

## ThA I : Best Paper

Session Chair : Hong Zhang

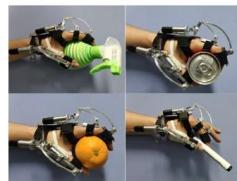
Jingya Pavilion : July 15, 14:00 - 15:45, Thursday

- 14:00~14:15

### **UCAS-Hand: An Underactuated Powered Hand Exoskeleton for Assisting Grasping Task**

Houcheng Li<sup>1,2</sup>, Long Cheng<sup>1,2</sup>, Zhengwei Li<sup>1</sup>, and Guotao Li<sup>1</sup>  
 1. State Key laboratory of Management and Control for Complex Systems,  
 Institute of Automation, Chinese Academy of Sciences, China  
 2. School of Artificial Intelligence, University of Chinese Academy of Sciences

- The UCAS-Hand is the first linkage-based exoskeleton to achieve the human-robot kinematic compatibility of the thumb joint.
- The UCAS-Hand can realize the self-adaptive grasp to different objects, apply only normal forces, and is passively backdrivable.
- The UCAS-Hand can achieve the thumb underactuated movement by constructing a spherical seven-bar linkage.

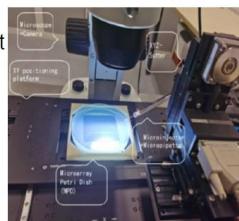


- 14:30~14:45

### **Design and Testing of an Automated Microinjection System for Batch Injection of Zebrafish Larvae**

Ziqiang Chi, Qingsong Xu, Nana Ai, and Wei Ge  
 University of Macau, Macau, China

- An automatic high-throughput microinjection system is designed and developed for the first time
- It is applicable to batch injection of zebrafish larvae
- Experimental results show that the system works fast and ensures stable success rate and survival rate for the fish larvae microinjection

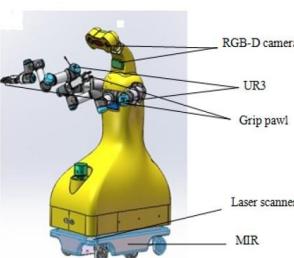


- 15:00~15:15

### **Development and initial experiments of an intelligent Dual-Arm mobile robot - Baymax-I**

Wei Liu, Haitao Wang, Rui Wang, Dayong Wen, Tao Lu, and Shuo Wang  
 State Key Laboratory of Management and Control for Complex Systems,  
 Institute of Automation, Chinese Academy of Sciences

- The mechanism design of Baymax-I is based on modular concepts, which is mainly composed of main body, dual-arms and a mobile chassis
- Software systems is designed based on hierarchical structure
- Three experiments including SLAM, pressing the elevator and opening the fridge are performed



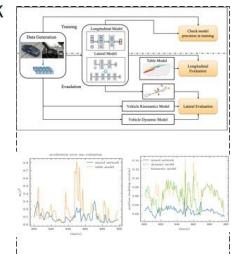
- 14:15~14:30

### **Vehicle Longitudinal and Lateral Dynamics Modeling by Deep Neural Network**

Xiaoxu Cao, and Huiyun Li  
 Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

Chunxiao Liu and Cong Qiu  
 SenseTime Group Limited, Shenzhen, China

- A data-driven method based on neural network is proposed to build the vehicle longitudinal and lateral dynamics model.
- The proposed network could learn the implicit dynamic model from the history data.
- The longitudinal acceleration modeling precision could be improved by 40%. the lateral distance mean absolute error of the neural network model is 0.026m while the traditional method is about 0.06m.



- 14:45~15:00

### **A 22-DOFs Bio-inspired Soft Hand Achieving 6 Kinds of In-hand Manipulation**

Jianshu Zhou, Hanwen Cao, Junda Huang, Yunhui Liu  
 MAE, The Chinese University of Hong Kong, Hong Kong  
 Yunquan, Li, Yang Yang.

Mechanical Engineering, The University of Hong Kong. Hong Kong

- An anthropomorphic 22-DOFs soft hand, S-22, is presented with comparable dexterity of human hand.
- The excellent dexterity of S-22 is enabled by the novel V-joint, which is easily applied to build multi-DOF soft robots by arranging them in a desired order.
- the successful processing of 6 kinds of in-hand manipulation was presented to demonstrate hand capability.



## ThB I : Best Paper In Robotics

Session Chair : Max Q.-H. Meng

Lanting Pavilion : July 15, 14:00 - 15:45, Thursday

- 14:00~14:15

### A Fireworks Algorithm Based Path Planning Method for Amphibious Robot

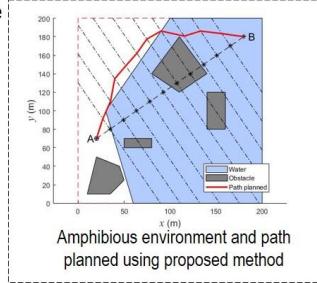
Yuanyang Qi and Junzhi Yu

College of Engineering, Peking University, China

Jincun Liu

College of Information and Electrical Engineering, China Agricultural University, China

- A path planning method adopting the Fireworks Algorithms (FWA) is proposed.
- An optimization model is designed aiming at the characteristics of path planning for amphibious robots.
- Simulation experiments are conducted to analyze and compare the performance of FWA variants.



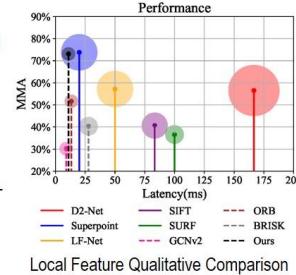
- 14:30~14:45

### Self-supervised Feature Detection and Binary Description in Hamming Space for Mobile Platforms

Shenghao Li, Guibao Zhang and Qunfei Zhao

Department of Automation, Shanghai Jiao Tong University, China

- This paper proposes to use self-supervised learning and iterative hash for feature detection and description.
- Local features with repeatability and robustness are extracted with low latency and memory footprint.
- The proposed method empowers real-time feature-based tasks in Hamming space on mobile platforms.



- 15:00~15:15

### Inverse Kinematics Formulations of a Continuum Endoscope for a View Adjustment Similar to the da Vinci Endoscope

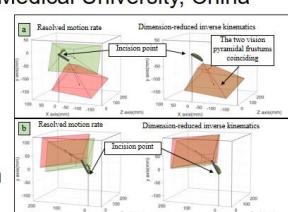
Lifei Deng, Zhonghao Wu, Yifan Wang and Kai Xu

Shanghai Jiao Tong University, China

Linhuai Wang

Department of Urology, Naval Medical University, China

- Two inverse kinematics formulations are investigated on a 6-DoF continuum endoscope to achieve view adjustment similar to the da Vinci endoscope.
- Dimension-reduced inverse kinematics formulation improves performances when resolved motion rate fails to converge.
- Dimension-reduced formulation has an 84.11% improvement compared with the resolved motion rate control.



Comparison results when the target visual point is (a) inside and (b) outside continuum endoscope's workspace

- 14:15~14:30

### Data-Driven Modeling the Nonlinear Backlash of Steerable Endoscope Under a Large Deflection Cannulation in ERCP Surgery

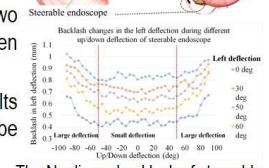
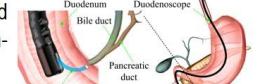
Wei Jiang, Tao Yu, Xiao He, Yongming Yang, Hao Liu

Shenyang Institute of Automation, Chinese Academy of Sciences, China

Zhidong Wang

Department of Advanced Robotics, Chiba Institute of Technology, Japan

- The backlash limits the positioning and orientation accuracy of the tendon-sheath-driven endoscope under large deflection.
- We proposed to model the backlash of two DoFs endoscope by using a data-driven method.
- Trajectory following and orientation results show that the model can accurately describe the nonlinear backlash.



The Nonlinear backlash of steerable endoscope in ERCP surgery

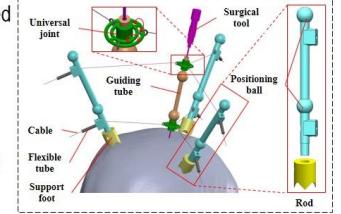
- 14:45~15:00

### Reconfigurable Cable-Driven Parallel Robot with Adjustable Workspace Towards Positioning in Neurosurgery: A Preliminary Design

Changsheng Li, Jingchen Huang, Mengya Su, Diao Wu, Peng Xu, Yushan Xie, Fansheng Meng, Hao Wen, Huanyu Tian and Xingguang Duan

School of Mechatronical Engineering, Beijing Institute of Technology, China

- A cable-driven parallel robot is proposed for positioning in neurosurgery.
- The robot is reconfigurable and lightweight, which is suitable for being mounted on the skull
- The workspace is adjustable according to the surgical requirements



# ThC I : Robotics Control I

Session Chair : Bo Zhao, Can Wang

Meeting Room 1 : July 15, 14:00 - 15:45, Thursday

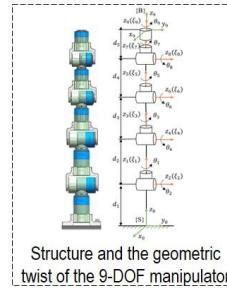
- 14:00~14:15

## Trajectory Planning for Hyper-Redundant Manipulators Based on Lie Theory

Tianyu Liu and Mingchao Zhu

Space Robot Engineering Center, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, Changchun, China  
University of Chinese Academy of Sciences, Beijing, China

- A discretized trajectory is generated by the cubic spline interpolation.
- Trajectory planning is achieved by finding the numerical solution of inverse kinematics (IK).
- IK algorithm combines feedforward and feedback control based on Lie theory.
- Redundancy is used to obtain the optimal configuration avoiding joint limits and singularities.



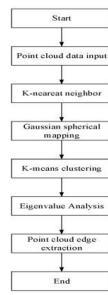
- 14:30~14:45

## Fast and Accurate Edge Extraction Algorithm of Stacked Workpiece Point

Keping Liu and Runze Gao and Yan Li and Weibo Yu

Department of Control Engineering, Changchun University of Technology, China

- An algorithm for edge extraction of stacked artifacts is proposed.
- Gaussian sphere mapping and Kmeans clustering algorithm.
- Experiments show that the proposed algorithm can solve the problem.

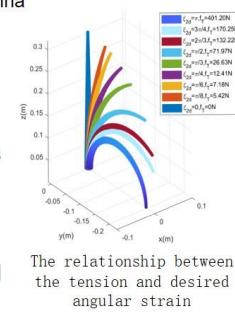


- 15:00~15:15

## Dynamics modeling of a soft arm under the Cosserat theory

Jie Ma, Zhiji Han, Linsen Yang, Gaochen Min, Zhijie Liu, Wei He. Automation and Electrical Engineering, University of Science and Technology Beijing, China

- In this paper, inspired by the Lagrangian model of a rigid robot, a Newton-Euler inverse dynamics algorithm for an equivalent continuous manipulator is adopted to compute all matrices of the Lagrangian inverse dynamics model about the soft arm.
- The iterative process is also improved to increase the computational efficiency.
- Eventually, a minimal set of ordinary differential equations is given for later control design.



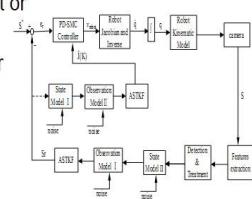
- 14:15~14:30

## Uncalibrated Image-Based Visual Servoing Control based on Image Occlusion using Dual Adaptive Strong Tracking Kalman Filter

Xiaolin Ren and Hongwen Li

Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, China

- The scenarios of image features being lost or occluded with image features
- Dual adaptive strong tracking Kalman filter Scheme
- Image occlusion analysis



- 14:45~15:00

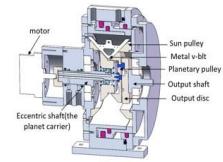
## Design, Modeling and Estimation of an Innovative Continuously Transmission

Zhipeng Liu and Shouqi Chen

Department of Precision Machinery and Precision Instrumentation, University of Science and Technology of China, Hefei, China  
Linsen Xu

Institute of Advanced Manufacturing Technology, Hefei Institutes of Physical Science, Chinese Academy of Sciences, Hefei, China

- An innovative continuously variable transmission for robots.
- This simple and effective structure can effectively reduce manufacturing costs and improve motor efficiency .
- Continuous geometric model of the metal v-belt and analyzes the kinematics and dynamics of a single metal segment.
- The factors affecting the stability of the v-belt transmission ratio are analyzed .



3D model of the innovative CVT

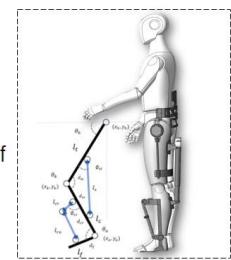
- 15:15~15:30

## Impedance Control for a novel Composite Modular Lower-Limb Hemiplegic Exoskeleton

Ruoyu Bao, Pengbo Li, Bailin He, Zhilong Su, Can Wang and Xinyu Wu

Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen

- Proposes a control scheme based on impedance control to realise the smoothing control of the operating movements of the lower limb hemiplegic exoskeleton robot.
- Simplifies the control complexity of the whole system by means of a crank rocker structure of the ankle joint.



## ThD I : Soft robotic system I

Session Chair : Zhi Li, Wu Yinan

Meeting Room 2 : July 15, 14:00 - 15:45, Thursday

- 14:00~14:15

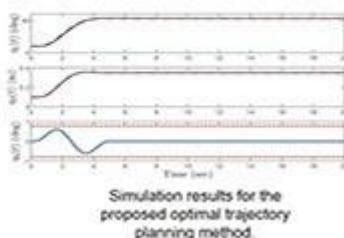
- 14:15~14:30

**A Time Optimal Trajectory Planning Method for Offshore Cranes With Ship Roll Perturbations**

Ran Zhang and He Chen

School of Artificial Intelligence, Hebei University of Technology, China

- A time optimal trajectory planning method is proposed for offshore cranes.
- Differential flatness property is utilized to better tackle the system couplings.
- Different kinds of physical constraints are successfully considered.

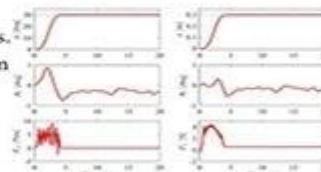


- 14:30~14:45

**Saturated PD with sliding mode control method for 4-DOF tower crane systems**

Meiqian Zhang, Member, IEEE, Fuguo Sun, Jin Zhang, Changhui Ma, and Zaixing Zhu

- It is robust against uncertain system parameters and external disturbances.
- The trajectory tracking controller can achieve finite-time convergence.
- The designed controller needs no payload-swing feedback.



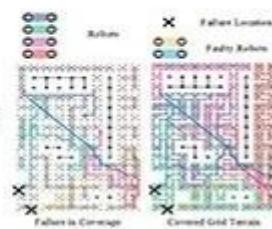
- 15:00~15:15

**FT-MSTC\*: An Efficient Fault Tolerance Algorithm for Multi-robot Coverage Path Planning**

Chun Sun, Jingtao Tang and Xinyu Zhang

Software Engineering, East China Normal University, China

- Present a new efficient fault tolerance algorithm for multi-robot coverage path planning using optimization method.
- After failures, FT-MSTC\* will minimize the overall maximum coverage cost while considering both the accomplished tasks and the remaining tasks.
- Our experiments show FT-MSTC\* outperformed other coverage path planning algorithms in terms of the overall maximum coverage cost.



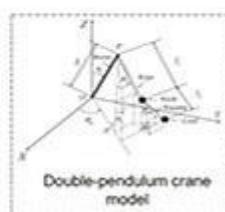
- 15:30~15:45

**Sliding Mode Control Approach for Double-pendulum Rotary Cranes**

Zheng Tian, Huimin Ouyang and Huan Xi

College of Electrical Engineering and Control Science, Nanjing Tech University, China

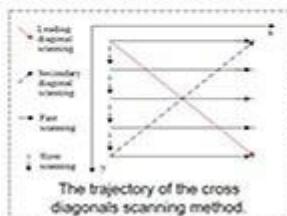
- A variable damping algorithm is proposed to solve the load/hook suppression problems.
- Disturbance observer is used to decouple it into two independent linear systems.
- A sliding mode controller with a nonlinear sliding surface is designed.
- Simulation results demonstrate the effectiveness of the proposed method.

**Correction of AFM image distortion caused by thermal drift**

Yinan Wu

Institute of Robotics and Automatic Information System, Tianjin Key Laboratory of Intelligent Robotics, College of Artificial Intelligence, Nankai University, Tianjin 300350, China

- Thermal drift causes image distortion of an atomic force microscopy (AFM).
- A novel offline drift correction algorithm based on cross diagonals scanning is proposed to reconstruct high-quality AFM images.
- The performance of the proposed method is verified by convincing experimental and application results.



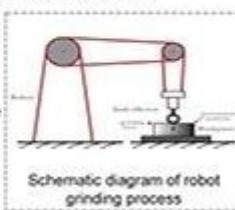
- 14:45~15:00

**Error Constrained Hybrid Force/Position of a Grinding Robot**

Chenglin Zhang, Ning Sun\*, Yiheng Chen, Zehao Qiu, Wenchuang Sang, and Yongchun Fang

Institute of Robotics and Automatic Information Systems, College of Artificial Intelligence, Nankai University, China

- The contact force model between the environment and the robot is presented.
- A hybrid force/position control method is given and a force controller is proposed.
- By using Lyapunov methods, the stability of the system is proven.
- By numerical simulations, the effectiveness of the presented force controller is verified.



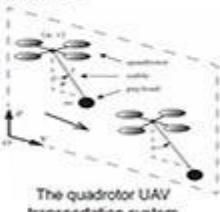
- 15:15~15:30

**Adaptive Neural Network Control of Quadrotor Unmanned Aerial Vehicle Transportation Systems**

Xiao Liang, Zhuang Zhang, Hai Yu, Yang Wang, Ning Sun

Institute of Robotics and Automatic Information Systems, College of Artificial Intelligence, Tianjin Key Laboratory of Intelligent Robotics, Nankai University, Tianjin 300350, China

- An adaptive controller is proposed based on sliding manifolds and RBFNNs.
- RBFNNs are utilized to compensate for system uncertainties/disturbances.
- The stability of the system can be guaranteed by Lyapunov techniques.
- Simulation results show superior performance and robustness of the proposed adaptive NN controller.



## ThA II : Best Student Paper

Session Chair : Hong Zhang

Jingya Pavilion : July 15, 16:15 - 18:00, Thursday

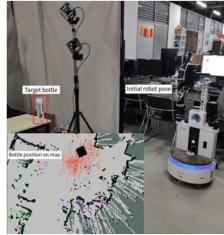
- 16:15~16:30

### Uncertainty Aware Mobile Manipulator Platform Pose Planning Based on Capability Map

Yuhao Meng, Yujing Chen and Yunjiang Lou

School of Mechanical Engineering and Automation, Harbin Institute of Technology Shenzhen, China

- Mobile manipulator platform has great pose uncertainty in cluster and dynamic environment.
- Find a platform pose with higher manipulability expectation under the uncertainty.
- Use a uncertainty distribution based filter to the feasible platform poses.
- Achieve higher manipulability expectation with less computing time increasement.



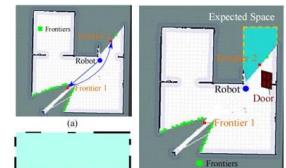
- 16:30~16:45

### A Prior Information Heuristic based Robot Exploration Method in Indoor Environment

Jie Liu, Yong Lv, Yuan Yuan, Wenzheng Chi, Guodong Chen and Lining Sun

Robotics and Microsystems Center, School of Mechanical and Electric Engineering, Soochow University, Suzhou, China

- A new exploration strategy is proposed on the basis of the prior information heuristic.
- A lightweight network model is proposed for the recognition of the heuristic objects.
- Experimental studies demonstrate the effectiveness of the proposed method.



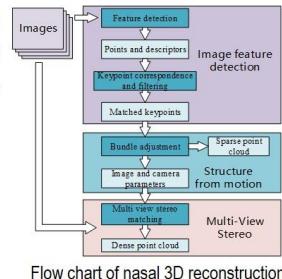
The influence of prior information heuristic on the selection of frontiers.

- 16:45~17:00

### Virtual reality navigation system of nasal endoscopy with real surface texture information

Z. Cui<sup>13</sup>, Y. He<sup>1</sup>, P. Zhang<sup>1</sup>, Y. Hu<sup>1</sup>, H. Jin<sup>2</sup>, S. Liu<sup>3</sup>1-Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences  
2-Shenzhen Broadcare medical robotics co. Ltd., Shenzhen, China  
3-Harbin Institute of Technology, Shenzhen, China

- 3D reconstruction of nasal cavity based on monocular nasal endoscopic images
- Variable-scale registration of monocular reconstruction model and CT model
- Collision-free path planning of nasal endoscope under the anatomical constraints of nasal cavity
- Experiments and discussion



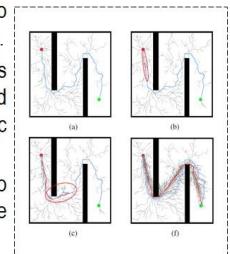
Flow chart of nasal 3D reconstruction

- 17:00~17:15

### Sliding-Window Informed RRT\*: A Method for Speeding Up the Optimization and Path Smoothing

Chenming Li<sup>1</sup>, Chaoqun Wang<sup>2</sup>, Jiankun Wang<sup>3</sup>, Yutian Shen<sup>1</sup>  
<sup>1</sup>EE, CUHK, HKSAR, China; <sup>2</sup>CSE, SDU, China;  
<sup>3</sup>Max Q.-H. Meng<sup>3</sup><sup>3</sup>Department of Electronic and Electrical Engineering, SUSTech, China

- A sliding-window method is proposed to accelerate the convergence of Informed RRT\*.
- The Softmax Action Selection-like method is applied to balance the exploration and exploitation, and guarantee the probabilistic completeness .
- Simulation experiments are carried out to demonstrate that our method can improve performance significantly.

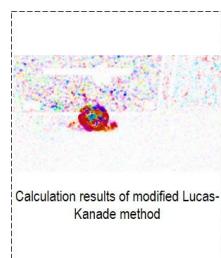


- 17:15~17:30

### A Moving Target Detection and Localization Strategy Based on Optical Flow and Pin-hole Imaging Methods Using Monocular Vision

Shun Wang<sup>1</sup>, Qingqiang Guo<sup>1</sup>, Sheng Xu<sup>2,3</sup> and Dan Su<sup>2,4</sup><sup>1</sup>School of Control Science and Engineering, Shandong University, Jinan, Shandong, China  
<sup>2</sup>Guangdong Provincial Key Lab of Robotics and Intelligent System, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences and CAS Key Laboratory of Human-Machine Intelligence-Synergy Systems, Shenzhen Institute of Advanced Technology, Shenzhen, China<sup>3</sup>Shandong Institute of Advanced Technology, Chinese Academy of Sciences, Jinan, Shandong, China<sup>4</sup>Orbbec Inc., Shenzhen, China

- This paper is concerned with moving target detection and localization based on monocular vision.
- The modified Lucas-Kanade optical flow method is applied to calculate optical flow.
- The two-level image segmentation strategy from coarse to fine is also designed.
- A low computational cost target localization algorithm is developed based on pin-hole imaging theory.



