**ICIT 2021 Abstract**

R. Pérez-Ubeda, R. Zotovic-Stanisic, S. C. Gutiérrez Rubert and J. Lluch-Cerezo, "Adjusting the active joint stiffness of a collaborative robot arm for force control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 13-18.  
doi: 10.1109/ICIT46573.2021.9453698  
Abstract: Collaborative robots are being used in machining task more and more. However, they have the disadvantage of elasticity in their joints, causing position errors, vibration, and poor performance in applications where contact forces are required. The main goal of this article is to study the effect of the joint stiffness in force control tasks. For this purpose, the active stiffness of the joints has been modified according to theoretical deductions. The experiments have been achieved on a UR3 robot through an inner/ outer force control loop. A theoretical and experimental analysis shows the advantage of this type of control, which allows adjusting the active stiffness when interacting with a different environment rigidity.  
keywords: {Vibrations;Service robots;Force;Dynamics;Collaboration;Programming;Rigidity;Force control;active stiffness;joint stiffness;collaborative robot},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453698&isnumber=9453463>  
  
K. Doki, K. Suzuki, A. Torii, S. Mototani, Y. Funabora and S. Doki, "Application of Augmented Reality based on Sensing Data to Teleoperation System for Operator Support," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 19-24.  
doi: 10.1109/ICIT46573.2021.9453619  
Abstract: In this paper, we propose a new system for operator support in teleoperation using Augmented Reality(AR) based on sensing data . In the proposed system, an 360-degree camera is equipped with a mobile machine in a remote place which is controlled by an operator, and the captured 360-degree image is displayed to the head mounted display put on the head of the operator. The operator can control the machine smoothly by watching what he needs for his current task by turning his head. In addition, the provided image around the machine has no blind spot because of the 360-degree image. However, a large transfer delay or a dropped frame occurs due to the enormous data size of the 360-degree image, which adversely influences the operator performance. In order to solve this problem, the AR image is actually provided to the operator, in which CG objects generated based on other sensor information are superimposed on the 360-degree image as AR objects. In this paper, the usefulness of the proposed method is shown through the experimental results on obstacle avoidance of a mobile robot by teleoperation.  
keywords: {Three-dimensional displays;Laser radar;Head;Resists;Cameras;Turning;Magnetic heads},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453619&isnumber=9453463>  
  
A. A. Araz, E. Ozkaya, F. Kocyigit, E. E. Bulut, M. Cibooglu and A. Erdogan, "Autonomous Vehicle Control Design Framework for Performance and Driveability," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 25-31.  
doi: 10.1109/ICIT46573.2021.9453632  
Abstract: User preference in shared-controlled systems are as important as user performance. Especially considering autonomous mobility systems, concepts such as comfort or perceived safety play crucial role on the enablement of this technology. In this paper, we propose a validation and control design framework that utilizes quantitative measurements of driveability combined with controller performance. Using AVL-DRIVE™ Autonomous to quantify these subjective metrics, we have shown that it is possible to design controllers for autonomous vehicles that not only focus on the tracking performance but also guarantee high comfort and perceived safety by the user.  
keywords: {Measurement;Control design;Pipelines;Human-robot interaction;Tools;Stability analysis;Safety;smart mobility;autonomous vehicle;model-based development;lane keeping system;driveability;control design framework},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453632&isnumber=9453463>  
  
F. Auris and C. Diedrich, "Design Guidelines for the Evolutionary Integration of Physical Behaviour Models into Plant Simulations for Production Engineering," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 32-38.  
doi: 10.1109/ICIT46573.2021.9453691  
Abstract: Currently, validation during the planning phases of smart production plants is approached very domain-specific. Interdisciplinary use of validation models is rare. Instead, models are often optimized for their single purpose. On the basis of a semi-formal analysis, a model integration concept, which spans different validation phases is proposed. A model for a production station is build based on "Component Behaviour Models" for mechatronic components, which are integrated into a plant simulation. In this publication, a mechanical interface for such integration is proposed and different interface concepts are discussed in order to establish guidelines for the model combination and integration depth, enabling an evolutionary introduction of this concept in practical applications.  
keywords: {Energy consumption;Analytical models;Solid modeling;Production systems;Mechatronics;Three-dimensional displays;Unified modeling language;Mechatronic Systems;Simulation;Factory and Process Automation;Dynamic Models;Geometry;Manufacturing Systems;Validation;Virtual Commissioning},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453691&isnumber=9453463>  
  
S. Kazeminasab, A. Akbari, R. Jafari and M. K. Banks, "Design, Characterization, and Control of a Size Adaptable In-pipe Robot for Water Distribution Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 39-46.  
doi: 10.1109/ICIT46573.2021.9453583  
Abstract: Leak detection and water quality monitoring are requirements and challenging tasks in Water Distribution Systems (WDS). In-line robots are designed for this aim. In our previous work, we designed an in-pipe robot [1]. In this research, we present the design of the central processor, characterize and control the robot based on the condition of operation in highly pressurized environment of pipelines with the presence of high-speed flow. To this aim, an extreme operation condition is simulated with computational fluid dynamics (CFD) and the spring mechanism is characterized to ensure sufficient stabilizing force during operation based on the extreme operating condition. Also, an end-to-end method is suggested for power considerations for our robot that calculates minimum battery capacity and operation duration in the extreme operating condition. Finally, we design a novel LQR-PID based controller based on the system's auxiliary matrices that retains the robot's stability inside pipeline against disturbances and uncertainties during operation. The ADAMS-MATLAB co-simulation of the robot-controller shows rotational velocity with -4°/sec and +3°/sec margin around x, y, and z axes while the system tracks different desired velocities in pipelines (i.e. 0.12m/s, 0.17m/s, and 0.35m/s). Also, experimental results for four iterations in a 14-inch diameter PVC pipe show that the controller brings initial values of stabilizing states to zero and oscillate around it with a margin of ±2° and the system tracks desired velocities of 0.1m/s, 0.2m/s, 0.3m/s, and 0.35m/s in which makes the robot dexterous in uncertain and highly disturbed environment of pipelines during operation.  
keywords: {Uncertainty;Service robots;Computational fluid dynamics;Pipelines;Process control;Water quality;Stability analysis;In-pipe robots;Water quality monitoring;Leak detection;LQR-PID controller;Modular robots},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453583&isnumber=9453463>  
  
R. Sawahashi, Y. Onozuka, T. Tanaka, M. Okui and T. Nakamura, "Development of a Wearable Four-Degrees-of-Freedom Force Feedback Device with a Clutch Mechanism Using Artificial Muscle Contraction," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 47-54.  
doi: 10.1109/ICIT46573.2021.9453574  
Abstract: In a virtual reality (VR) space, wearing a head-mounted display can help with the visualization of objects although users cannot experience realistic tactile sensations. Recently, several force feedback devices have been developed, including wearable devices that use straight-fiber-type pneumatic muscles and magnetorheological fluids. This allows the devices to render elastic, frictional, and viscous forces during spatially unrestricted movement. However, during friction and viscosity rendering, the elasticity of the artificial muscle is influenced by the elastic element of the muscle, preventing proper presentation of the force. Therefore, this study proposed a clutch mechanism to switch the force presentation of elastic elements by the contraction of artificial muscles. The mechanism was incorporated into a wearable four-degrees-of-freedom force feedback device, and its elastic, frictional, and viscous force feedback performances were quantitatively assessed via fundamental property experiments. Furthermore, a VR space was constructed to present the operator with force perceptions of virtual elastic, frictional, and viscous objects within that space, and the system's performance was qualitatively assessed. The results confirmed a reduction in the effect of elastic elements and an improvement in the presentation performance. Additionally, the use of this device in the VR space was confirmed to improve the realism of virtual objects in terms of friction and viscosity.  
keywords: {Viscosity;Performance evaluation;Friction;Wearable computers;Force feedback;Force;Muscles;Force feedback device;Magnetorheological fluid brake;Pneumatic artificial muscle;Clutch mechanism},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453574&isnumber=9453463>  
  
W. Wang, J. Ma, Z. Cheng, X. Li, A. Al Mamun and T. Heng Lee, "Generalized Iterative Super-Twisting Sliding Mode Control: A Case Study on Flexure-Joint Dual-Drive H-Gantry Stage," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 55-60.  
doi: 10.1109/ICIT46573.2021.9453472  
Abstract: Mechatronic systems are commonly used in the industry, where fast and accurate motion performance is always required to guarantee the manufacturing precision and efficiency. Nevertheless, the system model and parameters are difficult to be obtained accurately. Moreover, the high-order modes, strong coupling in multi-axis system, or unmodeled frictions will bring uncertain dynamics to the system. To overcome the above-mentioned issues and enhance the motion performance, this paper introduces a novel intelligent and totally model-free control method for mechatronic systems with unknown dynamics. In detail, a 2-degree-of-freedom (DOF) architecture is designed, which organically merges a generalized super-twisting algorithm with a unique iterative learning law. The controller solely utilizes the input-output data collected in iterations such that the it works without any knowledge of the system parameters. The rigorous proof of convergence ability is given and a case study on flexture-joint dual-drive H-gantry stage is shown to validate the effectiveness of the proposed method.  
keywords: {Industries;Mechatronics;Uncertainty;Tracking;Dynamics;Iterative algorithms;Trajectory},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453472&isnumber=9453463>  
  
B. Kaçmaz and M. T. Söylemez, "Implementation and Comparison of PID, PI-PD, LQR and MPC on Separation Clutch System in Slip," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 61-67.  
doi: 10.1109/ICIT46573.2021.9453664  
Abstract: Although the usage and investment on hybrid vehicles are increased in recent years, the production is demanding solutions due to complex structures. In this paper, it is aimed to provide a modular control algorithm for separation clutch closing process in hybrid vehicles by using well-studied theoretical control methods. The system is controlled by PID, LQR and MPC methods with both classical and further approaches. Then, the results of further approaches (PI-PD, LQR with known disturbances, and Multi-MPC) are compared in terms of performance and control cost. Multi-MPC has the best performance with highest controller cost while LQR with known disturbances has performed between the other two controllers. Moreover, PI-PD has the lowest controller cost and best performance for slip speed but it is not able to control the slip speed change.  
keywords: {Torque;Conferences;Process control;Production;Control systems;Mathematical model;Tuning;control;hybrid;modelling;MPC;clutch},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453664&isnumber=9453463>  
  
M. Švec, Š. Ileš and J. Matuško, "Model predictive control of vehicle dynamics based on the Koopman operator with extended dynamic mode decomposition," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 68-73.  
doi: 10.1109/ICIT46573.2021.9453623  
Abstract: The control of vehicle dynamics is a very demanding task due to the complex nonlinear tire characteristics and the coupled lateral and longitudinal dynamics of the vehicle. When designing a Model Predictive Controller (MPC) for vehicle dynamics, this can lead to a non-convex optimization problem. A novel approach to solve the problem of controlling nonlinear systems is based on the so-called Koopman operator. The Koopman operator is a linear operator that governs the evolution of scalar functions (often referred to as observables) along the trajectories of a given nonlinear dynamical system and is a powerful tool for the analysis and decomposition of nonlinear dynamical systems. The main idea is to lift the nonlinear dynamics to a higher dimensional space where its evolution can be described with a linear system model. In this paper we propose a model predictive controller for vehicle dynamics based on the Kooopman operator decomposition of vehicle dynamics with Extended Dynamic Mode Decomposition (EDMD) method. Both model identification and predictive controller design are validated using Matlab/Simulink environment.  
keywords: {Dynamics;Predictive models;Tools;Taylor series;Tires;Nonlinear dynamical systems;Trajectory;Koopman operator;basis function;data-driven methods;extended dynamic mode decomposition;model predictive control;vehicle dynamics},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453623&isnumber=9453463>  
  
A. Russo, G. Canciello and A. Cavallo, "MPC based Sliding Mode Control for More Electric Aircraft application," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 74-79.  
doi: 10.1109/ICIT46573.2021.9453663  
Abstract: This paper deals with the control of a bidirectional DC/DC converter in the framework of the More Electric Aircraft (MEA). The objective is to regulate the power flow between the aeronautical main generator and a battery connected to the grid through the bidirectional converter. The proposed control strategy comprises of a hierarchical control consisting of a fixed time Second Order Sliding Mode Control layer driven by a nonlinear Model Predictive Control strategy. The current entering (or exiting) the bidirectional converter on the network side is regulated by adaptively controlling the converter current on the battery side. Detailed simulations have been provided in order to verify the effectiveness of the proposed control strategy.  
keywords: {Conferences;Prediction algorithms;Generators;Batteries;Aircraft;Sliding mode control;Aerospace control;Sliding Mode Control;Model Predictive Control;Aeronautic Application;Power Systems;Robust Control},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453663&isnumber=9453463>  
  
M. Hanafusa and J. Ishikawa, "Operability Evaluation of Human-Adaptive Impedance Control for Human-collaborative Robots," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 80-86.  
doi: 10.1109/ICIT46573.2021.9453547  
Abstract: This paper discusses an operability of a human-adaptive impedance control to achieve human-robot co-manipulation of an object, in which a recurrent neural network (RNN) estimates a human state to be used in improving the contact stability of impedance control. The human sate, which is estimated from rectified-and-integrated electromyogram (iEMG) signals, is defined in this paper as what indicates that the human-arm becomes stiffer and causes an instability of the impedance control while the person and the robot are cooperatively manipulating the object. According to the degree of the estimated human state, the proposed method changes the impedance parameters to be heavier online so as to make the system more stable and then returns the mechanical parameters to be lighter once the stability is restored. In this paper, an operability of the proposed human-adaptive impedance control was evaluated quantitatively based on the crossover model in comparison with the case of fixed impedance control. In the case that the impedance characteristic was fixed lightly, the 0dB-gain-crossover frequency of the open-loop transfer function of the human-in-the-loop system (HILS), was at 0.21 Hz, achieving light-good operability. An undesirable oscillation, however, occurred depending on the situation between the human and the cooperative robot. In the case of fixed heavy impedance characteristics, stable operation was guaranteed, but the gain crossover frequency was reduced to 0.05 Hz, and the light handling was impaired even when the human exerted more force. On the other hand, the proposed method, which has a crossover frequency of 0.18 Hz, achieved stable operability while keeping light handling. Thus, those experimental results showed that the proposed method has both the reduced human effort and the good stability and can provide the human operator with an easy-to-work environment.  
keywords: {Recurrent neural networks;Mechatronics;Force;Transfer functions;Human-robot interaction;Stability analysis;Frequency response;human-adaptive mechatronics (HAM);variable impedance control;human-in-the-loop system;cross over model},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453547&isnumber=9453463>  
  
R. Wagle, P. Sharma, C. Sharma and C. Pradhan, "Perturbation and Observer Based Sliding-Mode Controller for Excitation control in Single-Machine Infinite Bus System," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 87-92.  
doi: 10.1109/ICIT46573.2021.9453522  
Abstract: The objective of this paper is to study and analyze operation of Perturbation and Observer-based Sliding-Mode control (POSMC) to enhance the power system stability instead of conventional Power system stabilizer (PSS). Conventional PSS are based on linearized models which might inherent linearization errors hence non linear controllers are chosen to replicate more practical power system dynamics. The rotor angle deviation together with perturbation are estimated through sliding-mode state and perturbation observer (SMSPO). The estimated signal is fed to the POSMC to generate a control signal which is applied to the AVR to regulate the voltage. The attractiveness of the sliding surface is analyzed theoretically in the perspective of the Lyapunov criterion. The presented POSMC enhances the system performance of the single-machine power system compared to conventional PID controller. Heffron-Phillips model of the synchronous generator is considered in this study.  
keywords: {Renewable energy sources;Voltage fluctuations;Perturbation methods;System performance;Rotors;Power system stability;Observers;Excitation control;PID-controller;Single-machine infinite bus;Perturbation and Observer based Sliding-mode control},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453522&isnumber=9453463>  
  
M. Dlapa, "Robust Control Design Toolbox for General Time Delay Systems via Structured Singular Value: Unstable Systems with Factorization for Two-Degree-of-Freedom Controller," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 93-98.  
doi: 10.1109/ICIT46573.2021.9453505  
Abstract: The application of the Robust Control Design Toolbox for General Time Delay Systems via Structured Singular Value: Unstable Systems for the Matlab system to the unstable plant with time delay in numerator and denominator is described in this paper. The uncertain time delays are treated using multiplicative and quotient uncertainty. The algebraic approach part implements evolutionary algorithm Differential Migration and pole placement for general 3rd order system with evaluation via structured singular value. Both, D-K iteration and algebraic approach, implements two-degree-of-freedom feedback loop controller with factoriz ation fixing internal instability. Both procedures are compared in simulations for maximum and half time delay and simple and two-degree-of-freedom feedback loop.  
keywords: {Robust control;Feedback loop;Uncertainty;Delay effects;Conferences;Evolutionary computation;Periodic structures;Algebraic approach;robust control;RQ-meromorphic functions;structured singular value;Uncertain time delay systems},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453505&isnumber=9453463>  
  
S. Harada and N. Uchiyama, "Robust Simple Adaptive Control with Augmented Output Signal and Friction Compensation for Industrial Feed Drive Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 99-104.  
doi: 10.1109/ICIT46573.2021.9453499  
Abstract: Feed drive systems are widely used for industrial machines in factories all over the world, and further robust performance is expected for precision motion. This study considers an application of simple adaptive control to feed drive systems, which generally requires an almost strictly positive real property in a plant. Although a parallel feedforward compensator is a typical approach to achieve this property, it may intrinsically deteriorate the control performance. This study applies an augmented output signal consisting of position and velocity information to achieve the above property. In addition, an adaptive friction compensator is also designed to further improve the performance. Experimental results demonstrate the effectiveness of the proposed approach.  
keywords: {Friction;Conferences;Control systems;Production facilities;Feeds;Adaptive control;Feedforward systems;Simple adaptive control;feed drive system;adaptive friction compensation},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453499&isnumber=9453463>  
  
S. Zhou, X. Dong, Q. Tan, Q. Wang and Z. Ren, "Time-varying group formation-tracking control for general linear multi-agent systems with switching topologies and time-varying delays," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 105-110.  
doi: 10.1109/ICIT46573.2021.9453550  
Abstract: Time-varying group formation-tracking control for general linear multi-agent systems with switching topologies and varying time delays is studied in this paper. Due to the deferent effects in coordinated problem, the agents in group formation-tracking are divided into two roles, leaders and followers, respectively. The followers are allowed to achieve the expected subgroup formation and, in the meantime, tracking the trajectory of the leaders in each group. Firstly, utilizing the neighboring information, the observers is proposed for each follower to estimate the leader's state in the subgroup. Based on the transformed of the estimated error and Lyapunov theory, the effectiveness of the proposed observer is proven. Secondly, by incorporating the state observer in the formation-tracking protocol, the novel controller is put forward to solve the group formation-tracking problem under the influence of both time-varying delays and switching networks. Then, an algorithm to determine the gain matrix is presented, and the convergence the of group formation error is also demonstrated. Finally, a numerical simulation result is given to verify the practical of the theoretical results.  
keywords: {Protocols;Network topology;Switches;Observers;Control systems;Topology;Delays;Group formation-tracking problem;general linear multi-agent systems;time-varying delays;switching topologies},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453550&isnumber=9453463>  
  
Y. Yamanaka, M. Kashima, H. Arakawa, R. Nishihama, K. Yokoyama and T. Nakamura, "Verification of the "AB-Wear" Semi-Exoskeleton-Type Power-Assist Suit in Providing Assistance to the Lower Back," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 111-117.  
doi: 10.1109/ICIT46573.2021.9453629  
Abstract: To reduce lower back pain of workers, we developed an assist suit for lumbar support in our previous studies. This suit, called AB-Wear II, has mechanisms to aid muscle strength through the inflating power of artificial muscles and balloon actuators, and reduce compressive forces acting on the spine through leaf springs. However, due to the stiffness of the leaf spring and the soft fabric supporter fixed to the wearer's waist, the device slipped out of place during a lifting motion, causing a loss of assistive force. In this study, a new version, AB-Wear III, was developed. The leaf springs in AB-Wear III are composed of a soft material that allows them to follow a wearer's movements. The leaf spring supports the posture of the spine by applying pressure against the back, and it should also reduce the shear force that causes lower back pain. In addition, a lumbar fixation mechanism using a leaf spring wound in an arc shape near the pelvis was developed to fix the device to the body of a wearer and prevent the device from slipping. Based on the electromyography (EMG) of the erector spinae muscles during a lifting motion while wearing AB-Wear III and a questionnaire, the optimal contact position between the back and leaf spring was found to be 60% of the spine length. At the abovementioned length, EMG was reduced by 16.7% than without the device. Subjective experiments also confirmed that the wearers' endurance was improved and lower back pain was reduced using the device.  
keywords: {Actuators;Torque;Three-dimensional displays;Pain;Force;Muscles;Back;Exoskeleton;Assist suit;Wearable robot;Lumbar assist;and Artificial muscle},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453629&isnumber=9453463>  
  
"Electrical Machines and Drives," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 118-120.  
doi: 10.1109/ICIT46573.2021.9453612  
Abstract: Start of the above-titled section of the conference proceedings record.  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453612&isnumber=9453463>  
  
