, Southeast Univ. Key Lab of Measurement and Control of Complex Systems of Engineering, Ministry of Education, Southeast Univ.
Changyin Sun School of Automation, Southeast Univ. Key Lab of Measurement and Control of Complex Systems of Engineering, Ministry of Education, Southeast Univ.

To deal with the position and attitude tracking control problem of a quadrotor unmanned aerial vehicle (UAV), the proportional-derivative (PD) and integral sliding mode techniques are adapted to design a double-loop controller in this paper. Firstly, the system model of quadrotor is established according to the Lagrange formalism. Then, a PD control method is put forward in the outer-loop to achieve the position tracking. Meanwhile, an integral sliding mode control method is adapted in the inner-loop to ensure the quadrotor track the desired attitude angles in the presence of external disturbances. Accordingly, a double-loop controller is generated. Finally, simulation results are presented to verify the effectiveness and robustness of the proposed control laws.

11:40-12:00 **TueB02-5**

A new sliding mode observer for the sensorless control of a PMLSM

Huacai Lu Anhui Polytechnic Univ.
Jinghua Wu Anhui Polytechnic Univ.
Manhua Li Anhui Polytechnic Univ.

In order to achieve sensorless control for permanent magnet linear synchronous motor (PMLSM) direct drive system, speed and position of the motor must be estimated. A new high speed sliding mode observer (SMO) is proposed for a PMLSM based on the sliding mode variable structure theory. A Sigmoid function is used for the SMO as a switching function of the control law, eliminating sliding mode chattering and improving its response rate. Simulation results show that the proposed SMO based on Sigmoid function is capable of estimating speed and position of the motor accurately and rapidly, and the proposed PMLSM sensorless control system has a good dynamic response.

12:00-12:20 **TueB02-6**

GA New Sliding Mode Observer for Systems with Continuous-time Models and Discrete-time Measurements

Yuan Tian Department of Mathematics of Miami Univ.
Wen Chen3 Division of Engineering Technology,Wayne State Univ.
L.-Y. Wang Department of Electrical and Computer Engineering, Wayne State Univ.
F. Lin Department of Electrical and Computer Engineering Wayne State Univ.

This work is to propose a new sliding mode observer (SMO) for systems described by continuous-time models but subject to discrete-time measurements. One of the important features of the SMOs is their robustness to disturbances and/or uncertainties in applications to control systems such that they are very important tools for robust system state estimation. For convenience of stability analysis, the measured output at a time instant is converted to a time-delayed output together with integral and derivative techniques such that the stability and of the new SMO could be handled using the Lyapunov method. Detailed design of the SMO is provided and the stability of the suggested SMO is also discussed. A battery cell with discrete-time measurements is employed to verify the effectiveness of the proposed SMO on system state estimation.

TueB03 **Room03**
Optimal control and optimization (IX) (Chinese) **10:20-12:20**

Chair: Peijun Zhang National University of Defense Tech.
CO-Chair: Zhu Wang Beijing Institute of Tech.

10:20-10:40 **TueB03-1**

Study on Trajectory Optimization for Single-Stage-To-Orbit Space Planes Using Gauss Pseudospectral Method

Ruizhi He National University of Defense Tech.
Peijun Zhang National University of Defense Tech.
Luhua Liu National University of Defense Tech.
Jianhua Wang National University of Defense Tech.
Deli Meng National University of Defense Tech.

A direct optimization algorithm, which satisfies multiple path and terminal constraints, is proposed to generate the optimal trajectories for the single-stage-to-orbit space planes. Minimum fuel cost is selected as the optimality criterion in this method, and a segment strategy of the ascent trajectory is proposed according to the characteristics of the combined engines. The optimal control problem is transformed into a multi-stage optimal control problem, and a Gauss pseudo-spectral method is used to solve the parameterized control variables. Both the numerical simulations and simplified calculation based on the Gauss pseudospectral method are carried out to test the effectiveness and robustness of the proposed algorithm. Results demonstrate that the algorithm can rapidly generate the optimal ascent trajectory for single-stage-to-orbit space planes and achieve complex flight missions.

10:40-11:00 **TueB03-2**

Aircraft Route Planning for Stealth Penetration Based on Sparse A* Search

Yan Cao Beijing Institute of Tech.
Teng Long Beijing Institute of Tech.
Zhu Wang Beijing Institute of Tech.
Xiaodong Chen Beijing Electromechanical Engineering Inst.
Jiabo Wang Beijing Electromechanical Engineering Inst.
Li Liu Beijing Institute of Tech.

To reduce the radar detection probability of the aircraft during penetration, the sparse A* search considering the radar cross section (RCS) distribution characteristic is proposed for route planning. Firstly, the aircraft RCS model and the radar detection probability model are established by considering the attitude and space position of the aircraft. Two kinds of turning modes are studied (the maximum overload mode and the minimum roll angle mode) considering the kinematics constraints of the aircraft. The minimization of radar detection probability and route length are taken as two cost functions. Then the sparse A* search algorithm is applied to get the satisfied route. Finally, the results of Monte Carlo simulation show that the route planned by the proposed method can navigate the aircraft to reach the target with low detection probability, and the comparison results show that the penetration performance of the minimum roll angle turning mode is better than that of the maximum overload turning mode.

11:00-11:20 **TueB03-3**

An algorithm to solve the grouping problem of interview and graduation defense

Yulong Xu Henan University of Traditional Chinese Medicine
Li Cao Henan University of Traditional Chinese Medicine
Lei Hu Henan University of Traditional Chinese Medicine
Peking University
Jie Chen Henan University of Traditional Chinese Medicine

The grouping problem of interview and graduation defense is a common problem in university and college. To ensure the fairness and science in the process of grouping, it is need to consider some constraints between supervisors and students. This work proposes an algorithm to research and solve this problem. In the first, we deeply analyze this problem based on constraint conditions. According the above analyses, we build the constraint rules for this problem. And then we present an effective algorithm to solve this problem. Finally, in order to test the validity of our method, we use two different data sets for testing simulation. The experiment result shows that the solution of grouping by the proposed algorithm is scientific and feasible.

11:20-11:40 **TueB03-4**

Solving Path Planning Problem Based on Ant Colony Algorithm

Kong Ming Qingdao University of Science & Technology

Ant colony algorithm as a new heuristic optimization algorithm, with distributed computing, information positive feedback, and heuristic search features, in solving a variety of combinatorial optimization problems has been widely used. In this paper, with restrictions, to any matter required multi-objective path planning problem using ant colony algorithm for path optimization, the ant colony system is relatively ant system improvements, based on ant colony algorithm path planning problem and pheromone updating the model were established. Simulation results show that ant colony algorithm has strong global search capability, search speed, and better use of the optimal path and a priori knowledge that can effectively overcome the basic ant colony algorithm to learn early stagnation phenomenon, easily with other methods combined beneficial practical application.

17:40-18:00 **TueB03-5**

Double-power Reaching Law Sliding Mode Control For Spacecraft Decline Based On Radial Basis Function Networks

Taihua Wang Changchun University of Tech.
Mingyue Zhao Changchun University of Tech.
Yuanchun Li Changchun University of Tech.
Keping Liu Changchun University of Tech.

In order to solve the problem of position and velocity control of asteroid detectors in the weak gravitational field, a double power sliding mode optimal control method based on radial basis network is proposed in this paper. The dynamic model of the detector in the asteroid fixed coordinate system and the detector landing point coordinate system is analyzed in detail. In the process of the detector descending , the double-power reaching law is adopted to reduce the time of convergence close in the slide surface and slow down the chattering of the system. Considering the influence of uncertainties and perturbations on the system, the radial basis network is used to compensate the influence of the uncertain and disturbances in the descent process of the detector.Completed the requirements of the position and speed control in the process of detector descending which prepared for the probe landing.The simulation results show the effectiveness and feasibility of the proposed method.

12:00-12:20 **TueB03-6**

Optimal Output Tracking Control for Discrete-Time Systems with State and Control Delays

Jian Zhang Ocean University of China
Hao Su Ocean University of China
Qing Yang Ocean University of China
Pan-Pan Du Ocean University of China
Gong-You Tang Ocean University of China

This study researches the tracking control problem for discrete-time systems with state and control delays under disturbances. This study is organized around the delay-free transformation and the successive approximation method. First by proposing a discrete variable transformation, the discrete-time system with input and control delays and the quadratic performance index are transformed into equivalent delay-free ones. According to the optimal control theory, the tracking control problem is transformed into a two-point boundary value problem. Then by using the successive approximation design method we solve the two-point boundary value problem and the optimal tracking control (OTC) law is obtained from Riccati and Stein equations. The existent and uniqueness of the optimal control law is roved. Finally, the feasibility and effectiveness of the proposed approaches are validated by numerical examples.

TueB04 **Room04**
Visual servoing **10:20-12:20**
Chair: Guoqiang Ye South China Univ. of Tech.
CO-Chair: Zhiwu Huang Central South Univ.

10:20-10:40 **TueB04-1**

New results in visual invariant features for improved image based visual servoing

Hao Wan South China Univ. of Tech.
Guoqiang Ye South China Univ. of Tech.
Weiguang Li South China Univ. of Tech.

Features selection plays an important role in image based visual servoing, the objective is to determine six independent visual features with nice decoupled and linear properties. Visual invariant is well-known as an ideal kind of features to design an improved IBVS. In this paper, a kind of visual invariant to rotational motions is derived from projection onto surface of a unit sphere, and it is calculated by vector inner product operation. Invariant based feature jacobian can be provided through a simple deduction with operation laws of vector or matrix. Then, six independent visual features are determined with three inner product features and homography-based features, and a decoupled IBVS controller is proposed. Finally, simulations results with a free-flying perspective camera are provided to illustrate the significance of our proposed method.

10:40-11:00 **TueB04-2**

Selection of the Optical Flow Algorithms for flying vehicles with high speed

Lan Huang School of Aerospace Engineering
Jiamei Song School of Aerospace Engineering

In order to choose the most suitable optical flow algorithm for guidance, navigation and control of flying vehicles with high speed, the paper focuses mainly on the computational accuracy and efficiency analysis of five optical flow algorithms for large displacement. The five optical low algorithms are Horn Schunck (HS), Lucas Kanade (LK), Pyramid Lucas Kanade (PLK), Scale Invariant Feature Transform (SIFT) and SparseFlow. Firstly, the computational principles and the application scope analysis of the optical flow algorithms are presented. Then, two experiments are conducted based on the benchmark sequences to compare the performance of optical flow algorithms. One is carried out based on the real image with small displacement; the other is carried out based on the realistic synthetic image with large displacement. The results show that the SparseFlow algorithm has the best performance with large displacement.

11:00-11:20 **TueB04-3**

Improved RGB-D vision SLAM algorithm for mobile robot

Yi Cheng Tianjing Polytechic Univ.
Jiaqi Bai Tianjing Polytechic Univ.
Chunbo Xiu Tianjing Polytechic Univ.

Simultaneous localization and mapping (SLAM) is one of the most challenging problems of mobile robots. An improved RGB-D visual SLAM algorithm is proposed in this paper, which based on the wheeled mobile robot to solve the problem of accumulative position error and large computation existed in the traditional algorithm. In order to overcome the error caused by the superposition of frames, a semi-random loop closures detection method is introduced at the backend of the graph optimization process. In this paper, we use the FR1/room data packet for experiments, and the experimental results show that the improved RGB-D visual SLAM algorithm saves computation time and enhances the real-time performance of the algorithm.

11:20-11:40 **TueB04-4**

Scene Flow Estimation methodologies and applications- A review

Xuezhi Xiang Haibin Engi. Univ.
Syed Masroor Ali Haibin Engi. Univ.
Mingliang Zhai Haibin Engi. Univ.
Deguang Xiao Haibin Engi. Univ.

Image processing is an inevitable tool for visual tracking. Visual object tracking is a very hot area of research in the computer vision. Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and in general, deal with the extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g., in the forms of decisions. In this core area, Scene Flow(3-D) Estimation is one of the most significant algorithm used in numerous applications like it can be used as image processing techniques, controlling processes, e.g., an industrial robot, as navigation, e.g., by an autonomous vehicle or mobile robot, as detecting events, e.g., for visual surveillance or people counting, as organizing information, e.g., for indexing databases of images and image sequences, as modeling objects or environments, e.g., medical image analysis or topographical modeling, as interaction, e.g., as the input to a device for computer-human interaction, and automatic inspection, e.g., in manufacturing applications. This indicates that the Scene flow (3-D) Estimation algorithm hold potential for more sophisticated and controlled applications in fields of Visual Tracking/Computer Vision. The main theme of this paper is to provide knowledge regarding the latest techniques of most known applications of Scene Flow/Scene Flow Estimations. Extensive references are provided for more in depth explanation.

11:40-12:00 **TueB04-5**

A Fast Servoing Strategy for Nonholonomic Mobile Robot with RGB-D Sensing

YeZhang Tu Central South Univ.
Zhiwu Huang Central South Univ.
Wentao Yu Central South Univ. of Forestry Tech.
Heng Li Central South Univ.
Fu Jiang Central South Univ.

In this paper, a servoing controller composing both homographic relation and direct depth information is designed without decoupling the depth as past contributions have done. The servoing strategy does not need

homograghy matrix decomposing to get rotation and displacement, or massive depth data computing, leading to less complex in calculation and faster in operation. The wheeled mobile robot computes the vector normal of and the distance to the feature plane to obtain relative current pose with a fixed RGB-D sensor mounted in direction of the robot linear velocity. Simulation and experiment results are shown for feasibility verification of the RGB-D servoing strategy.

12:00-12:20 **TueB04-6**

A Novel Three-Axis Visual Attitude Estimation Algorithm with Application to Quadrotors

Yuance Liu Univ. of Hong Kang
Michael Z. Q. Chen Univ. of Hong Kang

Attitude estimation is essential for various types of vehicles, especially aerial and underwater vehicles. Many of those vehicles rely on onboard inertial mechanical units (IMUs) to estimate its attitude, and some incorporate further algorithms, such as Kalman Filter, to improve the estimation and thus the stability. However, drifting estimation from gyroscope and corrupted estimation from accelerometer limits the accuracy of attitude estimation. In this paper, a new method was proposed utilizing a camera observing a pre-set object to recover its own attitude. The estimation can be drift-free while maintaining adequate accuracy. The attitude estimation accuracy was examined by experiments. To demonstrate the effectiveness of the proposed method, a simulation model utilizing quadrotor dynamics has been conducted. The estimation results from the proposed algorithm was adaptively fused with measurement from IMU, showing improved accuracy for attitude estimation.

TueB05 **Room05**
Co-operative control (I) **10:20-12:20**
Chair: Yongsheng Ding Donghua Univ.
CO-Chair: Jinzhi Wang Peking Univ.

10:20-10:40 **TueB05-1**

Internal Model-Based Synthesis for Networks of Multiple Multivariable Systems

Xinghu Wang Univ. of Science and Tech. of China
Youfeng Su Fuzhou Univ.
Dabo Xu Nanjing Univ. of Science and Tech.

The authors consider a cooperative output regulation problem (for short, CORP) for linear multi-agent uncertain multivariable systems by distributed output-feedback control. Specifically, based a specific coordinate transformation to establish a multi-input multi-output (MIMO) output-feedback norm form, we are able to develop a novel class of internal model-based protocols for the problem. Compared with existing designs in the recent literature, the proposed result is strictly extended and applicable to multivariable dynamical networks with unknown parameters or undergoing large parametric uncertainties. The result is also illustrated by a benchmark mass-spring system.

10:40-11:00 **TueB05-2**

Output Feedback Consensus Tracking for Second-Order Nonlinear Multi-Agent Systems with Directed Communication Graphs

Junjie Fu The Univ. of Melbourne
Peking Univ.
Ying Tan The Univ. of Melbourne
Jinzhi Wang Peking Univ.

In this paper, consensus tracking for a class of second-order nonlinear multi-agent systems with a dynamic leader under general directed communication graphs is considered. Only relative output measurements are assumed to be available for each agent. Based on a distributed observer design, global consensus tracking controller using only relative output information is proposed. Sufficient conditions on the controller parameters are derived to ensure consensus tracking. A simulation example is provided to illustrate the effectiveness of the proposed controller.

11:00-11:20 **TueB05-3**

A Neuroendocrine Inspired Dynamic Leader Selection Model in Formation Control for Multi-Robot System

Feng Li Donghua Univ.
Yongsheng Ding Donghua Univ.
Kuangrong Hao Donghua Univ.

Formation control is widely used in industrial, military and daily applications. The development of multi-robot system (MRS) provides new tools and theories to solve this problem. Among related works, the leader-follower strategy is famous for its simplicity and efficiency. Based on leader graphic theory, this paper proposes a neuroendocrine system inspired dynamic leader selection model (NeDLSM) to autonomously switch leaders as such helping the team get out of the woods. A fuzzy C-means algorithm is employed to simulate a nervous system in NeDLSM to evaluate states of robots by fusing external information and status of robots themselves. The neuroendocrine regulation mechanism is referred to adjust two kinds of hormones, which are defined as the specific properties of the leader and the followers, respectively. A superior concentration of hormones will trigger the leader re-selection process. Numerical simulation results show that the MRS with NeDLSM can decrease the convergence error significantly and maintain a required formation in a complex environment.

11:20-11:40 **TueB05-4**

The Fast-optimization for Configuration of Hypersonic Reentry Vehicle

Ming Liu National Univ. of Defense Tech.
Science and Tech. on Space Physics Laboratory
Guojian Tang National Univ. of Defense Tech.
Ming Yang National Univ. of Defense Tech.
Science and Tech. on Space Physics Laboratory
Ding Yang National Univ. of Defense Tech.
Science and Tech. on Space Physics Laboratory
Yajie Ge Science and Tech. on Space Physics Laboratory

Strong ability to fly, good stability, controllability and the thermal environment are the main goal of optimization for configuration of hypersonic vehicle. For the requirement of engineering development efficiency, it needs to determine the main dimensions of the vehicle quickly. During the fast optimization for configuration, Aerodynamic characteristics evaluation uses a more efficient engineering calculation method about Dahlem-Buck, the evaluation of thermal environment is analyzed by an engineering rapid assessment model, the models of flight ability and thermal environment parameters is built fleetly, based on the character of quasi equilibrium gliding. There is the analysis for the relation between configuration parameter and drag-to-lift ratio, lift load coefficient and other aerodynamic character parameters, which Determines the direction of optimization for configuration. The method makes the closed-loop optimization which has preferable application for project.

11:40-12:00 **TueB05-5**

UAV Formation Flight based on Artificial Potential Force in 3D Environment

Zunli Nie Beihang Univ.
Xuejun Zhang Beihang Univ.
Xiangmin Guan Civil Aviation Management Inst. of China

Unmanned Aerial Vehicle (UAV) is applied in various military and civil fields. UAVs in formation can improve the ability and efficiency of UAV system. In this paper, we present the UAV formation flight control based on the Artificial Potential Field (APF). We improve the method by considering the velocity status information, defining the dynamic safe distance and modifying the potential force. To demonstrate the method, two simulations are conducted, which test the performance in collision avoidance among the obstacles in environment and collisions among UAVs.

12:00-12:20 **TueB05-6**

The Study of Optimization Model and Cooperative Control Method for Heat Storage Electric Boiler to Consume the Abandoned Wind and Light

Feng Chen State Grid Corporation of China
Qingda Meng State Grid Corporation of China
Zhuang Zuo State Grid Liaoning Electric Power Supply Co.LTD
Wei Wang Northeastern Univ.
Hengyu Liu Northeastern Univ.
Xin Zhang State Grid Liaoning Electric Power Supply Co.LTD

Wind power and light power have anti-peaking characteristics. The amount of discarded light and wind is large, and the cost of users is high. In order to deal with the above problems, this paper establishes the minimum cost optimization model of the user by optimizing the charging power, heat release power of the heat storage electric boiler, the amount of abandoned wind, abandoned light and grid power. The paper takes into account the negotiated price of the abandoned wind and light, as well as Grid Time-of-use price (TOU) to achieve the minimum cost of the user. Then the optimal model of the maximum energy consumption is set up, and by optimizing the charging power of the heat storage electric boiler and the use of wind and light power, the text achieves the goal to maximize elimination of abandoned wind and light. Finally, the optimization problem is transformed into a single optimization goal by fuzzy satisfaction, and an improved particle swarm optimization algorithm is used to obtain the optimal solution. This paper ensures the lowest cost of the user to be achieved, at the same time, maximizes the consumption of abandoned wind and light, which is verified through simulation.

TueB06 **Room06**
Nonlinear systems (V) (Chinese) **10:20-12:20**
Chair: Kemao Ma Harbin Inst. of Tech.
CO-Chair: Qiang Zhang Univ. of Jinan

10:20-10:40 **TueB06-1**

Consensus-based Hybrid Kalman Filtering Algorithms for Systems with Multiplicative Noises

Long Xu Harbin Inst. of Tech.
Kemao Ma Harbin Inst. of Tech.
Hongxia Fan Harbin Inst. of Tech.

The consensus-based hybrid Kalman filtering problem is investigated for a class of hybrid systems with multiplicative noises. Here, we consider the system with linear state equation and nonlinear observation equation. A connected undirect graph is employed to represent the information exchange among the sensor nodes. Based on the hybrid approach (linear and nonlinear), a new hybrid Kalman filter is constructed. Then, by employing the consensus on information approach, the consensus algorithm based on hybrid Kalman filtering is designed. We finally provide a numerical example to show the performance of the proposed approach.

10:40-11:00 **TueB06-2**

Robust Adaptive Backstepping Sliding Mode Control of Near Space Vehicle via Self-organizing Hermite-polynomial-based Neural Network Controller

Cui Wang Univ. of Jinan
Qiang Zhang Univ. of Jinan
Xiaohong Wang Univ. of Jinan

A novel sliding mode method is proposed for near space vehicles with unknown external disturbance, parameter uncertainties and modeling error. The self-organizing hermite-polynomial-based neural network controller is presented to estimate the unknown compound disturbance. Based on it, we propose backstepping sliding mode strategy which may reduce the initial gains and the stability is proved by Lyapunov function. The simulation results demonstrate the effectiveness of the scheme.

11:00-11:20 **TueB06-3**

Decentralized Finite-time Output-feedback Stabilization for a Class of Uncertain Large-scale Stochastic Nonlinear Systems

Qixun Lan Henan Univ. of Urban Construction
Hu awe i Niu Henan Univ. of Urban Construction

The global decentralized finite-time stabilization problem for a class of uncertain large-scale stochastic nonlinear systems is addressed in this paper. First, a homogeneous finite-time output-feedback control law is constructed for each nominal subsystem without considering drift and diffusion terms by using the adding a power integrator technique and homogeneous systems theory. Second, aiming for global stabilization, a scaling gain is introduced into the proposed homogeneous output-feedback control laws. Then, it is shown that under the proposed decentralized output-feedback controller will render the whole closed-loop system globally finite-time stable in probability. Furthermore, a simulation example is conducted to show the effectiveness of the proposed control scheme.

11:20-11:40 **TueB06-4**

LTR Control Based on GA-BP Neural Network for Hammerstein Model of pH Neutralization Process

Bufan Tong Beijing Univ. of Chemical Tech.
Juan Chen Beijing Univ. of Chemical Tech.
Shuang Zhang Beijing Univ. of Chemical Tech.

A loop transfer recovery (LTR) control method based on Genetic Algorithm (GA) - Back Propagation (BP) neural network is proposed for Hammerstein model of pH neutralization process with typical nonlinear characteristics in this paper. GA-BP neural network is used to establish the inverse model of nonlinear part, so that the LTR control based on inverse system method can be used to recover the performance of the system. The simulation results shows that this method is efficient in Hammerstein model of pH neutralization process and the robustness and track performance of the proposed controller has also been demonstrated.

11:40-12:00 **TueB06-5**

Covariance Intersection Fusion Particle Filter for Nonlinear Systems

Gang Hao Heilongjiang Univ.
Yun Li Heilongjiang Univ.
Harbin Univ. of Commerce
Ming Zhao Harbin Univ. of Commerce
Hui Li Harbin Univ. of Commerce
Yinfeng Dou Heilongjiang Univ.

In this paper, a multi-sensor covariance intersection information fusion particle filter for nonlinear systems is presented. To avoid the calculation of the cross-covariance matrices and improve the estimation accuracy, a distributed fusion filter is presented by using the covariance intersection fusion algorithm, which has a less computational cost than centralized fusion algorithm. A simulation example with two sensors shows its effectiveness and correctness.

12:00-12:20 **TueB06-6**

Minimum Coloring Problem via Semi-tensor Product Method

Meirong Xu Univ. of Jinan
Yige Zhao Univ. of Jinan

This paper considers the minimum coloring problem by using the matrix semi-tensor product, and obtains a number of new results and algorithms. Firstly, the minimum coloring problem is expressed into a kind of optimization problem taking in an algebraic form of matrices, based on which an algorithm is designed to find all the minimum coloring schemes for any simple graph. Secondly, an equivalent problem of minimum coloring problem is studied, and a necessary and sufficient condition is proposed, from which a new algorithm to find all the minimum coloring schemes is established. Finally, the effectiveness of the results/algorithms presented in this paper is shown by one illustrative example.

TueB07 **Room07**
Decision-making theory and method (III) (Chinese) **10:20-12:20**

Chair: Rong Wan Shanghai Univ. of Engineering Science
CO-Chair: Beibei Wang Beijing Jiaotong Univ.

10:20-10:40 **TueB07-1**

Research on Tech Portfolio Schedule Based on Weapons Capability Requirements

Ming Qiao National Univ. of Defense Tech.
Xiaoxiong Zhang National Univ. of Defense Tech.
Jiang Jing National Univ. of Defense Tech.
Mengjun Li National Univ. of Defense Tech.

This paper treats the development planning of weapons Tech as a portfolio schedule problem. To meet the capability requirements, while minimizing the risk of R&D at the same time, we proposed a multi-objective optimization model considering R&D expenses and the average annual cost as constraints. Then an optimization algorithm based on differential evolution and NSGA-II is proposed. Next, a multi-objective decision-making method is used to obtain a satisfactory compromise solution from the Pareto solution set. Last, an example is studied to demonstrate the effectiveness of the proposed model and algorithm, which can provide decision support for the relevant technical planning issues.

10:40-11:00 **TueB07-2**

Rank to Intuitionistic Fuzzy Sets Based on Graphical Geometric Solution

Hui Li Harbin Univ. of Commerce
Ming Zhao Harbin Univ. of Commerce
Yun Li Harbin Univ. of Commerce
Gang Hao School of Electronic Engineering Heilongjiang Univ. Heilongjiang

To represent the Intuitionistic Fuzzy Sets (IFSs) simply and clearly, the whole three dimension geometric schemes for IFSs have been researched in cartesian coordinates, cylinder coordinates and spherical coordinates respectively, and the plane nature of IFS has been obtained. After analyzing the graphical solution of LP problems, this paper illustrates an improved rank approach to IFSs based on graphical solution. Comparing with other approaches, the result obtained by geometric scheme has simple and clear description.

11:00-11:20 **TueB07-3**

Development of the MEDEVAC Operations Simulation Model

Aksyonov K.A. Ural Federal Univ. n. a
Sheklein A.A. Ural Federal Univ. n. a
Vershinina I.V. Ural Federal Univ. n. a
Aksyonova O.P. Ural Federal Univ. n. a
Wang Kai Chinese Academy of Social Sciences

In the study, a subject matter is to be ways of evacuating the wounded from a battlefield. The goal of the paper is to find the fastest and the most economical way of evacuating the wounded and create the simulation model of the MEDEVAC operations. In the process, the existing MEDEVAC actions have been investigated, the analysis of the technical vehicles used at evacuation has been carried out. As a result of the research, the MEDEVAC operations simulation model has been created, a vehicle has been chosen, an assessment of necessary number of flights of the chosen vehicle has been made and the analysis of alternative options of MEDEVAC actions has been carried out.

11:20-11:40 **TueB07-4**

The Assessment of Inter-city Rail Operation Policy in China

Beibei Wang Beijing Jiaotong Univ.
Xiuyuan Zhang Beijing Jiaotong Univ.
Qiaoyun Qin Beijing Jiaotong Univ.

The rapid growth of inter-city activities cause traffic demand increasing, therefore, the intercity traffic network(ITN) is developed and improved to meet the need of resident travel in china. At present, the inter-city traffic network is composed of highway, railway, air, water and rail mass transit. There are a lot traffic flow is overlay on the intercity freeway. It is very important to construct high capacity inter-city rail mass transit transportation system, especially the distance about 120 km to 150 km between cities. As a high-capacity inter-city traffic, reasonable speed, energy consumption, the distance between stations, and rail ticket fare to reflect the rail transit construction investment and passenger flow size, especially, reasonable traffic demand rate among rail transit and other modes in the intercity. To form an optimal travel mode proportion both for the traffic planner and residents. This paper made simulation and bi-level model. And we discuss on the index relation of inter-city rail transit. Those calibrated results are given for parameters range of the inter-city rail operation management in china.

11:40-12:00 **TueB07-5**

An Algorithm for Attribute Reduction Based on Classification of Condition Attributes in Rough Set

Rong Wan Shanghai Univ. of Engineering Science
Ruixia Yan Shanghai Univ. of Engineering Science

Attribute reduction can remove redundant attributes and improve the efficiency of decision making in the case of keeping the classification of research objects. This paper researches attributes reduction of rough set theory. Based on the definition of core in rough set attribute reduction, this paper classifies condition attributes and extracts significant and insignificant attributes. On this basis, combining with Pawlak's attribute reduction method, this paper puts forward an algorithm for attribute reduction based on classification of condition attributes. The experimental results show that the algorithm is verified to be more feasible and effective.

12:00-12:20 **TueB07-6**

Deployment Optimization of Air Defense Force Deployment Based on Memetic Algorithm

Pengjiao Zhao North Automatic Control Tech. Inst.
Jianguo Li North Automatic Control Tech. Inst.

Forces deployment optimization is a key problem of air defense command and control system. In this paper, we consider the hybrid deployment of multi-types of air defense weapons in multiple lines and sections. Firstly, the combat effectiveness of different types of air defense weapons is standardized. Secondly, the calculation model of probability of air attack targets penetration based on queuing theory is given. By taking the defense effectiveness of air defense weapon system as the objective function, an optimization model of fan-shaped deployment of multi-types of air defense weapons is established. A constrained optimization algorithm is provided based on Memetic algorithm which constructed by genetic algorithm and local search. In the end, the simulation experiment shows that the proposed deployment optimization model and solving algorithm are feasible and effective. It can provide reference for scientifically making the troops deployment plans in air defense combat.

TueB08 Room08
Distributed control systems (I) 10:20-12:20

Chair: Jianchang Liu Northeastern Univ. tate Key Laboratory of Synthetical Automation for Process Industries, Northeastern Univ.
CO-Chair: Dun Ao Beijing Univ. of Tech.

10:20-10:40 **TueB08-1**

Synchronization of linear high-order heterogeneous multi-agent systems via event-triggered control with limited output communication

Dongming Liu Northeastern Univ. State Key Laboratory of Synthetical Automatio n for Process Industries, Northeastern Univ.
Jianchang Liu Northeastern Univ. State Key Laboratory of Synthetical Automatio n for Process Industries, Northeastern Univ.

In this paper we consider the output synchronization problem for linear high-order heterogeneous multi-agent systems with a directed communication graph. A distributed event-triggered control protocol is provided to solve the problem. The protocol is applicable to different agents, even with different dimensions. It is worth mentioning that the protocol only requires each agent to send the output information which are to be synchronized when an event-triggered condition is satisfied. Such a control protocol substantially reduces the cost of communication. The proposed protocol also ensures that the synchronization of the multi-agent system can be achieved asymptotically without Zeno-behavior. A numerical simulation is presented to illustrate the effectiveness of our protocol.

10:40-11:00 **TueB08-2**

Consensus Stability Analysis of Optimal Control for Stochastic Multi-Agent System

Pingsong Ming Shenyang Jianzhu Univ.
Songhua Li Shenyang Jianzhu Univ.
Huaitao Shi Shenyang Jianzhu Univ.
Yanze Long Shenyang Jianzhu Univ.

This paper investigates distributed optimal control and stochastic consensus stability problems for high-order stochastic multi-agent system over randomly switching topologies and stochastic communication noise. The switching is governed by a time-homogeneous Markov process, whose state corresponds to a possible interaction topology among agents. The influence factors such as Markovian switching topologies and stochastic communication noise on the optimal solution of the high-order stochastic multi-agent system under distributed optimal control is considered. Based on the stochastic optimal control dynamic programming principle, the distributed optimal controller is designed for the high-order stochastic multi-agent with Markovian switching topologies and stochastic communication noises. Then the consensus stability of the high-order stochastic multi-agent system with Markovian switching topologies and stochastic communication noises is analyzed under the distributed optimal control algorithm. Finally the numerical example is included to illustrate the theoretical analysis.

11:00-11:20 **TueB08-3**

Sampling-Based Event-Triggered Control for Distributed Generators

Yuan Fan Anhui Univ.
Mingwei Sheng Anhui Univ.
Chuanbao Dong Anhui Univ.
Yang Zhang Anhui Univ.

This work investigates the coordination control problem for multiple distributed generation (DG) units with a hierarchical control structure. At the secondary control level, an event-triggered power sharing strategy based on the concept of multi-agent consensus has been proposed for the DG coordination control. The performance evaluation results show that the proposed algorithm can achieve precise power sharing.

11:20-11:40 **TueB08-4**

Decentralized state estimation for large-scale spatially interconnected systems using a robust estimation framework

Huabo Liu Qingdao Univ.
Haisheng Yu Qingdao Univ.

A decentralized state estimator based on a robust estimation framework is derived for a spatially interconnected system constituting by many arbitrarily interconnected subsystems. It combines the robust estimation framework in [21] and the decentralized estimation design in [22] whose computation efficiently utilizes the block-diagonal characteristic of system parameter matrices and the sparseness of subsystem connection matrix. Numerical simulations show that the derived decentralized state estimator has nice estimation performance.

11:40-12:00 **TueB08-5**

Consensus of Nonlinear Dynamical Networks with Markovian Switching Topologies and Time-Varying Delay

Dun Ao Beijing Univ. of Tech.
Bojia Zhang Beijing Univ. of Tech.
Xudong Guo Beijing Univ. of Tech.

This paper addresses the consensus problem for complex dynamical networks with each node being a Lure system whose nonlinearity satisfies a sector condition. Communication time-delay and Markovian switching topologies are also considered in the dynamical network system. The switching for topologies is determined by a Markov chain, each topology corresponding to a state of the Markov chain. The partial stability theory, Lyapunov-Krasovskii function and Schur complement formula are applied to get the novel criterion, which have the forms of bilinear matrix inequalities. Moreover, the method of designing a static output controller is provided. Finally, numerical examples are presented to illustrate the efficiency and applicability of the proposed methods.

12:00-12:20 **TueB08-6**

Distributed Observer-based LQR Control for Discrete-time Multi-agent Systems

Chunyan Han Univ. of Jinan
Wei Wang Shandong Univ.

This paper investigates a set of uncoupled identical linear time-invariant multi-agent systems with a performance index coupling the behavior between the multi-agents. Based on the decomposition of the discrete algebraic Riccati equation of the centralized linear quadratic regulator control, an observer-based distributed controller design method is proposed. The design procedure is employed by applying the decomposition of the global discrete-time algebraic Riccati equations and estimation error systems. A stabilizing solution to the centralized linear quadratic regulator problem for the compact system is given firstly by compact Lyapunov function. The gain within a systematic solution is designed to make the closed-loop system asymptotically stable.

TueB09 Room09
Delay systems (II) 10:20-12:20

Chair: Dan Peng Yanshan Univ.
CO-Chair: Juan Liu JiLin Univ.

8:00-8:20 **TueB09-1**

Stability Analysis for Time-Delayed Systems of Retarded-Type with Inequitable/Equitable Multiple-Sectional Approaches

Ketian Gao Hohai Univ.
Jun Zhou Hohai Univ.

In this paper, stability analysis of time-delayed systems of retarded-type with single time delays is examined by means of inequitable and equitable multiple-sectioning of the time delays. More precisely, we introduce generalized Lyapunov functionals including sub-integrals with piecewise constant weighting matrices to deal with time delay multiple sectioning. Two stability criteria in terms of LMI are derived and proved. It is also examined under some special weighting matrices cases to reduce sufficiency redundancy via adopting sub-optimal segmentation positions or increasing segmentation number as appropriately. The suggested approach can provide us with more precise estimation information about upper bounds for allowable time delay when the time-delayed system remains asymptotically stable. Numerical examples are included to illustrate our main results.

10:40-11:00 **TueB09-2**

Absolute Exponential Stability for a Class of Switched Delay Systems

Juan Liu JiLin Univ. ShenYang Univ.
Qingdao Huang JiLin Univ.

In this paper, we inspect the absolute stability of a class of special switched delay system. The linear part of the switched system is a fixed matrix, while the uncertain nonlinearity satisfies the sector contains . The absolute stability of the switched system in this paper is exponential stability under arbitrary switching. The concept of absolute exponential stability given in this paper extends many types of stability such as global asymptotical stability, global exponential stability, absolute stability and so on. Therefore, absolute exponential stability is a more meaningful concept. Firstly, we construct a class of Lyapunov functions, and give the sufficient conditions for the absolute stability of the system with linear matrix inequalities. Then, we consider the stabilization control of this system. Finally, we examine the feasibility of the proposed method by an example.

11:00-11:20 **TueB09-3**

PID Controller Tuning for Neutral Type systems with time delay via dominant eigenvalue assignment

Honghai Wang Northeastern Univ.
Jianchang Liu Northeastern Univ.
Xia Yu Northeastern Univ.
Shubin Tan Northeastern Univ.
Yu Zhang Northeastern Univ.

This paper considers the problem of proportional-integral-derivative (PID) controller design for a closed-loop feedback system with time delay according some desired performance indexes. In this study, the characteristic equation of the closed-loop system is considered as that of a neutral type system with time delay. Besides, it is expected that the step response of the closed-loop systems has no overshoot. To achieve the objective of control, combining with Smith Predictor, we propose a new approach on the PID controller design for a neutral type delay system via dominant eigenvalue assignment. Such a method can make the performance of the system very close to the desired performance indexes for a standard first-order system. A numerical example is given to illustrate the effectiveness of the proposed approach.

11:20-11:40 **TueB09-4**

Design The Finite-Time H_infty Controller of A Class of Time-Delayed Uncertain Positive Systems

C. C. Ren Anhui Univ.
Q. L. Ai Anhui Univ.
S. S. Wu Anhui Univ.
S. P. He Anhui Univ.

This paper deals with the finite-time H_infty controller problem for a class of time-delay and with uncertain parameters continuous positive systems. For the systems with unknown disturbances, our aim is to design a suitable control law which makes the closed-loop system be finite-time bounded and satisfies the given H_infty performance. By using the constructed Lyapunov function and linear matrix inequalities (LMIs) technique, sufficient conditions that the solution of the finite-time H_infty controller existed are given and proved. Finally, a simulation example is presented to show the feasibility and validity of the present methods.

11:40-12:00 **TueB09-5**

New Approach to Delay-Dependent Stability of Two-Dimensional Discrete-Time Systems with Interval Time-Varying Delays

Jing Zhang Yanshan Univ.
Dan Peng Yanshan Univ.
Changchun Hua Yanshan Univ.
Ting Zhang Yanshan Univ.

A Lyapunov-based method: new finite-sum inequality approach is proposed to reduce the conservatism and the complexity of the stability result for one-dimensional (1D) time-delay systems. In this study, the authors further concern the analysis of delay-dependent stability for two-dimensional (2D) discrete-time systems with interval time-varying delays. By applying new finite-sum inequalities and the reciprocally convex combination inequality, a new delay-dependent stability criterion is derived in terms of linear matrix inequalities (LMIs). Less decision variables are involved in the stability condition and our approach leads to better results than the existing methods. Finally, the advantage of employing the proposed approach is illustrate via a numerical example.

12:00-12:20 **TueB09-6**

H_infty Filter for Sampled-data Systems with Sensor Saturation

Wenlin Zou Nanjing Univ. of Science and Tech.
Jiangsu Second Normal Univ.
Jie Cao Nanjing Univ. of Science and Tech.
Liuwen Li Southeast Univ.
Shumin Fei Southeast Univ.

The problem of H_infty filtering problem for sampled-data system in the presence of sensor saturation has been investigated. By utilizing discontinuous Lyapunov function as well as linear matrix inequality, sufficient conditions of asymptotical stability and prescribed H_infty performance for the filtering error system are given. Based on the conditions, the H_infty filter exists if certain matrix inequalities are solvable. Finally, a simulation example is employed to show the effectiveness of the proposed H-infty filter design method.

TueB10 **Room10**
Fault diagnosis and fault-tolerant control (VII) **10:20-12:20**
Chair: Chunchun Yang Tsinghua Univ.
CO-Chair: Xiaogang Deng China Univ. of Petroleum

10:20-10:40 **TueB10-1**

Multimode Process Fault Detection Method Using Local Neighborhood Standardization Based Multi-block Principal Component Analysis

Xiaogang Deng China Univ. of Petroleum
Lei Wang China Univ. of Petroleum

Traditional PCA assumes the unimodal distribution of process data and may not perform well in monitoring the process with multiple operation conditions. In order to detect the faults in multimode process, this paper proposes a novel process monitoring method using local neighborhood standardization strategy based on multi-block principal component analysis (LNS-MBPCA). Firstly, the proposed method applies local neighborhood standardization (LNS) strategy to transform the multimode data into unimodal data. Then, all the monitored process variables are partitioned into three sub-blocks based on their correlation with global principal components. By utilizing the variable division results, global PCA model is divided into three PCA sub-models and the local monitoring statistics are constructed. Lastly, Bayesian inference is applied to integrate the monitoring results of each sub-block and two probability-based monitoring statistics are developed to indicate process status. Simulation results on a simulated continuous stirred tank reactor (CSTR) system show that the proposed method has better process monitoring performance.

10:40-11:00 **TueB10-2**

A Cross Domain Feature Extraction Method based on Transfer Component Analysis for Rolling Bearing Fault Diagnosis

Chen Chen Tsinghua Univ.
Tsinghua National Laboratory for Information S cience and Tech.
Zhiheng Li Tsinghua Univ.
Jun Yang Tsinghua Univ.
Tsinghua National Laboratory for Information S cience and Tech.
Bin Liang Tsinghua National Laboratory for Information Science and Tech.
Tsinghua Univ.

Feature extraction plays a significant role in the rolling bearing fault diagnosis. However, the complexity and variability of the actual working condition leads to the data unstable and fault characteristics unpredictable. Traditional machine learning methods won't work or have a poor performance under this circumstance. In this paper, we propose a cross domain feature extraction method based on the Transfer Component Analysis algorithm to solve the problem. Transfer Component Analysis, as a novel method in transfer learning field, is an efficient method for cross domain feature extraction problem. The performance of the proposed method is verified with experiments using the actual rolling bearing data.

11:00-11:20 **TueB10-3**

Feature Representation Based on A Rearrangement of Principal Components Method for Fault Diagnosis of Multilevel Inverter

Zhuo Liu Shanghai Maritime Univ.
Tianzhen Wang Shanghai Maritime Univ.
Naval Academy Research Inst., Lanvéoc-Poulmic
Tianhao Tang Shanghai Maritime Univ.
Yefan Feng Shanghai Maritime Univ.
Junqi Yao Shanghai Maritime Univ.
Diju Gao Shanghai Maritime Univ.

Multilevel inverters are widely applied to medium and high voltage industrial fields because of their low harmonics and low requirements of withstand voltages. However, it will be more difficult for fault diagnosis of the power switching devices when the levels of the inverters increase. One of the key factors is the decreased sensitivity between the extracted features and the fault categories. Therefore, a Rearrangement of Principal Components (RePCs) method is proposed for the faulty data of the switching devices in multilevel inverters, which makes the features more representative and enhances the diagnostic efficiency of the inverter system. Besides, a diagnostic strategy is built based on the proposed method. Finally, the proposed feature representation method is verified by the experimental platform.

11:20-11:40 **TueB10-4**

The Research on Real-time Fault Diagnostic Method of Engine Embedded by GA Optimization and BP Neural Networks

Jing Zhang Kunming Univ. of Science and Tech.
Xin Fu Kunming Univ. of Science and Tech.
Hongbo Fan Kunming Univ. of Science and Tech.

Embedded system real time measurement and representation method is widely used in industrial CPS control system application, such as engine fault diagnosis.The malfunction diagnostic methods, which filter the changes in measurable parameters through Kalman filter and then map them to changes in performance parameters of the engine via neural network, have the weaknesses in that the neural network has a slow convergence rate and the optimum is prone to local optimum.Therefore, proposes an approach using genetic algorithm, which stands out in finding global optimum, to refine BP neural network. Our approach uses global optimum to refine the initial and threshold values of the neural network, decreasing the times of neural network trainings, and thus reducing the training error and lowering the time of diagnosis. The simulation shows that the approach is feasible, improves the real-timing and error precision of malfunction diagnosis, and therefore is highly valuable in applications.

11:40-12:00 **TueB10-5**

Operating State Evaluation Model of Motorized Spindle Based on Composite Index

Liting Fan Shenyang Jianzhu Univ.
Jiakai Chen Shenyang Jianzhu Univ.
Ke Zhang Shenyang Jianzhu Univ.
Lixiu Zhang Shenyang Jianzhu Univ.
Huaitao Shi Shenyang Jianzhu Univ.

The operating state of motorized spindle directly affects the machine tool performance, and the evaluation model of operating state was proposed in this paper to improve the stability and reliability of the motorized

spindle. The composite index was introduced based on multi-characteristic parameter evaluation model to quantitatively characterize the operating state. The statistical analysis method was used to classify the operating state data that matching the evaluation grade of the motorized spindle. The experimental results proved that the evaluation model can be used to classify the running status of the motorized spindle based on the composite index, and the index could provide references for tracing back the deterioration factor. The proposed operating state evaluation model could provide theoretical support for rational arrangement of maintenance and shorten maintenance time.

12:00-12:20 **TueB10-6**

A Particle Filter and Long Short Term Memory Fusion Algorithm for Failure Prognostic of Proton Exchange Membrane Fuel Cells

Chunchun Yang Tsinghua Univ. Shenzhen Key Lab of Space Robotic Tech. and Telescience
Zhiheng Li Tsinghua Univ.
Bin Liang Tsinghua Univ.
Weining Lu Heilongjiang Univ.
Xueqian Wang Tsinghua Univ. Shenzhen Key Lab of Space Robotic Tech. and Telescience
Houde Liu Tsinghua Univ. Shenzhen Engineering Lab of Geometry Measurement Tech.

Prognostics and Health Management (PHM) appears to be a promising maintenance strategy which can enhance reliability and reduce maintenance costs of the target system. In the process of PHM, Prognostics is the most important and crucial. Prognostic approaches can be roughly divided into two categories: model-based methods and data-driven methods, both of which have advantages and limitations. To overcome the limitations of these methods and improve the accuracy and precision of the forecasting, we propose a novel fusion prognostic method. This method fuses the Particle Filter (PF, model-based) and Long Short Term Memory (LSTM, data-driven) algorithms. In the literature, PF is used by estimating the system state and identifying the parameters of the model for the purpose of Prognostic. However, it does not have ideal performance due to the lack of measurements in the prediction phase. To solve this problem, LSTM is used to forecast the measurements and use the results as the observation of PF. The experiment is applied to the data of Proton Exchange Membrane Fuel Cell Stack from IEEE PHM 2014 Data Challenge. The results demonstrate that the proposed method can effectively integrate the advantages of PF and LSTM, which leads to a better forecasting performance than naive PF approach.

TueB11 **Room11**
Motion control (III) (Chinese) **10:20-12:20**
Chair: Bo Sun Shandong Univ.
CO-Chair: Xin Zhang Harbin Engineering Univ.

10:20-10:40 **TueB11-1**

Stabilizing a Rotary Inverted Pendulum Based on Lyapunov Stability Theorem

Jie Wen North Univ. of China
Yuanhao Shi North Univ. of China
Xiaonong Lu Hefei Univ. of Tech.

The stabilization of Rotary Inverted Pendulum based on Lyapunov stability theorem is investigated in this paper. The key of designing controls by Lyapunov method is the construction of Lyapunov function. A logarithmic function is constructed as the Lyapunov function and is compared with the usual quadratic function theoretically. The comparative results show that the constructed logarithmic function has higher numerical accuracy and convergence speed than the usual quadratic function. On this basis, the control of stabilizing rotary inverted pendulum is designed based on the constructed logarithmic function by Lyapunov method. The effectiveness of the designed control is verified by experiments, and is compared with the control designed based on quadratic function.

10:40-11:00 **TueB11-2**

Longitudinal Damping Control System Design of High-speed Trimaran

Xin Yuan Harbin Engineering Univ.
Xin Zhang Harbin Engineering Univ.
DongChen Li Harbin Engineering Univ.

Trimaran has become a hot topic in the field of high-performance vessels because of its high-speed and stability.T-foil is an effective anti-rolling device, the lift and torque it provided can significantly reduce the wave interference force and torque, then reduce the longitudinal movement of trimaran .Firstly, using Solidworks to make longitudinal motion model of T-foil and trimaran ,calculating the hydrodynamic coefficients of trimaran with AQWA and use Fluent analyzes the hydrodynamic characteristics of T-foil. Then, the longitudinal motion model of trimaran with T-foil is established. The LQR controller is designed to research the simulation of trimaran in MATLAB. The simulation results show that the motion control system based on the LQR control strategy and the sliding mode variable structure all make the stability of trimaran improved. But the second kind of control method is better.

11:00-11:20 **TueB11-3**

Direct-adaptive Fuzzy Predictive Control for Path Following of Stratospheric Airship

Shuaixian Yu Shanghai Inst. of Spaceflight Control Tech.
Guijia Xu Shanghai Inst. of Spaceflight Control Tech.
Kewei Zhong Shanghai Inst. of Spaceflight Control Tech.
Saixian Ye Shanghai Inst. of Spaceflight Control Tech.
Wenwen Zhu Shanghai Inst. of Spaceflight Control Tech.

This paper presents an effective path following control method for an under-actuated stratospheric airship with model uncertainties. Firstly, the model of the stratospheric airship is described with kinematics and dynamics equations which the controller design is based on. And then, the path following controller is designed which consists of two parts. One part is an analytic model predictive path following controller and the other part is a direct-adaptive fuzzy controller which is constructed to approximate the unknown terms caused by system model uncertainties in the predictive control law. Finally, the simulation results are presented to prove the effectiveness of the proposed method.

11:20-11:40 **TueB11-4**

The Impact of Decay Factor on Event-triggered Consensus Control Performance for Multi-agent System

Xiaobo Wang PLA Univ. of Science and Tech.
Juelong Li Research Center of Costal Defense Engineering
Xiaobo Sun PLA Univ. of Science and Tech.
Xiaopeng Zhang Jiuquan Satellite Launch Centre
Jianchun Xing PLA Univ. of Science and Tech.
Ying Chen PLA Univ. of Science and Tech.
Xuechen Zhao PLA Univ. of Science and Tech.

Multi-agent consensus has been widely applied in engineering. The multi-agent consensus problem is studied in this paper. The protocol based on the event-triggered control is presented. The stability of the system is proved. The decay factor is introduced to the threshold function. Then the relationship between the decay factor and the trigger frequency, the convergence time and the inter-event time is studied emphatically. Lastly, simulations are conducted to verify the effectiveness of the conclusions.

11:40-12:00 **TueB11-5**

Acceleration Planning Based Anti-swing and Position Control for Double-Pendulum Cranes

Cangcang Liu Shandong Univ.
Bo Sun Shandong Univ.
Fan Li Shandong Univ.

For a double-pendulum crane system with multi-state variables, strong coupling and under-actuated, the mathematical model is a nonlinear second order differential equations and the controller is a multi-input single-output system, leading to the challenge of controller design. Most of the existing good methods are based on advanced control theories or optimization theories, but it is difficult to put into practical application. In this paper, an anti-swing and position controller based on trapezoidal acceleration spline curve programming is designed to achieve the control requirements of effective anti-swing and precise position under constraints of the maximum acceleration, maximum velocity and maximum swing angle. The method has strong robustness which can adapt to the different length of the rope and the mass of the load, the most important thing is that it can be implemented in almost all controller devices and is suitable for engineering applications. The simulation results prove the effectiveness of the method.

12:00-12:20 **TueB11-6**

Research on Lane changing trajectory planning of intelligent vehicles based on polynomials and genetic algorithm

Yan Zheng Northeastern Univ.
Xiong Shang Northeastern Univ.
Long Xu Northeastern Univ.

In the research of polynomial lane changing trajectory planning algorithm, lane changing time and lane changing target position are given artificially. For complex traffic environment, there is a great deal of uncertainty in this approach, unreasonable lane changing time and lane changing target position may lead to trajectory planning failure. To solve this problem, this paper a lane changing trajectory planning algorithm based on polynomial and genetic algorithm is proposed. The simulation results show that this lane changing trajectory planning algorithm has better performance compared with the original algorithm.

TueB12 **Room12**
Signal processing (VIII) (Chinese) **10:20-12:20**
Chair: Ruiyan Du Northeastern Univ.
CO-Chair: Mingjie Dong Beijing Inst. of Tech.

10:20-10:40 **TueB12-1**

Color Image Enhancement Based on Retinex Theory with Guided Filter

Shi Tang Beijing Inst. of Tech.
Mingjie Dong Beijing Inst. of Tech.
Jinlei Ma Beijing Inst. of Tech.
Zhiqiang Zhou Beijing Inst. of Tech.
Changqing Li Beijing Inst. of Tech.