## ThB II : Best Paper In Control

Session Chair : Max Q.-H. Meng

Lanting Pavilion : July 15, 16:15 - 18:00, Thursday

- 16:15~16:30

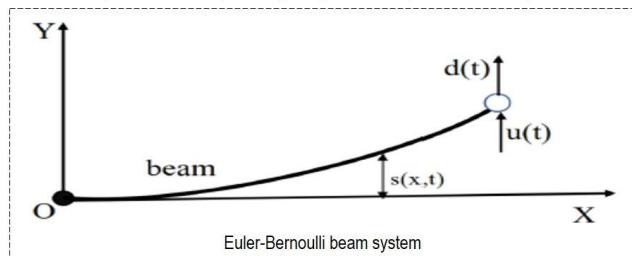
**Adaptive Vibration Iterative Learning Control of a Flexible Beam via Backstepping Technique**

Yu Liu, Xiaoqi Wu and Yanfang Mei

Automation Science and Engineering, South China University of Technology, China

Yilin Wu

Computer Science, Guangdong University of Education, China

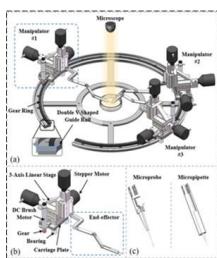


- 16:45~17:00

**Rail-Guided Robotic System for Multi-Configuration Cooperative Micromanipulation Based on Formation Control**Haojun Hu, Huaping Wang, Qing Shi, Han Tao  
Qiang Huang and Toshio Fukuda

Beijing Advanced Innovation Center for Intelligent Robots and Systems, Beijing Institute of Technology, China

- This paper presents a multi-configuration cooperative microrobotic manipulation system for executing multi-process.
- The method based on leader-follower and artificial potential field is proposed to achieve multi-configuration formation.
- Experimental results have verified the efficacy of the proposed method.



- 17:15~17:30

**Robust Image-based Landing Control of a Quadrotor on an Unknown Moving Platform Using Circle Features**Jie lin, Yaonan Wang\*, Zhiqiang Maio, Hang Zhong et al.  
College of Electrical and Information Engineering, Hunan University, China

- Image kinematics using circle features have simple form and decoupling properties for the landing system.
- The proposed controller does not incorporate depth of the target feature needed by IBVS-like approaches.
- The controller does not depend on the explicit knowledge of the landing platform.
- The prescribed transient and steady-state behavior of close-loop signals are guaranteed.



- 16:30~16:45

**Dual Arm Coordination with Coordination Diagram based on Teleoperation Demonstration**

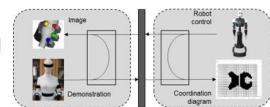
Guoyu Zuo, Zichen Xu, Lu Liu, and Daoxiong Gong

Faculty of Information Technology, Beijing University of Technology, China

Jianfeng Li

Faculty of Materials and Manufacturing, Beijing University of Technology, China

- This paper proposes a dual-arm coordination algorithm to improve the efficiency of coordination.
- Consider both robot's actions and operating sequences for tasks that require multiple operations with both arms.
- The coordination diagram in time domain is designed to more clearly represent the situations of trajectory collisions and find the collision free coordination action law.



- 17:00~17:15

**Inverse Kinematics and Master-Slave Control for a 7-DoF Tendon-Driven Humanoid Robot Arm**

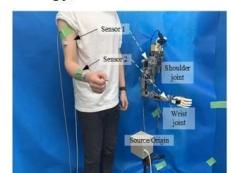
Zhenyu Sun and Wenyang Li

Department of Mechanical Engineering and Intelligent Systems, The University of Electro-Communications, Japan

Xiaobei Jing and Xu Yong

Shenzhen Institutes of Advanced Technology, China

- Analysis of Kinematics and Inverse Kinematics of 7-DOF Robot Arm.
- The mapping relationship between robot arm joints and human arm joints.
- Research on master-slave control strategy.
- Communication based on ROS/ARM/FPGA.



Schematic diagram of master-slave control system

## ThC II : Robotic Control II

Session Chair : Bo Yang, Rui Wang

Meeting Room 1 : July 15, 16:15 - 18:00, Thursday

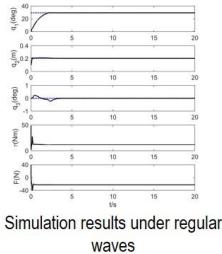
- 16:15~16:30

### **Stabilizing control for an offshore crane with unknown parameters**

Zhi Li, Xin Ma and Yibin Li

School of control science and engineering Shandong University, China

- The Dynamic model of an offshore boom crane is established in the presence of ship roll motion
- A parameter independent coupling controller is proposed which combines the proportional derivative controller and the SMC, to regulate the cargo to desired positions.
- The closed-loop stability is analyzed and the effectiveness is verified via simulation results



- 16:45~17:00

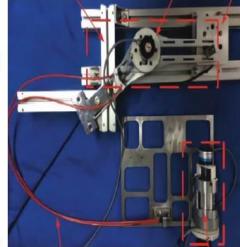
### **Saturated nonlinear control of robots with series elastic actuators**

Jie Cheng, Xuexin Zhang, Tairen Sun

School of Electrical Information and Engineering, Jiangsu University, China  
Hongjun Yang

The Institute of Automation, Chinese Academy of Sciences, China

- Two saturated nonlinear controllers are proposed based on singular perturbation (SP) and Energy Shaping (ES).
- The SP-based saturated controller requires the stiffness being relative large.
- The ES-based saturated controller requires accurate stiffness knowledge.

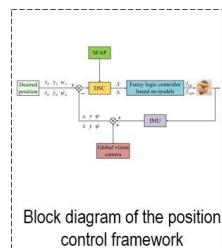


- 17:15~17:30

### **Dynamic Surface Control for an Underactuated Underwater Biomimetic Vehicle-Manipulator System**

Xuejian Bai<sup>1,2</sup>, Yu Wang<sup>2</sup>, Rui Wang<sup>2</sup>, Shuo Wang<sup>1,2</sup>, Min Tan<sup>1,2</sup><sup>1</sup>School of Artificial Intelligence, University of Chinese Academy of Sciences, China<sup>2</sup>State Key Laboratory of Management and Control for Complex Systems, Institute of Automation, Chinese Academy of Sciences, China

- This paper proposes a position control method based an improved dynamic surface control.
- A surge force adaptive process is designed to solve the underactuated problem of the UBVMS.
- Simulations and experiments validate the control method's feasibility and robustness in the application of UBVMSs.

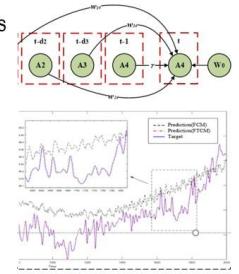


- 16:30~16:45

### **IEEE RCAR 2020 Digest Template Prediction of Key Parameters of Coal Gasification Process Based on TM-FTCM**

Congbin Jiang, Dan Wang, Cuiping Gong, Gang Zhang, Wen Gu, Lifeng Yang and Xingqiang Ding  
Changzheng Engineering Co., Limited, China

- The development of coal chemical industry has become a concern
- The time delay leads to the prediction model problems of poor interpretation and low accuracy.
- The method effectively solves the problem of inaccurate prediction model due to delay .



- 17:00~17:15

### **sensor development using novel multi-activation functions based ensemble echo state network**

Yan-Lin He, Yan-Ming Pan, Yuan Xu\*, Qun-Xiong Zhu\*

College of Information Science &amp; Technology, Beijing University of Chemical Technology, Beijing, 100029, China;

Email: xuyuan@mail.buct.edu.cn (Y. Xu); zhuqx@mail.buct.edu.cn (Q.X. Zhu)

In recent years, due to the continuous expansion of the scale of chemical industry, chemical industry data presents the characteristics of high dimensionality, large quantity, and strong nonlinearity, which greatly increases the difficulty of process modeling. Data-driven soft-sensing modeling methods have been widely used. Echo State Network, as a typical recurrent neural network, plays an important role in the field of time series prediction. However, the traditional Echo State Network (ESN) only uses a single kind of activation functions. Faced with strong coupling and high nonlinear influencing factors, the prediction performance of ESN will decrease. In order to solve the above problem, this paper proposes a variety of different activation functions into the Echo State Network to improve the ability to deal with complex process data. In the proposed method, three kinds of activation functions are utilized. In order to test the performance, High Density Polyethylene (HDPE) industrial process data is used. The simulation results show that the proposed method can achieve better performance in terms of accuracy than other models.

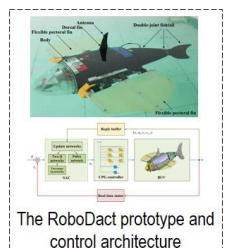
- 17:30~17:45

### **Locomotion Control of a Hybrid Propulsion Biomimetic Underwater Vehicle via Deep Reinforcement Learning**

Tiandong Zhang, Rui Wang, Yu Wang, and Shuo Wang

Institute of Automation, Chinese Academy of Sciences, China  
School of Artificial Intelligence, University of Chinese Academy of Sciences, China

- A novel locomotion control method of biomimetic underwater vehicle (BUV) is proposed based on deep reinforcement learning.
- A hybrid propulsion BUV named RoboDact is presented with two flexible long fins and a double-joint fishtail.
- The feasibility and effectiveness of the proposed control method is demonstrated after extensive comparative simulations.



## ThD II : Soft robotic system II

Session Chair : Yanding Qin, Lina Hao

Meeting Room 2 : July 15, 16:15 - 18:00, Thursday

- 16:15~16:30

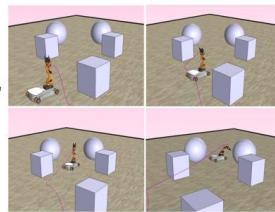
### RRT-GoalBias and Path Smoothing Based Motion Planning of Mobile Manipulators with Obstacle Avoidance

Jun Shao

School of Mechanical Engineering, Zhejiang University, China

Jianfeng Liao and Wei Song and Jason Gu and Shiqiang Zhu  
Zhejiang Lab, China  
Hao Xiong and Zheng Chen  
Ocean College, Zhejiang University, China

- The motion planning based on the RRT-GoalBias algorithm and path smoothing is proposed.
- The kinematics model of mobile manipulator, constraints of configuration and obstacle avoidance are given.
- The RRT-GoalBias algorithm is applied and modified to generate an initial path.
- A novel post-processing algorithm is proposed to smooth and optimize the initial path.

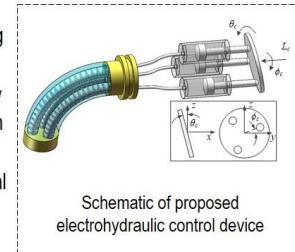


- 16:30~16:45

### Design and Test of an Electrohydraulic Control Device for Three-Chamber Soft Actuators

Tao Wang, Zhen Chen, and Shiqiang Zhu  
Ocean College, Zhejiang University, China

- An electrohydraulic control device with decoupling function is developed by using a swash plate mechanism.
- Stretched length, bending angle, and yaw angle of three-chamber soft actuators can be independently controlled.
- A prototype is fabricated and experimental results verify the effectiveness of the proposed concept.



- 16:45~17:00

### Experimental Study on Dynamic Characteristics and Fatigue of McKibben Pneumatic Artificial Muscles

Chen Wenlin, Ma Tianhua, Zhang Ying, Hao Lina\*,  
Wang Shuopeng, Liu Meng, Wang Rixin  
Mechanical Engineering and Automation, Northeastern University,  
Shenyang, China

- Dynamic output characteristics of the PAMs.
- Fatigue life test of the PAMs.
- This paper focuses on the dynamic hysteresis behavior related to the load of PAMs.



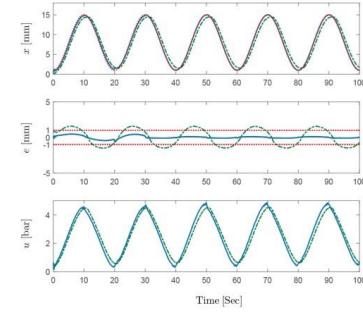
Experimental platform of fatigue life tests of PAMs.

- 17:00~17:15

### A Repetitive Learning Controller for PAM-Actuated Exoskeleton Robots With Motion Constraints

Tong Yang, Yiheng Chen, Ning Sun\*, and Yanding Qin  
Institute of Robotics and Automatic Information Systems (IRAS), College of Artificial Intelligence, Nankai University, China

- New repetitive learning-based error-constrained control for uncertain PAM-actuated exoskeleton robot systems
- Accurate tracking control and effective error constraints
- Asymptotic convergence of tracking errors by Lyapunov-based stability analysis

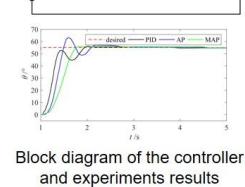
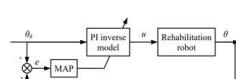


- 17:15~17:30

### Hysteresis Compensation of an Elbow Joint Rehabilitation Robot Featuring Flexible Pneumatic Artificial Muscle Actuation

Yuankai Xu, Yanding Qin, Jianda Han  
College of Artificial Intelligence, Nankai University, China

- A PAM actuated robot is developed for the elbow joint rehabilitation and movement assistance
- Direct inverse modeling method is utilized to obtain the inverse hysteresis model of the system
- A modified AP algorithm is used to dynamically update the weights of the inverse model

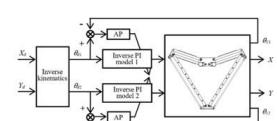


- 17:30~17:45

### Closed-loop Control of a Pneumatic Artificial Muscle Actuated 2-DOF Delta Mechanism with Adaptive Hysteresis Compensation

Haoqi Zhang, Yuankai Xu, Yanding Qin, Jianda Han  
College of Artificial Intelligence, Nankai University, China

- Direct inverse modeling approach was utilized to obtain the PAM's inverse hysteresis model.
- The parameters of PI inverse model are identified online by AP algorithm.
- The control performance is verified by trajectory tracking.



Block diagram of the closed loop control system

# FrA I : Sensing technology and recognition

Session Chair : Xin Jiang, Shengcai Duan

Jingya Pavilion : July 16, 14:00 - 15:45, Friday

- 14:00~14:15

## Research on SLAM of Corridor Environment Based on Multi-sensor

Fei Wang<sup>1</sup>, Haiyan Shao Member, IEEE, Qingshuai Zhao  
School of Mechanical Engineering, University of Jinan, China

Zhiqian Feng

School of Information Science and Engineering, University of Jinan, China

- Firstly, a multi-sensor environment awareness platform was built.
- Secondly, the data of each sensor was collected and processed and fusion was realized based on the CKF algorithm of weighted observation multi sensor.
- Finally, the cartographer algorithm was optimized at the back end and the map construction of corridor environment was realized.

- 14:30~14:45



Fig.19(a) Optimized cartographer algorithm corridor environment map

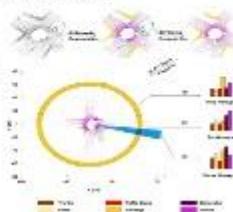
## Semantic Scan Context: Global Semantic Descriptor for LiDAR-based Place Recognition

Yuxiang Li, Pengpeng Su, Ming Cao, Haoyao Chen and Xin Jiang  
Harbin Institute of Technology, Shenzhen, China

Yunhui Liu

The Chinese University of Hong Kong, China

- A global semantic descriptor for finding loop closures using 3D LiDAR.
- Ring keys and sector keys based on semantic histograms for fast retrieval and alignment.
- Three-stage retrieval for fast and accurate matching of the proposed descriptors.
- Competitive performance in challenging situations for place recognition.

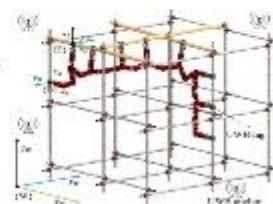


- 15:00~15:15

## Localization of Biped Pole-climbing Robots in Spatial Trusses

Jingheng Chen, Shaobin Zhuang, Shichao Gu, Yisheng Guan and Haifei Zhu<sup>\*</sup>  
School of Electromechanical Engineering, Guangdong University of Technology, China

- A two-stage localization method based on ultra-wideband (UWB) sensors is proposed.
- The proposed method can locate the robot with a position error less than 100mm and an orientation error less than 5°.
- The proposed method can be applied to global localization of biped pole-climbing robots moving in spatial trusses.



- 15:30~15:45

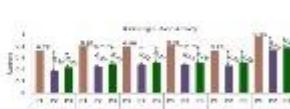
## sEMG-Based Gesture Recognition Using GRU With Strong Robustness Against Forearm Posture

Rui Chen<sup>1,2</sup>, YuanZhi Chen<sup>1</sup>, Weiyu Guo<sup>2</sup>, Chao Chen<sup>2</sup>, Zheng Wang<sup>2</sup>, Yongkui Yang<sup>2\*</sup>

<sup>1</sup>Guilin University of Electronic Technology, China

<sup>2</sup>Shenzhen Institute of Advanced Technology, Chinese Academy of Science

- Propose a novel sEMG based gesture recognition that uses GRU.
- The proposed gesture recognition is robustness against different forearm postures.
- The average classification accuracy of the proposed gesture recognition achieves a accuracy of 90%.

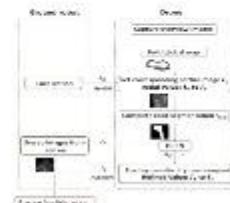


## Collaborative Recognition of Feasible Region with Aerial and Ground Robots through DPCN

Yunshuang Li, Zheyuan Huang, Zexi Chen,  
Yue Wang and Rong Xiong

Department of Control science and engineering, Zhejiang University, China

- A collaborative system with aerial and ground robots is proposed to assist the ground to gain precise information of feasible region.
- It contributes to ground robots' interacting with the environment.
- The match between heterogeneous images is done by deep phase correlation network.
- Our system has great accuracy and efficiency.



- 14:45~15:00

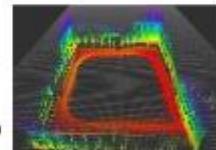
## Low-cost and Robust Mapping and Relocalization Method Base on LidarInertial Odometry

Pengfei Qu, Shenliang Li, Jinyang Zhang

Zhansheng Duan and Kuizhi Mei

Department of Electronic and Information Engineering, Xi'an Jiaotong University, China

- The design of low cost and robust mobile robot platform
- Ego-motion estimation with IMU and solid state Lidar
- 3D point clouds features extraction and selection
- The mapping of 3D point clouds and the method of relocalization.



- 15:15~15:30

## A Framework for Human-Exoskeleton Interaction Based on sEMG Interface and Electrotactile Feedback

Shengcai Duan, Can Wang, Mengyao Li, Zhilong Su, Jiaqing Liu and Xinyu Wu

Shenzhen Institute of Advanced Technology, University of Chinese Academy of Sciences, China

- Six-types motion intention is recognised by LSTM neural network based on sEMG of arms.
- The electrotactile is applied to feedback of five kinds states of exoskeleton and making up for the losing proprioception.
- Muscle fatigue of arms during use of exoskeleton is monitored and quantified with sEMG.



# FrB I : Human-Machine Interface I

Session Chair : Guanglin Li, Ning Lan

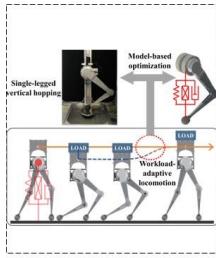
Lanting Pavilion : July 16, 14:00 - 15:45, Friday

- 14:00~14:15

## Workload-adaptive Vertical Hopping of A Single-legged Robot using Model-based Optimization

Yongming Yue, Yu Zhang, Wei Gao and Shiwu Zhang  
Department of Precision Machinery and Precision Instrumentation,  
University of Science and Technology of China, China.

- Explored workload adaptive vertical hopping using a single-legged robot.
- Fast gait generation given system workloads using SLIP based models and advanced Nonlinear Programming tools.
- Experimental verification on physical platform with  $\pm 4\%$  accuracy under up to 190% robot's weight.



- 14:30~14:45

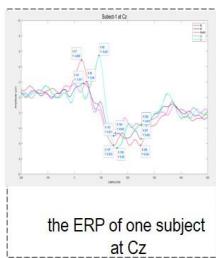
## Cognitive Components Characteristic Of Somatosensory Evoked Potentials In Upper Limb Amputees With Evoked Tactile Sensation

Changyu Qin and Wenyuan Liang

The National Research Center for Rehabilitation Technical Aids, China  
Sheng Bi

The National Research Center for Rehabilitation Technical Aids, China

- Plateau appears in cognitive component of SEP in amputees with PFM
- Amputees without PFM cannot evoke cognitive components
- Amputees reach the peak of ERP faster than Able-bodied man generally
- Distribution of exogenous components on the opposite side of the topographic map

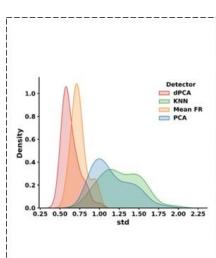


- 15:00~15:15

## Detecting Movement Timing from Primate Intracortical Signals for Brain-machine Interfaces in Dynamic Environment

Chenyang Li, Yiheng Zhang, Tianwei Wang, Xinxu Xu, Qifan Wang, Ruichen Zheng and He Cui  
CAS Key Lab of Primate Neurobiology, CEBST, Shanghai

- Movement timing recognition is neglected in current BMI decoding.
- Detecting movement timing is an outlier detection of recorded intracortical signals from unlabeled dataset.
- dPCA-based detector gives the best performance across 9 simultaneously recording set.

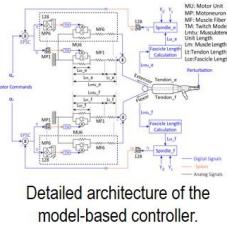


- 14:15~14:30

## An Integrated Virtual Hand Platform for Evaluation of Model-Based Control of Hand Prostheses

Zhuo-Zhi Zhang, Jie Zhang, Chuan-Xin M. Niu, and Ning Lan  
Laboratory of NeuroRehabilitation Engineering, School of Biomedical Engineering, Shanghai Jiao Tong University, China

- Integrate the neuromorphic model of muscles with the ETS-based sensory feedback in the virtual hand platform.
- Explore the compliant properties of the model-based biomimetic control system using the tendon-driven virtual hand.
- The control mode of the biomimetic controller was automatic switched depending on the external load conditions.



- 14:45~15:00

## Knee Joint Exoskeleton Device Based on Biological Motion Principle

Wenyuan Liang<sup>1,2</sup> and Ying Liu<sup>1,2</sup>

National Research Center for Rehabilitation Technical Aids, China  
Key Laboratory of Rehabilitation Technical Aids for Old-age Disability, China

- A knee joint exoskeleton device that is designed based on the biological motion principle of human knee joint.
- In order to follow the powering patterns of human walking, two one-way bearings and one set of gears are adopted to construct the knee joint exoskeleton device.
- The biological motions of femoral-on-tibial extension and tibial-on-femoral flexion can be adaptively imitated by the proposed device.

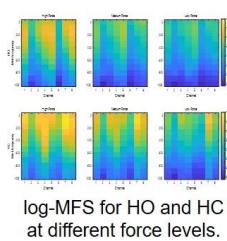


- 15:15~15:30

## Toward reducing the effect of force variations on electromyography pattern recognition by Mel-frequency spectrum

Yan Liu, Lan Tian, Yue Zheng, Xiaomeng Zhou, Xiangxin Li\*, and Guanglin Li  
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

- The energy distributions in frequency of different force levels were similar for the same motion class
- A Mel filter bank is applied to the power spectrum to achieve the Mel-frequency spectrum (MFS)
- For the un-trained high and low force levels, the accuracy increased by about 27% and 11% than TD feature set (MAV, WL, ZC, SSC)



# FrC I : Robot Mechanism I

Session Chair : Changsheng Li, Lisen Xu

Meeting Room 1 : July 16, 14:00 - 15:45, Friday

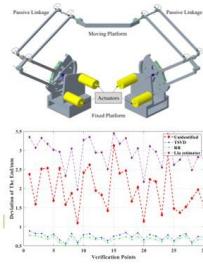
- 14:00~14:15

## Kinematic Self-calibration of a 3-DOF Parallel Mechanism with III-conditioned Identification Matrix

Xingguang Duan, Lixing Jin and Changsheng Li

Beijing Advanced Innovation Center for Intelligent Robots and Systems, Beijing Institute of Technology, China

- Redundant actuation parallel mechanism
- Self-calibration of the kinematic calibration
- III-conditioned identification matrix
- TSVD, RR and Liu estimation algorithm



- 14:30~14:45

## State Sensing of Spinal Surgical Robot Based on Fusion of Sound and Force Signals

Meng Li<sup>1,2</sup>, Xiaozhi Qi<sup>2</sup>, Fengqing Guan<sup>2</sup>, Haiyang Jin<sup>3</sup>, Ying Hu<sup>2</sup>, Wei Tian<sup>4</sup>

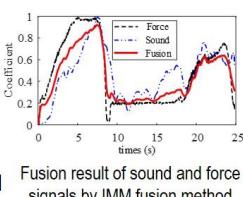
<sup>1</sup>Harbin Institute of Technology(Shenzhen), China

<sup>2</sup>Shenzhen Institute of Advanced Technology, CAS, China

<sup>3</sup>Shenzhen Broadcare medical robotics co. Ltd., China

<sup>4</sup>Shenzhen Beijing Jishuitan Hospital, China

- This paper proposes a state sensing method of spinal surgical robot based on multi-source information.
- The IMM and SVM is performed to train and identify the feature quantities of the sound and force signals.
- The effectiveness of the proposed identification method is verified and compared by using multi-parameter experiments.