E. G. Shehata, "A Comparison Between Conventional and Flux-Intensifying Interior Permanent Magnet Synchronous Machines," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 121-126.  
doi: 10.1109/ICIT46573.2021.9453564  
Abstract: Flux intensifying interior permanent magnet synchronous machine (FI-IPMSM) was designed to improve the characteristic of conventional permanent magnet machines, especially, in constant power or field weakening region. Increasing a saliency ratio is the main method to achieve this target which leads to increasing reluctance torque than magnetic torque and so improving the machine performance. In this paper, the characteristics of FI-IPMSM are investigated. The effect of PM material, PM width, PM thickness, flux barriers width and iron bridge thickness on the machine parameters, output torque and no-load characteristic is studied. A comparison is carried out between the FI-IPMSM and conventional IPMSM to evaluate the improvement in machine performance. Two-dimension time-steeping finite element method (FEM) is employed in analysis of the FI-IPMSM and conventional IPMSM.  
keywords: {Permanent magnet machines;Bridges;Magnetic flux;Forging;Torque;Iron;Permanent magnets;Interior permanent magnet synchronous machines;flux intensifying;saliency ratio;field weakening},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453564&isnumber=9453463>  
  
S. Khoshzaman and I. Hahn, "A Performance Comparison of GaN FET and Silicon MOSFET," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 127-133.  
doi: 10.1109/ICIT46573.2021.9453693  
Abstract: Introducing the excellent advantages of using wide bandgap semiconductors such as gallium nitride (GaN) in the construction of the power devices has set a starting point for a new era in the history of power electronics. Replacing the silicon-based with GaN-based power devices promises a number of benefits. Higher power densities, switching speeds and temperature stabilities with lower on-state resistance, reduced conduction and switching losses and a reduction in the die size are some of the performance improvements that the GaN transistors offer. To show both the advantages and challenges regarding this new technology, the methodology for an eligible comparison between Si-based and GaN-based transistors has been explained. Experimental comparison has been performed between a 100 V commercially available enhancement mode GaN FET and two silicon-based MOSFETs, and the results are discussed in detail.  
keywords: {Performance evaluation;MOSFET;Photonic band gap;Switching loss;Switches;Silicon;Gallium nitride;gallium nitride;silicon;wide bandgap devices;performance characterization},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453693&isnumber=9453463>  
  
J. P. Degel, S. Haehnlein, C. Kloeffer and M. Doppelbauer, "A phase based approach for machine inductance estimation via current slope detection of an inverter fed IPMSM," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 134-141.  
doi: 10.1109/ICIT46573.2021.9453555  
Abstract: The following describes a new method for estimating the parameters of an interior permanent magnet synchronous machine (IPMSM). For the estimation of the parameters the current slopes caused by the switching of the inverter are used to determine the unknowns of the system equations of the electrical machine. The angle and current dependence of the machine parameters are linearized within a PWM cycle. By considering the different switching states of the inverter, several system equations can be derived and a solution can be found within one PWM cycle. The use of test signals and filter-based approaches is avoided. The derived algorithm is explained and validated with measurements on a test bench.  
keywords: {Permanent magnet machines;Inductance;Magnetic separation;Estimation;Switches;Pulse width modulation;Filtering algorithms;AC machines;Current control;Estimation;Measurement;Monitoring;Parameter estimation;Permanent Magnet Machines;Predictive models},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453555&isnumber=9453463>  
  
J. S. Merino, M. Di Castro and A. Masi, "An Application of Active Disturbance Rejection Control to Stepper Motors with Field Oriented Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 142-147.  
doi: 10.1109/ICIT46573.2021.9453494  
Abstract: In this paper, an application of an Active Disturbance Rejection Controller (ADRC) to a hybrid stepper motor is presented. ADRC has gained the attention of practitioners due to its simplicity and robustness against model uncertainty and external disturbances compared to standard PID control. The performance of the Linear ADRC (LADRC) is addressed in this paper for a stepper motor under Field Oriented Control (FOC). First a simulation of current, speed and position control loops is performed, and after, a position reference step experiment is done in a real test bench. The results are systematically compared to the case of a PI controller showing improvements for the same given specifications. Also, a load torque observer (LTO) is added as feedforward to the PI controller for the experimental tests. Results show a better load rejection, setpoint tracking and repeatibility for the ADRC controller in hybrid stepper motors.  
keywords: {Analytical models;Tracking loops;PI control;Torque;Uncertainty;Tracking;Observers},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453494&isnumber=9453463>  
  
D. Pasqualotto, A. Navarro Navarro, M. Zigliotto and J. A. Antonino-Daviu, "Automatic Detection of Rotor Faults in Induction Motors by Convolutional Neural Networks applied to Stray Flux Signals," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 148-153.  
doi: 10.1109/ICIT46573.2021.9453624  
Abstract: The growth in cost and complexity of modern industrial plants leads to decreasing tolerance for performance degradation or system downtimes. In this context, the paper deals about the automatic condition monitoring of the rotor bars of induction AC motors which is performed through two main components. The former is the extraction of the Short-Time Fourier Transform of the motor stray flux during start ups as a fault-related index. The latter is the automatic classification and recognition of the signal through an Artificial Intelligence-based algorithm: a Convolutional Neural Network. This cutting-edge tool is particularly suitable for knowledge-based image recognition problems and its feasible training is here permitted by some data augmentation techniques.  
keywords: {Training;Induction motors;Image recognition;Knowledge based systems;Rotors;Tools;Industrial plants;Condition monitoring;induction motors;convolutional neural networks;stray flux;rotor faults},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453624&isnumber=9453463>  
  
M. E. Iglesias Martínez, J. A. Antonino-Daviu, C. A. Platero, L. Dunai, J. A. Conejero and P. Fernández de Córdoba, "Bispectrum and Kurtosis Analysis of Rotor Currents for the Detection of Field Winding Faults in Synchronous Motors," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 154-159.  
doi: 10.1109/ICIT46573.2021.9453682  
Abstract: In this work, the application of the bispectrum to rotor current signals is proposed to detect field winding faults in wound rotor synchronous motors. These signals are analyzed both under starting and under steady-state regimes. Furthermore, a new indicator based on bispectral kurtosis is proposed, yielding satisfactory results for fault classification. One of the interesting points of the paper is that a common specific failure pattern is obtained, regardless of the type of motor operating regime. A comparative analysis between the two motor operating regimes is carried out, obtaining several conclusions about the suitability of each regime and, in particular, of the steady-state-based variant for the application of the methodology in real applications.  
keywords: {Fault detection;Conferences;Windings;Rotors;Data visualization;Synchronous motors;Stability analysis;Synchronous motors;Bispectrum;Kurtosis;Field Winding;Faults;Maintenance;Rotor},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453682&isnumber=9453463>  
  
P. A. Scholtz and M. Njoroge Gitau, "Carrier Modulation Schemes of Asymmetric, Multileveled, Switched Reluctance Machine Drives," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 160-165.  
doi: 10.1109/ICIT46573.2021.9453465  
Abstract: Multilevel converter topologies are an ongoing research topic only recently extended to the asymmetric, switched reluctance machine drives. These topologies show potential in extending the operable speed range, reducing torque ripple and improving generation efficiency. However, due to the asymmetric, nonconventional nature of these topologies, traditional carrier modulation schemes have yet to be explored. This paper addresses a lack of available literature on the subject by proposing suitable carrier modulation strategies for the asymmetric flying capacitor, asymmetric neutral point clamped and asymmetric cascaded cell half bridge topologies. These strategies make use of interleaved carrier waveforms and can also be implemented with suitable capacitor balancing control strategies. The harmonic distortion of the input current waveform due to the modulation is also considered, providing a suitable criteria for comparing recently proposed topologies with their new modulation schemes.  
keywords: {Phase modulation;Modulation;Bridge circuits;Switches;Topology;Power capacitors;Harmonic distortion;Multilevel;pulse width modulation (PWM);switched reluctance motor (SRM);total harmonic distortion (THD);flying capacitor (FC);neutral point clamped (NPC);cascaded cell half bridge (CCHB)},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453465&isnumber=9453463>  
  
V. Gowtham and S. Sashidhar, "Comparison of Hybrid PM assisted Synchronous Reluctance Motors," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 166-171.  
doi: 10.1109/ICIT46573.2021.9453679  
Abstract: Permanent magnet assisted synchronous reluctance motors (PMa-SyRMs) are becoming popular in applications such as electric vehicles (EVs), refrigerant compressors, bore-well pumps, etc. The main role of PMs in a PMa-SyRM is to saturate the rotor iron bridges and improve the power factor of a conventional SyRM. Hence, limited volume of PMs is sufficient for this purpose. Usually, rare-earth PMs are used in these applications for achieving high performance. However, the prices of rare-earth PMs is increasing everyday. Low-cost ferrite PMs despite being an alternative to Nd-Fe-B PMs have low remanence. On the other hand, Al-Ni-Co PMs have higher remanence and are economically viable. However, they have a steep II-quadrant B-H curve and are thus prone to demagnetization. In this paper, various hybrid PMs based PMa-SyRM are analyzed. 2-D finite element (FE) analysis is carried-out on the these hybrid PMa-SyRMs and the comparison results are presented.  
keywords: {Ferrites;Reactive power;Rotors;Permanent magnet motors;Compressors;Permanent magnets;Finite element analysis;Permanent Magnets;Synchronous Reluctance Motor;Finite Element Analysis},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453679&isnumber=9453463>  
  
J. Kumar, V. Gowtham and S. Sampathirao, "Comparison of Synchronous Reluctance, PM assisted Synchronous Reluctance and Spoke-Type BLDC Motor for an E-Rickshaw," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 172-177.  
doi: 10.1109/ICIT46573.2021.9453466  
Abstract: Electric vehicles (EVs) are now rapidly emerging throughout the world. Due to high carbon emission by internal combustion engines (ICEs), EVs are being considered as a strong alternative to it. An auto-rickshaw is one of the very important and common modes of transportation in India. Due to the rising prices of petrol and diesel and emissions from ICE based auto-rickshaw, an E-Rickshaw is the best alternative. In this paper, various motors for E-Rickshaw are investigated and the performance comparison between the selected motors is presented. Three motors i.e., spoke-type (ST) permanent magnet (PM) brushless dc (BLDC) motor, magnet-less synchronous reluctance motor (SyRM) and magnet-assisted SyRM are compared using magnetic equivalent circuit (MEC) analysis. Further, 2-D FEA (Finite Element Analysis) is carried out and the results are presented.  
keywords: {Magnetic flux;Torque;Brushless DC motors;Transportation;Permanent magnet motors;Magnetic analysis;Finite element analysis;Permanent Magnet;Synchronous Reluctance Motor;Spoke-Type BLDC Motor;Interior Permanent Magnet Motor},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453466&isnumber=9453463>  
  
B. Sultana, K. Scicluna, J. Attard, C. Seguna and J. Scerri, "Design of a FPGA-based Inverter Drive for HF Injection Based Sensorless Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 178-183.  
doi: 10.1109/ICIT46573.2021.9453641  
Abstract: This paper presents the design of a Field Programmable Gate Array-based three-phase inverter intended for High-Frequency Injection as used with Low-speed Sensorless Control. Sensorless control includes a wide range of techniques used to control electrical machines without having a dedicated speed or position sensor. Several state-of-the-art techniques use High-Frequency Injection to obtain measurable HF currents which are position modulated.In this paper, a custom inverter was designed for use with an FPGA-based controller which generates both fundamental and High-Frequency rotating sinusoidal components. The use of an FPGA is recommended to increase both the HF signal and Pulse Width Modulation frequency to reduce acoustic noise and torque ripple. Experimental FPGA-based V/f control of a 12 V 400 W Permanent Magnet Synchronous Machine is described. Experimental phase fundamental and High-Frequency current results with different reference frequency setpoints are shown in both time and frequency domains.  
keywords: {Time-frequency analysis;Frequency modulation;Sensorless control;Logic gates;Pulse width modulation;Inverters;Torque measurement;Field programmable gate arrays;sensorless control;pulse width modulation inverters;permanent magnet machines},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453641&isnumber=9453463>  
  
S. H. Ebrahimi, M. Choux and V. K. Huynh, "Detection and Discrimination of Inter-Turn Short Circuit and Demagnetization Faults in PMSMs Based on Structural Analysis," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 184-189.  
doi: 10.1109/ICIT46573.2021.9453557  
Abstract: This paper presents a fault diagnosis method based on structural analysis of permanent magnet synchronous motors (PMSMs), focusing on detecting and discriminating two of the most common faults in PMSMs, namely demagnetization and inter-turn short circuit faults. The structural analysis technique uses the dynamic mathematical model of the PMSM in matrix form to evaluate the system's structural model. After obtaining the analytical redundancy using the over-determined part of the system, it is divided into redundant testable sub-models. Four structured residuals are designed to detect and isolate the investigated faults, which are applied to the system in different time intervals. Finally, the proposed diagnostic approach is numerically verified through a simulation of an inverter-fed PMSM and white Gaussian noise are added to the measured signals from the motor to verify its diagnosis performances.  
keywords: {Redundancy;Tools;Synchronous motors;Permanent magnet motors;Numerical models;Circuit faults;Mathematical model;fault diagnosis;inter-turn short circuit;demagnetization;structural analysis;PM synchronous motor},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453557&isnumber=9453463>  
  
A. Langheck, D. Stretz, J. Zhou, T. Rittgerott, J. Kolb and M. Doppelbauer, "Harmonic current injection for torque ripple reduction with optimum current trajectory for minimum induced voltage," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 190-197.  
doi: 10.1109/ICIT46573.2021.9453480  
Abstract: Electric drives often do not have a smooth torque. In most cases they are coupled with mechanical systems. These tend to have natural frequencies. Therefore, it is advisable to eliminate harmonics from the torque pulsation if they are close to a natural frequency. One possibility to do this is harmonic current injection or HCI for short. However, the question arises, how exactly this harmonic current should be. The fact that a harmonic in the torque can be influenced by the d and q current results in a greater degree of freedom. This paper presents a method to investigate all possible solutions. Furthermore, two optimization possibilities for the current trajectory are presented. The effect of this selection on the maximum torque speed curve is shown. It has been found that the method which minimizes the induced voltage achieves an up to 8% larger range of application in this example.  
keywords: {Human computer interaction;Torque;Atmospheric measurements;Current measurement;Harmonic analysis;Particle measurements;Trajectory;PMSM;Harmonic current injection;voltage optimal current trajectory;torque ripple},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453480&isnumber=9453463>  
  
U. R. Muduli and R. Kumar Behera, "High Performance Finite Control Set Model Predictive DTC for Three-to-Five Phase Direct Matrix Converter Fed Induction Motor Drive," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 198-202.  
doi: 10.1109/ICIT46573.2021.9453475  
Abstract: Direct Matrix Converter (DMC) solves problems due to the two-stage power conversion mechanism for heavy industrial drive applications. Control of multiphase drives operated by DMC is a serious problem due to the lack of technological advancement. A model predictive direct torque control (MPDTC) scheme for a five-phase induction motor (FPIM) driven by a three-to-five (3×5) phase DMC is therefore proposed in this paper. The proposed MPDTC uses the concept of virtual vectors to eliminate the effect of the xy component on 3×5 DMC output voltage space vectors. By using ranking analysis, the flux and torque of FPIM is controlled along with the grid power factor. The proposed work is simulated and further validated by DMC fed FPIM hardware prototype using FPGA based controller.  
keywords: {Reactive power;Monte Carlo methods;Torque;Torque control;Prototypes;Predictive models;Stators},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453475&isnumber=9453463>  
  
K. Cui, H. Eldeeb, M. Abdelrahem and R. Kennel, "Improved DC-link Voltage Utilization for Dual Three-phase Drives with Full Anti-windup and Harmonic Compensation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 203-208.  
doi: 10.1109/ICIT46573.2021.9453705  
Abstract: The paper presents a new control strategy for the asymmetrical dual three-phase IPMSM, which can optimize the voltage dispatch for the torque production and harmonic compensation to obtain a wide constant torque-speed range with an improved dc-link voltage utilization, especially in field-weakening mode. Depending on the operating point, a full or partial harmonic compensation is achievable. Eventually, the current controller produces the desired torque while minimizing the stator copper losses.  
keywords: {Electric potential;Torque;Limiting;Simulation;Production;Stators;Drives;dual three-phase machine;harmonic compensation;field-weakening mode},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453705&isnumber=9453463>  
  
A. Ibrayeva, F. Lopez and S. Eriksson, "Modelling of Permanent Magnet Synchronous Generator with Non-linear Magnets," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 209-214.  
doi: 10.1109/ICIT46573.2021.9453675  
Abstract: In this paper simulation results of a spoke-type synchronous generator for a wind turbine with three different grades of Alnico magnets were presented. COMSOL Multiphysics 5.4 finite element analysis (FEA) based software was used. The proposed model was used for simulation of a synchronous generator with non-linear Alnico magnets with recoil-lines with some approximations and can be used for modelling electrical machines with other non-linear permanent magnets. The geometry of the machines was kept fixed for all scenarios. The model takes into account the irreversible loss of magnetization of non-linear permanent magnets due to the magnetic field from the stator winding during normal operation and short circuit. Modelling results show that Alnico 5 (ArKomax800) magnets have the lowest output power, but they are the least sensitive to change of the load. The generator with Alnico 8 permanent magnets have the highest output power, is good at handling the nominal load but the most sensitive to short circuits. Alnico 9 magnets could be an option if the risk for short circuits is accounted for.  
keywords: {Magnetic flux density;Shape;Simulation;Permanent magnets;Synchronous generators;Generators;Integrated circuit modeling;Alnico;COMSOL;FEM;Non-linear Permanent Magnets;PMSG;Recoil Lines},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453675&isnumber=9453463>  
  
J. Ryu and I. Hahn, "Numerical modeling for 3D eddy current calculation in magneto-quasistatic approximation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 215-220.  
doi: 10.1109/ICIT46573.2021.9453688  
Abstract: In general, magnetic excitation of eddy current density is calculated in a 3-dimensional system to gain the most accurate results leading to long computational times. However, the long computational time might be problematic due to needs for high computational effort. In order to improve this disadvantageous point, this paper deals with a finite-difference approximation considering the curl and divergence operator of eddy current density. In particular, by using this numerical modeling calculation, the proposed method in this paper can quickly implement the eddy current calculation in the 3-dimensional system and build the eddy currents modeling of a specific part of interest. Lastly, the comparative analysis with a commercial tool for 3-D FEM is carried out, and the accuracy of the 3 dimensional finite difference method (3-D FDM) is verified.  
keywords: {Solid modeling;Three-dimensional displays;Tools;Numerical models;Mathematical model;Magnetic fields;High frequency;3D-FDM;Curl operator;Divergence operator;Eddy current density;Magneto-quasistatic approximation},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453688&isnumber=9453463>  
  
S. Kajii, M. Takemoto, T. Jikumaru, F. Suzuki, S. Ogasawara and K. Orikawa, "Reduction in Eddy Current Loss of Concentrated Windings in High-power Density IPMSM Using Rectangular Windings," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 221-227.  
doi: 10.1109/ICIT46573.2021.9453692  
Abstract: Researches on more electric aircraft (MEA) are actively conducted. It is necessary for realizing MEA to meet aircraft application requirements: high ability, high availability, and high-power density, while aiming to reduce weight and environmental impact. For example, interior permanent magnet synchronous motors (IPMSMs) are expected to be used for aircraft applications of MEA, because IPMSMs can achieve both high-power density and high efficiency at high speed and high torque area compared to other types such as induction motors. In general, IPMSMs with concentrated winding structure are available to utilize limited space effectively. Rectangular windings allow high winding factor and realizing more high-power density motors, whereas eddy current loss in rectangular windings is much higher than that in round windings. In this paper, high-power density concentrated winding IPMSMs that employ rectangular windings are discussed. We have examined three improvements for a reduction of the eddy current loss in the rectangular windings to attain continuous operation with high-power density in this motor. In order to reduce the eddy current loss in the windings situated in front of the rotor, we adopted an asymmetric tooth-tip. Moreover, an adequate groove shape between tooth and stator yoke allows to reduce the eddy current loss in stator yoke side windings. Windings, which have optimized unequal cross-sectional area, offer to reduce whole winding loss. Finally, we present a proposed motor employing the three improvements.  
keywords: {Induction motors;Torque;Shape;Windings;Stator windings;Rotors;Permanent magnet motors;IPMSM;high power density motor;rectangular winding;asymmetric tooth-tip},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453692&isnumber=9453463>  
  
S. Abdi, S. Sharifzadeh and S. Amiri, "Reliability Model Development for Wind Turbine Drivetrain with Brushless Doubly-Fed Induction Machine as Generator," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 228-233.  
doi: 10.1109/ICIT46573.2021.9453637  
Abstract: Brushless doubly-fed induction machines (BDFIM) are attractive generators to be used in wind turbines due to the absence of brushes and slip rings. Furthermore, the BDFIM is a medium-speed generator and hence only requires one or two-stage gearbox. This feature simplifies the gearbox system and therefore improve reliability and reduce maintenance costs for the wind turbine. Although the design and operation of the BDFIM has been widely studied in the literature, there are only few studies on reliability assessment of the machine as a wind turbine generator. This paper proposes a comprehensive reliability model for two wind turbine drivetrain configurations: One with doubly-fed induction generator, and the other when the BDFIM is employed as the generator. The model is capable of evaluating the failure rate and repair rate indexes for the both configurations. Real field survey data from a 90 MW wind farm as well as calculated reliability data are then utilised to determine the reliability index values for the two drivetrain configurations in order to compare their reliability performance.  
keywords: {Brushes;Induction generators;Conferences;Maintenance engineering;Wind farms;Reliability engineering;Generators;brushless Doubly-fed induction machines;failure rate;mean time to failure;mean time to repair;reliability assessment;repair rate;wind turbine drivetrain},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453637&isnumber=9453463>  
  