Color image enhancement is widely used in digital image processing. Retinex performs well in color image enhancement, however, traditional

Gaussian filter-based retinex algorithms exist some problems such as halo artifacts and detail loss. To solve these problems, we propose an improved retinex image enhancement algorithm based on the guided filter, which is processed in IHS color space. We replace Gaussian filter with the guided filter to get the detail information in different fine scales to better enhance different bands of high-frequency information. Then, we also extract a certain amount of low-frequency information through the decomposition with guided filter in the log domain, while the retinex method based on Gaussian filter only extracts the high-information to enhance the image. Next, we enhance the high-frequency information of the image and combine the enhanced high-frequency information and low-frequency information to get the combined image. Finally, we stretch the combined image to enhance the contrast of the image. In this way, we get the result image with enhanced details and contrast. Compared with some existing retinex methods in image enhancement, our algorithm can avoid the halo artifacts and detail loss.

10:40-11:00 **TueB12-2**

Feature Selection and Multivariate Gaussian Probability Distribution for User Behavior Recognition

Zhiping Zhou JiangNan Univ.
Lele Liu JiangNan Univ.
Xinning Li JiangNan Univ.

User behavior recognition using sensory data has become an active field of research in the domain of pervasive and mobile computing. The Principal Component Analysis (PCA) is a common method for feature selection. To obtain the best description and the best classification characteristics of different behaviors, an algorithm of Principal Component Analysis based on Regularized Mutual Information (RMIPCA) is presented. The new algorithm introduces the category information, and uses the sum of regularized mutual information matrices between features under different behavior to replace the covariance matrix. Furthermore, the extracted feature is calculated based on multivariate Gaussian probability distribution, and the transitional noise behavior data is removed according to the probability value. The simulation results show that the performance of the proposed is better than the others compared, which can effectively identify the user's daily behavior.

11:00-11:20 **TueB12-3**

An Improved Merging Algorithm for the Gaussian Mixture Probability Hypothesis Density Filter

Yongfang Nie Tsinghua Univ.
Naval Submarine Academy
Tao Zhang Tsinghua Univ.

The probability hypothesis density filter has attracted increasing interest since Mahler first introduced it in 2000.This paper proposes an improved merging algorithm for the Gaussian mixture probability hypothesis density filter , which can track closely proximity targets . The proposed algorithm utilizes not only the Gaussian components' means and covariance, but their weights as a new criterion to improve the conventional pruning algorithm's estimate precision. Simulation results demonstrate that this improved algorithm is more robust and easier to implement than the formal one.

11:20-11:40 **TueB12-4**

ICSGC-based Dynamic Spectrum Access Algorithm for Cognitive Radio

Fulai Liu Northeastern Univ. at Qinhuangdao
Northeastern Univ.
Junjiao Ma Northeastern Univ.
Ruiyan Du Northeastern Univ. at Qinhuangdao
Northeastern Univ.
Jian Wu Northeastern Univ.

The dynamic spectrum access, as one of the core technologies of Cognitive Radio (CR) system is an important step for users to realize the utilization of idle spectrum resources. To solve the problem of multi-user dynamic spectrum access in CR system, a dynamic spectrum access algorithm is proposed based on improved color sensitive graph coloring model. In this algorithm, the cognitive user power matrix and the interference threshold matrix constraint are added to the color-sensitive graph-based coloring model to achieve the effective control of the cognitive user power and the quantization of the interference between the cognitive users. Based on this, this paper design access criterion with the purpose of maximizing throughput of system, and then obtained optimal spectrum by using color-sensitive coloring theory, thus achieve multi-user dynamic spectrum access. The simulation results show that the proposed algorithm not only has a good command of the interference between cognitive users, but also can improve the throughput of the whole network effectively.

11:40-12:00 **TueB12-5**

An Effective Collaborative Spectrum Sensing Method Against SSDF Attack

Ruiyan Du Northeastern Univ.
Ying Zhou Northeastern Univ.
Northeastern Univ. at Qinhuangdao
Fulai Liu Northeastern Univ. at Qinhuangdao
Xinwei Wang Northeastern Univ. at Qinhuangdao

Spectrum sensing plays an important role in improving the spectrum utilization of cognitive radio networks (CRN). However, Byzantine attackers may incur the spectrum sensing performance degradation severely. Therefore, this paper presents an effective Correlation coefficient method against Byzantine attack (also known as SSDF attack) for collaborative spectrum sensing problem. Firstly, the proposed method exploits the path loss factor to improve the reliability of the data. And then, the fusion center utilizes the correlation of the perceived data in different time windows to detect the attackers. Eventually, the fusion center makes the final decision by comparing the detection statistics and the threshold weighted with path loss factor. Simulation results testify the effectiveness of the presented algorithm.

12:00-12:20 **TueB12-6**

Adaptive Cooperative Spectrum Sensing Based on Multiple Measurement Vectors

Ruiyan Du Northeastern Univ. at Qinhuangdao
Northeastern Univ.
Fulai Liu Northeastern Univ. at Qinhuangdao
Northeastern Univ.
Qinqin Zhao Northeastern Univ.

For cooperative cognitive radio networks (CR-Nets), spectrum sensing is a key technology to detect spectrum holes which are inadequacy exploited by primary communication system. This paper presents an adaptive spectrum sensing based on multiple measurement vectors. In the proposed method, by using this structure, cognitive user can use less number of measurements that achieve spectrum holes detection. And design the validation parameters that cognitive user terminal sampling and using the validation parameters adjust the number of samples. Simulation results verify the proposed algorithm can adjust the number of samples and ensure the spectrum sensing performance, and effectively reduce the sampling overhead of cognitive user.

TueB13 Room13
Supply chain and logistics management (I) 10:20-12:20

Chair: Xiao-yan Li Univ. of Science and Tech. Beijing
CO-Chair: Hualong Yang Dalian Maritime Univ.

10:20-10:40 **TueB13-1**

Supply Chain Coordination Contracts in Telecom Terminal Customization

Qihui Zhang Zhejiang Univ. of Tech.
Chao Hou Zhejiang Univ. of Tech.

Based on the context of terminal customization, the author focuses on user needs for terminal functions and its network support, developing a contracts model which operator inputs calls subsidies based on the situation that terminal manufacturer pays the cost of pre sales. The results of this study indicate that reasonable calls subsidies enable operator and terminal manufacturer to achieve supply chain coordination and to maximize benefit under certain sales investment.

10:40-11:00 **TueB13-2**

Optimization Model and Algorithm for Ordering and Logistics Distribution of Distribution Center

Yanqiu Liu Shenyang Univ. of Tech.
Ge Cao Shenyang Univ. of Tech.
Shida Xu Shenyang Univ. of Tech.
Jia Li Shenyang Univ. of Tech.

This paper studies ordering problem and logistics distribution of the distribution center in the supply chain. From the perspective of supply chain integration, considering inventory capacity constraints of distribution center and vehicle routing constraints, the optimization model of ordering and distribution are proposed firstly and the average total costs are minimized. In the process of logistics distribution, the grouping strategy is considered, and it improves the efficiency of logistics distribution. According to the characteristics of the optimization model, the genetic algorithm is selected to solve the model. A numerical example shows that the algorithm is effective and the model can provide a solution of ordering strategy and logistics distribution with heterogeneous items for the distribution center.

11:00-11:20 **TueB13-3**

Study on the Coordination Strategy of Supply Chain Considering the Uncertainty Demand of Product

Dao-ping Wang Univ. of Science and Tech. Beijing
Qing-yu Shang Univ. of Science and Tech. Beijing
Xiao-yan Li Univ. of Science and Tech. Beijing

Considering the uncertainty marketing prediction of product, the fuzzy function is used to describe the demand in this paper. Firstly, the decentralized and centralized decision models were established with fuzzy demand description on the basis of Vendor Managed Inventory Consignment (VMCI), the aims of these models are to find the optimal consignment inventory quantity and the expected profits of supplier and manufacturer. On this basis, the rebate contract was introduced to coordinate supply chain under decentralized decision. Studies have shown that this sales rebate contract optimized the expected profits of supplier and manufacturer, and to make the supply chain total expected profit reach the level of the centralized decision. Finally, a numerical example was shown to verify the feasibility and validity of the rebate contract.

11:20-11:40 **TueB13-4**

Logistics Network Configuration for Fresh Agricultural Products

Yingfeng Ji Dalian Maritime Univ.
Hualong Yang Dalian Maritime Univ.
Meitong Chen Dalian Maritime Univ.
This paper optimized the logistics network configuration of fresh agricultural products, consisting of original points, pre-cooling stations, distribution centers and demand points. Considering the time-sensitive features of fresh agricultural products and their empirical decay index, a nonlinear programming model was established. The objective is to minimize overall cost related to the logistics process. A genetic algorithm was designed to solve the proposed model. Finally, a case study was analyzed and the result shows the validity of the model and algorithm.

11:40-12:00 **TueB13-5**

Delivery Vehicle Routing Problem with Simultaneous Delivery and Pickup in E-commerce Environment

Jiajia Zheng Chongqing City Management Coll.
Guorong Liu Chongqing Univ.
Zhenyu Gu Chongqing Univ.
Xiaohui Bai Chongqing Univ.
This paper proposes a vehicle routing problem with simultaneous delivery and pickup in E-commerce environment. When receiving a real-time pickup order, it is hard to deal with the contradiction between logistics cost and service timeliness for express company. A dynamic scheduling strategy is developed to allocate real-time requirements utilizing on-delivery vehicle economically and quickly. Firstly, preprocess dynamic pickup orders and determine the scheduling time, which can translate the dynamic demand problem into a series of static problems; Secondly, an improved PFIH algorithm is designed to insert the pickup requirements into existing routes and generate the optimized routes; Finally, with the help of Relocation method and 2-opt method, all unserved pickup requirements are readjusted and re-optimized by the improved PFIH algorithm again. The example shows that the designed algorithm can insert new pickup requirements into the routes of on-delivery vehicles, and re-optimize the optimized routes with new inserted requirements effectively.

12:00-12:20 **TueB13-6**

Optimization on Loan-to-value Ratios in Inventory Financing under Price Fluctuation

Yong Zhou Dalian Maritime Univ.
Hualong Yang Dalian Maritime Univ.
Di Ye Dalian Maritime Univ.
Meitong Chen Dalian Maritime Univ.
In inventory financing business, the collaterals' value may deteriorate due to poor supervision of Third Party Logistics Providers (3PLs), which can influence the default probability of financing enterprises and further the commercial banks' profits. Considering the supervision effort level of 3PLs, this paper studied the issue of optimizing loan-to-value (LTV) ratios of banks with underside risk aversion in static pledge when the fluctuant ending price of collaterals followed three different distribution functions. An LTV ratio optimization model was developed and the objective was to maximize the bank's expected profit at the end of the loan. To solve this model, the risk assessment method of "subject + debt" was applied. Finally, by conducting numerical studies, results derived from this model were compared with those obtained without considering the supervision effort level of 3PLs. Comparison results prove that a high supervision effort level can help to reduce the financing enterprises' default risks facing banks and improve the optimal LTV ratios. Sensitivity analysis indicates that optimal LTV ratios have a positive correlation with loan interest rates and supervision effort levels, and have a negative correlation with price volatility and default probabilities. The results shed light on LTV ratios decisions for commercial banks with the market price of collaterals fluctuating.

TueB14 **Room14**
Data processing (V) **10:20-12:20**
Chair: Hui Cao Xi'an Jiaotong Univ.
CO-Chair: Xianzhong Zhou Nanjing Univ.

10:20-10:40 **TueB14-1**

Dielectric loss angle data processing based on adaptive weighted data fusion algorithm of the aging mine cable

Wenling Fan Xi'an Univ. of Science and Tech.
Xianmin Ma Xi'an Univ. of Science and Tech.
The dielectric loss angle is the key specification of the insulation performance for the coal cable, on which the mine power equipment and power system safety operation are depended for the underground working. In order to access a more actual value that can reflect the cable insulation from the rich supply of data of the mine XLPE dielectric loss tangent, thus the dielectric loss angle provides a significant basis for the coal cable life prediction. In this paper, according to the Grubbs criterion an adaptive weighted data fusion method is proposed to determine the weight of each group data in order to reduce dielectric loss angle error. The improved Grubbs criterion algorithm is used to eliminate the coarse error data in the data group and then the adaptive weighted data fusion method is used to deal with the batch estimation for the remaining data. Research shows that the adaptive weighted data fusion method has the less error the results compared with other algorithms.

10:40-11:00 **TueB14-2**

Variable Selection Based on Frequent Pattern Tree for Spectroscopy Quantitative Analysis

Shuo Yang Xi'an Jiaotong Univ.
Hui Cao Xi'an Jiaotong Univ.
Yanbin Zhang Xi'an Jiaotong Univ.
Longfei Luo Xi'an Jiaotong Univ.
Yiwei Yuan Xi'an Jiaotong Univ.
Qian Xie Xi'an Jiaotong Univ.
Huihui Zhang Xi'an Jiaotong Univ.
Spectroscopy is an important component analysis method and full spectrum prediction method may be complicated and inaccurate. In order to find out the irrelevant variables, a variable selection method based on the frequent pattern tree(FP-tree) is proposed in this paper. The proposed method firstly formulates an orthogonal array to generate wavelength selection plans, which makes the wavelength selection more reasonable. Then, partial least square(PLS) is performed on the spectral data which is selected by the orthogonal array, and the root-mean-square error of cross validation is adopted as the evaluation criteria of the performances of each prediction model. Based on the results of the evaluation, A set of data which contains the wavelength selection of these model whose performance are evaluated as good can be got. The support count of each wavelength is determined according to the data set and the infrequent wavelengths are discarded while frequent wavelengths are sorted in decreasing support counts. After this, an FP-tree is built based on processed data set. The final selection result is a branch in FP-tree which has the maximum number of sum frequent count. The prediction model is built based on the selection result by PLS. The full spectrum PLS, the uninformative variable elimination with the PLS method and the proposed method are conducted on a real spectral data set of flue gas, the effectiveness of these methods are compared and discussed. The experimental results show that the proposed method is more accurate and has presentable compression performance.

11:00-11:20 **TueB14-3**

Real-time Tracking Based on Compression Sensing of Multiple Features

Chunbo Xiu Tianjin Polytechnic Univ.
Fushan Ba Tianjin Polytechnic Univ.
Traditional compression sensing tracking algorithms use the gray feature of images to describe the tracking target, which not only cause a major fluctuation of the classification result of the classifier, but also give rise to the accumulation of classification error, so that the tracking target may be lost. In order to improve the robustness of traditional compression sensing tracking algorithm, this paper introduces the differential feature information of images, and describes tracking target with multiple features. This method improves the positioning precision of the target, makes up the instability and inaccuracy caused by single feature tracking method, constructs the feature weighting classifier, improves the tracking stability and accuracy, meets the real-time requirements and has higher practicability.

11:20-11:40 **TueB14-4**

Hybrid Tracking Based on Camshift and Template Matching

Chunbo Xiu Tianjin Polytechnic Univ.
Ruosi Wang Tianjin Polytechnic Univ.
In the process of the target tracking, the real-time target tracking can not be realized due to the Interference of the other factors, leading to tracking failure. A hybrid tracking algorithm combining camshift algorithm and template matching algorithm is proposed in this paper. The target tracking is achieved by camshift algorithm. The template matching algorithm is used to find the target again if the target is lost. The specific algorithm is that the tracking target which is used as the template image is selected in the first frame. When each frame in a video stream is traced by camshift algorithm, the Bhattacharyya coefficient is used to judge the tracking result. If the target is missing, the target can be re-found using template matching and be continued to track using camshift algorithm. The experimental results show that the shortcomings of camshift algorithm can be made up by the algorithm in this paper. The tracking effect is more obvious and the tracking integrity is more perfect can be achieved by the hybrid tracking.

11:40-12:00 **TueB14-5**

Salient Locations which Should be Interested

Wenting Hu Nanjing Univ.
Xianzhong Zhou Nanjing Univ.
Libo Zhang Nanjing Univ.
Tianqi Ji Nanjing Univ.
Xin Liu Nanjing Univ.
To explore whether the conscious options of human beings are influenced by bottom-up saliency, both theoretical and experimental analysis are presented. In the experiment, the subjects were required to indicate the most interesting regions of test pictures in the scene. The bottom-up saliency values of test pictures were computed by Itti model. Based on the results of experiments, a detailed experimental analysis is presented. It is indicated that the interest points are correlated with the bottom-up saliency locations.

12:00-12:20 **TueB14-6**

Anomaly Detection and Reconciliation of Pedestrian Tracking Trajectory

Shiyu Yang Donghua Univ.
Kuangrong Hao Donghua Univ.
Yongsheng Ding Donghua Univ.
Jian Liu Donghua Univ.

Pedestrian tracking plays an essential role in the domain of visual tracking. Much research in recent years has focused on how to obtain the accurate tracking results. However, few researchers have addressed the problem of the smoothness for the tracking trajectory. Most trajectory results are skipped and lack of smoothness, which does not comply with human vision habits. Also, some incorrect data has been recorded in the final trajectory due to the problem of partial occlusion. In this paper, we proposed a strategy to fix the present tracking trajectory. First, we detect and delete the anomaly tracking data. Second, we use a technique of supervised learning to do the linear regression for reconciling the tracking trajectory. The experiment manifests that the performance of the tracking trajectory is more accurate and stable than the original one after the implementation of our proposed strategy.

TueB15 Room15
Robot control (IV) 10:20-12:20

Chair: Yongzhi Wang South China Univ. of Tech.
CO-Chair: Xunyu Zhong Xiamen Univ.

10:20-10:40 TueB15-1

Wheeled Mobile Robot Based on Adaptive Linear Quadratic Gaussian Control

Yubin Liao Univ. of Chinese Academy of Sciences
Yongsheng Ou Univ. of Chinese Academy of Sciences
Shan Meng Shenzhen Univ.

To deal with the existing issues of input saturations and uncertain positioning corrupted by Gaussian noises in the tracking control of Wheeled Mobile Robot (WMR), this paper presents a framework which applies the Adaptive Linear Quadratic Gaussian (ALQG) control with Genetic Algorithm based on linear discrete system. The work of ALQG includes three aspects. First, to address the problem of input saturations, we consider a linear discrete system as the Lagrangian multiplier and saturation constraint as the inequality constraint, and the linear quadratic controller with the penalty function as the objective function is solved by the interior point method. Second, in the above implementation of Linear Quadratic Regulator control, the weighting matrix under different conditions may result in different tracking performances. To address this issue, weighting matrices of different initial poses and reference trajectories are adaptively explored by Genetic Algorithm with control performance indexes as constraint functions, and the optimal weighting matrix is final determined. Third, concerning the uncertainty problem in positioning, the Kalman Filter algorithm with real-time measurement of the disturbed position of the posture filter is applied in real time to obtain more accurate poses. The ALQG simulation of the WMR is carried out in the MATLAB software platform, and the tracking quality of the ALQG is discussed systematically. The results show that the trajectory tracking controller of wheeled mobile robot based on ALQG can track the target trajectory stably and has good anti-interference abilities.

10:40-11:00 TueB15-2

A Design of Realtime Communication Based on EtherCAT in Industrial Robot Control System Based on LinuxCNC

Buhai Shi South China Univ. of Tech.
Yongzhi Wang South China Univ. of Tech.
Chuan Ding South China Univ. of Tech.

In the control system of a six-axis industrial robot, a realtime and fast communication solution is needed to improve the kinematic accuracy of end effector. This paper designs a communication solution based on the CANopen over EtherCAT protocol, which supports PDO and SDO communication object in object dictionary. The robot controller is modified from LinuxCNC, and the communication solution is realized as a realtime component of HAL. This paper uses the communication solution to transfer the value of absolute encoder between PC and servo motor, and it can work stably and effectively.

11:00-11:20 TueB15-3

Time Optimal Trajectory Planning Based on Simulated Annealing Algorithm for a Train Uncoupling Robot

Jianjun Yao Harbin Engineering Univ.
Cheng Sun Harbin Engineering Univ.
Le Zhang Harbin Engineering Univ.
Chenguang Xiao Harbin Engineering Univ.
Ming Yang Harbin Engineering Univ.
Shiqi Zhang Harbin Engineering Univ.

A train uncoupling robot with four degrees-of-freedom has been developed to replace humans in the uncoupling task in a marshalling field for designating freight cars to different destinations. This can avoid picking the wrong hook, improve work efficiency and reduce the workload of workers. Trajectory planning can ensure that the robot moves to target position smoothly and quickly. Simulated Annealing (SA) algorithm based on penalty function is proposed to get the optimal time of trajectory planning in this paper. Time optimal trajectories of robot joints are obtained under the constraints of maximum speed, maximum acceleration and maximum jerk speed. It can be seen from the simulation curves that the robot can move smoothly and there is no impact phenomenon.

11:20-11:40 TueB15-4

Fault Detection of a 6-DOF Hydraulic Platform Based on Equivalent-Input-Disturbance Approach

Qianqiu Li Central South Univ.
Jinhua She China Univ. of Geosciences
Hubei Key Laboratory of Advanced Control and Intelligent Automation for Complex Systems
Tokyo Univ.
Min Wu Beifang Univ. of nationalities
Hubei Key Laboratory of Advanced Control and Intelligent Automation for Complex Systems
HeFei Univ. of Tech.
Pingping Lin Central South Univ.

This paper presents a method of fault detection for a 6-degree-of-freedom hydraulic platform based on the equivalent-input-disturbance (EID) approach. First, a model of the platform is derived based on the Lagrange equation. Then, the types of actuator faults are analyzed. Finally, an optimal feedback controller is designed and the EID approach is incorporated to detect and suppress actuator faults. Simulation results demonstrate the effectiveness of the method.

11:40-12:00 TueB15-5

Trajectory Tracking Control of Underactuated Surface Vessel With Output Tracking Error Constraints

Shilu Dai South China Univ. of Tech.
Chong Fang South China Univ. of Tech.
Shude He South China Univ. of Tech.

This paper studies the tracking control problem for underactuated surface vessel with unknown time-varying disturbances. To avoid the controller singularity problem, the constraints on output tracking errors of underactuated surface vessel are enforced in the control design. With the help of error transformation functions, the constrained tracking control of the vessel is converted into the stabilization of the transformed error systems. To compensate for the effect of the external disturbances, disturbance observers are presented to estimate the unknown time-varying disturbances. Subsequently, disturbance-observer-based tracking control is developed to steer the vessel along a desired reference trajectory with guaranteeing the tracking errors within certain predefined bounds. The performance of the proposed tracking control is demonstrated through simulation results.

12:00-12:20 TueB15-6

A Method to Coordinate Balance and Speed Control of a Two-wheeled Robot

Shaohui Hong Xiamen Univ.
Guiyi Zhao China Inst. of Tech.
Xiang Wang Xiamen Univ.
Xunyu Zhong Xiamen Univ.

Two-wheeled robot draws attention of scientists in fields of robotics and robot technique due to its intrinsic instability in kinetic and enormous application prospect. In order to get accurate pitch angle of robot body, Kalman filter is applied to data fusion of both gyroscope and accelerometer. For wheel speed measurement perturbed by pitch angle change of robot body, effective compensation is realised. Then a controller is designed to coordinate both balance control applied Fuzzy-PD control and speed control applied feedforward feedback compound control.

TueB16 Room16
Smart grids (IV) (Chinese) 10:20-12:20

Chair: Yuanyuan Zou East China Univ. of Science and Tech.
CO-Chair: Yiwei Gao Northeastern Univ.

10:20-10:40 TueB16-1

The Separation of Positive and Negative Sequence Component Based on SOGI and Cascade DSC and Its Application at Unbalanced PWM Rectifier

Qiming Cheng Shanghai Univ. of Electric Power
Fengren Tan Shanghai Univ. of Electric Power
Jie Gao Shanghai Univ. of Electric Power
Yu Zhang Shanghai Univ. of Electric Power
Deqing Yu Shanghai Univ. of Electric Power

The second-order generalized integrator (SOGI) and cascade delayed signal cancellation (DSC) have been used respectively in the separation of positive and negative component. But they have their own disadvantages. In order to extract grid’s positive and negative sequence fundamental component from unbalanced power system, the strategy of second-order generalized integrator eliminating higher harmonic and cascade delayed signal cancellation eliminating the specific frequency harmonic has been put forward in this article. It can quickly and accurately separate the positive and negative sequence fundamental component of the grid While grid voltage is distortion, symmetrical fault and asymmetric fault cases. Then, this new method is applied to unbalanced PWM rectifier.

10:40-11:00 TueB16-2

Independent Microgrid Day-ahead Optimization based on Demand Response

Yunjia Liu China Electric Power Research Inst.
Tenglong Meng Northeastern Univ.
Jialiang Liu China Electric Power Research Inst.

Zhanzhan Qu China Electric Power Research Inst.
According to absorb renewable energy and smooth the load curve of independent microgrid, a strategy of demand response optimization, including controllable distributed generation, energy storing device and shiftable loads resource , is proposed. According to the day-ahead power forecast of renewable energy generation and electric power users' load, the strategy draws the payload power curve. The objective function is to minimize the difference between power supply and demand. Then, a day-ahead optimization model based on demand response is established. The results of the model are used to obtain the working condition at a certain time in the future, such as the switching state of the controllable distributed generation, the working state of the shiftable loads, the reference charging power and discharge power of the energy storage device, and reference state of charge. The example shows that the proposed optimization strategy can effectively reduce the load during the peak period of power consumption, reduce the residual power of renewable energy generation and increase the load rate of the controllable distributed generation. Meanwhile, this method predicts renewable energy generation and the short-term power of the load. According to the level of prediction error, the running state is coordinated and controllable among the controllable distributed generation, shiftable loads and energy storage device, providing an adjustable power margin for real-time scheduling of individual microgrids.

11:00-11:20 **TueB16-3**

Fault Diagnosis Method of Distributed Power Distribution Network Based on Advanced Petri net

Yunjia Liu China Electric Power Research Inst.
Yiwei Gao Northeastern Univ.
Jialiang Liu China Electric Power Research Inst.
Yongjin Chu China Electric Power Research Inst.
A DG-based distributed fault diagnosis method based on BP neural network with dynamic adaptive fuzzy Petri nets is proposed to solve the problem that traditional fault diagnosis methods lead to complex matrix and switching functions. In this paper, the general fault diagnosis model is constructed, and the simplified model of protection information is processed in the form of sets. If the operation mode and protection are changed, the model need not be reestablished, and the logic of the protection circuit breaker error correction is used with high fault tolerance. Secondly, BP algorithm is used to train the fuzzy parameters in the model. Finally, simulation test is carried out for the distribution network with DG, which verifies the reliability and fastness of the method.

11:20-11:40 **TueB16-4**

The Research on Steady-State Control of Flexible DC Transmission Based on MMC

Tangxian Chen China Three Gorges Univ.
Yihui Zhou China Three Gorges Univ.
Zhu Liu China Three Gorges Univ.
Jiaquan Feng China Three Gorges Univ.
Zhipeng Li China Three Gorges Univ.
Modular Multilevel Converter, as a new member of VSC, has been used for DC transmission field for its special modular topology structure. Based on the research of traditional voltage source inverter control mode, MMC mathematical model is derived and it is pointed out that MMC - HVDC can adopt the traditional control strategy of VSC - HVDC, considering that station-level control strategy has direct action on HVDC steady state operation , this paper focus on the design of station-level control strategy, and finally by using PSCAD/EMTDC software to build 9 level model of HVDC based on MMC, and through the simulation results the validity of the station-level control strategy design is verified .

11:40-12:00 **TueB16-5**

Autonomous Frequency Regulation Control of V2G (Vehicle-to-Grid) System

Huachun Han State Grid Jiangsu Electric Power Company Research Inst.
Di Huang State Grid Jiangsu Electric Power Company Research Inst.
Dan Liu State Grid Jiangsu Electric Power Company Research Inst.
Qiang Li State Grid Jiangsu Electric Power Company Research Inst.
V2G technology considers EV as an energy storage unit to interact with the grid, which is the inevitable trend of future development. Based on the decentralized V2G system, a control strategy was proposed by considering users' individual demands and SOC constraints of EV battery. A simulation study is carried out to demonstrate the electric vehicle for frequency regulation as mobile energy storage unit. The simulation results show that the proposed control strategy can not only suppress system frequency deviation but also achieve charging demand.

12:00-12:20 **TueB16-6**

The Energy Optimal Management of Grid-connected Micro-grid Operation Based on Model Predictive Control

Xianchao Li East China Univ. of Science and Tech.
Yuanyuan Zou East China Univ. of Science and Tech.
Yugang Niu East China Univ. of Science and Tech.
Tinggang Jia Automation Division of Shanghai Electric Group Co.
In this paper, an energy management problem of grid-connected micro-grid is investigated. This micro-grid consists of renewable energy generations, conventional generations, storage devices, essential loads, transferable loads, controllable loads. Based on the power flow among different energy modules, a system model is established. Further, a model predictive control approach is presented to optimize the energy management of the micro-grid and the overall optimization problem can be solved by a mixed-integer quadratic programming (MIQP). Simulation results show that the proposed method can ensure the energy balance between supply and demand, meet different demands of various loads and improve the availability of renewable energy resources.

TueB17 **Room17**
Cyber-physical systems (I) **10:20-12:20**
Chair: Jiuxiang Dong Northeastern Univ.
CO-Chair: Jiao Wang Northeastern Univ.

10:20-10:40 **TueB17-1**

Study on Modulation Transfer Spectroscopy of Rb Atoms

Shengzhan Chen National Univ. of Defense Tech.
Qu Liu National Univ. of Defense Tech.
Yong Shen National Univ. of Defense Tech.
Hongxin Zou National Univ. of Defense Tech.
Closed-loop frequency stabilization-'laser locking'-is required for laser cooling, precision spectroscopy and atomic clocks. We compare the modulation transfer with the direct modulation in signal intensity and noise. By calculating, we get the conclusion that the ratio of signal intensity between modulation transfer scheme and the direct modulation scheme is 1.13: 1 whereas the SNR of the modulation transfer scheme and the direct modulation scheme is almost 1.17:1, when the power of the laser is equal and without considering the details of interaction between lights and atoms. And we experimentally realized a stable external-cavity diode laser via MTS referencing on the Rb D2 lines at 780nm.

10:40-11:00 **TueB17-2**

The Improvement of Authentication Mechanisms

Shuo Li Univ. of Science and Tech. Liaoning Northeastern Univ.
In this paper, a new authentication protocols is proposed based on asymmetric key encryption functions. Through analysis, the improved protocol not only meets to security requirement of the third generation mobile communication, but also improves the insufficient security of the published authentication protocol.

11:00-11:20 **TueB17-3**

Research on Long-Range Real-Time Visible Light Communications over Phosphorescent LEDs

Ziyang Wu Northeastern Univ.
Chuan You Northeastern Univ.
Chuang yang Northeastern Univ.
Lulu Liu Northeastern Univ.
Kepeng Xuan Northeastern Univ.
Jiao Wang Northeastern Univ.
Breakthrough progresses had been achieved in high-rate visible light communications for the past several years, which employed advanced material LEDs and were processed off-line, but only in a short transmission range. It is an incentive to exploit a real-time visible light communication system with a long transmission range over a highpower commercial LED. This paper proposes the methods from baseband modem procedures to improvements in optical transceivers to obtain an on-line long-range transmission utilizing orthogonal frequency division multiplexing (OFDM) and phosphorescent LEDs. Implementations verified the feasibility of extending the communication distance with a lowcost phosphorescent LED through those methods proposed.

11:20-11:40 **TueB17-4**

An Improved Real-time Task Preemptive Scheduling In Cyber-Physical Systems

Jing Zhang Kunming Univ. of Science and Tech.
Xiaoduo Yang Kunming Univ. of Science and Tech.
Hongbo Fan Kunming Univ. of Science and Tech.
To improve the performance of real-time task scheduling and the utilization of the system resources in Cyber-Physical System, at the same time, to reduce the number of task switching, this paper improved traditional preemptive task scheduling, introduced the concept of buffer time and the guard time, made judgments when the task may need to switch to, according to the situation to retain the task which had lower priority but should not be suspended, and let the higher priority task wait for a while. Finally, our research verifies the performance of the algorithm by examples and simulation experiments, demonstrates that the algorithm can optimize the performance of CPS, avoids the jitter caused by frequent task switching and its adverse effects on system performance, reduces the number of task switching, and improves the utilization of resources within the system to some extent.

11:40-12:00 **TueB17-5**

Adaptive Optimization Deception Attack on Remote State Estimator of Aero-Engine

Xin Huang Northeastern Univ.
Jiuxiang Dong Northeastern Univ.
This paper studies the effect of the deception attacks on the remote state

estimator equipped with the chisquared failure detector. It is assumed that the attacker can monitor and modify all the measurements. A novel adaptive optimization deception attack strategy is proposed, where using the current and previous sensor data, the attackers can ensure themselves to be undetected by the chi-squared monitor while yielding the largest estimation error covariance at the remote state estimator. From the attacker's perspective, the attack is better than the existing other attacks to degrade the system performance. Finally, the simulation on the aero-engine model is provided to demonstrate theoretical results.

12:00-12:20 **TueB17-6**

A Multi-vehicles Optimization Method for Intersection Cooperative Driving

Tong Zhou Chongqing Vocational Inst. of Engineering Univ.
Guilin Univ. of electronic Tech.
Hongzhuan Zhao Guilin Univ. of electronic Tech.
Chongqing Univ.
Ying Wang Chongqing Vocational Inst. of En gineering Univ.
Juan Yang Chongqing Vocational Inst. of En gineering Univ.
Guilin Univ. of electronic Tech.

The ICDS envisions that vehicles and an intersection controller could cooperatively work together to improve traffic operations and managements so that vehicles can safely and efficiently cross the intersection. Thus, the cooperation and optimization of the ICDS, which is solved simultaneously on incommensurable and conflicting objectives, is a typical multi-objective optimization problem (MOOP) with constrained conditions. For solving the ICDS' MOOP, an improved membrane computing-based multi-vehicles optimization method (IMC-MOOM) is proposed from vehicular cyber physical system (VCPS) perspective. In detail, the ICDS's MOOP is described using population P system, and then the IMC-MOOM is proposed to solve the ICDS's MOOP. Finally, experimental results and analysis demonstrate that our proposed method is superior or competitive to four optimization evolution algorithms recently reported in the literature.

TueBIS **Room18**
Interactive Session **10:20-12:20**

TueBIS-01

Verifying the Gesture Identification Effect of WNN and DWT for an Interference Driven Prosthetic Hand

Xiaorui Fan Nankai Univ.
Lili Dai Nankai Univ.
Wennan Chang Nankai Univ.
Xina Ren Nankai Univ.
Shili Sheng Nankai Univ.
Feng Duan Nankai Univ.

Human hand is very dexterous and has complicated functions. For amputees, it is significant to propose a myoelectric prosthetic hand which can recognize and accomplish various hand motions with reliable system. Therefore, this paper puts forward a mechanical hand with main joints individually powered by interference driven method. Driving program is redacted in Single-chip microcomputer (SCM), which controls the prosthetic hand to perform various movements according to different identification results. As for sEMG-Based identification of hand motion commands, we employed recognition algorithms using wavelet neural network (WNN) combined with discrete wavelet transform (DWT), recognizing six predefined kinds of hand motion with three sEMG sensors. The experimental results show that the developed myoelectric prosthetic hand can identify six kinds of human gestures and generate related hand motions, and the actual average accuracy rate is 91.44%.

TueBIS-02

Hand Gesture Based Control Strategy for Mobile Robots

Hang Zhao Univ. of Electronic Science and Tech. of China
Jiangping Hu Univ. of Electronic Science and Tech. of China
Yuping Zhang Univ. of Electronic Science and Tech. of China
Hong Cheng Univ. of Electronic Science and Tech. of China

In this paper, a hand gesture based control design is proposed for mobile robots. Mobile robots can move according to the control signals encoded by hand gestures. The gesture region is segmented from complicated background and the gestures are recognized by using some techniques such as image processing, image filtering processing, morphological image processing, image contour processing, etc. Then a template matching algorithm is proposed with the help of the invariant moment matching method to recognize the hand gestures. The recognition results are decoded as feedback information to control the mobile robots. Finally, some simulation results are provided to validate the proposed control algorithm.

TueBIS-03

Research on the Acquisition of Human Body Behavior Data Based on Binocular Stereo Vision

Xueping Liu Nanjing Univ. of Aeronautics and Astronautics
Yibo Li Shenyang Aerospace Univ.
Xuezheng Zhuang Shenyang Aerospace Univ.

Against a complex background, we can accurately recognize targets with our eyes. In the field of research on robot vision, it has become a hot research topic to acquire interesting information from the surroundings through image sequences and then recognize targets. This paper studies the acquisition and matching of human body behavior data based on binocular stereo vision, extracts sparse feature points through the set calibration method, and extracts more accurate matching points by comparing the point matching method of limit constraint and the matching method of combining point features and regional matching, thus increasing the stability of feature points and improving the accuracy of acquisition. Through experiments, it is proved that the method presented in this paper for the acquisition of human body behavior data is practical and feasible.

TueBIS-04

Monitoring Design of Dumper Control System Based on KingView

Jia Yan Anshan Normal Univ.

Taking an actual Car Dumper Control System as an example, the control system is composed of two leves, the first is to execute the PLC logic and the other is the CRT monitoring system which could record the process log, reports, process monitoring and so on. According to the function of the second level, this paper is concerned with the monitoring system design by the KingView so that the system man-machine interface is simple and friendly, easy to use.

TueBIS-05

Feature Extraction by Common Spatial Pattern in Frequency Domain for Motor Imagery Tasks Classification

Jie Wang Xi'an Jiaotong Univ.
Zuren Feng Xi'an Jiaotong Univ.
Na Lu Xi'an Jiaotong Univ.

Common spatial pattern (CSP) as a feature extraction algorithm has been successfully applied to classify EEG based motor imagery tasks in brain computer interface (BCI). Successful application of CSP depends on the character of input signals and the first and last m eigenvectors of projection matrix. In this study, we proposed a novel and robust feature extraction method designated frequency domain CSP (FDCSP) that the samples in frequency domain obtained by fast Fourier transform (FFT) algorithm and evenly distributed in 8-30Hz were employed as the input signals of CSP. Besides, we made some modifications to classical CSP to address the inconsistent issue and enhance the generalization ability. Cross validation classification accuracy and standard deviation based on training data were employed as the principle to optimize the subject-specific parameter m. Two public EEG datasets (BCI competition IV dataset 2a and 2b) were used to validate the proposed method. Experimental results demonstrated that the proposed method significantly outperformed many other state-of-the-art methods in classification performance. What's more, samples in frequency domain as the input signals of CSP are demonstrated more robust against preprocessing. Based on the two public datasets, the proposed FDCSP method has potential significance to motor imagery based BCI design in practice.

TueBIS-06

Impedance Control for Human-Robot Interaction with an Adaptive Fuzzy Approach

Ping Li Huaqiao Univ.
Shuzhi Sam Ge National Univ. of Singapore
Univ. of Electronic Science and Tech. of China
Chen Wang National Univ. of Singapore
Univ. of Electronic Science and Tech. of China

In order to guarantee the safety of the human-robot interaction, an impedance control with adaptive fuzzy approach is proposed in this paper. First, by introducing a coordinate transformation, the control objective to track a desired impedance model is converted to the convergence of an error signal. Then a filter is used to set up the relationship between the error signal and the control input of the robot dynamics. By doing this, a control law is obtained with fuzzy logic systems to approximate unknown nonlinear dynamical functions, and adaptive laws are designed to guarantee the stability of the closed-loop system. The control law is concise in structure and clear in design process, by which the impedance error will converge to an arbitrarily small neighborhood of origin. Simulation studies are conducted to verify the validity of the proposed approach.

TueBIS-07

Current Measurement Technology Based on Rogowski Coil Low Voltage Apparatus

Fucheng Lang Electric Power Research Inst. of State Grid Liaoning Electric Power Co., Ltd
High Voltage and Large Current Laboratory of State Grid Corporation
Hongkui Zhang CCTEG Shenyang Research Inst.

With the continuous development of low voltage apparatus theory and manufacturing technology, the current of low voltage apparatus products is increasing. The current measurement technology during the switching test has become a hot research interest. On the basis of analyzing the working principle of Rogowski coil, the current calculation method of Rogowski coil current transformer is discussed systematically. And the switching test circuit is designed based on the Rogowski coil low voltage apparatus. The results show that the Rogowski coil can accurately

measure the switching test current of the low voltage apparatus and meet the switching test requirements of the related products.

TueBIS-08

The Design and Development of the Multi-user Collaboration Operation Examination System of the Novel Marine Engine Simulation Platform

Hui Zhang Dalian Maritime Univ.
Jianbo Sun Dalian Maritime Univ.
Yongfeng Huang Dalian Maritime Univ.

The multi-user collaboration operation examination system based on the TCP is designed to solve the limitation of collaborative operations in previous novel marine engine virtual reality simulation platform system. This paper will use the design of the communication mode, operation of information processing and the establishment of evaluation module to realize the different terminals' collaborative operation in virtual engine room of the same simulation platform; use the testing of each terminal to send data packets to the server and fuzzy comprehensive evaluation method to evaluate the whole collaborative group. The novel marine engine virtual reality simulation platform system has improved the traditional crew examination mode that the crews' collaboration ability and team consciousness will be truly enhanced.

TueBIS-09

Research on Adaptive Attitude Control of Quadrotor UAV

Xuehui Liang Tianjin Univ. of Tech.
Jingtao Li Tianjin Univ. of Tech.

The classical control algorithm for the control of quadrotor UAV in complex environments is undesirable, takes long for adjusting, response overshoot is large even oscillating. It is difficult to ensure a stable flight. However the adaptive control can quickly adjust the object to the equilibrium state. Considering the problem that some parameter of a quadrotor may be changed in some complex or external jamming flight environment, herein an adaptive control scheme with feed-forward and feedback control structure is proposed. It can effectively suppress and eliminate the influence of the change of inertia, and improve the system's anti-interference ability and self-adjustment ability. The testing results show the effectiveness of the control method, and achieve good control performance when the inertia changes.

TueBIS-10

The Development of Digital Image Feature Detection and Matching Software

Yanqun Wu North China Electric Power Univ.
Changliang Liu North China Electric Power Univ.

Digital image feature detection and matching is an important research content in the field of computer vision and pattern recognition. Inspired by Harris corner detector, the Harris correlation detector and Harris correlation descriptor (HCD) was studied and improved. In this paper, t he scale adaptive Gaussian filter was introduced to optimize the descriptor and then the RANSAC algorithm was used to filter the matching result accurately. The experimental results show that the improved descriptor is invariant to image rotation, linear change of illumination and scale change, and its matching performance is independent of the type of feature points. According to the above research, a software of image feature detection and matching based on Open CV was designed based on VS2010 platform, which can clearly and intuitively show the process and results of feature detection and matching of different feature point detectors and descriptors.

TueBIS-11

Kinect-based Gait Recognition System Design Via Deterministic Learning

Fengjiang Chen South China Univ. of Tech.
Muqing Deng South China Univ. of Tech.
Cong Wang South China Univ. of Tech.
Key Laboratory of Biomedical Engineering in Guangdong

This paper proposes an effective and rapid human gait recognition system based on deterministic learning and Microsoft sensor. In order to deal with the difficulties of feature extraction in the gait recognition system, Kinect sensor is used for realtime skeleton detection and tracking. Dynamical deterministic learning algorithm implementation is achieved and a rapid gait recognition scheme is proposed. The graphical programming language of C# and MATLAB GUI controls are combined for building user-friendly and simple interfaces to display the gait training and recognition process. The recognition results and detailed parameters can be displayed on the system panels, which is also helpful for further data analysis and algorithm improvement. The effectiveness of the gait recognition system under multi-pattern is verified on the self-constructed gait database.

TueBIS-12

Temperature Model of Greenhouse Environment Based on The Conservation Law of Material and Energy

Yang Yu Shenyang Ligong Univ.
Feihe Yin Shenyang Ligong Univ.
Huimin Liu Shenyang Ligong Univ.
Caiyun Wu Shenyang Ligong Univ.

An improved mechanism modeling method was proposed based on the conservation law of material and energy, namely taking the humidity change amount ΔH as input variable of temperature model, to some extent, which characterizes the coupling relationship between temperature and humidity. And based on different implementing agencies, this paper simplifies the greenhouse temperature model into two types, one is winter temperature model and the other is summer temperature model. Then simulation is carried out to validate the models with Matlab, the results show that the temperature model established in this paper is reasonable, laying the foundation for the optimization of greenhouse environment control.

TueBIS-13

Research of Dissolved Oxygen Concentration Control Strategy Based on the Fuzzy Self-tuning PID Parameter

Xiaotong Liu Changchun Univ. of Tech.
Weibo Yu Changchun Univ. of Tech.

As the result of the increasing speed of industrialization, a growing quantity of environmental pollution issues are coming up. Global people now attach greater importance to the sewage treatment process. The process of Dissolved Oxygen concentration control can be of randomly disturbance and time-varying, so it is unable to establish an accurate mathematical model. The traditional PID control couldn't tune its own parameters online, and however, through the fuzzy inference, the unconventional one self-tunes the parameters of PID controller online in accordance to the deviation of dissolved oxygen concentration and its rate. So it can help accurately control the concentration of dissolved oxygen during the waste water treatment procedure. Simulation experiments have shown that, in many aspects such as quality control and anti-interference, the control policy that self-tune PID parameter is superior to the traditional PID one.

TueBIS-14

An edge feature-based approach for workpiece localization and determination of feasible clamping regions

Zhiying Tan Chinese Academy of Sciences
Lin Xin Chinese Academy of Sciences
Univ. of Science and Tech. of China
Univ. of Science and Tech. of China
Jian Xu Univ. of Science and Tech. of China
Bo Zhou Univ. of Science and Tech. of China
Hanbin Zhao Chinese Academy of Sciences

We present an approach for automatic grasping based on object recognition and localization using the maximum edge of workpiece. This approach firstly extracts the sum coefficient matrix in the horizontal, vertical, and diagonal by the first layer of high frequency of wavelet decomposition structure. Find the key points that could satisfy the requirements of being the local maximum value and greater than the given threshold. Searching the points located in the maximal edge of workpiece from the set composed of key points by polar coordinates transform. By linear interpolation method, obtain the radius under the radians defined beforehand. Artifacts teach an initial position and angle, and calculate the maximal edge. Matching each maximal edge of new workpiece with the maximal edge of initial workpiece, calculate the rotation angle current workpiece relative to the initial workpiece. Aiming at the classification of the workpiece, Principal Component Analysis (PCA) algorithm can be applied to compute the eigenvalues which are the rotational invariant. The vector being composed of main eigenvalues can be used to solve the problem of classification.

TueBIS-15

An adaptive weighted ant colony algorithm

Shiwei Gao Lanzhou Petrochemical Coll. of Vocational Tech.
Yajie Li Lanzhou Univ. of Tech.

The ant colony algorithm is a metaheuristic algorithm, it provides a new approach for solving discrete optimization problems-the traveling salesman problem, for instance, is usually tested as the benchmark. Since the ant colony algorithm was introduced, many refinements have been developed to improve the performance by refining the pheromone updating strategies, which have achieved great success on the traveling salesman problem. We introduce a new ant colony algorithm based on Adaptive Weighted Updating Rule. Results demonstrate the effectiveness and flexibility of the new algorithm in this paper.

TueBIS-16

Research and Simulation on Speed Curve Algorithm for Online mould width adjustment

Yingming Yang Guidaojiaotong Polytechnic Inst.

This paper mainly studied the online MWA (Mould Width Adjustment) speed curve algorithm. It's based on the variable speed and taper movement trajectory. It analyses the defect of current adjustable width trajectory and puts forward the adjustable movement trajectory automatically according to the adjustment range. Online MWA speed curve presetting simulation system is developed against the proposed width adjustment movement trajectory. We can find out that this kind of speed curve algorithm can automatically choose the width adjustment way and finally achieve the target from the system input data gathered from the scene of the continuous casting and the simulation curve. The technical personnel can know the whole process and key parameters of width adjustment process before the width adjustment production. It can make sure the safety of the width adjustment production.

TueBIS-17

Finite Element Analysis of Liquid-Solid Coupling Problem

Zhaofeng Wang Bohai Univ.
Guohong You Bohai Univ.
Qinghui Wu Bohai Univ.
Ying Tian Bohai Univ.

It is of great significance to accurately get the liquid-solid fraction of continuous casting slab with regard to decreasing internal defects of the slab such as the central segregation and shrinkage porosity and improving the quality of slabs and productivity. According to the similarity theory, a set of physical simulation device using the materials of organic glass and water is designed. And the finite element analysis is accomplished using ANSYS software following the model device. Basing on physical experiment and numerical simulation, the research results provide guidance and reference for the on-line detection of liquid-solid fraction and final solidifying end of the slab.

TueBIS-18

Research on Calculation Model of Water Isolation for Batch-sequence Operation of Slurry Pipeline Transportation Based on Longitudinal Turbulent Diffusion

Jun Ma Kunming Univ. Science and Tech.
Guangyue Pu Yunnan Tianlang Energy Saving and Environmental Protection Group Co. Ltd.
Hongwei Liu Yunnan Tianlang Energy Saving and Environmental Protection Group Co. Ltd.
Jiande Wu Kunming Univ. Science and Tech.

As results of the multi-slurry transportation and complex properties of the batch-sequence operation, the transportation technology is rather complex in the complex terrain long-distance pipeline transportation of iron ore. In the process of design, operation control and scheduling, some technical parameters directly relate to the effectiveness of switch and monitoring of operation conditions and safety of slurry transportation. The calculation model of water isolation, therefore, is built to accurately calculate the length of water isolation in the batch-sequence operation of complex terrain long-distance slurry pipeline and the model was verified through experiments. The experiments prove that the model mentioned in the paper can effectively calculate the length of water isolation and theoretical and experimental basis for the design of batch-sequence operation of slurry pipeline.

TueBIS-19

Mathematical model establishment for cable eccentricity online detection system based on X-ray

Lili Wang Qingdao Univ. of Science and Tech.
Qingdao Hanhe Cable Co. Ltd.
Chuansheng Wang Qingdao Univ. of Science and Tech.
Jingyuan Cheng Shenyang SIASUN Robot & Automation Co. Ltd.
Qingdao Hanhe Cable Co. Ltd.
Tao Zhang Qingdao Univ. of Science and Tech.
Huihui Wang Qingdao Univ. of Science and Tech.

China is the world's largest cable producer and eccentricity is an important indicator to measure the quality of cable. Lack of online detection technology has been the soft underbelly of China's cable industry development. The online detection technology is monopolized by few enterprises, and domestic online detection equipment all rely on imports which seriously affects the China's cable industry. In view of the above situation, the cable eccentricity online detection system was studied in this paper based on X ray. Firstly, the cable eccentricity detection way was established after the analysis of different detection method; secondly, the main performance and the influence factors were analyzed. According to the characteristics of cable online detection, the detection scheme was determined. And then the mathematical model and MATLAB simulation for detection point scanning method were finally accomplished.

TueBIS-20

Low-temperature thawing Refrigerator Based on the Internet of Things

Shuqing Wang Guangdong Ocean Univ.
Guibin Lei Guangdong Ocean Univ.
Wei Wan Guangdong Ocean Univ.
Ying Zhang Guangdong Ocean Univ.
Canping Li Guangdong Ocean Univ.

Quick thawing destroys the taste, some nutrients of frozen foods and their thawing in crisper of normal household refrigerator needs manual operation. Low temperature thawing refrigerator based on the internet of things includes refrigerator, AP (wireless access point), manufacturer's cloud computing service system, internet and remote terminal. Refrigerator is composed of three insulated crispers and six insulated freezers where temperature is controlled respectively. Cooling capacity of freezers flows into the crispers slowly in air pipes among them. Frozen foods thaw out slowly and automatically according to the user's appointment in the freezers. Their taste and nutrients are preserved better and it saves energy comparing with normal one. At the same time, the user supervises its operation parameters, foods status parameters and time of low-temperature thawing by remote terminal.

TueBIS-21

Design of Intelligent Control System for Plant Growth

Rong Li Beijing Vocational Coll. of Agriculture
Hongmei Liu Beijing Vocational Coll. of Agriculture
Xiangjun Wang Beijing Vocational Coll. of Agriculture
Yuchao Bian Beijing Vocational Coll. of Agriculture
Kun Li Beijing Vocational Coll. of Agriculture

Plants can improve our living environment and the quality of life in the home. At present, plants which are only limited to automatic watering have not yet achieved automatic maintenance. The temperature, humidity and illumination are not controlled by the whole. So this caused some problems, such as short survival time, poor growth and so on. To solve this problem, an intelligent plant system is presented in this paper. This system includes upper computer system and lower computer system. The lower computer system can realize automatic temperature control, plant watering, supplementary illumination automatically. Also it can realize display parameters in real time and alarm prompt. In upper computer system, remote monitoring can be realized by manual or automatic mode. This intelligent plant system can achieve the plant conservation automatically, meet the needs of plant growth, improve the plant growth status, and extend the survival time of plants. At the same time, this system can be used as a sub module of intelligent home, which can rich the existing home system.