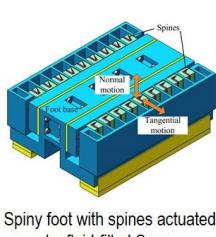
- 15:00~15:15

## Design of a Spiny Foot with Fluid-filled Sacs for Climbing Robots

Yanwei Liu, Xiang Huang, Hao Pan, Shujuan Li, Pengyang Li

School of Mechanical and Precision Instrument Engineering, Xi'an University of Technology, China.

- The spiny foot was inspired by the fluid-filled sac in gecko's foot for force distribution.
- All spines' tangential and normal motion of are actuated by two fluid-filled sacs respectively.
- The spiny foot is capable of adapting to the complex topography of rough wall surfaces.
- The spiny foot prototype is able to carry 540 g extra payload on inverted rough surfaces.



- 14:15~14:30

## Bronchoscopic Interventional Surgery Robot which Constrained by a Shear-Fork Mechanism

Jie Li<sup>1</sup> and Chao Han<sup>2</sup>

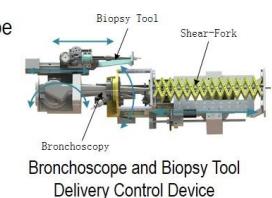
School of Mechanical Engineering, Shenyang Jianzhu University, China

Tao Yu<sup>3</sup>, Xiao He<sup>4</sup>, and Hao Liu<sup>7</sup>

State Key Laboratory of Robotics, Shenyang Institute of Automation, China

Zhenming Jiang<sup>5</sup> and Lei Sun<sup>6</sup>

First Hospital of China Medical University, China



- Research and Development of Bronchoscope Interventional Robot Delivery Mechanism.
- Requirements Analysis and Master Plan.
- Structure Design and Build Control System.
- Model Testing and Analysis.

- 14:45~15:00

## Design and Analysis of a Novel and High-efficiency Axe-foot Part for Razor Clam Inspired Anchoring Robot

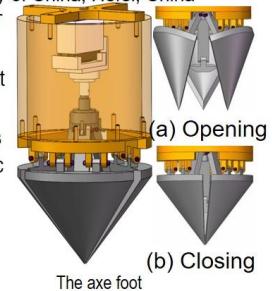
Bingxin Zhao, Lisen Xu,

Hefei Institutes of Physical Science, Chinese Academy of Sciences, Hefei, China

Lei Liu

University of Science and Technology of China, Hefei, China

- A novel and high-efficiency axe-foot part for razor clam inspired anchoring robot.
- The axe foot of the robot plays an important role in the movements of the robot.
- The rationality of the axe-foot part design is proved by mechanics analysis and dynamic analysis.
- The actual burrowing ability and anchoring ability of the axe-foot part is verified by the results of these experiments.



- 15:15~15:30

## Configuration Synthesis and Structure Design of a Reconfigurable Robot for Muscle Strength Training

Jianfeng Li, Pengfei Zhang, Qiang Cao and Mingjie Dong  
Faculty of Materials and Manufacturing Technology, Beijing University of Technology, China

Liwei Jiang

CCSSC System Engineering Research Institute, China

- The configuration of muscle strength training device suitable for all joints was synthesized.
- A reconfigurable robot configuration was proposed for muscle strength training.
- The three-dimensional structure of the muscle strength training robot was designed.
- The reconfigurable simulation was carried out to verify the muscle strength training configuration.



## FrD I : Vision I

Session Chair : Dapeng Tian, Zhi Han  
 Meeting Room 2 : July 16, 14:00 - 15:45, Friday

- 14:00~14:15

Robotic arm grasping through 3D point clouds recognition



2021 IEEE International Conference on Real-time Computing and Robotics

- 14:30~14:45

### An Infrared Image Enhancement Algorithm for Gas Leak Detecting Based on Gaussian Filtering and Adaptive Histogram Segmentation

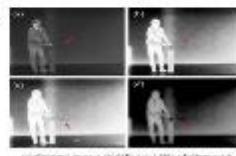
Xiaoxi Nie

School of Resources and Environment, University of Electronic Science and Technology of China, Chengdu, China

Wei Chen

Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China

- Separate the image into detail and background layers using a Gaussian filter.
- Enhancement of detail layers using adaptive histogram segmentation.
- Image enhancement by means of local mapping.



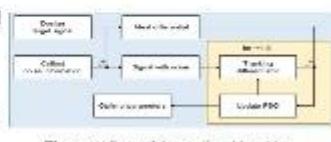
- 15:00~15:15

### Design of Optimal Tracking Differentiator Based on Particle Swarm Optimization

Yang Gao and Dapeng Tian

Key Laboratory of Airborne Optical Imaging and Measurement, Changchun Institute of Optics, Fine Mechanics and Physics, CAS, China  
 University of Chinese Academy of Sciences, China

- An optimal parameter design method for tracking differentiators.
- It is proved that the function of filter and error is convex.
- An off line parameter design method based on PSO



The workflow of the optimal tracking differentiator design based on PSO.

- 15:30~15:45

### A Depthwise Separable Convolution Based 6D Pose Estimation Network by Efficient 2D-3D Feature Fusion

Qi Feng, Chaochen Gu, Jianqi Qin and Rui Xu  
 Department of Automation, Shanghai Jiao Tong University, China

- A novel 2D-3D feature fusion module is proposed to enhance feature extraction in 6D pose estimation network.
- The depthwise separable convolution is integrated to our 6D pose estimation network, which drastically accelerates the model training speed and decreases the model storage space, yet achieves on par or better results than state-of-art methods.



Architecture of our 6D pose estimation network

### A One-step Pseudolinear Kalman Filter for Invasive Target Tracking in Three-dimensional Space

Ying Zhang<sup>1</sup>, Rui Liang<sup>1</sup>, Sheng Xu<sup>2</sup>, Luyuan Zhang<sup>1</sup>,

Ye Zhang<sup>1</sup> and Dandan Xiao<sup>1</sup>

<sup>1</sup>City West Power Supply Branch State Grid Tianjin Electric Power Company, Tianjin, 300190, China  
<sup>2</sup>Guangdong Provincial Key Lab of Robotics and Intelligent System, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences and CAS Key Laboratory of Human-Machine Intelligence-Synergy Systems, Shenzhen Institute of Advanced Technology, Shenzhen, 518055, China

- This paper investigates the problem of invasive target tracking in the 3D space.
- A one-step 3D PLKF algorithm is proposed, which is a modified version of the 3D two-step PLKF. The computation cost of the proposed one is lower than the two-step one.
- Based on statistical knowledge, the estimation accuracy comparison between the one-step and two-step PLKFs are clearly shown.
- The convergence of the two PLKFs are proven.
- Simulation examples verify the effectiveness of the proposed method and the correctness of the theoretical analysis.

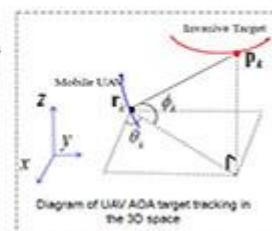


Diagram of UAV AOA target tracking in the 3D space

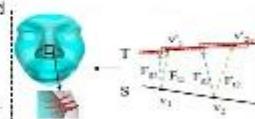
- 14:45~15:00

### 3D Facial Similarity Measure Based on Deformation Field

Jiajun Ma, Guoyuan Liang, Yu Liang, Xinyu Wu

Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- Construct a composite deformation field based on distance transform and correspondence relationship.
- Local similarity and global similarity are calculated based on smooth deformation path.
- The similarity measurement results are in line with the expectation through experiments on the synthetic data and the real data.



The deformation process based on deformation field.

- 15:15~15:30

### A Survey of Image Clustering: Taxonomy and Recent Methods

Jiexin Liu<sup>1</sup>, Dongwei Wang<sup>2</sup>, Siqian Yu<sup>3,4\*</sup>, Xueliang Li<sup>1</sup>, Zhi Han<sup>1,4</sup> and Yunlong Tang<sup>1,5</sup>

<sup>1</sup>State Key Laboratory of Power System, Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing, China  
<sup>2</sup>Institute for Intelligent Manufacturing, Chinese Academy of Sciences, Beijing, China  
<sup>3</sup>College of Information Science and Engineering, Northeastern University, Shenyang, China  
<sup>4</sup>State Key Laboratory of Power System, Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing, China  
<sup>5</sup>State Key Laboratory of Power System, Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing, China

- Image clustering is a fundamental problem in computer vision domain. In this survey, we provide a comprehensive survey for image clustering including traditional clustering methods and deep clustering methods. The main contributions of this paper can be summarized as follows:
- We provide an overview of existing machine learning techniques for image clustering. For each type of image clustering methods, we provide detailed descriptions on representative models, and make the necessary comparisons.
- We collect abundant resources on image clustering, including state-of-the-art models, benchmark data sets, common evaluation metrics and visualization methods. This survey can be used as a practical guide for understanding image clustering.



The definition of image clustering.

## FrA II : Mobile Robots I

Session Chair : Hongpeng Wang, Ziwei Zhou  
 Jingya Pavilion : July 16, 16:15 - 18:00, Friday

- 16:15~16:30

### Extreme Maneuvering Control and Planning of Multi-rotor UAV for High-speed Invading Target Avoidance

Wenhao Sun, Xiaoyang Zhang, Guanglian Lin, Hongpeng Wang,  
 Jianda Han  
 College of Artificial Intelligence, Nankai University, China

- Adopt a hybrid control system to control the extreme maneuvering of UAV.
- Apply extreme maneuvers to dynamically evade high-speed intrusion targets.
- The results are verified by simulation experiments.

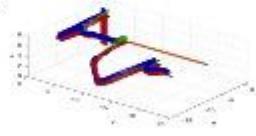


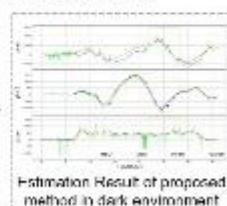
Diagram of UAV extreme maneuvering dynamic obstacle avoidance

- 16:45~17:00

### A cooperative positioning approach of Unmanned Aerial Vehicles with Accuracy and Robustness

Ziwei Zhou, Ziyi Lin, Wei Dong and Xiangyang Zhu  
 School of Mechanical Engineering, Shanghai Jiao Tong University, China  
 Yi Ni  
 Shanghai Electro-Mechanical Engineering Institute, China

- A novel cooperative positioning approach named is proposed, which is comprised of a marker-based position estimation and an end-to-end UAV detection.
- A data fusion algorithm is applied to ensure the accuracy and robustness of the localization.
- Extensive experiments under different environments are carried out to verify the effectiveness of the proposed method.

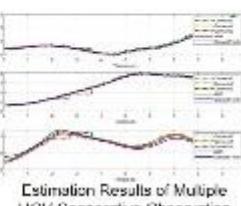


- 17:15~17:30

### Unmanned Aerial Vehicle's State Estimation with Multiple Unmanned Ground Vehicles Cooperative Observation Based on Set-Membership Filter

Jikang Hou, Jiayi Li and Wei Dong  
 School of Mechanical Engineering, Shanghai Jiao Tong University, China  
 Yi Ni  
 Shanghai Electro-Mechanical Engineering Institute, China

- There are usually problems with low observation accuracy or robustness and prior assumptions about noises.
- Set-Membership Filter (SMF) method is applied to the cooperative observation system.
- The application of SMF algorithm in single and multiple UGVs cooperative observation system with obstacles are researched respectively.
- Experiments are conducted to verify accuracy and effectiveness of SMF method.



- 17:45~18:00

### Autonomous mobile robot navigation in uncertain dynamic environments based on deep reinforcement learning

Zhangtan Lu and Ran Huang  
 College of Information Science & Technology, Beijing University of Chemical Technology, China

- This paper proposes E2E navigation based on deep reinforcement learning.
- Use multi-time environmental information to ensure continuous navigation.
- The proposed method has the property of safe and fast navigation in uncertain dynamic environments.
- Simulation results have verified the efficacy of the proposed method.



### IEEE RCAR 2020 Digest The Design of an Aerial/Ground Dual-modal Mobile Robot for Exploring Complex Environments

Daoxun Zhang, Ce Guo, Haoran Ren, Pengming Zhu, Ming Xu  
 and Huimin Lu  
 Robotics Research Center, College of Intelligence Science and Technology, National University of Defense Technology, China

- A novel design of a dual modal mobile robot
- The robot possess aerial and ground movement capability.
- The robot has high energy efficiency and rapid maneuverability.



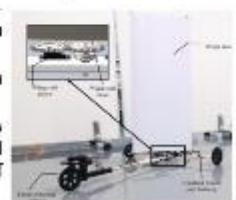
The aerial-ground dual-modal mobile robot prototype

- 17:00~17:15

### Modeling and Implementation of Tacking for Wing Sail Land-yacht

Yihan Huang, Yang Jiao and Xinyu Chen  
 The Chinese University of Hong Kong, Shenzhen, China  
 Lianxin Zhang, Xiaoqiang Ji and Huihuan Oian  
 Shenzhen Institute of Artificial Intelligence and Robotics for Society, The Chinese University of Hong Kong, Shenzhen, China

- A novel lightweight design of low cost three-wheeled land-yacht with a T-frame and a foamed wing sail is proposed.
- A model is developed to predict the minimum initial velocity for upwind steering (tacking).
- An acceleration error function C in the model is identified by a series of experiments, and tacking experiments with a high success rate of 94.7% verify the steering model.

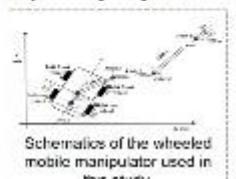


- 17:30~17:45

### Kinematic control of mobile manipulators subject to physical constraints and noise disturbances

Xiaoxiao Li and Zhihao Xu and Xueteng  
 Guangdong Key Laboratory of Modern Control Technology, Institute of Intelligent Manufacturing, GDAS, Guangzhou, Guangdong, P. R. China  
 Shuai Li and Kanyang Jiang  
 School of Engineering, Swansea University, Swansea, United Kingdom

- Considering the kinematic control of wheeled mobile manipulator subject to physical limits and external noise disturbances.
- Proposing an HMOC scheme incorporating path following and physical constraints' compliance based on the quadratic program.
- Validating efficiency of the HMOC scheme and the designed solver via simulation.



## FrB II : Human-Machine Interface II

Session Chair : Guanglin Li, Ning Lan  
Lanting Pavilion : July 16, 16:15 - 18:00, Friday

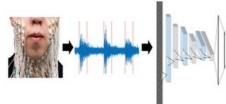
- 16:15~16:30

### **The effects of different training modes on the performance of silent speech recognition based on high-density sEMG**

Y. Pi, M. Zhu, Z. Yang, X. Wang, C. Wang, H. Zhang, S. Chen, and G. Li

The CAS Key Laboratory of Human-Machine Intelligence-Synergy Systems, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

- There are two different training modes for SSR.
- Using different training modes might lead to a big difference in the performance of the same model.
- The CNN model using the signals from a single subject performed better in these metrics, but it was only suitable for the SSR of the same subject.



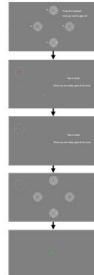
- 16:45~17:00

### **Asynchronous steady-state visual evoked potential brain-computer interface application: True and false positive rate comparison between with and without eye-tracking switch paradigms**

Jun Xie and Huanqing Zhang

School of Mechanical Engineering, Xi'an Jiaotong University, China

- This paper proposed eye-tracking switch based asynchronous BCI paradigm to reduce the false positive rate.
- Results showed that the false positive rate was reduced to less than 10%.
- Meanwhile, the recognition accuracy can also be improved to a certain extent.



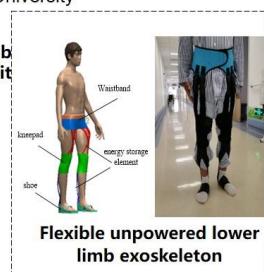
- 17:15~17:30

### **IEEE RCAR 2020 Simulation design of flexible Unpowered lower limb exoskeleton**

Yongfeng Wang, Yanan Diao, Yunkun Ning, Guanglin Li, and Guoru Zhao\*

Shenzhen Institutes of Advanced Technology  
Hubei Polytechnic University

- (1) Conventional unpowered lower limb exoskeleton pay less attention to gait energy efficiency
- (2) the structure design for flexible unpowered lower limb exoskeleton with rubber energy storage element.
- (3) the musculoskeletal model with exoskeleton is established, the variable ranges of the elongation of elastic elements for the ankle is bigger than hip during walking



- 16:30~16:45

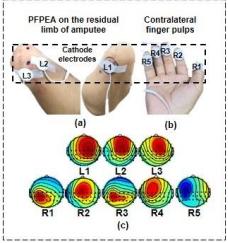
### **Evaluation of Phantom Finger Sensation Evoked by Electrical Stimulation for Transradial Amputee: A Case Study**

Yingying Wang, Xi Tang, Naifu Jiang, Lan Tian, Yue Zheng, Xiangxin Li, Guanglin Li\*, and Peng Fang\*

The CAS Key Laboratory of Human-Machine Intelligence-Synergy Systems, Shenzhen Institutes of Advanced Technology, China

Jun Xie  
The School of Mechanical Engineering, Xi'an Jiaotong University, China

- The non-invasive Electrical Nerve Stimulation (TENS) is used to reestablish the sensory function for a limb amputee
- An approach based on electroencephalogram (EEG) is proposed to evaluate the evoked somatosensory information
- Somatosensory information evoked at different positions of the stump could be distinguished by characteristics of Event-Related Potential (ERP)



- 17:00~17:15

### **IEEE RCAR 2020 Digest Template Performance Assessment of Artificial Intelligence Medical Device Software Using Synthetic Data**

Hao Wang, Xiangfeng Meng, Chao Zhang, Jiage Li  
Institute for Medical Device Control, National Institutes for Food and Drug Control, 31 Huatuo Rd, Daxing, Beijing, China

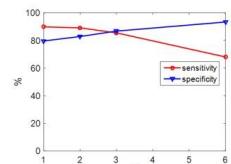


Fig. 7 Algorithm performance variation with focusing (red circle: sensitivity; blue triangle: specificity)

## FrC II : Robotic control III

Session Chair : Xin Wang, Xin Shi

Meeting Room 1 : July 16, 16:15 - 18:00, Friday

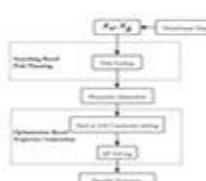
• 16:15~16:30

• 16:30~16:45

**Optimized Underwater Manipulator Path Planning to Minimize The Disturbance on Robot**

Xiaodi Liu , Xin Wang\* and Xiaotian Cai  
 Mechanical Engineering and Automation,  
 Harbin Institute of Technology Shenzhen, China.

- The goal of the path planning in this paper is to cause the smallest possible variation in disturbance moments to the robot body.
- Generates a disturbance map by data collection, on the basis of which the path search is then carried out.
- Develop an algorithm based on the path search of the underwater manipulator and the optimized trajectory generation to minimize the disturbance to the robot body.



• 16:45~17:00

**Reinforcement Learning of Serpentine Locomotion for a Snake Robot**

Mr. Ke Qiu and Mr. Yikai Lv  
 School of Mechanical Engineering  
 Mr. Hang Zhang  
 College of Electrical Engineering

Mr. Yunkai Wang, Dr. Chunlin Zhou and Dr. Rong Xiong  
 College of Control Science and Engineering , Zhejiang University, China

- The locomotion control of the snake robot.
- A central pattern generator (CPG) model for providing serpentine locomotion.
- Reinforcement learning (RL) for getting optimal model parameters.

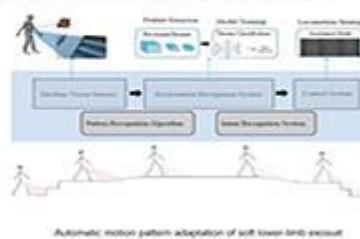


• 17:15~17:30

**environment classification and recognition for soft lower-limb exosuit**

Ni Jiangpeng and Wang Zhuo  
 Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences

- Reliable environmental context prediction is critical for wearable robots to assist terrain-adaptive locomotion.
- terrain classification and recognition system (TCRS) is designed for lower-limb soft exosuit robots.
- The results in this study may lead to novel context recognition strategies in reliable decision-making, improved intelligent system design in various applications.

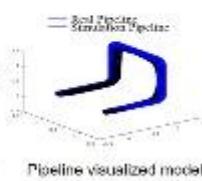


• 17:45~18:00

**Visualized Small-size Pipeline Model Building Using Multilink-articulated Wheeled In-pipe Inspection Robot**

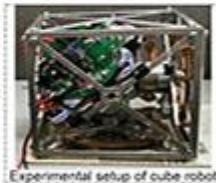
Dianzhen Guo and Jianjun Yuan  
 Shanghai Robotics Institute, Shanghai University, China  
 Zhaohan Yuan  
 Robotics Institute, Shanghai Jiao Tong University, China

- The robot is suitable for the inspection of pipelines with diameters between 120mm and 180mm.
- The visualized pipeline model building is based on small size inertial measurement unit (IMU) and encoder.
- A multi-sensor data fusion algorithm is used to improve the accuracy of the visualized pipeline model.

**Research on Balance Control of Cube Robot**

Qingsong Yin, Feifei Wang, Siliang Lu, Yuan Fan  
 College of Electrical Engineering and Automation, Anhui University, China  
 Yongbin Liu, Guoli Li  
 National Engineering Laboratory of Energy-Saving Motor and Control  
 Technology, Anhui University, China

- Mechanical structure of cube robot was design
- State-space equation were derived from system dynamics modeling
- The closed-loop state-space equation of robot system was simulated
- Balance control of cube robot was tested and verified by the experimental setup.

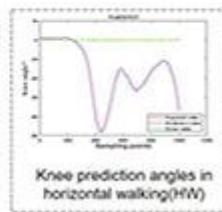


• 17:00~17:15

**Angle Estimation for Lower Limb Joint Movement Based on VMD-NARX Algorithm**

Xin Shi, Jieyi Zhang, Pengjie Qin, and Rongyi Liu  
 College of Automation, Chongqing University, China

- A variational mode decomposition (vmd) algorithm based on neural network is proposed
- The lower limb angle prediction model based on NARX neural network is established
- The RMSE of NARX prediction model based on variational mode decomposition is lower than 2



• 17:30~17:45

**Development of a Virtual Training System for Master-Slave Hip Replacement Surgery**

Riwei Zhang, Q. Liu, S. Cai, C. Wang, X. Zhang, L. Duan, Y. Lu, B. Zhang, Z. Wu, J. Guo  
 School of Automation, Guangdong University of Technology, Guangzhou, China  
 The First Affiliated Hospital of Shenzhen University, Shenzhen, China

- The Virtual Training System helps surgeons to better adapt to the robotic system.
- The System improves the surgeons' proficiency in Hip Replacement Surgery.
- The System provides vivid and intuitive perception, improves the understanding of the remote manipulation.