E. Rodriguez Montero, M. Vogelsberger and T. Wolbank, "Sensorless Speed Control of Single-Inverter Dual Motors based on Slotting Saliency Harmonic," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 234-239.  
doi: 10.1109/ICIT46573.2021.9453565  
Abstract: Traditionally in single-inverter dual motor drives, two current sensors are attached to two inverter output phases. This is an economic option and often used by industry. Applying this configuration to saliency-based sensorless control is challenging, since both motor saliency waves may present opposite phase. In this case, the sum saliency signal, calculated by the current responses obtained by the two current sensors, would lead to zero and no rotor position would be available.In order to obtain two saliency signals, one for each motor, and thus avoiding the zero saliency sum, this paper investigates the use of three current sensors instead, where two are attached to the phases of the first motor and the remaining one to a phase of the second motor. With this current sensor configuration, voltage step excitation strategy is applied. In the proposed test bench, two similar induction motors are fed by a single inverter and mechanically coupled by a belt drive that allows opposite phase slotting synchronous signals. It will proven by experimental measurements that each motors' sensorless position can be accurately calculated regardless of the phase shift between both slotting signals using the three current sensor.  
keywords: {Mechanical sensors;Induction motors;Phase measurement;Current measurement;Velocity control;Signal processing algorithms;Synchronous motors;Induction Motor;Sensorless Control;Signal Processing Algorithms},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453565&isnumber=9453463>  
  
D. Lendi, R. Raute, S. G. Fabri and R. Galea, "Stability Analysis of a Non-Linear PWM-Controlled Buck Converter with LC Input Filter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 240-245.  
doi: 10.1109/ICIT46573.2021.9453633  
Abstract: This paper analyzes the control stability of a DC motor soft starter. The soft starter uses a Buck converter for current control and an LC filter at the input to reduce the current ripple of the DC power supply. The required current control bandwidth is high and can excite the resonance frequency of the input LC filter. This paper analyzes the control stability of the non-linear system. It shows that the current control system enters a stable limit cycle at the region around the theoretical stability margin.  
keywords: {Current control;Buck converters;Limit-cycles;Power system stability;DC motors;Stability analysis;Circuit stability;Buck converter;DC Motor;Pulse width modulation;current control;Limit cycle},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453633&isnumber=9453463>  
  
"Power Electronics and Renewable Energy Conversion," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 246-248.  
doi: 10.1109/ICIT46573.2021.9453572  
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J. M. Paul and B. Jacob, "3D Space Vector Pulse Density Modulation Scheme for Two-Level Four-Leg Inverter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 249-254.  
doi: 10.1109/ICIT46573.2021.9453673  
Abstract: Four-leg inverters are widely used to mitigate the effects of unbalanced three phase supply and unbalanced three phase loads. The most popular switching signal generation technique for four-leg inverter are 3D Space Vector Pulse Width Modulation (3D SVPWM) schemes. In this paper a 3D Space Vector Pulse Density Modulation (3D SVPDM) scheme for two-level four-leg inverter is proposed. The proposed 3D SVPDM scheme uses abc coordinate system. The oversampling and noise shaping property of Pulse Density Modulation (PDM) provides better harmonic performance than SVPWM schemes. 3D SVPDM does not have any complex timing calculations. The proposed scheme can be used for active power filter applications. 3D SVPDM is validated through simulation by using Matlab/Simulink software. The simulation results of 3D SVPDM are compared with 3D SVPWM scheme and it is observed that 3D SVPDM shows better total harmonic distortion (THD) characteristics.  
keywords: {Space vector pulse width modulation;Total harmonic distortion;Three-dimensional displays;Simulation;Modulation;Switches;Inverters;3D Space Vector Pulse Density Modulation(3D SVPDM);vector quantization;Sigma Delta Modulation (SDM);Four-leg inverter},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453673&isnumber=9453463>  
  
D. Nakashima and Y. Ishizuka, "A Low-Voltage-Deviation and Small-Output-Voltage-Ripple DC-DC Converter with Reduced Output Capacitance in Automotive Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 255-259.  
doi: 10.1109/ICIT46573.2021.9453634  
Abstract: With the increasing demand for EVs, capacitors are a shortage to improve EV performance. In this paper, a reducing output capacitance control technique achieves to reduce the value of output capacitance with small output voltage ripple and low voltage deviation. Point of Load (POL) for secondary power supply in EV applications needs a simple design and implementation. The proposed Compensating Light-load Operation and a Simple voltage-mode (CLOS) control for POLs are designed simply by using the AND logic circuit as the gate signal mixture. A prototype experimental result with 12 V input, 5 V output is obtained to verify the circuit operation. The proposed control circuit with reduced output capacitance improves voltage deviation and output voltage ripple, while the experimental prototype circuit uses six times smaller output capacitance.  
keywords: {Low voltage;Power supplies;Automotive applications;Prototypes;Modulation;Logic gates;Capacitance;Δ∑ modulator;hysteresis control;automotive application;voltage mode;mixed-signal;POL;DC-DC converter;buck converter;PWM;PFM},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453634&isnumber=9453463>  
  
M. Lorenz, J. Kucka and A. Mertens, "A Modular Multilevel Converter with a Clamping Switch for Quasi-Three-Level Operation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 260-265.  
doi: 10.1109/ICIT46573.2021.9453540  
Abstract: The required module capacitances of modular multilevel converters can be significantly reduced in comparison to conventional operation modes when quasi-two-level operation is applied. Unfortunately, the output voltage distortion becomes similar to those of conventional two-level-converters. Adding a new current path to the topology enables quasi-three-level operation of the modular multilevel converter, which can reduce the harmonic content of the output voltage while still maintaining the advantage of small module capacitances. In this paper, a novel converter topology based on a combination of modular multilevel converter and bidirectional semiconductor clamping switch is presented, which is capable of quasi-three-level operation. This novel topology has all advantages of a quasi-three-level modular multilevel converter topology from literature, while overcoming the requirement for additional full-bridge modules connected between the phase output and the dc center tap. This is expected to reduce costs and losses.  
keywords: {Insulated gate bipolar transistors;Multilevel converters;Thyristors;Switches;Medium voltage;Pulse width modulation;Capacitance;Power converters;DC-AC;multilevel converters},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453540&isnumber=9453463>  
  
M. G. Marangalu, A. Samadian, N. V. Kurdkandi, A. Khoshkbar-Sadigh and S. H. Hosseini, "A new Switched Capacitor Nine-Level Inverter Based on Flyback DC-DC converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 266-271.  
doi: 10.1109/ICIT46573.2021.9453520  
Abstract: In this paper a new single DC-source switched capacitor Nine-level inverter based on flyback DC-DC converter is presented. The proposed topology reduces the number of switches, diodes and required independent DC-sources. In this topology, a single DC source is used to produce 9-level output voltage waveform. So that, it is suitable for renewable photovoltaic energy systems. Since, in this topology a DC-DC flyback converter is applied so three isolated DC voltage are generated to supply the proposed switched capacitor inverter. There is no need to any complicate control methods for adjusting capacitor voltage around constant values. In order to highlight the advantages of the proposed topology, it has been compared with some other presented topologies in last years. The simulation results of 9-level inverter are obtained by PSCAD software to verify the accurate performance of the proposed multilevel inverter.  
keywords: {Photovoltaic systems;Power supplies;Simulation;Capacitors;Switches;Boosting;Inverters;Multilevel Inverter;switched-capacitor Multilevel Inverter;Total Harmonic Distortion (THD)},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453520&isnumber=9453463>  
  
A. Zafari, M. Mehrasa, M. Sharifzadeh, S. Bacha, K. Al-Haddad and N. Hosseinzadeh, "A Novel Reference Current Detection Algorithm (RCDA) in 9-Level PEC Converter-based Shunt Active Power Filter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 272-277.  
doi: 10.1109/ICIT46573.2021.9453502  
Abstract: In order to enhance the power quality of single-phase Active Power Filters (APFs), which are used as the interface between distributed generators and the electrical power distribution grid, a novel approach is put forward in this paper. An accurate Reference Current Detection Algorithm (RCDA) is proposed as a critical part of Shunt Active Power Filter (SAPF) control system for a nine-level Packed E-Cell (PEC9)-based SAPF (PEC9-SAPF). All unwanted components of load current are incorporated in the proposed Reference Current Detection Algorithm (RCDA). The proposed PEC9-based SAPF not only guarantees the excellent power quality at the grid side, but also holds all advantages of PEC multilevel converters. Also, the proposed RCD algorithm is assessed to verify its accuracy through considering the impact of critical components such as reactive and harmonics currents. Simulation Results confirm that the proposed PEC9-based SAPF is able to compensate the harmonic components of nonlinear load, produce low THD sinusoidal waveform for grid current, reach unity power factor, and balance the capacitor voltages for PEC9 converter.  
keywords: {Reactive power;Simulation;Power quality;Capacitors;Power distribution;Active filters;Harmonic analysis;Grid-Connected Single-Phase Converter;Electrical Power Distribution Grid;Shunt Active Power Filter (SAPF);Single- Phase;PEC Converter;Reference Current Detection Algorithm (RCDA);RCDA-based SAPF;PEC9-SAPF},  
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S. Vahid and A. EL-Refaie, "A Novel Semi-Isolated Three-Port dc-dc Power Converter with Soft Switching Technique for Hybrid Energy Storage Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 278-284.  
doi: 10.1109/ICIT46573.2021.9453694  
Abstract: Tendency to achieve high power density in power converters brought multi-port converters into the center of attention. These converters, if designed properly, benefit from fewer active and passive components. Therefore, multi-port converters are expected to have higher power density and potentially lower cost compared to their counterparts. This paper presents a novel semi-isolated three-port dc-dc converter for hybrid energy storage systems. Moreover, a novel control method is applied to the proposed three-port converter to guarantee soft switching at different modes of operation. This control method uses both fixed and variable frequency PWM methods. Variable frequency PWM is employed to achieve boundary current mode operation for one port which enables optimum design for the inductor in the mentioned port. Furthermore, a 1.5kW model of the proposed converter, suitable for low power electric vehicles, such as electric motorcycles, bikes, and golf cats, has been simulated. Simulation results demonstrate the capabilities of the proposed three-port converter and effectiveness of the presented control method.  
keywords: {Power system measurements;Density measurement;Simulation;Soft switching;Motorcycles;DC-DC power converters;Pulse width modulation;Three-Port Converter;Multi-Port Converter;Battery;Super Capacitor;Hybrid Energy Storage;Boundary Current Mode (BCM);HF Transformer},  
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P. Zolfi, S. Vahid and A. EL-Refaie, "A Novel Three-Port DC-DC Converter for Integration of PV and Storage in Zonal DC Microgrids," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 285-291.  
doi: 10.1109/ICIT46573.2021.9453479  
Abstract: Energy conversion process of distributed renewable energy resources and energy storage devices highly depends on the DC-DC converters as interfaces. Reducing the number of conversion stages can lead to less complex energy conversion process. Multi-port converters with their flexible structure and control strategy are good candidates for this purpose. A management and integration study of PV/battery in zonal DC microgrids is presented in this paper. Moreover, a novel isolated three-port converter with continuous input current called three-port DC-DC interface is presented. Also, a zonal DC microgrid architecture based on three-port DC-DC interface is presented and discussed. An efficient four-layer control strategy for power flow management in DC microgrid is presented and discussed thoroughly. Simulations are conducted under various operation modes and loads to demonstrate the capability of proposed interface and the presented methods and strategies. The proposed three-port DC-DC interface converts and manages the power flow in the DC microgrid with high efficiency values of 91.8% and 95.6% for two-stage and single-stage conversion processes, respectively.  
keywords: {Renewable energy sources;Simulation;Microgrids;DC-DC power converters;Power electronics;Batteries;High frequency;Energy management;Photovoltaic systems;Multi-port Converter (MPC);Three-port Converter (TPC);Three-port DC-DC interface (TPDCI);Zonal DC microgrid},  
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R. Mandrioli, M. Ricco, M. Hammami, A. Viatkin and G. Grandi, "A Ripple-Free Output Current Interleaved DC/DC Converter Design Algorithm for EV Charging," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 292-297.  
doi: 10.1109/ICIT46573.2021.9453554  
Abstract: In this paper, a ripple-free output current interleaved DC/DC converter has been analyzed for Electric vehicle charging stations. Firstly, a ripple-free control strategy able to ensure a theoretically flat output current profile and input voltage ripple minimization at any working conditions is discussed. This strategy drives the active front-end to regulate the DC-link voltage and, at the same time, the interleaved back-end converter to operate in zero ripple working points. Secondarily, a generalized designing algorithm able to consider constraints like AC grid voltage and battery voltage is proposed. Finally, simulations support ripple mitigation capabilities in steady-state and transient conditions for a 12-leg scheme.  
keywords: {Employee welfare;Legged locomotion;Power system measurements;Density measurement;Numerical simulation;Minimization;Electric vehicle charging;interleaved converter;electric vehicle;battery charger;ripple minimization;optimization},  
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J. E. Mengou, A. Trovò, C. Gambaro and M. Guarnieri, "A vanadium redox flow battery bracing the pilot microgrid at Eni Renewable Energy & Environmental R&DCenter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 298-303.  
doi: 10.1109/ICIT46573.2021.9453702  
Abstract: Vanadium Redox Flow Batteries are a promising technology for stationary energy storage, in the framework of the expanding decarbonized renewable energy generation and smart grids. This paper presents a pilot microgrid consisting of a photovoltaic generator, a vanadium redox flow battery for storing excess energy and different loads. The microgrid is in operation at Eni Renewable Energy & Environmental R&D Center (Novara, Italy), with the aim of developing advanced decarbonized power management systems. A collaboration with the Electrochemical Energy Storage and Conversion Lab of University of Padua, Padova (Italy) allowed to develop a comparative analysis of the battery performance and its capability to store and release energy, coping generator/load mismatches. In addition, an evaluation of the aging effects after three years of operation was carried out based on the stack performance analysis, which indicates that no significant degradation phenomena had developed.  
keywords: {Degradation;Photovoltaic systems;Renewable energy sources;Power system management;Microgrids;Vanadium;Aging;VRFB;Vanadium Redox Flow Battery;microgrid;renewable energy generation;organic PV},  
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K. Günther and C. Sourkounis, "Active Damping Control for Variable-Speed Wind Turbines with VSM as Grid-Side Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 304-309.  
doi: 10.1109/ICIT46573.2021.9453518  
Abstract: Grid-supporting control structures with application in variable-speed wind turbines are in the focus of research to cope with the challenges that arise with the ever-growing integration of renewable energy sources in the electricity grid. Among others, the virtual synchronous machine has been pro-posed to emulate the behavior of conventional synchronous generators connected directly to the grid. Its application in variable-speed WTs requires an adaption of the overall control structure including also the controlled variable of the machine-side converter. Because of the growing nominal power, wind rotor dimensions and stochastic aerodynamic loads, the control of the assets also has to minimize the mechanical loads to attain a sufficient lifetime and to ensure an economic operation. Various control structures are proposed in research investigations for an active damping of torsional oscillations of the drive train, but they are mainly based on conventional control structures without grid-supporting methods such as the VSM. Therefore, in this paper a PID-shaft torque control is analyzed as additional controller of a variable-speed WT with a grid-side VSM and a cascaded machine-side control structure.  
keywords: {Damping;Visualization;Torque;Torque control;Synchronous generators;Wind turbines;Mathematical model;Wind energy;active damping;VSM;synchronverter},  
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M. Mehrasa, M. Babaie, M. Sharifzadeh, S. Bacha and K. Al-Haddad, "An Intelligent Linearization Control Method for Grid-Tied Packed E-Cell Inverter under Load Variations and Parameters Mismatch," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 310-315.  
doi: 10.1109/ICIT46573.2021.9453642  
Abstract: This paper focuses on designing an intelligent linearization control strategy for a nine-level packed E-Cell (PEC9) converter in grid-connected mode when the load and the inverter parameters are changed. The linearization controller is constructed based on input-output feedback linearization (IOFL) control strategy through a second-order dynamic model in d-q reference frame developed for PEC9 converter. In order to properly adapt the coefficients of proposed linearization controller in presence of load variations as well as parameter mismatch, an artificial neural network (ANN) tuner based on ABC algorithm and IAE cost function is developed. Several comparative simulation results are presented when the filter inductance mismatch and the current reference variations occur. The results verify the ability and superiority of proposed controller at suitable intelligent tuning of the controller coefficients.  
keywords: {Adaptation models;Inductance;Tuners;Simulation;Artificial neural networks;Load management;Inverters;Nine-Level Packed E-Cell (PEC9);Input-Output Feedback Linearization (IOFL);ANN Tuner;Load Variations;Parameters Mismatch},  
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H. Jedi, "Analysis and Design of Resonant Class Φ2 Inverter with Low-Voltage Stress," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 316-321.  
doi: 10.1109/ICIT46573.2021.9453468  
Abstract: This paper introduces analysis and design of a switched-mode ZVS Class Φ2 inverter that is capable to operate at high frequencies. The features of the inverter include low-voltage stress, small passive storage elements, and significant reduction of switching losses. The presented inverter, which has a ground-ended switch, can be constituted to exhibit soft-switching at operating of multimegahertz. A resonant network is tuned to second-harmonic to reduce voltage stress at the switch. The tuned series network has the desired impedance to form the switch voltage waveform from sinusoidal to a quasi-rectangular shape. The operation of the presented circuit, design procedure, and power loss analysis of the inverter are provided. The proposed topology is designed and simulated at 20 MHz. The inverter can be used in the industry, such as plasma generation and high-performance dc-dc converters among other applications requiring high frequencies.  
keywords: {Low voltage;Switching loss;Switches;Zero voltage switching;Inverters;Topology;Telecommunications;Class Φ2 inverter;single-switch inverters;fast switching frequency;ZVS operation;power MOSFET;low switching loss},  
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S. Hori et al., "Application of Variable Carrier Frequency Control by Using Wide Bandgap Semiconductors Inverter for WLTC Mode Driving," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 322-326.  
doi: 10.1109/ICIT46573.2021.9453618  
Abstract: This paper aims to propose a control method of a high efficiency electric vehicles(EVs) drive motor and to verify its effectiveness. One of the ways to extend the driving distance is to improve the efficiency of the motor control system. However, existing motor control systems which use Si-IGBT inverters have limitations in terms of efficiency due to device restrictions. New inverters using wide bandgap (WBG) semiconductors such as Gallium Nitride (GaN) are being investigated to improve the efficiency. The advantages of a GaN inverter are the lower conduction and switching losses than a Si-IGBT inverter and the higher switching frequency. If the switching frequency is increased, the motor harmonic loss as well as the whole loss in the motor control system can be reduced. However, most of the existing research have focused on small capacity modules, which are not sufficient to study the motor control system of EVs. Therefore, our research group has been working on improving the GaN inverter to realize a compact EV. We are investigating variable carrier frequency control as a control method to make WBG semiconductors more useful. In this paper, a variable carrier frequency control is applied to a motor control system using GaN and SiC inverters, and we discuss the usefulness of wide bandgap semiconductors for electric vehicles by measuring the loss in WLTC mode with the systems. The experimental results show that the application of variable carrier frequency control to the motor control system with SiC inverter reduces the loss in WLTC mode by up to about 6% compared to the conventional control method.  
keywords: {Motor drives;Semiconductor device measurement;Silicon carbide;Photonic band gap;Switching frequency;Switching loss;Electric vehicles;Wide bandgap;GaN;inverter;PMSM;Electric Vehicles},  
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H. J. Ferreira, S. Kouro, C. A. Rojas, N. Muller and S. Rivera, "Bidirectional Partial Power DC-DC Configuration for HESS interface in EV Powertrains," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 327-332.  
doi: 10.1109/ICIT46573.2021.9453530  
Abstract: In conventional EV powertrains the main energy storage system is based on battery banks. Potential higher current stress on battery during transient operation can considerably reduce its expected lifetime, while battery size is overrated to respond under heavy transient demands. The regenerative braking capability is also getting limited due to its charging dynamic constraints. Hybrid Energy Storage Systems (HESS) based on batteries and supercapacitors (SC) have the potential to solve this issue. However, SCs size and weight can deteriorate the power density of the solution. In this paper, a Partial Power Configuration (PPC) based on Dual-Active-Bridge (DAB) is proposed as a power interface to increase the power density of an HESS-based EV powertrain. A comprehensive efficiency analysis is provided, while transient dynamic results are provided to validate the proposed power configuration.  
keywords: {Power system measurements;Analytical models;Density measurement;Computational modeling;Mechanical power transmission;Batteries;Topology;Partial Power Converter;Dual Active Bridge;Hybrid Energy Storage System;Powertrains;Electric Vehicle},  
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S. Choi and A. P. Meliopoulos, "Binary Capacitor Voltage Control-based MMC with a Hybrid Arm Design for Low Nominal DC Voltage Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 333-338.  
doi: 10.1109/ICIT46573.2021.9453616  
Abstract: The main technical challenge of multilevel converters for low nominal voltage is to abate hardware and control complexity and concomitantly aggrandize DC-AC power- conversion quality and efficiency. In the modular multilevel converter (MMC), the half- or full-bridge sub-modules with the arm inductor can derive various sub-module capacitor voltage control approaches. This paper proposes a new MMC concept utilizing the above MMC's advantage to address the challenge effectively. The proposed binary capacitor voltage control and circulating current control regulate the sub-module capacitor voltages at the power-of-two reference values and the converter-arm voltages at the multilevel reference values through a Lyapunov stability-based cost-function optimization approach exploiting the binary numeral system and the proposed hybrid arm design. Therefore, the proposed MMC improves the DC-AC power conversion quality and efficiency by synthesizing a sinusoidal AC voltage with a significantly large number of voltage levels while extensively reducing hardware and control complexity for low nominal DC voltage applications. A simulation study is presented to demonstrate the steady-state and dynamic performance of the proposed MMC under several conditions.  
keywords: {Current control;Multilevel converters;Capacitors;Stability criteria;Redundancy;DC-AC power converters;Hardware;Binary capacitor voltage control;binary numeral system;MMC;hybrid arm;redundancy},  
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doi: 10.1109/ICIT46573.2021.9453524  
Abstract: The photovoltaic (PV) system has become increasingly promising as a source of renewable energy. Therefore, much research has been done on the integration of the Z-source inverter in the photovoltaic systems, due to its ability to perform two functions in a single stage, the boost function, and the inversion function, which reduces power losses and cost. This paper focus on the integration of the Z-source inverter in a photovoltaic system, using the maximum constant boost control strategy (MCBC) with five different maximum power point tracking (MPPT) methods such as Perturb & Observe (P&O), incremental conductance (INC), the fuzzy logic controller (FLC), fuzzy incremental conductance (INC-FLC), and fuzzy P&O (P&O-FLC). in the end, a comparative analysis is established to compare the results found. The comparison criteria are response time, tracking error, tracking efficiency, and complexity.  
keywords: {Photovoltaic systems;Maximum power point trackers;Fuzzy logic;Renewable energy sources;Conferences;Control systems;Inverters;Photovoltaique;MPPT;Z-source;MCBC;P&O;INC;FLC},  
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A. Abdayem, J. Sawma, F. Khatounian and E. Monmasson, "Control of a Single Phase Modular Multilevel Converter based on a New Modulation Technique," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 345-350.  
doi: 10.1109/ICIT46573.2021.9453516  
Abstract: Modular Multilevel Converter (MMC) topologies have a bright future for high-power applications. In order to operate them, the first objective is to control the current at MMC terminals. Therefore, the arm currents must be controlled. The second objective is to control the capacitor voltages. Therefore, the internal circulating current must be controlled too. Additionally, the third objective is to reduce the switching losses. As of late, there has been an extensive effort towards addressing the technical constraints associated with the control and operation of MMC. The control of single phase MMC is however not widely developed. This paper proposes a complete scheme for controlling the MMC load current and capacitor voltages. The proposed control scheme presents a new modulation technique called the Integral Modulation technique. Finally, the effectiveness of the control scheme with its new modulation technique is tested on a single phase MMC using MATLAB/Simulink.  
keywords: {Multilevel converters;Phase modulation;Conferences;Capacitors;Switching loss;Pulse width modulation;Topology;Modular multilevel converters;circulating current;integral modulation;average capacitor voltage;voltage balancing;HVDC transmission},  
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doi: 10.1109/ICIT46573.2021.9453532  
Abstract: For variable speed wind turbines (WT) operating in the full load range, a collective pitch control is used to limit the speed to its nominal value. The concept of a nonlinear PI gain scheduling controller is particularly suitable for compensating the nonlinear rotor behavior and is widely used in the wind industry. However, a simple calculation method to calculate its controller parameters while considering the full dynamics of the control loop is not available yet. In this paper the linearization process as well as a simple calculation method to find suitable controller parameters based on methods of classical control engineering is introduced. In contrast to previous methods the full dynamics of the open loop system, in particular the dynamics of the controlled pitch servomotors and the dynamics of the drive train with its first eigenfrequency, can be considered within the controller design. This is done by analyzing the behavior of the gain scheduling control and deriving a simplified linearized model of the open loop system. In this way it is possible to optimize the controller parameters by using the bode diagram. The usability of the simple design method is shown on the basis of simulation results considering the influence of wind fluctuations as well as wind gusts.  
keywords: {Job shop scheduling;Fluctuations;Simulation;Design methodology;Rotors;Open loop systems;Dynamic scheduling;Wind energy;Pitch control;Gain scheduling;Linearization;Mathematical design;Bode diagram;Simulation},  
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doi: 10.1109/ICIT46573.2021.9453683  
Abstract: Traditional microgrid applications use of battery-supercapacitor hybrid converters as a common approach to mitigate the effects of fluctuations in renewable energy sources. With the hybrid supercapacitors having around 2.5 times higher energy density, in the future environmentally unfriendly batteries can be minimized or eliminated in micro grids. A battery receiving a charge of Q coulombs will store an energy content of QV joules, compared to a fully discharged capacitor bank receiving the same charge will store only QV/2 joules. Given this fundamental reason, if SC banks are only used for energy storage, an efficiency loss of up to 50% may be experienced. However, by inserting a useful resistive load within the charging loop of the capacitor bank this loss can be significantly minimized. This paper presents details of using this approach in a residential DC microgrid, where LED luminaires and inverter-driven white goods are connected to a solar powered DC bus.  
keywords: {Renewable energy sources;Capacitors;Microgrids;Supercapacitors;Light emitting diodes;Radiofrequency integrated circuits;Inverters},  
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D. Pasqualotto, F. Tinazzi and M. Zigliotto, "Enhanced solar water-pumping system driven by a synchronous reluctance motor," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 365-370.  
doi: 10.1109/ICIT46573.2021.9453546  
Abstract: A self-reliant, economically-affordable and maximum-efficiency solar water pumping system is proposed in this paper. The autonomy is achieved powering the system through a PV source which well fits for remote or isolated applications. The costs are reduced by removing the DC-DC voltage converter usually present in these applications. The efficiency is enhanced by using a Synchronous Reluctance motor that directly control the pump speed through a Maximum Power Point Tracking algorithm. The paper includes novel implementation hints and a batch of experimental results that prove the effectiveness of the proposal.  
keywords: {Maximum power point trackers;Conferences;Proposals;Reluctance motors;Synchronous reluctance motors;solar pumps;PV source},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453546&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453560  
Abstract: In this paper, a new single-phase grid-connected photovoltaic (PV) system, based on the five-level S-Packed U-Cell (SPUC5) inverter, is presented. This novel topology requires a minimum number of components while providing a maximum number of voltage levels. The Pulse Width Modulation (PWM) controller is applied to the five-level SPUC inverter in order to insure the self-balancing to the capacitors voltages and fix them to the half of the DC-link voltage. The Incremental Conductance (INC) is the method of controlling the DC/DC converter chosen by the authors to reach the Maximum Power Point (MPP) delivered by the PV array. Simulation results obtained using MATLAB/Simulink environment prove the high efficiency and the good dynamic of the proposed system even in case of radiation changes. The Total Harmonic Distortions (THD) of the output current is less than 5% which corresponds to the grid injection standards even without using filters.  
keywords: {Photovoltaic systems;Total harmonic distortion;Simulation;Capacitors;Pulse width modulation;Inverters;Topology;Photovoltaic panel;SPUC;Multilevel Inverters;MPPT Technique;PWM Technique;Grid Connected;Total Harmonic Distortion},  
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Abstract: The high efficiency and the electromagnetic compatibility of wide-bandgap (WBG) power converters can be further improved using spread-spectrum (SS) modulations. This paper evaluates and compares the impact of SS techniques on voltage source converters (VSC) that use gallium nitride (GaN) semiconductors. These modulations work with a variable switching frequency, so they generate fewer switching losses. Moreover, SS modulations generate smaller low-order harmonics than the classical space vector pulse width modulation (SVPWM) does. The power losses are analysed using Matlab/Simulink and PLECS, and then compared with SVPWM. Moreover, this paper evaluates the frequency spectrum and the THD of the different SS modulations. Simulation results under various operating points are reported and compared.  
keywords: {Space vector pulse width modulation;Frequency modulation;Switching frequency;Simulation;Switching loss;Harmonic analysis;High frequency;Losses;modulation techniques;voltage source converter (VSC);PLECS;wide-bandgap semiconductors;gallium nitride (GaN);power electronics;spread-spectrum},  
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doi: 10.1109/ICIT46573.2021.9453696  
Abstract: This paper introduces a novel method of designing voltage controllers to improve the stability problem in the Common-Connection Point of the DC catenary railway system, using the QFT control technique. The considered stability problem is due to the interaction between the resonance of the LC filter connected to the DC catenary with the traction and auxiliary converters (3-phase inverters) it feeds, which behave like CPLs. An stability improvement is achieved by shaping the closed-loop input impedance of a three-phase inverter using impedance-based stability criteria. The obtained simulation results, under unfavourable conditions, verify the theoretical development.  
keywords: {Simulation;Conferences;Stability criteria;Inverters;Rail transportation;Impedance;Feeds;Admittance-shaping;QFT;CPL;robust control;voltage control;PECs},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453696&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453477  
Abstract: Batteries consist of a high number of single cells in order to fulfill the power and energy requirements of large-scale applications. Electrical and thermal imbalances among the cells of the battery arise during operation caused by cell to cell variations and battery design tolerances. This heterogeneous stress can result in a accelerated degradation of individual cells, which reduces the lifetime of the whole battery. To prevent this effect insights of the impacts on cell imbalances, regarding the State of Charge (SoC), temperature and current, are essential to improve the battery operation strategy. In this paper the influence of cell to cell variances and the thermal design of the battery on the mentioned cell imbalances are experimentally investigated for two parallel-connected cells. Experiments with three cell groups, having different cell parameter variances, are conducted. In order to investigate the thermal influence of the cell packaging and battery design, different cooling scenarios are considerd, like an insulation and a heterogeneous cooling of the cells.  
keywords: {Resistance;Insulation;Cooling;Packaging;Current distribution;Nonhomogeneous media;Batteries;lithium-ion battery;parallel cells;current distribution;heterogeneous thermal and electrical stress},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453477&isnumber=9453463>  
  