TueBIS-22

Intelligent home system based on ZigBee and CPS

Dongmei Yan Northeastern Univ. at Qinhuangdao
Yuandong Zhao Northeastern Univ. at Qinhuangdao

Intelligent home system based on ZigBee and CPS is proposed in this paper after studying the structure and function of ZigBee protocol and CPS (Cyber-physical systems). The remote communication is done by GPRS network. ZigBee wireless network platform uses the low power microcontroller CC2530, which consists of a photosensitive sensor, combustible gas sensor, humidity sensor, infrared sensor and 12864 LCD screen. Home execution system is composed of music light cube, step motor, GPRS module, and fan etc. , which can effectively improve the home environment. ZigBee protocol stack is used to design software in order to coordinate modules' tasks and effectively establish and maintain whole network. LabVIEW is adopted to achieve the dynamic data display and the realization of wireless opening lighting and fan, and selecting Home mode function. This intelligent home system is characterized by signal diversified information collection, diversified communication, friendly human-machine interaction and good tailoring and extensibility.

TueBIS-23

A Method for Knowledge Construction from Natural Language Based on Reinforcement Learning

Mengyang Zhang Shandong Univ.
Guohui Tian Shenzhen Research Inst. of Shandong Univ.
Jing Gong Shandong Univ.
Yuan Yuan Shandong Univ.

It is promising to raise the intelligence level of service robot by extracting information from natural language. The problem has been noticed that NLP system frequently mislabel passive voice verb phrases as being in the active voice on the condition without auxiliary verb, which will reduce the correctness of produced knowledge based on natural language. A method based on reinforcement learning for household knowledge construction is proposed in this paper, according to the problem. Firstly, a dynamic simulation platform modelled on the laboratoryl is built. Secondly, a system of justification is designed as agent to produce scores of the action sequences from natural language. Thirdly, with the combination of above parts, we adopt reinforcement learning algorithm for training to obtain the appropriate compositions of action sequences. As preprocessing has been made to reduce the complexity of the actions and states, expected results can be obtained with this method.

TueBIS-24

Project-Based Learning in Microcontrollers Using Virtual and Real Setups

Guojun Su Tianjin Univ. of Tech. and Education
Jin Wang Tianjin Univ. of Tech. and Education

The use of microcontroller (MCU) has become pervasive in every aspect of our daily life, and MCU is also an important course for most Chinese Univ. students of electrical engineering and automation major. Project-based learning (PBL) appears as one of the most interesting instructional strategies, the PBL strategy tries to engage students in authentic real-world tasks to enhance learning, PBL is a student-centered strategy that fosters student initiative and focuses the student on real-world, open-ended projects that can increase the motivation for most of them, these projects foster a wide range of abilities including knowledge and practical skills. Two tools were designed to help the students to study MCU based on PBL: a virtual Proteus simulation and a real setup. Using Proteus VSM, software development can begin as soon as the schematic is drawn, and the combination of hardware and software can be thoroughly tested before physical prototype is constructed. The combination of virtual and real setups can realize seamless connection between theory and practice, both virtual and real setups are described by example, and the results obtained by the students are discussed. Students gain hands-on experience, and also improve their skill in product development, self-directed learning, teamwork, and project management. Practical projects increase the challenge for students and, hence, their interest level. The results show that the students valued both tools and were able to address MCU problems at a high cognitive level.

TueBIS-25

Time-delay analysis of the remote control problem based on the internet of things

Yuan Wang Shanghai Jiao Tong Univ.
Zuohua Tian Shanghai Jiao Tong Univ.

Currently, household applicances and terminal equipment use switch or motor control mostly. The smart home and the needs of remote control are not fully considered at the beginning of design of the equipment. Because of the influence of the network time delay. The way to control the equipment directly through the internet of things is inconvenient. Switch controller will be forced changing between the two states for lag factors. In view of the reality that exist in a large number of nonlinear controller, this paper analyzes network time delay for the influence of dead zone relay control features and the way fluctuation in network time delay affect the nonlinear control system with “Smith forecast compensation”. By analyzing the relationship between fluctuation in network time delay and system stability margin and changing the structure of “Smith forecast compensation”, the paper put forward to change forecast device parameters dynamically and reduce the effect of the fluctuation network time delay on nonlinear controller system.

TueBIS-26

Design of Communication-Modulation Unit In PEBB

Boyang Xing Beijing Inst. of Tech.
Chao Pan Kunming Inst. of Physics
Di Zhang Beijing Inst. of Tech.
Feng Pan Beijing Inst. of Tech.
Kunming-BIT Industry Tech. Research Inst. INC

Power electric building blocks (PEBB) simplifies the design of three level inverter, the new system is high-integrated and high-standard. A three level communication-modulation power electric unit including a high-speed communications network base on power electronic high-speed communication network (PES-net) protocol and a three level SVPWM modulator, all the system is designed and realized on FPGA. By integrating the three level SVPWM modulator in this unit the communication bandwidth demand is effectively reduced and the master controller`s CPU resources can be released .In order to verify this design, an experiment platform based on SEMIKRON three level power unit is constructed in this paper. Three experiments validated the unit`s communication and modulation function .Our unit works right in distributed system and the newly-designed fiber auxiliary network ensures a 5ns delay between each module.

TueBIS-27

A Coverage Configuration Scheme of Wireless Sensor Networks Base on Collaborative Sensing in Shadow Fading

Ying Tian Bohai Univ.
Yang Ou Bohai Univ.
Guohong You Bohai Univ.
Zhaofeng Wang Bohai Univ.

This paper analyzes the coverage problem under the shadow fading of the WSN with sensors deployed in the monitor region randomly and high density. Because the target sensed probability by multi-sensors is better than the single sensor, in the paper the collaborative sensing model is deduced, and then a coverage configuration scheme based on cooperative sensing model under shadowing is promoted. In the coverage scheme the judgment of the area coverage is simplify to the judgment of some special points under Voronoi dividing. The simulation results show that our method is more excellent than other protocol in aspects of the number of active nodes and the network coverage quality.

TueBIS-28

K1,1-structure connectivity and K1,1-substructure connectivity of torus

Yali Lv Henan Univ. of Chinese Medicine
Yulong Xu Henan Univ. of Chinese Medicine

The connectivity of a network is directly related to its reliability and fault tolerability, hence an important indicator of the network’s robustness. In this paper, we investigate the fault-tolerant capabilities of torus networks with respect to the$K_{1,1}$-structure connectivity and$K_{1,1}$-substructure connectivity. TheK1,1-structure connectivity of a graph G, denoted by $\kappa(G;K_{1,1})$, is the minimum cardinality of a set of connected subgraphs in G, whose deletion disconnects the graph G and every element in the set is isomorphic to$K_{1,1}$. The$K_{1,1}$-substructure connectivity of a graph G, denoted by $\kappa^s(G;K_{1,1})$, is the minimum cardinality of a set of connected subgraphs in G, whose deletion disconnects the graph G and every element in the set is isomorphic to a connected subgraph of $K_{1,1}$. In this paper, we will establish both the $K_{1,1}$-structure connectivity and $K_{1,1}$-substructure connectivity of torus networks.

TueBIS-29

Solving for Time-Varying Inverse Square Root by Different ZD Models Based on Different Zhang Functions

Yunong Zhang Sun Yat-sen Univ.
Xiaotian Yu Sun Yat-sen Univ.
Yunjia Xie Sun Yat-sen Univ.
Hongzhou Tan Sun Yat-sen Univ.
Zhengping Fan Sun Yat-sen Univ.

A novel class of neural dynamics, Zhang dynamics (ZD), has been recently proposed for online time-varying problem solving. The design method of ZD is based on an indefinite error-monitoring function called the Zhang function (ZF), instead of the conventional norm-based scalar-valued energy function. In this paper, different ZD models based on different ZFs are proposed and developed for solving the time-varying inverse square root (TVISR) problem. In addition, this paper investigates the modeling of the proposed ZD models using MATLAB Simulink techniques. Results of the MATLAB Simulink modeling substantiate the efficacy and superiority of the ZD models for TVISR problem solving.

TueBIS-30

Discrete Jaya algorithm for solving flexible job shop rescheduling problem

Jing Guo Yangzhou Polytechnic Inst.
Kaizhou Gao Liaocheng Univ.
Chao Wang Yangzhou Polytechnic Inst.
Hongyan Sang Liaocheng Univ.
Junqing Li Liaocheng Univ.
Peiyong Duan Liaocheng Univ.

Rescheduling is a necessary procedure when new jobs come and are inserted into existing schedule in remanufacturing. The stability is an important metrics to evaluate the quality of rescheduling solution. This paper proposed a novel discrete Jaya algorithm to solve flexible job shop rescheduling problem with five objectives, including Makespan, total flow time, maximum machine workload, total machine workload, and stability metrics. The purpose is to analyze the influence or conflict between rescheduling stability and other objectives. Experiments are executed on a large scale remanufacturing case. When the stability metric is optimized, the convergence history of other objectives is recorded. The convergence curves of stability metric are counted when the four objectives are optimized individually. The results and discussions show that the stability metrics is conflict or conflict to a certain extent with other objectives.

TueBIS-31

Thermostatically Controlled Appliances for Demand Response Based on An Improved State Queuing Model

Jiao Liu Zhejiang Univ.
Qiang Yang Zhejiang Univ.
Wenjun Yan Zhejiang Univ.

Currently, the participation of Thermostatically Controlled Appliances (TCAs) weighs more and more heavily in the demand response. This paper presents a modified state queuing model with the improvement from two aspects: the modified method takes the user comfort constraints and lifetime protection of appliances into consideration, so the frequent state switching of appliances are avoided; the load diversity of the system consisting of thermostatically controlled appliances (TCAs) can be maintained and hence the capability of demand response will not be degraded. The modified state queuing model is implemented its performance for demand response has been studied through a set of simulation experiments for different scenarios. The numerical results demonstrate the effectiveness of the proposed model.

TueBIS-32

Improved Prim Algorithm and Its Application in Unmanned Aerial Vehicle Cruise System

Funa Zhou Henan Univ.
Po Hu Henan Univ.
Xiaoliang Feng Henan Univ. of Tech.
Yansui Song Northwestern Polytechnic Univ.

Unmanned Aerial Vehicle (UAV) can perform tasks such as military reconnaissance, monitoring, search and target pointing. When a UAV is used to perform a reconnaissance task on a cruise path planning, and certain set of multi-target point, the optimal cruise path should be well scheduled to ensure that the cruise time is minimal. In this paper, an improved Prim algorithm is studied by introducing constraint condition to improve the effect of UAV path planning. Based on the data provided by GPS module, the weight matrix between the target points is obtained by using coordinate transformation, and the optimal cruise sequence is obtained by using the improved Prim algorithm. Simulation results and success application in cruise path planning of UAV show the efficiency of this improved Prim algorithm.

TueBIS-33

Multi-agent Decentralized Scheduling for Dynamic Client Requirements in Logistics

Jiajia Zheng Chongqing City Management Coll.
Xiaohui Bai Chongqing Univ.
Zhenyu Gu Chongqing Univ.
Guorong Liu Chongqing Univ.

For the dynamic client of pickup in logistic, the existing model is that distribution center redeploys vehicles to service for client after accumulation of a certain amount of orders. This approach can't respond to client in time. Re-deployment of vehicles will also increase distribution costs. For the present situation, the paper proposes a multi-agent decentralized control dispatching model which integrates pickup and delivery process. All in-transit vehicles are an independent agent. When a dynamic client has a request of pickup, the nearby in-transit agents can process it in time. If an agent satisfies the condition, it can optimize the distribution route through the insertion algorithm and the self-learning algorithm. Finally, according to the difference of the objective functions before and after inserting dynamic client, setting different priority, the agent best suited the order has the highest priority, when more than one agent meet the conditions for the order.

TueBIS-34

GPRS Based River Water Level Monitoring and Measuring System

Yajun Wang Tianshi Coll.
Zhengguang LIU Tianjin Univ.

According to the current status for measuring water-level of the river, a river water-level remote monitoring system has been designed, which consists of a water-level sensor, a single chip microcomputer, a wireless module and user terminals. The designed contact type water-level sensor based on a simple principle with a high performance-cost ratio, has eliminated the shortcomings of the current sensors, which must be placed under the water with difficulty of water proof. The water level information collected can be real-time transmitted with signal of GPRS to the server terminal, users can easily transfer real-time data and history of data record from the server terminal. The experimental results show that the system can work stably, with a high accuracy, low cost, and easy to market.

TueBIS-35

Global Calibrating System Design of Three-dimensional Force Platform

Jianbo Yang Aircraft Strength Research Inst. of China
Jia Ren Aircraft Strength Research Inst. of China
Yunfang Xue Aircraft Strength Research Inst. of China

Traditional manufacturing processes of 3D force platform (three-dimensional force platform) are purchasing of three dimensional force sensor, calibrating of sensor in specialized agencies and building up with platform table and base. However, due to processing accuracy and installation error, the method of calibration before building up cannot guarantee the global accuracy of 3D force platform, and it is difficult to meet the requirements in practice. An improved method is proposed in this article that calibrating force sensors first, then dynamic monitoring the installation process, and global calibrating the 3D platform, verifying the calibration results at last. This article design a global calibrating system based on the global calibrating method which achieve the function of data extraction, classification, data evaluation and parameter optimization. The 3D force platform is calibrated again using the optimized parameters, and the result shows that the optimized calibration results are in coincide with the calculated results. At the same time, the method of sensitivity optimization based on global calibrating avoids the low efficiency caused by trial-and-error method and repeatedly loaded, and then improves the calibration efficiency and accuracy.

TueBIS-36

Research and Development of An On-line Electric Energy Data Acquisition and Monitoring System

Yuezhong Li East China Univ. Jiangxi Province Engineering Research Center of New Energy Tech. and Equipment
Lingyuan Zeng East China Univ. Jiangxi Province Engineering Research Center of New Energy Tech. and Equipment
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In view of the existence of manual meter reading various drawbacks, and achieving the remote monitoring, analysis and management of energy consumption, we present a practical application system: An Online Electric Energy Data Acquisition and Monitoring System. The system consists of intelligent data acquisition terminal and management platform. The intelligent data acquisition terminal gets data through Power Line Carrier or RS-485 from electric energy meter which is named downlink communication and uplink communication with the remote management platform by GPRS channel. Downlink communication uses “DL/T645-2007Multi-function watt-hour meter communication protocol”, and uplink communication protocol is the “Q/GDW1376.1—2012 power user electric energy data acquisition system communication protocol”. Both of the two protocols are in line with national standards which can ensure a good compatibility with electric energy meter product by different companies. To ensure high real time performance, a strictly time control mechanism for per meter reading and dynamic data storage management mode have been designed. Besides, a reasonable reconnection mechanism and an heartbeat frame between acquisition terminal and management platform is necessary to achieve high on-line performance.

TueBIS-37

Measurement and analysis of Atmospheric Transmittance based on radiometer

Wei Guan Shenyang Inst. of Aeronautical Engineering
Jianmei Liu Shenyang Inst. of Aeronautical Engineering
Qi Wang Shenyang Inst. of Aeronautical Engineering
Li Fu Shenyang Inst. of Aeronautical Engineering

Atmospheric transmittance is an important factor that affects the accuracy of target radiation measurement. In this paper, the radiation characteristics of the target body are measured by infrared radiometer MR170.The response of the spectral radiometer is calibrated by two-point method. Based on the measurement results of the target blackbody radiation under the condition of different temperatures, the atmospheric transmittance is calculated, and the radiation brightness is retrieved by calculating the atmospheric transmittance. The experimental results show that the method can be used to measure the atmospheric transmittance and improve the measurement accuracy of the radiation characteristics.

TueBIS-38

Analysis of Power Grid Harmonics with Wavelet Network

Xiao-lei Yuan Hebei Electrical Power Research Inst.
Gang Peng Hebei Electrical Power Research Inst.
Fudong Zhang Hebei Electrical Power Research Inst.
Chunlai Yang Hebei Electrical Power Research Inst.
Zhe Yin Hebei Electrical Power Research Inst.
Sulong Ren Hebei Electrical Power Research Inst.
Jianfeng Li Hebei Electrical Power Research Inst.

Harmonics are usually analyzed through Fourier transform or wavelet transform, both of which have their shortcomings. Wavelet neural-network is a new algorithm that combines wavelet analysis with neural-network, suitable for processing signals with time-varying frequency domain characters. To analyze the third and fifth harmonics, a wavelet network structure was constructed, training algorithm described in detail, simulation experiments showed very satisfactory results, proving the algorithm to be good at analyzing harmonics in real-time with high accuracy.

TueBIS-39

The Design of PM2.5 Detector Based on ARM

Ailing Qu Beijing Vocational Coll. of Agriculture
Changlu Ma Beijing Vocational Coll. of Agriculture
Qiuyan Liang Jiamusi Univ.
Hongmei Liu Beijing Vocational Coll. of Agriculture
Rong Li Beijing Vocational Coll. of Agriculture

PM2.5 detector has been designed based on ARM technology with PM2.5 laser sensor. The detector can detect the concentration of PM2.5 in the current environment in real-time, with three functions including of voice broadcast, LCD real-time display and air quality level LED light alert.

TueBIS-40

Design and Implementation of LiDAR Navigation System Based On Triangulation Measurement

Dehong Cong Northeastern Univ.
Liangqi Zhang Northeastern Univ.
Pengpeng Su Northeastern Univ.
Zaiyang Tang Northeastern Univ.
Yuhao Meng Northeastern Univ.
Yong Wang Northeastern Univ.

Lidar, an important navigation instrument, is applied on various service robots and is receiving increasing attention. To solve the problem that present lidar systems are large, expensive, complecated to use and have low accuracy. This paper introduces a lidar navigation system with an upper computer application facing service robots. This lidar system is based on triangulation measurement which can get accurate distance results with our algorithm and the upper computer application can draw a 2D image. This system emits laser with a 5nw visible laser transmitter and receives the laser with a Dlis 2k photosensitive sensor, so that the system can calculate the distance to the measured object. With our mechanical design, our lidar system can realize 360°measurement. It also has an accaptable accuracy and cost.

TueBIS-41

Switching Power Supply Design Suitable for Motor Control

Zhichao Zhao Tianjin Univ. of Tech.
Guohong Li Tianjin Univ. of Tech.

Motor control systems require multi-channel stable output low voltage DC power supply. According to the needs of motor control system, a switching power supply can meet the requirements of motor control is designed. The topology of switching power supply and the uses of PWM control chips are expatiated. The positive and negative bias generation circuit of IGBT is designed. Power circuit components’ choices and design method of a high frequency transformer of the flyback switching power supply are given. Finally, the basic performances of switching power supply were tested; the results show that it can meet the requirements of motor control systems.

TueBIS-42

Innovative Design and Realization of Lightweight Delta Robot Platform

Dehong Cong Northeastern Univ.
Chengyao Li Northeastern Univ.
Ruchao Wang Northeastern Univ.
Chen Song Northeastern Univ.
Chang Tian Northeastern Univ.
Zhijian Qiao Northeastern Univ.

In order to effectively reduce the cost of Delta robot in production applications and improve the application of Delta robot in the low industrialized area, this paper introduces the structure design and realization of a new type of Delta robot, which mainly by the traditional Delta robot dynamic and static platform structure inverting to achieve Delta structure of light weight and platform. In this paper, the design of the new Delta robot, kinematics inverse solution and the design of the control

system of PC and motion controller are introduced in detail.

TueBIS-43

The Research About Self-Balancing Mobile Platform Based On Differential Wheel

Dehong Cong Northeastern Univ.
Qichen Gong Northeastern Univ.
Peng Xu Northeastern Univ.
Huadong Li Northeastern Univ.
Hao Zhou Northeastern Univ.
Tian Kai Northeastern Univ.

In order to solve the problem of small application range, poor adaptability, mechanical structure and its function, this paper presents a design scheme of self-balancing mobile platform based on differential wheel drive. The mobile platform uses the nine-axis gyroscope and the magnetic encoder to collect the attitude information, through the processing of information to control the mobile platform to achieve the balance required to adjust the amount of adjustment of the motor, while balancing can also achieve the movement and other actions. The mobile platform for a wide range of applications, and can achieve automatic control and remote control two control methods. This article will be a detailed description of the design of the platform.

TueBIS-44

On low-cost and high precision localization of snowplow robot: A fuzzy and visuality approach

Lei Xu Chongqing Univ.
Junfeng Lai Chongqing Univ.
Xuehai Tu Chongqing Univ.
Yan Zhang Chongqing Univ.

In this paper, stabilization control of an undercatuated ship in the presence of input saturation is addressed. By introducing a virtual reference, the stabilization control of an underactuated ship is transformed into a path following problem thus the error dynamics is divided into a cascade of two subsystems, and the torques in surge and yaw axis are designed separately with backstepping technique. It is shown that the closed-loop system is stable and the position errors converge to the orign with arbitrarily small errors.

TueBIS-45

Stabilization Control of Underactuated Ships with Input Saturation

Jiangshuai Huang Congqing Univ.
Rui Hu Congqing Univ.
Tingting Gao Zhejiang Textile & Fashion Coll.
Dan Zhang Zhejiang Univ. of Tech.

In this paper, a new design of adaptive iterative learning control (ILC) for a class of uncertain nonlinear systems is proposed for the purpose of state tracking and improving convergence speed with both parametric and nonparametric uncertainties. The main feature of the design is that the controller signal is continuous due to the use of integral and employment of second-order sliding mode technique. Nonparametric uncertainties such as norm-bounded nonlinear uncertainties satisfying local Lipschitz condition can be effectively handled. In response to unknown bounded disturbances, a continuous sliding mode adaptive iterative learning control is more robust. By designing a suitable controller and composite energy function, the convergence of tracking error sequence within a small neighborhood of the origin is achieved in the iteration domain. In the end, an illustrative example is presented to demonstrate the efficacy of the proposed ILC scheme.

TueBIS-46

Ankle Rehabilitation robot control based on Biological Signals

Xingang Zhao Shenyang Inst. of Automation CAS
Huabao Sun Northeastern Univ.
Dan Ye Northeastern Univ.

In this paper, estimating joint torque of ankle joint with EMG signals to establish the relationship between joint torque and joint angle, to control continuous motion for ankle rehabilitation equipment. This research firstly uses LDA algorithm to deal with two channels EMG signals (anterior tibial (TA) and gastrocnemius (GA)) which have been already collected to achieve the classification of ankle joint movement, then selects the corresponding BP neural network model, and selects the active signals associated with such muscles as inputs to the BP neural network model to estimate the joint torque. In order to meet the requirements that the patients in different rehabilitation conditions need for ankle rehabilitation equipment movement range, patients just reset the angle range, to achieve the control of adjustable amplitude continuous motion. Experimental results on several subjects demonstrated that the ankle motion intention can be precisely predicted in advance, and the angle range was also adjustable based on the requirements of subjects.

TueBIS-47

An Improved TLD Method Based on Color Feature

Jianghai Hu Shanghai Jiao Tong Univ.
Meng Cai Luoyang Inst. of Electro-optical Equipment AVIC
Jianxun Li Shanghai Jiao Tong Univ.

Visual object tracking is a significant issue in the task of following a target in a stream of images. In this paper, we address this problem by proposing a novel parallel frame based on the original tracking-learning-detection method. The detector and the tracker in our algorithm are working simultaneously and output the candidate regions, then we perform analysis on these regions based on its color feature in HSV color space and the final position of target can be obtained naturally. Besides, this paper introduces BRISK into our tracker to alleviate the instability caused by target rotation and illumination variation. Extensive experimental results on massive benchmark datasets demonstrate that our algorithm has a crucial improvement over the original TLD and other state-of-the-art algorithms.

TueBIS-48

Multi-sensor Adaptive Data Fusion with Colored Measurement Noise

Yao Wu Shanghai Jiao Tong Univ.
Satellite Marine Tracking & Control Department of China
Meng Cai Luoyang Inst. of Electro-optical Equip ment AVIC
Jianxun LI Shanghai Jiao Tong Univ.

As one of the key theories of target tracking, Multi-sensor data fusion (MSDF) is widely utilized in engineering practice. Generally, the research of MSDF is under the hypothesis that the measurement systems of sensors are only influenced by white noise and their priori knowledge is obtained, which is not appropriate for practical application. Considering these situations, a white noise model convention and adaptive measurement noise adjustment is added into the two proposed fusion methods called centralized measurement fusion (CMF) and decentralized state fusion (DSF). The equations of fusion estimation results are derived both with and without white noise convention. The method of adaptive covariance adjustment based on artificial neural network (ANN) is explored. The simulation results show that the measurement model is estimated more precisely by denoting the colored noise with white noise, the adaptive variance adjustment method contributes to overcoming the priori information deficiency of noise and keep the tracking precision, and the DSF has higher tracking accuracy than the local filter based on each sensor but lower than the CMF.

TueBIS-49

Research on Experiment Control of Anti-Shock Damage Mechanism of Torpedo and Mine

Gao Xin No.91439 troops of PLA

This paper discusses the related problems of the weapon anti - shock damage mechanism test. Firstly, the damage mode of torpedoes and mines under underwater explosion is analyzed according to the relative conditions of the weapon's impact test. The mode of failure to torpedoes and mines is given in the explosion. Secondly, the damage mechanism of torpedoes and mines is analyzed. The influence factors of the damage mechanism test are obtained, and the type of verification test is given. Based on the confirmation of test types and influencing factors, according to the underwater explosion similarity theory, and considering the boundary conditions, the use of the environment, their own structure of torpedoes and mines, anti-weapon attack and other factors, the design of the verification test condition is carried out. Through the study of verification test of key issues, the theoretical guidance and support are provided to carry out the damage mechanism verification test.

TueBIS-50

Research on the Ship Local Structure Damage Subjected to Underwater Explosion

Yongkun Zhang No.91439 troops of PLA
Xin Gao No.91439 troops of PLA

Ship local structure damage effect subjected underwater explosion has been studied by using theory analyze and numerical simulation method. Firstly, the forms of local structure damage have been introduced. Secondly, the numerical model of deformation and crevasse has been established. The structure damage effect of classical ship has been gained according to those models and the results have been compared with experiment data. These show that those two methods have been achieved the same results in predicting ship local structure damage effect. Those results have validated correctness of theoretical model and feasibility of numerical simulation.

TueBIS-51

Face Recognition based on Weighted Multi-Resolution Kernel Entropy Component Analysis

Xiaoli Ruan Yunnan Univ.
Shunfang Wang Yunnan Univ.

In order to overcome the instability of non-linear high dimensional facial data caused by illumination and expression, and obtain rich, effective and complementary face features, we put forward a method for face recognition by improving kernel entropy component analysis (KECA) with weighted multi-resolution. First, we use traversal algorithm to search an optimal weight for the multi-resolution face feature, and extract the features of each face feature set via Gabor wavelets. Second, we utilize the nonlinear dimension reduction algorithms of KECA and KPCA (kernel principal component analysis) to process the data, respectively, and compare the results of these two. Third, K-nearest neighbor is used for final classification on the fusion of different weighted multi-resolution human face images. The experimental results of the ORL and YELA face database showed that our proposed method has a high recognition ability and stability compared with the common feature reduction algorithms.

TueBIS-52

Harmonic Detection Method Based on Compressed Sensing Theory in the Application of APF

Xifeng Guo Shenyang Jianzhu Univ.
Rui Zhang Shenyang Jianzhu Univ.
Meiju Liu Shenyang Jianzhu Univ.
Sen Tan Northeastern Univ.
Jinxiang Pian Shenyang Jianzhu Univ.

According to the demand of harmonic detection of APF, a new method using compressed sensing theory is proposed in this paper. Firstly, the signal is ensured to be expressed as sparse form using compressed sensing technique in actual grid, and harmonic signal detected is reconstructed by orthogonal matching pursuit after compressed sampling. The simulation and experiment results show detection precision and response of the system can be enhanced without the need to increase sampling points, which make it possible to improve the performance of APF with bright application foreground.

TueBIS-53

Dynamic Prediction for Thermal Error of High-speed Machine Center Using Grey Bootstrap

Taomei Lv Henan Quality Polytechnic
Fannian Meng Zhengzhou Univ. of Light Industry
Jiangping Tao Ping Gao Group CO.LTD

Thermal error is always the key factor which affects processing precision of high-speed machine center. How to predict the thermal error of the high-speed machine center is the prerequisite and foundation of thermal error compensation. To solve this problem, a grey bootstrap model is proposed, which is first used thermal error prediction of high-speed machine center. Experimental study shows that the prediction accuracy is very high using grey bootstrap model, and the maximum, the minimum and the mean of the relative errors of the predicted results are respectively 7.72% ,1.19% and 4.48%, and the reliability of the predicted interval is proved to be 100%. The point prediction and interval prediction are actualized, which solve the problem of dynamic evaluation of thermal error of high-speed machine center.

TueBIS-54

A User-side Non-Invasive Load Decomposition Method Based on SVM

Zesong Wang Shenyang Univ. of Tech.

The non-intrusive load decomposition method based on Support Vector Machine (SVM) is a new method of load decomposition. The process of SVM on non-invasive power load decomposition is studied in this paper. Using every period of sampling method, the characteristics are extracted to effectively filter out the spikes caused by the start or stop of the electrical appliances. The Principal Component Analysis (PCA) is used to reduce the dimensionality of the feature and the influence of the characteristics which is not strong or counterproductive on the accuracy of classification results. Finally, the selected key features are brought into SVM for classification simulation.

TueBIS-55

Establishment of theoretical model of magnetic dipole for ground marking system

Liying Sun Tianjin Chengjian Univ.
Yibo Li Tianjin Univ.
Yutong Wu Tianjin Chengjian Univ.
Jianghui Guo Tianjin Chengjian Univ.
Zongqiang Li Tianjin Chengjian Univ.

Ground marking system is an important device used in pipeline corrosion and leakage detector (MFL_PIG) for recording the exact time when the detector with strong magnets passes right below the above ground marker (AGM). The precision of AGM is critical to defect location during pipeline detection. In this paper, a theoretical model of magnetic dipole is established and its working principle and detail process are investigated thoroughly, and different situation of above ground markers layout are considered. Experiments are presented to verify the correctness of theoretical model. Different above ground markers laid on the ground perpendicularly or having a certain angle with the magnetic flux leakage, and traction experiments show that the results are satisfying.

TueBIS-56

Research on Image Detection and Recognition for Defects on the Surface of the Steel Plate Based on Magnetic Flux Leakage Signals

Zesong Wang Shenyang Univ. of Tech.

In order to improve CCD recognition accuracy for defection on the steel plate surface caused by illumination uniformity of light source, light color, impact of site environmental and the low signal-to-noise ratio images on the surface of the steel plate collected by the system, this paper proposes a new image process and BP neural network detection recognization method based on magnetic flux leakage data in order to realize accurate and effective identification on the surface of steel plate. In this paper, non-destructive magnetic flux leakage detection technology is used to replace the CCD detection method to collect data. And then we use the image conversion technology to convert the data into images. After that, the image processing technology is used to detect the defects and extract the features. Finally, the BP neural network defect identification model is constructed to identify the defects. The simulation results show that the trained model has a strong ability to recognize length, width and depth of the defects. The new method can effectively detect and identify low-contrast and small defects in the weak signal, which can furtherly improve the detection resolution and sensitivity.

TueBIS-57

The Result Extraction of Irregular Dial Instrument Based on the Image

Jinyu Zhang Research Inst. of Physical and Chemical Engineering of Nuclear Industry
Liying Yang Research Inst. of Physical and Chemical Engineering of Nuclear Industry
Jiaqiang Li Research Inst. of Physical and Chemical Engineering of Nuclear Industry
Jian Cao Research Inst. of Physical and Chemical Engineering of Nuclear Industry
Xiaoming Xu Research Inst. of Physical and Chemical Engineering of Nuclear Industry

Irregular dial instruments, such as SF6, are widely used in industry environment. The results of these instruments are usually obtained by artificial. In order to make the result's acquisition and record automatically, this paper proposed an irregular dial instrument's result extraction method based on the image. This method gets the major features of dial instruments through ransac method and least square ellipse fitting. The pointer point, reference point and center point of instruments are extracted and used for the calculation of instruments' results. The errors can be kept at 5% with proposed method contrast with the result by artificial. The experimental results show that the result of irregular dial instrument can be effectively got by the proposed method. The proposed method has a reference for the other dial instruments.

TueBIS-58

Time Series Forecasting Based on Deep Extreme Learning Machine

Xuqi Guo Taiyuan Univ. of Tech.
Yusong Pang Delft Univ. of Tech.
Gaowei Yan Taiyuan Univ. of Tech.
Tiezhu Qiao Taiyuan Univ. of Tech.

Multi-layer Artificial Neural Networks (ANN) has caught widespread attention as a new method for time series forecasting due to the ability of approximating any nonlinear function. In this paper, a new local time series prediction model is established with the nearest neighbor domain theory, in which the hybrid Euclidean distance is used as the similarity measurement between two sets of time series. In order to improve the efficiency, prediction performance, as well as the ability of real-time updating of the model, in this paper, the recombination samples of the model is derived by Deep Extreme Learning Machine (DELM). The experiments show that local prediction model gets accurate results in one-step and multi-step forecasting, and the model has good generalization performance through the test on the five data sets selected from Time Series Database Library (TSDL).

TueBIS-59

Parallel Processing Data Streams in Complex Event Processing Systems

Fuyuan Xiao Southwest Univ.
Cheng Zhan Southwest Univ.
Hong Lai Southwest Univ.
Li Tao Southwest Univ.

For distributed complex event processing systems, handling high volume and continuous data streams with high throughput are required for further decision support. Due to the specific properties of pattern operators, it is difficult to process the data streams in parallel over complex event processing systems. To address the issue, a novel parallel processing strategy is proposed. The proposed method can keep the complex event processing system working stably and continuously via the elapsed time. Finally, the utility of our work is demonstrated through the experiments on the Stream Base system.

TueBIS-60

Multi-class cost sensitive AdaBoost algorithm based on cost sensitive exponential loss function

Xiyang Zhai Air Force Engineering Univ.
Xiaodan Wang Air Force Engineering Univ.
Yang Jiang Air Force Engineering Univ.
Tong Wen Air Force Engineering Univ.

The AdaBoost algorithm which is an important ensemble learning algorithm can effectively improve the classification performance of weak classifiers. Meanwhile the cost sensitive AdaBoost algorithm is an important cost sensitive ME algorithm which can resolve cost sensitive problem effectively. Because the most existing cost sensitive AdaBoost algorithms are binary, a multi-class cost sensitive AdaBoost algorithm based on constructing base classifiers was proposed. The algorithm is complex and the capability relies on the base classifiers seriously. To solve these problems, this paper proposes a multi-class cost sensitive AdaBoost algorithm based on cost exponential loss function. This paper designs a cost sensitive multi-class exponential loss function, and it is proved that the decision function with minimum loss function converges to cost sensitive Bayesian decision function. On this basis, employ the stagewish additive modeling to deduce CSSAMME——a multi-class cost

sensitive AdaBoost algorithm. Finally, use UCI dataset to verify the CSSAMME algorithm. The experiment results show that the algorithm has cost sensitive characteristic and the convergence characteristic.

TueC01 Room01
Adaptive control (V) (Chinese) 14:00-16:20
Chair: Yanli Liu Northeastern Univ.
CO-Chair: Xianghua Wang Shandong University of Science and Tech.

14:00-14:20 TueC01-1

Observer-based fuzzy adaptive control for stochastic nonlinear time-varying delay systems with unknown control directions
Yanli Liu Northeastern Univ.
Hongjun Ma Northeastern Univ.
This paper discussed the problem of adaptive fuzzy output-feedback tracking control for a class of stochastic nonlinear systems with time-varying delay. With the help of a state observer and an appropriate stochastic Lyapunov-Krasovskii functional, an adaptive fuzzy tracking controller is developed, which ensures the boundedness of all the closed-loop signals and the convergence of the tracking error to a small neighborhood of the origin. A simulation example is given to illustrate the effectiveness of the proposed approach.

14:20-14:40 TueC01-2

The Realization of B-spline Surface Reconstruction Algorithm Based on Reverse Control Points
Lijuan Wu Shenyang Normal Univ.
JianJun Wu Shenyang Normal Univ.
Liu Li Shenyang Normal Univ.
Because of the good local modification of the B spline curve, it is widely used to reconstruct the B-spline surface in reverse engineering. A algorithm of reconstructing quasi-uniform B-spline surface is designed based on optimization quadrilateral meshes of the cloud data model by reverse control points in the paper, and the definite basic concepts, solve the data points selection, nodes parameterization, chasing method solve the control points equation, etc. In VS++2008 environment, the algorithm was programmed and debugged with C++ language, and the running results are given. The implementation of the algorithm showed its feasibility and reliability, as well as the advantages of high speed and high accuracy.

14:40-15:00 TueC01-3

Adaptive Sliding Mode Control for Fin Stabilizer System Based on Cloud Model
Hui Li Dalian Maritime Univ.
Zhendeng Xing Dalian Maritime Univ.
Dongshuang Xue Dalian Maritime Univ.
Chen Guo Dalian Maritime Univ.
Considering a series of problems such as the sea wave that acts on the ship is random when ship is sailing on the sea, there exists serious nonlinearity and uncertain factors in the ship roll motion, there is strong dependence on the mathematical model of the controlled object when designing the controller for fin stabilizer system. Aiming at solving the above problems, the paper designs the cloud-model adaptive sliding mode controller (SMC) for fin stabilizer system by combining the perfect approximation properties of cloud model and insensitive to disturbance as well as the object's variable parameters of sliding mode control. And simulations are carried out with long-crested random wave as disturbance under different sea conditions. The results show that the designed controller has high stabilizing efficiency, strong robustness and adaptive ability.

15:00-15:20 TueC01-4

Adaptive finite-time control for spacecraft to track and point non-cooperative space targets
Yanchao Sun Harbin Institute of Tech.
Chuanjiang Li Harbin Institute of Tech.
Huixiang Ling Shanghai Institute of Satellite Engineering
Yihao Wei Harbin Institute of Tech.
In this paper, we investigate the problem of tracking and pointing on-orbit non-cooperative targets. We establish the orbit and attitude dynamics equations between tracking spacecraft and non-cooperative targets in line-of-sight and body-fixed coordinate systems. Moreover, considering the bounded inputs of spacecraft, we propose the adaptive finite-time tracking and pointing control algorithm, which achieves finite-time stability of the closed-loop systems. Numerical simulation is given to illustrate the effectiveness of the proposed method.

15:20-15:40 TueC01-5

Projective Lag Synchronization Controller Design for Uncertain Fractional-Order Chaotic Systems
Hui Lv, Huainan Normal Univ.
Xiulan Zhang Huainan Normal Univ.
Heng Liu Shaanxi Normal Univ.
Song Xu Huainan Normal Univ.
This paper investigates the projective lag synchronization problem of fractional-order chaotic systems. The master and slave chaotic systems have different fractional order. Based on properties of fractional calculus and the stability theorems of fractional-order linear systems, a smooth fractional synchronization controller is designed. Finally, simulation results are given to show the effectiveness of the proposed method.

15:40-16:00 TueC01-6

Global Accurate Stabilization for Lower-triangular Systems of High Relative Degree with Mismatched Disturbances
Xianghua Wang Shandong University of Science and Tech.
Xiao Lu Shandong University of Science and Tech.
In this paper, the problem of global regulation for lower-triangular systems with high relative degree, disturbed by mismatched disturbances is investigated. Dynamic gain scaling technique combined with adaptive control is used to not only avoid "explosion of complexity" which is the disadvantage of backstepping method but also depress the effect of mismatched disturbances. With the the proposed scheme, the system states are precisely driven to the equivalent point as time goes to infinity, which is proved by the Lyapunov stability theory. Finally, an example is provided to demonstrate the effectiveness of the proposed design scheme.

TueC02 Room02
Optimal control and optimization (I) 14:00-16:00
Chair: Yunxiu Chen Huazhong University of Science and Techn.
CO-Chair: Qinghua Li Southwest Univ.

14:00-14:20 TueC02-1

A double-integrator system for distributed optimization of convex cost functions
Ngoc-Tu Tran School of Automation,Key Laboratory of Image Processing and Intelligent Control, Huazhong University of Science and Techn.
Xuan Feng Hubei Electric Power Company
Wen-Yuan Xu Central China Technology Development of Electric Power Co.
Na Zhan Central China Technology Development of Electric Power Co.
Xi Wang Central China Technology Development of Electric Power Co.
In this paper, the distributed optimization problem is investigated under a second-order multi-agent system. In the proposed algorithm, each agent solves the optimization via local computation and information exchange with its neighbors through the communication topology. However, in comparison with the existing second-order distributed optimization algorithms, the proposed algorithm is much simpler due to one coupled information exchange among the agents is reduced. To achieve the optimization, the distributed algorithm is proposed based on the consensus method and the gradient algorithm. The optimal solution of the problem is thus obtained with the design of Lyapunov function and the help of LaSallel's Invariance Principle. A numerical simulation example and comparison of proposed algorithm with existing works are presented to illustrate the effectiveness of the theoretical result.

14:20-14:40 TueC02-2

Optimal Control for IERs in Reverse Supply Chain
Qiaolun Gu Tianjin University of Technology and Education
Tiegang Gao Nankai Univ.
The reverse supply chain with inspection-error-rates (IERs) under our study consists of two members: remanufacturer and collector. The collector is responsible for collecting the used-products from the end consumers, and inspecting the collected used-products. Owing to technical or non-technical factors, the collector may make inspection errors. In order to decrease the IERs, the collector will add more investment, namely, the unit inspecting cost will increase. In this paper, we focus on the dynamic analysis for reverse supply chain with IERs. The causal loop diagram for the reverse supply chain with IERs is developed using system dynamics methodology. We simulate the impacts of IERs and cost-share-ratio on profits of remanufacturer and collector. Based on the simulation results, the analyses of cost-sharing in the reverse supply chain with IERs are presented: under which conditions the remanufacturer should share the inspection cost with the collector so as to control the IERs.

14:40-15:00 TueC02-3

Solving Differential Game between Affine Nonlinear System and General Nonlinear System
Guangyan Xu School of Aerospace Engineering, Shenyang Aerospace Univ.
Qiunan Meng College of Automation, Shenyang Aerospace Univ.
Hongmei Zhang School of Aerospace Engineering, Shenyang Aerospace Univ.
Shenna Wei College of Automation, Shenyang Aerospace Univ.
This paper mainly studies differential game problem between an affine nonlinear system and a general nonlinear system, whose control inputs are constrained. In order to solve the problem, a new method is proposed which uses the minimum value principle and the pseudo spectral method. It makes further development and promotion on the basis of semi direct method. Firstly, the system is transformed by the minimum principle. Then the pseudo spectral method is used to solve the whole problem, including the system after transformation by minimum principle and the rest of the general nonlinear system. In order to verify the validity of the

method, we use it to solve a pursuit-evasion problem of two nonholonomic systems on the same plane. The simulation results show that this method is feasible to solve the differential game model and has the characteristics of high precision and low computational complexity.

15:00-15:20 **TueC02-4**

Comparative Research on Multi-missile Cooperative Attack Between the Differential Game and Proportional Navigation Method

Guangyan Xu Faculty of Aerospace Engineering, Shenyang Aerospace Univ.
Guangpu Shi School of Automation, Shenyang Aerospace Univ.
Hongmei Zhang Faculty of Aerospace Engineering, Shenyang Aerospace Univ.
Qiunan Meng School of Automation, Shenyang Aerospace Univ.

This paper introduces an approach that involved with multi-missile cooperative attack based on the differential game. By comparing with the traditional proportional navigation method, the differential game shows better performance. Firstly, a mathematical model of multi-missile cooperative attack is established; Secondly, thesis introduces the differential game and proportional navigation method by solving the given problems; Finally, a numericalv simulation has been made in Matlab programming environment, which shows that the differential game has more applicability and cooperative tracing ability.

15:20-15:40 **TueC02-5**

Achieving Linear Convergence for Distributed Optimization with Zeno-Like-Free Event-Triggered Communication Scheme

Huaqing Li Southwest Univ.
Nanyang Technological Univ.
Shuai Liu Nanyang Technological Univ.
Yeng Chai Soh Nanyang Technological Univ.
Lihua Xie Nanyang Technological Univ.
Dawen Xia Guizhou Minzu Univ.

This paper develops a distributed algorithm for solving a class of optimization problems which are defined over undirected connected networks of N agents where each function fi is held privately by agent i. The communication between agents in the network is limited: each agent can only interact with its neighboring agents at some independent event-triggered sampling time instants. The algorithm uses a doubly stochastic mixing matrix and employs a fixed step-size and, yet, exactly drives all agents' states to a global and consensual minimizer. Under some fairly standard assumptions on objective functions, i.e., strong convexity and smoothness, we show that the algorithm converges to the optimal solution at a linear rate as long as the constant step-size do not exceed some upper bound and the convergence rate can be explicitly characterized. The Zeno-like behavior is rigorously excluded, that is, the difference between any two successive sampling time instants of each agent is at least two, reducing the communication cost by at least one half comparing with traditional methods. We provide a numerical experiment to demonstrate the efficacy of the proposed algorithm and to validate the theoretical findings.

15:00-16:00 **TueC02-6**

Optimal Control of Formation Reconfiguration for Multiple UAVs Based on Legendre Pseudospectral Method

Hongmei Zhang Shenyang Aerospace Univ.
Weining Wang Shenyang Aerospace Univ.
Guangyan Xu Shenyang Aerospace Univ.

The formation reconfiguration problem of the multiple unmanned aerial vehicles (Multi-UAVs) is described as an optimal control problem in this paper. Firstly, the control model of formation flight is constructed with the three-dimensional elastic distance vector, which describes the relationship between the speed and distance of adjacent UAVs in the leader-follower type. Furthermore, the constraints of communication distance and the security anti-collision distance are taken into account, and the formation is modeled to a fuel optimal problem with terminal state restrictions. Then, the optimal control problem of UAV formation flight is transformed into a nonlinear programming problem based on Legendre Pseudospectrum Method. The advantage of LPM is to obtain a higher accuracy with fewer nodes in the process of discretization. Finally, the formation with three UAVs is simulated in Matlab and solved by Tomlab toolkit. The simulation results show that the formation can be well achieved the desired new shape with minor position error and optimal fuel. The effectiveness and feasibility of the method is verified.

TueC03 **Room03**
Process automation **14:00-16:00**
Chair: Dongsheng Wang Nanjing Univ.
CO-Chair: Zhizhong Mao Northeastern Univ.

14:00-14:20 **TueC03 -1**

Raw water quality assessment oriented to the drinking water treatment based on SVM model

Dongsheng Wang Nanjing Univ. of Posts and Telecommunications
Yongjie Lu Nanjing Univ. of Posts and Telecommunications
Lei Zhang Nanjing Univ. of Posts and Telecommunications

To improve the adaptivity of drinking water treatment and stabilize the quality of treated water, raw water quality assessment based upon support vector machine (SVM) is developed in this study. Compared to existing raw water quality assessment methods, the assessment method studied herein can directly be used for the control of chemical (alum and ozone) dosing process of drinking water treatment. Firstly, based upon the operational experiences, a raw water quality assessment standard oriented to the drinking water treatment has been proposed. Secondly, a raw water quality model is set up to assess the raw water quality based upon SVM technique. Finally, a feedforward-feedback control scheme is designed for the chemical dosing process control. Thus, the chemical dosage can be adjusted in time to cope with the raw water quality variations and hence, the quality of treated water is stabilized. Experimental results demonstrate the improved effectiveness of the proposed method of raw water quality assessment and the feedforward-feedback control scheme.

14:20-14:40 **TueC03 -2**

An Improved Correlation-Based Just-in-Time Modeling Method Using Dynamic Partial Least Squares and Adaptive Local Domain Partition

Xiaolong Chen Northeastern Univ.
Zhizhong Mao Northeastern Univ.
Runda Jia Northeastern Univ.
Dong Xiao Northeastern Univ.
Xiaojun Wang Dalian Univ.

This paper proposes an improved correlation-based just-in-time modeling method, referring to as the ICoJIT, for improving the prediction accuracy and real-time performance of the conventional correlation-based just-in-time (CoJIT) modeling method. To achieve this objective, a novel adaptive local domain partition method has been developed based on the moving window technique and the fitting precision, which takes into account the input and output information simultaneously and has potentially the capabilities of obtaining the optimal local domain partition adaptively and capturing new process states by adding new local domains. Utilizing dynamic partial least squares and adaptive local domain partition method, multiple local domains and corresponding local models can be obtained during the offline operation stage. So online computation burden is reduced compared to CoJIT modeling method. In addition, the proposed ICoJIT modeling method can efficiently deal with nonlinearity and time-varying behavior of processes as well as the CoJIT modeling method. The effectiveness of the proposed method is demonstrated through a real industrial process dataset in sulfur recovery unit process.

14:40-15:00 **TueC03 -3**

Partial Least Squares Model-Based Batch-to-Batch Control of Particle Size Distribution in Cobalt Oxalate Synthesis Process

Shuning Zhang Ludong Univ.
Hongyong Yang Ludong Univ.
Guanlong Deng Ludong Univ.

A partial least squares (PLS) model based batch-to-batch control strategy for control of particle size distribution (PSD) in cobalt oxalate synthesis process is proposed. In order to overcome the difficulty in developing first principal model for the process, PLS model is developed from process operational data. However, due to the model plant mismatches, the optimal control policy calculated on the model may not be optimal when applied to the true process. Due to the repetitive nature of the process, a batch-to-batch control strategy using the information of the current and previous batches is possible to design the operating policy that drives the process to a target PSD. Applications to a simulated cobalt oxalate synthesis process demonstrate that the proposed approach can improve process performance from batch to batch in the presence of unknown disturbances.

15:00-15:20 **TueC03 -4**

Three Dimensional Stretch Bending Process Control Based on the Rule of the Arm Type Stretch Bending Machine

Yidong Yu Univ. of Scie. and Tech. Liaoning
Wei Ye Guangdong Univ. Petrochemical Tec.
Xuebo Chen Univ. of Scie. and Tech. Liaoning
Zhengjun Yu Anshan Iron and Steel Engi. Tech. Coll.

According to the actual needs of the three dimensional stretch bending process of 150T arm stretch bending machine. A rule based interactive control system for stretch bending is established. The control system is divided into two levels, which are composed of the WCC operation station, engineer station, SIEMENS S7-400, PLC, database and Sever OPC, etc. Firstly, the data of stretch bending production is sent to the second level system by the first level system and stored in the database. Then, the mathematical model is established according to the mathematical analytical calculation method. The relationship between the coating angle and the tensile force is calculated by the model. Coated angle is compared, optimized and then stored in the database. Using Sever OPC and control to access the known information in the database to generate the curve of stretch bending process. The curve is modified, optimized, and formulated as a drawing curve. Finally, select the control mode of the corresponding rules. Downloaded to the first level control system to achieve multi axis cooperative control bending machine. So as to achieve the automatic bending of profiles.

15:20-15:40 **TueC03 -5**

Host Computer Software Design of the Automatic Feeding System of the Tank Area Based on WinCC Configuration Software

Wei Zhang Qingdao Univ. of Scie. and Tech.
Lin Guo Qingdao Univ. of Scie. and Tech.

This paper designs and develops a set of real-time monitor and control system of the automatic feeding system of the tank area based on WinCC configuration software, which is based on the automatic control system of the tank area in Zibo Xinhua Pharmaceutical, and introduces the characteristics of Siemens WinCC configuration software.The composition and function of the system and the application of WinCC configuration software in the automatic feeding control system are described in detail. Combined with the lower computer PLC, the network control of five production plants and six PLC of the tank area can achieve the automatic delivery of 10 different materials to 47 metering tanks in 16 different positions of 5 plants quantitatively and automatically. And detailed feeding information about each of the 47 different metering tanks is stored in the SQL Server 2005 database. Finally, writing database query software by C # and the real-time electronic report can be generated in WinCC, and it can be exported or printed at any time.

15:40-16:00 **TueC03 -6**

Research on recognition algorithm of seal fitting point based on compressibility control

Jingdong Lin Chongqing Univ.
Lipei Huang Chongqing Univ.

According to the particularity of solid rocket motor tightening process seal compressibility which is difficult to measure directly, this article established mechanism model between the compressibility and the key parameters of screw based on analysis of the seal deformation mechanism. Using model prediction and expert control, we created expert rules of seal fitting point torque variation characteristics, and framed the expert estimation model of seal fitting point recognition. Therefore, the recognition accuracy of fitting point is improved. The experiment on hardware platform verified that fitting point recognition algorithm meet the seal compressibility 13% precise control requirements and achieve better effect.

TueC04 Room04
Complex networks and systems (I) 14:00-16:00

Chair: Qianfeng Zhang Nanjing Univ. of Posts and Telecommunications
CO-Chair: Tiedong Ma Chongqing Univ.

14:00-14:20 **TueC04-1**

Pinning Cluster Lag Synchronisation of Community Delayed Networks via Local Intermittent Effect

Yuhong Liu Univ. of Electronic Science and Tech. of China
Hui Li Univ. of Electronic Science and Tech. of China
Qishui Zhong Univ. of Electronic Science and Tech. of China
Shouming Zhong Univ. of Electronic Science and Tech. of China

This study investigates the problem of pinning cluster lag synchronisation of community delayed networks via local intermittent effect. Several pinning controllers have been designed to achieve the cluster lag synchronization. Both community networks with identical nodes and non-identical nodes are investigated. Sufficient cluster lag synchronization criterions for community delayed networks are derived. Finally, numerical examples are presented to demonstrate the effectiveness of the theoretical results.