## FrD II : Learning I

Session Chair : Yong He, Shifeng Guo

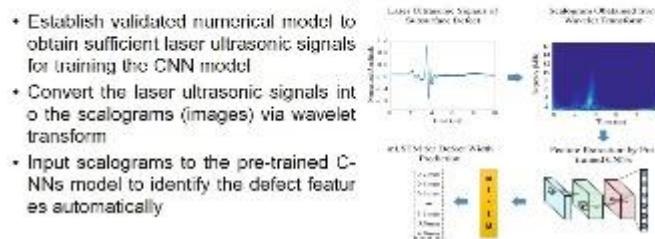
Meeting Room 2 : July 16, 16:15 - 18:00, Friday

• 16:15~16:30

### **Automatic Quantification Of Subsurface Defects By Analyzing Laser Ultrasonic Signals Using Convolutional Neural Networks And Wavelet**

Haowen Feng, Gaolong Lv, Dan Chen and Shifeng Guo\*  
Shenzhen Institutes of Advanced Technology, University of Chinese Academy of Science, China

- Establish validated numerical model to obtain sufficient laser ultrasonic signals for training the CNN model
- Convert the laser ultrasonic signals into the scalograms (images) via wavelet transform
- Input scalograms to the pre-trained CNNs model to identify the defect features automatically



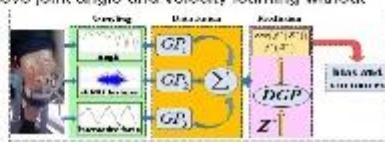
• 16:45~17:00

### **Evolving Gaussian Process based Learning of Knee Angle and Velocity**

Jiantao Yang<sup>1</sup>, Yong He<sup>2</sup>, Chen He<sup>1</sup>, and Ping Shi<sup>1\*</sup>  
1. Institute of Rehabilitation Engineering and Technology, University of Shanghai for Science and Technology, China

2. CAS Key Laboratory of Human-Machine Intelligence Synergy Systems, Shenzhen Institutes of Advanced Technology, China

- Dependent Gaussian process is established to fuse multi-source information from each of the human exoskeleton subsystems
- Gradient estimation model is then performed to obtain the joint velocity
- The proposed model can achieve joint angle and velocity learning without velocity measurement.



• 17:15~17:30

### **Socially-Aware Multi-Agent Following with 2D Laser Scans via Deep Reinforcement Learning and Potential Field**

Yuxiang Cui, Xiaolong Huang, Yue Wang, Rong Xiong  
CSF, Zhejiang University, China

- We propose a potential field based method for formation control and goal assignment.
- We propose a deep model of socially-aware following policy trained by reinforcement learning.
- Our method can be applied to random environments with an arbitrary number of robots.
- We train the policy in a decentralized policy sharing multi-agent simulation environment.



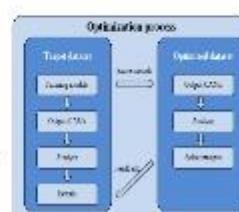
Real robot evaluation

• 17:45~18:00

### **Deep Convolutional Neural Network Transfer Learning Optimization Based on Visual Interpretation**

Yibo Xu, Jiongming Su, Fengtao Xiang, Ce Guo, Haoran Ren, Huimin Lu  
College of Intelligent Science, National University of Defense Technology, China

- Introduce "feedback" to pre-recognize optimized datasets
- Visual interpretation of military images using class activation mapping
- Optimization of the training set for the test set



### **Efficient Learning-based Trajectory Tacker for Quadrotor at High-speed Flight**

Peng Peng, Gang Chen and Wei Dong  
School of Mechanical Engineering, Shanghai Jiaotong University, China  
Yi Ni  
Shanghai Electro-Mechanical Engineering Institute, China

- This paper aims to improve the accuracy of the trajectory tracking of the quadrotor
- Combining traditional PID controller with the idea of neural network modeling based MPC.
- The tracking performance is obviously improved both in simulation and experiment.



Home-made quadrotor for tracking experiment

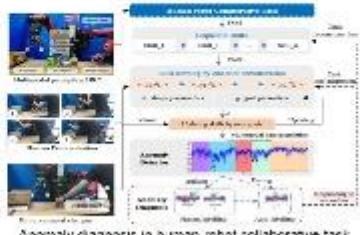
• 17:00~17:15

### **Robot Multimodal Anomaly Diagnosis by Learning Time-lagged Complex Dynamics**

Lin Yang<sup>2</sup>, Wu Yan<sup>1</sup>, Zhihao Xu<sup>1</sup>, and Hongmin Wu<sup>1\*</sup>

Institute of Intelligent Manufacturing, Guangdong Academy of Sciences, China  
Guangdong Provincial Key Laboratory of Electronic Information Product Reliability Technology, China

- A novel method of multimodal anomaly diagnosis by learning the time lagged dynamics of anomalies detected during an Human-robot collaborative task
- A time-lagged variational auto-encoder model (TVAE) is first proposed to compress complex multivariate dynamics into simple manifolds.
- The manifolds are used to filling a dynamic time warping based K nearest neighbors model for anomaly diagnosis in a multi-classes classification scheme.



• 17:30~17:45

### **Human Parsing with Edge Enhancement**

Lei Ma and Liqing Zhang  
RICI, Shanghai Jiao Tong University, China  
Jian Wang and Jie Shao  
AI Lab, ByteDance Inc., China

- Focusing on enhancing body's edge segmentation performance of the human parsing problem.
- Three aspects: feature extraction, context embedding, and edge refinement.
- Refining the body's edges in the up-sampling procedures in a coarse-to-fine fashion.
- Achieved excellent performance, mIoU 54.05% on LIP dataset, and mIoU 66.88% on PASCAL-Person-Part datasets.

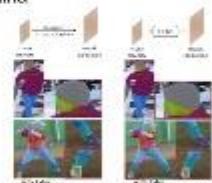


Fig.1 Comparison of models w/o the edge enhancement.

## SaA I : Vision II

Session Chair : Yunjiang Lou, Yue Ma  
 Jingya Pavilion : July 17, 8:30 - 10:15, Saturday

- 8:30~8:45

### Total Variation Regularized Low-Rank Tensor Decomposition with nonlocal for single image denoising

Shengchuan Li<sup>1</sup>, Yanmei Wang<sup>2,4,5</sup>, Qiong Luo<sup>3,4,5</sup>, Kai Wang<sup>2</sup>, Zhi Han<sup>1,4</sup> and Yandong Tang<sup>3,4</sup>

- State Grid Liaoning Electric Power Research Institute, Shenyang, China
  - State Grid Shandong Electric Power Company, Shandong, China
  - State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang, China
  - Institutes for Robotics and Intelligent Manufacturing, Chinese Academy of Sciences, Shenyang, China;
  - University of Chinese Academy of Sciences, Beijing, China
- Sparse noise and Gaussian noise are modeled separately.
  - Introducing the non-local prior into tensor decomposition with TV model.
  - Experiments prove the effectiveness of the proposed method.



Comparison of different methods under different noise cases

- 9:00~9:15

### A full-body 3D reconstruction using planar mirrors

Pengju Xie, Yuping Ye, Lijun Shu and Zhan Song  
 Shenzhen Institute of Advanced Technology, University of Chinese Academy of Sciences, China

- This paper proposed an SL based full body 3D reconstruction method utilizing two planar mirrors.
- Our method adopted the light reflection principle and comprehensively considered the calibration problem essential for the point cloud registration.



- 9:30~9:45

### Stereo calibration of defocus cameras without the limitation of overlapping fields of view

Xiaokai Song and Xiangcheng Chen  
 School of Automation, Wuhan University of Technology, China  
 Wenyuan Liang  
 National Research Center for Rehabilitation Technical Aids, China

- Each feature point is coded by the phase-coding method.
- Stereo calibration can be realized even if the cameras are defocused.
- Without the limitation of the cameras' overlapping fields of view.

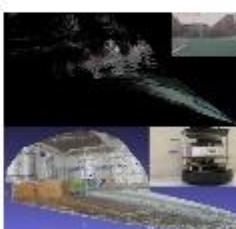


- 10:00~10:15

### Colorful Reconstruction from Solid-State-LiDAR and Monocular Version

Jinyang Zhang, Pengfei Qu, Shenliang Li  
 Kuizhi Mei and Zhansheng Duan  
 Faculty of Electronics and Information Engineering of Xi'an Jiaotong University, Xi'an, Shaanxi, China

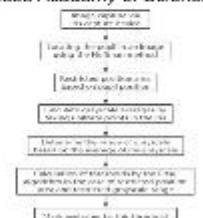
- The fusion is both of LiDAR's higher precision depth and version's colorful texture.
- New solid-state LiDAR has denser pointcloud than convention Velodyne LiDAR, the former contains more details.
- The cheaper LiDAR improved robot perception ability with a wide range of applications.



### An Eyelashes Segmentation Method Based on Improved Inter-class Variance Maximization Algorithm

Hantong Zhang  
 Shenzhen Institute of Advanced Technology Chinese Academy of Sciences, University of Chinese Academy of Sciences, China  
 Wei Chen  
 Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- Restrict the location of the region of interest by pupil position.
- Limit the grayscale range by the average grayscale of the iris.
- Calculation of thresholds by the Otsu algorithm in the case of restricted position area and restricted grayscale range.



- 9:15~9:30

### High-Precision Pose Estimation Method of the 3C Parts by Combining 2D and 3D Vision for Robotic Grasping in Assembly Applications

Nan Zhang, Yixin Xie, Xiansheng Yang, Haopeng Hu and Yunjiang Lou  
 School of Mechanical Engineering and Automation, Harbin Institute of Technology, Shenzhen, China

- This paper presents a high-precision 6D pose estimation method for robotic grasping in assembly applications.
- The Mask R CNN is used to map and extract point cloud of the component.
- An accurate estimation of component pose is got by PCA and ICP, and the robot can grasp accurately after hand-eye calibration.



- 9:45~10:00

### A High-Precision Assembly System of 3C Parts Based on 6D Pose Estimation and Visual Servoing

Yixin Xie, Nan Zhang, Xiansheng Yang and Yunjiang Lou  
 School of Mechanical Engineering and Automation, Harbin Institute of Technology, Shenzhen, China

- This paper presents an automatic high-precision assembly system.
- A pose compensation strategy and real-time visual servoing approaches are flexibly implemented.
- Can tackle the assembly tasks even if two parts both exist uncertain poses.



# SaB I : Advanced Control I

Session Chair : Jingshuai Liu, Qiang Qu  
 Lanting Pavilion : July 17, 8:30 - 10:15, Saturday

- 8:30~8:45

- 8:45~9:00

## Fixed-time leader-follower consensus based secondary voltage control for microgrid under directed communication graph

Junkang Ni,

School of Automation, Northwestern Polytechnical University

Hui Cao,

School of Electrical Engineering, Xian Jiaotong University

Xinghua Liu, Lei Yang,

School of Electrical Engineering, Xi'an University of Technology

Liansong Xiong

School of Automation, Nanjing Institute of Technology

- A fixed-time leader-follower consensus based secondary voltage controller is proposed.

- The proposed consensus scheme achieves fixed-time consensus tracking for multi-agent systems under digraph.

- The proposed consensus scheme achieves secondary voltage restoration within a fixed time.

- 9:00~9:15



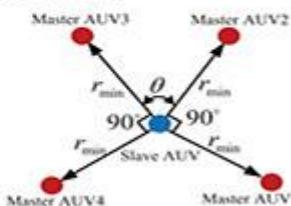
The voltage responses of the DGs under control

## Optimality analysis for formation of Multi-AUV cooperative positioning based on genetic algorithm

Junqi Qu, Gongwu Sun, Jun Zhang, Xinguang Li, and Ying Mao  
 China Ship Scientific Research Center

- the measurement equation of correlation between measurement information and measurement error is established.
- the performance evaluation function of multi-AUV formation configuration is established based on the information matrix
- the analysis method of optimal formation configuration is proposed based on the genetic algorithm.

- 9:30~9:45



## Distributed Adaptive Control of Multiple Robots for Cooperative Load Transportation

Bo Zhang, Pudong Liu, Runhao Xi, Youqiang Ye and Shiyu Chen  
 College of Mechatronics and Control Engineering, Shenzhen University, China

Yao Cui

Research & Development Institute of Northwestern Polytechnical University In Shenzhen, China

- An adaptive control (MRAC) method based on model reference is proposed.
- The common load state space model of multiple omnidirectional mobile robots is established.
- The controller of automatic adjustment of control parameters is designed to approach the reference model.
- Prior knowledge of robot position and load characteristics is not needed to control the robots transport load.



Multi-robot transport system

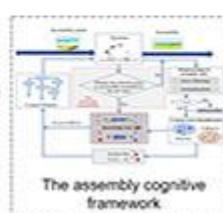
- 10:00~10:15

## A robot assembly framework with "perception-action" mapping cognitive learning

FengMing Li, TianYu Fu, GuoQing Chu, Rui Song<sup>\*</sup> and YiBin Li  
 1 School of Control Science and Engineering, Shandong University,  
 Jinan, 250061, China

2 School of Mechanical and Electrical Engineering, Harbin Institute of Technology, Harbin 150006, China

- the proposed framework integrates the cognitive recognition and online control strategy of the assembly state.
- it can monitor the unknown state of the robot in the process of assembly contact in real time.
- It can recognize the new assembly state, update the assembly experience knowledge base in real time, and guide the robot to complete the assembly work.

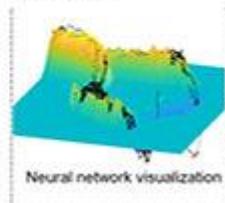


## Force Tracking Control for Electro-Hydraulic Actuators Based On RBF Neural Networks

Xinhui Tian, Honglei An, Zhitong Zhang, Xu Chang, Hongxu Ma and Qing Wei

Robot Research Center, College of Intelligence Science and Technology, National University of Defense Technology, China

- The static relationship between velocity-force-input has been demonstrated in hydraulic actuators.
- The least square method and RBF neural network are used to identify this relationship.
- The performances of force-tracking and disturbance-rejection have been improved.

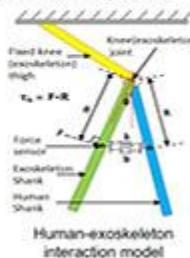


- 9:15~9:30

## Adaptive Admittance Control of Human-Exoskeleton System Using RNN Optimization

Pengchen Lian, Yong He, Yue Ma, Jingshuai Liu and Xinyu Wu  
 Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- A new adaptive admittance control law is proposed, which provides a harmonious human-exoskeleton interaction.
- The proposed admittance control law is further optimized by Jordan Recurrent Neural Network (JRNN).
- Compared with fixed admittance control, the proposed method significantly improves the interaction level.



- 9:45~10:00

## IEEE RCAR 2020 Digest Template

### WRS: A Novel Word-embedding Method for Real-time Sentiment with Integrated LSTM-CNN Model

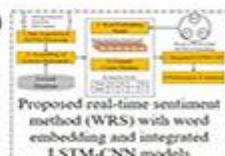
Abdur Rasool<sup>1,2</sup>, Qingshan Jiang<sup>1</sup>, Qiang Qu<sup>1</sup>, Chaojie Ji<sup>3</sup>

<sup>1</sup>Shenzhen Key Lab for High Performance Data Mining, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

<sup>2</sup>Shenzhen College of Advanced Technology, University of Chinese Academy of Sciences, China

<sup>3</sup>Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China

- Propose a novel Word-to-Word Graph (W2WG) embedding for the real-time sentiment (WRS).
- Two neural networks integrate (LSTM-CNN) to gain the highly efficient features.
- Experiment with IMDB and real-time Twitter data and achieved effective results.



## SaC I : Learning II

Session Chair : Hui Cao, Chunjie Chen

Meeting Room 1 : July 17, 8:30 - 10:15, Saturday

- 8:30~8:45

- 8:45~9:00

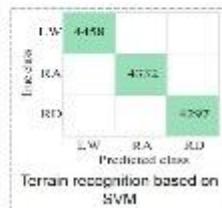
### Recognition and Gait Cycle Prediction Using IMU

Zhuo Wang, Yu Zhang, Jiangpeng Ni,

Xinyu Wu, Yida Liu, Xin Ye and Chunjie Chen\*

Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences

- Terrain recognition based on intersection angle only quickly recognizes the terrain when walking stably, and its robustness is limited.
- Terrain recognition based on SVM is achieved to 100% after introducing the Gaussian kernel function.
- Wiener one step prediction is applied in predicting the GC, the error from which is less than 4.35%.



- 9:00~9:15

### Multi-Stage Decision-Making Skill Learning for Soccer Robot

Zhike Chen, Zhiye He, Haozhe Du, Chenrui Han, Rong Xiong  
College of Control Science and Engineering, Zhejiang University, Hangzhou, China.

- Hierarchical Reinforcement Learning method is used to learn complex multi-stage decision-making skill
- The method is validated by learning skill for robot on small size soccer robot platform
- Our method has the advantage on higher success rate comparing with traditional methods

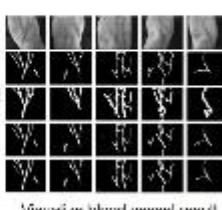


- 9:15~9:30

### Time-frequency decomposition-based weighted ensemble learning for motor imagery EEG classification

Liangsheng Zheng, Yue Ma, Mengyao Li, Yang Xiao, Wei Feng and Xinyu Wu  
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- Establish a data set of human arm venous blood vessels for training deep learning models.
- Use deep learning models to replace traditional digital image processing methods to identify veins
- Real-time automatic segmentation of veins in the venipuncture robot



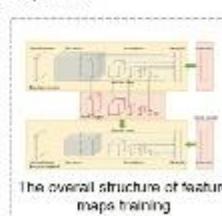
- 9:30~9:45

### Feature Maps Training for Substation Defect Detection

Xingyu Yan, Yangjing Ma, Ning Wang, Yuxing He and Hui Cao  
School of Electrical Engineering, Xi'an Jiaotong University, China

Jie Zhou  
CON New Energy Holdings Co., Ltd, China

- Feature maps of complex networks are used in training
- A loss function is designed to meet different training targets
- Ideal pixel is proposed in object detection to trade-off the background and the foreground.
- This paper summarizes the common object detection requirements in substations and carries out experiments.



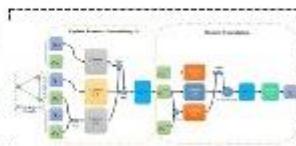
- 10:00~10:15

- 9:45~10:00

### Multi-Agent Trajectory Prediction Based on Graph Neural Network

Haozhe Du, Zhike Chen, Yufeng Wang, Zheyuan Huang, Yunkai Wang and Rong Xiong  
Institute of Cyber Systems and Control, Zhejiang University, China

- Construct ZJUNictSSL dataset for multi-agent prediction problems
- Propose a heterogeneous graph neural network method for multi-agent prediction problems.
- Our method focuses on environment and tasks of agents in problems.
- Present a new view for graph-like scenes in multi-agent prediction problems.



### Finger Joint Angle Estimation based on sEMG signals and deep learning method

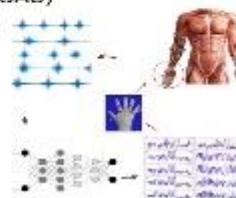
Chentel Ma and Lisheng Xu

College of Medicine and Biological Information Engineering,  
Northeastern University, China

Welyu Guo and Guanglin Li

Shenzhen Institute of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS)

- Continuous finger movement estimation based on sEMG signals
- Simultaneous 10 DoFs joint angle output on 8 complex finger movements
- Modified AlexNet outperforms ResNet, LSTM and GRU on 8 abled subjects



## SaD I : Robot Mechanism II

Session Chair : Jianquan Sun, Jizhuang Fan  
 Meeting Room 2 : July 17, 8:30 - 10:15, Saturday

- 8:30~8:45

### Bionic Design of a Self-Reconfigurable Modular Robot for Search and Rescue

Guangju Gao, Jingshuai Liu, Yong He,

Jianquan Sun and Xin Yu Wu

Shenzhen College of Advanced Technology, Chinese Academy of Sciences, China

- A novel self-reconfigurable modular robot for search and rescue
- The modular robot can be connected or disconnected according to the actual task requirements
- The robot has a strong flexibility to cross obstacles in a disaster environment



- 9:00~9:15

### A Modular Rehabilitation Lower Limb Exoskeleton for Stroke Patients With Hemiplegia

Pengbo Li, Wenhao Wei, Ruoyu Bao, Beilin He, Zhilong Su, Can Wang and Xinyu Wu  
 Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen

- A modular exoskeleton robot, including an independent hip joint, knee joint and ankle joint
- Not cause additional harm to the human body
- SIAT-II meets the design requirements, light, modular, versatile, and suitable for left or right leg.



- 9:30~9:45

### Research status and Development trend of Inspection Robot for Steam Generator Heat Transfer Tubes

Kuan Zhang, Biying Xu, Zhenming Xing, Jie Zhao, Jizhuang Fan\*  
 State Key Laboratory of Robotics and System,  
 Harbin Institute of Technology, China

- The key technologies are analyzed in detail.
- Summarize the existing problems and challenges
- Prospects the future development trend



- 10:00~10:15

### Design and implementation of variable stiffness rigid-soft coupling pneumatic actuated joint

Jinfeng Zhao, Changqu Wu, Wenbiao Wang, and Guanjun Bao  
 College of Mechanical Engineering, Zhejiang University of Technology, China

- Rigid-flexible coupling joint with variable stiffness
- Attitude sensing for soft body robots
- Stiffness test experiment of soft-body



### A new structure of end-effector traction upper limb rehabilitation robot

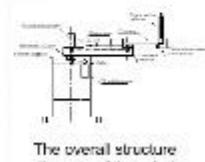
Liaoyuan Li, Jianhai Han, Xiangpan Li, Bingjing Guo, Pengpeng Xia

School of Mechanical and Electrical Engineering, HAUST, China

Gangqin Du

Department of Neurology, First Affiliated Hospital of HAUST, China

- 2 horizontal rotary joints and 1 vertical prismatic joint
- Realize rehabilitation training in three-dimensional space with compact structure
- Realize passive and active rehabilitation training.
- With passive and active compliance and safety.



The overall structure diagram of the robot

- 9:15~9:30

### Design and motion performance of new inspection robot for Steam Generator heat transfer tubes

Biying Xu, Ge Li, Zhenming Xing, Jie Zhao and Jizhuang Fan\*  
 State Key Laboratory of Robotics and System,  
 Harbin Institute of Technology, China

- Remote control inspection robot for Steam Generator heat transfer tubes
- Structural modeling and kinematic
- Modular control system
- Tube sheet motion experiments and performance analysis



- 9:45~10:00

### Design of a Quadruped Wall-Climbing Robot (WCR) with a Three-Row Opposed Gripping Mechanism

Shengchang Fang, Chao Xie, Xuan Wu, and Xiaojie Wang  
 Institute of Intelligent Machines, Hefei Institutes of Physical Science,  
 Chinese Academy of Sciences, Hefei

- A quadruped climbing robot with a three-row opposed gripping mechanism is designed.
- The degree of freedom of the robot is demonstrated and adopting the trotting gait as the climbing mode.
- The feasibility of the mechanical structure and gait scheme is verified.
- The prototype of the robot is made and a preliminary experiment is carried out.



The robot can attach to the wall with four feet equipped with three-row opposed grippers

## SaA II : Vision III

Session Chair : Chao Wang, Feifei Gu

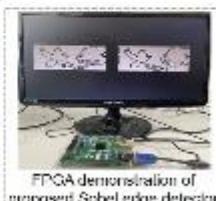
Jingya Pavilion : July 17, 10:45 - 12:30, Saturday

• 10:45~11:00

**Low Computation and High Efficiency Sobel Edge Detector for Robot Vision**

Fei Liu, Jipeng Wang, Bingqiang Liu, Run Min, Guoyi Yu, Fengwei An and Chao Wang  
School of Optical and Electronics Information, Huazhong University of Science and Technology, China

- An area-efficient and energy-efficient Sobel edge detector design is proposed.
- The bit-width pruning, shift-add operation and bit width tuning techniques is utilized.
- The required area and computation is significantly reduced with negligible edge information loss.
- The detector is suitable for resource-limited and energy-constrained mobile robots in edge IoT applications.