A. Shahin, J. . -P. Martin, S. Pierfederici and A. M. Sharaf, "Integration of Renewable Energy Sources to Wireless Charger of Electrical Vehicle," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 397-402.  
doi: 10.1109/ICIT46573.2021.9453645  
Abstract: In the near future, the electrical vehicles will replace the traditional vehicles to get pollution free environment. Today, the electrical vehicles attract the interest of many researchers. In the recent years, the technology Wireless Power Transfer (WPT) was emerged and has a potential application. WPT is the technology using the magnetic resonance to transfer the electrical power without a direct connection. The WPT adopts the same basic theory which is based on the inductive power transfer employed in the conventional transformer. WPT can be applied to the electric vehicle (EV) for both charging system: stationary and dynamic chargers. This global system can integrate the photovoltaic systems in the charging stations which are built for the electric vehicles and the supervision base. The communication has been set up through a wireless network. An 8-kW prototype to charge 120 V battery was proposed to verify the theoretical analysis. The overall system efficiency is ~ 93%. The charging system can get rid of the effects of the load, to obtain a reliable operation. The effectiveness of the proposed WPT is theoretically analyzed and validated by the simulations.  
keywords: {Coils;Analytical models;Wireless networks;Magnetic resonance;Wireless power transfer;Solar energy;Electric vehicles;Electric vehicle (EV);inductive power transfer (IPT);stationary charging;wireless power transfer (WPT);DC-DC converter;DC-AC converter;photovoltaic energy},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453645&isnumber=9453463>  
  
E. P. P. Soares-Ramos, L. de Oliveira-Assis, R. Sarrias-Mena, P. García-Triviño, C. A. García-Vázquez and L. M. Fernández-Ramírez, "Large-Scale Wind Turbine With Quasi-Z-Source Inverter and Battery," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 403-408.  
doi: 10.1109/ICIT46573.2021.9453537  
Abstract: Grid connection of permanent magnet synchronous generator -based wind turbines can be performed through a three-stage power conversion system: 1) uncontrolled rectifier, 2) DC boost converter, and 3) voltage source inverter. In this paper, this topology is modified by replacing the two intermediate stages by a quasi-Z-source inverter (qZSI). Additionally, a battery is integrated with the qZSI without any additional DC/DC converter. This battery will allow reducing the intermittence of the generation and improving the operability of the wind turbine. The application and control of qZSI for large-scale wind turbine with energy storage systems is illustrated in this work. An energy management system is implemented for the proper operation of the wind turbine and the battery. The qZSI is controlled through a Z-Space Vector Modulation (ZSVM) technique to achieve maximum power point tracking in the wind turbine, reactive power control, and battery charge/discharge depending on the operating conditions and the battery state-of-charge. The simulations show the proper behavior of the system under study.  
keywords: {Maximum power point trackers;Reactive power control;Voltage source inverters;Simulation;Rectifiers;Synchronous generators;Wind turbines;Wind turbine;permanent magnet synchronous generator (PMSG);quasi-Z-source inverter (qZSI);energy storage systems (ESS);control system},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453537&isnumber=9453463>  
  
A. Narvaez A, C. Carretero, J. Acero and J. M. Burdio, "Large-Signal Electrical Parameter Characterization in Inductive Power Transfer Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 409-414.  
doi: 10.1109/ICIT46573.2021.9453478  
Abstract: This paper presents the characterization of electrical parameters at large signal levels in an inductive power transfer (IPT) system by performing oscilloscope measurements. For this purpose, a harmonic analysis technique known as the First Harmonic Approximation (FHA) has been carried out. A previous analysis is performed to know the effect of a filtering technique to pre-process data, and the possible causes of error during this characterization process. The simulation results obtained from a Simulink® model, without adding noise, were very useful for applying the methodology proposed. The experimental measurements were taken from a built prototype that consists of a transmitter board and a receiver board. The obtained values of the resonant tank elements and load have great adjustments that match with the nominal values and tolerances of the characterized elements.  
keywords: {Robust control;Inductance;Filtering;Transmitters;Simulation;Receivers;Harmonic analysis;IPT system;first harmonic approximation;FHA;harmonic extraction;parameter characterization;median filtering},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453478&isnumber=9453463>  
  
F. Huerta, D. Santamargarita, P. Zumel, C. Fernández and L. Ortega, "LQG digital state-feedback control of a Dual-Active-Bridge Series-Resonant Converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 415-420.  
doi: 10.1109/ICIT46573.2021.9453539  
Abstract: Dual-active-bridge series-resonant converter (DABSRC) is popularly used in low- and medium-voltage applications that demand bidirectional power flow and galvanic isolation. From a discrete-time model of the converter, this paper explores the application of a linear-quadratic Gaussian (LQG) digital state-feedback controller to regulate the output voltage of the DABSRC. The proposed control includes a multivariable servo controller (regulator-integrator loops), a steady-state Kalman filter (SSKF) operating as a full state estimator to avoid increasing the number of sensors and an anti-windup algorithm to avoid the undesirable integrator windup. The SSKF also allows estimating the converter current and the anti-windup algorithm softens the converter start-up. The paper also proposes tuning criteria to facilitate the design of the controller. The results confirm the suitability of this kind of proposal for controlling the DABSRC.  
keywords: {Windup;Estimation;Medium voltage;Sensors;Steady-state;Proposals;Kalman filters;dual-active bridge series-resonant converter;linear quadratic Gaussian control;digital control;Kalman filter},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453539&isnumber=9453463>  
  
T. J. L. Oliveira, L. M. A. Caseiro, A. M. S. Mendes, S. M. A. Cruz and M. S. Perdigão, "Model Predictive Control for paralleled UPS systems with load-side neutral wire," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 421-426.  
doi: 10.1109/ICIT46573.2021.9453668  
Abstract: Uninterruptible Power Supplies (UPS) play a key role in feeding a wide range of critical applications such as high-tier datacenters and medical facilities. Given the variety of loads that typically exist in such applications, UPS systems should be able to correctly operate under highly unbalanced load conditions and to simultaneously supply single- and three-phase loads. On the other hand, UPS systems are usually parallel-connected in order to improve the overall system feasibility and/or to increase the overall installed power capacity. In this paper, a system topology based on two paralleled UPS systems with neutral wire at the load-side is proposed. Moreover, a new Finite Control Set Model Predictive Control (FCS-MPC) strategy is also proposed to control all converters of the paralleled systems. The proposed technique permanently ensures: the generation of a high-quality load voltage waveform; elimination of the undesired circulating current that can flow between both UPS systems; a fully controlled load power distribution. Simulation results are presented, demonstrating the effectiveness of the proposed strategy even under highly unfavourable load conditions.  
keywords: {Simulation;Conferences;Wires;Power distribution;Control systems;Topology;Steady-state},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453668&isnumber=9453463>  
  
G. R. Broday, G. Damm, W. Pasillas-Lépine and L. A. C. Lopes, "Modeling and dynamic feedback linearization of a 5-switch tri-state buck-boost bidirectional DC-DC converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 427-432.  
doi: 10.1109/ICIT46573.2021.9453569  
Abstract: Energy storage devices are frequently employed for dynamic voltage regulation in DC nano and microgrids. For that, the power electronic interface should allow fast and accurate control of the bidirectional power flow. This requires an appropriate set of power electronics topology and control strategy. This paper focuses on a novel 5-switch DC-DC converter capable of reversing the power flow direction without changing the current direction in the intermediate inductor. A tri-state buck-boost plus free-wheeling modulation scheme is discussed. One issue with conventional PI-type controllers designed for converter models linearized around a typical operating point is their performance deteriorates as the operating point changes. In such cases, advanced control methods based on non-linear control theory can be beneficial. This paper discusses an approach for the modelling and control by dynamic feedback linearization of a 5-switch bidirectional DC-DC converter. The performance is verified by means of simulation results.  
keywords: {Simulation;Modulation;DC-DC power converters;Power electronics;Nanoscale devices;Feedback linearization;Topology;Bidirectional DC-DC converter;DC-Nanogrids;Non-linear control;Tri-State;Buck-Boost},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453569&isnumber=9453463>  
  
J. E. Huber and J. W. Kolar, "Modular Multilevel Converter Circulating Current Control with Single Active Filter Module per Phase," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 433-439.  
doi: 10.1109/ICIT46573.2021.9453655  
Abstract: Phase-legs of DC/AC modular multilevel converters (MMC, M2LC) transfer power from the DC input to the corresponding phase output terminal by means of a current that circulates through the DC input and the phase-leg. In addition to the load-dependent DC component required for the power transfer, this circulating current contains significant harmonics if no countermeasures are implemented. Prominently, a large second harmonic appears, essentially because each converter arm performs a single-phase power conversion. This results in higher RMS values of the arm currents and ultimately in higher-than-necessary losses. One option to mitigate these undesired harmonics and the associated losses extends each arm of the MMC by an active filter module that controls the circulating current by injecting a common-mode component into the arm voltage. In this paper, we propose a new variant of an MMC topology with such active filter modules. In contrast to the state of the art, the proposed realization shows lower realization effort: it uses only a single active filter module per MMC phase-leg instead of two, which corresponds to a reduced effort in terms of both, power hardware components and also control and communication electronics. Furthermore, a single active filter module can operate fully self-contained if desired, i.e., without an external communication interface, thus simplifying system integration.  
keywords: {Multilevel converters;Current measurement;System integration;Harmonic analysis;Active filters;Hardware;Topology},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453655&isnumber=9453463>  
  
A. Viatkin, M. Ricco, R. Mandrioli, T. Kerekes, R. Teodorescu and G. Grandi, "Modular Multilevel Converters Based on Interleaved Half-Bridge Submodules," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 440-445.  
doi: 10.1109/ICIT46573.2021.9453643  
Abstract: This paper reports a novel modular multilevel converter with interleaved sub-modules (ISM-MMC). The ISM-MMC exhibit a higher scalability in current rating then conventional MMC structures with parallel devices. It can employ low-cost, low-current power switches rather than their bulky and expensive counterparts normally designed in classical MMCs. Another remarkable feature is that the number of the output voltage levels is synthetically multiplied by the number of interleaved SMs. The ISM-MMC is capable of bringing the known advantages of MMC to low voltage - high power applications making it a good candidate for the sector of ultra-fast chargers for electrical vehicles where typical power rating in excess of 1 MW is required for the low voltage supply. A proper modulation scheme is implemented and explained in this paper. A comparison with a classical MMC topology is also provided in terms of number of voltage levels, output voltage harmonic content, and number of components by fixing the number of SMs. Simulation results are given to demonstrate the feasibility of the proposed topology and the implemented modulation scheme. Despite this paper is dealing with a single-phase configuration, the extension to a three-phase scheme can be obtained in a straightforward manner.  
keywords: {Legged locomotion;Multilevel converters;Low voltage;Software packages;Phase modulation;Simulation;Scalability;modular multilevel converter (MMC);interleaved half-bridges;sub-modules;modular;modulation technique;ultra-fast ev chargers},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453643&isnumber=9453463>  
  