14:20-14:40 **TueC04-2**

The Optimization Strategy of Network Structure Based on Epidemicspread Considering Characteristic Spectrum and Clustering Coefficient

Qianfeng Zhang Nanjing Univ. of Posts and Telecommunications
Yurong Song Nanjing Univ. of Posts and Telecommunications

As a crucial part in the complex network research, how to control epidemic spread has drawn much of the attention. The existing research shows that the spectral radius of the network is reciprocal to the threshold of epidemic spread, and the network with large clustering coefficient has a great effect on virus transmission. Therefore, this paper proposes an edge rewriting strategy to optimize the network's structure which leads to the improvement of epidemic threshold and the clustering coefficient. This method utilizes the method of grouping continuous edge-breaking and reconnection, which can keep the average degree of the network unchanged, to decrease the spectrum radius and synchronously increase the clustering coefficient of network at the same time. The simulation results verify the conclusion above and show the great performance on suppressing the virus spreading in the real network.

14:40-15:00 **TueC04-3**

Synchronization of Multi-Agent Delayed Neural Networks with Stochastic Disturbances via Impulsive Distributed Control

Teng Li Chongqing Univ.
Liuyang Zhang Chongqing Univ.
Tiedong Ma Chongqing Univ.

The cooperative synchronization of multi-agent delayed neural networks with stochastic disturbances is investigated in this paper. Impulsive inputs are used to synchronize the followers to the leader, which requires state information exchange only at discrete time instants and reduces the communication cost of bandwidth. Some novel synchronization sufficient conditions are given in terms of matrix inequalities. It is shown that synchronization can be realized if the impulsive control parameters are suitably selected. Simulation results verify the effectiveness of the proposed synchronization protocol.

15:00-15:20 **TueC04-4**

A Faster Algorithm to Calculate Centrality Based on Shortest Path Layer

Baoqiang Li National Defense Univ. of PLA
Guangya Si National Defense Univ. of PLA
Jianfei Ding National Defense Univ. of PLA
Fei Wang National Defense Univ. of PLA

Network centrality is an important index to measure the centrality of a node in a network. Calculating node centrality parameters is difficult, as networks become Large-Scale, it is essential to find out new algorithms to calculate the centrality of the more complex and bigger networks. Motivated by this trend, a new data structure and faster algorithm for nodes' centrality is provided in this paper. Our algorithm is based on the foundation of the Shortest Path Layer, we used this algorithm to calculate degree centrality, betweenness centrality and closeness centrality for unweighted networks simultaneously. To test its calculation speed, we did 540 simulation experiments using Ulrik Brandes' algorithm, using SPL without evolution and SPL with evolution, respectively. Results show that our structure and algorithm can improve calculation speed by at least 170.43% compared with Brandes' algorithm, and margin of betweenness result error is less than 10^{-10}.

15:20-15:40 **TueC04-5**

Research on Dynamic Robustness Model Based on Random-walk Betweenness

Bin Hu Naval Univ. of Engineering
Yi-fan Xu Naval Univ. of Engineering
Gang Liu Naval Univ. of Engineering

By introducing random-walk betweenness (RB) into dynamic robustness model， a dynamic robustness model based on RB is proposed, which is more realistic than the dynamic robustness model based on betweenness. In order to study characteristics of the model, we compare the model with dynamic robustness model based on betweenness in scale-free network by simulation. We find that node betweenness of dynamic robustness model based on RB is smaller and difference among different nodes is smaller; Dynamic robustness of dynamic robustness model based on RB is related with degree distribution of scale-free network. When degree distribution of scale-free network is uniform, dynamic robustness of the model is larger.

15:40-16:00 **TueC04-6**

Power and Rate Control for Wireless Communication Networks with Nonlinear Channel Fading

Cunwu Han North China Univ. of Tech.
Mengqi Li North China Univ. of Tech.
Xueting Zhang North China Univ. of Tech.
Lei Liu North China Univ. of Tech.

This paper investigates power and rate control for wireless communication networks. A new system model with nonlinear channel fading is established, while it was not considered in existing power and rate control methods. After that, a power and rate control method is presented based on the model predictive control (MPC), and the stability and the performance of the closed-loop system are guaranteed via Lyapunov approach with linear matrix inequality (LMI). The effectiveness of the proposed controller is verified through simulation results.

TueC05 Room05
Co-operative control (II) 14:00-16:00

Chair: Qingdong Li Beihang Univ.
CO-Chair: Wei Wang Shandong Univ.

14:00-14:20 **TueC05-1**

Optimal Synchronization Control for Nonlinear Multi-Agent Systems with Input Delay

Huaipin Zhang Huazhong Univ. of Science and Tech.
Dong Yue Nanjing Univ. of Posts and Telecommunications
Wei Zhao Huazhong Univ. of Science and Tech.

In this paper, optimal synchronization problem of multi-agent systems (MASs) with time-varying input delay is investigated. To remove the effect of input delay, the delayed MAS model is firstly transformed into a new discretetime delay-free version. Then we establish an equivalence relation on the performance indexes of the two systems so as to formulate a new optimal consensus control problem of the transformed delay-free system. Based on the Bellman optimality theorem, we derive optimal consensus control policies from the coupled HJB equations. A policy iteration algorithm is introduced to learn the solutions to the HJB equations in real-time. To execute iterative ADP method, the critic neural networks (NN) are utilized to approximate the value functions and help to calculate the control policies. Finally, a numerical simulation is provided to show the effectiveness of the proposed approach.

14:20-14:40 **TueC05-2**

Consensus with Distributed LQR Control Algorithm for Discrete-time Multi-agent Systems

Xiaoqian Li Shandong Univ.
Wei Wang Shandong Univ.

In this paper, the distributed consensus problem with a performance index coupling the behavior between the multi-agents for discrete-time identical scalar subsystems has been investigated. Assuming a time-invariant undirected network topology for the multi-agents, we first present a suboptimal design method with the aid of the decomposition of

discrete algebraic Riccati equations and robustness of local controllers. Then by constructing the gain matrix which with two parameters, the consensus problem presents the property the same as the condition for distributed optimal controller was proposed based-on the form of optimal control. The structure of the penalty matrix related to state is selected under the condition of the asymptotically stable and the final state of the multi-agents system is obtained.

14:40-15:00 **TueC05-3**

Distributed Time-Varying Formation Control for Second-Order Nonlinearmulti-Agent Systems Based on Observers

Jianglong Yu Beihang Univ.
Xiwang Dong Beihang Univ.
Qingdong Li Beihang Univ.
Yingrong Yu Beihang Univ.
Zhang Ren Beihang Univ.

In this paper, time-varying formation analysis and design problems for second-order nonlinear multi-agent systems are studied using a distributed observer-based method. The formation in this paper can be specified by timevarying continuously differentiable vectors and the dynamics of each agent has nonlinearity. Firstly, a nonlinear timevarying formation control protocol is proposed based on the distributed observer. Then a nonsingular transformation matrix is constructed using the property of the Laplacian matrix. Sufficient conditions for the second-order nonlinear multi-agent systems to achieve time-varying formations are presented using only position feedback, where a description of the feasible time-varying formation set is given. Thirdly, an algorithm with three steps is proposed to design the distributed observer-based formation control protocol. By using the Lyapunov theory, the stability of the proposed algorithm is proven. Finally, a numerical example with five nonlinear agents is provided to demonstrate the effectiveness of the obtained results.

15:00-15:20 **TueC05-4**

Synchronization of Chaotic Multi-Agent Systems with Stochastic and Impulsive Disturbances

Teng Li Chongqing Univ.
Liuyang Zhang Chongqing Univ.
Tiedong Ma Chongqing Univ.

The cooperative exponential synchronization of chaotic multi-agent neural networks with stochastic and impulsive disturbances is investigated in this paper. Sufficient conditions for exponential synchronization to a leader are established and linked directly with graph topology, the control coupling gains, and the individual agent system parameters. Some relations between the synchronization performance and the system parameters are discussed, and it is shown that synchronization can be realized if the control parameters are suitably selected. Simulation results verify the effectiveness of the proposed synchronization protocol.

15:20-15:40 **TueC05-5**

Coordinated Control for Vehicle Handling and Stability: A Fuzzy Robust Approach

Zhenyu Yuan Southeast Univ.
Rongrong Wang Southeast Univ.

This paper proposes a novel control strategy for improving vehicle handling and stability by integrated controlling yaw rate and sideslip angle. Therefore, a T-S fuzzy robust controller is intended to maintain both of the objectives. During normal driving situations, steerability enhancement is the main control objective. However, when the vehicle reaches the handling limits, the controller is involved to ensure vehicle stability. In this controller, the weight between yaw rate and sideslip angle is changing simultaneously according to the estimation of cornering stiffness. A Luenberger observer is intended to identify the tire cornering stiffness. Steer-by-wire system is also put in place to improve the performance. The benefit of this method reduces the influence of habitual driving without losing the control of vehicle safety performance. Linear matrix inequalities (LMIs) are the foundation to obtain such a controller. CarsimSimulink joint simulation results show the effectiveness of the proposed control method under different driving conditions and the results are shown in this paper.

15:40-16:00 **TueC05-6**

Adaptive Impulsive Consensus of Multi-Agent Nonlinear Systems with Uncertain Parameters

Liuyang Zhang Chongqing Univ.
Teng Li Chongqing Univ.
Tao Huang Chongqing Univ.
Ming Li Chongqing Univ.
Tiedong Ma Chongqing Univ.

This paper studies the consensus problem of multi-agent nonlinear systems with uncertain parameters. Based on the theory of impulsive differential equations, adaptive control technique and Lyapunov stability theory, some novel adaptive impulsive consensus conditions are given to realize the consensus of a class of multi-agent nonlinear systems. Compared with the existing investigations of impulsive consensus of multi-agent systems, the proposed impulsive control protocol with uncertain parameters is more rigorous and effective in practical systems. Two numerical simulations are verified to confirm the effectiveness of the proposed methods.

TueC06 Room06
Nonlinear systems (VI) (Chinese) 14:00-16:00

Chair: Xianfu Zhang Shandong Univ.
CO-Chair: Yanxia Hu North China Electric Power Univ.

14:00-14:20 **TueC06-1**

Finite-time Output Feedback Control of Spacecraft Attitude Based on "Adding a Power Integrator" Method

Boyan Jiang Harbin Inst. of Tech.
Chuanjiang Li Harbin Inst. of Tech.
Li Yuan Harbin Inst. of Tech.
Guangfu Ma Harbin Inst. of Tech.

This paper investigates the problem of finite-time output feedback control for spacecraft attitude stabilization with attitude-only measurement. First, a finite-time filter is proposed to generate the pseudo-angular-velocity signal, which is fed to the controller, and then a continuous finite-time attitude controller is designed based on the proposed filter. The overall finite-time stability of entire filter-controller closed-loop system is given through the adding a power integrator technique. The rigorous proof shows that the attitude will converge to its equilibrium states in the absence of disturbance.

14:20-14:40 **TueC06-2**

Applying a Cubature Kalman Filter for the Nonlinear State Estimations of a Continuous Stirred Tank Reactor

Juan Chen Beijing Univ. of Chemical Tech.
Shuang Zhang Beijing Univ. of Chemical Tech.
Bufan Tong Beijing Univ. of Chemical Tech.

Applying cubature Kalman filter (CKF) to the nonlinear state estimations of continuous stirred tank reactor (CSTR) whose process exhibits strongly nonlinear and high dimensions is proposed in this paper. Moreover, the main contribution of this paper is to show the efficacy of CKF in comparison with extended Kalman filter (EKF) and scaled unscented Kalman filter (SUKF) in terms of calculation speed and estimate accuracy within two studies which are normal operating conditions and changing parameters conditions. The estimate effect of the states is demonstrated by conducting simulation studies on a CSTR which has been dynamically simulated. Simulation results show that designing the observer by CKF approach not only can realize more reliable state estimation, but also has the main advantage of lower operation time for both cases.

14:40-15:00 **TueC06-3**

Traveling Wave Solutions of a Nonlinear Schrodinger Type Equation by Using First Integral Method

Weiping Gao North China Electric Power Univ.
Yanxia Hu North China Electric Power Univ.

Control systems, electric power systems and so on are often described by differential equations. In this paper, the first integral method is performed to a class of partial differential equations, that is, the nonlinear Schro¨dinger type equation. The traveling wave solutions of the equation under the certain parametric condition are obtained.

15:00-15:20 **TueC06-4**

Output Feedback Control for a Class of Output-Constrained Nonlinear Systems

Hanfeng Li Shandong Univ.
Xianfu Zhang Shandong Univ.
Xiandong Chen Shandong Univ.
Qingrong Liu Shandong Univ. of Finance and Economics

This paper is concerned with the problem of output feedback stabilization for a class of output-constrained nonlinear systems that are dominated by a lower triangular system. Firstly, an observer based output feedback control scheme is proposed using the dynamic gain control design approach. Then, based on the property of Barrier Lyapunov Functions and Lyapunov stability theory, the asymptotic stability of the closed-loop system is analyzed and the output constraint is not violated. Finally, an example is given to show that the proposed design procedure is very simple and efficient.

15:20-15:40 **TueC06-5**

Spin Attitude Estimation Method Based On Markley Variables and Star Observations

Xiaolin Ning Beihang Univ.
Liwei Jiang Beihang Univ.
Zonghe Ding Beihang Univ.

The Markley variables recently proposed are used to describe spin satellite attitude, whose advantages include slow varying, easy calculation and high-precision. This paper presents a new spin attitude estimation method, which uses the Markley variables as state variables. A reduced form of extended Kalman filter (EKF) based on norm constraint of Markley variables is employed for state estimation. In this new method, star sensor replaces traditional sun sensor and earth sensor to provide measurement information. This new method makes full use of the advantages of Markley variables, and can achieve high-precision spin attitude parameters by using only one star sensor. Simulations using FY-2 orbital data show that, the estimation precision of the spin axis is less than 0.3" and the estimation precision of spin angular velocity is of 10-5 (°)/s magnitude when the star sensor precision is 3''.

15:40-16:00 **TueC06-6**

Ndob-Based Three-Dimensional Guidance Law with Fast and Finite-Time Convergence

Huijie Li Xi'an Jiaotong Univ.
Yuanli Cai Xi'an Jiaotong Univ.

In this paper, a three-dimensional finite-time guidance law is proposed for both nonmaneuvering and maneuvering targets. Unlike the usual approach of decoupling the engagement dynamics into two mutually orthogonal two-dimensional planes, a fast and finite-time guidance law for the coupled engagement dynamics is derived by selecting a special Lyapunov function. The proposed guidance law is constructed through a combination of finite-time stability theory and nonlinear disturbance observer (NDOB) technique. More specifically, augmented functions are involved to improve the convergence of the guidance system, while the NDOBs are used to compensate the unknown target accelerations and handle the chattering problem. Finally, simulation results on three-dimensional missile-target interception examples are included to verify the effectiveness of the proposed approach.

TueC07 Room07
Decision-making theory and method (IV) 14:00-16:00

Chair: Gang Liu Naval Univ. of Engineering
CO-Chair: Yiyun Liu Wuhan Univ. of Science and Tech.

14:00-14:20 **TueC07-1**

Machine Learning Based Approaches for Medium-thick Plate Stress Analysis Feature Extraction and Product Defect Prediction

Hui Zhang Shanghai Baosteel Engineering Consulting Co., Ltd
Jiahui Zhao Shanghai Baosight Software Co., Ltd
Xiaoyue Yong Northeastern Univ.
Chen Zhang Northeastern Univ.
Yingjun Ji Northeastern Univ.

In order to accurately predict the plate production process defects, and increase the rate of finished products , and improve enterprise profits, on the base of large-scale industrial data accumulated in medium-thick plate production process, this paper proposes using machine learning and data analysis theories and methods to study the data-driven stress and product defect prediction model of plate. After selecting the data features which have significant effect on the stress of the plate, we establish the logistic classification and forecasting model, and use cross-validation to train and validate the model. The experimental results show that the feature extraction and prediction model can accurately predict the stress defect classification of the medium-thick plate production process.

14:20-14:40 **TueC07-2**

A Driving Assistant Safety Method Based On Human Eye Fatigue Detection

Suhua Zeng Chongqing Univ. Of Posts And Telecommunications
Jialong Li Chongqing Univ. Of Posts And Telecommunications
Li Jiang Chongqing Univ. Of Posts And Telecommunications
Jianchun Jiang Chongqing Univ. Of Posts And Telecommunications

Driver's Fatigue is one important factor leading to traffic accident. So, how to detect driver's fatigue status accurately is critical to avoid traffic injuries and deaths. In the driving environment of vehicles, there are higher requirements for the real-time performance and reliability. The traditional fatigue judging methods are sensitive to the light fluctuation and have lower real-time performance. This paper improves eye location method and presents a fatigue judgment rules to meet the demanding of the automobile driving environment. In the whole process, we take inter-frame information to define eye region to improve the eyes location method based on AdaBoost. Then, we combine skin color segmentation and eyelids ellipse fitting method to judge the eye state. In the last, we design a fatigue recognition rules based on rough set which combines closing eyes rate, average eyes blinking time and consecutive eye closure frames together. These methods can achieve better real-time performance. The experimental results show this method can meet with the requirements of driving environment and improves fatigue judgment accuracy rate.

14:40-15:00 **TueC07-3**

The Empirical Analysis on Demand of property Insurance in Hubei Province based on Panel Data

Guici Chen Wuhan Univ. of Science and Tech.
Yiyun Liu Wuhan Univ. of Science and Tech.

From the current situation of the property insurance market of Hubei Province, the comparison analysis of the property insurance development statement of six provinces in central part of China is studied in this paper. The influential factors of the demand of property insurance in Hubei province are theoretical analyzed. At the same time, the influential orientation is predicted. Then it takes unit root test and cointegration test based on panel data to establish fixed effect model and quantile regression model for the empirical analysis.The obtained results point out that the increase of GDP, per capita disposable income and insurance claim can promote the development of demand of property insurance of Hubei Province, the population growth is significant negative correlation with the demand of property insurance.Finally, some strategic suggestions to the demand of property insurance of Hubei Province are proposed based on the empirical analysis results.

15:00-15:20 **TueC07-4**

Situation-driven Fuzzy Cognitive Maps Applied in Air-To-Ground Target Attack

Zhe Zhao National Univ. of Defense Tech.
Yifeng Niu National Univ. of Defense Tech.

Air-to-ground target attack (A/GTA) executed by UCAVs is an important approach to operate the precision air strike missions. When UCAVs combat in the complicated battlefield environment, fast decision making and cooperative cognition to the combat of multiple UCAVs is the operational effectiveness multiplier to raise the target-damage probability, and the key issue to improve the accuracy, effectiveness and intelligent level of A/GTA decision making. FCM theory is an intelligence method which has powerful decision making capability and provides a lot of conveniences when multi-UCAV cooperates. In this article, we will recommend SDFCM which combines the FCM with SA theory to help UCAV and operator make decisions in A/GTA.

15:20-15:40 **TueC07-5**

A New Testability Allocation Method Based on Improved AHP

Gang Liu Naval Univ. of Engineering
Jianwei Lü Naval Univ. of Engineering
Bin Hu Naval Univ. of Engineering

Testability allocation is one important job of testability design, for allocating relevant indexes to the lower levels of system. The traditional AHP is influenced by subjective factors, which make the final evaluation results unreasonable, and too far out of the actual condition. So the traditional AHP is optimized to make the results of testability allocation more reasonable and close to life, scale was improved, judgment matrix was modified, and expert eliminating strategy was introduced, and error caused by subjective reason was decreased and avoided, consequently testability optimization allocation method based on improved AHP was proposed. Example results show that this method is reasonable and corresponded to engineering practice.

15:40-16:00 **TueC07-6**

Decision Models of Closed-loop Supply Chain with Different Recycling Channels Considering Manufacturer's Fairness Concerns

Fengmin Yao School of Management, Harbin Univ. of Science and Tech.
Shan Liu School of Management, Harbin Univ. of Science and Tech.

To research the optimal decision problems of closed-loop supply chain composed of a dominant retailer and a manufacturer with fairness concerns. Under two different recycling channels of manufacturer and retailer, the effect of manufacturer's fairness concerns to the pricing of new products and the recycling rate of waste products were analyzed, the profits of members and whole closed-supply chain system were compared. It shows that the behavior of manufacturers' fairness concerns will lead to the increase of wholesale price and retail price of new products, but the decrease of recycling rate of waste products. The enhancement of manufacturer's fairness concerns is beneficial to maximize his own profit and utility, but unbeneficial to retailer and whole system. When the manufacturer is directly responsible for the recycling, which may not be beneficial to the members and whole system, however, when the dominant retailer is responsible for the recycling, which is always favorable to oneself.

TueC08 Room08
Networked control systems (III) (Chinese) 14:00-16:00

Chair: Fei Hao Beihang Univ.
CO-Chair: Wenlin Zou Nanjing Univ. of Science and Tech. Jiangsu Second Normal Univ.

14:00-14:20 **TueC08-1**

Stabilization of nonlinear event-triggered control systems with time-varying triggering conditions

Hao Yu Beihang Univ.
Fei Hao Beihang Univ.
Shenrui Pan The Univ. of Chicago

This paper studies the stabilization problem of nonlinear event-triggered control systems using the hybrid system model approach. An extension of the concept, maximum allowable sampling period, is proposed by considering the effects of the time-triggered manner and the event-triggered manner simultaneously. Then a time-varying triggering condition is given where the threshold parameter varies adaptively based on the interval between two consecutive triggering instants. Moreover, to reduce the on-line computational load for the time-varying triggering condition, a look-up table method and an improved time-invariant triggering condition are proposed. Finally, a numerical example is given to illustrate the efficiency and the feasibility of the proposed results.

14:20-14:40 **TueC08-2**

Event-triggered H∞ control for networked control system subject to sensor and actuator saturations

Wenlin Zou Nanjing Univ. of Science and Tech. Jiangsu Second Normal Univ.
Jie Cao Nanjing Univ. of Science and Tech.
Liuwen Li Southeast Univ.
Shumin Fei Southeast Univ.

This paper is devoted to the event-triggered H∞ control problem for networked control systems with sensor and actuator saturations. A new

event-triggered scheme in consideration of saturation constraint is introduced for the networked control system. By constructing an appropriate Lyapunov-Krasovskii functional associated with the LMI technique, criteria for the exponential stability with an H∞ norm bound and H∞ control design have been obtained for the networked control system with proper event-triggered parameters. A simulation example is employed to show the effectiveness of the proposed control method.

14:40-15:00 **TueC08-3**

Event-triggered Filtering for Networked Systems Under Unreliable Communication Links

Ziran Chen Nanjing Univ. of Science and Tech.
Baoyong Zhang Nanjing Univ. of Science and Tech.

This paper is concerned with the event-triggered $H\infty$ filtering for discrete-time nonlinear systems with unreliable communication links. In order to reduce the number of transmitted data, an event-triggered scheme is proposed to determine whether the sampled data should be released into the network or not. Then, when the released data is transmitted in the network, a Bernoulli process is employed to model the phenomenon of data losses. Consequently, considering the instants at which the sampled data is not released or data losses occur, a buffer is employed to hold the input signal of the filter to be consecutive and a new random process is developed to model the input data sequence. Thus, a novel method is presented to process the stability analysis based on the T-S fuzzy model approach. Finally, a simulation example is given to illustrate the effectiveness of the proposed method.

15:00-15:20 **TueC08-4**

Simulation Tech for Networked Motion Control System

Chuang Wang Univ. of Jinan
Fang He Univ. of Jinan

Simulation Tech of networked motion control system (NMCS) is study. The method and steps of observing the system performance of steady state and dynamic are discussed and described considering the inference of network parameters. Simulation software of Truetime for NCS is applied. The method of system modeling and parameter setting of simulation module for NMCS are illustrated in detail. Specially, the model structure of NMCS applied to modeling is a speed and current double closed loop motion control system. And the model of motor controlled is set up based on motor dynamic mathematical model rather than model of its single transfer function. All the parameters of motor and many parameters of network nodes can be flexibility set through interactive interface, such as time delay, packet loss rate, network scheduling, and so on. The results of simulation research verified the feasibility of the simulation method proposed in this paper.

15:20-15:40 **TueC08-5**

Simultaneous Fault Detection and Control Protocol Design for Coordination of Multi-Agent Systems

Shaobo Zheng Nantong Univ.
Xiaomei Zhang Nantong Univ.
Suying Sheng Nantong Univ.

The problem of simultaneous fault detection and control protocol design for coordination of discrete-time multi-agent systems is investigated in this paper. Based on the relative output measurements and relative control inputs between adjacent agents, both the distributed fault detection filters and an observer-based distributed control protocol are presented. The aim of the problem addressed is to simultaneously design the parameters of the observers, the residuals and the controller such that multi-agent systems achieve coordination with some H ∞ coordination performances and the observers ensure stability with H−/H ∞ performance. Using Finsler's lemma, sufficient conditions for the existence of such controllers and observers are proposed in terms of some linear matrix inequalities. A team of autonomous unmanned underwater vehicles is utilized to illustrate the effectiveness of the proposed method.

15:40-16:00 **TueC08-6**

Distributed Quantized Gradient-Free Algorithm for Multi-Agent Convex Optimization

Jingjing Ding Nanjing Univ. of Posts and Telecommunications
Deming Yuan Nanjing Univ. of Posts and Telecommunications
Guoping Jiang Nanjing Univ. of Posts and Telecommunications
Yingjiang Zhou Nanjing Univ. of Posts and Telecommunications

In this paper, we study a convex optimization problem that arises in a network where multiple agents cooperatively optimize the sum of nonsmooth but Lipschitz continuous functions, subject to a convex and compact constraint set. Under the additional constraint that each agent can only transmit quantized information, we develop a distributed quantized gradient-free algorithm for solving the multi-agent convex optimization problem over a time-varying network. In particular, we provide the convergence rate analysis results of the proposed algorithm, and highlight the dependence of the error bound on the smooth parameter and quantization resolution.

TueC09 **Room09**
Social economy systems (II) **14:00-16:00**

Chair: Li Yang Xi'an Univ. of Tech.
CO-Chair: Zunshui Cheng Qingdao Univ. of Science and Tech.

14:00-14:20 **TueC09-1**

M&A Strategy of Double-acquirers based on Option Game Under Dynamic Competition

Weiguo Zhang Xi'an Univ. of Tech.
Li Yang Xi'an Univ. of Tech.
Ruiyao An Shaanxi International Trust and Investment Co., Ltd
Chang Yue Chang'an Xinsheng (Shenzhen) Financial Investment Limited

Based on the practice that the value-enhancing and cost of merger and acquisition between competitive acquirers are different, this paper build an asymmetric competitive option game model covering bids and timing of M&A, and solves the possible competitive equilibrium results and the optimal bidding and timing under equilibrium. Then we verify the accuracy of the conclusion by numerical analysis. This study finds that competition improves the merger offer of acquirer and decreases option value. That makes the timing of merger not being determined by real option threshold of merger any more, but by Marshall threshold of merger, which lead to earlier occurrence of M&A. The proportion of value-enhancing from merger and the cost of merger co-determine the equilibrium outcome of asymmetric competition merger. When the random shock is large enough, the acquirer with higher proportion of value- enhancing could always able to win in the competition. When the random shock is large enough, the acquirer with higher proportion of value-enhancing could always able to win in the competition. Whereas, if the cost of the acquirer with lower proportion of value-enhancing is small enough, there are some interval of random shocks, which makes this acquirer win in the competition.

14:20-14:40 **TueC09-2**

On Linkage Effects between Economic Growth and Industry Employment for Beijing as an Example

Wei Wang Harbin Univ. of Commerce
Chunyan Lu Harbin Univ. of Commerce
Ping Li Harbin Univ. of Commerce
Yongzhi Yao Harbin Inst. of Tech.

It was a traditional topic to discuss the relationship between economic growth and employment, the results was also different. In the paper, economy aggregate, three industry employment, three industry output of Beijing were regarded as research indexes, the statistical data from 1990 to 2013 were taken as research variables, the model of state space was set up to test and estimate the impact of industry employment on economic development. The linkage effects were shown as follows, first industry employment of Beijing has negative effect on economic growth, which is weak about 0.025%, second industry employment has negative effect on economic growth, which is strong about 1.20%, third industry employment has a positive effect on economic growth, which is more stable about 0.62%.

14:40-15:00 **TueC09-3**

Analysis on Contributions of Energy Consumption to Economic Growth for Harbin as an Example

Wei Wang Harbin Univ. of Commerce
Jiankang Yang Harbin Univ. of Commerce
Yanan Yang Harbin Univ. of Commerce
Yongzhi Yao Harbin Inst. of Tech.

From the micro analysis aspect, energy consumption aggregate, energy consumption elasticity and energy consumption intensity of Harbin were quantitatively analyzed in the paper, Gross Domestic Product was regarded as the target, energy consumption aggregate of coal, crude oil, natural gas and electric power of industrial enterprises above designated size were made as the constraints, the model of multiple regression analysis was constructed to measure contributions of energy consumption to economic growth. The results have shown that the consumption of coal, oil, natural gas and electric power had a positive role on economic growth of Harbin, in which the coal was the maximum contribution, the oil was the second, and the electricity and natural gas were relatively small.

15:00-15:20 **TueC09-4**

Study on the Financial Investment Level of Home Care Services in Shanghai

Hongyan Li Shanghai Univ. of Engineering Science
Jing Wang Shanghai Univ. of Engineering Science
Rui Zhang Shanghai Univ. of Engineering Science

As the aging of population in China is ahead of its economic and social modernization, the social accumulation for the elderly care services is very limited. As the most developed city in China, Shanghai is the first region to enter the aging society in our country. However, the level of home care services in Shanghai can not meet the demand of the elderly. From the macro level, this paper use a financial investment level of home-based care services and a financial investment level of service number can draw conclusions: The financial investment level of home-based care services in Shanghai is lower than the national level, and the financial investment level of service number in Shanghai is slightly higher than the national level.

15:20-15:40 **TueC09-5**

Fire Extinguishing Model by Robots of Artificial Intelligence Based on ABM

Yun Shang Qingdao Univ. of Science and Tech.
Qingdao Univ.
Zunshui Cheng Qingdao Univ. of Science and Tech.
Southeast Univ.
Youming Xin Qingdao Univ. of Science and Tech.
Shandong Univ. of Science and Tech.

This paper describes a fire extinguishing model by robots of artificial intelligence based on ABM. The research focus on a quantitative analysis of the affect of extinguishing speed by adding separation rules under various situations. Unlike the pure mathematical model, we show the simulation results taking Netlogo software as a platform. The simulation results show that obstacle avoidance almost does not affect the fire-fighting efficiency.

15:40-16:00 **TueC09-6**

Research on Geo-relationship Network and Competing (or Mutually Beneficial) Relationship Network of Chinese Textile Enterprises

Jie Liu Wuhan Textile Univ.
Jian Jiang Wuhan Textile Univ.
Qunjiao Zhang Wuhan Textile Univ.

In this paper, two textile industrial clusters's complex networks of China are established according to public data published by the China council for the promotion of international trade (CCPIT). Both the geo-relationship network and the competing (mutually beneficial) relationship network of all 2,436 textile firms (enterprises) in China are constructed and analyzed. The category including cotton spinning, knitting, fiber, nonwovens, printing and dyeing cloth, garments, home textiles, wool, silk, linen, textile machinery, all together there are 11 different industries clusters. Based on network analysis of these clusters' mathematical characteristics, some strategies for improving the development of China's textile industry are provided. Networks' community analysis and its economic significance are also provided for optimizing the product distribution of different textile firms (enterprises) in China.

TueC10 Room10
Fault diagnosis and fault-tolerant control (VIII) 14:00-16:00

Chair: Huajing Fang Huazhong Univ. of Science and Tech.
CO-Chair: Zhonghua Pang North China Univ. of Tech.

14:00-14:20 **TueC10-1**

Active Fault Tolerant Control of Networked Systems with Sensor Fault

Zhonghua Pang North China Univ. of Tech.
Ji Zhang Qingdao Technological Univ.
Beijing Inst. of Tech.
Yuguo Zhou Qingdao Technological Univ.
Cunwu Han North China Univ. of Tech.

In this paper, the active fault tolerant control problem of networked systems with sensor fault is studied. The network-induced delay treated as the round-trip time (RTT) delay and additive sensor fault are taken into consideration. A networked predictive active fault tolerant control (NPAFTC) scheme based on networked predictive control approach is proposed to eliminate the effect of the sensor fault and compensate for the network-induced delay at the same time. The network-induced delays of the two data transmission channels are described by the RTT delays, which can be extended to represent or include other communication constraints, such as packet disorder and loss. A new fault estimation method that can estimate the sensor fault and the system state simultaneously based on Kalman filter is presented. Then a predictive controller based state-feedback, which can generate a sequence of predictive control signals to actively compensate for the RTT delay, is designed. A sufficient condition is derived for the stability of the resulting closed-loop system by using the switched system theory. Finally, numerical simulation demonstrates the effectiveness of the proposed method.

14:20-14:40 **TueC10-2**

Active FTC Approach Design for A Class of Nonlinear Flight Control Systems with Actuator Faults

Peng Cheng Nanjing Univ. of Posts and Telecommunications
Zhifeng Gao Nanjing Univ. of Posts and Telecommunications
Zepeng Zhou Nanjing Univ. of Posts and Telecommunications
Moshu Qian Nanjing Univ. of Aeronautics and Astronautics
Jinxing Lin Nanjing Univ. of Posts and Telecommunications

In this paper, an active fault tolerant controller is designed for a class of nonlinear flight control systems with bounded external disturbances and unknown actuator effectiveness loss faults. Firstly, the nonlinear flight control system models of an aircraft are given. When some actuators occur the unknown loss of effectiveness faults, the faulty flight control systems is further established. To obtain the accurately fault estimated value, an adaptive fault estimation observer is designed for the faulty flight control systems. Then, an active fault tolerant controller design approach is proposed by using terminal sliding mode technique and the obtained estimated value of unknown actuator fault, which could asymptotically accommodate the effects of actuator faults and guarantees the stability of the closed-loop flight control systems in the case of actuator loss of effectiveness faults. Finally, these results in simulation indicate the efficiency of our presented fault tolerant control (FTC) scheme.

14:40-15:00 **TueC10-3**

Improved Fault Detection and Estimation for Nonlinear Stochastic System with Abrupt Faults

Bo Ding Huazhong Univ. of Science and Tech.
Huajing Fang Huazhong Univ. of Science and Tech.

In this paper, we investigate the fault detection and estimation problems for the nonlinear stochastic system with abrupt faults. Based on particle filter and the reasonable assumption about the abrupt faults, the improved fault estimation algorithm is proposed, while the system state is simultaneously estimated. In light of the improved fault estimation, an intuitive fault detection strategy is introduced. The effectiveness of the proposed algorithm is verified by the simulation of the Three-tank system.

15:00-15:20 **TueC10-4**

Landing Condition Analysis of a Loss-of-thrust UAV Based on Adjoint Method

Maohua Zhang National Univ. of Defense Tech.
Jianjun Ma National Univ. of Defense Tech.
Zhiqiang Zheng National Univ. of Defense Tech.

A loss-of-thrust UAV (unmanned aerial vehicle) needs to land to a predetermined area, which not only requires a higher accuracy of landing area, but also needs to maintain a certain attitude angle. In this paper, the Schwartz inequality and state space form are used to derive the guidance law with angle constraint. The influence of heading error and angle constraint on aircraft landing area are analyzed quantitatively based on the adjoint method. The simulations show the range of the heading error and angle constraint on the condition of certain miss distance. Compared with traditional Monte-Carlo method, the method of adjoint in this paper has the advantages of small computation and simple data processing.

15:20-15:40 **TueC10-5**

Approach to Fault Feature Extractions of Rolling Bearing via EEMD and Full-Vector Envelope Spectrum

Hongcheng Xiang Kunming Univ. of Science and Tech.
Engineering Research Center for Mineral Pipeline Transportation
Xiaodong Wang Kunming Univ. of Science and Tech.
Engineering Research Center for Mineral Pipeline Transportation
Guoyong Huang Kunming Univ. of Science and Tech.
Engineering Research Center for Mineral Pipeline Transportation

Misjudgments and missed judgment widely occur during the fault detections of rolling bearing due to the fact that single-channel vibration signal information is often collected incomprehensively. In order to recognize bearing faults as possible, a method is proposed that features the combination of Ensemble Empirical Mode Decomposition (EEMD) and full-vector envelope spectrum through the following steps. Firstly, the two homologous double-channel fault signals of bearings undergo EEMD decomposition individually. Then intrinsic mode functions (IMF) with the maximum and secondary kurtosis values at all directions are selected as the reconstructed signals. Finally the reconstructed signals are subjected to full-vector envelope fusion by the use of full-vector envelope spectrum so that the fault feature frequency of bearings can be extracted. By the use of the present method, the real vibration state of rolling bearing were reflected objectively, and the fault feature frequencies of rolling bearing were extracted effectively for the purpose of recognizing fault types, as the experiment results showed.

15:40-16:00 **TueC10-6**

Adaptive Sliding Mode Observer Based FTC Method Design for Rigid Satellite Against Actuator Faults

Zhifeng Gao Nanjing Univ. of Posts and Telecommunications
Zepeng Zhou Nanjing Univ. of Posts and Telecommunications
Moshu Qian Key Laboratory of UAV Tech. (NUAA), Ministry of Industry and Information Tech.
Jinxing Lin Nanjing Univ. of Posts and Telecommunications

In this paper, an adaptive sliding mode observer based fault tolerant control (FTC) design method is proposed for the rigid satellite attitude control systems in actuator multiple fault case. The rigid satellite attitude control systems can be described by the dynamic equations and kinematic equations. The actuator fault model is given to represents the bias fault and loss of effectiveness fault. Then a novel nonlinear sliding mode observer is designed in order to get the estimation value of the effects of unknown actuator faults. An fault tolerant attitude controller is further designed for the rigid satellite attitude systems by utilizing the estimated fault information and backstepping control scheme. Meanwhile, the stability of closed-loop attitude control systems is analyzed by using Lyapunov appraoch. Finally, simulation results are given to demonstrate the effectiveness of the developed FTC scheme.

TueC11 Room11
Control applications (V) (Chinese) 14:00-16:00

Chair: Ruiyun Qi Nanjing Univ. of Aeronautics and Astronautics
CO-Chair: Yunfeng Hu Jilin Univ.

14:00-14:20 **TueC11-1**

Decoupling Vibration Control for Active Suspension Systems

Gong-You Tang Ocean Univ. of China
Hua Lin Ocean Univ. of China

Hao Su Ocean Univ. of China

This paper focuses on the problem of vibration control for vehicle active suspension systems. According to the characteristics of the independent suspension system in vehicles, we decompose the suspension system into two subsystems from the perspective of practical. To complete the design of the vibration controller, we design a decoupling control law with respect to disturbances and a stabilization vibration control law for the car body subsystem respectively. The performance analysis shows that the designed controller has the function of feedforward control in theory, and can improve the performance of the suspension system significantly. Simulation results show the effectiveness of the proposed design approach.

14:20-14:40 **TueC11-2**

Soft Sensor Modeling Method of Dynamic liquid Level Based on Improved KS Algorithm

Tong Wang Shenyang Univ. of Tech.
Zewen Duan Shenyang Univ. of Tech.

Duing to the problem that the sample data of the soft-sensor modeling in the oilfield production process has influence on the modeling quality, this paper proposes a subspace-based Kennard-Stone algorithm. Firstly, according to the characteristics of oil production data, production process parameters are divided into subspace of different working conditions. Then, the method of similarity of spatial data is used to replace the original Euclidean distance calculation method to complete the sample selection of KS algorithm. Finally, the soft-sensing model of the dynamic liquid level is constructed based on the sample selected and BH-LSSVM algorithm. Experimental results show that compared with random sample selection and KS algorithm based on Euclidean distance, this method can improve the prediction quality of the model, and save the modeling time.

14:40-15:00 **TueC11-3**

Predictor-Corrector Guidance for Reentry Hypersonic Vehicle Based on Feedback Linearization

Xiaoping Guo Nanjing Univ. of Aeronautics and Astronautics
Ruiyun Qi Nanjing Univ. of Aeronautics and Astronautics
Xuelian Yao Jiangsu Univ. of Tech.

This paper presents an improved predictor-corrector reentry guidance law for hypersonic vehicle based on the feedback linearization theory. Considering the overload as intermediate variable, a new conversion of constraints is proposed based on the Quasi Equilibrium Glide Condition (QEGC), and all the path constraints are converted to constraints of overload variable. Using the theory of feedback linearization to gradually eliminate the deviation of line of sight between the vehicle and target location, the required longitudinal and lateral overload can be obtained respectively. Using the elevation-angle of line-of-sight to predict the terminal velocity, and the lateral maneuver strategy is added to make the vehicle deceleration. A feasible flight path is generated and the vehicle is smoothly and safely guided to the Terminal Area Energy Management (TAEM). An important aspect of reentry missions is how to make the vehicle recover to the original mission in case of random perturbations or failures. If random perturbations or failures occur, the current states and the aerodynamic coefficient will change obviously. Simulation results are presented to show the performance of the guidance law in the nominal trajectory. Numerical results under the different deviation of states or aerodynamic coefficients, determined the robustness and fault-tolerant redundancy for this guidance law.

15:00-15:20 **TueC11-4**

Development of the Nozzle Control System in 0.6m Trans-supersonic Wind Tunnel

Chuan Gao China Aerodynamics Research and Development Center
Xuhui Huang China Aerodynamics Research and Development Center
Jingyan Jiang China Aerodynamics Research and Development Center
Ning Du China Aerodynamics Research and Development Center
Wei Rui China Aerodynamics Research and Development Center
BoWen Wang China Aerodynamics Research and Development Center

To realize the contour control of the full flexible nozzle in the new 0.6m×0.6m transonic and supersonic wind tunnel of CARDC, compare with Hydraulic Mode, Hydraulic+Motor Mode, Motor Mode and solve the multi-axis synchronous control problem. Adopt electric cylinders and electric putters as the actuators of the control system. Address Virtual Axis synchronization strategy and optimize the relevant control parameters based on SIMENS SIMOTION D, design the hardware composing and software function according to its structure and technical requirements. Test results of the multi-axis synchronous control experiment were analyzed, which validate that the nozzle control system has high accuracy and good stability in synchronous control. The developed system and proposed algorithm can meet the engineering application request and achieve good effect in addition.

15:20-15:40 **TueC11-5**

Neural Network-based Model Predictive Control for Wastegate of a Turbocharged Gasoline Engine

Huan Chen Jilin Univ.
Yunfeng Hu Jilin Univ.
Pengyuan Sun China FAW Group Corporation Research and Design Center
Hong Chen Jilin Univ.

In this paper, a model predictive control strategy based on neural network is developed for the boost pressure tracking of a turbocharged gasoline engine. Firstly, the predictive model is trained by neural network due to its capacity of learning nonlinear process, institutive structure and simple training procedure. Secondly, the online linearization of neural network model is deduced by Taylor's expansion, and the feasibility of neural network model and linear predictive model are accessed. Thirdly, with the requirements of boost pressure tracking control, a linear model predictive controller is designed to track the desired boost pressure by adjusting the wastegate. Finally, the simulation results show the effectiveness of the proposed controller.

15:40-16:00 **TueC11-6**

Design and implementation of remote myocardial ischemia monitoring software system

Peng Lei South China Univ. of Tech.
Muqing Deng South China Univ. of Tech.
Cong Wang South China Univ. of Tech.

This paper designs and implements a software system for myocardial ischemia monitoring based on Android. This system consisted of client and server. The client consisted of inquire part, service part, report part and person center part. The server consisted of heart rate calculation, cardiodynamicsgram (CDG) calculation and data storage. Uploading the electrocardiography (ECG) data from client, using differential threshold method, the heart rate information is extracted. Using deterministic learning theory, the CDG is calculated from the ST-T segment of ECG, and displayed in the client interface. By analyzing CDG, user can detect myocardial ischemia. Design and implementation shows that the system is a portable, usable and rapid myocardial ischemia monitoring software.

TueC12 Room12
Supply chain and logistics management (II) (Chinese) 14:00-16:00

Chair: Min Huang Northeastern Univ.
CO-Chair: Jinyan Sang Shandong Univ. of Tech.

14:00-14:20 **TueC12-1**

PSO Algorithm for the Fourth Party Logistics Network Design Considering Multi-Customer Behavior under Stochastic Demand

Daxing Yue Northeastern Univ.
Min Huang Northeastern Univ.
Mingqiang Yin Northeastern Univ.

The design of the fourth party logistics network with stochastic demand and multi-customer behavior using the value function of prospect to despite the customer psychological behavior is studied in this paper. The optimization model of the fourth party logistics network design problem is established with the constraint of network investment to maximize customer satisfaction. According to the characteristics of the model, the particle swarm intelligence algorithm with adaptive inertia weight is designed. Numerical study is used to obtain the best combinations of algorithm and to analysis the influence of network investment. The results suggested that to provide the better service to customer, the certain amount of budget should be invested.

14:20-14:40 **TueC12-2**

Graph Model for Conflict Resolution in the Information Sharing Conflict of the Fourth Party Logistics

Di Liu Northeastern Univ.
Hanbin Kuang Northeastern Univ.
Min Huang Northeastern Univ.

With the rapid development of modern logistics industry, the fourth-party logistics develops as an integrator of supply chain services for customers. At the same time, information sharing conflict arises among the fourth-party logistics, the third-party logistics, customers and local government, because the third-party logistics may still be hesitant to share information with the fourth-party logistics. The methodology of the graph model for conflict resolution is used to systematically analyze the information sharing conflict. Decision makers and the options of the decision makers involved in the conflict are provided in this paper. And the preferences for decision makers over the states of the conflict model are analyzed and then the equilibria for the model are calculated by using the decision support system GMCR+. After that, a through strategy analysis reveals the potential evolution path of the conflict and the important decision strategy for the fourth-party logistics and the local government.

14:40-15:00 **TueC12-3**

A Hybrid Ant Colony Optimization Based on Cloud Model for OoS Multicast Routing Problem

Xiaoxia Zhang Univ. of Science and Tech. Liaoning
Xuanyao Sun Univ. of Science and Tech. Liaoning
Jiewei Tong Univ. of Science and Tech. Liaoning
Guoxuan Li Univ. of Science and Tech. Liaoning

This paper presents a novel hybrid ant colony optimization approach (ACO&CM) to solve quality of service (QoS) multicast routing problem. The main feature of this hybrid algorithm is to hybridize the solution construction mechanism of the ACO with cloud model (CM). Moreover, the hybrid algorithm considers both solution diversification and solution

quality, and it adopts cloud model to avoid excessive use of nodes and making algorithm fall into local optimal solution by changing pheromone trail. The method has both the advantages of ant colony optimization, the ability to find the higher performance solutions, and that of cloud model, the ability to explore different parts of the solution space and to find better solutions. Finally, the experimental results have shown that the ACO&CM algorithm is to be very efficient and competitive in terms of solution quality.

15:00-15:20 **TueC12-4**

Multi-type products collaborative vehicle routing problem under consideration of transshipment

Xiao Wu Northeastern Univ.
Hui Zhang Northeastern Univ.
Min Huang Northeastern Univ.

Facing the increasing pressure in road transportation, small and medium-sized carriers are trying to establish horizontal coalition to reduce operational costs and improve their profitability. In this paper, the multi-type products Collaborative Vehicle Routing Problem with Transshipment (CoVRPT) is proposed. A mixed-integer linear programming model for this problem is established. The result of this problem is compared with that of multi-type products vehicle routing problem without collaboration and multi-type products CoVRP without transshipment. Numerical studies suggest that proposed method is more effective in terms of transportation cost-saving.

15:20-15:40 **TueC12-5**

Development Modes and Performance Evaluation of Fresh Agricultural Products Logistics—Evidenced from Shandong Province in China

Hao Zhao Shandong Univ. of Tech.
Meiyan Pang Shandong Univ. of Tech.
Ronghui Lin Hualong Township People's Government
Jinyan Sang Shandong Univ. of Tech.

With the healthy development of social economy, people have become increasingly concerned of the safety and quality of fresh agricultural products. The development of fresh agricultural products logistics has become the bottleneck of agricultural market and trade. Based on the analysis of fresh produce logistics modes, the paper discusses the four fresh produce logistics modes: the enterprise self-conducting logistics mode, third-party logistics mode, wholesale market for logistics mode and supply chain partners alliance logistics mode. Combined with the actual data in Shandong Province of China, the paper evaluated the logistics performance of fresh agricultural products. Development modes of fresh agricultural products logistics were given based on the situations of cities. The study would play an active role in promoting the development of regional economy.

15:40-16:00 **TueC12-6**

Strategic investment in low-carbon technology and optimal production under carbon cap-and-trade regulation

Yonghong Cheng Anhui Polytechnic Univ.
Zhongkai Xiong Chongqing Univ.

To investigate the effects of carbon cap-and-trade regulation on firm's production and low-carbon technology investment decisions, we firstly introduced a model for production decision without considering carbon cap-and-trade regulation as a benchmark. Under cap-and-trade regulation, we established the model for production decision and the model for joint decisions on production and low-carbon technology investment, then discussed the impacts of the carbon emissions quota and carbon trading price on firm' production quantity and carbon emissions as well as profits, and compared the optimal production quantity, total carbon emissions, and profit. Finally, the relevant propositions and corollaries were verified and analyzed by numerical examples, some management Implications for the firm making decisions on production and low-carbon technology investment and for the governments operating effectively the carbon cap-and-trade regulation were proposed.

TueC13 **Room13**
Data processing (VI) **14:00-16:00**
Chair: Leilei Li Beijing Inst. of Tech.
CO-Chair: Yan Guuo Zhejiang Univ.

14:00-14:20 **TueC13-1**

Detection of the Main Symmetry Axis Based on the Clustering Analysis

Xiaopeng Wang Tianjin polytechnic Univ.
Chunbo Xiu Tianjin polytechnic Univ.
Tiantian Wang Tianjin polytechnic Univ.

In order to improve the detection performance of the main symmetry axis, a new detection method based on the clustering analysis is proposed. Some feature points are extracted from the image based on the Harris corner detection, and C-means clustering method is used to classify the feature points into C groups. Multiple random sampling is performed in each cluster to get the feature point pairs. The candidate symmetry axis can be determined by resolving the perpendicular bisector of each pair of feature points. The main symmetry axis can be determined according to the distribution of the candidate symmetry axes. Main symmetry axes of many images are detected by the method. Simulation results prove the method valid.

14:20-14:40 **TueC13-2**

A new method of data processing of division-of-amplitude polarization navigation angle sensor

Yansheng Dai Beijing Inst. of Tech.
Leilei Li Beijing Inst. of Tech.
Jiabin Chen Beijing Inst. of Tech.
Xusheng Zhang Beijing Inst. of Tech.
Zhongyu Zhang Beijing Inst. of Tech.

Due to elements production defect, installation error, etc., the accuracy of the division-of amplitude is greatly restricted. In this paper, the principle of division-of-amplitude measuring polarized light and the POL-neural model are analyzed, putting forward utilizing Radical Basis Function (RBF) neural network instead of instrument matrix to process data. This method has more complex mapping relationship between input vector and output vector, which can reduce the influence of system error. And its accuracy is greatly better than other methods. Its difference between actual Stokes parameters and ideal stokes parameters is 10^-3level, and its maximum difference between actual angle and ideal angle is 0.08651°.

14:40-15:00 **TueC13-3**

A novel Intelligent Credit Scoring Method using MOPSO

Yan Guo Zhejiang Univ.
Chao Dong Ningbo Dahongying Univ.

We present an intelligent credit scoring method to categorize credit applicants. Then, a novel multi-objective credit scoring model is proposed in this paper. In term of the defects of linear discriminant analysis (LDA): lack of accuracy, a multi-objective particle swarm optimization for credit scoring is designed in this paper. Finally, through the experiments with two real-world data set and one benchmark data set, we compare our approach with NaiveBayes, Logistic Regression (LR), Sequential Minimal Optimization (SMO), Neural Networks (NN), and Decision Trees (DT), the results of experiments demonstrate our proposed method outperforms the abovementioned five data-driven counterparts in term of accuracy and specificity while maintaining acceptable sensitivity.

15:00-15:20 **TueC13-4**

Ensemble One-Class Classification Applied for Anomaly Detection in Process Control Systems

Shengji Lu Liaoning Water Conservancy Vocational Coll.
Biao Wang Northeastern Univ.

In order to achieve better control performance for process control systems (PCSs) a plenty of advanced control methods have been proposed recently and most of them all need the support of process data generated during operation. While not much attention had been paid to the issue of anomaly detection for PCSs, which may be the main factor that prevents practical applications of these methods. This paper proposed a general anomaly detection method for online identifying anomalies mixed among process data of PCSs. Converting the issue of anomaly detection to one-class classification (OCC) can remit the absence of anomalies in PCSs. Exploiting the thought of ensemble can provide a more general solution for varying PCSs. Experimental results prove the effectiveness and applicableness of the proposed method and its ability to outperform state-of-the-art algorithms for detecting anomalies for PCSs.

15:20-15:40 **TueC13-5**

Effect of Zero Time Point Bias on Offline Navigation Recomputation

Jinhua Fan Taiyuan Satellite Launch Center.

In order to verify the scheme of the navigation system after a real flight test, the effect of the zero time point bias on offline navigation recomputation is analyzed. A general navigation computation procedure is firstly introduced, and then the effect of the zero time point bias is analyzed by resorting to the apparent acceleration. As a result, a quantitative relationship between the zero time point bias and the navigation parameters is established. With the flight test data, it is demonstrated that the zero time point bias can lead to an evident navigation velocity bias. In addition, the navigation velocity bias curve has a similar shape with the apparent acceleration curve, and the difference between these curves depends on the zero time point bias.