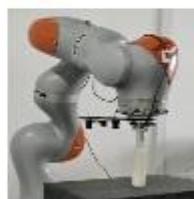


• 11:15~11:30

**Zener Model based Impedance Control for High-precision Force Tracking of Robot-environment Interaction**

Xi Wu, Panfeng Huang, Zhengxiong Liu and Zhiqiang Ma  
School of Astronautics, Northwestern Polytechnical University, China

- Combined the conventional Voigt impedance model and Maxwell impedance model.
- Switching model with parameter changing.
- Force tracking is less affected by the uncertainty of the robot dynamics and environmental force.
- Proving the system is still stable even in the presence of uncertainties in the environment.

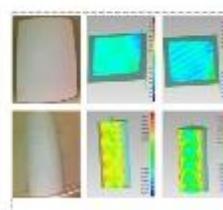


• 11:45~12:00

**An Accurate Speckle 3D Reconstruction System Based on Binocular Endoscope**

Junguang Guo<sup>1</sup>, Feifei Gu<sup>1</sup>, Yuping Ye<sup>1</sup> and Zhan Song<sup>1,2</sup>  
<sup>1</sup>Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China  
<sup>2</sup>The Chinese University of Hong Kong, China

- A high-accuracy calibration method is proposed to calibrate the system.
- An improved Semi Global Matching (SGM) algorithm is proposed to improve the correctness of the stereo matching.
- The experimental results showed that, the proposed algorithm we put forwarded can play a significant role in improving the 3D measurement accuracy.



• 12:15~12:30

**Design of scanning robot for atherosclerosis detection via photoacoustic imaging**

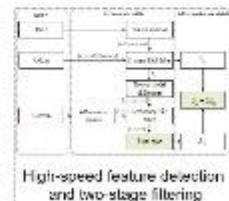
Yongjian Zhao, Yuting Shen, Fei Gao  
School of Information Science and Technology, ShanghaiTech University  
Li Liu  
Department of Electronic Engineering, the Chinese University of Hong Kong, Hong Kong, China

- Designing a rotating scanning robot for photoacoustic imaging of cervical atherosclerosis.
- It can replace the doctor's manual inspection. Play the role of liberating hands.
- Photoacoustic imaging has been applied as a perception of this Robot

**Multi-robot real-time cooperative localization based on high-speed feature detection and two-stage filtering**

Zeyu Zhou, Wei Tang, Zenghui Wang, Lijian Wang, and Renyuan Zhang  
Automation, Northwestern Polytechnical University, China

- A high-speed feature detection and transformation method based on visual information is proposed.
- A multi-robot cooperative localization method based on two-stage EKF is established for dynamic real scene.
- A lightweight multi-robot information intersection mechanism is utilized to deploy the system in actual platform.

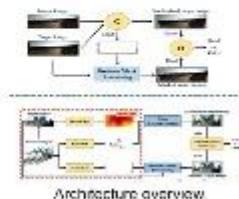


• 11:30~11:45

**Masked GAN for Unsupervised Depth and Pose Prediction with Scale Consistency**

Chaoqiang Zhao and Yang Tang  
East China University of Science and Technology, China

- We introduce a masked GAN framework for unsupervised pose and depth estimation.
- We discuss the effect of unreconstructed regions on adversarial learning.
- We consider the scale-inconsistent problem and propose an adaptive constraint for a better global trajectory prediction.
- Both the pose and depth networks proposed in this paper show competitive results on public datasets.

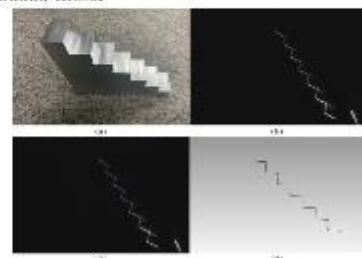


• 12:00~12:15

**A Flexible and Accurate Calibration Method for Line Structured Light**

Yuping Ye, Lijun Shu and Zhan Song  
Shenzhen Institute of Advanced Technology, University of Chinese Academy of Sciences, China

- In this paper, we proposed a flexible and accurate laser calibration method.
- The method we proposed needs only one scan of the stair block to calculate the optimal laser plane function.





## SaC II : Planning and Navigation

Session Chair : Hang Yu, Yizhai Zhang

Meeting Room 1 : July 17, 10:45 - 12:30, Saturday

• 10:45~11:00

### IEEE RCAR 2020 Digest Template Paper Title in One or Two Lines

Yujing Chen and Yunjiang Lou  
School of Mechatronics Engineering and Automation,  
Harbin Institute of Technology Shenzhen

- We construct a vector field histogram based on the observed static obstacles and pedestrians
- An objective function is proposed to get an optimal direction of the mobile robot
- We introduce a fuzzy inference system to generate smooth and efficient motion.
- The proposed planner is tested on a robot in various densely crowded scenarios



Robot navigation in dense crowds by the proposed planner

• 11:15~11:30

### Trajectory Planning for Collaborative Transportation by Tethered Multi-UAVs

Chongxu Pei and Fan Zhang and Panteng Huang and Hang Yu  
Research Center for Intelligent Robotics,  
Northwestern Polytechnical University, China

- A multi-robot cooperative trajectory planning method with constraints is proposed
- A hybrid A\* algorithm with cluster obstacle avoidance is used for path search
- Some special rope constraints of UAV swarm flight are defined.
- The trajectory is optimized by nonlinear optimization with the problem of trajectory smoothing.



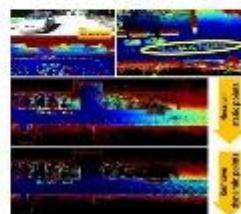
Collaborative transportation by Tethered Multi-UAVs

• 11:45~12:00

### Method for Static 3D Point Cloud Map Building using Multi-View Images with Multi-Resolution

Chen Yao, Hu Zhu, Shipeng Lv, Dingyuan Zhang, Zhenzhong Jia\*  
Department of Mechanical and Energy Engineering,  
Southern University of Science and Technology, China

- Multi-view image-based algorithm to robustly detect the discrepancy and correct unreliable calculation of projected images.
- A novel recover-then-remove mechanism to generate a pure reliable static 3D point cloud map and exclude dynamic points.
- Different view with various resolution to enhance the quality of static maps with adjustable motion ambiguity



• 12:15~12:30

### A Hierarchical Semantic Map for Large-scale Outdoor Environment

DI Zhang and De Xu  
Research Center of Precision Sensing and Control, Institute of Automation,  
Chinese Academy of Sciences, Beijing

- Make full use of the pre-known knowledge of environment
- Use HOG features of landmarks to store semantic information
- Use ORB feature points and their 3D position to form the local metric map.
- Build topological map, simple global metric map, semantic map, and local metric map.



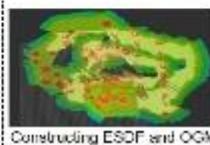
### A GPU Mapping System for Real-time Robot Motion Planning

Yizhou Chen and Ben M. Chen  
Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong, China

Shipeng Lai, Feng Lin  
Pang Cheng Laboratory  
Biao Wang

Department of Automation Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China

- Construct Occupancy Grid Maps (OGMs) and Euclidean Signed Distance Fields (ESDFs)
- Optimize the global ESDF storage and address the limited observation problem in an efficient manner
- Can be applied to robotics onboard sensors
- Propose a real-time robot mapping system on GPU.

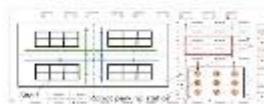


• 11:30~11:45

### Task Allocation and Path Planning of Many Robots with Motion Uncertainty in a Warehouse Environment

YinBin Shi, Biao Hu and Ran Huang  
College of Information Science and Technology, Beijing University of Chemical Technology, China

- The more robots are deployed, the higher efficiency logistics operation will be
- The decentralized auction-bid scheme is used to allocate tasks
- We take the robot's motion uncertainty into account and predict the robot density.
- We also design an effective scheme to sufficiently avoid the robot collision.



Examples of robot parking stations and local roads, the arrow indicates the passable direction

• 12:00~12:15

### The Navigation and Control Study of UAV for Cross-domain Bridge Collaboration Detection

Yuchen Yan, Yizhai Zhang, Panteng Huang  
School of Astronautics, Northwestern Polytechnical University, China

- Proposed a path planning method and UAV control method
- Designed the UAV control system to track and control the planned path
- Establish the kinematics and dynamics model of the UAV.
- Design a four-channel PID controller to realize the trajectory and altitude control of the four-rotor UAV.



## SaD II : Robotic Control IV

Session Chair : Mingjie Dong, Pengyue Zhang  
 Meeting Room 2 : July 17, 10:45 - 12:30, Saturday

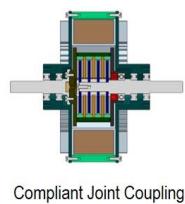
- 10:45~11:00

### Transmission Characteristics of Compliant Joint for Rehabilitation Robot Based on Magneto-rheological Fluid Variable Stiffness

Wei Wei and Fugang Yi and Bilei He and Shibo Cai and Guanjun Bao

College of Mechanical Engineering, Zhejiang University of Technology, China

- Magneto-rheological fluid is kind of the solid-liquid materials with magneto-sensitive rheological property;
- The compliant joint of robots based on magneto-rheological fluid has the characteristics of active variable stiffness;
- The shear transmission of magneto-rheological was proposed to facilitate the operation compliance and intrinsic safety.



Compliant Joint Coupling

- 11:15~11:30

### Pan-tilt Control Method Applied to Mobile Robots

Wei Huang\*, Baichuan Den, Wenfeng Zou

the Project manager of Project management center, HuiZhou Power Supply Bureau, Guangdong, China

Runfeng Lou, Tingyi Yuan, Chuqi Xiong

Faculty of Electrical Engineering, Xi'an Jiaotong University, ShanXi, China.

- In this paper, particle swarm optimization algorithm is used to optimize the weight and threshold of BP neural network.
- BP neural network is used to realize the online control of three parameters of digital PID.
- PSO-BP reasonably determine the initial weights of neural network, and overcome the neural network easy to fall into local minimum.



The mobile robot of this paper

- 11:45~12:00

### Stiffness-Tunable and all-soft electrical smart material made by magnetic liquid metal and sponge

K. Wang, J. Zhou, S. Li, J. Hu, J. Yang,  
 M. Liu, H. Yang, X. Li, and L. Sun

School of Mechanical and Electric Engineering, Soochow University, China  
 S. Zhang

Department of Precision Machinery and Precision Instrumentation, University of Science and Technology of China, China

Z. Huan and W. Ma

School of Electrical Engineering and Automation, Xiamen University of Technology, China

- We present a novel and easy method to design and manufacture mechanically durable, all-soft electrical and stiffness-tunable MLM-sponge elastomer.



50% of tensile strain

- 11:00~11:15

### Estimation of muscle activation during ankle rehabilitation

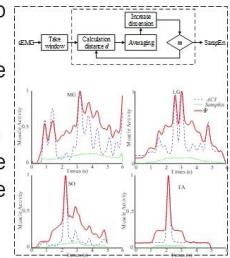
Jianfeng Li, Yu Zhou, Mingjie Dong\*, Ran Jiao

Faculty of Materials and Manufacturing, Beijing University of Technology, China

Liwei Jiang

CCSC System Engineering Research Institute, China

- A new method based on sample entropy to judge muscle activation state is proposed.
- Sample entropy is used to modify Hill muscle model..
- This algorithm is suitable for judging by sEMG.
- The muscle activation state during ankle rehabilitation training is measured more accurately.



- 11:30~11:45

### Liquid Metal Universal Micro-Gripper

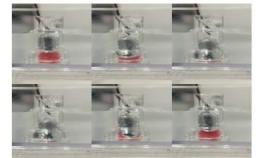
J. Zhou, K. Wang, S. Li, J. Hu, J. Yang, H. Yang, X. Li, and L. Sun  
 College of Mechanical and Electrical Engineering, Soochow University, China  
 S. Zhang

Department of Precision Machinery and Precision Instrumentation, University of Science and Technology of China, China

Z. Huan, W. Ma

School of Electrical Engineering and Automation, Xiamen University of Technology, China

- We have developed a universal micro-gripper based on liquid metal, which can grip small objects of various shapes, materials and sizes.



wrapping and releasing small objects

- 12:00~12:15

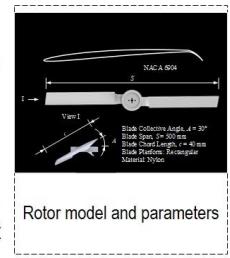
### Hover Performance Experimental Setups for a Miniature Mars Rotorcraft Design and Preliminary Experiments

Chunguang Fan, Pengyue Zhao, Jianwei Wu and Zongquan Deng  
 Ultra Precision Research Institute, Harbin Institute of Technology, China

- Design of experimental setups for a miniature Mars rotorcraft.

- The measurement of lift by hover test stand is in an indirect way, by which the effect of rotor system's gravity is reduced.

- The results show that at the maximum speed of hover test stand, the lift generated by the rotor can achieve approximately **120 gf**, which means that it is possible for a coaxial rotorcraft with **200 g** mass to fly in Martian atmosphere.



# SuA I : Vision IV

Session Chair : Lei Wang, Yue Wang

Tencent ID: 234 889 136 : July 18, 8:30 - 10:15, Sunday

- 8:30~8:45

- 8:45~9:00

## Calibration and Measurement of Large Distortion Binocular Cameras Based on Fully Connected Neural Network

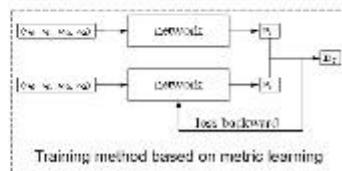
Tianwei Wu

Zhongke Shijie Technology Co., Ltd, China

Xilong Liu,Mengjuan Chen,Xuejian Ma,Wenxiang Qin,Tingyu Yan  
and Jiawei Lu

Chinese Academy of Sciences Institute of Automation, China

- Large distortion model
- Data drive calibration
- Metric learning
- High flexibility and stability



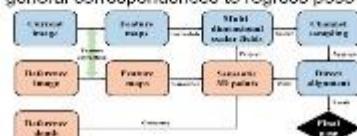
- 9:00~9:15

## Direct alignment with generalized correspondences: A unified framework for visual pose estimation

Xiaqing Ding, Yue Wang and Rong Xiong

Control Science and Engineering, Zhejiang University, China

- A multi dimension field based unified framework is proposed that can summarize both direct and indirect structure-based visual pose estimation methods, where the differences exist on the data association front end.
- Arbitrary shapes with the same semantic information on different images can be introduced as constraints in this framework without explicit modeling.
- A hybrid visual pose estimator is designed based on a three-layer of pyramid constructed with general correspondences to regress pose from coarse to fine.



- 9:30~9:45

## Panoptic Lintention Network: Towards Efficient Navigational Perception for the Visually Impaired

Wei Mao<sup>1,2</sup>, Jiaming Zhang<sup>1</sup>, Kailun Yang<sup>1</sup>, Rainer Stiefelhagen<sup>1</sup>

<sup>1</sup>IAI, Karlsruhe Institute of Technology, Germany

<sup>2</sup>Shin-German School, Tongji University, China

- VerConv models Multi-scale and Channel Interactions
- Lintention learns long-range dependencies in linear time & space
- Panoptic Lintention Net. Fewer Parameters, Fewer FLOPs, Better Performance
- A Wearable Assistive System: Fulfill the navigational perception needs of the visually impaired



- 10:00~10:15

## Complementary Multi-Branch CNNs Towards Real-World 3D Point Classification

Zifeng Tang, Fusheng Hao, Qieshi Zhang, Jun Cheng, Jin Zhang,

Shuai Yuan

CAS Key Laboratory of Human-Machine Intelligence-Synergy Systems,  
Shenzhen Institute of Advanced Technology,  
Chinese Academy of Science, China

- Conventional point-based convolution models are accelerated by utilizing the voxel based indexing, which reduces 30% time in searching neighbors.
- A point-based spherical CNN is proposed to directly process point clouds
- In MBCNN, a fusion strategy is utilized to gain features more comprehensively.



## Dilated Nearest-Neighbor Encoding for 3D Semantic Segmentation of Point Clouds

Xiaoyuan Fan, Lei Wang and Jun Cheng

Shenzhen Institute of Advanced Technology, (CAS), China

Shan Jiang and Senwei Ma

University of Michigan, United States

- A dilated nearest-neighbor encoding is introduced to the point cloud sampling network.
- One end to end point cloud semantic segmentation framework has been presented.
- We have achieved better performance than state of the art methods on the large scale benchmark S3DIS dataset



- 9:15~9:30

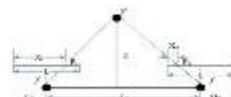
## Research on AGV Navigation System Based on Binocular Vision

Changsheng Ai , Dunyang Geng , Zhengguang Qi , Lei Zheng  
School Of Mechanical Engineering, University of Jinan, China

Zhiqian Feng

School Of Information Science And Technology, University of Jinan, China

- This paper presents an AGV navigation method using binocular camera.
- Position and orientation deviation of vehicle body relative to lane line by binocular camera
- The pose deviation of the vehicle body relative to the lane line is verified experimentally.
- The experimental results show that the posture obtained by the camera is reliable and stable.



- 9:45~10:00

## Perception Framework through Real-Time Semantic Segmentation and Scene Recognition on a Wearable System for the Visually Impaired

Yingzhi Zhang, Haoye Chen, Kailun Yang,  
Jiaming Zhang and Rainer Stiefelhagen  
Institute for Anthropomatics and Robotics,  
Karlsruhe Institute of Technology, Germany

- We designed a unified perception framework for assisting visually impaired people
- The real-time wearable system based on multi-task architecture feedbacks object information and scene classes via speech signal.
- In the experiments, we verified the systems' accuracy and efficiency on public datasets and real world scenes



## SuA II : Robotic Control V

Session Chair : Yajing Shen, Jinke Li

Tencent ID: 234 889 136 : July 18, 10:45 - 12:30, Sunday

• 10:45~11:00

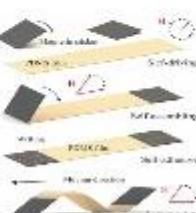
• 11:00~11:15

**Magnetic sticker with water-triggered adhesiveness for object manipulation**

Xiong Yang and Yajing Shen

Biomedical engineering, City University of Hong Kong, China

- Magnetic sticker with directional magnetization and water triggered adhesiveness
- Manipulate object, especially the targets with small size and flexible material
- The thin thickness makes it more suitable for the tasks in limited space.
- They can also cooperate with other stickers to achieve a more complex and precise manipulation task.



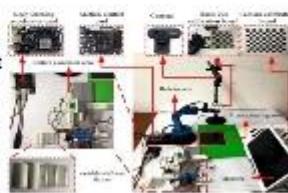
• 11:15~11:30

**FPGA-based Deep Learning Acceleration for Visual Grasping Control of Manipulator**

Haibin Yin\*, Haiping Hong and Jing Liu

Key Laboratory of Hubei Province for Digital Manufacture, School of Mechanical and Electronic Engineering, Wuhan University of Technology, China

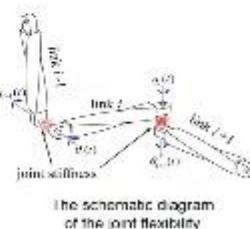
- Use FPGA to accelerate neural network.
- Use Vivado and Petalinux development kit to build software and Hardware system.
- Kinematic analysis enables the robot to grasp the target.



• 11:45~12:00

**Dynamic Modeling and Vibration Analysis of a 6-DOFs Industrial Robot Considering Joint Flexibility**Guodong Shen<sup>1</sup>, Sheng Xu<sup>14</sup>, Chunjie Chen<sup>2</sup> and Qiang Wang<sup>1</sup>Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, 518082, P.R.China  
Guangdong Provincial Key Lab of Robotics and Intelligent System, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, 518082, P.R.China  
CAD Key Laboratory of Human-Machine Intelligent-Intelligent Systems, Shenzhen Institute of Advanced Technology, Shenzhen, 518055, P.R. China

- This paper is concerned with the dynamic modeling and vibration analysis of multi-DOFs industrial robot considering joint flexibility.
- A dynamic model based on Kane method is developed to analyze the vibration characteristics under different joint stiffness parameters.
- The results of the proposed strategy can be used to design an accurate model-based controller for an industrial robot.



• 12:15~12:30

**Dispensing robot for toxic drugs in pharmacy intravenous admixture services**H. Jin<sup>1</sup>, P. Gao<sup>1</sup>, J. Cao<sup>1</sup>, Y. He<sup>2</sup>, Y. Hu<sup>2</sup>, Y. Liu<sup>2</sup>1-Shenzhen Broadcare Medical Robotics co. Ltd., Shenzhen, China  
2-Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences  
3-Peking University Shenzhen Hospital, Shenzhen, China

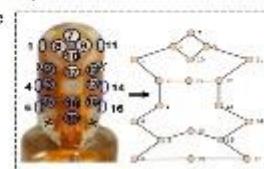
- Structural design of dispensing robot on environmental control and protection of toxic drugs
- The robot dispensing precise suction scheme for vial and ampoule
- Comparative experiment and analysis of suction residue



T-26

**Tactile Grasp Stability Classification Based on Graph Convolutional Networks**Tingting Mi<sup>1,2</sup>, Dashun Que<sup>1</sup>, Senlin Fang<sup>2</sup>, Zhenning Zhou<sup>2</sup>, Chaoxiang Ye<sup>2</sup>, Chengliang Liu<sup>2</sup>, Zhengkun Yi<sup>2</sup> and Xinyu Wu<sup>2,3</sup><sup>1</sup>Wuhan University of Technology<sup>2</sup>Shenzhen Institutes of Advanced Technology<sup>3</sup>SIAT Branch, Shenzhen Institute of Artificial Intelligence and Robotics for Society

- Transform the electrode values of the BioTac sensor into a graph structure
- Complete the convolution operation on the tactile graph
- Present two fusion strategies to integrate the features of multiple sensors



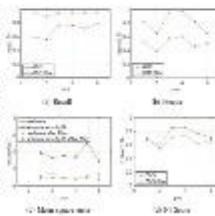
• 11:30~11:45

**Estimating Pose of Object and Manipulator Grasping Control**

Dong Wang, Dong Yang, Qinghui Pan, Chaochao Qiu, Yongxiang Dong, Jie Lian

School of Control Science and Engineering, Dalian University of Technology, China

- Using the RANSAC algorithm and affine invariant principle to filter out false match pairs based on GMS algorithm
- Combined with depth image, The least square SVD method is used to solve the rotation and translation matrix of the object. We use this matrix to estimate the pose of object
- The control of the end effector based on the projection angle has good experimental results



• 12:00~12:15

**A data-driven shared control system for exoskeleton rehabilitation robot**Feng Li, Yong He<sup>4</sup>, Jinke Li, Jiangpeng Ni and Xinyu Wu  
Guangdong Provincial Key Lab of Robotics and Intelligent System, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518082, China

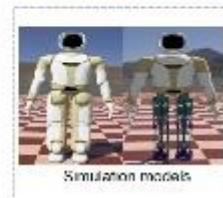
- A novel shared control system is designed, which solve the problem of exoskeleton robot system integration
- A gait trajectory revision mode based on data iteration is designed.
- The modular development of human-machine interaction interface is realized to make the exoskeleton rehabilitation robot system more humanized and visual



• 12:30~12:45

**Effects of Backlash on the Walking Stability of Biped Robots**Yisen Hu, Hongyu Ding, Jingchen Li, Wenguang Wang and Jianxin Pang  
UBTECH Robotics, Inc., Shenzhen, ChinaXinyu Wu  
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China

- Dynamics simulation is used to analyze effects of backlash on walking
- Series parallel mechanism works better than series mechanism under effects of backlash
- Coupled movement of knee and ankle joints reduces effects of backlash.