A. Peña Asensio, M. García Plaza, J. López Merino, F. R. Martinez Mendoza, M. Marek Niegowski and P. L. Camuñas García, "Numerical Analysis of Renewable Generation Variability for Energy Storage Smoothing Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 446-451.  
doi: 10.1109/ICIT46573.2021.9453635  
Abstract: With the increasing penetration of Wind Turbine (WT) and Photovoltaic (PV) generation, there is a rising concern about the problems associated to power variability and how the system can be operated to mitigate its effects. Energy Storage Systems (ESSs) can be used to limit or smooth variability while maximizing the generation of renewable energy. However, existing references to the problems caused by power variability are not clear on the technical requirements of smoothing algorithms. This paper reviews existing information, including academic research, technical reports and international grid codes, on the problems caused by power variability and how they can be numerically evaluated in terms of severity, probability and time range of variations. The effects in power variability of smoothing algorithms according to existing evaluation methods is analyzed in a hybrid plant case study.  
keywords: {Technical requirements;Time-frequency analysis;Smoothing methods;Fluctuations;Writing;Wind farms;Time measurement;Energy Storage Systems (ESSs);Wind Energy;Smoothing control;Ramp-rate;Power Quality;Energy Management System;Frequency fluctuations},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453635&isnumber=9453463>  
  
R. W. T. Bonten, J. M. Schellekens and H. Huisman, "Optimal Utilization of the Dual-Active Bridge Converter with Bidirectional Charge Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 452-457.  
doi: 10.1109/ICIT46573.2021.9453656  
Abstract: This study describes a new method to optimize the utilization of the dual-active bridge converter. The optimized DAB converter utilization is defined as the maximum power displacement per Ampere of RMS current flowing through the inductor, a design target that encompasses both the control parameter (power displacement) and the quantity responsible for the majority of the losses in the converter (inductor current). Various studies have already described the minimization of the inductor current in the dual-active bridge converter, thereby employing less efficient fixed-frequency and dynamic incapable phase-shift control strategies. Bidirectional charge control though, is a recently proposed control strategy that comprises excellent dynamic behaviour and has the potential to facilitate variable-frequency operation. In order to optimize the variable-frequency operation, this paper discusses the DAB converter utilization for a fixed frequency to determine its dependency on the switching events so that this optimum can then be used with a variable frequency. Therefore, bidirectional charge control is used to describe the power displacement and the RMS current flowing through the inductor as a function of both the primary and secondary switching event. It shows that the DAB converter utilization has an optimum depending on only three variables, i.e. the primary and the reflected secondary voltage. This is demonstrated both quantitatively (numerical) and qualitatively (analytical), after which identical results are acquired through simulation. Moreover, component non-idealities that complicate the implementation and verification of the desired control, are described and included in the simulations. Finally, countermeasures for the non-idealities are both described and verified. To further explore the feasibility of the optimal utilization of the DAB converter, it should be investigated in an experimental manner in addition to the discussed simulations.  
keywords: {Analytical models;Time-frequency analysis;Bridge circuits;Switches;Frequency conversion;Minimization;Control systems},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453656&isnumber=9453463>  
  
G. S. Zappulla, B. Cougo, A. L. Rodríguez Vázquez, A. Russo and B. Guida, "Optimization of Bidirectional Modular DC/DC Converter for Low and High Power Operation in Aircraft Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 458-463.  
doi: 10.1109/ICIT46573.2021.9453512  
Abstract: This paper presents a multi-objective optimization method for DC/DC converters used in More Electrical Aircrafts applications. Very high efficiency associated with high power density requires the use of wide bandgap devices, such as SiC semiconductors. Results show that, due to the use of SiC devices, the designed converter produces lower losses at hard-switching (HS) modulation than at soft-switching (SS) modulation. Furthermore, we show that there is an optimal number of small converters in parallel, which provides high efficiency even at low power as well as high reliability, compared to a single converter.  
keywords: {Power system measurements;Density measurement;Silicon carbide;Photonic band gap;Switching frequency;Optimization methods;Modulation;Aircraft;DC/DC converter;modular converter;SiC semiconductors;converter optimization},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453512&isnumber=9453463>  
  
A. Wilson, H. Renaudineau, F. Flores-Bahamonde and A. Llor, "Partial Power Converter for DCX-based High-Power LED Drivers," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 464-469.  
doi: 10.1109/ICIT46573.2021.9453605  
Abstract: Light-emitting diode (LED) technology has become one of the most important luminaire, due to its environmentally-friendly behavior, high efficiency, quality of light and large lifespan. Different LED drivers based on power converters have been presented. However, most of these solutions are focused principally on low-power lighting systems, above 100 W. This paper presents a novel modular solution for 1200 W LED driver with very high efficiency. The proposed power architecture is based on a cascade connection of a DC transformer (DCX) and a partial power converter (PPC). A comprehensive comparison between different PPC configuration is presented and supported by simulations to validate the theoretical results.  
keywords: {Conferences;Lighting;Resonant converters;Light emitting diodes;Topology;Voltage control;DCX;partial power regulation;high power LED driver},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453605&isnumber=9453463>  
  
Q. Hilpert, S. Caux, F. Bonnet and M. Malagoli, "Primary Control and Large-Signal Stability Criteria of an Enhanced Electrical Power System for Space Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 470-475.  
doi: 10.1109/ICIT46573.2021.9453699  
Abstract: The stability of a spacecraft's Electrical Power System (EPS) is of the utmost importance as the success of the entire mission relies on it. Its aim is to generate, condition, store and distribute the energy to the whole system in a particularly isolated and hostile environment. These important constraints and the resulting need for robustness and reliability, have shaped the EPS into a very high efficiency system, electrically speaking. However, the space industry is changing and we are witnessing its digital and industrial revolution in the same time. This trend, called New Space, brings new challenges but also opportunities to rethink the different systems and give them new features. In term of EPS, this allows to give modularity, flexibility and scalability to the system and thus respond to the constraints imposed by Lunar or Martian base projects that conventional systems cannot do. In this paper, a novel EPS architecture is proposed and analyzed using state-plane analysis techniques. The stability of various equilibrium points and the transient response of the system are also evaluated. The large-signal behavior of the different modules is then determined in view of power and energy management stability.  
keywords: {Power conditioning;Transient response;Scalability;Stability criteria;Moon;Power system stability;Robustness;New Space;electrical architecture;modularity;power flow analysis;state-plane trajectories;COTS},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453699&isnumber=9453463>  
  
X. Zhang, J. Sun, X. Wu, X. Wu and W. Yao, "Research on SIDO Converter and Its Power Decoupling Control Strategy," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 476-481.  
doi: 10.1109/ICIT46573.2021.9453504  
Abstract: Different voltage levels are needed in the wide application of microgrids and distributed energy. To meet demand, this paper proposes an integrated single-input dual-output (SIDO) ac-dc converter with a component count reduction, providing two different dc voltage levels. Based on the comprehensive analysis of the topology, power factor correction (PFC) control strategy and the power decoupling control strategy for different voltage levels are designed. Furthermore, the experimental results based on a prototype circuit are demonstrated to validate the theoretical analysis.  
keywords: {Current control;Conferences;Prototypes;Microgrids;Power factor correction;Control systems;Topology;different voltage levels;integrated single-input dual-output (SIDO);PFC;power decoupling},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453504&isnumber=9453463>  
  
E. G. Shehata and J. Thomas, "Simple Model Predictive Control of High Power Direct-Driven PMSG Wind Energy Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 482-487.  
doi: 10.1109/ICIT46573.2021.9453506  
Abstract: In this paper, a simple model predictive controller with constant switching frequency is designed to determine switching states of machine and grid NPCs. The proposed controller is designed based on modulated model predictive control principle to reduce computational burden of the algorithm. Time delay and weight factors in cost functions of the conventional model predictive control are eliminated to simplify the controller design. Also, space vector modulation algorithm is introduced to fix switching frequency of the converter. Machine side NPC is controlled to regulate the electromagnetic torque, stator flux and capacitors voltage of NPC while grid side NPC is controlled to regulate the active power, reactive power injected to the grid and DC-link voltage. The performance of the proposed controller is evaluated using 3MW/3kV generation system model. Simulation results of the proposed algorithm are good in spite of using low switching frequency.  
keywords: {Total harmonic distortion;Torque;Wind energy;Switching frequency;Capacitors;Stators;Prediction algorithms;Wind energy;PMSG;Three level NPC converters;Modulated FCS-MPC},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453506&isnumber=9453463>  
  
S. Choi and A. P. Meliopoulos, "Space Vector Modulation (SVM)-exploited Binary Capacitor Voltage Control (BCVC)-based Flying-Capacitor-Clamped Multilevel Converter (FCCMC) for Low Nominal DC Voltage Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 488-493.  
doi: 10.1109/ICIT46573.2021.9453556  
Abstract: Maximizing DC-AC power conversion quality and efficiency while minimizing hardware and control complexity is a major technical challenge for multilevel converters in low nominal DC voltage applications. Among the conventional multilevel converters, the flying-capacitor-clamped multilevel converter (FCCMC) has the least hardware and control complexity; and redundant switching combinations for each reference multilevel voltage due to its flying capacitors clamped to serially-connected switches. The space vector modulation (SVM) method synthesizes a reference voltage vector by utilizing the three adjacent voltage vectors, and each voltage vector has a three-phase multilevel-voltage combination redundancy. Furthermore, these switching combination and three-phase multilevel-voltage combination redundancies can lead to various clamped flying-capacitor voltage and converter-leg voltage control strategies. This paper proposes a new FCCMC concept utilizing the advantages of FCCMC and SVM to address the above primary technical challenge. The proposed SVM-exploited binary capacitor voltage control (BCVC) regulates the clamped flying-capacitor voltages at the power-of-two reference values and the converter-leg voltages at the multilevel reference values through a Lyapunov stability-based cost-function optimization approach exploiting the binary numeral system. In low nominal DC voltage applications, the proposed FCCMC significantly improves the DC-AC power conversion quality and efficiency by synthesizing a sinusoidal AC voltage with a large number of voltage levels while extensively reducing the hardware and control complexity. Simulation results demonstrate the steady-state and dynamic performance of the proposed FCCMC under various operating conditions.  
keywords: {Support vector machines;Multilevel converters;Capacitors;Modulation;Switches;Aerospace electronics;DC-AC power converters;FCCMC;SVM;BCVC;binary numeral system},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453556&isnumber=9453463>  
  
R. E. Carballo and F. Botterón, "State Space Model for a Droop Control Strategy with Fault Ride-Through in UPS Parallel Inverters," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 494-501.  
doi: 10.1109/ICIT46573.2021.9453607  
Abstract: A droop control strategy with fault ride-through capability to overcome overload and short circuit operation in UPS applications is proposed in this work. This strategy is based on multiple resonant controllers designed to comply with performance specifications given by IEC62040-3. An state-space model is proposed to explore the stability limits of the parallel-connected inverters and design the virtual impedance loop. Experimental results obtained using two parallel-connected UPS inverters are presented to validate the proposal.  
keywords: {Analytical models;Stability criteria;Power system stability;Inverters;Data models;State-space methods;Circuit faults;UPS;Parallel inverters;Droop control;Fault Ride-Through;State-space model;Resonant controllers;Standards specifications},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453607&isnumber=9453463>  
  
R. González, C. A. Rojas and L. Callegaro, "Three-level DC-DC GaN-based Converter with Active Thermal Control for Powertrain applications in Electric Vehicles," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 502-507.  
doi: 10.1109/ICIT46573.2021.9453595  
Abstract: The use of electric vehicles (EVs) has grown notably in the last years and with it new challenges for power electronics have appeared. Since typically the main energy storage system in EVs consists of batteries, one of these challenges is the efficient and reliable management of power flows in charging/discharging mode. This paper presents an electrical and thermal modelling of a three-level buck-boost DC-DC converter (TLBBC) with semiconductors based on gallium nitride (GaN) technology. Also an active thermal control (ATC) scheme to mitigate the thermal stress in the semiconductor is proposed, together with control schemes for DC-link voltage and voltage balance between capacitors in the TLBBC. The TLBBC is designed to operate in a boost mode at rated power of 25 kW, using a parallel design with GaN semiconductors. Proposed control schemes are implemented using linear controllers. Finally, comprehensive simulation results confirm and validate the proposed control schemes.  
keywords: {Simulation;Mechanical power transmission;Electric vehicles;Power electronics;Reliability;Gallium nitride;Voltage control;Active Thermal Control (ATC);DC-DC converter;Gallium Nitride (GaN);Three-level buck-boost converter (TLBBC);Voltage Balance Control (VBC)},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453595&isnumber=9453463>  
  
T. Hemmati, M. G. Marangalu, N. V. Kurdkandi, A. Khoshkbar-Sadigh, S. H. Hosseini and H. K. Jahan, "Topology Review of Grid-Connected Multilevel Inverters Supplied by Photovoltaic Panels using Switched-Capacitor Based Circuits," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 508-513.  
doi: 10.1109/ICIT46573.2021.9453484  
Abstract: The appealing features of multilevel inverters (MLIs) have made them suitable for many applications like in photovoltaic (PV) systems. Traditional MLIs suffer some issues like complicated control scheme and incapability in utilizing the full capacity of the input source. In order to overcome these points, switched capacitor (SC) based MLIs have been introduced. In these structures, the applied capacitors are charged and discharged when connecting in series or parallel with the input supply, contributing in multiple output stages. In this paper, some of the latest grid-connected SC MLIs supplied by PV modules are introduced. Each structure is discussed in terms of advantages and disadvantages. Moreover, two main problems of these topologies including inrush currents and leakage currents are investigated in details.  
keywords: {Photovoltaic systems;Conferences;Capacitors;Switches;Multilevel inverters;Power grids;Topology;multilevel inverter;switched-capacitor;common ground;reactive power;leakage current;PV applications},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453484&isnumber=9453463>  
  
A. Ebrahimian, S. Vahid, N. Weise and A. EL-Refaie, "Two Level AC-DC-AC Converter Design with a New Approach to Implement Finite Control Set Model Predictive Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 514-520.  
doi: 10.1109/ICIT46573.2021.9453659  
Abstract: Due to various applications of variable frequency drives in industry, design procedure and control methods of these converters have attracted many researchers from both industry and academia. In this paper, a high power density AC-DC-AC converter design is presented alongside finite control set model predictive control method. Using model predictive control for the LC filter at the load side enables load voltage control which is an important issue in variable frequency drive applications. Also, input, output, and DC link filters' design methods are presented and the results are compared to the designed filters in the literature. The comparison shows significant filter size decrease by using presented approach. Applying the proposed control method to the AC-DC-AC converter brings benefits such as simple implementation, robustness to the load changes, and fast dynamic response compared to conventional control methods. Finally, to demonstrate the effectiveness of the proposed design and control method, the designed variable frequency drive has been simulated and the results are presented.  
keywords: {Industries;Power system measurements;Density measurement;Switching frequency;Design methodology;Variable speed drives;Robustness;Model Predictive Control;Active Front End Rectifier;Inverter;Direct Power Control;Back to Back Converter;AC-DC-AC Converter;DC link design},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453659&isnumber=9453463>  
  
S. Arazm and K. Al-Haddad, "ZPUC9-MMC: An Increased Voltage Level Modular Multilevel Converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 521-526.  
doi: 10.1109/ICIT46573.2021.9453681  
Abstract: In this paper a nine level Z-packed U-cell (ZPUC9) multilevel converter has been proposed as a submodule of modular multilevel converter (MMC) to increase the voltage level at the output waveform. Single DC source ZPUC9-MMC generates 17-level phase voltage and 33-Level line voltage waveform through single submodule per arm which increases the voltage quality owing to total harmonic distortion (THD) reduction and increase the reliability due to reduced counts of devices. Single DC source operation for single-phase and three-phase operation as well as the modularity is the main advantages of proposed configuration in comparison with the counterpart converters. Voltage balancing integrated with modulation technique has been used to control and regulate the flying capacitors (FCs) voltages of the converter. Simulation results obtained by MATLAB-Simulink validate the performance of proposed converter in transient and steady state in stand-alone mode.  
keywords: {Multilevel converters;Total harmonic distortion;Software packages;Simulation;Capacitors;Modulation;Steady-state;ZPUC9-MMC;Single DC source;Phase shift pulsed width modulation;Voltage balancing;power quality},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453681&isnumber=9453463>  
  
"Power Systems and Smart Grids," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 527-528.  
doi: 10.1109/ICIT46573.2021.9453610  
Abstract: Start of the above-titled section of the conference proceedings record.  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453610&isnumber=9453463>  
  
J. Pesente and M. L. Sosa Rios, "A Case Study for maximizing Hydroelectric annual revenue on Brazilian Power Market," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 529-534.  
doi: 10.1109/ICIT46573.2021.9453601  
Abstract: In the countries where most of the generation is hydroelectric, the long term operation planning is performed using techniques of decision making under uncertainties, due to the nature of water inflows. Also, in power systems with these characteristics which are in the process of deregulation, rules were designed in a way that generators could simultaneously profit and be protected from the risk of uncertainties. In the case of the Brazilian power market, the plan of operation defines the maximum energy a power plant can sell in a specific year but allows facilities to distribute it among the months of the year of the contract. Once the energy price is defined based on stochastic simulations, different strategies of generation distributions can be simulated and used to determine the expected profit, considering the energy available for the forthcoming year along with the short-run price of the power market. In this paper, a case study for maximizing the revenue of hydroelectric in Brazil is presented in which experiments using the Itaipu power plant were performed and discussed to illustrate the expected outcomes.  
keywords: {Uncertainty;Conferences;Decision making;Power markets;Generators;Power systems;Planning;Power System Economics;Firm Energy},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453601&isnumber=9453463>  
  
C. D. Widjaja, F. S. Rahman, K. M. Banjar-Nahor and N. Hariyanto, "A Novel Approach of Loss Sensitivity Factor for Optimal Placement of Battery Energy Storage System," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 535-540.  
doi: 10.1109/ICIT46573.2021.9453579  
Abstract: One of the methods to reduce peak-time generation costs is by using a battery energy storage system (BESS). To effectively utilize BESS, its installation must be considered carefully since incorrect site placement will increase grid losses and reduce BESS's benefits. This paper presents the application of loss sensitivity factor (LSF) to obtain BESS's optimal placement. The approach will be based on a novel approach considering the charging and discharging period of BESS. The optimization process aims to minimize grid losses when BESS is installed. The performance of the proposed method is validated by using IEEE RTS-96 24 bus system. The results obtained show that this novel approach can significantly minimize the grid losses compared to the conventional LSF approach.  
keywords: {Energy loss;Sensitivity;Conferences;Batteries;Optimization;optimal BESS placement;peak shaving;Loss Sensitivity Factor},  
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M. Andalibi, M. Hajihosseini, M. Gheisarnejad, M. -H. Khooban and J. Boudjadar, "A Novel Method for Stabilizing Buck-Boost Converters with CPL using Model Prediction Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 541-545.  
doi: 10.1109/ICIT46573.2021.9453639  
Abstract: Nowadays the use of power converters, in particular, DC/DC converters in a large number of power electronics applications such as DC micro-grids (MGs) is an interesting subject in power systems. However, the use of such converters in MGs results in instability problems inflicted by the constant power loads (CPLs) because of their negative impedance feature. Thus, a controller with specific characters including, robustness and fast response to system dynamics to address unsteadiness issues and better performance of DC/DC converters feeding CPLs is vital. In this paper, a model prediction control (MPC) approach is introduced to tackle the de-stabilization problem and mitigate the destructive effect of CPLs, leading to a robust control approach as well as enlarging the system stability margin. To demonstrate and verify the usefulness of the proposed scheme in a real-time setup, the performance of the MPC controller applied to the DC/DC buck-boost converter feeding CPL is examined in a Model-In-the Loop (MiL) environment.  
keywords: {Robust control;System dynamics;Predictive models;Power system stability;Stability analysis;Robustness;Real-time systems;DC/DC Buck-Boost Converters;Constant Power Load (CPL);Model Prediction Control (MPC);Model-In-the Loop (MiL)},  
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S. O. Kimbrough and H. Ümitcan Yilmaz, "A Symmetric Block Resampling Method to Generate Energy Time Series Data," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 546-551.  
doi: 10.1109/ICIT46573.2021.9453485  
Abstract: Energy modeling frequently relies on time series data, whether observed or forecasted. This is particularly the case, for example, in capacity planning models that use hourly production and load data forecasted to occur over the coming several decades. This paper addresses the attendant problem of performing sensitivity, robustness, and other post-solution analyses using time series data. We propose an efficient and relatively simple method, which we call the symmetric block resampling method, a non-parametric bootstrapping approach, for generating arbitrary numbers of time series from a single observed or forecast series. The paper presents and assesses the method. We find that the generated series are both visually and by statistical summary measures close to the original observational data. In consequence these series are credibly taken as stochastic instances from a common distribution, that of the original series of observations. We find as well that the generated series induce variability in properties of the series that are important for energy modeling, in particular periods of under-and over-production, and periods of increased ramping rates. In consequence, series produced in this way are apt for use in robustness, sensitivity, and in general post-solution analysis of energy planning models. These validity factors auger well for applications beyond energy modeling.  
keywords: {Wind energy generation;Analytical models;Sensitivity;Time series analysis;Stochastic processes;Predictive models;Robustness;energy modeling;bootstrap;time series data;sensitivity analysis;robustness analysis;post-solution analysis;synthetic data;time series generation},  
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K. Günther, B. Spichartz and C. Sourkounis, "Adapted Operational Management of Wind Turbines for the Provision of Primary Power Reserve," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 552-558.  
doi: 10.1109/ICIT46573.2021.9453519  
Abstract: Aiming a further integration of wind power plants in the electrical grid, control and operational management algorithms of wind turbines that allow the provision of ancillary grid services are in the focus of research. The supply of primary power to stabilize the grid frequency in case of imbalances requires power reserves of the plants, so that WTs stationary need to operate at a deloaded operating point. In this work, a robust and reliable operational management is proposed to realize a conventional as well as a deloaded operation without additional sensor data required of the wind speed. The stationary provision of primary power reserve and the instantaneous power supply during a frequency dip are analyzed both with simulation and experimental results to validate the proposed control structure.  
keywords: {Analytical models;Power supplies;Wind speed;Conferences;Wind power generation;Frequency response;Wind turbines;wind energy;wind turbine;primary control;grid support},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453519&isnumber=9453463>  
  