15:40-16:00 **TueC13-6**

Research of Text Clustering Based on improved VSM by TF under the framework of Mahout

Langcai Cao Xiamen Univ.
Zhihui Li Xiamen Univ.
Yuanfang Liu Xiamen Univ.

Currently, the data that dealt by traditional text clustering methods is small. Text representation model that text clustering used is traditional vector space model (VSM). The traditional text clustering has defect of low efficiency when processing big data. The quality is bad when using traditional VSM model for text representation. To solve these two problems, this paper puts forward a VSM model for text representation, which is improved by Term Frequency(TF), and using Mahout to text clustering. Experimental results show that use Mahout for text clustering has a higher efficiency than traditional text clustering; this novel VSM model can improve the text clustering quality.

TueC14 **Room14**
Robot control (I) (Chinese) **14:00-16:00**
Chair: Dongsheng Guo Huaqiao Univ.

CO-Chair: Xinfan Yin National Univ. of Defense Tech.

14:00-14:20 **TueC14-1**

A New Feedback-Added Obstacle Avoidance Scheme for Motion Planning of Redundant Robot Manipulators

Dongsheng Guo Huaqiao Univ.
Zhaozhu Su Huaqiao Univ.
Sibo Sun Huaqiao Univ.
Xinjie Lin Huaqiao Univ.
Qingping Liu Huaqiao Univ.

How to avoid obstacle is one of the fundamental issues in motion planning of redundant robot manipulators. In this paper, a new scheme based on the pseudoinverse-type formulation is developed and investigated for obstacle avoidance of redundant robot manipulators. For this obstacle avoidance scheme, the feedback is added to guarantee the precision of Cartesian error. Theoretical results are then given to show its excellent property. Simulation results based on the PA10 robot manipulator with point and window-shaped obstacles are illustrated to further substantiate the efficacy of the presented feedback-added obstacle avoidance scheme for motion planning of redundant robot manipulators.

14:20-14:40 **TueC14-2**

Formation Control Based on Leader-Following Method for Multi-robot to Reduce Path deviation

Yiqun Yang Shanghai Inst. of Tech.
Hongjie Jiang Shanghai Inst. of Tech.

In view of the unavoidable Path deviation of the leader-following method in the course of movement. A method to reduce the deviation by using the ZigBee positioning system is proposed.In the process of real-time movement of the leader and followers to locate, thereby constantly modifying the followers forward angle and speed, making the Path deviation smaller.In this paper, as zigbee positioning to take the wireless signal loss model, affected by the environment, so in order to improve the positioning accuracy, the use of the triangle centroid algorithm. So that the formation of more reliable to maintain.

14:40-15:00 **TueC14-3**

The Research on Game Manipulator Based on Bionic

Yanwen Wang Shenyang Aerospace Univ.
Zhengqiang LI Shenyang Aerospace Univ.
Hongmin Shi Shenyang Aerospace Univ.
Wenliang Ge Shenyang Aerospace Univ.
Wenxi Ding Shenyang Aerospace Univ.
Zhihao Zhang Shenyang Aerospace Univ.
Jinghong Fan Shenyang Aerospace Univ.

Bionics game equipment manufacturing system is a trend in industrial area in the future. The game of bionics manipulator is an indispensable link in production and circulation. With the development of modern industry, previous game mechanical arm is unable to meet the fast, accurate automatic production. To free people from the game, game manipulator development is particularly important. This paper introduces the working principle of bionics, game manipulator structure characteristics and design. The overall design process and calculation method of bionics manipulator game are analyzed and described specifically and.The game of the manipulator is divided into three parts: mechanical system, drive system and control system. The mechanical system is composed of the manipulator's hand, arm, rotating base and rotary feed mechanism. In this paper, by designing, calculating and verifying every part of the mechanism, the requirements for freedom manipulator, trajectory, stroke are met. This design adopts mechanical drive, respectively, calculating and designing the mechanical system and mechanical drive. The control system, PLC control, has also been introduced concisely. Through designing the above three parts, a bionic manipulator has created, which has achieved the goal of the game.

15:00-15:20 **TueC14-4**

Research on Modeling and Stability Control of Micro Unmanned Helicopter

Xinfan Yin National Univ. of Defense Tech.
Daibing Zhang National Univ. of Defense Tech.
Qiang Fang National Univ. of Defense Tech.
Lincheng Shen National Univ. of Defense Tech.

The micro unmanned helicopter has become a hot spot in the fields of military applications because of its advantages of flexibility, good concealment and the capability of VTOL. In recent years, it has become the focus of the research institutes in various countries. In order to realize the goal of autonomous flight of the micro unmanned helicopter, it is necessary to have a precise model. In this paper, firstly, the theoretical model of the micro unmanned helicopter is carried out, and then a PID controller is designed for the linearized model, and finally, we carry out experiments on the "Ling-QueS" unmanned helicopter system which is designed by the authors of this paper. The results of the experiments show that the designed PID controller in this paper can correct the flight attitude shift effectively, and achieve the goal of stable and reliable flight. It is useful for the flight control system design and the further miniaturization design of the unmanned helicopter.

15:20-15:40 **TueC14-5**

Analysis of paths by the multi-constraints support vector machine method for path planning

Qingyang Chen National Univ. of Defense Tech.

Path planning for robots with obstacles is an important problem and has not been resolved well yet. An extended Support Vector Machine (SVM)-based path planning method (which is named the multi-constraints SVM method in this paper) was proposed in previous work. However, no analysis was provided for the planned paths. So, a detailed analysis of the paths based on the method above will be given in the paper. The continuity of curvature and uncontinuity of the first order derivation of curvature for the planned paths will be mainly discussed in the paper. What's more, the relationship between the uncontinuous points of the first order derivation of curvature and the focuses for human driving behavior will be discussed. Based on that, an important conclusion about the support vectors and the focuses for path following is derived, and it is believed to be important for the path following problem. The correctness of the analyzing results and the effectiveness of the path planning method were verified through simulation results.

15:40-16:00 **TueC14-6**

Artificial Landmark Design and Detection Using Hierarchy Information for UAV Localization and Landing

Wen Fei Northeastern Univ.
Zhuo Su Northeastern Univ.
Changfu Zhou Northeastern Univ.

Localization and landing are of fundamental importance for Unmanned Aerial Vehicles (UAVs), and with the research on compute vision information processing, artificial landmark detection ,a more efficient and accurate method, becomes a hot topic. In this paper, in order to provide sufficient information for localization, we design an artificial landmark with an annulus and some circles inside with specific positions and colors. We firstly use color and hierarchy information to find possible patter, then calculate its cross-ratio to check this pattern, localize our UAV at last. To prove our landmark and detection-recognition algorithm, two kinds of experiments are conducted and the results demonstrate our feasibility and accuracy. One is putting our landmark on random backgrounds to imitate complex environment, another is on real environments with different projection and distance. With those experimental results, we get the conclusion that our landmark and algorithm are robust and feasibility under various environments.

TueC15 **Room15**
Data processing (I) (Chinese) **14:00-16:00**

Chair: Chunhui Zhao Zhejiang Univ.
CO-Chair: Wei Zhou Northeastern Univ.

14:00-14:20 **TueC15-1**

Fault isolation method for nonstationary industrial processes

He Sun Zhejiang Univ.
Shumei Zhang Zhejiang Univ.
Chunhui Zhao Zhejiang Univ.
Youxian Sun Zhejiang Univ.

It is very important to isolate the faulty variables after a fault is detected. However, it is challenging to isolate the faulty variables due to the nonstationarity which widely exists in the industry processes. The statistical properties of nonstationary process variables are time-variant, i.e., these variables are time-dependent. This paper proposes an effective faulty variable isolation method for the nonstationary industrial processes using the cointegration method. In the nonstationary industrial processes, not all the variables are nonstationary. The nonstationary variables should be distinguished from the stationary ones. Then, the nonstationary variables are used to build the cointegration model to describe the long-run equilibrium relation among those nonstationary variables. Finally, the least absolute shrinkage and selection operator method is integrated to the cointegration model for selecting the faulty variables that are mainly responsible for the fault. The proposed faulty variable isolation method can deal with the nonstationary issue in the industrial processes and isolate multiple faulty variables simultaneously. Its feasibility and performance are illustrated with a real industrial process of the thermal power plant.

14:20-14:40 **TueC15-2**

A Novel Approach for Red Lesions Detection Using Superpixel Multi-Feature Classification in Color Fundus Images

Wei Zhou Northeastern Univ.
Chengdong Wu Northeastern Univ.
Dali Chen Northeastern Univ.
Zhenzhu Wang Northeastern Univ.
Yugen Yi Jiangxi Normal Univ.
Wenyou Du Northeastern Univ.

Since red lesions have been found to be one of the earliest lesions in diabetic retinopathy (DR), automatic red lesions detection plays a critical role in diabetic retinopathy diagnosis. In this article, we develop a novel method using superpixel segmentation and multi-feature classification (SMFC). Using our proposed method, the retinal images are segmented into superpixels with the similar color and spatial location. And then, a set of features under multi-channel are proposed for each superpixel. Specifically, a novel contextual feature is developed to describe the superpixels with red lesions. Next, FDA classification algorithm is used to classify the red lesions with multi-feature for each superpixel. Additionally, post-processing is applied to remove the blood vessels and the fovea. Experiments are carried out on public DiaretDB1 database and extensive results show the effectiveness of our proposed method.

14:40-15:00 **TueC15-3**

Maneuvering Target Tracking Based on Wavelet Transform Denoising

Guicheng Wang Shanghai Inst. of Tech.
Shenyang Univ. of Chemical Tech.
Ran Mo Shenyang Univ.
Min Zhang Shanghai Inst. of Tech.
Weipeng Zhang Shanghai Inst. of Tech.

Because of the influence of various disturbances, the measured value of the target state parameter obtained is different from the real state by the radar. To track the target continuously, the error can not be zero, so that the target can not be accurately maintained. And it is a problem that the target tracking system needs to be solved to suppress all kinds of error interference. In the processing of target tracking data, we can decompose the signals of different frequencies into different frequency ranges by introducing the wavelet filtering, which can be used to update the state of the maneuvering target. The simulation results show that the wavelet filtering can reduce the dynamic hysteresis error and noise interference error, and obtain better tracking performance.

15:00-15:20 **TueC15-4**

Research on Postgraduates Innovation Ability Based on the Cloud Model

Yaozong Dai Zhengzhou Inst. of Information Science and Tech.
Jianjing Shen Zhengzhou Inst. of Information Science and Tech.
Liren Zhang Zhengzhou Inst. of Information Science and Tech.

This paper focuses on the evaluation of postgraduates' innovation ability based on cloud model. Considering that the innovation capability is mostly qualitative index and has strong fuzziness, the cloud model method can realize the effective conversion between the qualitative index and the quantitative value. Compared with traditional methods, the evaluation method is more scientific and the result is more intuitive.

15:20-15:40 **TueC15-5**

A Modified Particle Swarm Optimization Algorithm - CPSODE

Libo Zhang Nanjing Univ.
Qijian Fu Nanjing Univ.
Jiao Chen Nanjing Univ.
Han Bai Nanjing Univ.
Xianzhong Zhou Nanjing Univ.

To solve the local minima problem of Particle Swarm Optimization (PSO) algorithm, a novel cooperation algorithm called CPSODE is proposed. CPSODE is based on PSO algorithm and Differential Evolution (DE) algorithm, which introduces the cooperation mechanism into the evolution of search agents. For each particle, the evolved strategy is based on the cooperation and information sharing of particles. If the number of trapped particles reaches a certain threshold, the trapped particles will be replaced by new particles from the other evolution group. Experimental analysis validates the effectiveness of CPSODE model.

15:40-16:00 **TueC15-6**

A New Constraint Spectral Clustering Algorithm

Zhiping Zhou Jiangnan Univ.
Xuan Jia Jiangnan Univ.
Xiaoxiao Zhao Jiangnan Univ.

Subspace clustering methods based on spectral clustering have been very popular due to their theoretical guarantees and empirical success. However, considering the constraint information of data, these subspace-clustering-based constraint clustering algorithms are difficult for the high-dimensional data with data nuisances to achieve better clustering results. This paper proposes a novel constraint spectral clustering algorithm based on the program of sparse subspace. Firstly, constraint term which are suitable for sparse subspace model are established according to the different statuses of representation matrix. Then a novel semi-supervised sparse subspace model is presented with the constraint terms mentioned above. Finally, the final clustering results could be acquired by spectral clustering under the guidance of constraint information. Experiments on two real-world dataset verify the property of the algorithm and show that this approach could achieve better clustering accuracy than others.

TueC16 **Room16**
Smart grids (V) (Chinese) **14:00-16:00**

Chair: Liqun Shang Xi'an Univ. of Science and Tech.
CO-Chair: Zhaohui Tang Central South Univ.

14:00-14:20 **TueC16-1**

Study on Adaptive Reclosure Criterion Based on Mutual Distance Algorithm

Liqun Shang Xi'an Univ. of Science and Tech.
Feng Chen Xi'an Univ. of Science and Tech.
Ronghua Zhao Xi'an Univ. of Science and Tech.

When single-phase grounding fault occurs on a transmission line with shunt reactors, due to the difference of the recovery voltage between transient faults and permanent faults, the relationships of the fault phase recovery voltage and the voltages of shunt reactors and neutral reactors are deduced. Criteria for the self-adaptive reclosure based on the value of mutual distance function are presented. The proposed criteria use the difference of the voltage on reactor shunt and neutral reactor in the fault phase at the same time to determine the fault type. If there are big differences, the calculated mutual distance function values are large, the fault is judged to be transient fault, and on the contrary it is judged to be permanent fault. ATP-EMTP simulation results showed that the criterion can determine the type of single-phase grounding fault on the transmission lines with shunt reactor simply and accurately.

14:20-14:40 **TueC16-2**

Study of Short-term Load Forecasting in Big Data Environment

Haifan Zhao Central South Univ.
Zhaohui Tang Central South Univ.
Weidong Shi Central South Univ.
Zixun Wang Central South Univ.

This paper presents an improved support vector machine method based on the Hadoop, which can solve the problem of short-term load forecasting in the big data environment. In the control design, the fuzzy C clustering model of quantum behaved particle swarm optimization is used to analyze the historical load data. Then, the load data and the influencing factors data are stored and matched in Cloud platform, through this way which can improve the accuracy of the input data and the speed of the response. At last, the model is established. According to the certain area load big data, the improved support vector machine forecast model and the normal support vector machine forecast model are compared in forecasting accuracy and forecasting time. The results indicate that Hadoop-SVM has better predictive ability and faster computing time when processing the big data.

14:40-15:00 **TueC16-3**

A Robust Interval Economic Dispatch Model Accommodating Large-scale Wind Power Generation with Consideration of Price-based Demand Response

Liudong Zhang Electric Power Research Inst. of State Grid Jiangsu Electric Power Company
Southeast Univ.
Yubo Yuan Electric Power Research Inst. of State Grid Jiangsu Electric Power Company
Bing Chen Electric Power Research Inst. of State Grid Jiangsu Electric Power Company
Dawei Su State Grid Jiangsu Electric Power Company

Demand response can promote large-scale wind power accommodation via utilizing demand side resources to participate in power systems dispatch. Because the wind power uncertainty is neglected and the probabilistic model of wind power forecast error is difficult to be accurately obtained in the existing wind power dispatch models considering demand response, the impacts of wind power uncertainty on demand response load regulation are unable to be accurately evaluated. By utilizing the interval information of wind power forecast which can be conveniently obtained, the robust interval optimization method can be used to achieve the joint optimization of dynamic demand response load regulation and uncertain wind power accommodation. Therefore, a price-based demand response model is introduced to the conventional robust interval dynamic economic dispatch model, an hours-ahead robust interval economic dispatch model accommodating large-scale wind power with consideration of price-based demand response is developed and its solution method based on linear programming is proposed in this paper. Simulation studies on the IEEE 26-generator reliability test system connected to a wind farm are presented to verify the effectiveness and advantage of the proposed model.

15:00-15:20 **TueC16-4**

Analysis of ice disaster failure considering the multi angle information modification for distribution network

Xinrui Liu Northeastern Univ.
Yaoyao Zheng Northeastern Univ.
Peng Jin Liaoning Provincial Power Grid Corp
Tianqi Lu State Grid Liaoning Electric Power Company Limited Economic Research Inst.

In this paper, the method of ice disaster for distribution network failure rate analysis is developed. This method takes the line segment as a research unit according to the characteristic of obvious regional differences in distribution network. The priority is rightly to determine the high risk line segments based on the analysis of history sensitivity of disaster and component loss rate. Besides, it is assumed that the rate of a real-time failure due to the ice disaster weather depends on failure rate for operation and frozen disaster together with the interaction of internal and external factors. In order to mitigate severe consequences of future ice disasters in an efficient way it is essential to be able to estimate the risk failure rate based on forecast of the real-time failure rate and the history sensitivity of disaster. And the real-time analysis of risk failure rate can be modified by the multi angle information to achieve early warning timely and accurately. The numerical example show the impact of ice disaster on a part of the Shen Yang distribution network using date from real weather situations and the analysis method, and the validity of the method is verified.

15:20-15:40 **TueC16-5**

An Electricity Charge Strategy Mechanism based on Dynamic Reward and Punishment in Smart Grids

Xin Li Shenyang Univ.
Xiaoning Qin Shenyang Dongling Power Supply Branch Company
Tong Xu Shenyang Univ.
Yingkui Du Shenyang Univ.

An electricity charge strategy mechanism based on dynamic reward and

punishment is discussed in this paper. Several types of electricity charge strategy are proposed, such as unilateral linear punishment and nonlinear charge strategy, bilateral linear punishment and nonlinear charge strategy, bilateral linear reward and punishment and nonlinear charge strategy, unilateral nonlinear punishment and linear charge strategy, bilateral nonlinear reward and punishment and approximate linear charge strategy. The proposed mechanism can dissolve the contradiction between charging class and power supply-demand, which brought by the fixed class electricity price mechanism dominated by the power sector. Finally, the principle and algorithm of determining the expected power consumption is proposed from the perspective of Stackelberg strategy. Meanwhile, the principle of determining customers' optimal electric activities and electricity price algorithm is proposed.

15:40-16:00 **TueC16-6**

A Simulated Annealing Based Fuzzy Markov Game Energy Management in Smart Grids

Xin Li Shenyang Univ.
Yingkui Du Shenyang Univ.
Bowen Xiao Shenyang Univ.
Xiaoning Qin Shenyang Dongling Power Supply Branch Company

With the development of smart grid technology, the user participation in demand side gradually plays a more important role in energy management. Because of the uncertainties of user behavior, it is not easy to accurately obtain the complete information for energy management in smart grids. What's more, energy users have different respond to the energy management strategy. The competition of energy users with different priorities is regard as a zero-sum game. The fuzzy Markov game energy management controller is proposed to deal with the presence of unknown parameter variations. The problems of parameter optimization are solved by simulated annealing algorithm. The proposed controller can learn to take the best action to regulate energy usage for different users. Simulation results demonstrate the viability of the proposed controller for accelerating learning and promoting the performance of energy usage in smart grids.

TueC17 **Room17**
Renewable energies (I) (Chinese) **14:00-16:00**
Chair: Rui Ling Chongqing Univ.
CO-Chair: Changhao Yang Chongqing Univ.

14:00-14:20 **TueC17-1**

Enumeration-Based Predictive Control for Buck Dc-Dc Converter

Qin Huang Chongqing Univ.
Xiaodong Yan Chongqing Univ.
Rui Ling Chongqing Univ.
Qing Hu Chongqing Univ.
Daxia Yu Chongqing Univ.
Hui Liu Chongqing Univ.

In this paper, Enumeration-Based mode predictive control (EMPC) approach is applied to Buck dc-dc converter. First of all, the continuous state space model and the discrete-time state space model of the converter are derived. Secondly, the strategy of Enumeration-based predictive control for continuous current mode (CCM) and discontinuous current mode (DCM) of buck converter is presented in detail. The controller can stabilize the voltage of the converter fast with non-overshoot and have favorable performance in dynamic transition. Finally, the control strategy has been verified by simulations.

14:20-14:40 **TueC17-2**

Power Compensation and Efficiency Promotion of PV Modules under Partially Shaded Condition

Qin Huang Chongqing Univ.
Changhao Yang Chongqing Univ.
Rui Ling Chongqing Univ.
Qing Hu Chongqing Univ.
Hui Liu Chongqing Univ.
Daxia Yu Chongqing Univ.

This paper presents a method based on voltage balance for enhanced bidirectional Cúk converter in power compensation of PV modules under non-uniform irradiation condition. The modelling and analysis of the converter circuit is presented. The method of voltage balance makes each module operating close to the ideal MPP without current sensing. The efficiency is greatly improved to about 97%. All simulation results demonstrate the effectiveness of the compensator and method with a typical structure consisting of three PV modules.

14:40-15:00 **TueC17-3**

A New Modulation Strategy of Quasi-Z-source Inverter in Photovoltaic System

Qiming Cheng Shanghai Univ. of Electric Power
Jie Gao Shanghai Univ. of Electric Power
Yinman Cheng Tongji Univ.
Fengren Tan Shanghai Univ. of Electric Power
Yu Zhang Shanghai Univ. of Electric Power
Deqing Yu Shanghai Univ. of Electric Power

A photovoltaic system based on quasi-Z-source inverter (QZSI) is discussed. The QZSI has higher boost capacity and stability than the traditional inverters, but different modulation strategy is needed to realize these characteristics. A new space vector pulse-width amplitude modulation strategy is proposed to reduce the switching loss and the weighted total harmonic distortion of the output voltage of photovoltaic system. Its algorithm and implementation are discussed. The proposed method is validated by simulations and experiments. Simulation results are presented to verify the effectiveness of the proposed approach.

15:00-15:20 **TueC17-4**

Selective Sampling Using Active Learning for Short-term Wind Speed Prediction

Xin Zhao Southeast Univ.
Haikun Wei Southeast Univ.
Chi Zhang Southeast Univ.
Kanjian Zhang Southeast Univ.

Wind power prediction is very important to guarantee security and stability of the wind farm and power system operation, and wind speed forecasting is the key to wind power prediction. Due to dramatic changes and shorter collection intervals in wind speed, it generates a larger numbers of samples, which affects modeling time and accuracy. Therefore, a short-term wind speed prediction method based on active learning with sample selection is proposed. The main objective of active learning is to collect training samples by minimizing the error of the prediction process while minimizing the number of training samples used. First the initial training set is selected, then selecting the sample with higher Euclidean distance adding to the training set and delete the samples with lower cross-validation error. Finally, the establishment of support vector machine model and neural network model to predict the results of comparison. Taking a wind farm in Jiangsu Province as the actual experimental data, simulation results show that this method can ensure the prediction accuracy, while effectively reducing the number of training samples.

15:20-15:40 **TueC17-5**

Analysis of Wind Power Characteristics of Typical Wind Farm in Inner Mongolia Area

Jizhen Liu North China Electric Power Univ.
Juan Wang North China Electric Power Univ.
Yang Hu North China Electric Power Univ.
Junlin Guo North China Electric Power Univ.
Bao Zhang North China Electric Power Univ.

In recent years, the rapid development of wind power, resulting in large scale wind power consumptive difficult, wind energy is serious. The volatility and randomness of wind also brings great difficulties to wind power grid connection. Therefore, based on the measured wind speed, a wind farm in Inner Mongolia area of our country in 2015 the power of data, from the analysis of the characteristics of wind power, the wind resource characteristics of abandoned wind characteristics, fluctuation characteristics and counter peaking characteristics and time characteristics. The research shows that the wind resource rich, serious abandoned wind, the maximum monthly rate of abandoned wind up to 28.7% days; output change rate is smaller, and the conventional power compensation device can timely carry on the output response; according to the ramp rate, you can select the appropriate unit to adapt to the fluctuation of wind power output of wind power operation; obviously, the anti-peaking, need further attention; wind power output characteristics of the time can be used to guide the grid frequency. According to wind farm wind power characteristics, combined with the local power grid load situation, in order to develop a reasonable scheduling scheme.

15:40-16:00 **TueC17-6**

Modeling of DFIG based Wind Farm Considering Temporal and Spatial Non-Uniformity of Wind Speed in Mountainous Region and its Applicability Analysis

Xinglong Wang Guizhou Univ.
Song Han Guizhou Univ.

In order to improve the validity and accuracy of wind farm integrated power system dynamic analysis in high-altitude mountainous region, it is necessary to study on modeling of DFIG (Double-Fed Induction Generator) based wind farm considering non-uniformity of wind speed in mountainous region and its applicability analysis. Firstly, the wind speed characteristics of wind farm in high-altitude mountainous areas can be reviewed. Secondly, the simplified modeling method for wind farm could be briefly discussed. Thirdly, a detailed modeling method for wind farm based on a user-defined model with temporal and spatial distribution of wind speed using PSS/E is proposed. A case study has been carried on a high-altitude mountainous wind farm in Guizhou which may analyze the applicability of detailed model and simplified model by the comparisons in three involving the variation of wind speed distribution, cut-in wind speed, and cut-out wind speed. The discussions and conclusions would be useful for dynamic characteristics analysis of high-density wind power integrated power system in mountain areas.

TueCIS **Room18**
Interactive Session **14:00-16:00**

TueCIS-01

Research on Avoidance Obstacle Strategy of Coal Underground Inspection Robot Based on Binocular Vision

Kai He Xi'an Univ. of Science and Tech.
Xianmin Ma Xi'an Univ. of Science and Tech.

In this paper, aiming at the problem of obstacle avoidance in coal underground inspection robot, a control strategy to improve the avoidance obstacle precision of the robot is put forward, which combines

the ultrasonic detection ranging technology and image processing method of machine vision. Firstly the ultrasonic detection technology is used to detect the remote distance obstacle, then the image processing method is adopted to perform closed ranging observation of the shape.The experimental simulation results show that the proposed obstacle avoidance combined strategy has a good effect on the inspection and avoidance obstacle of the underground inspection robot.

TueCIS-02

Research on Path Planning for Mobile Robot Based on ACO

Yi Gan Univ. of Shanghai for Science and Tech.
Chuo Univ.
Fengting Qu Univ. of Shanghai for Science and Tech.
Fujia Sun Univ. of Shanghai for Science and Tech.
Weiming He Univ. of Shanghai for Science and Tech.
Chuo Univ.
Pengju Zhang MSP/DRILEX (SHANGHAI) CO, LTD

A planning method based on the expansion path of the ant colony optimization is proposed for path planning of mobile robot in a complicated environment. Introducing to time-varying characteristics of pheromone distribution, pheromone update strategy, inflection path optimization and local optimal path of expansion, and it is designed that inflection parameters and overall evaluation as the path evaluation criteria. The three algorithms were compared with each other by the simulation results and practical tests. The comparisons verified the expansion path of the ant colony optimization which shows better search performance, stronger searching ability and shorter path than the traditional ant colony algorithms and improved algorithms. The algorithm inhibits algorithm into local optimum and achieves search of mobile robot's optimal path. Mobile robot can avoid obstacles to reach the target point safely and quickly.

TueCIS-03

A Fast Key Frame Extraction Algorithm and an Accurate Feature Matching Method for 3D Reconstruction from Aerial Video

Cheng Zhang NanKai Univ.
Tianjin Key Laboratory of Intelligent Robotics
Hongpeng Wang NanKai Univ.
Tianjin Key Laboratory of Intelligent Robotics
Hanzhen Li NanKai Univ.
Tianjin Key Laboratory of Intelligent Robotics
Jingtai Liu NanKai Univ.
Tianjin Key Laboratory of Intelligent Robotics

In this paper, we present a fast method of key frame selection and an accurate feature point matching method for 3D reconstruction through the control of quadrotor. The quadrotor is controlled to fly at a fixed altitude and the gimbal camera has always been a downward direction. Therefore, the additional information of the quadrotor could be easily added to the 3D reconstruction process. As a result, we find a fast method to select key frames and an optimized matching method through the geometric constraints of the flight path and direction. The method is mainly to improve the efficiency of key frame selection and to get more accurate matching points. The advantage of our approach is to combine the two processes between video capture and video processing by adding flight control to the 3D scene reconstruction method. Therefore, it can use less time to complete the entire reconstruction task. The proposed approach is tested by quadrotor platform. Experiment results show that our method can greatly reduce the key frame selection time and get more matching points at the same accuracy.

TueCIS-04

Research of nozzle pressure control system based on air pressure 3d printer

Huanbao Liu China Agricultural Univ.
Huixing Zhou China Agricultural Univ.
Beijing Univ. of Civil Engineering and Architecture
Xuhan Wang China Agricultural Univ.
Hejie Yu China Agricultural Univ.
Xiaolong Liu China Agricultural Univ.

With advances in 3D bio-printing, multi-material tissue and organs regeneration have become realistic foreground in the field of tissue engineering. 3D bio-printing - the distribution of well-organized cells to construct the biofabrication that can substitute the damaged tissue and organs - is a prospect strategy. But there are still many problems such as material extrusion speed, forming precision, which will affect the cell distribution uniformity and prototyping precision. In this paper, we have developed a novel pneumatic control technology, which has been successfully applied to 3D bioprinter. The correlative experiments were designed to verify reliability of system, and experimental results show that pneumatic control system (PCS) can maintain the 3D bio-printing process output pressure stable, which improves control precision, and also prevents material accumulation or insufficient material. It could further confirm that the PCS has potential application prospect in the field of 3D bio-printing.

TueCIS-05

An EEG-bas ed brain-computer interface for gait training

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This work presents an electroencephalography (EEG)-based Brain-computer Interface (BCI) that decodes cerebral activities to control a lower-limb gait training exoskeleton. Motor imagery (MI) of flexion and extension of both legs was distinguished from the EEG correlates. We executed experiments with 5 able-bodied individuals under a realistic rehabilitation scenario. The Power Spectral Density (PSD) of the signals was extracted with sliding windows to train a linear discriminate analysis (LDA) classi fier. An average classi fication accuracy of 0.67±0.07 and AUC of 0.77±0.06 were obtained in online recordings, which confirmed the feasibility of decoding these signals to control the gait trainer. In addition, discriminative feature analysis was conducted to show the modulations during the mental tasks. This study can be further implemented with different feedback modalities to enhance the user performance.

TueCIS-06

Vessel Segmentation Algorithm for Thorax CT images Based on Fast Marching Method

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Zhaonan Liang Northeastern Univ.
Enjian Ye Northeastern Univ.
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Lung vessel segmentation plays an important role in lung disease detection. In order to improve the accuracy and the algorithm running time of pulmonary vascular segmentation method, a new pulmonary vascular segmentation method based on the improved fast marching method is proposed in this paper. Firstly, the lung tissue is extracted from thorax CT images by Otsu algorithm; Secondly,the vessels are crudely extracted in middle layer of the CT images as the initial diffusing surface; Finally, the lung vessels are extracted by spreading throughout the lung tissue from the initial diffusing surface with the threshold and gradient restrictions. The experiment results show that this method can quickly and accurately segment the lung vessels even if the small vessels.

TueCIS-07

Multi-AUVs Cooperative Complete Coverage Path Planning Based on GBNN Algorithm

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Chaomin Luo Univ. of Detroit Mercy

For the complete coverage path planning of multi-AUVs (autonomous underwater vehicles), a method of cooperative complete coverage path planning for multi-AUVs based on GBNN algorithm is proposed in this paper, where all AUVs share the common working environment information, and each AUV treats other AUVs as moving obstacles. Firstly, a grid map is constructed by discretizing the underwater workspace. Secondly, the corresponding dynamic neural networks are built on the grid map, and there are N neural networks for N AUVs, respectively. Finally, each AUV plans its reasonable coverage path according to its own neural activity through GBNN strategy, until work together to cover the entire workspace. The simulation results show that multi-AUVs can not only cooperatively accomplish the common coverage tasks without any mutual collision and overlapped coverage, but also automatically avoid obstacles and escape from deadlocks, and effectively improve work efficiency of each single AUV, reduce complete coverage time and save AUVs' power.

TueCIS-08

Autonomous Flight Control Law for an Indoor UAV Quadrotor

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Yaoxian Song Hangzhou Dianzi Univ.
Lingjun Zhu Hangzhou Dianzi Univ.

This paper proposes a control law using open source autopilot controller to realize autonomous flight of indoor UAV quadrotor in the environment of motion capture system (i.e. Optitrack) . Dynamic modeling, controller design, overall system design are introduced respectively. The working principle of the system, hardware components and software components are described as well. The experimental results are provided to demonstrate the effectiveness of the proposed scheme.

TueCIS-09

Deep Stall Landing Strategy for Small Fixed-Wing Aircraft Aided by Morphing

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Da Li Nanjing Univ. of Aeronautics and Astronautics

Deep stall landing is a space saving landing method for fixed-wing aircraft. In this paper, the deep stall landing strategy is investigated for small fixed-wing aircraft aided by morphing parts. The dynamic model of morphing aircraft in deep stall state is constructed, and the aerodynamic characteristics of deep stall state is analyzed. Then, a reference trajectory for deep stall landing is designed, and a control law is designed to ensure the trajectory tracking of the aircraft. Simulation results demonstrate the successful deep stall landing, which verifies the effectiveness of the proposed landing strategy.

TueCIS-10

Improved Nonlinear Dynamic Inverse Guidance-Based Collision Avoidance For UAVs

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Jie Liu Univ. of Science and Tech.
Chengzhi Qu Univ. of Science and Tech.
Zhifu Chang Univ. of Science and Tech.
Jing Zhang Univ. of Science and Tech.

An improved nonlinear dynamic inverse guidance law is proposed for the problem of UAV s collision avoidance in this paper. First, a method based on collision cone boundary is investigated for collision detection. Second, an improved nonlinear dynamic inverse guidance law, which can be applied to multiple initial angles and speeds, is designed to ensure the security of UAV s collision avoidance. In addition, the stability of system is proved. The method of calculating the guidance coefficient is investigated by the optimal proportional navigation law. In order to analysis the performance of this guidance law, a simulation system based on 6-DOF UAV is established. The results conclusively demonstrated that there is no need for precise collision avoidance time and this guidance law applies to multiple initial angles and speeds.

TueCIS-11

Method of Multi-UAVs cooperative search for Markov moving targets

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Aiming at the regional cooperative search problem for multiple unmanned aerial vehicles (UAVs), a greedy iterative decision-making method based on distributed model predictive control (DMPC) was proposed. Firstly, based on search information map model, the state variation of the environment and targets with the change of search process was described. Secondly, it established movement model, and analyzed the kinetic characteristics of UAVs. Thirdly, Markov chain was used to represent hidden movement of targets, and then, it predicted the position of targets. Fourthly, on the basis of DMPC, a greedy iterative decision-making method was adopted. Finally, through simulation experiment, it verified the feasibility and superiority of the method.

TueCIS-12

Reentry Guidance Method Based on Predictive Control for Hypersonic Vehicle

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Hao Feng Tianjin Univ.
Na Wang Tianjin Univ.
Tianjin Polytechnic Univ.

Reentry guidance problem is a prominent problem for hypersonic vehicle in reentry phase. A reentry guidance approach based on predictive control is proposed in this paper. According to the nominal trajectory guidance method, the feasible trajectory is designed at the beginning. And then the predictive control method is introduced in the reentry trajectory tracking process. The predictive control problem is established in each guidance period with a steady predictive horizon and corresponding initial conditions. For the demand of on-line computation, the Gauss pseudospectral method is employed to deal with the optimization problem to obtain the actual control variables. Finally, the actual state variables are gained according to these control variables. The theoretical analysis and simulation results are conducted to illustrate the effectiveness of the proposed guidance law for hypersonic vehicle.

TueCIS-13

ROS-based UAV Control Using Hand Gesture Recognition

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Xiangke Wang National Univ. of Defense Tech.
Zhiwei Zhong National Univ. of Defense Tech.
Yongwei Zhang National Univ. of Defense Tech.

As the first step towards the natural interaction between human and multi-UAV system, we present a novel human-UAV interaction method based on hand gesture recognition. We design different hand gestures corresponding to different UAV commands and propose a stable algorithm to distinguish these gestures. Then, considering the fact that the operation of multi-UAV system may need multiple cooperative operators, an algorithm based on position information and color information is designed to identify multiple operators. Thus multi-user recongnition by hand gestures is achieved. Lastly, we combine the results of hand gesture recognition of multiple operators with UAV control under Robot Operation System (ROS) framework and use AR Drone platform to test the whole system's performance.

TueCIS-14

Fault-Tolerant Gait Implementation of Hexapod Robot Based on Finite State Automata

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Minghao Li Southwest Univ. of Science and Tech.
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In this paper, the hexapod robot model with symmetrical structure is established. Based on the hexapod robot's movement mechanism, the motion model about different fault joints of the leg is established. A strategy of fault-tolerant tripod gait is proposed. Finite state automata (FSA) is used to analyze the attitude transformation of the robot during normal operation and fault operation. Besides, the adjustment method of the fault tolerant triangle gait is analyzed when the different leg joints malfunction randomly. Finally, the effectiveness of this method is verified by physical platform.

TueCIS-15

Prediction Model of Glutamic Acid Production of Data Mining Based on R Language

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Qiaoyu Duan Shanghai Inst. of Tech.
Min Zhang Shanghai Inst. of Tech.
Bing Xu Shanghai Inst. of Tech.

For the modeling problem of microbial fermentation process, taking glutamic acid fermentation process as the research object, the decision tree and the random forest model were established by using the data mining method, and the model was evaluated and predicted by using the R language. Good effect of the decision tree model, indicating that the decision tree package of R language has a certain flexibility, through the choice of parameters can be a useful model. In addition, under the same conditions, a random forest model is constructed. The simulation results show that the combined model based on random forest algorithm is superior to the single decision tree model, and the prediction result is better.

TueCIS-16

Pulse control of a delay HIV epidemic model with switching parameters

Ning Zhao Shandong Univ. of Science and Tech.
Xinzhu Meng Shandong Univ. of Science and Tech.

This paper proposes a new delay HIV (Human Immunodeficiency Virus) epidemic model with switching parameters and pulse control. We investigate the global attractivity of infection-free periodic solution and the persistence of the disease. Furthermore, two thresholds which govern the extinction and the persistence of the epidemic disease are derived. Numerical simulations are performed to illustrate the theoretical findings and the effects of control measures.

TueCIS-17

Soft sensor model of marine enzyme fermentation process based on NN-MIV variable selection

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Peisuo Yang Jiangsu Univ.
Guohai Liu Jiangsu Univ.
Yonghong Huang Jiangsu Univ.
Xianglin Zhu Jiangsu Univ.

To solve online estimation of the key variables that cannot be used in the online real time measurement in the process of marine enzyme fermentation, a variable selection method based on the mean impact value (MIV) of neural network (NN) is proposed. The principle of NN-MIV soft sensing is that firstly through the analysis of the mechanism of marine enzyme fermentation process, the external contribution rate of auxiliary variable to key variables is computed by the MIV method and the internal contribution rate of auxiliary variables to key variables is computed by the NN method, then considering the two contribution as a basis for the choices of auxiliary variables. NN-MIV variable selection method is applied to soft sensor model of marine enzyme which can screen input variables purposefully, so the optimized soft sensor model of NN-MIV can realize online soft sensing of enzyme activity. The simulation results show that this kind of soft sensing model has higher prediction precision and stronger generalization ability.

TueCIS-18

3D structure stability of RNA hairpin controlled by loop size

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The thermodynamic stability of RNAs, which is important for unravelling structure-function relationships for RNAs, can be controlled by loops. To predict RNA 3D structure and stability, we have previously proposed a three-bead coarse-grained model. In this work, we further employ the model to predict the stability of RNA hairpins with different lengths of hairpin loops in monovalent/divalent ion solutions. The melting temperatures for the hairpins predicted by the present model are in correspondence with the extensive experiments. Our results suggest that RNA hairpin stability decreases with the length of hairpin loops, and the change is slowed down gradually as the increases of ion concentration and loop-size.

TueCIS-19

An Improved Mass Spring Model Based on Internal Point Set Domain Constraint

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Siqi Zhou Zhejiang Univ. of Tech.
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Virtual surgery system aims to simulate the real surgery for doctor-training, while the soft tissue deformation is the one of the most significant part. To solve the lacks of object volume feature due to the problem that surface model defects in internal volume force together with the stability and real-time of the mass spring model, this paper proposes a mass spring model based on the internal point set domain constraint. First, this paper performs preprocessing, recording the information between adjoining points so the point search in further algorithm is easy to implement. The internal volume force interaction simulation is attained from establishing internal point set domain constraint, which guarantees the volume feature in deformation. Then, a dynamic deformation method is applied to update the deformed region on the surface based on internal point set domain constraint so the arithmetic speed is enhanced simultaneously. The experimental results show that the proposed method inherits the advantages of the traditional mass spring model while effectively conquers the defect in lacking the interaction of internal volume force and ensures the real-time superiority.

TueCIS-20

Real-time and Authentic Blood Simulation for Surgical Training

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Yongqiang Li Zhejiang Univ. of Tech.
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Ye Wu Zhejiang Univ. of Tech.

Blood simulation is an important part in the virtual surgery training system. However, the huge computational complexity and authenticity of blood simulation is of great challenge to the surgical training system. In this paper, a simulation method based on GPU-accelerated is used for blood simulation in surgical training system. The grid method is used to divide the target area, create space grid domain, and search neighboring particles by neighboring grid. We solve the particle control equation and calculate the interaction between blood and solid by parallel computing architecture (CUDA) multi-threaded parallel acceleration technology, which greatly improve the operational efficiency and improve the real-time of training. In addition, an improved marching cube algorithm was used to render the surface of fluid, which improved the authenticity of surgical training. Experimental results show that the authenticity and flexibility of blood meet the simulation requirements during the surgical training when using our method. Furthermore, the speed of blood simulation was significantly improved comparing to the realization of CPU.

TueCIS-21

Modeling and Analysis of Blueberry Gray Mold

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Gray mold causes a sharp drop in blueberries production, the modeling and analysis of blueberry gray mold are important for the future study of blueberry related diseases and insect pests. In the introduction, the related diseases and insect pests of blueberry were summarized. The modeling method of blueberry pests and diseases was introduced. On this basis, the blueberry gray mold was modeled. And the results of the model test are in good agreement with the target.

TueCIS-22

Application Research of ZigBee Protocol in CPS Based on Multi-Agent

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Ling Chang Shenyang Urban Construction Univ.
Lili Guo Shenyang Urban Construction Univ.
Yimei Wang Shenyang Urban Construction Univ.
Xuesong Jia Shenyang Urban Construction Univ.

For the research status that domestic and foreign for the research of theory of Cyber-Physical Systems is just beginning, many theoretical studies are in the exploratory stage, the author puts forward a new attempt that is the Multi-Agent technology and ZigBee protocol are used in the research of intelligent building CPS system by in-depth analysis to the CPS. This paper designs a wireless network user-level CPS based on Multi-Agent technology, discusses specific communication process among the Agent nodes in the system, and designs communication protocols of the system using of ZigBee protocol. By the author designs and researches the communication protocols of intelligence building actual CPS system, for the study of CPS communication protocol is more in-depth. It plays a certain promoting role for the research of CPS theories.

TueCIS-23

Cyber Attacks in Cyber-Physical Power Systems: A Case Study with GPRS-Based SCADA Systems

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With the integration of computing, communication, and physical processes, the modern power grid is becoming a large and complex cyber physical power system (CPPS). This trend is intended to modernize and improve the efficiency of the power grid, yet it makes the CPPS vulnerable to potential cascading failures caused by cyber-attacks, e.g., the attacks that are originated by the cyber network of CPPS. To prevent these risks, it is essential to analyze how cyber-attacks can be conducted against the CPPS and how they can affect the power systems. In light of that General Packet Radio Service (GPRS) has been widely used in CPPS, this paper provides a case study by examining possible cyber-attacks against the cyber-physical power systems with GPRS-based SCADA system. We analyze the vulnerabilities of GPRS-based SCADA systems and focus on DoS attacks and message spoofing attacks. Furthermore, we show the consequence of these attacks against power systems by a simulation using the IEEE 9-node system, and the results show the validity of cascading failures propagated through the systems under our proposed attacks.

TueCIS-24

Research on a New Electromechanical Energy Acquisition System

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Since the mechanical vibration widely exists in nature, how to utilize new smart material for collecting energy generated by mechanical vibration is a general trend in new energy field. Consider the effect of magnetic field, the magnetically controlled shape memory alloy (MSMA) is characteristic of high deformation value, high dynamic response frequency, high power density, high electromechanical energy conversion efficiency and so on, which is utilized for developing vibration acquisition system in this paper. Based on finite element analysis software ANSYS, the ANSYS is obtained simulation for magnetic field, then, the feasibility and practicality of the proposed design and production for prototype are testified. The research in this paper lays foundation of theory and experiment for the application of new smart material and the conversion of electromechanical energy.

TueCIS-25

The Influence of Material on the Performance of Permanent Magnet Eddy Current Speed-Control Device

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The performance of permanent magnet eddy current speed-control device is closely related to the material properties of each component. In view of different permanent magnets, a three-dimensional finite element transient model of 500kw permanent magnet eddy current speed-control device is established. The finite element method is used to calculate torque, loss and output power of the permanent magnet eddy current speed-control device with different grades of NdFeB. The effects of different permanent magnet materials on the performance and temperature of the permanent magnet eddy current speed-control device are compared and analyzed. The influence of the dispersibility of permanent magnet materials on the starting performance and the no-load performance are analyzed by using the analysis method of induction motor. The experimental results were verified to be effective. The conclusion is of great reference value to the research and application of permanent magnet eddy current speed-control device.

TueCIS-26

A Neural Network Model Reference Adaptive System for Speed Estimation of Sensorless Induction Motor

Youlin Yang Bohai Univ.

A neural network model reference adaptive system is designed for speed estimation of sensorless induction motor. The neural network identifier is used as reference model to replace the voltage model of rotor flux. This improves the accuracy of speed estimation under the interference of parameters such as winding resistance and mutual inductance. On the basis of model reference adaptive system, the single neuron adaptive algorithm is applied to increase the robustness of system compared with the PI regulation algorithm. The simulation results have shown that the neural network model reference adaptive system has better accuracy and stronger stability than ordinary model reference adaptive system for speed estimation of sensorless induction motor.

TueCIS-27

Optimal Scheduling of Electric Vehicle Charging in Different Periods

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Large-scale electric vehicle charging will bring a serious burden to grid, orderly regulation of electric vehicles will reduce the impact when access to the grid, effective regulation could benefit grid direction. Firstly used the Monte Carlo method to forecast regional electric load demand, then divided the membership function for daily load, consider electric vehicles at different times have different response and different demands to establish different strategies of multi-time electric vehicle charging, a case study of typical regional power grid load data, verify the effectiveness and feasibility of charging optimization method in the article.

TueCIS-28

Lane Level Turning Trajectory Tracking of Intelligent Vehicle Based on Drivers' Manipulate Habits

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In order to make intelligent vehicle trajectory tracking achieve lane-level accuracy requirements in the city, this paper takes two axle vehicle as research object, the prediction model of motion posture was derived. The driver's manipulate habits of ideal turning mode was analyzed. According to information of GIS and GPS, based on drivers' manipulate habits, the turning trajectory tracking control algorithm of lane level was puts forward .In order to improve the accuracy and reduce tracking error and vehicle swing, based on the vehicle dynamics constraints the algorithm was improved . Finally, through the analysis and comparison of driving turning trajectory data and actual turning intersection data, the effectiveness of algorithm was verified. In order to better display the lane level control effect, the trajectory of the turning control was shown on the GIS map.

TueCIS-29

Driving Decision-making Analysis of Lane-changing for Autonomous Vehicle under Complex Urban Environment

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Lane-changing decision-making is critical to complete driving mission for autonomous vehicles under complex urban environment. The complex information (such as the running conditions of interfering vehicles, signal lamp, and road facilities) have a great influence on autonomous vehicle's lane-changing decision. This paper proposes to use the Rough Set theory to abstract the lane-changing rules to support the decision-making of autonomous vehicles under the complex urban environment. Firstly, a virtual urban traffic environment is built by Prescan (a simulation environment for developing advanced driver assistant system). Secondly, the Rough Set theory is proposed to reduce the influence of weak interdependency data, and extract the driver's decision rules. Finally, the result is that: 1) During the intention generation process of lane-changing, the decision-making is associated only with the relative distance between the subject Car and the interfering Car(D2) and the relative velocity between the subject Car and the leading Car(V1). 2) Both of the decision-making rules during intention generation and implementation phase process are extracted based on Rough Set method, which provide a theoretical basis for the lane-changing decision-making under complex urban environment.

TueCIS-30

Research on Dynamic Equalization for Lithium Battery Management System

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The key factor which restricts the Lithium battery packs using widely is the capacity issue. By analyzing the functional requirements of Lithium battery management system, we will design a battery management system with dynamic equalization to realize maximize of the whole set lithium batteries after charging. This devise can extend the service life of lithium batteries.

TueCIS-31

Real-time Road Slope Estimation Based on Adaptive Extended Kalman Filter Algorithm with In-vehicle Data

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Dihua Sun Chongqing Univ.
Weining Liu Chongqing Univ.
Weijian Han Chongqing Univ.

The accurate and real-time knowledge of road slope is a key of vehicle dynamic control while running on the road. In order to obtain accurate road slope considering the random disturbance in complex driving circumstance, an algorithm based on adaptive extended Kalman filter (AEKF) is proposed to estimate the road slope in real time in this paper. Firstly, the nonlinear vehicle longitudinal dynamics is established and transformed into discrete state space system to implement the recursive estimation. Then the innovation-based adaptive tuning part is designed to estimate time-varying process noise covariance and measurement noise covariance. Finally, the simulations are conducted to verify the algorithm through CarSim platform. The results are in good agreement with the robustness of the AEKF method for the unknown time varying disturbances, which is better than the existing regular extended Kalman filter algorithm.

TueCIS-32

Lithium Battery Remote Monitoring System for Vehicle Mounted

Jun Xu Harbin Univ. of Science and Tech.
Zhou Liu Harbin Univ. of Science and Tech.

In order to improve the real time monitoring ability and safe operation of the electric vehicle lithium battery, save the cost of battery, this paper presents a remote monitoring system for lithium battery of electric vehicle. Which is composed of the vehicle information collector and the upper computer. The collector of vehicle information is composed of microprocessor, CAN bus controller, GPS module and GPRS module. The collector is connected with the CAN bus and the central control system of the electric vehicle by ECU. It will receive the lithium battery information and GPS data through the GPRS network to transfer to the host computer. PC software system use C++ and Oracle database to develop, to analyze and to handle the information of battery and locate electric vehicle, to ensure the stability and efficiency of data storage. The system has entered the testing phase. It has been achieved for the monitoring of lithium battery information. It has good stability, low cost, high reliability.

TueCIS-33

Research and design of control strategy for on-board charging system in electric vehicle

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In the process of design of electric vehicle control system, the response of each control node in the charging process is analyzed, then the control strategy of the charging process of vehicle on-board charging system is studied and designed according to the electric vehicle on-board charging system structural characteristics, with reference to the national standard of the electric vehicle conduction charging system. Based on the simulation technology of Simulink/Stateflow, the logic simulation model of vehicle on-board charging system control process was established. By changing the input data of the model, the transformation of the running state of the main control system between different state objects and the output control signal to carry on the simulation verification via observations. The simulation results show that the control logic of charging system is correct and practically useful.

TueCIS-34

Improved Rotor Configuration for Starting Current of Permanent-Magnet Synchronous Motor

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High starting current is one of the most important issues which restrict the development of Permanent-Magnet Synchronous Motor(PMSM) which could result in the serious damage of the insulation premature. In this work, a novel rotor configuration based on YKK355-4 motor was developed based on the relationship between air-gap flux and groove clearance, which could significantly suppress a high temperature rising caused by instantaneous current. Finite-element analysis was employed in the analysis of transient and steady-state performance. The simulation results indicate that the proposed rotor configuration could achieve the similar starting current as asynchronous motor with same specifications.

TueCIS-35

Online Prediction of Electrical Load for Distributed Management of PEV Based on Grey-Markov Model

Yang Zhou Beihang Univ.
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Boyan Zhang Beihang Univ.

In order to improve the prediction accuracy of distributed management of Plug-in Electric Vehicles (PEV) to the change of the future electrical load, we proposed an improved algorithm which based on Grey-Markov model. This method makes full use of the advantages of grey model and Markov chain model, where, the grey model is used to reveal the total trend and principle of object change while the Markov chain model is used to indicate the objective random fluctuation and then determine the disturbance rule. The prediction model can be established according to the real value which obtained by distributed management system, then comparison of the model predictions with the improved and traditional prediction algorithms. the results show that improved algorithm is better than traditional prediction algorithm.

TueCIS-36

D-Q Axis Decoupling Control of LCCL Type Photovoltaic Grid Inverter

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Longzhen Ma Harbin Univ. of Science and Tech.
Guangming Cheng Harbin Univ. of Science and Tech.

For the existence of harmonics in the grid voltage, a high-order harmonics may occur in the grid, which will affect the power quality of grid network system. In this paper, to avoid the adverse effect on the grid current by the high-order harmonics in the d-q axis current decoupling component, the d-q axis referring current is used to replace the d-q axis current decoupling component, hence the waveform quality of the grid current is improved. Furthermore, it is analyzed the influence of passive damping control method of LCCL type filter on the grid connected power loss. Simulation results show that the proposed decoupling control method can improve both the quality of grid connected power and the system efficiency, thus the fast dynamic response of grid current and high waveform quality are achieved.