## SuA III : Advanced Control III

Session Chair : Miaomiao Wang, Jianxin Pang

Tencent ID: 234 889 136 : July 18, 14:00 - 15:45, Sunday

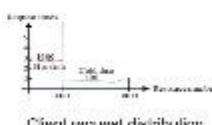
- 14:00~14:15

- 14:15~14:30

### High-Speed Proxy Cache Management Strategy Based on Comprehensive Resident Value and Generation

Chunmei Huang, Min Xiang, Yuzhou Jiang and Zhong Xia  
School of Automation, Chongqing University of Posts and Telecommunications, Chongqing

- This paper proposes an efficient proxy cache management strategy named HPCMCSRVG.
- The strategy based on generational garbage collection mechanism.
- The strategy based on the 80/20 rule.
- The strategy can significantly reduce backbone network traffic consumption and proxy cache response delay.



- 14:30~14:45

### Finite Representability of Discrete-time Switched Linear Systems

Zhendong Sun<sup>1</sup>, Mianmian Wang<sup>2</sup>

1. College of Automation, Shandong University of Science & Technology  
2. Academy of Math. & System Science, Chinese Academy of Sciences

- In this work, the finite representation problem was addressed for a class of discrete-time switched linear control systems with decoupled controllable/uncontrollable states.
- We showed that, the problem is solvable when the uncontrollable sub mode is finite representable.
- Constructive design procedures were developed in the proof of the main result.

- 15:00~15:15

### Ripple Minimization of PMLSM Using Robust Two Degrees-of-Freedom controller and Thrust Ripple Observer

Mingfei Huang<sup>1,2</sup>, Yonglinglei Deng<sup>1</sup>, Hongwen Li<sup>1</sup>, Jing Liu<sup>1</sup> and Meng Shao<sup>1</sup>

1.Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, Changchun 130033, China;  
2. University of Chinese Academy of Sciences, Beijing 100049, China.

- Permanent-magnet linear synchronous motor;
- Robust two-degree-of-freedom control;
- Thrust ripple observer.

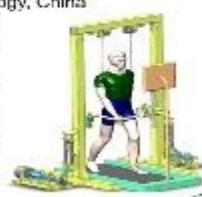
- 15:30~15:45

### Design and Position Servo Control of an Active Body-Weight Support Training System

Chao Wei<sup>1</sup>, Tao Qin<sup>1\*</sup>, Xin Meng<sup>1</sup>, Jinxing Qiu<sup>1</sup>, Ollong Meng<sup>1</sup> and Bo Li<sup>1,2</sup>

1.Mechanical Engineering, Hubei University of Arts and Sciences, China  
2.Xiangyang Institute of Advanced Manufacturing Engineering , Huazhong University of Science and Technology, China

- An active BWSTS with double-shoulder suspension based on cable-driven was designed for rehabilitation training.
- The mathematical model of the system drive unit was established by using mechanism analysis method.
- The position servo control strategy with disturbance feedforward compensation was proposed to improve the system loading accuracy.
- The system simulation model was built to prove the effectiveness of the position servo control strategy.



### Joint Torque Feedback-based Decentralized Neuro-optimal Control of Input-constrained Modular Robot Manipulator System

Bing Ma and Yuanchun Li

Control Science and Engineering, Changchun University of Technology, China

- A novel decentralized neuro-optimal control method of input-constrained MRM system is presented.
- Adaptive dynamic programming
- Joint torque feedback technique
- Actuator saturation constraints
- Experimental verification



2 DOF MRM experimental platform for verification of the developed method

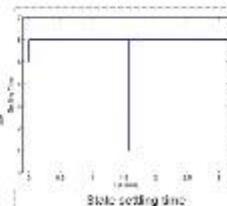
- 14:45~15:00

### Optimized Design of Settling Time for Multi-model Systems

Miaomiao Wang<sup>1</sup>, Zhendong Sun<sup>2</sup>

1. Academy of Math. & System Science, Chinese Academy of Sciences  
2. College of Automation, Shandong University of Science & Technology

- The problem of settling time optimization for a class of multi-model systems is addressed.
- An upper bound estimate is obtained based on the path-wise contraction of stabilizability
- The proposed design procedure is an algorithm that terminates in a finite number of steps
- A numerical example is presented to validate the proposed scheme.



- 15:15~15:30

### Planning strategy for intruder agent based on game theory and artificial potential field

Jiahong Xu and Xiaofeng Liu

College of IoT Engineering, Hohai University, China

- Propose a improved artificial potential field (APF).
- The finite pure strategy matrix is obtained by considering the opponent's response iteratively base on the APF
- Particle Swarm optimization is taken to compute approximate Nash equilibrium based on the pure strategy matrix

- 15:45~16:00

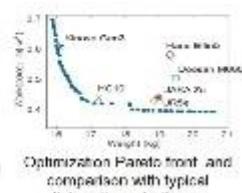
### Optimization Design of Configuration, Structure and Drive Train Synthesis for Serial Robotic Arms

Jingchen Li<sup>1,2</sup>, Jia Liu<sup>2</sup>, Hongyu Ding<sup>1</sup>,

Yisen Hu<sup>1,2</sup> and Jianxin Pang<sup>1</sup>

<sup>1</sup>UBTECH Robotics Inc., China  
<sup>2</sup>Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

- New method for optimally integrated designing a robotic arm for desired functions and performances.
- Complete and efficient co-simulation framework for optimization
- A design example demonstrates the application of designing a light-weight arm with maximized workspace



Optimization Pareto front and comparison with typical collaborative robotic arms.

## SuA IV : Vision V

Session Chair : Qieshi Zhang, Chengzhi Hu

Tencent ID : 234 889 136 : July 18, 16:15 - 18:00, Sunday

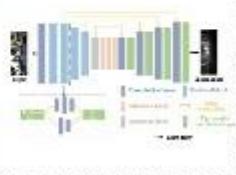
• 16:15~16:30

• 16:30~16:45

**Attention Mechanism-based Monocular Depth Estimation and Visual Odometry**

Qieshi Zhang, Dian Lin, Ziliang Ren, Yuhang Kang, Fuxiang Wu,  
Jun Cheng  
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences,  
China

- Propose a depth estimation network encoder based on attention mechanism for predicting the spatial features of the adjacent frames.
- Improve the depthwise separable convolution to replace the convolution layers in the main architecture for improving efficiency.
- Validate the performance of our algorithm on a public dataset and real world experiments with our mobile robot, including outdoor and indoor with ground truth.



• 16:45~17:00

**Bidirectional Weighted Loss with Feature Perception for Self-supervised Learning of Consistent Depth-pose**

Fei Wang, Jun Cheng and Penglei Liu  
CAS Key Laboratory of Human-machine Intelligent-Syntax Systems, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- Take full advantage of limited data by using the bidirectional photometric loss.
- Deal with moving objects and occlusions by reweighting the bidirectional photometric loss.
- Improve the robustness for textureless regions by employing the bidirectional feature perception loss.
- Enforce consistency between depths by employing the bidirectional depth structure consistency loss.

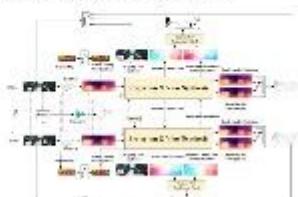


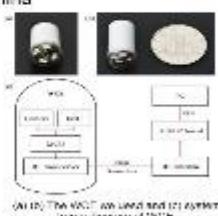
Diagram of the general framework

• 17:15~17:30

**Real-time Attitude Tracking of Capsule Endoscope Based on MEMS IMU and Error Analysis**

Zhuokang Huang and Chengzhi Hu  
Department of Mechanical and Energy Engineering, Southern University of Science and Technology, China

- A method for calculating the attitude of WCE based on MEMS IMU is implemented.
- The accuracy of attitude tracking is measured by a series of experiments.
- The experimental results show that the method meets the requirements in about six minutes.
- Additionally, we propose a method to improve the attitude accuracy by reciprocating the rotational motion.



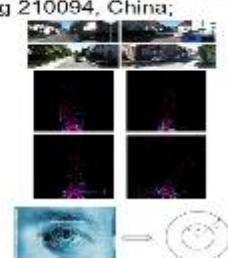
• 17:45~18:00

**3D LiDAR Point Cloud Loop Detection Based on Dynamic Object Removal**

Pan-Yun Ding, Zhi-Hui Wang

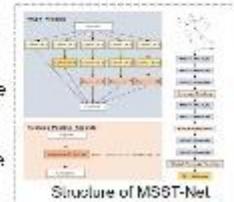
School of Computer Science and Engineering, Nanjing University of Science and Technology, Nanjing 210094, China;

- 3D object detection model OpenPCDet is employed to detect dynamic objects in the outdoor scene, such as vehicles, pedestrians, etc.
- We use the bounding box detected by the model to perform cube filtering on the original data to remove dynamic objects.
- The preprocessed data is utilized to extract scene descriptors for loop detection. In the road scene, experimental results demonstrate that our approach yields superior performance against the traditional methods.

**Skeleton-based Action Recognition with Multi-scale Spatial-temporal Convolutional Neural Network**

Qin Cheng, Ziliang Ren, Jun Cheng, Qieshi Zhang, Hao Yan and Jianming Liu  
Guilin University of Electronic Technology, Guilin, China

- Action recognition based on skeleton data needs comprehensive spatial-temporal features.
- A novel MSST-Module is established to capture robust spatial temporal features.
- The MSS1-Net constructed by MSS1-Module achieved remarkable performance on two large dataset.

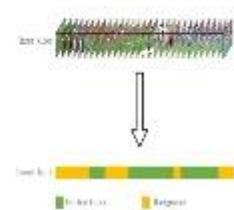


• 17:00~17:15

**Two Stream Dynamic Threshold Network for Weakly-Supervised Temporal Action Localization**

Hao Yan, Jun Cheng, Qieshi Zhang, Ziliang Ren, Shijie Sun, Qin Cheng  
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- Weakly-supervised methods only require video level labels to train the models.
- The proposed DI-L-WTAL features a dynamic attention threshold decision for the attention.
- Our model further adjust the extreme values of the attention mechanism for different videos accordingly.

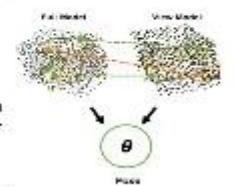


• 17:30~17:45

**Unseen Object Pose Estimation via Registration**

Jun Wu, Yue Wang and Rong Xiong  
Control Science and Technology, Zhejiang University, China

- Current object pose estimation methods mostly rely on instance specific features, which limits their ability to generalize to unseen objects.
- 3D geometrical construction is embedded in observation, yet commonly neglected.
- We reconstruct full model and view model from reference and query observation, then seek for probabilistic correspondence between them to solve registration problem.
- Our method achieves comparable performance with SOTA, with accuracy and efficiency.



# SuB I : Modelling I

Session Chair : Weixin Si, Xiaodong Yang

Tencent ID: 311 159 883 : July 18, 8:30 - 10:15, Sunday

• 8:30~8:45

• 8:45~9:00

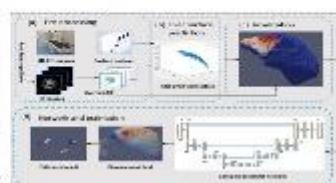
## Internal Motion Estimation during Free-Breathing via External/Internal Correlation Model

Yangyang Shi

Wuhan Research Institute of Posts and Telecommunications, China  
Yuqi Tong and Ruotong Li and Weixin Si

Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

- Two-step external/internal correlation model
- ✓ MLS based liver surface prediction
- ✓ CNN based non-rigid registration
- Accurate estimation of the target structures
- Improve clinicians' perception of vessels and tumors



The overview of our workflow

• 9:00~9:15

## A Stability Control Strategy for Tractor-Aircraft System on Deck

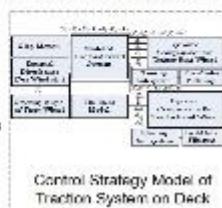
Hongbo Liu and Xiaodong Yang

School of Mechanical and Power Engineering,  
Harbin University of Science and Technology, China

Nengjian Wang

Mechanical and Electrical Engineering department, Harbin Engineering University , China

- An active rear-wheel steering and compensative front-wheel steering control strategy is presented.
- Aircraft parameters diversity, marine environment uncertainty and the characteristics of steering subsystem are considered.
- The proposed controller provides the basic robustness to parametric uncertainties and external disturbance.



• 9:30~9:45

## Design and Implementation of A Novel Internet of Things Irrigation System With A Precision Irrigation Robot

Minghan Chen, Yilong Sun, Boyi Liu, Bingjie Yan

The RoboAI-Lab, Harbin University, China

Xiulai Li, Kai Lu, Tenglong Ren, Bin Ma, Yangyang Tian

Ulanqab Zhong Chuan Technology Co., Ltd; Ulanqab Vocational College of Political Science and Law, China; The College of Intelligence and Computing, Tianjin University, China; State Grid Hebei Electric Power Company Research Institute, China

- This paper designs and implements the IoT irrigation system based on an intelligent path planning algorithm and designs and manufactures the agricultural irrigation robot combining the Internet of Things. The system transmits humidity information to the server through the soil humidity sensor, and performs path planning through an improved path planning algorithm.

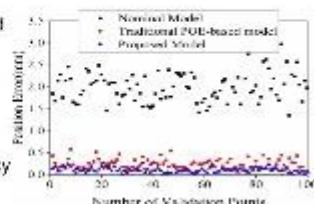


• 10:00~10:15

## A Generalized Kinematic Error Modeling Method for Serial Industrial Robots Based on Product of Exponentials Formula

Zeyin Zhao, Xin Wang, Jiafan Chen and Mengzhong Chen  
School of Mechanical Engineering and Automation,  
Harbin Institute of Technology Shenzhen, China

- Based on POF formula, a generalized kinematic error model is proposed.
- The Levenberg-Marquardt method is used to identify the unknown model parameters.
- Experiments carried out on an Efort ECR5 robot have verified the accuracy of the model.

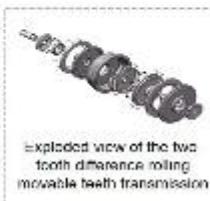


## Characteristic Analysis and Virtual Modeling of Two-tooth Difference Rolling Movable Teeth Transmission

Yanfang Wang , Weiwei Song and Rongyu Ge

College of Mechanical Engineering, University of Jinan, China

- Structure and Transmission Principle of Two-tooth Difference Rolling Movable teeth Transmission
- Kinemtical Pair and Tooth Profile Curve Analysis of Two-tooth Rolling Movable Teeth Transmission
- Virtual Modeling of Two-tooth Difference Rolling Movable Teeth Transmission



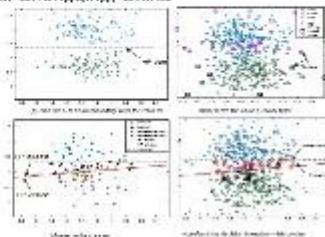
• 9:15~9:30

## A Fast-Incremental SVM Algorithm for Online Motor Imagery-Based Brain-Computer Interface

Olin Jiang, School of Computer Science and Technology, Chongqing University of Posts and Telecommunications, Chongqing,China

Yi Zhang, Xiao-Yi He, and Ke Ren, Advanced Manufacturing and Automation Engineering Laboratory, Chongqing University of Posts and Telecommunications, Chongqing, China

- An incremental SVM learning method based on natural neighbor clustering
- A nonparametric filter to reveal the underlying structure of the train set and the test set
- Less training time and storage consumption

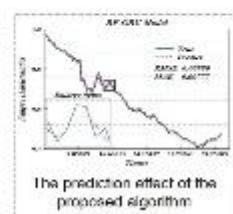


• 9:45~10:00

## Prediction Method of Lower Limb Muscle Fatigue Based on Combining Random Forest and Gated Recurrent Unit Neural Network

Xin Shi, Shuyuan Xu, Pengjie Qin, Gaojie He, and Zhengli Leng  
College of Automation, Chongqing University, China

- Muscle fatigue reduces the stability of human-computer interaction
- Random forest algorithm improves the lag phenomenon of GRU prediction
- Compared with RNN ~ LSTM ~ GRU and BPNN, the algorithm has higher prediction accuracy and generalization



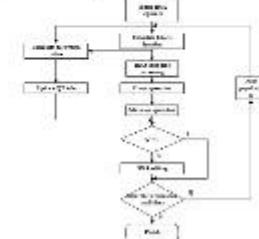
• 10:15~10:30

## Genetic algorithm based on octopus learning mechanism

Zhang Lifeng and Wu Qiuxuan

School of Automation, Hangzhou Dianzi University, Hangzhou

- Use a single RNA chain to represent the individuals of the population
- Imitating the octopus's A-to-G RNA editing method to replace traditional gene mutations, using behavioral learning to design the RNA chain
- Use behavioral learning to design the RNA chain, and determining the possibility of RNA editing by evaluating the RNA chain.



## SuB II : Mobile robots II

Session Chair : Xiaoqiang Ji, Wei Guo

Tencent ID: 311 159 883 : July 18, 10:45 - 12:30, Sunday

- 10:45~11:00

- 11:00~11:15

### **A Localizability Estimation Method for Mobile Robots Based on 3D Point Cloud Feature**

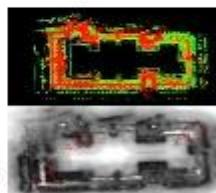
Ying Liu and Jingchuan Wang

the Department of Automation, the Institute of Medical Robotics, Shanghai Jiao Tong University, China

Yi Huang

Kingzhuang Intelligent Equipment Technology Co., LTD., Nanjing

- Firstly, we propose a real-time point cloud clustering algorithm with multiple constraints based on depth map.
- Localizability is set to be equal to the strength of the constraints associated with 3D point cloud.
- Based on the method of using information matrix theory, this paper integrates the Fisher's information matrix and point cloud features to estimate localizability.

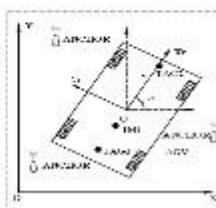


- 11:15~11:30

### **Research of AGV Positioning and Navigation System Based on UWB**

Changsheng AI , Lei Zheng , Dunyang Ceng , Zhengguang QI  
School of Mechanical Engineering, University of Jinan, China

- A navigation method combining UWB and inertial measurement unit (IMU) is proposed.
- The time-based wireless positioning principle is used to obtain the UWB positioning data.
- The Kalman filter algorithm is used to fuse the UWB measurement data and IMU calculation data.
- The experimental results show that the error of UWB is less than 75mm in the static condition.



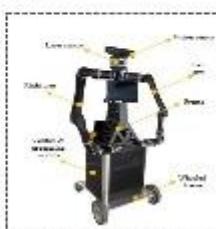
- 11:45~12:00

### **Workspace Analysis of a Dual-arm Mobile Robot System for Coordinated Operation**

Yue Meng, Ziqi Zhao, Weinan Chen, Xiao Xiao, and Max Q.-H. Meng

Department of Electronic and Electrical Engineering, Southern University of Science and Technology, Shenzhen, China

- The mechanical and software structure of dual-arm mobile robotic system is introduced;
- DH method is used to establish forward kinematics of the robotic arm;
- The workspace is analyzed by Monte Carlo method. The shape and boundary of the workspace is provided;
- Cooperative operation with the dual-arm is demonstrated.

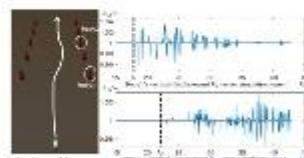


- 12:15~12:30

### **Computational Efficient Simulation of Kelvin Wake for Unmanned Surface Vehicles**

Yao He, Qinbo Sun, Weimin Qi, Xiaoqiang Ji and Huihuan Qian  
Shenzhen Institute of Artificial Intelligent and Robotics for Society (AIRS)  
The Chinese University of Hong Kong, Shenzhen, Guangdong, China.

- Propose a computation efficient simulation of Kelvin Wake using J.J. Stoker's analysis
- Modify J.J. Stoker's model to make the simulation accurate
- Equip the simulation function into a Unmanned Surface Vehicles simulator



### **Construction and evaluation of SLAM and navigation system for mobile robot based on diverse environments**

Haodong Wang ,Wei Guo and Yu Fu

the State Key Laboratory of Robotics, Harbin Institute of technology, China



- 11:30~11:45

### **Stereo Vision-based Autonomous Navigation for Oil and Gas Pressure Vessel Inspection Using a Low-cost UAV**

Leijian Yu, Erfu Yang, Beiya Yang, Andrew Loeliger and Zixiang Fei

Department of Design, Manufacturing and Engineering Management, University of Strathclyde, United Kingdom

- The ORB-SLAM3 is improved by the image contrast enhancement capability
- A stereo vision-based autonomous navigation approach is developed
- The ROS-Gazebo-PX4 simulator is customised deeply to simulate the real scenario.
- The effectiveness of the proposed approach is demonstrated in the developed simulation environment.



- 12:00~12:15

### **Research on Graph-Based SLAM for UVC Disinfection Robot**

Xuan Tan and Xidong Zhou

College of Electrical and Information Engineering, Changsha University of Science and Technology, China

Hui Zhang, Hang Zhong and Li Liu

School of Robotics, Hunan University, China

- The aim of the present work is to contribute in the fight against the spread of Covid-19.
- It can automatically, efficiently and accurately carry out autonomous mobile disinfection of the hospital indoor environment.
- The real time localization accuracy is about 0.04m, which provides high reliability localization for autonomous navigation.



## SuB III : Wearable robots

Session Chair : Lin Wang, Qingsong Li

Tencent ID: 311 159 883 : July 18, 14:00 - 15:45, Sunday

- 14:00~14:15

- 14:15~14:30

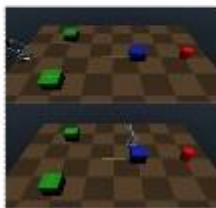
### A Motion Planning Method Based on HRL for Autonomous Exoskeleton

Yao Dong, Yong He, Zhilong Su, JiangPeng Ni,

Wei Feng, Xinyu Wu

Guangdong Provincial Key Laboratory of Robotics and Intelligent System, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518055, China

- Propose a Motion Planning algorithm(HIPPO) to solve the path planning and gait policies of autonomous exoskeleton(Auto-LFF)
- HIPPO contains two levels: High level path planning controller (HLC), Low-level gait generation controller(LGC)
- LHC is responsible for planning a reasonable path in various complex terrains; LGC generates a movement gait and executes actions to complete the interaction with the environment



- 14:30~14:45

### The Measuring ZMP of Self-balancing Exoskeleton Robot Is Calibrated by Using The Neural Network

Yang Xu and Yang Xiao

School of Automation, Chongqing University of Posts and Telecommunications, Chongqing

Yue Ma, Liangsheng Zheng and Yong He

Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen

- The footplate is used with the double-deck structure in this experiment.
- The footplate makes the ZMP have a large measurement error.
- Four kinds of neural networks are used to calibrate measured position of ZMP.



- 15:00~15:15

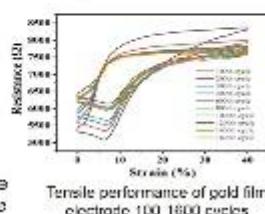
### Cycle stability of flexible stretchable electrode

Jing Sun, Qingsong Li, Rui Su, Hang Zhao, Guanglin Li\*, Zhiyuan Liu\*

Neural Engineering Center

Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences  
1066 Xueyuan Road, Shenzhen 518055, China

- The gold film electrode produces small cracks
- The resistance of the flexible stretchable electrode generally decreases during 1 to 600 cycles
- The resistance change is not large after 600 cycles
- combining Au with a flexible substrate is an excellent way to prepare flexible electrode



- 15:30~15:45

### A Human-Computer Interaction Scheme of Lower-Limb Power-Assist Flexible Robot

Defan Zeng, Lei Sun, Xin Chen, Yuntao Li, Mu Hu, Xinxian Gong  
Tianjin University of Technology

- A human mechanical and electrical system
- Improving the walking state of the senior citizen.
- Understanding the movement of the subjects according to the hip joint angle.
- Playing an important role in rehabilitation training, maintaining and restoring the ability of the elderly.