K. López, W. Mariscal, J. Plazarte and J. Urquizo, "Allocation and Optimal Sizing of Flexible Capacitor Banks for the Minimization of Active Power Losses in Long Unbalanced Rural Medium Voltage Distribution Feeders using Heuristic Algorithms," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 559-566.  
doi: 10.1109/ICIT46573.2021.9453500  
Abstract: This article explores a heuristic based optimization methodology for power loss reduction and the voltage profile improvement in a medium voltage distribution network. The objective function provides minimum values for the power losses using three-phase capacitor banks located and dimensioned throughout the distribution network. This location and dimensioning were carried out using two heuristic methods: ant colony and genetic optimization algorithms. These algorithms involve determining which capacitor bank might be installed in a specific bus; under these conditions, the losses are optimized. Such heuristic optimization methods were tested in three distribution networks with radial topology to show feasibility of the methodology: the IEEE 33-bus and the IEEE 69-bus, and the long unbalanced rural Medium Voltage feeder Piñal of CNEL Guayas-Rios (Ecuador). The results show significant power losses reductions, especially in the IEEE model networks and moderate power losses reductions in Piñal. The proposed approach permits the flexible optimization variables that are represented in their natural form.  
keywords: {Network topology;Heuristic algorithms;Capacitors;Optimization methods;Medium voltage;Distribution networks;Minimization;Ant colony optimization;capacitor banks;genetic algorithm;heuristic method;index of active power losses;non-technical losses;radial topology;technical losses},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453500&isnumber=9453463>  
  
D. Lendi, C. S. Staines, C. Caruana and J. Licari, "Analysis of Droop controlled paralleled Aircraft Generators through common DC Bus," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 567-572.  
doi: 10.1109/ICIT46573.2021.9453593  
Abstract: With the increase in electrical loads and the shift from hydraulic and pneumatic to electrical systems, such as in the Boeing 787s no-bleed system architecture, the concept of the More Electric Aircraft is gaining popularity. The no-bleed system architecture brings with it also the introduction of a ±270V(540V) DC power system. This paper analyses a 540V DC aircraft electrical power system using two turbine-driven synchronous generators, which are controlled through their excitation field windings. The generators are paralleled through a common DC bus. Load sharing between the two generators is achieved through a droop control scheme. The analysis carried out in this paper encompasses changes in load power and operating frequency of the generators. This is carried out using the Simscape simulation toolbox in MATLAB/Simulink.  
keywords: {Simulation;Windings;Systems architecture;Generators;Synchronous generators;Aircraft;Voltage control;Aircraft Electrical Power System;Common DC Bus;Droop Control;Synchronous Generator},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453593&isnumber=9453463>  
  
P. L. Camuñas, J. López Merino, A. P. Asensio, M. García Plaza and S. A. Gomez, "Analysis of methods to improve energy storage arbitrage benefit considering capacity degradation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 573-578.  
doi: 10.1109/ICIT46573.2021.9453614  
Abstract: The addition of energy storage systems into the grid will allow to mitigate the effects of imbalances caused by the uncertainties of renewable energy sources. Energy storage facilities would give the grid more reliability and efficiency. One of the applications of these facilities is energy arbitrage, which is the trade of energy with the grid using price variability through the day to obtain a benefit. To impulse the investments on energy storage systems connected to the grid, they must be economically viable. The arbitrage operation can be optimized to ensure that viability. The optimization can improve the device's profitability by controlling its degradation. This degradation management can be done in different perspectives attending to economical considerations which may change the way that profitability is viewed. In this paper, the mitigation of this deterioration process is done with two approaches by whether considering it as an operational or as an opportunity cost. Both approaches are compared, with simulation results of a Li-ion Battery Energy Storage System (BESS) performing arbitrage on the Spanish day-ahead electricity market. The main contribution of this work is the opportunity cost concept, which uses a more realistic calculation of degradation impact on arbitrage schedule.  
keywords: {Degradation;Schedules;Renewable energy sources;Uncertainty;Profitability;Simulation;Switches;BESS;arbitrage;optimization;degradation;SOH},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453614&isnumber=9453463>  
  
Z. Hameed, S. Hashemi and C. Træholt, "Applications of AI-Based Forecasts in Renewable Based Electricity Balancing Markets," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 579-584.  
doi: 10.1109/ICIT46573.2021.9453469  
Abstract: Rising environmental concerns are integrating more renewables in power systems. This increase introduces uncertainty in generation and makes it challenging to maintain a balance between demand and supply. To avoid balancing problems and consequent stability issues, better forecast models are needed as traditional techniques are not fully equipped to deal with these new challenges. Thus, artificial intelligence (AI) based forecast techniques are gaining potential recognition in the realm of electricity markets. This paper aims at investigating the state-of-art of AI applications for price forecasts in electricity balancing markets (EBMs). The focus of previous studies extended in this direction has been towards the day- ahead markets, whereas studies targeting EBMs are rather scarce. This paper shows how AI-based forecasts support EBMs modeling, resulting in more secure grid integration of distributed technologies. The benefits driven from such forecasts by market participants like brokers and customers are also investigated.  
keywords: {Uncertainty;Biological system modeling;Reinforcement learning;Predictive models;Power system stability;Electricity supply industry;Stability analysis;artificial intelligence;balancing markets;imbalance settlement;forecasts;classification;modelling;brokers},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453469&isnumber=9453463>  
  
E. Hleihel, M. Fadel and H. Y. Kanaan, "Control and Power Management of a 24-Hour DC Microgrid Improved Model," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 585-592.  
doi: 10.1109/ICIT46573.2021.9453661  
Abstract: In recent decades, the microgrid concept emerged as a solution to electrify remote areas and integrate renewable energy sources to mitigate environmental pollution. Owing to the evolution of power electronic devices, the ease of control, and the improved efficiency and reliability, DC microgrids are gaining increased interest. Many kinds of research address the hierarchical control in DC microgrids to accomplish multi-objectives. On the first and second levels, the control targets fast dynamic variables to achieve its objectives. Yet, on a third control level, general management functionalities are executed. Many of these management functionalities target the system variables with a slower dynamic and so, to prove the effectiveness of the proposed hierarchical control, a 24-hour model simulation is required. The wide time-range dynamics of the existing system variables make the 24-hour modeling subject a complicated matter especially, on standard computers with conventional performances. To overcome this problem, this paper proposes a 24-hour DC microgrid model which offers the best tradeoff between model precision, complexity, and simulation speed. The multi-objectives hierarchical control is adopted: on a first and second control level, several averaging techniques are introduced and compared to a detailed reference model in terms of accuracy and calculation step size. DC microgrid's general management strategy is adopted on the third control level. Simulation tests are performed on MATLAB/Simulink software to prove the viability of the proposed 24-hour model.  
keywords: {Renewable energy sources;Computational modeling;Microgrids;Software;Complexity theory;Table lookup;Mathematical model},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453661&isnumber=9453463>  
  
S. O. Muhanji and A. M. Farid, "Distributed Economic Model Predictive Control of an Electric Power System Using ALADIN," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 593-598.  
doi: 10.1109/ICIT46573.2021.9453627  
Abstract: This paper presents a Distributed Economic Model Predictive control (DEMPC) for the electric power distribution system using the augmented lagrangian alternating direction inexact newton (ALADIN) algorithm. Specifically, this DEMPC solves the Alternating Current Optimal Power Flow (ACOPF) problem over a receding time horizon. The ACOPF problem has been at the heart of many electric power transmission system market operations for decades. Generally, it is a non-linear, non-convex large-scale optimization problem that determines the optimal operation of electric generation, transmission and distribution networks to meet demand while respecting physical system constraints. However, the ACOPF in its traditional form has several limitations when it is applied to emerging electric power distribution system markets that include large amounts of variable renewable energy resources which demand significant ramping capabilities. More specifically, such distribution systems require optimization algorithms that better address the inherent dynamic characteristics of the grid and scale to address the explosion of actively controlled devices at the grid's edge.  
keywords: {Economics;Renewable energy sources;Heuristic algorithms;Power system dynamics;Pricing;Prediction algorithms;Power grids},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453627&isnumber=9453463>  
  
F. Huerta, D. Santamargarita, E. J. Bueno, R. Zhu and M. Liserre, "Flexible Control Structure of a Smart Transformer for Universal Operation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 599-604.  
doi: 10.1109/ICIT46573.2021.9453549  
Abstract: The smart transformer (ST) is considered as one of the key technologies for modernizing distribution grids and facilitating large-scale integration of distributed generation and battery energy storage systems into them. The new grid scenarios demand that the ST will not be merely a substitute for the conventional transformer operating as a power transmitter, but that it plays a key role in providing both ac and dc connectivity and advanced grid support, and in modifying the functionality of its AC-side converters. Under different control objectives and varying grid configurations, an approach based on a different control structure for each objective presents critical aspects such as smooth transition and flexible reconfiguration of network. To overcome these aspects, in this work, a three-level hierarchical control approach based on the virtual-synchronous generator (VSG) and the stored energy model of the DC links capacitors provides a unified and flexible control structure that allows responding to different control objectives without modifying the control structure and parameters. The control has been validated under different grid scenarios and control objectives.  
keywords: {Reactive power;Transmitters;Conferences;Capacitors;Generators;Large scale integration;Distributed power generation;Smart Transformer;solid-state transformer;unified control;virtual-synchronous generator},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453549&isnumber=9453463>

H. Ye, X. Chen, Y. Cui, C. Lu, J. Gu and X. Ling, "Generator Available Inertia Estimation Based on Various Disturbance Measurements of PMU," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 605-610.  
doi: 10.1109/ICIT46573.2021.9453654  
Abstract: Considering the inertia time-varying nature and its significance on frequency initial dynamics, it is meaningful to online real-time estimate available inertia with synchronous measurements. To avoiding the influence of neighboring connected systems on the inertia of specific concerned system, monitoring the system inertia is realized by estimating inertia of individual generator connected to it and aggregated them. Inertia estimation methods presented are swing equation based method with large disturbance measurements and system identification based method with ambient signals, which guarantee the accuracy and continuity of inertia monitoring respectively. The proposed generator inertia estimation system takes full advantage of effective information in PMU measurements, and achieves a useful input to adaptive protection and control application in a near-time way. The methods have been validated with the simulation of IEEE 39 bus system and PMU measurements in power grid in Shanghai, China.  
keywords: {Time-frequency analysis;Power measurement;Power system dynamics;Estimation;Generators;Phasor measurement units;Real-time systems;generator inertia estimation;swing equation;system identification;ambient signals;synchronous measurements},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453654&isnumber=9453463>  
  
N. Kianpoor, B. Hoff and T. Østrem, "Load modeling from smart meter data using neural network methods," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 611-616.  
doi: 10.1109/ICIT46573.2021.9453662  
Abstract: Electricity load modeling plays a critical role to conduct load forecasting or other applications such as non-intrusive load monitoring. For such a reason, this paper investigates a comparison study of two common artificial neural network methods (Multilayer perceptron (MLP) and radial basis function neural network (RBF-NN) for home load modeling application. The accuracy of load modeling using neural network methods highly depends on chosen variables as the input data set for the networks. For this purpose, data including weather, time, and consumer behavior are considered as the input dataset to train the networks. The results of this study show that the RBF-NN model has higher accuracy in training data. On the other side, the MLP model outperforms in test data. To sum up, the results prove that the load model obtained by MLP has a better performance in terms of mean square and root mean square error indices.  
keywords: {Temperature measurement;Wind speed;Simulation;Training data;Artificial neural networks;Data models;Smart meters;Advanced metering system (AMS);Load modeling;residential load sector;neural network;multilayer perceptron;radial basis function neural network},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453662&isnumber=9453463>  
  
I. Ziyat, P. R. Palmer and G. Gary Wang, "Optimisation of Location and Size for Distributed Generation in Unbalanced Grids," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 617-624.  
doi: 10.1109/ICIT46573.2021.9453669  
Abstract: This paper proposes a distributed generation installation procedure that can be applied to balanced and unbalanced distribution grids. This is achieved through metaheuristic optimisation and by modelling the grid using the three-phase grid model rather than the one-line diagram model. Both the power loss in the lines and the voltage deviation from the nominal voltage are minimised using the multi-objective genetic algorithm. This installation procedure facilitates grid planning for the distribution system operator. In particular, various possible Pareto optimal solutions can be chosen, which all lead to significant improvements in the performance of the grid. When applied to the unbalanced IEEE37 grid, this method achieves an installation capacity of 3 MW while significantly reducing power loss in the lines by 83.7%, and voltage deviation from the nominal by 90.6%.  
keywords: {Conferences;Pareto optimization;Distributed power generation;Planning;Complexity theory;Indexes;Optimization},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453669&isnumber=9453463>  
  
S. Puls, J. Austermann and H. Borcherding, "Potential Hazards of Transient Overvoltages in an Industrial DC Grid and Basic Protective Measures," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 625-630.  
doi: 10.1109/ICIT46573.2021.9453597  
Abstract: This article highlights the special electrical properties of an industrial DC grid and compares it with other typical DC grids. In this article, the extent of transient overvoltages is presented, which must be assumed to be caused by grid faults and switching operations. Basic measures for the protection of devices are listed and evaluated.The article clarifies that basic protection is necessary for the reliable operation of devices in industrial DC grids, but is easy to implement.  
keywords: {Varistors;Semiconductor device measurement;Current measurement;Surge protection;Switches;Inverters;Circuit faults;drive inverters;DC grid;overvoltage protection;DC grid faults},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453597&isnumber=9453463>  
  
H. Palahalli, E. Ragaini and G. Gruosso, "Real-time Smart Microgrid Simulation: The integration of communication layer in electrical simulation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 631-636.  
doi: 10.1109/ICIT46573.2021.9453491  
Abstract: Microgrids are smart electrical grid composed of the communication network among its power devices for better operation and control. The information sharing is done locally through measurement but globally by adopting a protocol over the communication network for fast and reliable information exchange for microgrid protection and coordination among the devices present in the power network. In this article, a real-time simulation of a smart microgrid with the emulation of the intelligent electronic devices present in the grid that takes action over the events is proposed using the hardware-in-the-loop methodology. The information exchange between the simulated microgrid and the emulated intelligent trip unit of the circuit breaker is adopted using a physical communication network and User datagram protocol over Ethernet. The unique aspect is to approach the problem of co-simulating the power system simulator with the communication network without platform dependencies to obtain more realistic results. The mathematical models are created using model-based design approach with which a C code can be generated and can be simulated in real-time with any of the digital twins available. The proposed framework is used to test a protection scenario in the microgrid that exchanges the information over Ethernet for measurement and action coordination with the emulated trip unit for stable operation of the microgrid.  
keywords: {Protocols;Microgrids;Ethernet;Power system stability;Real-time systems;Smart grids;Delays;Real-time Simulation;Hardware-in-the-loop;Co-simulation;Microgrid;Communication protocol},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453491&isnumber=9453463>  
  
B. B. Quispe, G. de A. e Melo, R. Cardim and J. M. de S. Ribeiro, "Single-Phase Bidirectional PEV Charger for V2G Operation with Coupled-Inductor Cuk Converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 637-642.  
doi: 10.1109/ICIT46573.2021.9453665  
Abstract: This paper presents the design of a single-phase bidirectional plug-in electric vehicle (PEV) charger for charging/discharging the vehicle's battery. The charger operates in all quadrants of the active-reactive (P-Q) power plane, thus enabling reactive power support service to the utility grid. The proposed charger topology consists of two cascaded power stages: a full-bridge inverter and a coupled-inductor bidirectional Cuk converter. A hybrid control system is used, which consists of a set of PI controllers and Takagi-Sugeno (T-S) fuzzy controllers. This control system allows the charger to follow reference measures for active and reactive power in a smart grid environment. T-S fuzzy models are derived from the converter-inverter system for the controller's design analysis via linear matrix inequalities (LMI). Finally, the effectiveness of the proposed control strategy for the charger through simulation results is verified.  
keywords: {Plug-in electric vehicles;Reactive power;Vehicle-to-grid;Total harmonic distortion;Power measurement;Simulation;Batteries;PEV charger;Vehicle-to-grid (V2G);T-S fuzzy model;T-S fuzzy control;LMI},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453665&isnumber=9453463>  
  
K. Hajar, B. Guo, A. Hably and S. Bacha, "Smart charging impact on electric vehicles in presence of photovoltaics," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 643-648.  
doi: 10.1109/ICIT46573.2021.9453600  
Abstract: The emergence of electric vehicles (EVs) promises to be the turning point of sustainable energy and, in particular, renewable energy production in the world. EV Charging will generate substantial extra demand for electricity. Renewable energy, including solar and wind power, can be met in the grid technically and economically. Recent studies have shown that smart charging of EV can increase the synergy between photovoltaics (PV), electrical transmission and electricity usage, resulting in technological and economic advantages. Given the increasing emphasis on this area, this analysis summarizes an overview on smart charging studies taking into account PV power output and consumption of electricity.  
keywords: {Photovoltaic systems;Economics;Renewable energy sources;Conferences;Production;Wind power generation;Turning;Electric vehicles;plug in electric vehicles;V2G;RESs;EV charging program;charging station},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453600&isnumber=9453463>  
  
C. M. Paredes, A. F. Bayona, D. Martínez, A. Crespo, J. Simo and A. González, "Socio-economic and technological impact of a microgrid in isolated communities using Simulation Modeling," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 649-656.  
doi: 10.1109/ICIT46573.2021.9453608  
Abstract: In this paper, we analyzed the impact that has a microgrid in isolated communities. The social appropriation of these systems involve aspects that go beyond of their operation and can put their sustainability at risk. Whereby, has increased interest in the development of analyzing methods for these solutions during the design stages, contributing to more accurate evaluations of their feasibility and impact. A simulation of an isolated microgrid is presented, which integrates the computational, energy and automation sublevels. Also, a Multi-agent System (MAS) was used to study the evolution of indices related to the affectation that the microgrid could generate in a community in environmental and economic terms. The MAS then analyzes the socio-technological interdependence in the operation of an isolated microgrid. The contribution aims to the comprehensive study of the performance of these projects and the economic, social, technological and environmental impacts on specific communities, which contribute to decision making in the design and implementation of these systems.  
keywords: {Economics;Automation;Conferences;Computational modeling;Decision making;Microgrids;Sustainable development;isolated communities;microgrid;multi-agent system;socio-economic impact;socio-technological impact},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453608&isnumber=9453463>  
  
H. Palahalli, P. Maffezzoni and G. Gruosso, "Statistical simulation of Electric Vehicle behaviour applied to low voltage distribution network," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 657-662.  
doi: 10.1109/ICIT46573.2021.9453667  
Abstract: The usage of Electric vehicles is increasing every day, and its penetration into the present electrical distribution network on large-scale needs to be investigated by the distribution companies to be future-ready and to provide good quality of electric supply. This article provides a statistical methodology to model electric vehicle charging behavior in a large network using real measurement data set. The vital information such as time of connection, duration of the connection, and power absorbed during the charging are extracted. The probability distribution of these extracted events is used to model 300 electric vehicle charging behavior whose integration with a non-synthetic low voltage European test network built using the real measurement data set is investigated for voltage distribution and the Voltage unbalance factor among the busses, feeders, and other elements present in the network. The numerical simulation framework is executed with Opendss for load flow analysis and MATLAB for statistical analysis and to invoke the load flow solver.  
keywords: {Low voltage;Statistical analysis;Europe;Distribution networks;Numerical simulation;Data models;Electric vehicle charging;Numerical simulation;Electrical Vehicles;Probability distribution;Statistical analysis;Grid impact},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453667&isnumber=9453463>  
  