TueCIS-37

Evaluation and Application of Accommodation Capability of Wind Power for Grid

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Accurately mastering the capability of wind power accommodation is conducive to construction planning of wind plant and provide auxiliary to dispatching decision in actual operation. Based on deep analysis of key factors influencing accommodation capability of wind power basic idea and method were proposed to manoeuvre wide and flexible adequacy resources involved in system regulation. Comprehensively considering technical characteristics of various power generations and such constrains as the balance of power and thermal loads and transfer capacity and taking the maximum accommodation capability of new energy as objective function, a model is built to analyze new energy accommodation capacity of power grid. Taking shanxi province in China, which is rich in new energy resources, as calculation example, the changes of new energy accommodation capability were simulated and analyzed under different scenes of introducing in different flexible resources.

TueCIS-38

Detection and Analysis of High Voltage Electrical Equipment Corona Discharge Based on Ultraviolet Imaging Technology

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Ting Guo Shanxi Provincial Electric Power Corp.
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The corona discharge phenomena of electrical equipment are generated with the increasing of insulation aging, electrical equipment, surface filth or atmospheric humidity. The corona discharge will cause the waste of power energy, radio interference, audible noise, insulation aging, and these defects are great threats to the safety and stability of electrical equipment. Using appropriate method to detect the operational state of electrical equipment is always significantly concerned by operation department. In this paper, the different corona discharge defect part of high voltage electrical equipment are summarized such as the grading ring, drop wire, jumper and over line, spacing rods, tube bus end and connecting joint. While the photon numbers of corona discharge under different defects are measured by the ultraviolet imager. The result shows that: the corona discharge characteristics of electrical equipment are different under the different defect type, and the photon number increases with the rising of the applied voltage. The detected photon number varies with different kinds ofdefects through applying same voltage. The ultraviolet imager shows the excellent performance in the detection of discharge defects and thus it can be prospectively used in the operation state detection of electrical equipment.

TueCIS-39

The Influences of an Improved Pumped-Wind-Hydro-Thermal Optimization Sategy in Power System and Research on Different Optimal Proportion in Dfferent Large Regional Grid

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Chongzhi Yin State Grid Shanxi Electric Power Company
Yongxiang Li State Grid Shanxi Electric Power Company

Until the end of the year 2015, the world’s installed capacity of wind power reached 432419MW. And the capacity of wind farm in china was 145.1GW, which was 141.6GW in European Union at the same time. China became an important region that has the largest wind installed capacity. Wind power has its characteristic of randomness and uncertain. And the large-scale wind would bring a lot of challenge to the safety and economic of operation in state grid. At the present, the fluctuation of wind power is adjusted through the participating of thermal units, which is a waste of fossil energy and money. Due to the fluctuation caused by integration of large-scale wind power, current grid cannot deal with it without considering the features of renewable energy. In recent years, the pumped-storage stations had been proposed to arrange the output in order to smooth the fluctuation of wind power. In this paper, a new scheduling policy is put forward to deal with the randomness of wind farm and to improve the intermittent of wind power. The improved pumped-wind-hydro-thermal optimization strategy discussed here only aims at cutting down the fluctuation and operation cost, but also improving the power generation of clean energy. The main algorithm was based on the improved particle swarm optimization algorithm. We simulated several different large regional grids and discussed the impact of different optimal proportion in different large regional grid.

TueCIS-40

Study on an Sufficient Method to Make an Smart Test Plan in Grounding Grid Fault Diagnosis

Wei Zhang Shanxi Electric Power Research Inst.
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Rui Li Shanxi Electric Power Research Inst.
Yifan Zhang Shanxi Electric Power Research Inst.
Ziqiang Zhu Shanxi Univ.

During these years, the accident of grounding grid equipment occurs more frequently in the substation, which has been one of the most serious threat to safety and stability of power system. Traditional detection method is blind, slowly and uneconomical to find the erosion point. This paper provides an method based on the analysis of testability in topology of substation grounding grid. Through the comparison of different results by different amounts of equations, we can obtain an reasonable test program in view of the sensitivity algorithm. In the test program discussed in this paper, we choose the node voltage of testable node to simulate and calculate the erosion result of grounding grid. And we can set up an plan to find and check the erosion point from the simulation result, which can save a lot of manpower, material and money. In the comparison of different testing method , this paper put forward an test method concerning the construction time and the degree of fault. We decide the appropriate amount of equations according to the duration and the degree of fault, and improve the accuracy of the diagnosis. In the simulation cases, we compare the different results and we can achieve an conclusion that the test method we decided is quite reasonable and accurate. The simulation result and diagnosis result is coincide, and the method discussed above can be applied to the fault diagnosis in actual grounding grid.

TueCIS-41

Fault probability prediction of transmission lines under icing disaster

Peng Jin Shenyang Power Supply Company
Yadong Li Northeastern Univ.
Kunya Guo Shenyang Power Supply Company
Yaoyao Zheng Northeastern Univ.

According to the formation mechanism of different types of ice, including glaze, rime and mixed glaze, this paper derives the ice thickness under different weather conditions. The stress of the transmission line is calculated based on the deduction of the ice amount covered on the conductor. In addition, taking into account the aging failure factor of the circuit and the fatigue damage ratio of the failure repair, it is appropriate to use the exponential function to fit the probability of the break of the transmission line. The purpose is to provide the expected fault set by taking the icing disaster as the external disturbance of the transmission network, which is for the assessment of security and stability and early warning of the power grid.

TueCIS-42

Improved harmonic detection algorithm applied to APF

Yonglong Peng North China Electric Power Univ.
Kunfeng Zhang North China Electric Power Univ.
Yabin Li North China Electric Power Univ.
Pengkai Yang North China Electric Power Univ.
Huiqiang Liu North China Electric Power Univ.

The speed and accuracy of harmonic current detection are the important index of active power filter. Due to the low pass filter, the traditional ip-iq algorithm has the disadvantage of slow detection speed. The paper proposes a variable step size LMS/LMF adaptive filter algorithm.The adaptive filter can not only change the step size according to the change of original signal, but also change the proportion of the Least Mean Square(LMS) algorithm and the Least Four-order Moment (LMF) algorithm,which makes the advantages of high detection accuracy of LMF and high detection speed of LMS fully played. The simulation results show that the proposed algorithm is effective, and the speed of harmonic current is improved obviously.

TueCIS-43

Online Determination Method of Power System Fault Chains Based on the Bus Load Rate

Jun Yang Northeastern Univ.
Kai Jiang SGCC Binzhou Power Supply Company
Xiaolong Li State Grid Hebei Electric Power Company
Jinhai Liu Northeastern Univ.

Fault chain model, the basis of risk assessment and prevention control, is used to avoid cascading outages. In this paper, a new fault chain model is established. The fault chain, calculated by this fault chain model, is consisted of the initial segment and the middle segment. The index of bus load rate for the initial and the middle segments is presented firstly to reflect the load condition of a system in the fault chain model. Then, other indices, such as historical fault statistics, line load degree, and correlation coefficient in the initial segment and power flow transfer, sequent overload of lines, and damage of transmission sections in the middle

segment, are concerned and normalized to predict all the fault chains. Besides, the maximizing deviations method is used to calculate the weight of index. Finally, the rationality of the proposed fault chain model is demonstrated via New England 39 bus system.

TueCIS-44

An Identity-Based Secure Communication Scheme for Advanced Metering Infrastructure in Smart Grid

Taimin Zhang Zhejiang Univ.
Xin Lu Zhejiang Univ.
Xiaoyu Ji Zhejiang Univ.
Wenyuan Xu Zhejiang Univ.

Advanced metering infrastructure (AMI) is designed to collect power consumption information of households for the utility companies and provide real-time price for customers to allow them make informed choices about energy usage. As AMI is a key component in smart grid, cyber security should be considered prior to the AMI system applications to ensure reliable and secure operations of smart grid. This paper proposes an identity-based secure communication scheme for AMI. In our proposed scheme, the limited computing ability of the smart appliances in AMI is considered as well. Furthermore, we specify an identity-based key updating protocol to periodically refresh all public/private key pairs. Our proposed scheme is an easy-to-deploy solution for AMI systems.

TueCIS-45

Multi-level Charging Control Algorithm of Electric Vehicle in EVs-Grid System

Yan Li Northeastern Univ. at Qinhuangdao
Peng Han Northeastern Univ. at Qinhuangdao

In order to satisfy the needs of the clean energy usage and the rapid development of the smart micro grid and electric vehicle industry under the energy internet environment, an effective and highly applicable control algorithm which could ensure the safe and stable operation of smart micro grid with the large access of the electric vehicles is desperately needed. This paper firstly built the agent-based model of the electric vehicle by analyzing the autonomous operation of the electric vehicles, and then proposes a multilevel charging control algorithm oriented to the regional smart micro grid and the EVs' different kinds of power supplement, which includes the micro grid-level centralized control for the batteries' centralized charging and the user-level active control for the EVs' dispersed charging. The optimization goal is to minimize the fluctuation of the load in the regional smart micro grid under the premise that it does not affect the normal operation of electric vehicles. Finally, the corresponding case scene simulation is carried out in order to verify the effect of the proposed algorithm.

TueCIS-46

Research on Control Structure of Microgrid System with Grid-Connected Photovoltaic

Greyard Tembo Tianjin Univ. of Tech. and Education
Dongtao Wang Tianjin Univ. of Tech. and Education

In order to maximize the use of renewable energy and increase reliability and economics of energy supply for end consumers, there has been rapid development in Microgrid technologies in recent years. In this paper, the concept and development of Microgrids is introduced, and then a Microgrid structure with Photovoltaic is presented. Maximum Power Point Tracking (MPPT) Algorithm and PQ control philosophy for a grid-connected photovoltaic Microgrid system is developed. The system structure and control architecture of a Microgrid is modeled and simulated in PSCAD/EMTDC. Finally, the simulation results of PQ control with varying weather conditions is given, and the effectiveness of control method presented is verified.

TueCIS-47

Simulation of All-Vanadium Redox Flow Batteries based on COMSOL

Mingang Zhu Hangzhou Dianzi Univ.
Qiuxuan Wu Hangzhou Dianzi Univ.
Xiaoni Chi Hangzhou Vocational &Technological School
Yanbin Luo Hangzhou Dianzi Univ.

In the current situation of energy shortage and environmental deterioration,all vanadium redox flow battery is the most promising new energy storage battery, playing a key role on popularization of distributed power grid and new energy power generation. Following the rigorous mathematical process and the mechanism of VRFB, a VRFB numerical simulation model is established based on COMSOL according to principles of VRFB, the Nernst equation and the electrodynamics. The effects of electrolyte concentration distribution, electrolyte flow rate, electrode compression and electrode temperature on cell performance are studied through the model. The research shows that the vanadium ions will gather to the membrane side and The gradient of vanadium ions concentration near the membrane side is smaller, indicating that the reaction mainly concentrated on the membrane side; The excessive flow rate of electrolyte is too fast for oxidation-reduction reaction, which will reduce cell performance; When the electrode thickness is compressed from 0.36 mm to 2 mm by electrode compression, the terminal voltage drop is 13mV, mainly due to the decrease of ohmic loss; In the allowable range, the battery performance is enhanced with the increasing of the electrode temperature. The model provides an important reference value for the optimization of material properties, geometric parameters and operating conditions.

TueCIS-48

Operational Conditions Division of Wind Turbines

Haiying Dong Lanzhou Jiaotong Univ.
Kelei Xu Lanzhou Jiaotong Univ.
Lixia Yang Lanzhou Jiaotong Univ.
Yaoqin Gu Lanzhou Jiaotong Univ.
Ningning Chen Lanzhou Jiaotong Univ.

Due to the complicated and variable operating environment of wind turbines, a method based on k-means clustering algorithm is proposed to divide the operating condition for wind turbines and supplies the forceful foundation for making a maintenance plan. In this method, the fault characteristic analysis and the characteristic frequency calculation for the gear box and the generator are proposed. And then, the vibration characteristics of the two subsystems are extracted by using the wavelet packet theory. Finally, the k-means clustering algorithm is used to classify the measured data from a wind farm. According to the central-limit theorem, the criterion is established to evaluate whether the state characteristic parameters are normal or not. It's beneficial to the early warning under the different working conditions of wind turbines. The results show that this division is accurate and it is beneficial to evaluate the operating states of wind turbines.

TueCIS-49

Research on MPPT Control Based on Combined Algorithm of Perturbation Observation

Na Liu Tianjin Univ. of Tech.
Demin Zhang Tianjin Univ. of Tech.

In order to improve the tracking effect of the maximum power point of photovoltaic power generation system, several kinds of combinational algorithms of control method and perturbation observation method are listed and analyzed in view of the contradiction between accuracy and speed of traditional perturbation observer. The variable step perturbation observation method can reduce the tracking time and improve the tracking accuracy. The variable step perturbation observation method based on power prediction and the variable step perturbation observation method based on fuzzy control method can not only improve the stability and fastness of the system, but also can effectively eliminate errors and misjudgment phenomenon.

TueCIS-50

Control Strategy of Hybrid Electric Ship Based on Improved Fuzzy Logic Threshold

Diju Gao Shanghai Maritime Univ.
Kangkai Pan Shanghai Maritime Univ.
Jianxin Chu Shanghai Maritime Univ.
Aidi Shen Shanghai Maritime Univ.
Yanyan Sun Shanghai Maritime Univ.

Diesel generators and power battery hybrid all electric ship is the research object in this paper. The key components of the hybrid power system models are established and the energy management strategy is studied. The diesel generators power output is chosen as control variables and a logic threshold control strategy is suggested taking the diesel fuel economy and efficiency as the control target. Fuzzy algorithm is used to further improve the logic threshold energy control strategy. The two algorithms are validated by the hybrid ship physical simulation platform. The experimental results show that the improved fuzzy energy control strategy can be adapted to various ship maneuver scenarios and has good fuel economy, compared with the traditional logic threshold energy control strategy.

TueCIS-51

Study of Marine Power Station Based on Active Disturbance Rejection Control Technique

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Zhongcai Liang Guangzhou Maritime Univ.
Guopiao Li Guangzhou Maritime Univ.
Yiyi Zhan Guangzhou Maritime Univ.

This paper expounds a new type of control system for marine power station, which combines the Industrial Ethernet technology with Active Disturbance Rejection Control (ADRC) . The technology parameters of marine power station generator sets were collected real-time by the system. The system allows the distance measurement where the data is sent to the S7-1200 PLC using Ethernet bus to upper computer(WinCC) . The data can be also accessed using Human Machine Interface (HMI) on an operators screen, which provides complete centralized management. The lower computer composed of three S7-1200 PLC distributed control systems, which have made an decentralized control for marine power station to realize frequency regulation control of marine power station. In this paper, ADRC frequency regulation of marine Power Station System was proposed, which was used to solve the problem existing in marine engineering ship commonly in the rapidly changing in load and the unknown disturbance. Experimental results show that the control system of marine power station based on ADRC can effectively restrain the dynamic load disturbance, and the algorithm has strong robustness.

TueCIS-52

An Adaptive Energy Allocation Strategy for Battery/Supercapacitor Hybrid Energy Storage System

Xiaoyong Zhang Central South Univ.
Yuanjun Chen Central South Univ.
Yanhui Zhou Central South Univ.
Zheng Xu Central South Univ.
Zhiwu Huang Central South Univ.
Weirong Liu Central South Univ.

Battery/supercapacitor hybrid energy storage system is widely used in renewable energy grid since its excellent power and energy performances. However, the load and grid output power may fluctuate drastically, resulting in the dc bus voltage rise or fall sharply. The power demand is composed of both high-frequency and low-frequency component that brings some difficulties to energy distribution. Therefore, it is still a challenge to design a safe and high-efficiency energy allocation strategy to respond to the power demands and stabilize the bus voltage in time. In this paper, an adaptive energy allocation strategy based on the isolation frequency is proposed to address this challenge. The isolation frequency is adjusted adaptively that can improve the energy utilization ratio and ensure the energy storage element safety. In addition, a practical control method based on frequency-domain analysis is adopted since its less computation. Simulation results validate the potential advantages and effectiveness of the proposed strategy.

TueCIS-53

An Overview of Energy Routers

Youjie Ma Tianjin Univ. of Tech.
Xuyan Wang Tianjin Univ. of Tech.
Xuesong Zhou Tianjin Univ. of Tech.
Zhiqiang Gao Tianjin Univ. of Tech.

Energy router is the core equipment of the energy internet with the function that control of energy and information, satisfy different requirements and management through network. The key of energy router is solid state transformer (SST) and the control of different forms of energy. Ultimately, basic design considerations and components of the E-router in terms of power conversions, energy management and communication are summarized in details.

TueCIS-54

The Acquisition and Analysis of Vibration Energy Signal Generated by Magnetic Shape Memory Alloys

Qingxin Zhang Shenyang Aerospace Univ. Automation Inst.
Tong Lin Shenyang Aerospace Univ. Automation Inst.
Jing Yang Shenyang Aerospace Univ. Engineering Training Center

Mechanical vibration energy is widespread in nature. Lots of research shows that the inverse effect of the magnetic shape memory alloys (MSMA) can be fully used to convert the vibration energy in nature into electrical energy, to achieve the power supply of the sensor and the lithium battery. In order to acquire the accuracy of simulate of the MSMA, the signal generated by MSMA need to be transformed by Fourier decomposition into the frequency domain signal. So it can be fitted into several superposition of sinusoidal signals with different Frequency, amplitude and phase, and then be collected through the chip BQ25570 and its surrounding circuit. The simulation of signal acquisition and analysis is achieved and the output power is studied.

TueCIS-55

An improved comprehensive SOC prediction method based on adaptive particle filter

Tong Li Xian Jiaotong Univ.
Junyi Cao Xian Jiaotong Univ.

It's important for battery safe use and performance of the play to predict the capacity changes and the state of charge (SOC) of the battery accurately. However, accuracy of SOC forecast is affected by SOC definition, battery model and algorithm. In this paper, the factors which affect battery capacity are analyzed based on experiment. Storage capacity decay, recycling capacity fade and dynamic changes of the current effect are modeled, considering the influences of temperature, current ratio and so on. Based on the models, the definition of SOC was modified from the perspective of capacity. Besides, prediction algorithm is a key factor affecting the accuracy of SOC prediction. Compared with other SOC prediction methods, Particle Filter (PF) is a complete nonlinear filter. Due to the large amount of computation, the practicability of Particle Filter is limited. Thus, in order to take into account the calculation quantity and accuracy, adaptive particle filter based on Kullback-Leibler distance (KLD) sampling is introduced. Finally, the new method based on modified SOC definition and adaptive particle filter is verified by experimental data of federal urban driving schedule (FUDS) condition.

TueCIS-56

Storage Control Strategy for Energy Hub of We-Energy in the Energy Internet

Ning Zhang Northeastern Univ.
Qiuye Sun Northeastern Univ.
Dazhong Ma Northeastern Univ.

This paper consider the role of energy hub in We-Energy (WE). WE is a novel energy accessing mode in order to match up Energy Internet. This new mode is proposed for the convenience of energy regulation, energy trading and information interaction. A new power flow expression of energy hub which contain storage is given in order to overcome the disadvantage of traditional power flow expression. The comparison between new power flow expression and traditional expression is also given in this paper. This study also investigates the optimal operation of using storage systems. To avoid the influence of forecast accuracy, a new control strategy of storages without the forecast based on historical data has been proposed in which economic problem has been given for an energy hub include both electricity, natural gas and heating storage. This new control strategy determines the optimal storage operation to minimize the total energy cost of the hub contained by WE. The proposed control strategy has been applied to two simple case studies which are used to compare the economic cost between the energy hub contain storage or not. The obtained simulation results demonstrate that the new control strategy can make great economic benefit for energy hub contain storage system.

TueCIS-57

An Active Boost Type APFC Power Management Circuit

Qingxin Zhang Shenyang Aerospace Univ. Automation Inst.
Yan Li Shenyang Aerospace Univ. Automation Inst.
Jing Yang Shenyang Aerospace Univ. Engineering Training Center
Jikun Yang Shenyang Aerospace Univ. Automation Inst.

With the development of wireless sensors, wireless technology and micro-electromechanical systems, the micro power supply system attracts people more attention. And since mechanical vibration energy is widely distributed in nature and is subject to less restrictive environmental factors, it is gradually becoming a new study object for energy collection. At present, according to the latest study, the Magnetic Shape Memory Alloys (MSMA) under the condition of external stress will change its own magnetic permeability, and we can obtain a large induced voltage by the mutative magnetic flux through the induction coil. This article proposes an active boost type APFC (Active Power Factor Correction) power management circuit, the APFC circuit aims to allow the input current waveform to follow the input voltage waveform so as to improve power factor and this circuit here mainly includes AC / DC rectifier, control circuit and capacitor energy storage module. By doing circuit simulation, it is found that in the case of the input voltage amplitude and frequency changing, the input current will follow the changes and both of them have almost the same phase, finally this circuit can achieve the goal to charge the capacitor stably. At last, this article summarizes that this circuit can boost the output power of the vibration energy, reduce energy loss, and increase the power factor to 0.90 by using power meter.

TueCIS-58

Control and Simulation of Bi-directional DC / DC Converter for 5KW Distributed Wind / Solar Hybrid System

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Nantong Advanced Communication Tech. Research Inst.
Xianyi Cheng Nantong Univ.
Nantong Advanced Communication Tech. Research Inst.
Jianshan Wang Nantong Univ.
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In this paper, a bi-directional DC / DC converter is designed for the energy storage devices in the 5KW wind-solar hybrid system. The feasibility of the bidirectional DC / DC converter is verified by using the wind-solar hybrid system model built by MATLAB / Simulink. In the system, we use the Ampere-Hour method for detecting the State-Of-Charge (SOC), adaptive algorithm to control bi-directional DC / DC converter. The simulation results show that the bi-directional DC / DC converter in the system to achieve the battery charge and discharge control, improve the stability of the system.

TueCIS-59

Ramp Metering of Freeway Network Based on Dynamic Graph Hybrid Automata

Yuanhang Wu Beijing Univ. of Tech.
Yangzhou Chen Beijing Univ. of Tech.
Wei Li Beijing Univ. of Tech.
Yuqi Guo Beijing Univ. of Tech.

In this paper, we present a ramp metering strategy to reduce urban freeway network traffic congestion. In order to implement the control method on the large-scale urban freeway network, we apply the Dynamic Graph Hybrid Automata (DGHA) and Modified Cell Transmission Model (MCTM) to describe the evolution laws of traffic flow. Based on the DGHA macroscopic traffic model, we design a complete ramp metering system for the freeway network. The local ramp metering control strategy is proposed to reduce the freeway congestion, in addition, the queue constraint scheme is employed to prevent the queue from exceeding the ramp storage space. At last, this approach is applied to the Beijing third ring road by Modelica language on the OpenModelica. Experimental results validate the DGHA modeling method and demonstrate the effectiveness of the ramp metering strategy.

TueCIS-60

Travel Trajectories Analysis Based on Call Detail Record Data

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Compared with conventional travel data such as GPS data, detector data and float car data, call detail record data from the cell phone communication not only cost low but also has a large scale which demonstrate it is the best way to collect travel information for studying macroscopic travel activities. This paper presents a complete method to discover hot path and travel feature in a traffic network by clustering trajectory data which was acquired from cell phone signaling data. It is valuable for traffic planning, public transportation management, travel network monitoring.

TueD01 **Room01**
Robust control (III) (Chinese) **16:20-18:20**
Chair: Yuying Guo Southwest University of Science and Tech.
CO-Chair: Qian Fan Wuhan University of Science and tech.

16:20-16:40 **TueD01-1**

PCHD control strategy of three phase current type PWM rectifier

Xin Ping College Electric and Information Engineering
Bai Jing College Electric and Information Engineering,

In order to improve the power factor and anti-interference ability of current mode PWM rectifier, this paper presents a new control strategy which is based on interconnection and damping assignment passivity-based control scheme.The current type PWM rectifier has no harmonic pollution of electric network,unit power factor and power control system of high performance, high efficiency, high stability and other advantages, the simulation results prove the feasibility of the scheme.

16:40-17:00 **TueD01-2**

An analysis of the strategies for human simulated intelligent control system in complex process

Jing Wang Chongqing College of Electronic Engineering
Ting-ting Liu Chongqing College of Electronic Engineering

Considering the poor control quality caused by the difficulty of mathematical modeling in the complex process of the industrial base, a multi-mode control strategy is explored in this paper. Based on the analysis of characteristics for a complex process control theory, this paper tends to analyze the complex control problems existing in the process and makes a comparative study on the control strategy. Also, it proposes one imitation human intelligent strategy based on multi-mode control system, and constructs a multi-mode control algorithm based on the bottom control level. In this paper, we tend to use the control of combustion process of industrial gas heating furnace as an example, make the simulation contrast experiment for its process and the results indicate that the proposed control strategy is reasonable and available.

17:00-17:20 **TueD01-3**

Relaxed Dissipativity Conditions of Neural Networked with Time-Varying Delay via Generalized Free-Weighting-Matrix Approach

Hong-Hai Lian Hunan University of Tech.
Key Laboratory for Electric Drive Control and Inte lligent Equipment of Hunan Province
Shen-Ping Xiao Hunan University of Tech.
Key Laboratory for Electric Drive Control and Inte lligent Equipment of Hunan Province
Hong-Bing Zeng Hunan University of Tech.
Key Laboratory for Electric Drive Control and Inte lligent Equipment of Hunan Province
Xiao-Hu Zhang Hunan University of Tech.
Key Laboratory for Electric Drive Control and Inte lligent Equipment of Hunan Province
Gang Chen Hunan University of Tech.
Key Laboratory for Electric Drive Control and Inte lligent Equipment of Hunan Province

This paper focuses on the robust delay-dependent dissipativity problem of neural networks with a bounded time-varying delays. Firstly, a proper augmented Lyapunov-Krasovskii functional, which doesn't demand all the symmetric matrices to be positive definite, is constructed. In addition, by employing relaxed integral inequality and the combining generalized free-weighting-matrix (GFWM) approach to bound integral term in the derivative of the Lyapunov-Krasovskii functional, some less conservative sufficient conditions are deduced to ensure that considered neural networks are strictly (Q,S,R)-dissipative. The advantages and effectiveness of presented techniques are demonstrated via two numerical examples.

17:20-17:40 **TueD01-4**

On the Performance of Improved Extended State Observer Based Control for Uncertain Systems with Measurement Noises

Yuying Guo Southwest University of Science and Tech.
Hongfei Sun Southwest University of Science and Tech.

This paper investigates a new framework of extended state observer (ESO) based active disturbance rejection control (ADRC) design methodology for a class of uncertain nonlinear systems subject to measurement noises. First, based on nonlinear filtering function, an improved ESO is designed to estimate both state, and total disturbance which includes the internal uncertain nonlinear part and the external uncertain disturbance. Then, the explicit analysis about how to select nonlinear filtering function and the convergence analysis for the error dynamics are presented. Numerical simulation results are shown to demonstrate the effectiveness of the proposed method.

17:40-18:00 **TueD01-5**

Application of robust reliable control algorithm in finite frequency domain for active suspension systems

Qian Fan Wuhan University of Science and tech.
Minsong Yang Central China Logistics Corporations
Jianliang Chen Wuhan University of Science and tech.

This paper addresses the reliable control problem of actuator faults and the varied damping coefficient in the finite frequency domain for active suspension systems. First, the model of vehicle active suspension is established, and the general model of actuator fault is adopted. Afterward, according to the characteristic of the model, the design method of robust reliable state feedback controller is adopted for linear parameter-varying systems in finite frequency domain. The result of simulation indicate that the active suspension can work stably for both faults free and actuator faults and robust performances is satisfied. In addition, the ride comfort is improved and the effectiveness of algorithm is illustrated.

18:00-18:20 **TueD01-6**

Adaptive fault-tolerant control for attitude tracking of near space vehicles with input and output saturation

Qingyun Yang Zaozhuang Univ.
Jian Fu Nanjing University of Science and Tech.

An adaptive fault-tolerant control method was proposed for attitude tracking of near space vehicles (NSVs) with actuator faults, system uncertainties, input and output saturation. The actuator faults were treated as the disturbances by passive tolerant control method, and the adaptive control scheme was adopted to solve with the compounded disturbances including actuator faults, unknown external disturbances and system uncertainties. Then, an auxiliary system was constructed to eliminate the effects of input saturation. Meanwhile, to handle the output saturation problem, the error transformed method was introduced. The attitude tracking error was proved to be bounded under the proposed control scheme by Lyapunov stability theory. Finally, simulation results was studied to demonstrate the effective of the proposed controller.

TueD02 **Room02**
Optimal control and optimization (II) **16:20-18:20**
Chair: Lin Cheng Beihang Univ.
CO-Chair: Jianqiao Yu Beijing Institute of Tech.

16:20-16:40 **TueD02-1**

LQR tracking guidance law for hypersonic vehicle

Qing Lu Northwestern Polytechnical Univ.
Jun Zhou Northwestern Polytechnical Univ.

In order to study the reentry guidance law for hypersonic vehicle, the theory of linear quadratic regulator (LQR) is introduced into the solving process of guidance law based on a determined standard trajectory. Small disturbance linearization of complete three-degree-of-freedom (3DOF) model is carried out. Guidance command which satisfies the requirement of the mission can be obtained by using LQR method. Simulations are done by parameter deviating so as to verify the robustness of the algorithm. The results shows that the method of this paper can ensure high accuracy tracking of nominal trajectory and has strong robustness.

16:40-17:00 **TueD02-2**

Optimal Linear Quadratic Guidance Law with Terminal Impact Angle Constraint

Jianyu Zhao Beijing Institute of Tech.
Jianqiao Yu Beijing Institute of Tech.
Kun Yang Xing'an Vocational and Technical Coll.

Traditional guidance methods ensure simple algorithm and precision, however, they may create a lower impact angle. In recent years there has been an increasing interest in guidance law in order to improve the impact angle. This paper proposes an optimal guidance law under the constraints of miss distance and impact angle. The approach adopted extensively is called linear quadratic optimal control theory. Simulation results indicate that the damage ability can be increased significantly compared with the proportional navigation law, which improves the performance of modern guided weapons enormously.

17:00-17:20 **TueD02-3**

Extraction Method of Rules for Measuring Air Threat to Surface Vessel Formation under the Condition of Incomplete Information System

Lin Zhang Department of Missile Dalian Naval Academy

IA kind of extraction method of rules for measuring air threat to surface vessel formation under the condition of incomplete information system is put forward to measure air threat to surface vessel formation in such a case. Discount coefficient, which is produced when expert decision-making information are the most similar to each other, is generated after the study on information filling when condition attribute is missing and strategy generation when decision-making attribute is missing in the incomplete information system. On the condition that the requirements of air defense decision-making are met, the value of θ - λ is set to calculate the reduction rules of incomplete information system. When part of condition attribute or decision-making attribute is missing, this method can provide satisfactory target threat measurement for surface vessel formation to make air defense decisions.

17:20-17:40 **TueD02-4**

Carrier Aircraft Support Resource Procedure Optimization Based on Genetic Algorithm

Liang Ma Dalian Naval Academy

In order to enhance the rapid response capability of carrier aircraft, aircraft carrier support resource procedure model is established, aiming at optimizing support procedure, saving support resource and shortening support time according to the carrier aircraft support resource distribution. Genetic algorithm is introduced into eM-Plant software to compare the support time of each support step and shift to parallel or serial support step. As a result, task is completed and support resource is saved. The optimization can improve resource utilization and reduce resource waste.

17:40-18:00 **TueD02-5**

PIDNN Decoupling Control of Boiler Combustion System Based on MCS

Yong Zhang University of Science and Technology Liaoning
Haibo Zhu State Grid Liaoning Electric Power Company Limited Economic Research Inst.

Aimed at the problem that traditional decoupling control method is not ideal for the decoupling effect of nonlinear, multi variable and strong coupling systems, we put forward a control method combining the cuckoo search algorithm (MCS) which use learning evolution as search guide with PID neural network, it eliminate the strong coupling effect between the loops through the PIDNN network training and use the improved cuckoo algorithm to optimize the connection weights. Compared with the reverse BP neural network, the MCS algorithm overcomes the characteristic that is easy to fall into local convergence of PIDNN, and comparing with basic cuckoo algorithm, it has better ability in search precision and convergence speed. By the combination of learning evolving and Gauss distribution and the new search mechanism formed by mixing it with Levy flight search mechanism based on probability of selection, it accelerate the optimization of PIDNN weights. Through the simulation of boiler combustion system of strong coupling fire power plant, it appears that this method has better control characteristics such as good decoupling performance, strong robustness and high control accuracy, which provides an effective way to improve the actual industrial production process of strong coupling control system.

18:00-18:20 **TueD02-6**

Advanced Reentry Guidance based on On-board Reference Trajectory Reconstruction

Lin Cheng Beihang Univ.
Qingzhen Zhang Beihang Univ.
Kun Ni Beihang Univ.
Yang Cheng Beihang Univ.
Pei Chu Beihang Univ.

Along with the growing demands of hypersonic vehicle reentry guidance in autonomy, robustness, and situation with insufficient performance of current methods, one compound reentry guidance method is proposed based on altitude-velocity reference profile on-board regeneration and tracking. Aiming at the vehicle reentry problem, overall guidance scheme and related key technologies are studied in this work, and vehicle feasible trajectory on-board planning subject to multiple constraints and adaptive trajectory tracking problem are specially focused on. On basic of reentry problem research and constraints analysis, a novel kind of compound altitude-velocity (short for HV) corridor is designed on-line, in consideration of current state, path constraints, vehicle flying capability and terminal condition constraints. New compound HV corridor provides feasible flight envelope with satisfying constraints. The tracking reference profile is obtained by weighting the upper and lower bounds of HV corridor and strict function monotone property between weighted coefficient and flyable range is also proved. Gauss-Newton method is introduced to solve the transformed single parameter and single constraint problem. For sake of avoiding integral in range prediction, the designed altitudevelocity profile is fitted with Lagrange polynomials and the Legendre primary functions help algorithm improve running speed significantly. Pole place and PID control methods are introduced to finish the tracker design of reference profile. The above researches constitute an autonomous, robust and reliable entry guidance scheme for hypersonic vehicles. Feasible trajectory validity test and Monte Carlo simulations illustate that the proposed compound guidance method performs well in reentry flight under conditions of initial launch deviation, parameter uncertainty and strong interference. New method has be proved with remarkable performance of autonomy, adaptability and robustness.

TueD03 Room03
Mobile robotics 16:20-18:20

Chair: Xunyu Zhong Xiamen Univ.
CO-Chair: Yalong Zhang Beihang Univ.

16:20-16:40 **TueD03-1**

A Novel Navigation Scheme in Dynamic Environment Using Layered Costmap

Xiaoning Han Univ. of Chinese Academy of Sciences
Yuquan Leng Univ. of Chinese Academy of Sciences
Haitao Luo Chinese Academy of Sciences
Weijia Zhou Chinese Academy of Sciences

Navigation is one of basic functions of auto-mobile robots. After dozens of years of development, now the navigation in static environment almost has been realized, taking the method in ROS (i.e. Robot Operation System) navigation stack as an example. However, when cruising in dynamic environment, there are more difficulties, as the objects in the environment can change their positions. To deal with such cases, we propose a scheme to navigate using layered costmap. By predicting the dynamic object's encounter position according to both its and the robot's kinematic information, and put it in another layer, and set different costs around the objects according the estimation of the motion of them, then path based on the layered costmaps can be planned. In this paper, the safety and efficiency of our scheme have been proven by the results of simulation.

16:40-17:00 **TueD03-2**

Variable-Step-Length A* Algorithm for Path Planning of Mobile Robot

Da Ke Wnhan Univ. of Scie. and Tech.
Xiaoyu Liu Wnhan Univ. of Scie. and Tech.
Bi Zhang Wnhan Univ. of Scie. and Tech.

The path planned by the traditional A* algorithm is not the shortest and there are too many steps because of the one grid step length. To overcome the drawbacks, an improved A* algorithm based on variable-step-length is presented for path planning of mobile robots. The environment of the mobile robot is modeled by the grid method. Considering that the reachable region of the mobile robot may be larger than one grid in each searching step, a variable-step-length scheme is proposed. The path planned in each cycle can be selected from the lines pointing to every grid in the reachable range surrounding the current grid. For the sake that the line distance between two points is the shortest, the planning indices such as the path distance and the step number are all better than those of the polygonal line planned by the traditional A* algorithm. Base on the variable-step-length, the searching direction and the improved cost function are designed for the optimal step. The corresponding obstacle avoidance algorithm is also discussed. The proposed variable-step-length A* algorithm make the mobile robot to choose an appropriate step according to the current environment and find a shorter and less steps path. The simulation results show the improved algorithm is more efficient for the path planning of the mobile robot.

17:00-17:20 **TueD03-3**

An Improved FastSLAM2.0 Algorithm Based on Ant Colony Optimization

Shiguang Wen Northeastern Univ.
Mingde Yao Northeastern Univ.
Chengdong Wu Northeastern Univ.
Jun Li Northeastern Univ.

Montemerlo et al. proposed an algorithm called FastSLAM2.0 as an efficient and robust solution to the simultaneous localization and mapping problem. We proposed an ant colony optimization based resampling method, which seriously reduces the problem of particle depletion. Simulation experimental results illustrate the advantages of our method over previous approach.

17:20-17:40 **TueD03-4**

Path-planning of Automated Guided Vehicle based on Improved Dijkstra Algorithm

Qing Guo Beijing University of Chemical Tech.
Zheng Zhang Beijing University of Chemical Tech.
Yue Xu Beijing University of Chemical Tech.

In the automated storage and retrieval system (AS/RS), a reasonable path-planning is fundamental for the effective work of AGV. For the rectangular environment map of the AS/RS system, the traditional Dijkstra algorithm can only find one shortest path, and skip over other paths with the same distance. An improved Dijkstra algorithm is proposed to solve the path-planning problem in the rectangular environment, which can find all equidistant shortest paths. The optimal path with both the shortest distance and time is obtained by adding running time to the path-planning evaluation. The algorithm is programmed using Visual C++, and the simulation results show that the algorithm is effective and feasible for path-planning in the AS/RS system.

17:40-18:00 **TueD03-5**

A New Adaptive Artificial Potential Field and Rolling Window Method for Mobile Robot Path Planning

Yalong Zhang Beihang Univ.
Zhenghua Liu Beihang Univ.
Le Chang Beihang Univ.

The artificial potential field (APF) method is a classical path planning

algorithm for mobile robots. Although the artificial potential field method is simple, it still has some defects, which limit the scope of its application. In this paper, we propose an adaptive repulsive potential function to solve the problem, goals nonreachable with obstacles nearby (GNRON). Then, the adaptive artificial potential field (AAPF) combined with the rolling window method is used to solve the local-minima problem and can be used for the path planning in dynamic environment.

18:00-18:20 **TueD03-6**

Motion Planning Implemented In ROS For Mobile Robot

Yingbing Chen Xiamen Univ.
Xiang Wang Xiamen Univ.
Shaohui Hong Xiamen Univ.
Xunyu Zhong Xiamen Univ.
Chaosheng Zou Xiamen Univ.

In a dynamic environment, the automatic mobile robot requires a real-time independent path planning for safe navigation. To solve this problem, this paper represents a hybrid path planning approach combining the safe global path planning and a new improved adaptive window approach. The improved adaptive window approach base on the concept of safe path which improves the accuracy of obstacle avoidance significantly. Based on the robot operating system, all works in this paper are validated both in the virtual environment and the real world. The experiments show that the hybrid path planning can safely control the mobile robot in a dynamic environment.

TueD04 Room04
Complex networks and systems (IV) (Chinese) 16:20-18:20

Chair: Chunxia Fan Nanjing Univ. of Posts and Telecommunications
CO-Chair: Liang Zhou Naval Univ. of Engineering

16:20-16:40 **TueD04-1**

Synchronization of Complex Dynamical Networks via Sampled-Data Control: A Threshold Function Event-Triggered Method

Fei Wang Jiangnan Univ.
Yongqing Yang Jiangnan Univ.
Xianyun Xu Jiangnan Univ.

The synchronization problem of a general complex dynamical networks is studied in this paper. Sampled-data feedback controllers with event triggered mechanism are designed to synchronize the complex network. The event in this paper is formed as a kind of monotone non-increasing threshold function. According to Lyapunov stability theory, quasi-synchronization can be reached, and the error level is related with some parameters of selected threshold function. Furthermore, under some appropriate parameters, the completed-synchronization can be guaranteed. Some examples are given to illustrate the effectiveness of the proposed to support theoretical results.

16:40-17:00 **TueD04-2**

Fault-Tolerant Synchronization of Complex Dynamical Networks with Actuator Faults

Chunxia Fan Nanjing Univ. of Posts and Telecommunications
Lunsai Gong Nanjing Univ. of Posts and Telecommunications
Ying Zhou Nanjing Univ. of Posts and Telecommunications
Jinxing Lin Nanjing Univ. of Posts and Telecommunications

This paper presents the fault-tolerant synchronization controller design for a class of complex dynamical networks (CDNs) in the presence of actuator being partial faulting. By using the prior knowledge of the actuator faults, the complex network with actuator faults is described as a complex network with parameter uncertainties. Furthermore, a fault tolerant synchronization criterion in the form of linear matrix inequality is proposed on the basis of the Lyapunov stability theorem and Schur complement lemma. Finally, a numerical simulation is carried out to demonstrate the effectiveness of the proposed fault-tolerant synchronization controller.

17:00-17:20 **TueD04-3**

Nonlinear Dynamics in Hub-Structured Genetic Regulatory Networks

Min Xiao Nanjing Univ. of Posts and Telecommunications

In this paper, the stability and Hopf bifurcations are investigated in hub-structured genetic regulatory networks with multiple delays and bidirectional couplings. The existence of the positive equilibria is firstly examined. Then sufficient conditions for the delay-dependent stability and Hopf bifurcations are derived for genetic regulatory networks with hub structure. Finally, some simulation examples are provided to verify the correctness of the theoretical results.

17:20-17:40 **TueD04-4**

Decentralized Resilient H∞ Filtering for Large-Scale Systems with Delayed Interactions under Communication Constraints

Yan Liang Nantong Univ.
Xiaomei Zhang Nantong Univ.
The System Science Inst. of Nantong Univ.
Suying Sheng Nantong Univ.

This paper is concerned with the decentralized resilient H_∞ filtering problem for a class of large-scale discrete-time systems with delayed interactions under communication constraints. A switched time-delay system with randomly occurring uncertainties is employed to model the network-based filtering system where measurement quantization and data missing phenomena are taken into account. The main purpose of this paper is to design decentralized resilient filters with randomly occurring gain variations such that filtering error system is exponentially stable in the mean square and satisfied a prescribed H_∞ disturbance attenuation. Sufficient condition are first established in virtue of the switched system method for the existence of the desired decentralized resilient filters. By utilizing the conditions, the filter gains are then designed. Finally, a numerical example is illustrated to show the efficacy of the results proposed.

17:40-18:00 **TueD04-5**

Sparse Reconstruction Based Structure Estimation of GRNs UsingTime Series Experimental Data

Wanhong Zhang Qinghai Univ.
Yan Zhang Qinghai Univ.
Zengcao Liu Qinghai Univ.

A strategy for estimating structure of gene regulatory networks (GRNs) is proposed on basis of time series experimental data in this paper. This strategy is an essential for transforming the problem of identifying a GRN into that of sparse reconstruction whose measurement matrix is composed of the nonlinear functions of a GRN. Differently from tradition methods, this method is well suitable for a large scale network identification, and may avoid both linearized inaccuracy and limitation of the length of time series data. We utilize an algorithm of the stagewise modified orthogonal matching pursuit (SmOMP) to estimate the sparse vector that denote a gene regulated by other genes. Compared with robust state estimator (RSE), the well known extended Kalman filter (EKF) and unscented Kalman filter (UKF) based method, the efficiency of this method has been verified by numerical simulations. Actual results show that this suggested method not only has better convergence speed and higher estimate accuracy, but also can significantly reduce the computational complexity in GRN inferences.

18:00-18:20 **TueD04-6**

Evaluation Modeling Of Spare Parts Scheme under Different Support Systems

Yin-wu Peng Naval Univ. of Engineering
Guang-qiang Bai Naval Univ. of Engineering
Liang Zhou Naval Univ. of Engineering

Spare parts are one of the most important substances that guarantee the sustainable work of the equipment. For different tasks, spare parts support structure is different. Based on the METRIC theory, the inventory model of two level single layer spare parts under different support system is established. Through an example analysis, it compares the changes of the equipment availability with time under the different parts of the dynamic support system and the fixed support system. The case results are in good agreement with the actual situation.

TueD05 Room05
Co-operative control (III) (Chinese) 16:20-18:20

Chair: Yanchao Sun Harbin Inst. of Tech.
CO-Chair: Feiqi Deng South China Univ. of Tech.

16:20-16:40 **TueD05-1**

Distributed Coordinated Attitude Tracking Control for Spacecraft Formation Based on Neural Networks

Wenjia Wang Harbin Inst. of Tech.
Chuanjiang Li Harbin Inst. of Tech.
Yanchao Sun Harbin Inst. of Tech.
Boyan Jiang Harbin Inst. of Tech.

This paper investigates the distributed attitude tracking control problem of spacecraft formation under a directed communication topology. A distributed coordinated attitude tracking control law based on neural networks is introduced to deal with the uncertainties and external disturbances when the time-varying leader's trajectory is available to only a subset of follower spacecraft. A Lyapunov analysis guarantees the convergence ofattitude tracking errors to an arbitrarily small domain. Simulation results demonstrate the effectiveness of the proposed controller.

16:40-17:00 **TueD05-2**

Leader-Following Almost Surely Exponential Consensus for General Linearmulti-Agent Systems with Stochastic Disturbances

Birong Zhao Guangzhou Univ.
Yunjian Peng South China Univ. of Tech.
Feiqi Deng South China Univ. of Tech.

This paper deals with the leader-following consensus tracking problem for general linear multi-agent systems driven by Brownian motion, which is more general and can better describe the actual systems; a directed graph is used to represent the communication topology of the multi-agent network. By using the auxiliary function method and stochastic Itô integrals techniques with Brownian motion, sufficient criteria are derived for exponential consensus tracking in the sense of almost surely. A simulation example is utilized to illustrate the usefulness of the proposed control protocol.

17:00-17:20 **TueD05-3**

Coordinate Control of Multi-UUVs Formation under Double Independent Topologies with Time-vary Delays

Zheping Yan Harbin Engineering Univ.
Yibo Liu Harbin Engineering Univ.

Jiajia Zhou Harbin Engineering Univ.
Haomiao Yu Harbin Engineering Univ.
This paper provides a new method which uses consensus algorithm to solve the coordinate control problems of multi-UUVs in the case of leaderless formation. As band width is constraint in the water, a new topology method is proposed which divides the communication topologies into two independent parts, position communication topology and velocity communication topology. And in the novel communication topologies there are different time-varying delays. In additions, the math model of UUV is nonlinear and coupled. With the help of state feedback linearization method, the nonlinear math model of UUV can be transferred into a double-integrator dynamic model. Based on the result of linearized model, the UUVs formation coordinate control can be regarded as a consensus problem with time-varying communication delays. As a result, sufficient conditions for the stability of system are proposed and they are proven by using the Laypunov-Razumikhin theorem. In the end, the simulation results are presented to confirm and illustrate the theoretical results.

17:20-17:40 **TueD05-4**

Consensus of Discrete-Time Second-Order Multi-Agent Systems with Delayed and Noisy Measurements under Balanced Digraphs

Xiaofeng Zong China Univ. of Geosciences
Hubei Key Laboratory of Advanced Control and Intelligent Automation for Complex Systems
Tao Li East China Normal Univ.
Shanghai Key Laboratory of Power Station Automation Tech.
This paper studies mean square and almost sure consensus of discrete-time second-order multi-agent systems with time-delays and multiplicative noises in the information exchange with neighbors. By using the stochastic stability theorem of discrete-time stochastic delay systems, we find sufficient conditions for mean square and almost sure consensus explicitly related to the network and control parameters. It is shown that if the network graph is balanced and strongly connected, then the weighted-average type control protocol can be properly designed to ensure mean square and almost sure consensus for any given time-delays and noise intensity coefficients.

17:40-18:00 **TueD05-5**

Cooperative Output Regulation of Discrete-Time Linear Multi-Agent Systems Based on State Observer

Mengna Zheng Zhejiang Sci-Tech Univ.
Jinfeng Gao Zhejiang Sci-Tech Univ.
Huijiao Wang Zhejiang Sci-Tech Univ.
Cooperative output regulation of discrete-time linear multi-agent systems under an undirected interaction topology is investigated. A new distributed control law based on the state observer is proposed, which makes the system have a faster convergent speed. This distributed observer will provide, to each agent, not only its own estimated state and the estimated state of its neighbor agents, but also the estimated state of the neighbor net of its neighbor agents. Under some standard assumptions, necessary and sufficient conditions for the solvability are given. A numerical example illustrates applicability of the proposed approach.

18:00-18:20 **TueD05-6**

Guidance Law for Multi-UAVs Collaborative Ground Target Tracking under Obstacle Environment

Jin Xiong National Univ. of Defense Tech.
Yifeng Niu National Univ. of Defense Tech.
Multi-UAVs collaborative target observation and tracking is one of the typical applications of UAVs. In this paper, we focus on the study of multi-UAVs collaborative ground target tracking under obstacle environment. A UAV field for avoidance is given, and a UAV guidance law based on the Lyapunov guidance vector field is proposed to control the UAVs converging to the limit cycle over the target as well as avoiding the obstacles. Taking into account that the observation efficiency has a great degree of correlation with the observation angle, we design a phase control to maintain the phase angle between UAVs. Due to the speed limit of UAVs, the amplitude ofthe phase angle will increase when the speed limit is reached, and the observation efficiency will decrease. We use the standoff distance compensation strategy to reduce the amplitude of the phase angle. The simulation results show that the method we proposed in this paper can make the UAVs keep track of the target while avoiding the obstacle.

TueD06 **Rom06**
Intelligent systems (IV) (Chinese) **16:20-18:20**
Chair: Jihong Liu Northeastern Univ.
CO-Chair: Linlin Ou Zhejiang Univ. of Tech.

16:20-16:40 **TueD06-1**

Study on Medical Image Segmentation Methods of Humerus

Zipeng Zhang Northeastern Univ.
Jihong Liu Northeastern Univ.
Rui Wang Northeastern Univ.
Ting Li Northeastern Univ.
Currently, many people suffer from osteoporosis. Judgment of osteoporosis is usually measured using a machine such as a bone densitometer. We propose a method of grading the degree of osteoporosis in bone using images. Using a regional growth model (humeral stem) based on statistical ideas, a dynamic contour model based on segmentation (humeral head) and Otsu Law to image segmentation, processing, analysis, and then assist the doctor to choose the appropriate way to treatment. This method is based on the analysis ofpixel points of medical DR images. The experimental results are valuable and more in line with modern society for medical requirements.

16:40-17:00 **TueD06-2**

Low-Order Stabilization of Two-Wheeled Mobile Manipulator

Linlin Ou Zhejiang Univ. of Tech.
Ledzilva Paurel Abia Corot Zhejiang Univ. of Tech.
Xinyi Yu Zhejiang Univ. of Tech.
Yanlin He Zhejiang Univ. of Tech.
Qing Xu Zhejiang Univ. of Tech.
A design approach of the low-order controller to stabilize a two-wheeled four-degree-of-freedom mobile manipulator is investigated in this paper. The two-wheeled mobile manipulator is known to be nonlinear in the relationship between each motor torque and motor angle. Exploiting the fact that the variation of each joint angle at the equilibrium point is very small, the relation between the input and output of the whole system which considers the time delay is firstly established and the linear model of the mobile manipulator at the equilibrium point is presented. In terms of the resultant model, a proportional-derivative (PD) and a disturbance observer (DOB) are both designed to stabilize the manipulator and attenuate the external disturbances respectively. Based on the extended Hermite-Biehler theorem, the set of the PD control parameters that ensures the stability of the whole system is determined. Then a new approach used to determine the bandwidth of the filter in the disturbance observer is presented. The DOB can not only enhance the robustness of the entire system against external disturbance but also compensate the model uncertainties. Finally, the simulation is carried out to verify the effectiveness of the proposed method.

17:00-17:20 **TueD06-3**

Study on Cable Length Measurement Methods

Yu Zhou Northeastern Univ.
Jihong Liu Northeastern Univ.
Heng Wu Northeastern Univ.
Ying Zheng Northeastern Univ.
With the development of digital image processing, traditional contact measurement cannot satisfy the accuracy needs of the cable length measurement. The technology of non-contact photoelectric detection is becoming more and more practical. Using optical mouse chip to test motion can effectively avoid the system errors brought by touching with things. Under this background, we design a non-contact measurement equipment that is based on MCU system, to measure the length of cable for cable manufacturers. The experimental results show that it could meet the engineering needing.

17:20-17:40 **TueD06-4**

Activity Recognition Based on Importance Degree Reduction of Decision Table

Xi Yu Dalian Maritime Univ.
Dalian Inst. of Science and Tech.
Can Wang Dalian Inst. of Science and Tech.
Bing Yang BT Global Services
Recently, people pay more attention to quality of life in the smart home, so activity recognition based on sensors become research hotspot. In the past study, people care more about the recognition accuracy rather than recognition data. Few researches consider the problem that recognize based on reduced and characteristic sensor data. In the paper, an activity recognition method which based on importance degree reduction of decision table is proposed. By the method characteristic sensors can be found. The experiment results show that recognition accuracy is promoted based on characteristic sensors than all the sensors.