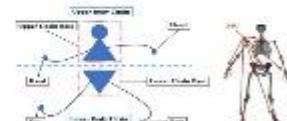
### A Pilot Study on a Multimodal Wearable System by Applying a Two-Chain Biomechanical Model in the Alpine Ski Slalom

Ye Wang, Tianqi Shao, Peng Jiang, Lin Wang and Guanglin Li  
SIT, Chinese Academy of Sciences, China

Gongbing Shan

Kinesiology & Physical Education, University of Leibniz, Canada

- Proposing a wearable system to monitor, acquire and fuse multi-source signals in real-time for skiers
- Adopting the two-chain biomechanical model as a basis
- Demonstrating multiple IMUs can work simultaneously in the same coordinate system with high consistency



The two-chain biomechanical model

- 14:45~15:00

### Quantitative evaluation of hand functions using a wearable glove with multiple sensors

Chaoyue Yin, Quan Liu, Wei Meng, Qingsong Ai

School of Information Engineering, Wuhan University of Technology, China

- Evaluate hand functions using a **wearable glove** with multiple sensors.
- Obtain **range of motion** and evaluate **flexibility**.
- Use neural network to **score automatically** based on setting rehabilitation task.
- The accuracy of automatic scoring (classification) can reach **94.3%**.



- 15:15~15:30

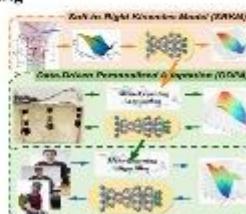
### Personalized Assistance Learning for Soft Wearable Robot

Ning Li, Wenyuan Chen, Yang Yang, Tie Yang, Peng Yu, Wenxue Wang, and Lianqiang Liu

Shenyang Institute of Automation, Chinese Academy of Sciences, China

Ning Xi  
University of Hong Kong

- Uncertainty of model for soft structure and the diversity of motion parameters restrict the application in exoskeleton robots
- Personalized control can adapt to different characters and improve control performance
- Model based meta learning to adapt new individuals more quickly based on the prior knowledge of learned individuals



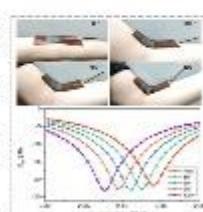
- 15:45~16:00

### Graphene Film Based Wireless and Flexibly Wearable Sensor for Human Joint Angle Measurement

Rongguo Song, Zelong Hu, Shaoqiu Jiang, Li Ma, Qingsong Ai  
and Daping He

Wuhan University of Technology, China

- A wireless wearable angle sensor based on flexible graphene film microstrip antenna is proposed.
- The flexible graphene film has low density of  $1.45 \text{ g/cm}^3$  and high conductivity of  $10^6 \text{ S/m}$ .
- The graphene sensor has a good positive linear relationship between frequency response and bending angle.
- The graphene sensor has radiation capabilities and can transmit detection information wirelessly.



## SuB IV : Learning III

Session Chair : Cai Chen, Zhengkun Yi

Tencent ID : 311 159 883 : July 18, 16:15 - 18:00, Sunday

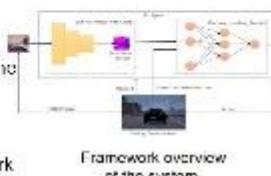
- 16:15~16:30

### Towards Autonomous Driving Decision by Combining Self-attention and Deep Reinforcement Learning

Meiling Chen, Yanjie Li, Qi Liu, Shaohua Lv,  
Yunhong Xu, Yuecheng Liu

Department of Control Science and Engineering,  
Harbin Institute of Technology (Shenzhen), Shenzhen

- We proposed an framework based on self-attention model and DRL for autonomous driving.
- We used the self-attention model to reduce the dimension of image.
- We used DDPC algorithm to complete the autonomous driving task.
- The results show that the proposed framework performs better than existing methods.



- 16:45~17:00

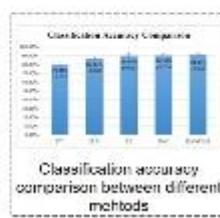
### Gesture Recognition by Rotation Forest-Based Extreme Learning Machine

Fulai Peng, Cai Chen, Xikun Zhang, Xingwei Wang, Changpeng Wang  
Shandong Institute of Advanced Technology, Chinese Academy of Sciences

Lin Wang

Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

- This paper proposes a rotation forest-based extreme learning machine method (RoF-ELM).
- The proposed method enhanced the stability and accuracy of ELM in recognizing gestures from eEMG signals across different subjects.
- Results show that the RoF-ELM method have the highest accuracy across different subjects with relatively short runtime compared with decision tree (DT), ELM, random forest (RF), and RoF methods.



- 17:15~17:30

### A Traffic Scene Object Detection Method Combining Deep Learning and Stereo Vision Algorithm

Linhui Li, Minhang Fang, Yuhang Yin, Jing Lian, and  
Zhenhao Wang

Vehicle Engineering and Mechanics, School of Automotive Engineering,  
Dalian University of Technology, Dalian

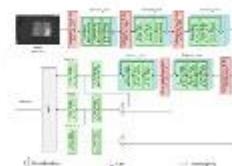
- A method combining depth information with YOLOv6s object detection algorithm is proposed.
- The depth information is obtained by the disparity images which generated by the PSMNet.
- Add Attention Feature Fusion Module to YOLOv6s to improve the accuracy of small object detection.
- The depth information is fused with the object detection to obtain distance information.

- 17:45~18:00

### ToF 3D Vision Detection and Localization of Soft Packaging Bags Based on Deep Learning

Chengyang Shen and Weidong Chen  
Department of Automation, Shanghai Jiao Tong University, China

- ToF 3D Vision
- Detection and Localization of Soft Packaging Bags
- deep learning

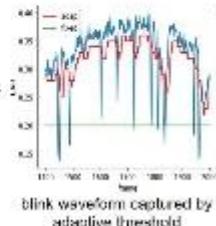


### Blink Detection and Duration Estimation by Using Adaptive Threshold with Considering Individual Difference

Ruitao Liang and Qi Song

the School of Electronic and Information Engineering, Beijing Jiaotong University, China

- Dual functions for blink detection and duration estimation.
- Real-time blink detection which can adapt to feature changes in individuals and periods.
- The blink detection performances on two public datasets are better than the real-time methods compared.
- For the estimation of duration, MAE of below 2.6 frames(30fps) can be achieved.



- 17:00~17:15

### TactCapsNet: Tactile Capsule Network for Object Hardness Recognition

Senlin Fang<sup>1</sup>, Tingting Mi<sup>1</sup>, Zhenning Zhou<sup>1</sup>, Chaoxiang Ye<sup>1</sup>, Chengliang Liu<sup>1</sup>, Hancheng Wu<sup>1</sup>, Zhengkun Yi<sup>1,2</sup> and Xinyu Wu<sup>2,3,4</sup>

<sup>1</sup>Shenzhen Institutes of Advanced Technology

<sup>2</sup>Guangdong Provincial Key Lab of Robotics and Intelligent System

<sup>3</sup>Shenzhen Key Laboratory of Smart Sensing and Intelligent Systems

<sup>4</sup>SIAT Branch, Shenzhen Institute of Artificial Intelligence and Robotics for Society

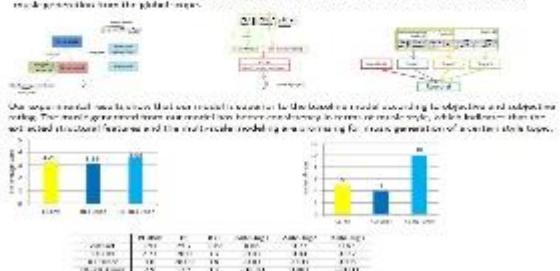
- Develop a method of constructing the tactile image which could make full use of the spatio-temporal information.
- Introduce a TactCapsNet for object hardness recognition.
- Collect the tactile hardness dataset by using the Barrett Hand to press three shapes of silicone samples with 13 hardness levels.



- 17:30~17:45

### RE-RLTuner: A topic-based music generation method

RE-RLTuner is a topic-based music generation method. It can generate new music based on the music of different styles based on the genre of the target music. This method can also learn the style and tone of the popular songs and then generate new songs through machine learning. It can also generate new songs from the global music.



- 18:00~18:15

### LSTM based Model for Real-time Stock Market Prediction on Unexpected Incidents

Saba Aslam<sup>1</sup>, Abdur Rasool<sup>2</sup>, Qingshan Jiang<sup>2</sup>, Qiang Qu<sup>2</sup>

<sup>1</sup>Computer Science, East NUST Chiniot-Pakistan.  
<sup>2</sup>Shenzhen Key Lab for High Performance Data Mining, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, China.

- Build an AI-based LSTM model to predict the stock market direction for unexpected incidents.
- Find the impact of terrorist attacks, floods and earthquakes incidents on Stock market direction.
- Web crawler crawls unexpected data → Information extractor → LSTM prediction Model → Market direction



# MoA I : Vision VI

Session Chair : Yuming Dong, Wanfeng Shang

Tencent ID: 200 149 087 : July 19, 8:30 - 10:15, Monday

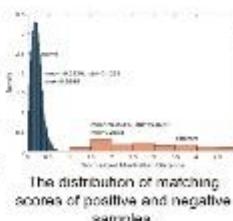
• 8:30~8:45

• 8:45~9:00

## Gun Model Recognition Using Geometric Features of Contour Image

Zhisheng Zhou, Jun Han, Jiaxin Chen and Yuming Dong  
Shenzhen Institute of Advanced Technology, CAS, China

- A method to recognize a gun's model based on image classification is presented.
- The procedure involves contour image acquiring and classification based on geometric features.
- Geometric features include area, circumference, maximum distance and Hu moment.
- Experimental results show a high accuracy of larger than 99%.

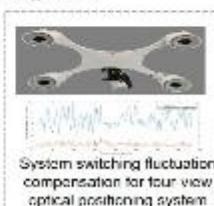


• 9:00~9:15

## Switching fluctuation compensation of the multi-view optical positioning system under camera occlusion

Zhengjun Yu, Shibo Li\*, Ying Hu  
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China  
Haiyung Jin\*  
Shenzhen Broadband medical robotics co. Ltd., China  
Gang Yu  
Harbin Institute of Technology (Shenzhen), China

- Positioning system measurement model and System switching fluctuation under camera occlusion
- Vanished image point prediction based on neural network
- Simulation of system switching fluctuation and compensation based on neural network
- System switching fluctuation compensation in real environment

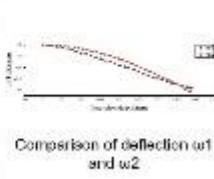


• 9:30~9:45

## Research on Mechanical Properties of Bevel-Tip Needle Based on Image Guidance

Linze Wang , Dedong Gao\* , Yan Zhao and Juntao Zhang  
the School of Mechanical Engineering, Qinghai University, Xining  
Jiali Cui  
Department of Computer Technology and Application, Qinghai University, Xining

- The flexible needle is a minimally invasive medical device mainly used for human biopsy.
- the mechanical model between the needle holder and the force sensor is established.
- A quasi static cantilever beam model is established
- The results show that the cantilever beam model can predict the insertion trajectory.

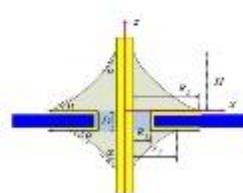


• 10:00~10:15

## Vision-based soldering process parameters calculation for Robotic soldering

Hao Ren, Xinyu Wu and Wanfeng Shang  
Center for Intelligent and Biomimetic Systems, SIAT and CAS, CHINA

- Automatic soldering for THT Components
- Vision-based automatic soldering process parameters decision.
- High quality soldering result



## Rapid identification method of fresh tea leaves based on lightweight model

Zhonghui Chen, Dengzhen Wang, Hongbo Fang, Guang Wang , and Benliang Xie  
College of Big Data and Information Engineering, Guizhou University, China  
e-mail: blxie@gzhu.edu.cn

- By improving the MobileNetV2 network, the MobileNetV2 tea model has obtained
- Depth-separable convolutional structure has less the computation of parameters
- Using attention optimization module
- building a new average pooling layer and a new fully connected layer

MobileNetV2-Tea model	
Model	MobileNetV2
Input	224x224x3
Layer	1
Op	Conv
Param	10,740
Comput.	1.17M
Layer	2
Op	ReLU
Param	0
Comput.	0.00M
Layer	3
Op	Conv
Param	10,740
Comput.	1.17M
Layer	4
Op	ReLU
Param	0
Comput.	0.00M
Layer	5
Op	Conv
Param	10,740
Comput.	1.17M
Layer	6
Op	ReLU
Param	0
Comput.	0.00M
Layer	7
Op	Conv
Param	10,740
Comput.	1.17M
Layer	8
Op	ReLU
Param	0
Comput.	0.00M
Layer	9
Op	Conv
Param	10,740
Comput.	1.17M
Layer	10
Op	ReLU
Param	0
Comput.	0.00M
Layer	11
Op	Conv
Param	10,740
Comput.	1.17M
Layer	12
Op	ReLU
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Comput.	0.00M
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Op	ReLU
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Comput.	0.00M
Layer	65
Op	Conv
Param	10,740
Comput.	1.17M
Layer	66
Op	ReLU
Param	0
Comput.	0.00M
Layer	67
Op	Conv
Param	10,740
Comput.	1.17M
Layer	68
Op	ReLU
Param	0
Comput.	0.00M
Layer	69
Op	Conv
Param	10,740
Comput.	1.17M
Layer	70
Op	ReLU
Param	0
Comput.	0.00M
Layer	71
Op	Conv
Param	10,740
Comput.	1.17M
Layer	72
Op	ReLU
Param	0
Comput.	0.00M
Layer	73
Op	Conv
Param	10,740
Comput.	1.17M
Layer	74
Op	ReLU
Param	0
Comput.	0.00M
Layer	75
Op	Conv
Param	10,740
Comput.	1.17M
Layer	76
Op	ReLU
Param	0
Comput.	0.00M
Layer	77
Op	Conv
Param	10,740
Comput.	1.17M
Layer	78
Op	ReLU
Param	0
Comput.	0.00M
Layer	79
Op	Conv
Param	10,740
Comput.	1.17M
Layer	80
Op	ReLU
Param	0
Comput.	0.00M
Layer	81
Op	Conv
Param	10,740
Comput.	1.17M
Layer	82
Op	ReLU
Param	0
Comput.	0.00M
Layer	83
Op	Conv
Param	10,740
Comput.	1.17M
Layer	84
Op	ReLU
Param	0
Comput.	0.00M
Layer	85
Op	Conv
Param	10,740
Comput.	1.17M
Layer	86
Op	ReLU
Param	0
Comput.	0.00M
Layer	87
Op	Conv
Param	10,740
Comput.	1.17M
Layer	88
Op	ReLU
Param	0
Comput.	0.00M
Layer	89
Op	Conv
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Param	0
Comput.	0.00M
Layer	93
Op	Conv
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Op	ReLU
Param	0
Comput.	0.00M
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Op	Conv
Param	10,740
Comput.	1.17M
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Comput.	0.00M
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Comput.	1.17M
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Comput.	1.17M
Layer	100
Op	ReLU
Param	0
Comput.	0.00M

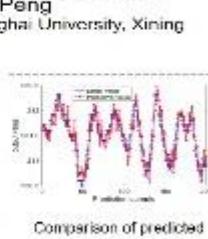


• 9:15~9:30

## The Optimization of Adiabatic Pulses with Constant Amplitude Spin-lock for MR $T_{1p}$ Imaging

Yuxin Yang, Xi Xu and Zhongmin Chen  
Biomedical Engineering, Chongqing University of Technology, China  
Yuanyuan Liu, Yanjie Zhu and Dong Liang  
SIAT, Chinese Academy of Sciences, China

- HS and HSEad adiabatic spin-lock pulses were optimized using a duration of 4ms
- Images with higher SNR were obtained compared with those using pulses of 8ms
- Almost equivalent mapping quality was achieved compared with that using pulses of 8ms.



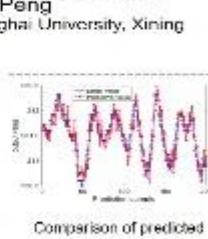
• 9:45~10:00

## Research on Diameter Prediction of Silicon Single Crystal Based on Data Driven

Xiya Zhang, Shan Wang\*, Dedong Gao, Yan Zhao, Guangwei Lin and Xin Peng

The School of Mechanical Engineering, Qinghai University, Xining

- In this paper, based on the long-term and massive crystal growth data of the crystal pulling workshop of the single crystal furnace, a crystal diameter prediction model based on the BP neural network is constructed.
- The model prediction results are verified by actual crystal pulling data, and the results show that for 6 groups of randomly selected crystal pulling data, the average relative percentage error is 0.083±5%



- Automatic soldering for THT Components
- Vision-based automatic soldering process parameters decision.
- High quality soldering result

## MoA II : Robotic Control VI

Session Chair : Ning Ding, Hongliu Yu

Tencent ID: 200 149 087 : July 19, 10:45 - 12:30, Monday

- 10:45~11:00

- 11:00~11:15

### Monocular Object SLAM using Quadrics and Landmark Reference Map for Outdoor UAV Applications

Pengtao Shao, Fan Mo, Yaqian Chen, Ning Ding, and Rui Huang  
Shenzhen Institute of Artificial Intelligence and Robotics for Society, and Institute of Robotics and Intelligent Manufacturing, The Chinese University of Hong Kong, Shenzhen, Shenzhen, Guangdong, 518172, China.

- We propose geolocation method based on object-level SLAM using visual input only
- We use buildings as the landmark objects to match with offline reference maps.

- Keywords:  
GPS-denied, Object SLAM  
UAV geolocation

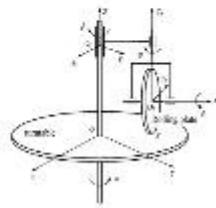


- 11:15~11:30

### Simplification of Dynamic Equations of a Nonholonomic Motion Transfer Mechanism

Wang Yong, Cui Jinchao, Xiao Jing and Zhang Huailing  
School of Biomedical Engineering, Guangdong Medical University, China

- The simplification of the dynamic equations may be realized by simplifying the configuration space.
- The dynamic equations of first-order linear nonholonomic systems can be given by quasi-Newton's law.
- The dynamic equations of the motion transfer mechanism is reduced to the simplest form by quasi-coordinates.

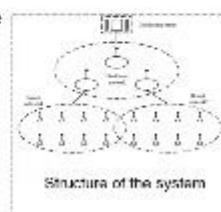


- 11:45~12:00

### Environmental Monitoring System Based on Hybrid Mode Network

Zhishuo Li<sup>1,2</sup>, Guodong Yang<sup>1,2</sup>, En Li<sup>1</sup>, Zize Liang<sup>1</sup>  
<sup>1</sup>State Key Laboratory of Management and Control for Complex Systems, Institute of Automation, Chinese Academy of Sciences, China  
<sup>2</sup>University of Chinese Academy of Sciences, China

- This paper proposes a hybrid network structure based on the ZigBee and Mesh.
- It consists of the backbone network, branch network, and monitoring center.
- It has the advantage of long transmission distance, large bandwidth, and low cost.



- 12:15~12:30

### Robot-Assisted Haptic Rendering of Bilateral Physical Tasks via Physical Engine

Yudong Liu, Kaiya Chu and Qing Miao  
Department of Biomedical Engineering, SUSTech, China  
Mingming Zhang  
Department of Biomedical Engineering, SUSTech, China

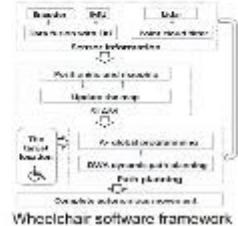
- This study developed a haptic-integrated robotic system capable of delivering bilateral physical training that resembles ADLs.
- The system is implemented with robotic motion control and a physical engine.
- The system showed satisfying motion control and haptic transparency in terms of position tracing during bimanual tasks.



### Research on Autonomous Movement of Nursing Wheelchair Based on Multi-sensor Fusion

Yingbing Su, Huarui Zhu, Zhou Zhou, Bingshan Hu, Hongliu Yu  
School of Medical Instrument and Food Engineering, University of Shanghai for Science and Technology, China

- According to the mobile needs of semi-disabled patients, an intelligent nursing wheelchair was designed.
- Fusion of multiple sensor information to improve positioning accuracy.
- Realize the autonomous movement of wheelchair and improve its intelligence and interactivity.

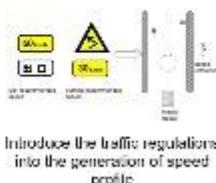


- 11:30~11:45

### An Intelligent Speed-Suggestion Planner for Coverage Path with Multiple Constraints

Xinbo Ma and Guolai Jiang and Yuanzhe Peng and Tingchen Ma and Chao Liu and Yongsheng Ou  
Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS), China.

- We introduce the commonly used traffic regulations in daily life into the generation of speed profiles.
- We construct a cost function to evaluate the safety performance of the trajectory, which can better evaluate different experimental results.
- Our proposed method achieves not only high safety but also efficiency in the tracking of coverage paths.



Introduce the traffic regulations into the generation of speed profile

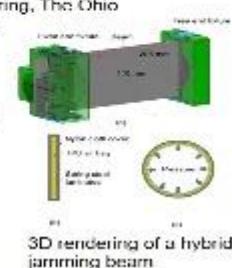
- 12:00~12:15

### Hybrid Jamming Variable-Stiffness Link for Safe Co-Robots

Yitong Zhou

Shien-Ming Wu School of Intelligent Engineering, South China University of Technology, China  
Leon M. Headings and Marcelo J. Dapino  
Mechanical and Aerospace Engineering, The Ohio State University, USA

- We propose a tunable stiffness mechanism for co-robot links based on hybrid jamming.
- It is made of multiple thin layers of spring steel and cloth, and an air bladder.
- Bending stiffness and cross-section area increases with air pressure.
- Around 66 times bending stiffness change is achieved (0.26 to 17.42 N/mm)



3D rendering of a hybrid jamming beam

## MoA III : Vision VII

Session Chair : Sheng Xu, Zhan Yang

Tencent ID: 200 149 087 : July 19, 14:00 - 15:45, Monday

- 14:00~14:15

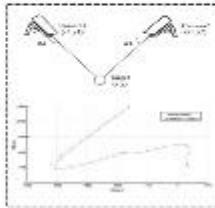
- 14:15~14:30

### **An Invasive Target Detection and Localization Strategy Using Pan-tilt-zoom Cameras for Security Applications**

Jia Hu<sup>1</sup>, Chuanchen Zhang<sup>2</sup>, Sheng Xu<sup>1\*</sup>, Chunjie Chen<sup>2</sup>

<sup>1</sup>School of Mechatronics and Intelligent Technology, Chinese Academy of Sciences, Shenzhen Institute of Advanced Technology, Shenzhen, 518055, China  
<sup>2</sup>School of Physics Science and Information Technology, Liaocheng University, Liaocheng, 252000, China  
<sup>3</sup>Guangdong Provincial Key Laboratory of Intelligent Manufacturing System, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Shenzhen, 518055, China

- This paper designs a practical security monitoring system to quickly detect and localize the invasive animals.
- To resolve the inaccurate and time-lag problems in the target recognition, a strategy combined with YOLOv5 and DeepSOFT is developed.
- Furthermore, an improved PID controller using particle swarm optimization (PSO) is proposed to control the PTZ for target localization.



- 14:30~14:45

### **Nano Robotic Manipulator Positioning Accuracy Measurement By Secondary Electron Image**

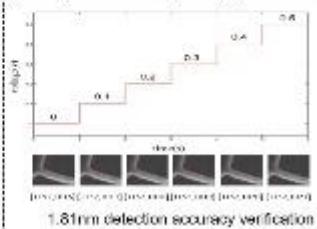
Litao Yang, Lue Zhang, Zhi Qu, Zengsheng Li, Zhan Yang

Robotics and Microsystems Center, School of Mechanical and Electric Engineering, Soochow University, Suzhou, China

Zengsheng Li

School of Mechanical Engineering, Tianjin University, Tianjin, China

- The mapping relationship between SEM image pixel and actual displacement is established.
- Construct characteristic areas to track displacements at the nanometer scale.
- The operation machine outputs a displacement of 2nm to verify the effectiveness of the displacement monitoring method.