P. Peng, Y. Li, Z. Hu, C. Deng, L. Zhu and J. He, "Study on the Planning Method of Electric Vehicle Charging Station considering the Efficiency of Peak Shaving and Frequency Regulations," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 663-668.  
doi: 10.1109/ICIT46573.2021.9453510  
Abstract: China's provincial and municipal power grid companies continue to introduce the peak shaving and frequency modulation (FM) incentive policy for the auxiliary service market, which will affect the planning and development of electric vehicle(EV) charging stations. In this paper, considering some scenarios of EV charging stations and EVs as a whole to provide power grid peak shaving and FM services, based on the EV charging demand prediction model. This paper proposes an EV charging station planning method that considers the benefit of grid peak shaving and FM. The goal is to minimize the annual social comprehensive cost of the charging station. The optimal location and capacity of EV charging stations are obtained by optimization of simulated annealing particle swarm algorithm. Finally, a simulation analysis was carried out with a part of Xiangzhou area in Zhuhai City as an example, which verified the validity and correctness of the method proposed in this paper.  
keywords: {Frequency modulation;Roads;Urban areas;Transportation;Simulated annealing;Charging stations;Electric vehicle charging;Electric Vehicle;Charging station planning;Demand forecasting;Monte Carlo;Peak Shaving and Frequency Modulation},  
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"Sensors, Actuators and Micro-Nanotechnology," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 669-670.  
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F. J. Aranda, F. J. Álvarez, F. Parralejo, E. Sansano-Sansano and R. Montoliu, "A novel method for in-home Gait Speed estimation in Health Monitoring Using Bluetooth Low Energy," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 671-676.  
doi: 10.1109/ICIT46573.2021.9453578  
Abstract: Gait speed (GS) is a crucial parameter in the evolution and diagnosis of degenerative illnesses. Nowadays, it is measured in clinical environments where it is impossible to keep track of all patients due to the lack of resources. The development of GS measurement systems for in-home environments could solve this problem, but current methods present, at least, one of these problems: they require expensive hardware, are intrusive for the patient, or are imprecise. A novel method to measure GS in these scenarios using Bluetooth Low Energy and smart wearable devices is proposed in this work. The proposed system is inexpensive, non-intrusive, and its precision is comparable to the current state of the art methods. This system could be commercialized as part of an in-home health monitoring system.  
keywords: {Wrist;Bluetooth;Ultrasonic imaging;Current measurement;Wearable computers;Estimation;Energy measurement;Bluetooth Low Energy;Gait Speed;Health Monitoring},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453578&isnumber=9453463>  
  
M. Guidolin, E. Menegatti, M. Reggiani and L. Tagliapietra, "A ROS Driver for Xsens Wireless Inertial Measurement Unit Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 677-683.  
doi: 10.1109/ICIT46573.2021.9453640  
Abstract: This paper presents an efficient open-source driver for interfacing Xsens inertial measurement systems (in particular the Xsens MTw Awinda wireless motion trackers) with the Robot Operating System (ROS). The driver supports the simultaneous connection of up to 20 trackers, limit fixed by the Xsens software, to a master PC, and directly streams sensors data (linear accelerations, angular velocities, magnetic fields, orientations) up to 120 Hz to the ROS network through one or multiple configurable topics. Moreover, a synchronization procedure is implemented to avoid possible partial frames where the readings from one (or multiple) trackers are missing. The proposed messages are based on ROS standard ones and comply with the ROS developer guidelines. This guarantees the compatibility of any ROS package requiring as input ROS standard messages with the proposed driver, thus effectively integrating Xsens inertial measurement systems with the ROS ecosystem. This work aims to push forward the development of a large variety of human-robot interaction applications where accurate real-time knowledge of human motion is crucial.  
keywords: {Wireless communication;Wireless sensor networks;Measurement units;Tracking;Operating systems;Magnetic sensors;Real-time systems;Human-Robot Interaction;Xsens;IMU;ROS;Hi-ROS;Inertial Measurement Units},  
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Y. Li, J. Wu, Z. Wang, H. Lv, Y. Wang and Y. Li, "Design and Manufacturing of a Wireless Temperature Monitoring System for Gas Insulated Switchgear," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 684-689.  
doi: 10.1109/ICIT46573.2021.9453508  
Abstract: The design, manufacturing, and characterization of a temperature monitoring system is presented in this work. The system is used to measure the temperature of critical locations on the Gas Insulated Switchgear (GIS) including bus bar, contact, and switches. A compensation algorithm is developed to eliminate the influence of glass window, SF6 gas and the surface profile of the bus bar. The system is also capable of provide warning information on the overheating issues at the early stage of different equipment failures. The proposed temperature monitoring system is capable of measuring temperature of the GIS key locations in the range of 30-100°C, and an accuracy of ±2°C. The temperature monitoring system and its integration to GIS are intended to be the initial stage of the development of new GIS product line and its standard with temperature monitoring and warning function.  
keywords: {Temperature measurement;Temperature sensors;Resistors;Temperature distribution;Sulfur hexafluoride;Windows;Gas insulation;IR temperature sensor module;Gas Insulated Switchgear (GIS)},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453508&isnumber=9453463>  
  
D. Castano-Cano, M. Grossard and A. Hubert, "Design and Validation of a Resonant Multi-Axis Force Sensor for Collaborative Robotics," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 690-696.  
doi: 10.1109/ICIT46573.2021.9453602  
Abstract: This paper presents the design and characterization of a new multi-axis force/torque sensor based on resonant technology. This sensor is capable of simultaneously estimating the three force components as well as the three torque components. It is designed for use in collaborative robotics applications and can be integrated into handles or grippers of robotic manipulators to estimate interactions between robots and humans. Compared to the technologies currently in use and based on strain gauges, this system offers many advantages, particularly in terms of both safety and redundancy. This paper describes the design of this sensor and then compares the prototype to a state-of-the-art commercial sensor. Comparisons show that the proposed technology is at least as efficient as the industrial system, although its dimensions remain slightly larger.  
keywords: {Performance evaluation;Service robots;Force;Collaboration;Prototypes;Robot sensing systems;Safety;Multi-axis force sensors;wrench estimation;resonant transducers;collaborative robotics},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453602&isnumber=9453463>  
  
"Cloud Computing, Big Data and Software Engineering," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 697-698.  
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N. V. Varghese, A. Azim and Q. H. Mahmoud, "A Feature-Based Machine Learning Approach for Mixed-Criticality Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 699-704.  
doi: 10.1109/ICIT46573.2021.9453482  
Abstract: Driven by the recent technological advancements in the field of artificial intelligence, machine learning has emerged as a promising representation learning and decision-making method in many technological domains. Inspired by impressive these results, now machine learning techniques are also being applied to address the decision-making and control problems in the area of cyber-physical systems. For instance, some of these systems fall under the category of safety-critical systems such as chemical plants, autonomous vehicles, surgical robots, and modern medical equipment. One of the major performance issues related to the applicability of machine learning with safety-critical systems is related to the probability-based prediction nature of machine learning components used within such systems. This particular characteristic of machine learning makes it extremely difficult to guarantee safety as directed by standards such as ISO 26262. More importantly, the non-transparent and complex nature of machine learning algorithms make both the reasoning as well as formally establishing the safety aspects of the underlying system extremely difficult. The objective of this research work is to investigate on this key issue, and further on propose an efficient machine learning methodology based on the mixed-criticality approach feasible to safety-critical systems.  
keywords: {Uncertainty;Medical robotics;Machine learning algorithms;Filtering;ISO Standards;Decision making;Machine learning;Machine Learning;Deep Learning;Cyber-Physical Systems;Safety-Critical Systems;Partitioning},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453482&isnumber=9453463>  
  
D. Lennick, A. Azim and R. Liscano, "A Microservice-Based Architecture for Performance and Energy Benchmarking of Docker-Host Linux Distributions on Internet-of-Things Devices," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 705-711.  
doi: 10.1109/ICIT46573.2021.9453517  
Abstract: Containers are rapidly being adopted in several areas of the information technology industry. A major area is edge and embedded Internet-of-Things systems. In this paper, we present a microservice-based architecture for performance analysis and energy consumption of Internet-of-Things "Docker host" Linux distributions. Our methodology builds on previous container benchmarking work, with analysis of performance metrics such as processing, memory, and disk throughput. Furthermore, our methodology introduces container-engine performance metrics related to container lifecycle operations, and concurrent container performance. We demonstrate by comparing four Linux distributions in this domain: BalenaOS, HypriotOS, RancherOS, and Raspbian Lite. All source code is provided.  
keywords: {Performance evaluation;Industries;Energy consumption;Linux;Conferences;Containers;Benchmark testing;containers;iot;performance;energy consumption},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453517&isnumber=9453463>  
  
Z. Ke and N. Park, "A Queueing Model for Industrial Public Blockchains and Validation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 712-717.  
doi: 10.1109/ICIT46573.2021.9453552  
Abstract: This paper presents a queueing model for mining-based public blockchains and validations with respect to specific yet practical characteristics of public blockchains such as Bitcoin and Ethereum, primarily in terms of transaction queue size and block waiting time, as an alternative solution to the conventional industrial networks for the trustworthiness it offers. A set of variables taken into account in this model lists the network traffic intensity, the maximum number of transactions in a block, the block time, and the transaction arrival rate, to mention a few. The proposed model provides a comprehensive yet fundamental basis to assure and ultimately optimize the design of blockchain technology-based applications in specific terms of performance. Numerical simulations have been conducted and the efficacy of the proposed model is validated in a quantitative yet practical manner versus Bitcoin and Ethereum.  
keywords: {Conferences;Loading;Blockchain;Bitcoin;Telecommunication traffic;Numerical simulation;Market research;Blockchain;queueing model;Bitcoin;Ethereum;validation},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453552&isnumber=9453463>  
  
A. Nowitschkow, C. Saal and O. Lohse, "Factory data management: Definition and differentiation from manufacturing operations management," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 718-721.  
doi: 10.1109/ICIT46573.2021.9453563  
Abstract: Digitalization is based on the availability of specific data that can be analyzed. Especially in the field of flexible production, a well-developed data management system plays a crucial role, although its various functions - including management of production resources in the factory - have not yet been clearly defined. For example, there is currently no clear differentiation between the functions of factory data management (FDM) and manufacturing operations management (MOM). This paper takes this undefined area as its starting point and assigns specific functions to the term "factory data management". It also describes the need for robust factory data management and the opportunities for refining these functions in a global production network.  
keywords: {Conferences;Refining;Production facilities;Manufacturing;Frequency division multiplexing;Method of moments;Digitalization;factory data management;smart manufacturing;production resource management;production control},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453563&isnumber=9453463>  
  
Z. Bakhshi, G. Rodriguez-Navas and H. Hansson, "Fault-tolerant Permanent Storage for Container-based Fog Architectures," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 722-729.  
doi: 10.1109/ICIT46573.2021.9453473  
Abstract: Container-based architectures are widely used for cloud computing and can have an important role in the implementation of fog computing infrastructures. However, there are some crucial dependability aspects that must be addressed to make containerization suitable for critical fog applications, e.g., in automation and robotics. This paper discusses challenges in applying containerization at the fog layer, and focuses on one of those challenges: provision of fault-tolerant permanent storage. The paper also presents a container-based fog architecture utilizing so-called storage containers, which combine built-in fault-tolerance mechanisms of containers with a distributed consensus protocol to achieve data consistency.  
keywords: {Fault tolerance;Cloud computing;Fault tolerant systems;Prototypes;Distributed databases;Computer architecture;Containers},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453473&isnumber=9453463>  
  
S. Friedl, T. Heinemann, A. Lechler and O. Riedel, "Implicit Templates for Conformance Units in OPC UA Companion Specifications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 730-735.  
doi: 10.1109/ICIT46573.2021.9453582  
Abstract: Due to its importance in the Industry 4.0 movement, the usage of OPC UA has increased in recent years. More and more vendor-independent and domain-specific models are developed as so-called Companion Specifications. OPC UA Profiles allow to subdivide functionality within the Companion Specifications, and thus offer flexibility to the standards. An OPC UA Profile is a set of individually testable entities called Conformance Units, which are also defined within the Companion Specification. In this work, similarities between Conformance Units defined by different working groups are analyzed and grouped in CU classes by the scope of the Conformance Units. For the most prevalent CU classes, textual templates are suggested, based on the typical formulations in existing Companion Specifications. These templates are intended to ease the development of Companion Specifications and the Conformance Units therein. The CU classes identified in this work suggest the templates can be used for more than two-thirds of the Conformance Units in a Companion Specification. The CU classes and templates are also a step towards automation in the generation of OPC UA Companion Specification Documents and test cases for the Conformance Units.  
keywords: {Conferences;Standards;OPC UA Companion Specification;Conformance Units;Industrial Communication;Standardization},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453582&isnumber=9453463>  
  
S. König, B. Vogel-Heuser, R. Mäckel and D. Schnittger, "Improve Test Quality by Applying a Clustering-based Test Planning Procedure for Customer Experience Vehicle Functions," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 736-743.  
doi: 10.1109/ICIT46573.2021.9453674  
Abstract: The automotive industry is undergoing technological change that is not only shaped by electro mobility, but also by the rising importance of customer experience. It puts the customers first and manages their journeys with the help of software. These software-driven customer experience vehicle functions can promote competitive technological advantages for the automotive company. In the ramp-up phase of new car models, testing of electric and electronic customer experience vehicle functions is conducted on prototypes. The functional availability of these functions depends on various requirements. Thus, test planning quickly becomes difficult to conduct manually. In order to optimize the test planning procedure for these functions, we developed a data-driven procedure that automates test planning on test objects. In this paper we introduce a procedure that comprises interaction of hierarchical clustering, weighted parameters and ranking. We evaluated a proof of concept at an Original Equipment Manufacturer and conclude that the procedure leads to higher quality in testing. This use case is a successful application of unsupervised machine learning in the automotive industry.  
keywords: {Industries;Conferences;Prototypes;Machine learning;Companies;Software;Planning;automotive;customer experience;test planning;application of hierarchical clustering;weighting;ranking},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453674&isnumber=9453463>  
  
I. Miladinovic, S. Schefer-Wenzl, T. Burger and H. Hirner, "Multi-Access Edge Computing: An Overview and Latency Evaluation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 744-748.  
doi: 10.1109/ICIT46573.2021.9453495  
Abstract: Multi-Access Edge Computing (MEC) is one of the key emerging technologies currently being deployed by mobile network operators. By introducing cloud application capabilities close to end-users, MEC enables a range of new use cases, in particular those with real-time requirements. This is possible because of low network latency of MEC compared with traditional cloud services. In this paper we evaluate the network latency of one service running in a MEC-like environment and compare it with the latency of the same service running in two geographically different cloud locations. Our goal was to quantify MEC latency, as one of the most important benefits of MEC. The results show an essential advantage of MEC over cloud computing, which makes it a promising technology for real-time services and beyond.  
keywords: {Cloud computing;5G mobile communication;Conferences;Real-time systems;Time factors;Quality of experience;Edge computing;Multi-access Edge Computing (MEC);IoT;Latency;Round Trip Time;5G},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453495&isnumber=9453463>  
  
W. Tärneberg, P. Skarin, C. Gehrmann and M. Kihl, "Prototyping intrusion detection in an industrial cloud-native digital twin," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 749-755.  
doi: 10.1109/ICIT46573.2021.9453553  
Abstract: Digital twins are poised to play a vital role in the industry 4.0 era. A cloud-based digital twin can augment the entity that it represents. To that effect, we envision that digital twins can have embedded control systems when paired with a cyber physical system, yielding significant performance and configurability advantages. However, relegating controllers to a cloud-based digital twin exposes them to a new set of attack surfaces. Given the intricacy of such systems and the plethora of mitigating actions they can take, intrusion detection is integral to maintaining the integrity of such system. In this paper, we propose and prototype a cloud-native digital twin proof of concept for evaluating the viability of the concept. The resulting platform is evaluated for its ability to host a cyber-physical system and its potential to incorporate an intrusion detection system.  
keywords: {Digital twin;Conferences;Intrusion detection;Prototypes;Control systems;component;formatting;style;styling;insert},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453553&isnumber=9453463>  
  
A. Schwung, J. Pöppelbaum and P. C. Nutakki, "Rigid Body Movement Prediction Using Dual Quaternion Recurrent Neural Networks," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 756-761.  
doi: 10.1109/ICIT46573.2021.9453587  
Abstract: This paper presents a novel approach for the data based prediction of rigid body movements. To this end, we combine data based learning with a physically motivated neural network architecture using the theory of dual quaternions. Particularly, we develop a novel neural network architecture based on dual quaternion algebra which is particular suitable for representing rigid body movements. To account for multi-step predictions and the inherent dynamics of rigid bodies, we particularly focus on recurrent neural networks. As such we propose both dual quaternion recurrent neural networks as well as dual quaternion long short term memories. We apply the approach to a simplified simulation environment developed using the discrete element method which allows for a very detailed simulation of the movements. The obtained results underline the applicability and potential of the approach in terms of improved prediction performance.  
keywords: {Recurrent neural networks;Algebra;Quaternions;Conferences;Dynamics;Finite element analysis;Task analysis;Rigid body movements;dual quaternion algebra;dual quaternion neural networks;recurrent neural networks},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453587&isnumber=9453463>  
  
A. Bucaioni, V. Dimic, M. Gålnander, H. Lönn and J. Lundbäck, "Transferring a model-based development methodology to the automotive industry," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 762-767.  
doi: 10.1109/ICIT46573.2021.9453680  
Abstract: This paper reports on our experience in transferring an academic model-based methodology for the development of automotive software systems into an industrial integrated development environment. The transferred methodology makes use of two industrial modelling languages and provides for the development and architectural exploration of automotive system and software designs with temporal awareness. We demonstrate the usage of the transferred methodology using the brake-by-wire automotive functionality. Eventually, we describe the challenges we have faced and the lessons we have learned in performing this technology transfer.  
keywords: {Industries;Software design;Conferences;Technology transfer;Software systems;Automotive engineering},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453680&isnumber=9453463>  
  
"Electronic Systems on Chip and Embedded Control," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 768-770.  
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doi: 10.1109/ICIT46573.2021.9453628  
Abstract: Designing and simulating large networks, based on the Time Sensitive Networking (TSN) standards, require complex and demanding configuration at the design and pre-simulation phases. Existing configuration and simulation frameworks support only manual configuration of TSN networks. This hampers the applicability of these frameworks to large-sized TSN networks, especially in complex industrial embedded system applications. This paper proposes a modular framework to automate offline scheduling in TSN networks to facilitate the design-time and pre-simulation automated network configurations as well as interpretation of the simulations. To demonstrate and evaluate the applicability of the proposed framework, a large TSN network is automatically configured and its performance is evaluated by measuring end-to-end delays of time-critical flows in a state-of-the-art simulation framework, namely NeSTiNg.  
keywords: {Schedules;Job shop scheduling;Embedded systems;Simulation;Manuals;Tools;Syntactics},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453628&isnumber=9453463>  
  
C. Seguna, E. Gatt, I. Grech, O. Casha and G. De Cataldo, "Development of an New ASIC based, Multi-channel Data Acquisition and Real-Time Processing System," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 779-782.  
doi: 10.1109/ICIT46573.2021.9453615  
Abstract: This work presents the development of a newly Application Specific Integrated Circuit suitable for the simultaneous readout, real-time measurement, and processing of digital data in a multi-channel data acquisition system. High-speed multi-channel digitizers are useful for large-scale high-energy physics, astrophysics, nuclear and plasma physics experiments. The developed application specific integrated circuit allows the simultaneous continuous readout and processing of 240 12-bit analogue channels, at data transfer rates of 4.0 Gbps via five 3-lane Low-Voltage Differential Signaling transmitter drivers. Additionally, unlike the various vendor-defined high-speed digitizers that are currently available in the market, the developed ceramic quad flat 160-pin package microelectronic circuitry includes the implementation of an integrated fault tolerant and recoverable Triple-Modular Redundancy voting circuitry, use of Zero-suppression compression algorithm and implementation of Cyclic-Redundancy Check technique. The integration of such features reduces development time and enables the developed integrated circuitry to be used in a radiation physics environment where single-event upset or latch-up could lead to event data corruption or even electronic failures. The implemented system architecture lowers maintenance costs, and further improves system performance by ten-fold when compared for example to other various data acquisition readout electronic systems currently present in the A Large Ion Collider experiment in CERN. Additionally, the developed XFAB 180 nm 6-layer parallel readout integrated circuit architecture can be easily interfaced with other various vendor-specific analogue-to-digital convertor modules that are currently available on the market, thus further facilitating the upgrading process of data acquisition systems.  
keywords: {Application specific integrated circuits;Power demand;System performance;Data acquisition;Systems architecture;Real-time systems;Readout electronics;acquisition;ASIC;multi-channel;high-speed;stream-data},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453615&isnumber=9453463>  
  
F. Muttenthaler, S. Wilker and T. Sauter, "Lean automated hardware/software integration test strategy for embedded systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 783-788.  
doi: 10.1109/ICIT46573.2021.9453538  
Abstract: The integration of software components in safety-critical systems requires dedicated verification of software components on the target hardware platform. Executing Processor In the Loop (PIL) tests on a microcontroller as verification of software components in a target environment are established as a common method. For the automated verification of associated hardware peripherals the PIL test strategy is extended by applying comprehensive Hardware In the Loop (HIL) tests. Functional verification based on a PIL test setup requires extensive instrumentation in addition to the productive software on the microcontroller. An alternative strategy for the automation of hardware/software integration verification methods on microcontroller target environments is proposed in this work. By carrying out tests on the host platform which, on the one hand interacts with the HIL test system and on the other hand communicates with the microcontroller via a debugger, overcomes the extensive instrumentation on the microcontroller target environment. A concept for a test platform and how to use it for software component and integration tests, as well as for hardware/software integration tests in a given target environment is presented in this paper. This platform was evaluated by verifying Low-Level Driver software components on the respective microcontroller target environment. The efficiency of the test runtime with automated execution was compared and analyzed with those of manual tests.  
keywords: {Runtime;Embedded systems;Automation;Microcontrollers;Instruments;Conferences;Manuals;HIL;PIL;System Integration;Hardware/Software Integration;Integration Verification;ISO 26262;Component Testing},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453538&isnumber=9453463>  
  