17:40-18:00 **TueD06-5**

Preliminary Research on Dynamics and Control of On-Orbit Disabled Satellites for Positive Tumbling Breaking

Wenjie Duan Beijing Inst. of Control Engineering
Science and Tech. on Space Intelligent Control Laboratory
Zhibin Zhu Beijing Inst. of Control Engineering
Science and Tech. on Space Intelligent Control Laboratory
For disabled satellites tumbling at high speed (several or dozens of ° /s), the movement can usually be divided into two parts, i.e., the spinning around a fixed axis and the nutation, which introduce challenge for capturing task. The principal condition for capturing is to perform positive tumbling breaking such that the spinning velocity is reduced to the acceptable range. In this paper, we consider positive tumbling breaking satellites with flexible-link brushes and disabled satellite with solar panel. The contact force between the brush and the satellite includes the flexible force due to bend transform and the friction, which is utilized to achieve tumbling breaking by reducing the spinning velocity. Contact dynamics is set up and simulation of the contact problem is conducted to analyze the effects of the flexible link (including the bending stifness, the link-length and the penetration depth) to tumbling breaking, e.g., the tumbling breaking times、 the consumption time and the moving distance during the tumbling breaking process.

18:00-18:20 **TueD06-6**

Design and implementation of multi robot research platform based on UWB

Qiang Lv The Academy of Armored Forces Engineering
Heng Wei The Academy of Armored Forces Engineering
Huican Lin The Academy of Armored Forces Engineering
Ying Zhang The Academy of Armored Forces Engineering

Based on the ultra wideband (UWB) technology in the Ubuntu robot operating system (ROS) framework to build a centralized distributed multi robot research platform. Based on the UWB chip, a bidirectional ranging module is designed, and the singular value removal module based on the minimum covariance determinant (MCD) Mahalanobis distance detection algorithm is designed for the singular values in the ranging process. The extended Calman filtering optimization module is designed to solve the problem of excessive coordinate jump and edge effect in three edge location algorithm. ROS communication network is constructed based on multi master design, and the entry and exit mechanism, so that when a robot failure will not affect the operation of the whole system or after the completion of the task can exit the system to reduce the burden of the central processor. Finally, the kinematics and dynamics model of omni-directional robot based on the design of inverse dynamic compensation control strategy of synovial control combining with PID control, and complete the single robot trajectory tracking experiment and multi robot formation mission experiment.

TueD07 **Room07**
Decision-making theory and method (V) **16:20-18:20**

Chair: Xiaoyue Yong Northeastern Univ.
CO-Chair: Hui Lin Zhejiang Univ. of Finance and Economics.

16:20-16:40 **TueD07-1**

Machine Learning Based Approaches for Medium-thick Plate Stress Analysis Feature Extraction and Product Defect Prediction

Hui Zhang Shanghai Baosteel Engineering Consulting Co., Ltd
Jiahui Zhao Shanghai Baosight Software Co., Ltd
Xiaoyue Yong Northeastern Univ
Chen Zhang Northeastern Univ
Yingjun Ji Northeastern Univ

In order to accurately predict the plate production process defects, and increase the rate of finished products , and improve enterprise profits, on the base of large-scale industrial data accumulated in medium-thick plate production process, this paper proposes using machine learning and data analysis theories and methods to study the data-driven stress and product defect prediction model of plate. After selecting the data features which have significant effect on the stress of the plate, we establish the logistic classification and forecasting model, and use cross-validation to train and validate the model. The experimental results show that the feature extraction and prediction model can accurately predict the stress defect classification of the medium-thick plate production process.

16:40-17:00 **TueD07-2**

Identification of Key Factors in Health Service Adoption Based on Internet of Things and Empirical Test

Yujia Zhai Harbin Inst. of Tech.
Yupeng Liu Harbin Inst. of Tech.
Dalian Univ. of Tech.
Tongtong Zhou Harbin Inst. of Tech.

With China's increasingly serious problem of aging, and chronic diseases and other diseases increasingly extending toward younger people, health problems have become the focus of social concern. The application and development of the Internet of things in health services has been paid more and more attention by the country and the society. Whether the Internet of things Tech and its derivative products can be adopted by consumers has become an important scientific problem to be solved urgently. This article constructs the index system of adoption of key influencing factors from the aspect of IoT and the concept of health services. This article analyses the relationship between the various factors using DANP method, and builds the improved PROMETHEE method by introducing the concept of expectation level into the preference function. And it makes an empirical analysis taking the similar service of three companies as the research object, and finds out the gap between the three companies' services and expectation levels, and suggestions are given.

17:00-17:20 **TueD07-3**

Graph-based Modeling and Non-decoupling Solution for Distributed Cooperative Mission Planning

Weinan Wu Harbin Inst. of Tech.
Naigang Cui Harbin Inst. of Tech.
Jifeng Guo Harbin Inst. of Tech.

This paper addresses the problems of autonomous task assignment and path planning for a fleet of heterogeneous unmanned aerial vehicles in cooperative mission. In previous work many algorithms almost run on centralized architecture and handle the task assignment decoupling with the path planning. This may result in poor solutions. Therefore, this paper investigates a novel integrated solution for UAV to perform multiple consecutive tasks cooperatively on multiple ground targets based on distributed planning architecture. In a given scenario, the heterogeneous vehicles have different capabilities, kinematic constraints, and fuel constraints. Furthermore, the task has other constraints, such as task execution orders, UAV conflict free constraints, etc. This paper presents details of the non-decoupling solution which produces optimal assignment and trajectories for several given scenarios. The performance of the algorithm is compared to that of some previous methods in real-time simulation environment. The simulations results show the viability of the non-decoupling approach, and the non-decoupling solution has an advantage over hierarchical algorithms, and the distributed architecture improves the operation efficiency of the algorithm and the robustness of the UAV.

17:20-17:40 **TueD07-4**

TOPSIS-based approach for hesitant fuzzy linguistic term sets with possibility distribution information

Zhibin Wu Sichuan Univ.
Xue Chen Sichuan Univ.
Jiuping Xu Sichuan Univ.

Making decisions are in need of methodological and/or computational support under various environments. The hesitant fuzzy linguistic term sets (HFLTSs) are widely used to manage such an environment where the experts are hesitant between several possible linguistic values. The concept of possibility distribution for an HFLTS has been developed which provides a way to express the additional information within the HFLTS. The aim of this paper is to present a new TOPSIS method to solve multiple attribute group decision making (MAGDM) problems with hesitant information. The hesitant fuzzy linguistic weighted average (HFLWA) operator is given to aggregate individual preferences into group preferences. Due to the fact that both comparisons and distance measures over preference format play critical roles in the TOPSIS method, new definitions for comparison method and distance measure between two HFLTSs are presented. Further, a procedure of the new TOPSIS for HFLTSs is proposed in detail and a framework for MAGDM based on the TOPSIS method is presented. Finally, an example for supplier selection is shown to highlight how the proposed approach works in practice.

17:40-18:00 **TueD07-5**

An approach to linguistic multi-attribute decision making based on risk preferences of decision makers

Hui Lin Zhejiang Univ. of Finance and Economics

An approach is proposed to solve linguistic multi-attribute decision making problems with the risk preference of the decision maker (DM). Firstly, a generalized linguistic term set (GLTS) is defined based on a semantic function to simulate some kinds of linguistic term sets such as the uniform and symmetric linguistic term set (LTS), the non-uniform and asymmetric LTS, the uniform and asymmetric LTS and the non-uniform and symmetric LTS. Then, a method of calculating risk parameters is presented to determine the type of the DM's risk preference. Furthermore, the GLTS has six properties, and the corresponding proofs are given. Finally, a numerical example about the company investment is proposed to illustrate the feasibility and effectiveness of the method given in this paper.

18:00-18:20 **TueD07-6**

A UAV Formation Maneuvering Decision Algorithm Based on Heuristic Tactics Knowledge

Wei Zu Inst. of Automation, Chinese Academy of Sciences
Yang Gao Inst. of Automation, Chinese Academy of Sciences
Hongxing Chang Inst. of Automation, Chinese Academy of Sciences
Jie Zhang Chengdu Aircraft Design and Research Inst.
Yao Ma Inst. of Automation, Chinese Academy of Sciences
Yesheng Zhang Inst. of Automation, Chinese Academy of Sciences

A UAV formation is the essential air combat unit which consists of two or three UAVs. An autonomous maneuvering decision algorithm in an adversarial environment based on pilots tactics experience knowledge is proposed. Firstly, a situation assessment modeling method based on naive Bayes is addressed, in which the historical situation is took into consideration when predicting the next moment situation. Secondly, pilots' tactics experiences and the heuristic multi-UAVs cooperative attack strategy are mathematically modeled and brought in which can improve the decision operator efficiency. Finally, a decision method based on Nash equilibrium is described to work out sequences of optimal maneuvering at discrete time moment. Simulations results show that the algorithms quickly provide good feasible solutions, and find the optimal maneuvering solution in different typical air combat scenarios.

TueD08 **Room08**
Sensor network systems (III) (Chinese) **16:20-18:20**

Chair: Yulong Xu Henan Univ. of Traditional Chinese Medicine
CO-Chair: Zhiping Zhou Jiangnan Univ.

16:20-16:40 **TueD08-1**

Design and Implementation of a New Wireless Sensor Network Node

Jun Qi Harbin Inst. of Tech.
Guoping Liu Faculty of Advanced Tech. Univ. of South Wales

ZigBee is most widely used in the Wireless Sensor Network (WSN) in all the network protocol because of its low power consumption, On the other hand, ZigBee's rate is so low that we can't design a product that has the high value of practical application by using it, especially, Internet of Things (IoT) is applied to all walks of life, such as smart home and intelligent industry, needing a high rate WSN. This paper reports the design and development of a new WSN node based on WIFI protocol, which solve the problem of energy consumption and can transmit the sensor's data with a high-speed bandwidth. WI-FI is a wireless networks technologies that can connect personal computer and other wireless terminal equipment and high frequency radio signals. WI-FI networks, based on the IEEE802.11b/g standards, have become very popular in recent years, numerous Personal housings and corporations have added Wi-Fi access points to their wired networks, So WSN node base on WI-FI has practical value, which utilizes CC3200 which is a single-chip microcontroller unit (MCU) with built-in WI-FI connectivity and designed by Texas Instruments (TI). The CC3200 device is a wireless MCU that integrates a high-performance ARM Cortex-M4 MCU that can be used for signal acquisition and processing.

16:40-17:00 **TueD08-2**

Data fusion and bias registration based on sensor selection for large-scale sensor networks

Junjun Guo Xi' an Jiaotong Univ.
Chongzhao Han Xi' an Jiaotong Univ.
Longfei Lie China Tobacco Henan Industry Co. Ltd,.

This paper presents a new target tracking and the possible changing bias registration approach based on sensor selection for large-scale distributed sensor networks. We try to address this target tracking problem at the following three steps. Firstly, local-level tracking is addressed based on the estimated sensor biases for each sensor, and only the state estimates are transmitted to the fusion center; Secondly, data fusion is carried out by using the sensor selection approach at the fusion center, target state is estimated based on the tracking results reported by the selected sensors; Finally, sensors' biases are updated at the fusion center. In addition, both of sensor coverage problem and the possible changing bias problem are considered in our paper. The proposed approach only needs to select a small number of sensors for tracking, rather than the traditional approaches, which prefer to use all of the sensors. Simulation results show the effectiveness of the proposed approach.

17:00-17:20 **TueD08-3**

Cryptanalysis of the LMAP Protocol: A Low-cost RFID Authentication Protocol

Jing Li Jiangnan Univ.
Zhiping Zhou Jiangnan Univ.
Ping Wang Jiangnan Univ.

Through analyzing the security of LMAP protocol, we point out that this protocol is vulnerable to several attacks including the data integrity, reader impersonation and traceability, forward traceability. Based on the above security drawbacks, an improved LAMP protocol is proposed. Aiming at the problem of data integrity, the backend server uses message authentication code to encrypt data information of tag; the reader mixes message generated by tag side to ensure resist impersonation reader attack; the tag side introduces blind factor against traceability attack; in addition, the keys of tags and backend server side can be updated dynamically according to the random number generated by tag side in different authentication cycles, to ensure the forward/backward privacy. The formal proof of correctness of the improved protocol is given based on GNY logic, and shows that the improved protocol resists various attack.

17:20-17:40 **TueD08-4**

Based on differential evolution to research the control problem of area-coverage in WSNs

Yulong Xu Henan Univ. of Traditional Chinese Medicine
Tao Duan Henan Univ. of Traditional Chinese Medicine
Wenwen Chen Henan Univ. of Traditional Chinese Medicine
Jie Chen Henan Univ. of Traditional Chinese Medicine

Differential evolution (DE) is one of the most powerful stochastic real parameter optimizers of current interest. In this article, we aim to study the differential evolution and its' variants to research the area-coverage problem of wireless sensor networks (WSNs). Due to the area-coverage problem of WSNs is more important and pragmatic than the point coverage, we introduce a common method to generate test data set for area-coverage problem of WSNs firstly. Meanwhile, we propose a method that converts the area-coverage problem into point disjoint set covers problem. Then using DE and its' variants to solve the disjoint set covers problems. Namely we use DE and its' variants to research the area-coverage problems of WSNs. Finally, simulation comparison experiment are performed for the DE and its' variants. Results show that the JADE (an adaptive differential evolution proposed by Jingqiao and Arthur Sanderson) performance outperforms or same with others algorithms by solution quality, but the proposed variant has greatly better in terms of time complexity and optimization speed. The reason is that there combination operation can enhance the solution quality in early evolution.

17:40-18:00 **TueD08-5**

WSN Key Management Scheme Based on Fully Bomomorphic Encryption

Jing Zhang Kunming Univ. of Science and Tech.
Chen Ma Kunming Univ. of Science and Tech.
Hongbo Fan Kunming Univ. of Science and Tech.

Improving the safe WSN's real-time, energy consumption, and anti-leak is an important research problem. Based on specific operations as addition, multiplication, and so on. Fully homomorphic encryption can manipulate the ciphertext directly to get the correct results without decryption. Because fully homomorphic encryption's process of the decryption can be omitted, the safe WSN's characteristics such as real-time and so on can be improved effectively. Key management is an important problem of fully homomorphic encryption, in which the ability to anti-capture in WSN comes first. In this paper, based on the calculation algorithm of two element symmetrical polynomials proposed by Blundo, we propose a pairwise key establishment scheme by introducing fully homomorphic encryption, which does not only prevent enemy intercepting information about polynomial relation, but also resist the large-scale node capture attack successfully. Analysis and experiments show that this scheme can totally meet the requirements of resource, energy consumption and so on of WSN, and improve the security of WSN at the meantime.

18:00-18:20 **TueD08-6**

Abnormal Activity Detection Based on Received Signal Strengths of Radio Tomographic Networks

Tong Liu Huizhou Univ.
Xiaohui Wei Huizhou Univ.
Zhiming Chen Huizhou Univ.
Xiaomu Luo Guangzhou Univ. of Chinese Medicine
Jun Liu Wenzhou Univ.

Radio tomographic networks based imaging is bringing significant impact in activity sensing. In this article, we proposed an abnormal activity detection method without any computed recovery imaging. By organizing a vertically arranged profile-aware network, the critical state feature of abnormal activity is encoded into data stream of received signal strengths (RSSs). Then, the new coming sensor data is compared with the instantaneous state feature already recorded, and abnormal detection is performed according to similarity. To validate the efficacy of our method, we defined walking as normal activity and fall as abnormal activity in indoor environments. Experiments give the encouraging results.

TueD09 **Room09**
Delay systems (II) **16:20-18:20**
Chair: Yulin Du Fudan Univ.
CO-Chair: Jinyan Sang Shandong Univ. of Tech.

16:20-16:40 **TueD09-1**

Grey Clustering Evaluation on Senior High School Education Development in Henan Province

Fenyi Dong Henan Agricultural Univ.
Yuyang Jie Henan Agricultural Univ.

Due to the regional imbalance of social and economic development and the regional differences of education consciousness, there is a big gap in the educational development of senior high school among different areas in Henan Province. Evaluating the gap in the senior high school education among cities in Henan Province scientifically and reasonably will provide education authorities a reference to set better educational development policies in different areas correspondingly. Analyse the regional high school education development assessment in Henan province. Considering the influence of evaluation perspective，evaluation index and method, objective index and methods are selected as much as possible to make the evaluation result more scientific and reasonable. Thus, the grey clustering evaluation method was adopted.

16:40-17:00 **TueD09-2**

Management Performance Evaluation of Bank Listed Companies Based on Grey Integrated Clustering

Yuyang Jie Henan Agricultural Univ.
Fenyi Dong Henan Agricultural Univ.
Dehai Li Ping An Life Insurance Company of China

Commercial bank as the pillar of the national economy is the most important part of the financial system. The commercial bank's operating performance not only affects the bank itself, but also relates to the normal operation of the national economy and social stability. Scientific and reasonable evaluation of operating performance of listed banks has very important meaning. This article is based on the annual report of the 16 listed banks in 2015, comprehensively consideration of bank profitability, safety, liquidity and growth, combined with the feature of banking industry, construct a more perfect performance evaluation system of commercial bank. Because the scope of indicators has certain uncertainty, so the grey clustering method was used to study. Taking into account that the general grey clustering method ignores the effect of the other components except the largest component of the clustering coefficient vector, the paper uses the grey integrated clustering method to adjust the clustering results.

17:00-17:20 **TueD09-3**

Policy Orientation Transformed, Factor Market Distortions and International Technology Spillover

Zhao Hao Shandong Univ. of Tech.
Meiyan Pang Shandong Univ. of Tech.

Zhaojun Hu Shandong Univ. of Tech.
Jinyan Sang Shandong Univ. of Tech.
Scientific discoveries, technological achievements and R&D investment are mainly from the developed countries. Developing economies belong to the technical followers and imitators. So, international technology spillover is significant for them. Considering our Chinese policy and market characteristics, the paper selected 1999-2015 Provincial Panel Data, gave an empirical test about the effects of factor market distortions on international technology spillovers before and after policy-oriented. The results showed that the technology spillover effects of the import trade, FDI and patent applications presented different feature in different stages. In the original phase (1999-2007), local governments controlled the resource elements' pricing power leading to factor market distortions, thus weakening and barraging the international spillover effects. In policy orientation phase (2008-2015), government payed more attention to the quality of economic development, the degree of market distortion factors significantly reduced and the role of market mechanism played, international technology spillover got an increase gradually.

17:20-17:40 **TueD09-4**

The Research on Division and Comparative of Stock Bubble Evolution Stage in China

Lina Jia Xi'an Polytechnic Univ.
Jing Niu Xi'an Financial Services Inst.
Erwei Kang Northern special energy xian Qinghua company
Academics have a commonality of the evolution stages of stock bubble , the stage includes formation, expansion and burst of bubble, but less research on how to divide into the evolution stages. Based on this background, this paper presents the idea for the division of stock bubble evolution stages by utilizing Monte-Carlo simulating techniques and stock return data. On this basis, it division the stock bubble evolution stages in Shanghai and Shenzhen stock markets. The result shows that stock concentrate area just happened in which stock market bubble full burst in 2007, and fewer stock areas just happened in which notable financial crisis in 2008. In addition, we contrastively analyze the stock market trading characteristics under different evolutionary stages. Our results show there are significant differences for turnover rate, trading volume, return, and volatility under the different evolutionary stage when the level of significance was 5%.

17:40-18:00 **TueD09-5**

System of Systems Supportability Assessment Model Based on DoDAF

Qi Xiong Department of Management High-Tech Inst. of Xi'an
Guiming Chen Department of Management High-Tech Inst. of Xi'an
Leilei Chang Department of Management High-Tech Inst. of Xi'an
Tianjun Liao Beijing Inst. of System Engineering State Key Laboratory of Complex System Simulation
Zhaojun Mao Beijing Inst. of System Engineering State Key Laboratory of Complex System Simulation
The System of System (SoS) supportability assessment problem has become more and more complicated and lacks of efficient means because there are multiple combatant tasks and numerous weapons and systems. In this study, the Department of Defense Architecture Framework (DoDAF) is used as a top-down perspective to analyze the SoS supportability problem. Moreover, the fundamental elements which are relatedto SoS supportability are categorized from a down-top perspective. With the two perspectives integrated, the SoS supportability assessment model is constructed which is comprised of the supportability composite parameters, the supportability design parameters and the supportability resource parameters.

18:00-18:20 **TueD09-6**

Multi-Asset Option Pricing Based on Stochastic Optimal Control Assuming Correlations Lie in Given Intervals

Yulin Du Fudan Univ.
The assumption of constant correlation between the underlyings cannot be satisfied in market. In this paper, we find the multi-asset option price intervals assuming the correlation lies within a given interval. First we transform this financial problem to a stochastic optimal control problem, then obtain options' maximum and minimum price models through dynamic programming principle. We further discuss how to solve the Black-Scholes-Barenblatt equation through finite difference schemes. We conclude this paper by giving its applications in multi asset option market, comparing with the analytical solutions, and giving a method how to identify arbitrage opportunity in multi-asset option markets.

TueD10 **Room10**
Fault diagnosis and fault-tolerant control (IX) **16:20-18:20**
Chair: Xiumin Li Chongqing Univ..
CO-Chair: Manman Jin Qingdao Univ. of Science and Tech.

16:20-16:40 **TueD10-1**

Fault Diagnosis of Chemical Process Based on Factor Analysis and Improved K-neighbor Algorithm

Manman Jin Qingdao Univ. of Science & Tech.
Hongyue Guo ZHONGKEHUALIAN New Material Co. Ltd
It has been more and more difficult to just depend on the mechanism models to diagnose the faults of the increasingly complex chemical system. This paper proposes an improved K-neighbor algorithm based on data driven method for process fault diagnosis. For training data, the fault diagnosis accuracy rate is seen as the standard to optimize the value of K. The choice purpose of this improved algorithm is to eliminate the value of K's effect on consequence. In order to improve the fault diagnosis accuracy and reduce the calculation time, this paper integrates factor analysis and improved K-neighbor algorithm. Through TE process, this paper verifies the effectiveness of the proposed method. The fault diagnosis accuracy is increased from 78.7% to 86.7% and the calculation time is reduced 52%.

16:40-17:00 **TueD10-2**

Fault Tolerant Control for T-S Fuzzy Systems With Simultaneous Actuator and Sensor Faults

Fuqiang You Northeastern Univ.
Mingjian Li Northeastern Univ.
This paper studies the problem of fault estimation (FE) and the active fault tolerant control (FTC) for a class of Takagi-Sugeno (T-S) fuzzy systems with time-varying delay and simultaneous actuator and sensor faults. Based on the fault estimation algorithm, an adaptive observer-based controller is designed to guarantee the dynamic error system to be asymptotically stable and satisfy the H_infty performance index. Then, based on the information of online fault-estimation information, a dynamic output feedback fault tolerant controller is designed to compensate the fault effects on the closed-loop fuzzy system. Finally, simulation results are given to verify the effectiveness of the proposed method.

17:00-17:20 **TueD10-3**

Robust Actuator Fault Estimation Combining Unknown Input Observer and Invariant Set Approach

Junbo Tan Tsinghua Univ.
Bin Liang Tsinghua Univ.
Xueqian Wang Tsinghua Univ.
This paper proposed a novel robust actuator fault estimation (FE) approach for dynamic systems combining the unknown input observer (UIO) and the invariant sets. The proposed method achieves FE robustness by active and passive decoupling unknown inputs and measurement noises. The core idea is to divide the unknown inputs into two groups. For one group, we design a reference system whose all unknown inputs can be actively decoupled by designing a UIO. For the other group, we turn to the invariant set-theoretic approach to passively decouple the effect of uncertainties (i.e., unknown inputs and measurement noises) on FE. Specifically, a fault estimation observer (FEO) is designed for the state-reference-error dynamics to estimate faults. Moreover, a fault-estimation set is computed using invariant set theorem to guarantee the FE robustness. The aim of this paper is to not only estimate the real fault magnitudes but also compute the FE set containing all possible fault magnitudes, which guarantees the fault-estimation effectiveness as well as the robustness. At the end, the effectiveness of the proposed method is illustrated by a numerical example.

17:20-17:40 **TueD10-4**

Rapid Detection of Rotating Stall in Axial Flow Compressors on Computer Cluster

Qinghua Sun South China Univ. of Tech.
Cong Wang South China Univ. of Tech.
Peng Lin South China Univ. of Tech.
Early detection of rotating stall is of great significance to improve the performance of the compressor. In this paper, based on the fault detection decision scheme, early detection of rotating stall is realized via dynamical pattern recognition on computer cluster. Firstly, based on deterministic learning theory, stall detection scheme used for early detection of rotating stall is introduced. Secondly, a PC cluster treated as the computing platform is constructed in detail. Finally, an experiment in an axial compressor through dynamic recognition is included to demonstrate the effectiveness of the detection scheme.

17:40-18:00 **TueD10-5**

Fault Detection of a Non-Linear Continuous Stirred Tank Heater Based on SVM

Xinrui Shen Bohai Univ.
Tianyu Tan Univ. of Birmingham
Jian Hou Bohai Univ.
Industrial big data has created a challenge for data measurement, detection, and processing. This paper shows that support vector machine (SVM) is extremely useful in detecting fault information in modern complex industrial processes. With a pilot plant of Continuous Stirred Tank Heater (CSTH) process, the SVM method with radial basis function (RBF) kernels is tested on the CSTH database and compared with an improved Partial Least Squares (IPLS) and Principal Component Analysis (PCA). The performance of SVM is validated using k-fold cross-validation where the classifier based on SVM outperforms those based on PCA and IPLS. These comparisons show that SVM has remarkable detection performance and satisfying elapsed time. From an industrial point of view, the vitality of SVM algorithm in actual industrial process is discussed.

18:00-18:20 **TueD10-6**

Fault Tolerant Control for a General Class of Nonholonomic Dynamic Systems via Terminal Sliding Mode

Chenglong Zhu Southeast Univ.
Chenxi Li Southeast Univ.
Kanjian Zhang Southeast Univ.
Haikun Wei Southeast Univ.

In this paper, a constructive fault tolerant control strategy is developed for a general class of uncertain non-holonomic systems. The terminal slide mode technique and the minimal dilation degree scheme are used to accommodate the actuator partial loss of effectiveness and additive actuation fault. Two step control procedures are proposed under the finite time convergence. The parking problem for a wheeled mobile robot is presented to illustrate the effectiveness of the fault tolerant control strategy and demonstrate the application of the general system.

TueD11 **Room11**
Control applications (VI) (Chinese) **16:20-18:20**
Chair: Fangzheng Xue Chongqing Univ.
CO-Chair: Zhen-wu Lei North China Univ. of Tech.

16:20-16:40 **TueD11-1**

A Combined Anti-Disturbance Strategy of DC-DC Converter

Yanqiu Shi Yangzhou Univ.
Jiawei Zhou Yangzhou Univ.
Shengquan Li Yangzhou Univ.
Southeast Univ.
Juan Li Yangzhou Univ.
Southeast Univ.
Jin Zhang Yangzhou Univ.
Xinquan Liu Jiangsu Surveying and Design Institute of Water Resources Co., Ltd

In this paper, a combined control strategy based on Model Predictive Control (MPC) and Extended State Observer (ESO) is proposed to solve the output fluctuation problem caused by the variation of load resistance and input voltage. The optimal control strategy means that Model Predictive Controller is used as the main controller. The Extended state observer is used to observe the disturbance from a variety of uncertainties caused by internal and external interference, and compensation this disturbance. Computer simulation results show that the proposed control method has good performance of tracking voltage, and the disturbance caused by modeling error and load variation can be suppressed.

16:40-17:00 **TueD11-2**

Design of Explicit Model Predictive Control for PMSM Drive Systems

Yuntao Shi North China Univ. of Tech.
Xiang Xiang North China Univ. of Tech.
Yuan Zhang North China Univ. of Tech.
Hengjie Zhu North China Univ. of Tech.
Dehui Sun North China Univ. of Tech.

The performance of current vector control for the permanent magnet synchronous motor (PMSM) is affected by factors such as cross-coupling, applying delay and parameter mismatch. In order to solve these problems, a current control strategy based on the model predictive control (MPC) algorithm is proposed. This strategy uses the prediction state of MPC to reduce the effect of output delay on decoupling. Combining the advantages of MPC with multivariable system and system constraints, it can deal well with the current and voltage limitations in actual systems, and ensure the current tracking performance. In view of the heavy computational burden features of on-line MPC and it is difficult to meet real-time performance in motion control area. In this paper, the Explicit Model Predictive Control (EMPC) is adopted. This method solves the optimization problem through off-line multi-parameter quadratic programming (mp-QP). During real-time operation, it only needs to look up the table according to the current state to obtain the control law with affine form in the current optimization region. The simulation results show that the method satisfies the system constraints and has good dynamic, static and anti-disturbance performance.

17:00-17:20 **TueD11-3**

Dynamic Modeling and High Accuracy Attitude Control of a Stewart Spacecraft

Yufei Xu Shanghai Inst. of Satellite Engineering
He Liao Shanghai Inst. of Satellite Engineering
Yanbin Zhao Shanghai Inst. of Satellite Engineering
Fei Xie Nanjing Normal Univ.
Jing Zhao Nanjing univ. of Posts and Telecommunications

A novel spacecraft using Stewart vibration isolation platform is discussed and applied to improve the performance of precision payloads in this paper. Firstly, the structural architecture of the Stewart spacecraft is implemented and the advantages are introduced. In this new architecture, the voice coil actuator which is structurally separated is adopted, and then the payload is free of all the vibrations transmitted from the vibration equipments. Secondly, the dynamic model of the Stewart spacecraft is established and the disturbance free characteristics are analyzed. Thirdly, the high accuracy attitude control strategy is designed based on sliding mode control algorithm. Finally, simulation results are illustrated to demonstrate the effectiveness of attitude control, and furthermore, to demonstrate the validity of the proposed Stewart spacecraft.

17:20-17:40 **TueD11-4**

Research on the Architecture and Application of Industrial Cloud Experimenta Platform Based on OpenStack

Zhen-wu Lei North China Univ. of Tech.
De-min Zhao North China Univ. of Tech.
Yun-tao Shi North China Univ. of Tech.
De-hui Sun North China Univ. of Tech.

Without breaking the original industrial automation system architecture, it is an important research topic to apply cloud computing to the current automation system in order to realize the function of industrial big data processing, optimizing control and intelligent decision making on the cloud platform. An industrial cloud experimental platform architecture based on OpenStack is proposed in this paper. The proposed architecture is experimentally verified with a double-tank system. Experimental results show that the industrial cloud experimental platform is convenient to deploy, and has a strong practical value.

17:40-18:00 **TueD11-5**

Simulation of PMSM Field-Oriented Control Based on SVPWM

Li Yu Changchun Univ. of Science and Tech.
Chunyang Wang Changchun Univ. of Science and Tech.
Hongwei Shi Changchun Univ. of Science and Tech.
Ruihao Xin Changchun Univ. of Science and Tech.
Lingxin Wang Changchun Univ. of Science and Tech.

Aiming at the nonlinear and multivariable complex systems of permanent magnet synchronous motor, a magnetic field oriented control strategy based on SVPWM permanent magnet synchronous motor is proposed. The space vector PWM has the character of wide linear range, little higher harmonic and easy digital realization. The FOC theory and SVPWM technique make the PMSM can achieve the performance as well as DC motor. The mathematical model of PMSM is analyzed and the system model of FOC vector control has been established. The control system has been also simulated by MATLAB/Simulink. The simulation results accord with the real motor's performance and provide the theory basis for the designing of real system.

18:00-18:20 **TueD11-6**

Feasibility of ballistic missile with all-directions launch

Cong-cong Han Xi'an Research inst. of Hi-tech
Hua-feng He Xi'an Research inst. of Hi-tech
Jia-qi Dai Xi'an Research inst. of Hi-tech

This paper firstly analyzes the current research status and existing problems of ballistic missile aiming and changing direction technology. Secondly, it discusses the basic principles of Missile Attitude Control System. The adaptive analysis of inertial measurement system, control force system and aerodynamics are carried out respectively, Eventually come to realize the feasibility of the ballistic missile with all-directions launch, and it has important theoretical and practical significance.

TueD12 **Room12**
Control applications (IV) **16:20-18:20**
Chair: Miao Yu Chongqing Univ.
CO-Chair: Zongli Li Jilin Univ.

16:20-16:40 **TueD12-1**

Spacecraft Attitude Tracking via Robust Disturbance Observer

Ruidong Yan Beihang Univ.
Zhong Wu Beihang Univ.

Previous work has shown that the disturbance observer based control (DOBC) can improve the performance of spacecraft attitude control system for its good disturbance rejection ability. The disturbance rejection ability of DOBC is mainly determined by the disturbance observer. However, the conventional nonlinear disturbance observer for the disturbance with bounded derivative has an estimation error, thus leading to performance degradation. To solve this problem for spacecraft attitude tracking, we propose a composite control scheme. A robust disturbance observer (RDO) is proposed for spacecraft attitude tracking first. RDO not only avoids the re-estimation of spacecraft attitude variables and makes full use of the information of spacecraft dynamics, but also reduces the effects of disturbance model uncertainty on the observer estimation accuracy and achieves finite-time convergence. Second, the composite control scheme is developed by combining RDO with a nonlinear backstepping controller. The disturbance rejection ability of the closed-loop system is improved significantly by compensation of the output of RDO. Finally, numerical simulations are conducted to verify the effectiveness of the proposed method.

16:40-17:00 **TueD12-2**

Design of Model Predictive Controller Based on Extended State Observer

Zongli Li Jilin Univ.
Fang Xu Jilin Univ.
Dinan Liang Jilin Univ.
Hong Chen Jilin Univ.

This paper proposes a linear model predictive control (LMPC) based on extend state observer (ESO) which can approximate the control performance of the nonlinear model predictive control (NMPC). The ESO is used to estimate the disturbance caused by the linearization of actual nonlinear system. The estimated disturbance is added into the system model of the LMPC controller design. The low speed control problem of the permanent magnet DC (PMDC) motor is studied. The simulation results show that this method can obtain satisfied control performance

and the ESO can estimate the uncertain disturbance accurately caused by the linearization if the parameters of ESO are chosen appropriately.

17:00-17:20 **TueD12-3**

An experimental study of vehicle suspension semi-active control with skyhook controller and magneto-rheological dampers

Youxiang Peng Chongqing Univ.
Miao Yu Chongqing Univ.
Xiumei Du Chongqing Univ.
Xiaoying Xu Chongqing Univ.
Jie Fu Chongqing Univ.

The semi-active control algorithm for the vehicle independent suspension which equipped with magnetorheological (MR) dampers is investigated in this paper. First, a quarter-vehicle suspension system model is established, and then a semi-active control algorithm based on skyhook damping control is designed. According to the demand of control algorithm, the MR dampers and corresponding sensors are installed on the test vehicle, and the road experiment is carried out with bump input. The experimental results show that the semi-active control algorithm can effectively improve the vehicle ride comfort.

17:20-17:40 **TueD12-4**

String stability of a group of nonholonomic mobile robots whose models incorporate kinematic and dynamic equations of motion

Amit Ailon Ben Gurion Univ. of the Negev
Afeka Akademic Coll. of Engineering
Shai Arogeti Ben Gurion Univ. of the Negev

The paper considers some control problems of multi mobile robot systems as both kinematics and dynamics are intertwined in the mathematical model of the group members. The effects of all components (wheels and platform) and kinematic constraints will be taken into account in the equations. The problems of driving the vehicle towards a desired string-like formation and the associated stability problem will be studied. Finally, demonstrations of a group of mobile robots with the augmented model will be presented.

17:40-18:00 **TueD12-5**

DC Voltage Control Strategy Based on Active Disturbance Rejection Control for Active Power Filter

Yunhong Zhou Xi'an Jiaotong Univ.
Aimin Zhang Xi'an Jiaotong Univ.
Hang Zhang Xi'an Jiaotong Univ.

As one of the most effective means to eliminate the harmonic interference on the grid side, the study and application about active filter has drawn more and more attention. It is necessary to ensure the active power filter DC capacitor voltage stability for the Active Power Filter efficiently and accurately operation while compensating the harmonics of the power grid. In this paper, a voltage control strategy based on Active Disturbance Rejection Control for the stabilization of the DC side capacitor voltage is proposed, and the design methods of the tracking differentiator, nonlinear feedback unit and extended state observer are given. This DC voltage control strategy improves the response speed, reduces the overshoot and improves the control precision of the DC capacitor voltage. MATLAB/Simulink is used for modeling, simulating and analyzing of the proposed control strategy. The simulation results prove the feasibility and stability of the strategy.

18:00-18:20 **TueD12-6**

Research on the Control Strategy of Three-Level Active Power Filter with Single H-Bridge

Jian Huan Jiangsu Univ. of Science and Tech.
Yan Tian Jiangsu Univ. of Science and Tech.

Aim to the harmonic compensation of three-level active power filter with single H-bridge structure, the control scheme of multi vector proportional resonant controller to suppress specific harmonic is proposed. The advantages of three-level converter topology with single H-bridge are analyzed. The mathematical model of active power filter is established based on αβ coordinate system, and current cross decoupling link is omitted. The current tracking characteristics of vector resonant controller is analyzed, and determine controller parameters. The closed-loop control system based on multi vector resonance controller is established, and the performance is analyzed. Both the simulation and experiment results showed that the three-level active power filter with the proposed control method has the advantages of good harmonic filtering effect, fast dynamic response and high tracking accuracy, which can provide reference for the experimental device.

TueD13 Room13
Data processing (II) (Chinese) 16:20-18:20

Chair: Wei Zhou Northeastern Univ.
CO-Chair: Dengyin Jiang Shanghai Jiao Tong Univ.

16:20-16:40 **TueD13-1**

A Self-trained Semi Supervised Fuzzy Clustering Based on Label Propagation with Variable Weights

Jiannan Zheng Fujian Electric Power Technical Coll.
Yuling Zhou Fujian Provincial Key Laboratory of Data Intensive Computing
Tian Deng Fujian Provincial Key Laboratory of Data Intensive Computing
Xiyang Yang Fujian Provincial Key Laboratory of Data Intensive Computing

Clustering accuracy of fuzzy clustering is sensitive to the structure of dataset to be studied. Semi-supervised clustering algorithms aim to increase the accuracy under the supervisions of a limited amount of labeled data, but the classification rate is highly dependent on the size of available labeled data. To overcome this disadvantage, we propose a novel semi-supervised clustering based on label propagation. Under our label propagation mechanism, an unlabeled datum propagates an estimated label from two aspects: (1) from its adjacent labeled data; (2) from a previous clustering result. The effects of these estimated labels are controlled by weights indicating their confidence levels. The effectiveness of the proposed model with label propagation scheme are evaluated by several real-life data sets. Experimental results show that accuracy level would increase by applying this learning scheme, compared to other semi-supervised models.

16:40-17:00 **TueD13-2**

Automatic Microaneurysm Detection of Diabetic Retinopathy in Fundus Images

Wei Zhou Northeastern Univ.
Chengdong Wu Northeastern Univ.
Dali Chen Northeastern Univ.
Zhenzhu Wang Northeastern Univ.
Yugen Yi Jiangxi Normal Univ.
Wenyou Du Northeastern Univ.

Diabetic retinopathy (DR) is a serious diabetic complication, and Microaneurysm (MA) is the earliest lesion in diabetic retinopathy, so early MA detection plays a critical role in diabetic retinopathy diagnosis. In this paper, we propose the Joint Dynamic Sparse Representation (JDSR) algorithm with multiple-channel multiple-feature dictionaries. Candidates for MA are first extracted as small image blocks; then we develop the multiple-channel multiple-feature dictionaries for candidate representation. Next, sparse coefficient can be obtained by the proposed JDSR algorithm which can be used for classification. Additionally, in order to form an optimal dictionary, the group sparsity dictionary selection method is also introduced. We evaluate our algorithm by comparing it with other state-of-the-art algorithms. Extensive experiment results on ROC database demonstrate the effectiveness of the proposed algorithm.

17:00-17:20 **TueD13-3**

A weighted fusion method based on robust error scale estimation

Zhang Xu Luoyang Electronic Equipment Test Center of China
Huang He Luoyang Electronic Equipment Test Center of China
Chen Qing-liang Luoyang Electronic Equipment Test Center of China
Hong Liu Luoyang Electronic Equipment Test Center of China
Jiangong Wang Luoyang Electronic Equipment Test Center of China
Jianxing Liang Luoyang Electronic Equipment Test Center of China
Xudong Huang Luoyang Electronic Equipment Test Center of China

In view of the interference of complex electromagnetic environment and the non-robustness of traditional method in the weighted fusion of multi-source electronic measurement data, with robust statistics theory as a guide, this paper proposed a robust filter method based on real-time median estimation, and applied the filter residual error scale to the dynamic fusion weights calculation under the optimal weight assignment principle, then obtained a new distributed robust weighted fusion method. The results of the test with typical measured data showed that the methods proposed were effective and robust in practical engineering application.

17:20-17:40 **TueD13-4**

A Khmer NER method based on conditional random fields fusing with Khmer Entity Characteristics Constraints

Yu Nuo Kunming Univ. of Science and Tech.
Xin Yan Kunming Univ. of Science and Tech.
Zhengtao Yu Kunming Univ. of Science and Tech.
Shuhui Huang Kunming Univ. of Science and Tech.
Jianyi Guo Kunming Univ. of Science and Tech.

In order to improve the performance of Khmer named entity recognition(NER), a NER method based on conditional random field (CRF) model fusing with Khmer entity characteristics constraints is proposed in this paper. First of all, we carried out analyses on the Khmer entity characteristics, summarized the constraint on these entity characteristics and introduced into the CRF; then solved the labeling sequence by integer linear programming integrated entity characteristic constraint and obtained a model of CRF integrated with constraints based on Khmer entity characteristics. Based on a contrastive experiment, CRF model of the constraint has a better performance than traditional CRF model when carrying out the Khmer NER.

17:40-18:00 **TueD13-5**

An Adaptive Image Dehazing Algorithm based on Dark Channel Prior

Chunlin Chen Univ. of Science and Tech. of China

Jiatong Li Univ. of Science and Tech. of China
Sibin Deng Univ. of Science and Tech. of China
Feng Li Univ. of Science and Tech. of China
Qiang Ling Univ. of Science and Tech. of China
Traditional dehazing algorithm based on dark channel prior may suffer weak robustness against the variation of hazy weather and may fail in bright regions. To resolve these issues, this paper proposes an improved adaptive dehazing algorithm based on dark channel prior. Our method can adaptively calculate dehazing parameter, such as the degree of haze removal. Here the dehazing parameters are local, rather than global variables. We compute the local dehazing parameter automatically according to haze distribution, which makes our method being able to handle different dehazing degrees under various weather conditions, and makes haze removal more robust. We also propose a new method to optimize the rough transmission paramters, which can help to remove the distortion in bright regions. Experiments confirm the advantages of our method, such as robustness against different scenes, high color fidelity of the restored images and greatly enhanced details of the hazy regions.

18:00-18:20 **TueD13-6**

Contaminant Monitoring for Industrial Emission-Diffusion Process based on Non-negative Tensor Factorization

Dengyin Jiang Shanghai Jiao Tong Univ.
Lisheng Hu Shanghai Jiao Tong Univ.
This paper considers the contaminant emission diffusion monitoring problem by applying the tensor approach for the industrial-environmental protection. The emission contaminant concentration is used from an embedded sensor for computation of features and monitoring of contaminant diffusion. A reduced feature subset, which is optimal in both estimation and clustering least squares errors, is then selected using a new dominant feature monitoring algorithm to reduce the signal processing and number of sensors required. The matrix based subspace method can't capture the spatiotemporal characteristics effectively. The tensor space method is proposed to be used to monitor the contaminant concentration in environmental protection area. In order to fit the multiple invariance of the measurement output tensor data processing for contaminant emission diffusion monitoring, the non-negative tensor factorization model is proposed to analyze the tensor data, which stems from uniqueness of low-rank decomposition of higher-order tensor. By using the non-negative tensor factorization, the estimated latent contaminant concentration data structure combing with the covariance-based algorithm are given to derive the metric of contaminant concentration in the environmental protection area. Contaminant concentration is then measured using non-negative tensor factorization with observable data based on the reduced features. A simulation example is provided to test the effectiveness and advantages of proposed method using tensor method with only the dominant features measurement.

TueD14 Room14
Robot control (II) (Chinese) 16:20-18:20

Chair: Xianbo Xiang Huazhong Univ. of Science and Tech.
CO-Chair: Qing Guo Beijing Univ. of Chemical Tech.

16:20-16:40 **TueD14-1**

Parameter Tuning of Linear Active Disturbance Rejection Controller Based on Chaotic Quantum Behaved Particle Swarm Optimization

Qing Guo Beijing Univ. of Chemical Tech.
Shijie Zhu Beijing Univ. of Chemical Tech.
Juan Chen Beijing Univ. of Chemical Tech.
Linear active disturbance rejection control (LADRC) can effectively control complicated systems due to its character of high accuracy and strong robustness. The performance of LADRC depends on appropriate parameters. An improved chaotic quantum behaved particle swarm optimization algorithm (CQPSO) is proposed for parameter tuning of the LADRC. The chaos sequence is introduced to improve the diversity of the quantum behaved particle swarm algorithm (QPSO) in order to avoid the iteration trapping into the local optimum. Then the improved CQPSO algorithm is used to tune the parameters of the LADRC that is used to rectify deviation of a differential drive automated guided vehicle (AGV). The simulation results show that the tuned LADRC can effectively overcome the influence of model uncertainty and achieve better performance.

16:40-17:00 **TueD14-2**

Study on The Convergence Speed of Iterative Learning Control Algorithm

Hongbin Wang Yanshan Univ.
Xiaoyan Cheng Yanshan Univ.
Jian Dong Yanshan Univ.
Ping Zhang Yanshan Univ.
Xiaoshuai Guo Yanshan Univ.
Yiming Hu Yanshan Univ.
In the field of iterative control, the convergence speed of iterative learning control algorithm is an important characteristic for judging whether this algorithm is applicable. Therefore, this paper propose several methods of justifying the convergence speed of iterative learning control algorithm to provide the basis for comparing speed of convergence of different iterative learning control algorithm.

17:00-17:20 **TueD14-3**

Design of Motion Control System for Robot Car Based on DSP

Min Xu Xiamen Univ. of Tech.
Huazhen Zhang Xiamen Univ. of Tech.
Hongji Tang Xiamen Univ. of Tech.
Based on research of the robot car's motion control system, TMS320f2811 chip which produced by Texas Instruments (TI) was used as the core chip of the control circuit. How to design the control circuit of robot car was illustrated in this paper from hardware part and software part. The design of motion control system for robot car based on DSP technology and integrated-separated PI control algorithm was putforward, which guarantee the control accuracy and improve the real time control. It is proved by practice that this scheme of design is effective for the robot car's motion control system.

17:20-17:40 **TueD14-4**

Adaptive Tracking Control of Underactuated Surface Vessels With Model Uncertainties

Shilu Dai South China Univ. of Tech.
Shude He South China Univ. of Tech.
This paper presents adaptive trajectory tracking control of underactuated surface vessels with uncertain hy- drodynamic damping dynamics. Thanks to the universal approximation capability, radial basis function (RBF) neural networks (NNs) are employed to approximate the unknown damping dynamics. A transverse function approach is applied to introduce an additional control input for tackling the difficulties of underactuated systems. A smooth adaptive tracking controller is proposed to guarantee semi-globally practical stabilization (i.e., semi-globally stability of a small neighborhood of the desired trajectory), where the desired trajectory is allowed to be feasible or non-feasible. The effectiveness of the proposed adaptive controller is demonstrated through simulation results.

17:40-18:00 **TueD14-5**

Path following control of mini autonomous underwater vehicle

Hui Liu Huazhong Univ. of Science and Tech.
Xianbo Xiang Huazhong Univ. of Science and Tech.
This paper proposes and experimentally validates a path following control system of a mini autonomous underwater vehicle. Firstly, a two-layer mode framework of the control system is presented, which includes the human-machine interaction unit and the onboard control unit. Secondly, a design pattern named model-view-controller (MVC) is adopted in the software, which decouples the various components to improve the operating performance. Since it needs to handle multiple tasks such as communication, map-drawing and data processing in parallel running, multithread technology also plays a key role in the system. Finally, the field experiment results show that the proposed control system successfully steers the mini AUV toward and along the desired path.

18:00-18:20 **TueD14-6**

Visual Landing System Of UAV Based On ADRC

Wei Bai Beijing Inst. of Tech.
Feng Pan Beijing Inst. of Tech.
Boyang Xing Beijing Inst. of Tech.
Chao Pan Beijing Inst. of Tech.
Mengxin Pei Beijing Inst. of Tech.
The fixed-point landing technology of multi-rotor aircraft is an indispensable step to realize fully autonomous flight.Most of the aircraft in the horizontal positioning relies on visual guidance, and PID control is generally used in height control, but it is difficult to resist the interference of the aircraft at low altitude spoiler.The Active Disturbance Rejection Controller(ADRC) designed in this paper can compensate the unknown disturbance independently of the exact model of the system, and effectively overcome the above problems.By detecting the target circle, the displacement vector from the center of the image to the center of the circle can be calculated, and then output the horizontal control amount to realize the horizontal alignment of the aircraft. Simultaneously, the landing height of the aircraft is controlled by using the auto-disturbance rejection controller. The experimental results show that the proposed algorithm can eliminate all kinds of spoiler disturbances at low altitude by feedforward compensation, and make the four - rotor aircraft landing in the target area quickly, steadily and accurately.

TueD15 Room15
Medical robots and bio-robotics (I) 16:20-18:20

Chair: Han Shang Nankai Univ.
CO-Chair: Wenjun Tan Northeastern Univ.

16:20-16:40 **TueD15-1**

Design of Tumor Therapy System Based on Irreversible Electroporation

Jianxun Zhang Nankai Univ.
Han Shang Nankai Univ.
Yu Dai Nankai Univ.
Irreversible electroporation (IRE) based on the high-voltage and steep pulses is a new technique developed in recent years to treat cancer. In this paper, the high-voltage and steep pulses tumor ablation system used the DSP and CPLD as the controller. The pulse output width, pulse frequency, pulse voltage and other parameters can be adjustable. The experimental results show that the system can be operated safely and stably. The output pulse waveform has reached the expected design goal of the system, which is in accordance with the theoretical requirement of

irreversible electroporation. At the same time, irreversible electroporation experiments in mice also achieved good results.

16:40-17:00 **TueD15-2**

Modeling and Motion Controller Design of Clamping Endoscopic Mechanical Arm

Yedan Li Nankai Univ.
Jianxun Zhang Nankai Univ.
Yu Dai Nankai Univ.
Sen Xie Nankai Univ.
Gang Cao Nankai Univ.

Minimally invasive surgery robot has been widely used in the medical field, which improves the quality of surgery. Combined with the robot system for clamping endoscopic mechanical arm developed by our team, studies have been focused on the motion control. Both the forward and inverse kinematics of clamping endoscopic mechanical arm is established by using the method of D-H parameters. And the mapping relation between angular velocity of a joint space and line speed of Cartesian coordinate system is obtained. It provides the foundation for the kinematics control algorithm. Taking the advantage of DSP in digital signal processing and the flexibility of CPLD in constructing logic functions, a hardware system is designed and implemented according to practical requirements in the surgery. Finally, the fixed learning rate of the SPIDNN control algorithm is improved to the variable learning rate that can be adjusted online, and the speed control and the position control of the clamping endoscopic mechanical arm is realized by using the improved SPIDNN control algorithm. Experiments show that the improved control method has better control quality than the traditional PI control method, and the controller meets the real-time and stability requirements of the motion control.

17:00-17:20 **TueD15-3**

Design of Modular Humanoid Rehabilitation Robot for Apoplectic Hemiplegia

Shuai Li Beijing Inst. of Tech.
Jian Li Beijing Inst. of Tech.
Siqi Li Beijing Inst. of Tech.
Guodong Li Beijing Inst. of Tech.
Yu Mu Beijing Inst. of Tech.

Stroke is mainly caused by the brain damage due to the acute cerebral vascular disease and its primary disease, which can make upper limb or lower limb on one side of the body movement-disorder. Early rehabilitation training is the most effective way to regain the Activities of Daily Living (ADL). Based on the concept of humanoid and modular design, this paper outlines the design process of humanoid robot. Conventionally, kinematics and dynamics are calculated in different coordinate frames, which makes simulation and control algorithms are more complex and not intuitive, for the forked-tree structure rehabilitation robot, a modified geometric description method of DH parameters is proposed to solve the problem of inconsistent frames, the whole body Jacobian matrix of this structure is derived and used for the inverse kinematics, and the singular configurations of redundant manipulator are analyzed. The important design criteria of humanoid robot is discussed, and the realization of the mechanical design is described. Finally, the experimental results show that the humanoid robot can effectively carry out multiple parts rehabilitation training.

17:20-17:40 **TueD15-4**

LQR Controller for Robotic Skull Drilling System

Meftah Mahmoud Mohamed Dalhousie Univ.
Jason Gu Dalhousie Univ.
Jun Luo Shanghai Univ.

This paper presents state of art in neurosurgical robotic manipulators. A modular design for an automatic skull drilling system is presented. The proposed model is simulated to test the performance of skull drilling device. Linear Quadratic Regulator is used for optimizing the performance of Skull drilling control system and proofs that the system has good disturbance rejection. The designed method is simulated and the system performance is improved.