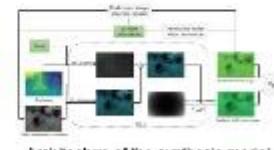
- 14:45~15:00

### **A Novel Underwater Image Synthesis Method Based on a Pixel-Level Self-Supervised Training Strategy**

Zhiheng Wu, Zhengxing Wu, Yue Lu, Jian Wang and Junzhi Yu

State Key Laboratory of Management and Control for Complex Systems, Institute of Automation, Chinese Academy of Sciences, China

- An underwater image synthesis method is proposed to generate various underwater images.
- Pixel level supervision is designed to make sure the authenticity of the synthetic underwater image.
- A self-supervised training strategy is proposed to reduce the difficulty of data preparation and also improve the training performance.



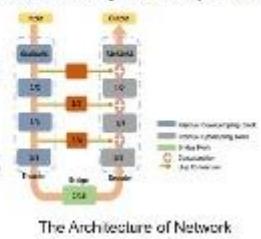
- 15:15~15:30

### **Attention Residual Network with 3D convolutional neural network for 3D Human Pose Estimation**

Jianyu Yan and Kuiyi Mei

Institute of Artificial Intelligence and Robotics, Xi'an Jiaotong University, China

- We proposed a method estimate 3D pose from voxelized grid data. Our method output the heat map, which contains per-voxel likelihood for each joint.
- We evaluated our method on public dataset, ITOP dataset; and collect a 3D human pose estimation dataset to evaluate our method.
- We design a attention block to help network focus on more important information



- 15:30~15:45

### **A Framework of Cooperative UAV-UGV System for Target Tracking**

Zhilong Su, Can Wang, Xinyu Wu, Yan Dong, Jianglong Ni, Hailin He  
 Guangdong Provincial Key Lab of Robotics and Intelligent System, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518055, China

- UAV is composed of an airborne processor, navigation module, perception module, and data transmission module.
- The UGV is composed of a navigation module and a perception module.
- The ground station control is installed on the UGV.



- 15:45~16:00

### **Measuring Method of Involute Profile Error Based on Machine Vision**

ZHI Shan

College of Mechanical Engineering  
 Liaoning Institute of Science and Technology  
 China

- A new algorithm for measuring involute tooth profile error based on machine vision with gear local image is proposed.
- The gray image of gear is acquired by gear visual measuring instrument.
- The center of gear positioning is determined by fitting the circle based on fixed radius least square method with constraints.

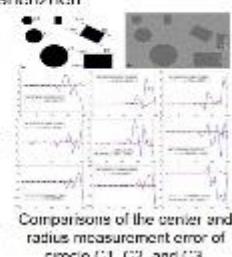


### **Stable Line and Circle Detection Method in Noise Image for Machine Vision**

Xiaojun Wu and Xinhuan Wang

School of Mechanical Engineering and Automation, Harbin Institute of Technology, Shenzhen

- A region of interest (ROI) of line or circle is detected using a template matching method of the stable feature.
- A 2D feature detection problem can be converted to 1D. Then, the local noise scale and filtering variance are computed from pixels along the sample line.
- The edge point is detected from the first order derivative and the outliers are rejected.
- The line or circle is fitted by using a linear least square method.



## MoA IV : Robotic Control VII

Session Chair : Haojian Lu, Peng Li

Tencent ID: 200 149 087 : July 19, 16:15 - 18:00, Monday

- 16:15~16:30

- 16:30~16:45

### Active Vibration Control of the Cantilever Beam Using a Manipulator

Pengyu Jie, Guangzeng Chen, Ke Li, Yuhao Meng, Jiangtao Ran and Yunjiang Lou  
Harbin Institute of Technology (Shenzhen), Shenzhen, China

- Used for vibration suppression of cantilever beam under large deformation.
- Structural dynamics is used to predict deformation without terminal deformation or acceleration feedback and a manipulator is used for force output to control vibration.
- Active vibration control algorithm is designed based on zero strain expectation.



Vibration Control Equivalent Experimental Platform

- 16:45~17:00

### Deployable Polyhedral Mechanisms with Radially Reciprocating Motion Based on Non-crossing Angulated Structural Element

Tao Yang and Peng Li  
Harbin Institute of Technology Shenzhen, China  
Qing Shi  
Beijing Institute of Technology, China

Yunhui Liu  
The Chinese University of Hong Kong, China

- Propose a non-crossing angulated element with a constant subtended angle.
- Construct a family of deployable polyhedral mechanisms with radially reciprocating motion but no singularity.
- Build 3D model both in computer and prototypes to demonstrate the feasibility of the proposed mechanisms.

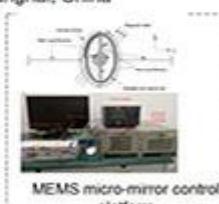


- 17:15~17:30

### A Predictive Control Scheme for Electromagnetic Scanning Micro-mirrors

Peijun Zheng<sup>1</sup>, Ruili Dong<sup>1</sup>, Yonghong Tan<sup>2</sup> and Huiyu Wang<sup>1</sup>  
1. Donghua University, Shanghai China  
2. Shanghai Normal University, Shanghai, China

- MEMS electromagnetic scanning micro-mirror (ESMM) is an optical actuator used in optical-electro-mechanical instrument.
- The ESMM is a micro-opto-electro-mechanical system with complex characteristics.
- A predictive control scheme is proposed for angular control of electromagnetic scanning micro-mirrors.

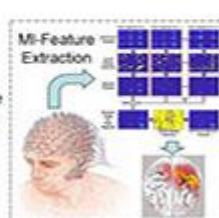


- 17:45~18:00

### Short-Time Fourier Transform Covariance and Selection, A Feature Extraction Method for Binary Motor Imagery Classification

Yue Ma, Liangsheng Zheng, Zhengkun Yi, Yang Xiao, Can Wang,  
and Xinyu Wu  
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, China

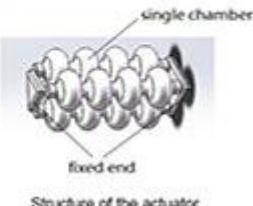
- A feature extraction method STFT covariance that integrates spatial-time-frequency domain information is proposed.
- The novel feature selection method, the infinite feature selection, is introduced in the proposed method to improve the stability and effectiveness.
- Good classification average accuracy and stability of 83.8% ± 14 are obtained in the BCI Competition IV DataSet IIb.



### Multi-chamber Pneumatic Actuator for Peristaltic Soft Robot

Sheng GAO, Yue WANG, Rong XIONG, Zhefeng GONG,  
Nenggan ZHENG, and HaoJian LU  
Zhejiang University, China

- Designed and fabrication the pneumatic corrugated structure driver for squirmy soft robots
- Built a set of controller systems to control actuator deformation
- Completed the action of forwarding and turning with the actuator on experiments



- 17:00~17:15

### SongBot: An Interactive Music Generation Robotic System for Non-musicians Learning from A Song

Kaiwen Xue, Zhixuan Liu, Jiaying Li, Xiaoqiang Ji, Huihuan Qian  
Shenzhen Institute of Artificial Intelligence and Robotics for Society (AIRS)  
The Chinese University of Hong Kong, Shenzhen, China

- An interactive music generation robotic system
- Unify the analysis of notes and phrases in a general form with music theory
- Enhance the detail-capture ability with tunable parameter  $k$
- Optimize the system with the users crowd sourcing data



- 17:30~17:45

### Design and Simulation of a Hip Exoskeleton for Lateral Walking

Zhang Zhewen and Cao Wujing  
Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences

- The effect of lateral walking training on human rehabilitation is analyzed and discussed.
- Analysis of transverse walking gait law.
- Structural design of lateral walking assist exoskeleton.
- The mathematical modeling and simulation are carried out for the mechanism design..



Virtual prototype of transverse exoskeleton

# MoB I : Advanced Control IV

Session Chair : Ye Wang, Fan Zhang

Tencent ID: 944 405 004 : July 19, 8:30 - 10:15, Monday

• 8:30~8:45

• 8:45~9:00

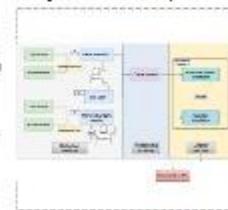
## A Preliminary Study on an IMU-Based Surgery Assisting Method for Minimally Invasive Puncture of Intracranial Hematoma

Tianqi Shao<sup>1</sup>, Ye Wang<sup>1</sup>, Peng Jiang<sup>1</sup>, Chong Wu<sup>2</sup>, Guanglin Li<sup>1</sup>, Lin Wang<sup>1</sup>, and Shiwei Du<sup>2</sup>

<sup>1</sup>Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

<sup>2</sup>Department of Neurosurgery, Shenzhen University General Hospital

- A real-time processing navigation system for assisting minimally invasive puncture and drainage (MIIPD) of intracranial hematoma (ICH).
- Initial Measurement Units(IMU)-based method for tracking puncture path and surgery needle.
- A data fusion method fusing IMUs and CT data.



• 9:00~9:15

## IEEE RCAR 2020 Digest Observer-based Second Order Sliding Mode Control for Tethered Quadrotor Transportation

Jiale Gao, Fan Zhang, Panteng Huang and Ya Liu  
the Research Center for Intelligent Robotics, School of Astronautics,  
Northwestern Polytechnical University, China

- Precise control: the disturbance can be compensated in proposed controller via the signed observer.
- Comparative test verification: two different experiments were conducted by hovering test and circling test.
- A double loops observer based second order sliding mode control scheme is proposed for tethered quadrotor transportation.

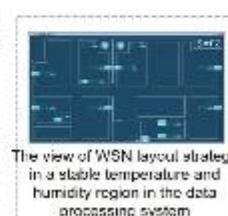


• 9:30~9:45

## A Study on Wireless Sensor Network Layout Strategy in the Stable Temperature and Humidity Region

Ying Zhao, Weiren Shi, Pengjie Qin, Wenbin  
Automation, Chongqing University, China

- The stable temperature and humidity region is obtained by CH-0, K-Means, and mathematical statistics.
- The WSN is laid out in the stable temperature and humidity region.
- The WSN is used to design a data processing system.
- This study focuses on the tobacco production industry.



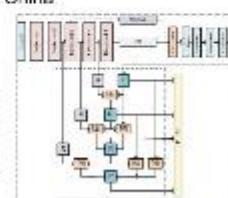
• 10:00~10:15

## Algorithm for the Detection of Thin Strip Shaped Structural Small Diseases on Airport Pavement based on improved pyramid and feature fusion

Haifeng Li, Hongyang Han, Jianping Zong, and Jilin Li  
College of Computer Science and Technology, Civil Aviation  
University of China, China

Zhongcheng Gui  
Shanghai Guimu Co. Ltd, China

- This paper proposes a deep Neural Network algorithm, named as DFAMNet, based on improved pyramid and feature fusion.
- The method improves the detection accuracy of small target diseases in the thin strip shape on the airport pavement.
- Experimental results have verified the efficacy of the proposed method.



## Theoretical and Experimental Study of Adaptive Control for Fixed-wing UAV Arrested Recovery on the USV

Lingling Chu and Feng Gu

Shenyang Institute of Automation, Chinese Academy of Sciences, China

Yuqing He

Shenyang Institute of Automation, Chinese Academy of Sciences, China

- Shipborne recovery of fixed wing UAV is an important technology for UAV.
- An adaptive control method combined with LPV model and  $\alpha - \beta$  filter for fixed-wing UAV arrested recovery.
- Flight experiments under different conditions are completed to verify the performance of the controller.
- The UAV with the proposed method can satisfy the requirements of recovery on the USV.



• 9:15~9:30

## A Novel Method for Predicting Action Switching in Continuous Motion based on sEMG Signals

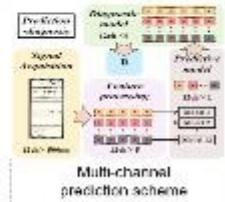
Xin Shi, Jiaqing Zhu and Pengjie Qin

School of Automation, Chongqing University, China

Haoyang Cui

Provincial Key Lab of Robotics and Intelligent System, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

- This paper proposes a predictive classification method based on multi channel sEMG signals.
- Selects the most suitable model from several traditional prediction models through experiments.
- Through online simulation testing the data of 8 objects, the average switching delay is 145.5ms.



• 9:45~10:00

## Cloud-based Robot Path Planning in Dynamic Environments

Xinquan Chen, Lujia Wang and Xitong Gao

SIAT, Chinese Academy of Sciences, China

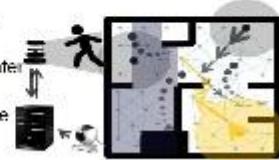
Cheng-Zhong

the University of Macau, China

- Cloud-base framework for multi-agent path planning under dynamic environments.

- Modified A\* global planner to make plans safer and more reasonable.

- Improved A\* local planner to make obstacle avoidance more simple and effective.



## MoB II : Robot Mechanism III

Session Chair : Qiao Hu, Yanlong Tai

Tencent ID: 944 405 004 : July 19, 10:45 - 12:30, Monday

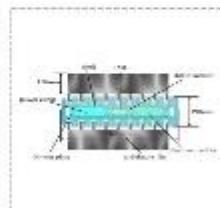
• 10:45~11:00

• 11:00~11:15

### Kinetic Analysis and Design of a Bio-Inspired Amphibious Robot with Two Undulatory Fins

Shenglin Yin, Qiao Hu\*, Yangbin Zeng, Chang Wei, Zhenhan Chen  
School of Mechanical Engineering, Xi'an Jiaotong University, China

- A bio-inspired amphibious robot featuring with two undulatory fins
- The kinetic analysis of the undulatory fin propulsion both underwater and on the ground
- The prototype design are presented in detail.
- Three-dimensional movements test as well as ground propulsion test are introduced.

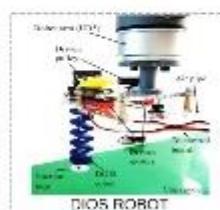


• 11:15~11:30

### Dexterous Origami-inspired Soft (DOIS) Robot for Objects Reorientation and Overtur

Zhi Chen, ShiPan Siu, Sinyee Tin, Yukhei Liu, Hanwen Cao, Yuan Gao, Jianshu Zhou, and Yunhui Liu.  
Mechanical Automation Engineering, The Chinese University of Hong Kong, Hong Kong

- A novel dexterous origami-inspired soft (DOIS) robot is proposed with bi-lateral bending and linear extension/contraction in a compact structure.
- Design, modeling, control of DOIS robot are introduced for versatile customization.
- two challenging tasks, egg reorientation and envelop flipping, are performed by DOIS robot, which shows the promising practical application potential of DOIS robot.



• 11:45~12:00

### Lower Limb Exoskeleton Design Based on Knee Joint Assistance

Peng Jiang, Ye Wang, Tianqi Shao, Lin Wang, Guanglin Li  
Institute of Advanced Integration Technology, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, P.R.China

- Propose a passive lower limb exoskeleton to benefit patients with knee dysfunction
- The effectiveness of the exoskeleton in assisting patients with walking dysfunction was verified using OpenSim simulation software.
- It can help to regain the ability to walk with a natural gait by wearing this exoskeleton. Ultimately, it is hoped to improve the physical and mental health of patients.



• 12:15~12:30

### A Non-zero-sum-based Neural-optimal control method for Modular and Reconfigurable Robot Systems

Tianjiao An, Xinye Zhu, Yuanchun Li and Bo Dong  
Department of Control Science and Engineering, Changchun University of Technology, Changchun, China

- Using non-zero-sum neural-optimal control on modular and reconfigurable robot
- Extending ADP to non-zero-sum algorithm complete trajectory tracking task
- Each module is regarded as one player in the game theory.

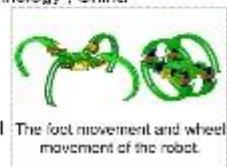


### Simulation Study of a Spider-like Robot Based on Leg Reorganization

ShuQi Wang and JiZhuang Fan and Kuan Zhang and GangFeng Liu and Jie Zhao  
State Key Laboratory of Robotics and System, Harbin Institute of Technology, China

Wei Zhang  
College of Mechanical and Power Engineering, Harbin University of Science and Technology, China

- A four-legged bionic robot with wheel-foot integrated is designed.
- The principle of wheel-foot conversion was analyzed.
- The bionic motion simulation of the robot virtual prototype is realized.



• 11:30~11:45

### The Ground Motion Dynamics Analysis of a Bionic Amphibious Robot with Undulatory Fins

Yangbin Zeng, Qiao Hu\*, Shenglin Yin  
Baocheng Tong and Tangjia Zhang  
Department of Mechanical Engineering, Xi'an Jiaotong University, China

- A novel type of bionic undulatory fin robot is designed.
- The kinematics of undulatory fin is modeled based on the ruled surface model.
- The ground dynamics of undulatory fin is analyzed based on wheel dynamics.
- The research focus is verified through experiments



• 12:00~12:15

### Robot-assisted quantitative assessment of axis misalignment of wrist joint

Dong Xu, Han Xu, Yibin Li, Xu Zhang, Xiaolong Li, ATM&RFRC, Tangji Zhejiang College, China

Jianming Fu  
the Second Affiliated Hospital of Jiaxing University, Jiaxing, China

- proposed a quantitative assessment method of axis misalignment** of wrist joint by introducing a self-aligning mechanism based on the rehab-robot.
- the axis variation of wrist joint can be mimicked naturally and **quantitative values can be recorded to assess axis misalignment**.
- Experiments were conducted and ICC(2, 1)  $\geq 0.866$ , and SEM  $\leq 1.34$  mm.



• 12:30~12:45

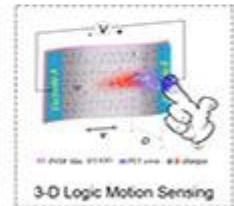
### 3-D Logic Motion Sensing of Polyvinylidene Fluoride based Flexible Interactive Electronics

Pengcheng Wu, Guanglin Li, and Yanlong Tai  
Shenzhen Institutes of Advanced Technology, CAS, Shenzhen, 518055, China

Zhenguo Yang

Department of Materials Science, Fudan University, Shanghai 200433, China

- Fabricate a new 3D tactile sensing technology based on rGOPF flexible film
- Achieve a logic potential responds to various tactile motions accurately
- Applications to human-machine interactions, human finger electronics



## MoB III : Robotic Control VIII

Session Chair : Huihuan Qian, Huiyun Li

Tencent ID: 944 405 004 : July 19, 14:00 - 15:45, Monday

- 14:00~14:15

- 14:15~14:30

### Design and Energy Consumption Optimization of an Automatic Hybrid Sailboat

Rong Ou

Central South University, China

Cheng Liang, Xiaoqiang Ji, Huihuan Qian  
Shenzhen Institute of Artificial Intelligence and Robotics for Society,  
The Chinese University of Hong Kong, Shenzhen, China

- Hybrid Sailboat-III, an energy-saving ASV which can make use of both wind and electricity.
- It solves the problem of tacking when the sailboat is making a zig-zag path.
- Experiments show that new design can significantly decrease energy cost and enhance the course stability of hybrid sailboat.



Hybrid Sailboat-III Model

- 14:30~14:45

### Data-efficient Deep Reinforcement Learning Method Toward Scaling Continuous Robotic Task with Sparse Rewards

Junkai Ren, Yichuan Zhang, Yujun Zeng and Yixing Lan  
College of Intelligence Science and Technology,  
National University of Defense Technology, China

- A model-free, off-policy RL algorithm TD3MHER is proposed to solve continuous tasks with sparse rewards.
- TD3MHER motivates the agent to learn the potential physical model of the robot.
- TD3MHER uses the previously collected samples to train the agent.
- TD3MHER is convenient to be applied because it requires no extra exploration.



Figure 1. The structure of our proposed method TD3MHER.

- 15:00~15:15

### Design of a Battery Carrying Barge for Enhancing Autonomous Sailboat's Endurance Capacity

Cheng Liang

Shenzhen Institute of Artificial Intelligence and Robotics for Society, China  
Rong Ou, Bairun Lin, Xiaoqiang Ji, Ray C. C. Cheung and  
Huihuan Qian

Department of Electronic Engineering, City University of Hong Kong, China  
Shenzhen Institute of Artificial Intelligence and Robotics for Society, China

- Autonomous mono-hull sailboat is reformed to tow a battery carrying barge.
- The angles of the two sails are optimized to produce maximum lift.
- The batteries in the barge provide more energy for the sailboat.
- Autopilot tests show greater endurance.



Mono-hull Sailboat

- 15:30~15:45

### Auditory Brainstem Responses evoked by Swept-tone in Unilateral Sensorineural Hearing Loss Patients

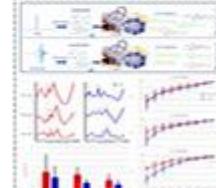
Xin Wang<sup>1</sup>, Jingqian Tan<sup>1</sup>, Boya Wang, Mingxing Zhu, Yao Pi, Xiaochen Wang,  
Cheng Wang, Chen Wang, Feng Wan, Shidong Chen<sup>\*</sup> and Guanglin Li<sup>1</sup>

<sup>1</sup> Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen

<sup>2</sup> Shenzhen College of Advanced Technology, University of Chinese Academy of Sciences, Shenzhen

<sup>3</sup> Guangdong-Hong Kong-Macao Joint Laboratory of Human-Machine Intelligence-Synergy Systems, Shenzhen

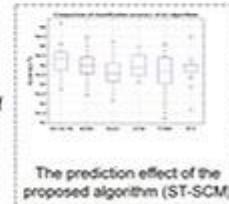
- A swept-tone method which adjusted the show-up times of different frequency components based on the basilar-membrane model is proposed.
- The proposed swept-tone method in ABR test shows advantages on morphology, time-saving, and hearing threshold evaluation.
- The swept-tone ABR could help with more accurate and efficient disease diagnosis.



### A new sEMG signal feature extraction method based on S transform

Xin Shi, Maqiang Zhai, Pengjie Qin, Keqi Yu, and Wenbo Zhou  
College of Automation, Chongqing University, China

- sEMG signal can reflect the state of human movement.
- The combination of SVD and concentration measurement can reduce the dimensionality of S transformation's result.
- Compared with RMS、MAV、STD、VMD and WT, the algorithm has higher prediction accuracy.



- 14:45~15:00

### Kinematics Modeling and Trajectory Planning for the Skull Reconstruction Robot

Weiwen Wang<sup>1</sup>, Xiru Wang<sup>2</sup>, Zeng-Guang Hou<sup>1</sup>, Zhijie Fang<sup>1</sup>,  
Yuze Jiao<sup>1</sup>, Yangyu Luo<sup>1</sup> and Jian Gong<sup>3</sup>

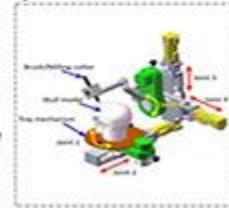
<sup>1</sup>the State Key Laboratory for Management and Control of Complex Systems,

Institute of Automation Chinese Academy of Sciences, China

<sup>2</sup>Department of Electronics, Polytech Nice Sophia, France

<sup>3</sup> Department of Pediatric Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, China

- A skull reconstruction robot has been developed firstly in the world.
- The contour data for cutting are obtained based on the laser scanning sensor.
- A PCA based method is designed to ensure the end tools perpendicular to the skull surface
- A polynomial interpolation based method is designed to construct the curves between adjacent key points.



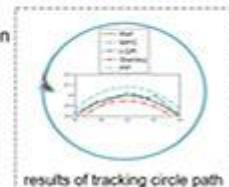
- 15:15~15:30

### Simulation Performance Evaluation of Pure Pursuit, Stanley, LQR, MPC Controller for Autonomous Vehicles

Jia Liu, Zhiheng Yang, Zhejun Huang, Wenfei Li, Shaobo Dang, and Huiyun Li

Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China

- Build geometry path tracking methods based on Ackerman steering model
- Build optimal path tracking methods based on Ackerman steering model
- Carry on simulation experiments on different paths



results of tracking circle path