17:40-18:00 **TueD15-5**

Design of a Lower Limb Rehabilitation Robot Based on 3-RPR Parallel Mechanism

Libo Zhou Beihang Univ.
Weihai Chen Beihang Univ.
Jianhua Wang Beihang Univ.
Jingmeng Liu Beihang Univ.

As the population ages, the need for rehabilitation robots is becoming greater and greater. Considering that lower limb motion plays an important role in the activities of daily life. This paper focus on developing a 3-degree of freedom bionic knee lower limb exoskeleton rehabilitation robot. The exoskeleton consists of a 1-DOF hip joint and 2-DOF knee joint in the sagittal plane. According to the theory of human gait and lower limb structure, a 3-RPR (Revolute pair – Prismatic pair – Revolute pair) parallel mechanism was designed to fully accommodate the motion of the human knee joint and obtain the trajectory of lower limb. The parameters of the mechanism was optimized based on maximizing the useful work space. In order to enable people of different height to use the exoskeleton robot, we designed a leadscrew nut mechanism to adjust the length of the exoskeleton steplessly. Compared with other traditional lower limb exoskeleton robots, this robot has the characteristics of compact structure and bionic knee joint. In order to verify the feasibility of this exoskeleton, a simulation based on MATLAB and ADAMS was performed.

18:00-18:20 **TueD15-6**

A Novel Registration Method of Brain PET Images and Talairach Atlas

Wenjun Tan Northeastern Univ.
Ying Kang Northeastern Univ.
Xiaohan Sun Northeastern Univ.
Chan Guo Northeastern Univ.

In recent years, the PET as an important clinical examination imaging technology of radionuclide imaging has become the indispensable tool of for cancer and neurological diseases diagnosis. For the defect of poor resolution and brain structural features are not clear on PET image, it is difficult to select the points accurately when brain PET image register for the brain atlas. The CT image has good spatial resolution and high density resolution. So a novel registration algorithm of PET and standard brain atlas is presented in this paper by transforming PET-CT-atlas multimodality image based on marking the feature points on the CT images. Firstly, the brain tissue, the minimum oriented bounding box and the mid-sagital plane are extracted from brain CT images. Secondly, the brain cortical landmarks is manually marked from CT images and transformed into PET images with mutual information matrix of PET-CT images. Finally, the automatic registration of PET-Talairach atlas is realized with the spatial affine transformation matrix, which is calculated by using the brain cortical landmarks of PET image and Talairach atlas. The experimental results show that the method of multi modality registration of PET-CT-T atlas greatly reduces the error of manual intervention, and is good accuracy and lower time complexity.

TueD16 Room16

Electric vehicles and intelligent transportation (III) (Chinese) **16:20-18:20**

Chair: Defeng He Zhejiang Univ. of Tech.
CO-Chair: Linhuan Song Jilin Univ.

16:20-16:40 **TueD16-1**

Evaluation of Passenger Travel Plan Based on Entropy and Gray Theory

Bowen Gao China Academy of Railway Sciences

In order to rank all the alternatives, basing on the systematic analysis of influencing factors of passenger travel plan selection, railway passenger travel plan evaluation system is established, using travel cost consumption, travel time consumption, travel convenience, travel fatigue and travel time satisfaction as evaluation index. In order to avoid the deviation of subjective factors, the weight of each index is determined by using the information entropy. The paper extracts optimal value of different indexes to set an ideal solution, apply the method of TOPSIS and grey relational analysis for proposed schemes and ideal solution to achieve the optimal scheduling of travel plans. Finally, the paper makes use of example of Lanzhou-Beijing travel planning to verify that, although some indexes in transfer train operation plan are better than those in the direct train operation plan, overall, the latter has greater advantage.

16:40-17:00 **TueD16-2**

Vehicle stability control and vehicle speed compensation based on adaptive terminal sliding mode method

Niaona Zhang Changchun Univ. of Tech.
Haolin Li Changchun Univ. of Tech.
Yanyang Li Changchun Univ. of Tech.

Hub motor driven pure electric vehicle's transmission structure is simple and the driving wheel torque is controlled independently of each other.When the vehicle turns, both sides of the hub motor around the main pin to produce differential torque, so it can be flexible control of vehicle steering. In this paper, the hub motor driven pure electric vehicle as a prototype, side-slip angle and angular velocity as a controlled variable to design a path tracking controller based on adaptive terminal sliding mode. The simulation results show that the controller can effectively improve the stability of vehicle turning, but at the same time, it is found that the method can make the vehicle have a deviation from the ideal value. In order to solve the problem , a linear sliding mode steering torque controller is designed to compensate the speed of the vehicle. The vehicle torque control strategy is built in Matlab/Simulink environment and real-time connection with veDYNA dynamics simulation software to build a vehicle torque control method simulation model. The simulation results show that based on the stability control and speed compensation system adaptive terminal sliding mode method can guarantee the stability of the vehicle, angular velocity and side-slip angle can reach the target value, and also has better performance in speed.

17:00-17:20 **TueD16-3**

Predictive Cruise Control of Vehicles with Pre-planned Acceleration/Deceleration Command

Defeng He Zhejiang Univ. of Tech.
Wentao He Zhejiang Univ. of Tech.
Xiulan Song Zhejiang Univ. of Tech.
Haifeng Guo Zhejiang Univ. of Tech.

This work considers the adaptive cruise control (ACC) problem of vehicles and we propose a new ACC algorithm for vehicle cruising systems based on the model predictive control (MPC) technique. In this

algorithm, the acceleration/deceleration command of vehicles is pre-planned within the predictive window that the incremental command action is decaying geometrically. Then the command in the predictive window will change along the same direction (i.e. increasing or reducing), which, from the control theory point of view, leads to a smoother command and response of the ACC vehicle. Moreover, the algorithm is to greatly decrease the online computational demand of ACC controllers by reducing the numbers of decision variables of the MPC optimization. In addition, safety is regarded as constraints and car-following requirements are synthesized into the performance criteria of MPC. Finally, several representative traffic scenarios are used to illustrate the effectiveness of the proposed ACC algorithm from comparisons of ride comfort, fuel consumption and safely car-following.

17:20-17:40 **TueD16-4**

An Extended FVD Model Considering Road Radians and Gradients

Dihua Sun Chongqing Univ.
Xuanjin Wang Chongqing Univ.
Min Zhao Chongqing Univ.
Huamin Li Chongqing Univ.
Senlin Cheng Chongqing Univ.

The microscopic car following model can depict the interaction between adjacent vehicles, but the existing studies rarely consider the effect of complex road conditions on the model. Based on the FVD model, an extended car following model with the consideration of the road radians and gradients is proposed in this paper. The linear stability condition is obtained by applying the linear stability theory. Experiments in different scenarios are carried out by VISSIM to evaluate the model performance. Results show that the extended FVD model can accurately reflect the driving behavior under real road conditions.

17:40-18:00 **TueD16-5**

Model Predictive Control Oriented Shared Steering Control for Intelligent Vehicles

Linhuan Song Jilin Univ.
Hongyan Guo Jilin Univ.
Fei Wang Jilin Univ.
Jun Liu Jilin Univ.
Hong Chen Jilin Univ.

It presents a constrained model predictive control (MPC) scheme to discuss the shared steering control with a driver. It considers the shared control from the following two aspects that are the safety of vehicle and the driving intention of human. For the safety, obstacle avoidance is very important and it is taken as constraints. Furthermore, the vehicle's shape is considered. About the driving intention of human, the vehicle follow the driver's steering command as an objective in the scheme. Finally, simulations are carried out to validate the effectiveness of the constrained MPC approach.

18:00-18:20 **TueD16-6**

LiFePO4 Battery Modeling and SOC Estimation Algorithm

Anna Wang Northeastern Univ.
Xin Jin Neusoft Reach Automotive Tech. Co, Ltd
Yapei Li Northeastern Univ.
Nana Li Northeastern Univ.

Lithium iron phosphate (LiFePO4) battery is widely used in electric vehicle power supply. For the estimation of lithium iron phosphate battery model and the remaining power, a new third-order RC circuit model has been designed, and the state of charge (SOC) estimation based on sampling point Kalman joint algorithm is used to estimate the remaining capacity of the proposed battery model. This algorithm not only uses improved time integration method to estimate real-time battery power, but also uses the sampling point Kalman algorithm to correct the SOC estimation error when the error accumulation of improved integration method is too large. The new third-order RC circuit model is better than the second-order RC circuit model in characterizing the battery, and the error value of the improved sampling point SOC estimation algorithm is controlled within 2%.

TueD17 **Room17**
Traffic control (I) **16:20-18:20**

Chair: Zhiwu Huang Central South Univ.
CO-Chair: Lianchun Wang National Univ. of Defense Tech.

16:20-16:40 **TueD17-1**

Suspension System Status Detection of Maglev Train Based on Machine Learning Using Levitation Sensors

Lianchun Wang National Univ. of Defense Tech.
Peichang Yu National Univ. of Defense Tech.
Jinhui Li Science and Tech. on Near-Surface Detection Laboratory
Danfeng Zhou National Univ. of Defense Tech.
Jie Li National Univ. of Defense Tech.

The objective of this paper is to design a new method, based on machine learning, to detect the abnormal status of the suspension system of maglev train by using the real-time signals collected by the levitation sensors. The abnormal status is harmful to the operation of maglev train. It is necessary to detect the abnormity timely. Generally, the operation data of train is recorded online, but it is analyzed by experts off-line, the efficiency of this approach is very low. So, an efficient and accurate method is urgently demanded. There are 120 levitation sensors in a carriage, which measure the levitation states with nearly 40khz sampling frequency. In tradition, the information of sensors is just used as the feedback of suspension controllers. This paper will study how to use these information for detecting the abnormal status of suspension system by using support vertical machine (SVM). Firstly, some reasonable features originate from experience are extracted from levitation sensors. Secondly, considering that the fault rate is very low, resulting in less fault samples. So, the SVM method is introduced. At last, the raised machine learning model is applied in the practical usage on maglev train by using the programming in the Digital signal processor (DSP) controller. By this method, the existing abnormal status of suspension system can be diagnosed in real-time. The experiment results show that this algorithm can achieve the detection accuracy of 91.3%.

16:40-17:00 **TueD17-2**

DSRC Based Vehicular Platoon Control Considering the Realistic V2V/V2I Communications

Yongfu Li Chongqing Univ. of Posts and Telecommunications
Wenbo Chen Chongqing Univ. of Posts and Telecommunications
Kaibi Zhang Chongqing Univ. of Posts and Telecommunications
Taixiong Zheng Chongqing Univ. of Posts and Telecommunications
Huizong Feng Chongqing Univ. of Posts and Telecommunications

This study proposes a dedicated short range communications (DSRC) based vehicular platoon control considering the realistic vehicle-to-vehicle/vehicle-to-infrastructure (V2V/V2I) communications. In particular, the information on vehicles of interest, i.e., speed and position, is shared with the neighboring vehicles or roadside units (RSUs) through the on-board units (OBUs) via the DSRC. Then, the leader-follower approach is used to manage the vehicular platoon. The leader of platoon can receive/send the relevant information from/to the followers so as to guarantee the stable platoon formation. Field experiments are performed in two scenarios: platoon forming and merging. Results from the experiments validate the effectiveness of the proposed method in terms of the speed and position trajectories.

17:00-17:20 **TueD17-3**

Distributed Control for High-Speed Trains Movements

Yan Zhao Beijing Jiaotong Univ.
Tianzhi Wang Beijing Jiaotong Univ.

In this study, the distributed cruise control problem of high-speed trains' movements is investigated. Firstly, the problem of a single train with multiple cars is interested, and the aim is focused on the design of a distributed controller, with which the train achieves the safe moving, i.e., all the cars track a desired speed and any neighbouring cars keep a safe distance from each other. By considering, among the cars, the physical coupling structure between each neighbouring cars constitutes a physical connected interaction graph, and by posing the speed information exchange mode that the communication topological graph has a directed spanning tree, a new approach based on the complete consensus technique is proposed to solve the problem. Compared to the existing centralized control scheme or the decentralized control scheme, where the control design of each car need the measurement information (i.e. the displacement and the speed information) of all the cars, the designed distributed control laws have the merit that the control design of each car only uses the measurements of itself and its neighbouring cars; besides, the problems are solved in terms of the purely graphic topological conditions, which are easy to be verified. Then, simulations are provided to illustrate the effectiveness of the obtained theoretical results.

17:20-17:40 **TueD17-4**

Priority model of BRT signal based on ABM

Ying Guo Zaozhuang Univ.
Yong Han Zaozhuang Univ.

This paper describes a traffic system, the model simulation is intended to explore the influence caused by BRT with autonomous control of traffic lights on the traffic of urban main roads.

17:40-18:00 **TueD17-5**

Self-Organization Traffic Flow Methods Based on Traffic Intelligent Control Systems

Duofu Ye Research Inst. of Hi-Tech
Xin Liu Research Inst. of Hi-Tech
Gang Liu Research Inst. of Hi-Tech
Bing He Research Inst. of Hi-Tech
Haoshen Lin Research Inst. of Hi-Tech

This Intelligent Transportation Systems(ITS), an instance of a new transport model, will hopefully improve the present traffic conditions, which has been emphasized by many states, including China. In this paper, we study the rapid transit strategy of the intelligent control system and the optimal planning problem under three different conditions. The macroscopic optimization method of road traffic network is designed under the intelligent control system. In the case of road traffic speed limit, the simulation of comfort index (LOS), traffic volume and safety index is carried out. The results show that compared with the traditional traffic control, the characteristics of intelligent traffic control can overcome the

negative factors such as delay response time, asymmetry of human body and visual restriction. In addition, the intelligent network can perform the best general guidance.

18:00-18:20 **TueD17-6**

A Novel Estimator for Adhesion Force of Railway Vehicles Braking Systems and Reference Speed Calculation

Jianfeng Liu Central South Univ.
Qing Peng Central South Univ.
Zhiwu Huang Central South Univ.
Heng Li Central South Univ.
Dongyang Wang Central South Univ.
Yuanjun Chen Central South Univ.
LinzhouFu Central South Univ.

In this paper, sliding mode control is designed as the controller for railway vehicle braking systems and a novel estimator is introduced to estimate the immeasurable adhesion force torque, which is based on the locomotive wheel model and a proportional integral control. Then value of adhesion force can be achieved by a simple division transformation of the estimated adhesion force torque. The value of adhesion force calculated from the estimation of adhesion force torque has three benefits. Due to the accuracy of estimated adhesion force, it can be used to calculate the reference speed and used as a necessary parameter of controller. What's more, it can be used as an input of the algorithm for calculating the optimal slip rate, which lays the foundation for future research. The simulation verifies the performance of the proposed estimator.

TueDIS **Room18**
Interactive Session **16:20-18:20**

TueDIS-01

The design and implementation of a computer game algorithm of Dou Dizhu

Renzhi Wu Beijing Information Sci. and Tech. Univ.
Shuai Liu Beijing Information Sci. and Tech. Univ.
Shuqin Li Beijing Information Sci. and Tech. Univ.
Meng Ding Beijing Information Sci. and Tech. Univ.

AlphaGo come into view, artificial intelligence for board games once again becomes the focus of the world, while the research for card games isn't deep enough. At present, the study of computer game algorithm of board games is more than in card games. One reason for this is the algorithms of card games are more difficult to implement than board games due to the imperfect information nature of the card games. We present a method that based on rules. We carry on research on card splitting, bidding, playing and following of Dou Dizhu. Experimental results show higher ratio of winning of our method than the method with simple strategies.

TueDIS-02

The Method for Glass Bottle Defects Detecting Based on machine vision

Li Fu College of Automation of Shenyang Aerospace Univ.
Zhou Hang College of Automation of Shenyang Aerospace Univ.
Yu Gong Shenyang Aircraft Design Inst.
Wei Guan College of Automation of Shenyang Aerospace Univ.
Xinyu Chen College of Automation of Shenyang Aerospace Univ.

With the increasing production of glass bottles, the detection efficiency and accuracy of glass bottles become more and more important. In order to improve the quality of the glass bottles and the detection efficiency, a method to detect glass bottles based on the connectivity domain feature was presented in this paper. This method extracts the defect features by pre-processing the collected image and threshold segmenting the image of the bottle. The method of analyzing the aperture area and width of the connected area of the bottle mouth is used to detect the image of the bottle mouth. The matching of the connected domain pixels is used to judge whether the bottle mouth is qualified and detect the defect location, and use the range of the detected defects to be compared with the range of the manually calibrated defects. The experimental results of bottle detection show that this method can accurately determine whether the bottle mouth is defective and detect the defect range of the bottle. The detection rate has reached a high level with good detection accuracy.

TueDIS-03

Design and Implementation of Mixed Strategy System of Phantom Go

Tianyu Liu Shenyang Aerospace Univ.
Fei Li Shenyang Aerospace Univ.
Yuhan Liang Shenyang Aerospace Univ.

Phantom Go is an incomplete information computer game. Pure strategy is often employed in Phantom GO, such as Monte Carlo. However, pure strategy cannot cope with different types of opponents. This paper presents a mixed strategy for Phantom Go, which can access information effectively. The experiments show that the mixed strategy system can improve the performance of the system.

TueDIS-04

Design and implementation of an Adaboost-based Landlord bidding strategy

Shuqin Li Computer School,BISTU
Sensing and Computational Intelligence Joint Lab
Meng Ding Computer School,BISTU
Lukang Peng Computer School,BISTU
Shuai Liu Computer School,BISTU

Landlords is a Chinese card game for all ages, each game requires at least three players. An artificial intelligence service is growing rapidly to replace mankind to ensure that there are enough players online to play with people 24 hours a day. Since bidding is a vital part of this game, in this paper, we developed a bidding strategy by studying the real online gaming data from human's playing based on the Adaboost algorithm. We choose 12 kinds of card combinations as weak classifiers, and train them with Adaboost algorithm to get the final strong classifier. The strong classifier can make an evaluation for a given hand, which can be used for making decisions whether bid or not. Tested by different eigenvalue and card combinations data, we get an accuracy of 75% at most, basically reached the design requirements.

TueDIS-05

Research on Linear Evaluation Function Based on LMS Algorithm

Haoran Zhang Beijing Information Sci. & Tech. Univ.
Shuqin Li Beijing Information Sci. & Tech. Univ.
Sensory and Computational Intelligence Laboratory
Meng Ding Beijing Information Sci. & Tech. Univ.

Evaluation function is one of the core components of the computer game system. The traditional way to build evaluation function is usually to use a number of features on the board extracted by human, according to experience and game rules, which gives a set of parameters, and design a static linear evaluation function to calculate the evaluation value of current situation. This paper proposes a method to dynamically adjust and optimize the parameters in the evaluation function by least mean squares, and implements a dynamic evaluation function. Experiments based on Surakarta chess show that the method of dynamic evaluation is effective.

TueDIS-06

Research and Implementation of Einstein würfelt nicht! Algorithm

Dayi Wang Shenyang Aerospace Univ.
Xiaoyan Wang Shenyang Aerospace Univ.
Yajie Wang Shenyang Aerospace Univ.
Junting Li Shenyang Aerospace Univ.

Based on the characteristics of Einstein würfelt nicht!, this paper puts forward the Monte Carlo algorithm applied to Einstein würfelt nicht!(EWN), and on its basis, it realizes the UCT algorithm.In order to analyze the advantages and disadvantages of the algorithm, we have done a lot of experiments. The experimental results show that the UCT algorithm based on Monte Carlo tree search can improve the ability of EWN to make decision and increase the skill of game.

TueDIS-07

Spectral Emissivity Estimation Based on K - means Clustering RBF Neural Network

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A K-means clustering RBF neural network modeling method is introduced in this paper, this model is for infrared target spectral emissivity estimation. Part of the transmission of infrared radiation in the atmosphere is absorbed by the atmosphere, the use of RBF neural network measurement samples for analysis and learning. An infrared energy model of 3-14 μ m was established to estimate the spectral emissivity of the target at different wavelengths. The experiment results show that the maximum relative error is less than 1% compared with the theoretical emissivity calculated by the RBF network. Finally, that method is a good way to learn the spectral emissivity and it is verified by the aerospace aluminum alloy.

TueDIS-08

A Study on Human－Machine Interaction Computer Games Robot

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Cheng Qian Shenyang Aerospace Univ.
Junbo Lv Shenyang Aerospace Univ.
Yuhang Cui Shenyang Aerospace Univ.

This paper puts forward a Human–Machine Interaction robot which can play chess games with human. Based on the existing Computer Games and Robot technology, the robot can accomplish more functions. The robot can recognize the human players' wrong, and send a signal to remind human players. Windows environment could run Artificial Intelligence software base on C language and LabVIEW. And the software can have an information exchange simultaneously. Based on STM32, it will distinguish the chess board by Image Recognition. And it will transfer the information to the computer at the same time. Mechanical structure completes the functions of taking a piece, putting a piece, settling on the board, which controlled by the Arduino.

TueDIS-09

Research on Robot Based on Computer Games

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Yajie Wang Shenyang Aerospace Univ.
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Game robot is a challenge in the field of artificial intelligence. First of all, the current status of robot and computer game were described. After the techniques of computer games and the characteristics of intelligent robots were analyzed, a concept of intelligent robot was proposed, which can be used in computer games. Then the design and implementation methods were given. In the end, the importance of the kind of intelligent robots was discussed and several application prospects were provided in the future.

TueDIS-10

Study of Strategy Selection Based on Hex

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Hex is going to be more and more popular because of its simple rules. The simple rules also bring enormous situation of Hex. It is hard for computer to assume the best situation after several rounds even simply use Alpha-beta pruning in a few minutes. In this page, we analysis the Hex and compare MTD(f) with using Alpha-beta pruning only. Our conclusion is that MTD(f) can make it much more effective. We also summarize a useful strategy—TCL (Two Choice Link). Using this strategy based on the topology, we can make a link to win succinctly and flexibly.

TueDIS-11

Design and Implementation of Bridge Card Game Platform

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A platform of online bridge card game is designed for computer games in this paper. To implement a real-time platform for sharing information, we use TCP/IP network transport protocol to realize it, and data for transmission is very few. MFC development framework is used for programming. By using the platform, it is easy to develop other game platform and AI programs in a short time. So the research of game platform has some reference significance to the development of the computer games.

TueDIS-12

Research on Parallel Optimization of UCT Algorithm for NoGo Computer Game

Ziyang Zhang Shenyang Aerospace Univ.
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The theoretical system and evaluation methods of NoGo is not mature for it is been proposed in recent years. Recently UCT Algorithm has become a popular approach for NoGo game. But UCT Algorithm based on Monte-Carlo Tree Search only runs on a single thread, which does not make full use of multi-core CPU performance. In this paper, a multi-thread parallel optimization method of UCT algorithm is put forward. The experimental results show that the parallel optimized UCT algorithm enhances researching efficiency for NoGo, and makes the decisions of the best move for NoGo faster and more accurate. Meanwhile, it also increases the skill of NoGo game.

TueDIS-13

Research and Implementation of Static Evaluation Algorithm for Checkers

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Computer Game is one of the important and challenging research directions in the field of Artificial Intelligence (AI). This paper introduces the composition of the computer game system and the rules of Checkers (100) that is a complex two-player chess game. The characteristics of the evaluation of the Checkers are described in this paper. Four main features and value matrix of the pieces are also mainly elaborated. According to the importance of the different positions of the Checkers, an evaluation function with value matrix of the pieces was proposed. The experimental results show that the proposed evaluation function is feasible and effective.

TueDIS-14

Research on the Surakarta chess game program based on Unity 3D

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Surakarta chess is researched with the computer game technology, which is a kind of computer chess game in the complete information game. In order to increasing the human-computer interaction of the computer games system, the representing method of chessboard with 3D form is studied by use of unity 3D game engine technology. The Surakarta game system is designed using VC++ language. In this system, the Monte Carlo Tree Search(MCTS) algorithm and Minimax Algorithm are used together. This system has improve the visual effect, and combining two searching algorithm is feasibility

TueDIS-15

Research on the Advantages and Equilibrium of Computer Game with Incomplete Information

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Xin Qi Harbin Univ. of Sci. and Tech.
Liyuan Hou Harbin Univ. of Sci. and Tech.
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The research on computer game with complete information theory has been mature. The computer has established a more obvious advantage in the competition with human in game projects such as Chess and Go. Computer game with incomplete information mainly refers to the name of the other party or the position of the pieces is not clear, or the number of points in the other hand is unknown, which makes the computer more difficult to make the right decision. The research has just started. Many areas are still in the exploratory stage. This paper describes the development of computer game technology with complete information. It compares the main differences and difficulties between the computer game with incomplete information and the computer game with complete information. It mainly gives the main factors which influence the advantages of the game of Phantom Go, Military Chess and Dou Dizhu. It gives the basic method of adding advantages from information nonlinear functions and the modified adaptive backstepping method is applied to constructing the controller. The proposed controller can realize the quick tracking of the reference signal when system parameters are uncertain with external disturbances. System stability and convergence is demonstrated by Lyapunov method. The efficiency and robustness of this control method is demonstrated by the numerical simulation.

TueDIS-16

A Method of Fault Detection on Diesel Engine Based on EMD-Fractal Dimension and Fuzzy C-Mean Clustering Algorithm

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For the non-stationary characteristics of vibration signal and fuzzy characteristics of feature parameter, a method based on EMD-fractal dimension and FCM is proposed for feature extraction and pattern recognition of diesel engine mechanical fault .Firstly decompose vibration signal by EMD, choose IMFs can reflect fault characteristic information better according to the correlation factor, and compute fractal dimension of the selected IMFs as feature vector, which is used as input of FCM after standardization. The optimized classified matrix and clustering centers are obtained. By calculating the nearness degree between the unknown-fault samples and the known-fault ones, the fault pattern is identified at last. The experimental results express that this method can diagnose faults of the crank-shaft bearing of diesel effectively.

TueDIS-17

Fault Diagnosis of Diesel Engine Based on Genetic Algorithms and Dempster-Shafer Fusion Theory

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The multiple evidence from different information sources of different importance are not equally important when they are combined in fault diagnosis of diesel engine. To calculate and adjust weighting coefficient of multiple evidence, the method of weighted evidence balance based on genetic algorithms is used. First it searches for the optimal weighting coefficients of different evidence using genetic algorithms, then balances the considered evidences according to the weighted average of all and the preferred evidence, and finally combine them. Thus it is guarantied that the balanced evidences won't change the weighted average of all and the preferred evidence. The experimental results demonstrate the excellent performance of the weighted evidence balance method to fault diagnosis of diesel engine as it enhance the confidence of correct judgment and advance the accuracy as compared with basic evidence theory method.

TueDIS-18

Target-Focused Video Stabilization for Human Computer Interaction

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As an important task of video enhancement, a lot of video stabilization methods have been proposed. However in many real-world applications, especially the systems with human-computer interactions, existing methods only remove camera motion in stabilized frames, the remaining object motion will also lead to deviations in manual inputs. In this paper, we collect practical hand drawn bounding boxes which have been shown to contain serious errors. Then we propose a target-focused video stabilization method consisting of a proposal-based detection component and a trackingbased motion estimation component. The experiments demonstrate our method can remove camera jitter and target motion simultaneously, and also offer users a friendly and effective way to draw accurate target regions.

TueDIS-19

Numerical Study of Secondary Cooling Technology in Continuous Casting

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The quality of wide heavy plate is depended on the secondary cooling technology, which has a serious impact on the operation of the continuous casting process. Based on the realistic roller-layout and secondary cooling water design principle, a secondary cooling technology schedule of the alloyed medium carbon steel has been designed. And combining with the heat transfer and solidification numerical model, the simulation results show that the slab surface temperature obtained by designed cooling technology is closed to the target temperature, which verifies the feasibility of the secondary cooling water distribution scheme.

TueDIS-20

A Novel Suspended Method Based on Flux Density Feedback for AMB System without Position Sensors

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A novel suspended method based on flux density feedback for AMB system without position sensors is presented in this paper. Ultra-thin Hall sensor is a part of the flux density feedback control with the function of detecting the flux density. According to the model of AMB rotor, position control-loop is realized with rotor position resolved from magnetic flux density and winding current. Flux density feedback control eliminates the model error caused by the inconsistencies between sensor target and AMB. With the novel approach, position sensors and detection target are not required; besides, size and weight of AMB system are reduced. It is of great benefit to miniaturization and integration for the space AMB system.

TueDIS-21

Intersection Signal Timing Estimation Using Bus GPS Data

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Signal timing information (such as cycle length, red time, etc.) is important to bus scheduling and travel time estimation, etc. So it is of great significance to estimate the signal timing information. The existing signal timing estimation method cannot timely respond to the changes of the signal timing parameters, and it cannot well estimate the time that the vehicle arrives at the stop line. Furthermore, it assumes a uniform arrival pattern of the intersection. In order to solve the above problems, a new signal timing estimation method using bus GPS data is proposed. In order to estimate the signal timing parameters, an improved interpolation method is proposed to estimate intersection travel time of individual vehicles, and a new method of cycle breaking is proposed. Then, a method for estimating cycle boundary and cycle length using the GPS data sequence near the stop line is given. Combined with the cycle boundary estimation results, a new method for estimating red time is proposed. The simulation and field test results show that the proposed signal timing estimation method is valid and the estimation effect is obviously better than the effect of the existing method.

TueDIS-22

A Non-Contact Dynamic Angular Displacement Detecting Method for Detecting The Sheet Metal Structure of Household Appliance

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Xiang Cheng Foshan Univ.
Zhiting Liu Foshan Univ.

Aiming at the problem of vibration detection in the factory production line, a dynamic angular displacement detection method based on laser displacement sensor is proposed. This article takes the air conditioner as an example. The dynamic angular displacement detection method is used to detect the dynamic angular displacement of a certain point of the air conditioning external unit. The results show that the test point in the region of the axial fan speed abnormal air conditioning external unit is more violent twist, In the case of axial fan blades installed incorrectly, the twist of the air conditioner is relatively gentle. The dynamic angular displacement test method can effectively detect the fault phenomenon.

TueDIS-23

CodeCube: A Multi-Layer Color Barcode for Mobile Social Applications

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With the rapid proliferation of camera-equipped smart device, two dimensional barcode obtains the widespread application in daily life. Embeding URL information to a barcode becomes popular and convenient. There is increased interest in the use of color barcode to encode more information than regular black-and-white barcode. This paper presents CodeCube-a multi layer color barcode for mobile society applications. CodeCube is specially used for three independent data to transmit together. We adopt eight colors to realize three layer information capacity barcode by exploiting the digital color image red (R), green (G), and blue (B) channels. CodeCube adapts the barcode version size to deal with the problem cause by different length of the three independent data. To eliminate color blur caused by different color module border, we propose a blur aware border methodology. We implement the sender and receiver application on Android platform, which realised the proposed barcode's encoding and decoding process. Our approach is evaluated through extensive experiment on Android samrtphones. Experimental results show that the proposed CodeCube can be an effective and practical mobile society application.

TueDIS-24

Research on the Algorithm of the Front Vehicle Speed Based on Vehicle Video

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Vehicle speeding is a lead to one of the major causes of highway traffic accidents, the range of traditional fixed camera video velocity measurement system is very limited. In this paper, the front vehicle's driving state is obtained by using the vehicle mounted binocular CCD camera, and a method for measuring the speed of the front vehicle is proposed. The proposed method using the improved Hough transform to identify the lane lines and extract the region of interest. Complete the vehicle detection based the characteristic of vehicle shadow, and the distance between the speed measuring vehicle and the front vehicle is obtained by using the three-dimensional reconstruction distance measurement algorithm. The relative displacement of the vehicle and the corresponding time interval are obtained by selecting the appropriate image frame in the vehicle video image, and the driving speed of the front vehicle can be calculated. The above algorithm is tested, and it can get the high accuracy of the speed measurement results.

TueDIS-25

Research on Sensor Modeling Methods in ECT

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Hua Yan Shenyang Univ. of Tech.
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The sensor modeling problem of electrical capacitance tomography (ECT) is to establish the functional relationship between normalized capacitance values and normalized permittivity distributions. Three different sensor modeling methods are presented in this paper, that is, the sensitivity definition (SD) method, the electric field strength (EFS) method and the multiple linear regression (MLR) method. Using eight representative permittivity distributions, the modeling errors, reconstruction quality and antinoise capability corresponding to these three modeling methods are investigated. Research results show that usually the MLR method corresponds to the minimum modeling error and reconstruction error, while the SD method corresponds to the maximum errors. These three methods are similar in the antinoise ability. Taking into account the implementation difficulty, the EFS method is significantly superior to the other two methods. Therefore, the EFS or MLR method rather than SD method is recommended.

TueDIS-26

The Method of Testing and Analysis Stress Damage of Oil-gas Pipeline Based on Hysteresis

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Stress concentration is a serious threat to the safety of pipeline. It is great significant to security management of oil-gas pipeline that the stress concentration can be tested and evaluated. The relation model between stress and coercive force is established based on hysteresis of ferromagnetic material. Through tensile test, stress damage critical state parameters are obtained, the parameter ranges corresponding with different stress damage state are obtained. Stress damage state is

analyzed and evaluated based on these parameters. The results show that the relation between stress and coercive force is linear. The critical parameters of deformation state are corresponded with stress damage critical state parameters. Under three stress damage states: safety, control and danger, the critical coercive force parameter ranges of X80 steel are obtained though experiment. The correctness and the effectiveness of analysis method for stress damage are validated through application on pipeline.

TueDIS-27

Features Extraction of Butt Joint for Tailored Blank Laser Welding Based on Three-line Stripe Laser Vision Sensor

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In this paper, a measurement method for features extraction of butt joint for tailored blank laser welding based on three-line stripe laser vision sensor is proposed. The measurement system is composed of a laser stripe vision sensor and a control module. A three-line stripe laser, a CMOS camera and a LED lighting unit are used to constitute the laser stripe vision sensor. Laser lines and narrow weld joint are both recorded in the image by vision sensor. And then the image is sent to the control module for evaluating in order to obtain high quality raw images. Additionally, the image processing algorithms for extracting the features of weld joint are discussed depending on the characteristics of laser beam welding of tailored blanks and the algorithm is as follows: firstly, the original image is filtered by Laws texture energy filter; secondly, the edge of joint is extracted by Canny operator; thirdly, the laser stripe is segmented by threshold; lastly, textural feature and laser stripe information are fused for extracting feature points of butt joint. Experiments are well conducted to verify the effectiveness of the proposed method.

TueDIS-28

Gesture Detected by Inertial Sensor

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In the wearable technology, inertial sensor has great significance in tracking the object movements. The paper focused on detecting the movement of users fingers based on the inertial sensor to give the control signal. Firstly, the attitude matrix, which represented the transformation relation of carrier coordinate system and the navigation coordinate system, was obtained. Secondly, the attitude matrix was expressed based on the quaternions. Thirdly, the angle of the finger gesture was processed by the attitude matrix to get the attitude angle. The experimental results showed the detection of the finger movement is effective.

TueDIS-29

Research on the Application of 3D Spectrogram in Bird Tweet and Speech Signals

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Dan Yang Northeastern Univ.
Ye Zhou Northeastern Univ.

A new visualization method of researching bird tweet and speech signals is presented in this paper, this means that we use 3D spectrogram to display and analyze bird tweet and speech signals. In this paper, the hawk sound and swallow sound signals are taken as the research object of birdsong signals application, and Chinese and English are used as the research object of application of human speech signals. Compared with the 2D spectrogram of the bird tweet or speech signals, the 3D spectrogram not only improves readability, but also preserves all energy information, and it is clearer and more accurate in the energy change curve which represents bird tweet and speech signals energy change from high to low.

TueDIS-30

Study on surface crack detection of low voltage current transformer

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Objective for low-voltage current transformer surface crack detection, traditional methods cannot effectively distinguish cracks and scratches problem, crack detection method is proposed based on geometrical features and Moment Invariant. Method Extraction algorithm by osmosis from the gray image of the target area, according to the crack and scratches different texture features, the use of geometric features and invariant moments, determine the characteristic parameters threshold, and finally using clustering algorithm to determine the threshold determination cracks and scratches to be judged. Results After tests proved that the method can effectively distinguish cracks and scratches, and to solve the noise problem on low-voltage current transformer crack detection. Conclusion Compared with the traditional object of cracks and scratches detection methods, the method proposed in this paper has the mathematical property of invariant to rotation, translation and size of image, and it is also used to detect the crack image in the moving state.

TueDIS-31

A Hysteresis Comparator for Level-Crossing ADC

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Sensors are used to collect the natural signals, including rarely change signals. Level-crossing ADC (LC-ADC) employs the idea of irregular sampling, which is adapted to convert the sparse signals. The comparator is an important block of the converter and hysteresis is useful for removing erroneous sampling due to noise. Two hysteresis comparators are presented, one is used in the detection of the signal down and the other is used in the detection of the signal up. The comparators have been implemented in 0.18μm CMOS technology, the area is 940.7μm2 and 864.5μm2 respectively, and the propagation delay for the low-to-high transition is 9.5ns and the propagation delay for the high-to-low transition is 10.5ns with the common mode input voltage is 800mV.

TueDIS-32

Corner Point Set-based Camera Monitoring Range Deviation Detection Method in Video Surveillance System of Highway

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Camera monitoring range deviation detection is the prerequisite and foundation for monitoring video content analysis. Due to the interference of moving object, light and noise in the scene of highway, the existing detection methods have some problems in aspect of real-time and robustness, which can't meet the demand of highway monitoring. This paper presents a new method to detect camera deviation based on corner set feature. The proposed method eliminates pseudo-corner points based on the extreme value of Taylor series at corner points and the low clustering property of the random noise. Then the corner set feature obtained by training is adopted to represent the image accurately. In addition, cross correlation and dynamic threshold analysis method are applied to correct the event falsely detected as a deviation. Finally, the contrast experimental results demonstrate that the proposed method can improve the real-time performance as well as ensure a high detection rate, which meets the requirements of highway monitoring in practical application.

TueDIS-33

Structural Comparison of Electrical Capacitance Tomography Sensor

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The electrical capacitance tomography technology is based on the principle of capacitance sensitivity. It can realize the visualization of the distribution of internal multiphase media by measuring the change of the external capacitance array of the closed pipe or container. The design of capacitance sensor is one of the key problems in the electrical capacitance tomography system. This article carries on the analysis for the two-dimensional structure of the capacitance sensor. The effects of different sensor structure on the measuring capacitance, image reconstruction and so on are compared in detail, through the use of the driven guard electrode, shielding strip, shielding ring. The corresponding simulation data and reconstructed results are given. The simulation results show that the dynamic range of capacitance is small and the

reconstruction effect is better by using the combination of driven guard electrode, shielding strip and shielding ring. This paper provides a reference for the optimal design of the electrical capacitance tomography sensor in industrial applications.

TueDIS-34

Analysis of Focusing Characteristics for Phased Array Used in Acousto-Electric Effect

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Acousto-Electrical Tomography (AET) based on the acousto-electric effect, is a promising new technique for a direct image formation method with enhanced resolution. Acousto-Electrical Tomography requires the focusing energy of ultrasonic focus to be greater in the security context and the focal point to be as small as possible. Contrasting with existing focusing techniques, phased array focusing technique is applied to Acousto-Electrical Tomography. In this study, the effects to the focus spot of ultrasound phased array are explored. A square phased array transducer is used to facilitate the study in the analysis and simulation. The effects of two dimensional array transducer parameters are analyzed from two aspects: focus width and focal depth. The delay precision of hardware circuit design is analyzed theoretically in order to achieve the full coverage of the focal points. The analysis results are verified by acoustic field simulation.

TueDIS-35

Direct Torque Control of Three-Level Inverter-Fed PMSM Based on Zero Voltage Vector Distribution for Torque Ripple Reduction

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Dan Yang Northeastern Univ.
Xiaoyan Shi Northeastern Univ.

A direct torque control strategy based on zero voltage vector distribution is proposed for neutral point clamped (NPC) three-level inverter-fed permanent magnet synchronous motor (PMSM) drive system, which is characterized by low torque ripples and fast speed response. In this proposed control scheme, 12 synthesizing voltage vectors with zero voltage vector are selected according to the error switching table of the flux and torque. Subsequently, the action time of zero voltage vector in each sample period is calculated online considering the selected voltage vector and the motor's speed. Simulation results based on MATLAB/Simulink show that the proposed strategy is effective in reducing torque ripples of NPC three-level inverter-fed PMSM drives.

TueDIS-36

A Novel k-Means Based on Spatial Density Similarity Measurement

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k-Means clustering algorithm is widely used in many machine learning tasks. However, the classic k-Means clustering algorithm has poor performance on classification of non-convex data sets. We find that k-Means effect depends heavily on the measurement of similarity between instances of the datasets. In novel algorithm, we define the new distance measurement of scalable spatial density similarity in data sets, and propose a cluster-center iterative model in the algorithm. Experimental results show that compared with Euclidean distance based k-Means, our proposed algorithm with spatial density similarity measurement generally perform more accurate on several synthetic and real-world datasets.

TueDIS-37

The design of the tracking system base on visual and Wireless Location Appliance

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It is difficult to address the problem of occlusion and loss of target when a single image tracking algorithm is utilized in high reliability occasions, such as prison, coal mines and military area. This paper presents a novel tracking and monitoring system based on wireless location and video. A coordinate frame of wireless system of scene constructed by binding the targets with RSSI labels is used to extract the real-time location information of targets. A high-speed ball camera is used to set up the coordinate frame based on vision system. Double shaft angle encoder added on the high-speed ball camera and control system devised based on ARM are adopted to obtain real-time coordinates of field of visual system. Thus, it solves the problems of the high-speed ball camera without real-time angle feedback, and improves the reliability of the system. It makes the position of camera as the origin of coordinates, and fuses the two coordinates to find out the relationship with Pan & Tilt and the label position. Firstly, the system detects and captures targets by the help of label. Secondly, using the image processing algorithm tracks the targets on a larger scale. Finally, it uses the label information as a feedback to correct position when the targets lost or be covered. Results show that, the new system is robust in the large-scale scene and complicated background.

TueDIS-38

Study of A Refractive Index Sensor Based on Dual-core Photonic Crystal Fiber

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Kil To Chong Northeastern Univ.

A refractive index sensor based on dual-core photonic crystal fiber (PCF) with hexagonal lattice is proposed. The effects of geometrical parameters of the PCF on performances of the sensor are investigated by using the finite element method (FEM). Two fiber cores are separated by two air holes filled with the analyte whose refractive index is in the range of 1.35–1.41. Numerical simulation results show that the highest sensitivity can be up to 32682 nm/RIU(refractive index unit) when the analyte refractive index is 1.41. The lowest sensitivity can reach to 31291 nm/RIU when the analyte refractive index is 1.35. The sensor we proposed has significant advantages in the field of biomolecule detection as it provides a wide-range of detection with high sensitivity.

TueDIS-39

Research on non-intrusive acoustic monitoring for valve internal leakage

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Yufeng Shi Beijing Univ. of Chemical Tech.
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A non-intrusive acoustic monitoring method for valve internal leakage with dual-sensor is proposed. Sensing device is designed to be able to adjust and lock the contact degree between the sensor and pipe wall, and can be loaded and unloaded quickly. The time-frequency domain features of the acoustic signal, which sampled under the conditions of valve normal, valve leak, pipe tapping, pump starting when the valve at open or closed state, are analysed and compared. Feature extraction approach based on the wavelet packet energy ratio for valve leak acoustic signal is proposed, which can effectively distinguish valve internal leakage and external interferences. It has a high leakage detection sensitivity, and can greatly reduce the sampling frequency and the difficulty of valve internal leakage diagnosis.

TueDIS-40

Research on Distance Movement Correction Algorithm Based on Time - Shift

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Keystone transform can correct range migration on the moving target in the PD radar coherent integration time, and improve the signal-to-noise ratio of the echo signal. However, there is a problem of complex operations when Keystone transform is applied to high-speed targets after interpolation operations, In this paper, the time-shifting envelope compensation method is proposed to solve the problem of large amount of computation. The algorithm can not only reduce the computational complexity obviously, but also improve the output SNR.

TueDIS-41

Detection Method of High Voltage Bushing Based on Hu Moment Invariants and SVM

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In this paper, a new detection method of high voltage bushing is proposed using Hu invariant moments and Support Vector Machine (SVM), which is designed in regard to both complex environments of transformer substation and the characteristics of pictures obtained by inspection robots. The Niblack algorithm is first used as a binarization method to decrease the influence of changing of lighting. The morphology method is then used to remove messy interference while maintaining the morphological characters of the target, and a few potential regions of high voltage bushing can be found. Hu invariant moments is used to extract the features of the potential positions, and a SVM is trained to classify and recognize the positions of high voltage bushing. The experimental results show that the proposed detection method is effective and it can remove the complex background of the substation and reduces the influence of changed lighting, shooting position and shooting angle.

TueDIS-42

Research on Moving Target Detection of Spaceborne SAR Based on STAP and CS Algorithm

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In this paper, STAP algorithm is further studied based on the theory of

CS-based moving target detection in spaceborne SAR, and a method of detecting STAP and CS combined moving target is proposed. This method restores STAR clutter again for target data reconstructed by CS reconstruction algorithm for each distributed satellite. The STAP clutter suppression can detect the moving target position more efficiently. The theoretical and simulation results show that the proposed method can detect the exact position of the moving target. Compared with the traditional CS algorithm, this method has obvious superiority.

TueDIS-43

Fractional Order Hierarchical sliding mode Control of Linear Motion Velocity of Spherical Robot

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Spherical robot is a typical underactuated system so it is hard to control the velocity of linear motion. In order to gain better control performance of spherical robot, a fractional order hierarchical sliding mode controller is proposed in this paper. The simulation result show that the controller is effectively. Compared with the integer order hierarchical sliding mode controller, the fractional order hierarchical sliding mode controller had better control performance and stronger robustness when system was subject to the disturbance.

TueDIS-44

Fractional Calculus Guidance Algorithm For Aircraft Pursuit-Evasion

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Aiming at intercepting hypersonic target in a pursuit-evasion game, this paper presents a fractional calculus guidance algorithm based on a Nonlinear Proportional and Differential Guidance law (NPDG). According to relative motions between the interceptor and target, quantitative values were proposed for the parameters of the fractional calculus guidance law and system stability condition was given. Numerical experiment results demonstrated that the proposed guidance algorithm effectively reduced the miss distance against target maneuver. A stronger robustness compared to the NPDG was also shown under noisy condition.

TueDIS-45

Stability Analysis for the Fractional-Order Single-Species Model with the Dispersal

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In this paper, the single-species model with the dispersal is extended to the fractional-order model. Caputo fractional order derivatives are used. Fractional-order single-species model with the dispersal is interpreted as a coupled system on a network. By using graph theoretical approach of the coupled systems, constructing Lyapunov functions method and stability theory of the fractional-order system, positive equilibrium's existence theorems and stability theorems for the new model are obtained. An example is given to illustrate the applications of main results.

TueDIS-46

Spectral method for the fractional diffusion-wave equation with variable coefficients

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In this paper, we consider the spectral method for the time fractional diffusion-wave equation with variable coefficients in a bounded domain. The time fractional derivative is described in the Caputo sense with the order. We transform the equation into an equivalent form with Riemann-Liouville fractional integral operator, based on the weighted and shifted Gr¨unwald difference operator, the convergence rate of the fully discrete scheme in norm is. Detailed analysis for the stability and convergence of the fully discrete scheme is given. Numerical examples are presented to demonstrate the theoretical results

TueDIS-47

Fractional Dual-Phase-Lag Heat Conduction Model For Laser Pulse Heating

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In the present work, the short-pulse laser heating of a semi-infinite medium is considered. The time fractional dual-phase-lag model is used as the heat conduction model and the corresponding fractional heat conduction equation with a volumetric heat source is established. The semi-analytical solution for the temperature distribution is obtained by using the Laplace transform method. Finally, the influence of pertinent parameters on the temperature distribution is studied graphically.

TueDIS-48

Fractal Dimension of Fractional Integral of Continuous Functions

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This paper mainly makes research on fractal dimension of fractal functions. We give basic estimation of fractal dimension, such as Box dimension and Hausdorff dimension, of fractional calculus of continuous functions. For a continuous function, upper Box dimension of its Riemann-Liouville fractional integral of order v has been proved to be no more than when $0 < v < 1$. Furthermore, if a continuous function which satisfies older condition, upper Box dimension of its Riemann-Liouville fractional integral is no more than 2 when $0 < v < 1$. This means upper Box dimension of Riemann-Liouville fractional integral of a continuous function satisfying older condition of order v is no more than minf2□v; 2□g when $0 < v$; < 1. With method of auxiliary function, upper Box dimension of Riemann-Liouville fractional integral of any continuous functions satisfying -H¨older condition of order v is strictly less than min when $0 < v < 1$.

TueDIS-49

Fractional-Order Impedance Control for a Wheel-Legged Robot

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To make robots walk smoothly and stably, it is necessary to solve ground impacts during dynamic walking. Compliance motion control can help to reduce the impacts and improve the robot's adaptability to complex terrain. Impedance control is a useful framework to provide robot's leg compliance. The conventional impedance control employs second-order mass-damping-spring system as a force disturbance controller. In this paper, position-based impedance control is applied to legged locomotion of the wheel-legged robot and a novel impedance controller with fractional order form is put forward to increase the system degrees of freedom for adjustment. The simulation tests of electric cylinder actuator and leg systems are carried out to demonstrate the effectiveness of the proposed algorithm.

TueDIS-50

Optimal Control of Positive Solution to Initial Value Problem for Fractional Integro-differential Equations

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In this paper, we consider the existence and uniqueness of positive solutions to fractional integro-differential equations by using mixed monotone operator. On this basis, we investigate the control problem of positive solutions to our equation and obtain the existence condition of an optimal control that minimizes the nonlinear cost functional.

TueDIS-51

State Transition Matrix of Linear Time Varying Fractional Order Systems

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Fractional order time varying dynamic systems are a kind of important and the less involved systems. In this paper, the state transition matrix of fractional order linear time varying systems is obtained. The results extend the corresponding conclusions from linear varying integer order systems to fractional order linear time varying systems. The solutions and its properties of fractional order linear time varying systems can be studied by the state transition matrix. The results of fractional order linear time invariant systems can be pointed out as a reduction of counterpart of fractional order linear time varying systems. Numerical simulation examples are given to verify the correctness of results presented. The controllability of fractional order linear time varying systems can be derived and discussed in the near future.

TueDIS-52

Comments on "State space modeling and stability theory of variable fractional order systems"

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With several counterexamples, it is pointed that the commutative law and the principle of superposition of fractional calculus are invalid. The so-called variable order state space modeling method proposed in the above research paper mentioned in the title does not hold. The proof of judgement theorem for stability addressed in the above paper is lack of theory evidence. A counterexample is provided to show the contradiction between the condition and the conclusion of stability theorem.

TueDIS-53

The Research on The Gas Leakage Repair Operations Based on Multi-Agent

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This paper introduces the application research on gas pipeline leakage repair based on Multi-Agent. For the characteristics of Multi - Agent system and collection of information exchange between these Agents were described in detail. The core of the research is the scheduling algorithm based on the Multi-Agent cooperation time. So, the cases

modeling and optimization scheme are established as a result of theoretical foundation. Finally, a examples on gas pipeline leakage repair operation is verified by simulation platform based on AnyLogic software.

TueDIS-54

Predictive Control of Mobile Robot Based on Tensor Product Model Transformation

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A Robust Model Predictive Controller (RMPC) is designed for the visual stabilization of mobile robots. The image-based visual servoing (IBVS) task is represented by the discrete state-space model of the mobile robot. The image Jacobian vertex matrix is obtained by using the tensor product (TP) model transformation method, and the constraint problem of the mobile robot is classified into the solution of linear matrix inequality The optimal problem obtains the control signal, which makes the system have closed-loop asymptotic stability. The control method ensures the system input constraint and can ensure that the visual measurements stay in the image plane. The simulation results for a mobile robot with eye-in-hand configuration demonstrate the effectiveness of the algorithm.

TueDIS-55

An Improved Target Tracking Scheme via Integrating Mean-shift with TLD Algorithm

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Tracking-Learning-Detection (TLD) is an excellent long-term tracking method which has the advantages of high accuracy of tracking rate and self-detection mechanism. Noting that TLD algorithm is sensitive to illumination change and clutter results in drift even missing, and the corresponding tracker designed based on the pyramid Lucaks-Kanade optical flow method needs vast computation. To overcome these shortcomings, an improved target tracking scheme by integrating mean-shift and TLD algorithm is proposed. The designed scheme improves the ability of resistance to shade and increases the processing speed through setting the reasonable iterative starting point of mean-shift algorithm. Meanwhile, by combining self-detection with on-line learning mechanism, we can solve the problem of goals lost in tracking process. Finally, experimental results are provided to demonstrate that the proposed method can properly detect and accurately track a target in complex scenes.

TueDIS-56

New Fault Detection Scheme for Spacecraft Attitude Control System Based on the Convex Hull Model

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A new convex hull model based fault detection scheme for the spacecraft attitude control system (SACS) is investigated in this paper. To reduce the modeling conservatism of the rigid spacecraft's kinematics equation and dynamics equation, a nonlinear model for the SACS is derived by combining Rodrigues parameter and quaternion. Considering the influences brought by the nonlinear dynamics and external disturbances, the above nonlinear model is simplified to be a new convex hull linear model. Then, an observer based convex hull robust filter is further constructed to generate the desired residual signal, and significant existence conditions of the desired filter can be solved by the LMI convex optimization method, where the system's stability and robust performance can be guaranteed. Finally, a numerical example based on a small satellite is given to show the effectiveness of the proposed method.