J. Jeong and C. -G. Lee, "Multiple PRM-Based Lockstep/Performance Mode Switches for Critical/Non-Critical Real-Time Tasks," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 789-796.  
doi: 10.1109/ICIT46573.2021.9453526  
Abstract: Due to the complex computation requirements of autonomous car functions, high-performance ECUs are inevitable for the future automotive system architecture. However, it has been reported that high-performance ECUs are usually more susceptible to the soft-error due to the technology scaling. One of the key methods to tolerate these soft errors (i.e. transient faults) is the lockstep mechanism based on the hardware redundancy. However, since this uses multiple redundant cores to execute a single program, it is very inefficient in terms of resource usage. To cope with this drawback, a new feature, `Lockstep/Performance mode switch' was introduced. It aims to guarantee safety for safety-critical tasks using the lockstep and maximize throughput for non-critical tasks using different cores for different tasks. This paper proposes a real-time scheduling method in order to efficiently use this new feature following the previous work. We first propose a condition of Periodic Resource Model(PRM) that avoids pessimism while we construct a PRM with the harmonic task set. Then, we partition the given input set into multiple PRMs where each PRM possesses a harmonic task set and has the optimal PRM period and budget. Consequently, The proposed method achieves optimal maximum schedulable utilization, which is more resource-efficient than the previous work.  
keywords: {Laser mode locking;Redundancy;Systems architecture;Switches;Harmonic analysis;Throughput;Real-time systems;Real-Time Scheduling;Lockstep/Performance Mode Switch;Hierarchical Scheduling;Periodic Resource Model},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453526&isnumber=9453463>  
  
R. Almeida, L. Novais, N. Naia, R. Faria and J. Cabral, "Reliable Software Design Aided by QEMU Simulation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 797-804.  
doi: 10.1109/ICIT46573.2021.9453486  
Abstract: Highly reliable systems achieve a low failure probability during their operational lifetime with the help of redundancy. This technique ensures functionality by replicating components or modules, on both software and hardware. The addition of redundancy and further architectural decisions that arise from its usage results in increased system complexity. The resultant complexity hinders analytical approaches to evaluate competing architectural designs, as the time and effort spent with this type of evaluation may significantly delay development. A way to avoid time spent on this type of analysis is to submit the designed architecture to simulation, both for validation and evaluation. In this paper, we propose the usage of a simulation tool, specifically QEMU, to assist reliable system development and simulation. Based on this tool, extensions were developed, aiming for a simulation environment that covers the redundancy use case, allowing to validate the complex interactions under redundant architectures, and supports reliability estimations to compare architecturally redundant designs.  
keywords: {Software design;Redundancy;Prototypes;Computer architecture;Tools;Reliability engineering;Software;reliability design and estimation;co-simulation;QEMU;redundancy},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453486&isnumber=9453463>  
  
S. Amiri, S. Abdi and S. Sharifzadeh, "Simultaneous Multiprocessing on FPGA-CPU Heterogeneous Chips," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 805-809.  
doi: 10.1109/ICIT46573.2021.9453638  
Abstract: Heterogeneous chips integrating different core architectures, including multi-core CPUs and fast-processing FPGAs, are providing a promising solution for running computationally-intensive applications. Schedulers can help assign dataset proportionally to the compute units and hence improve execution performance and/or energy consumption. The emergence of high-level software-defined heterogeneous design tools has made it possible to merge these schedulers into the design environment. In this paper, we introduce and develop two schedulers for parallel execution of applications on heterogeneous platforms. One scheduler is designed to adaptively assign data chunks to CPU cores depending on the throughputs of compute units on an FPGA-CPU chip. This enables balanced execution of an application on the platform. The second scheduler introduced has a simpler design where dataset is processed from two sides by different devices, without requiring the overheads associated with traditional schedulers. The evaluation of these two schedulers using four benchmark applications on a Zynq UltraScale+ ZCU102 device shows that the latter scheduling method can improve throughput by a factor of 1.38. Similar improvement can be observed in energy consumption too.  
keywords: {Energy consumption;Job shop scheduling;Scheduling algorithms;Multicore processing;Pipelines;Benchmark testing;Throughput;scheduling;heterogeneous;parallelisation;throughput;energy;power;FPGA;ARM;SoC;ZCU102},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453638&isnumber=9453463>  
  
B. Wood and A. Azim, "Triton: a Domain Specific Language for Cyber-Physical Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 810-816.  
doi: 10.1109/ICIT46573.2021.9453575  
Abstract: The design of cyber-physical systems is non-trivial, and often filled with tedious, error prone tasks that could be represented in a better way. Engineers often work with low-level languages such as C and C++, real-time operating systems, or straight on the metal under limited hardware constraints which requires engineers to have extensive domain specific knowledge. In this paper, we propose Triton, which is a language focused on increasing abstraction by providing high-level domain-specific features to engineers working on cyber-physical systems and IoT devices through a domain specific language (DSL). We propose dedicated code blocks to handle task scheduling at the language level, with the addition of a constraint system to handle faults, such as erroneous sensor data. Triton integrates with the Remote Method Delegation (RMD) platform to allow the developer to easily offload work to the cloud, in addition to providing native support for publish-subscribe network communications. The Triton prototype has been implemented for the JVM target, allowing for interroperability with other JVM languages and supports execution on any platform with an available JVM. Example code provided shows a clear reduction in boilerplate and a simple case-study shows the effectiveness of the proposed solution when compared with languages traditionally seen in embedded or cyber-physical systems development.  
keywords: {Knowledge engineering;Job shop scheduling;Operating systems;Prototypes;Metals;Publish-subscribe;Cyber-physical systems;domain specific languages;cyber-physical systems;embedded systems;constraints;remote evaluation;internet of things (IoT);cloud},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453575&isnumber=9453463>  
  
E. Díaz Llerena, R. Mateos Gil, J. Pavón Luque and D. Calvo Guillén, "Versatile SoC architecture for integration of HW accelerators in power electronics applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 817-822.  
doi: 10.1109/ICIT46573.2021.9453471  
Abstract: The use of high-level synthesis (HLS) tools for HW implementation of control algorithms has become very popular in power converter applications. This work presents a versatile SoC architecture for integrating HLS-generated HW accelerators in power electronics applications. The novel proposal uses a Hub-based architecture that controls the execution of multiple HW accelerators. The Hub-based architecture provides an improved development, maintainability, scalability, and reusability of HW accelerators compared to the typical monolithic approach. Besides, it offers the possibility to split and parallelize them to achieve a modular design. This architecture has been validated using a real application (battery charger) as a case study. The new proposal does not significantly increase the logic of resource consumption in the FPGA. The case above study also reduces the latency by more than 50% compared with a single monolithic IP used to implement the control algorithm.  
keywords: {Battery chargers;Electron accelerators;Scalability;Tools;Control systems;Power electronics;Proposals;SoC;FPGA;HLS;Power Electronics;HW accelerators;Hub},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453471&isnumber=9453463>  
  
"Signal and Image Processing and Computational Intelligence," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 823-824.  
doi: 10.1109/ICIT46573.2021.9453571  
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Y. Qu, Z. Ma, A. Clausen and B. N. Jørgensen, "A Comprehensive Review on Evolutionary Algorithm Solving Multi-Objective Problems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 825-831.  
doi: 10.1109/ICIT46573.2021.9453636  
Abstract: In the real world, it is challenging to determine optimal solutions over multiple conflicting objectives in complex systems. As a mainstream method for solving multi-objective problems, the development and the application of Evolutionary Algorithm (EA) methods have attracted thousands of researches since the 1950s. However, as we know, there are few studies on the comprehensive review of multi-objective EA (MOEA) methods in general domains. In this review research, firstly, the categories of MOEA methods according to the classification strategy of reproduction operators is proposed. Then, a systematic literature search methodology and logical citation management are introduced in order to create a literature pool for further analysis. On the basis of the literature pool, the categories of MOEA methods concerning three aspects and the application domains are analyzed. The purpose of this review is to provide a comprehensive view and a guide reference for the MOEA method selection on solving a specific type of multi-objective optimization problems (MOPs).  
keywords: {Systematics;Conferences;Bibliographies;Evolutionary computation;Search problems;Complex systems;Optimization;Multi-objective optimization;Evolutionary Algorithm;Literature review;MOEA category},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453636&isnumber=9453463>  
  
S. Sharifzadeh, S. Amiri and S. Abdi, "A New Method for Semi-Supervised Segmentation of Satellite Images," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 832-837.  
doi: 10.1109/ICIT46573.2021.9453700  
Abstract: Satellite image segmentation is an important topic in many domains. This paper introduces a novel semi-supervised image segmentation method for satellite image segmentation. Unlike the semantic segmentation strategies, this method requires only limited labelled data from small local patches of satellite images. Due to the complexity and large number of land cover objects in satellite images, a fixed-size square window is used for feature extraction from 7 different local areas. The local features are extracted by spectral domain analysis. Then, classification is performed based on similarity of the local features to those of the 7 labelled patches. This also allows efficient selection of the suitable window scale. Furthermore, the labeled features remove the need for iterative clustering for decision making about features. The labelled data also allows learning a subspace of transformed features for segmentation of water and green area based on simple thresholding. Comparison of the segmentation results using the proposed strategy compared to unsupervised techniques such as k-means clustering and Superpixel-based Fast Fuzzy C-Means Clustering (SFFCM) shows the superiority of the proposed strategy in terms of content-based segmentation.  
keywords: {Image segmentation;Satellites;Sensitivity;Shape;Semantics;Urban areas;Green products;Satellite Image;unsupervised segmentation;semi-supervised segmentation;formatting;feature clustering},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453700&isnumber=9453463>  
  
T. Ibarra-Pérez, M. Del Rosario Martínez-Blanco, F. Olivera-Domingo, J. M. Ortiz-Rodríguez and J. Gomez-Escribano, "A novel optimization robust design of artificial neural networks to solve the inverse kinematics of a manipulator of 6 DOF," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 838-843.  
doi: 10.1109/ICIT46573.2021.9453701  
Abstract: In the design of neural networks, generally the selection of the structural parameters is chosen through trial and error procedures, consuming large amounts of resources and unavailable time, without guaranteeing the optimal configuration of the parameters that allow obtaining the best performance of the network. In this paper, the robust design methodology of artificial neural networks based on the Taguchi philosophy was used to select the optimal parameters in a back-propagation network architecture to solve the inverse kinematics in a 6 degrees of freedom robotic manipulator. The parameters to optimize were the number of hidden layers, the number of neurons per layer, the learning rate, the momentum, the number of neurons per layer and the size of the training set versus the test set. Allowing to identify all the combinations possible in relation to the number of variables involved by performing a significant number of experiments compared to other methods where they usually run a huge number of experiments. The results obtained allowed to optimize the design parameters and substantially improve the precision of the results, achieving a prediction percentage of 90% with a margin of error less than 5% during the testing stage.  
keywords: {Training;Systematics;Neurons;Training data;Kinematics;Artificial neural networks;Manipulators;artificial neural networks;backpropagation;optimization;robot kinematics},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453701&isnumber=9453463>  
  
U. -S. Suh, T. -W. Kim, D. -H. Kang, K. -M. Lee, W. -S. Ra and T. Kim, "A Robust Passive Target Localization for Substation Inspection of UAV in a GPS-denied Environment," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 844-849.  
doi: 10.1109/ICIT46573.2021.9453470  
Abstract: This paper addresses a conceptual study on a precise passive target localization approach for substation facilities inspection using unmanned aerial vehicle (UAV) under GPS-denied environments. First, a cruciform receiver array that provides the range difference (RD) measurements between a facility (receiver array) and a UAV (transmitter) is devised. Then, to effectively deal with the real-time and accurate localization performance issue, our RD-based target localization problem is reformulated from the viewpoint of the linear least-squares estimation theory, and constrained robust weighted least-squares (C-RWLS) estimation scheme is applied. The proposed method shows excellent location estimates with the help of hard constraints on the geometric relation to the transceivers. Also, it is suitable for real-time implementation due to its linear structure. The reliability of the proposed estimation method is demonstrated through simulations from various points of the UAV.  
keywords: {Location awareness;Uncertain systems;Substations;Transmitters;Receivers;Estimation theory;Inspection;Geometrical constraint;passive target localization;UAV inspections},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453470&isnumber=9453463>  
  
B. -T. Dong and H. -Y. Lin, "An On-board Monitoring System for Driving Fatigue and Distraction Detection," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 850-855.  
doi: 10.1109/ICIT46573.2021.9453676  
Abstract: In the past few decades, it is shown in various studies that driving fatigue or distraction are the main threats of traffic accidents. Thus, the on-board monitoring for driving behaviors is becoming an important component of advanced driver assistance systems (ADAS) for intelligent vehicles. In this paper, we present the techniques to simultaneously detect the fatigue and distracted driving behaviors using vision and learning based approaches. In fatigue driving detection, we use facial features to detect the open/close of eyes, yawning and head posture. The random forest is adopted to analyze the driving conditions. In the distraction detection, the convolutional neural network (CNN) is used to classify various distracted driving behaviors. The experiments are carried out on the PC and embedded hardware platform using public and our own datasets for training and testing. Compared to the previous approaches, the proposed methods provide better results in terms of accuracy and computation time.  
keywords: {Training;Intelligent vehicles;Training data;Fatigue;Real-time systems;Hardware;Monitoring;Fatigue Detection;Distraction Detection;Convolutional Neural Network;Driving Monitoring System},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453676&isnumber=9453463>  
  
S. Frizzi, M. Bouchouicha and E. Moreau, "Comparison of two semantic segmentation databases for smoke detection," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 856-863.  
doi: 10.1109/ICIT46573.2021.9453622  
Abstract: Researchers have found strong correlation between warm summer and the frequency and intensity of fires around the world. Climate models due to global warming tells us that average summer temperature will increase drastically in the next few decades entailing an increase of wildfire. Computer vision is a good tools to detect and locate an incipient fire and prevent a rapid spread of fire destroying huge forest areas as in Australia or Brazil. Smoke is the first clue of an incipient fire that can be detected by a camera to warn firemen to act as quickly as possible. Convolutional neural networks and semantic segmentation can achieve this task by giving location and scale of the fire to firemen. In order to efficiently train this type of network architectures, we need a database composed of many images and corresponding masks. The complexity of the smoke in terms of shape, texture, color and intensity is difficult to segment properly. The diversity of smoke types in the image database is crucial for generalizing prediction in real-world circumstances. Numerous research papers proposed new network architectures for segmenting smoke in visible images spectrum and tested the accuracy of the segmentation on their database. Database that, for the most of the time, was not available. This article deals with comparison of a network performances on two smoke databases and highlight the importance of a rich images database in terms of quality rather than quantity.  
keywords: {Measurement;Image segmentation;Databases;Image databases;Shape;Semantics;Network architecture;database;semantic segmentation;smoke detection;Kappa Cohen coefficient;CNN},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453622&isnumber=9453463>  
  
T. Sander et al., "Detection of Defects on Irregular Structured Surfaces by Image Processing Methods for Feature Extraction," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 864-868.  
doi: 10.1109/ICIT46573.2021.9453646  
Abstract: During the industrial processing of materials for the manufacture of new products, surface defects can quickly occur. In order to achieve high quality without a long time delay, it makes sense to inspect the work pieces so that defective work pieces can be sorted out right at the beginning of the process. At the same time, the evaluation unit should come close the perception of the human eye regarding detection of defects in surfaces. Such defects often manifest themselves by a deviation of the existing structure. The only restriction should be that only matt surfaces should be considered here. Therefore in this work, different classification and image processing algorithms are applied to surface data to identify possible surface damages. For this purpose, the Gabor filter and the FST (Fused Structure and Texture) features generated with it, as well as the salience metric are used on the image processing side. On the classification side, however, deep neural networks, Convolutional Neural Networks (CNN), and autoencoders are used to make a decision. A distinction is also made between training using class labels and without. It turns out later that the salience metric are best performed by CNN. On the other hand, if there is no labeled training data available, a novelty classification can easily be achieved by using autoencoders as well as the salience metric and some filters.  
keywords: {Measurement;Training;Delay effects;Neural networks;Training data;Production;Feature extraction;Image Processing;Defect Detection;wooden surfaces;Machine Learning;Neural Networks},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453646&isnumber=9453463>  
  
S. Lange, D. Schröder, C. Hedayat, H. Kuhn and U. Hilleringmann, "Development of Methods for Coil-Based Localization by Magnetic Fields of Miniaturized Sensor Platforms in Bioprocesses," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 869-874.  
doi: 10.1109/ICIT46573.2021.9453609  
Abstract: In this publication important aspects for the implementation of inductive locating are explained. The miniaturized sensor platform called Sens-o-Spheres is used as an application of this locating method. The sensor platform is applied in bioreactors in order to obtain the environmental parameters, which makes a localization by magnetic fields necessary. Since the properties of magnetic fields in the localization area are very different from the wave characteristics, the principle of inductive localization is investigated in this publication and explained by using electrical equivalent circuit diagrams. Thereby, inductive localization uses the coupling or the mutual inductivities between coils, which is noticeable by an induced voltage. Therefore some properties and procedures are explained to extract the location of Sens-o-Spheres or other industrial sensor platforms from the couplings of the coils. One method calculates the location from an adapted ratio calculation and the other method uses neural networks and stochastic filters to obtain the results. In the end, these results are evaluated and compared.  
keywords: {Location awareness;Coils;Couplings;Nonuniform electric fields;Magnetic separation;Neural networks;Training data;Magnetic Fields;Near Field;Inductive Localization;Neural Networks;Extended Kalman Filter},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453609&isnumber=9453463>  
  
A. Genovese, V. Piuri, F. Rundo, F. Scotti and C. Spampinato, "Driver Attention Assistance by Pedestrian/Cyclist Distance Estimation from a Single RGB Image: A CNN-based Semantic Segmentation Approach," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 875-880.  
doi: 10.1109/ICIT46573.2021.9453567  
Abstract: Automotive companies are investing a relevant amount of resources for designing autonomous driving systems, driver assistance technologies, and systems for assessing the driver's attention. In this context, two important applications consist in processing images of the surrounding environment to respectively separate the different objects in the scene (semantic segmentation) and to estimate their distances. In both applications, methods based on Deep Learning (DL) and Convolutional Neural Networks (CNN) are being increasingly used, considering LiDAR scans or RGB images. However, LiDAR scanners require dedicated sensors, high costs, and post-processing algorithms to estimate a dense depth map or a three-dimensional representation of the surrounding environment. Moreover, current methods in the literature based on RGB images do not consider the combination of semantic segmentation and depth estimation for assessing the distances of specific objects in the scene. In this paper, we propose the first method in the literature able to estimate the distances of pedestrians/cyclists from the vehicle by using only an RGB image and CNNs, without the need for any LiDAR scanner or any device designed for the three-dimensional reconstruction of the scene. We evaluated our approach on a public dataset of RGB images captured in an automotive scenario, with results confirming the feasibility of the proposed method.  
keywords: {Deep learning;Image segmentation;Laser radar;Databases;Semantics;Estimation;Sensors;Deep Learning;CNN;Semantic Segmentation;Driver Attention;LiDAR},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453567&isnumber=9453463>  
  
J. Zumsande, K. -P. Kortmann, T. Ortmaier and M. Wielitzka, "Estimation of Stochastic Time Lags between Data Sources in Distributed Production Facilities Based on Cross-Correlated Signals," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 881-888.  
doi: 10.1109/ICIT46573.2021.9453671  
Abstract: The increasing degree of automation in modern industrial production is accompanied by a growing number of data sources located in the shop floor at the machines and products. Methods of data mining allow to make statements and predictions about the machine processing hidden in heterogeneous data. In condition monitoring, however, large and often indefinite time delays exist between the collected process data and quality measurements at distributed work stations, which make these analyses difficult. In order to estimate the time lags, a probabilistic directed graph can be used. Parameters of such a graph are the sojourn times of the production goods in the stations. To identify these times, cross-correlation and transfer entropy can be applied to signals with known collinearity. To compare the two methods, both simulated and real-world data of an industrial return sand cooler are used. For evaluation, we propose a novel method for image-based time delay distribution measurement in bulk material processing by use of a fluorescent contrast medium. A dependence of the estimation result on the signal's statistic is shown. Nevertheless, without knowledge of the signal model a statement about the magnitude and scattering of the stochastic time delay can be made.  
keywords: {Delay effects;Stochastic processes;Estimation;Distributed databases;Scattering;Fluorescence;Probabilistic logic;Production systems;lagged signals;cross-correlation;transfer entropy;Gaussian processes},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453671&isnumber=9453463>  
  
J. Pettersson and P. Falkman, "Human Movement Direction Prediction using Virtual Reality and Eye Tracking," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 889-894.  
doi: 10.1109/ICIT46573.2021.9453581  
Abstract: One way of potentially improving the use of robots in a collaborative environment is through prediction of human intention that would give the robots insight into how the operators are about to behave. An important part of human behaviour is arm movement and this paper presents a method to predict arm movement based on the operator's eye gaze. A test scenario has been designed in order to gather coordinate based hand movement data in a virtual reality environment. The results shows that the eye gaze data can successfully be used to train an artificial neural network that is able to predict the direction of movement ~500ms ahead of time.  
keywords: {Tracking;Service robots;Robot kinematics;Conferences;Collaboration;Virtual reality;Artificial neural networks;Virtual reality (VR);movement prediction;collaborative robots;human intention prediction;eye tracking},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453581&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453573  
Abstract: This article describes the elaboration of a low-cost system that allows user interaction with VR environments modeled in Unity and viewed through Google Cardboard. The proposed system divides the processing in a client-server architecture in which the VR experience is executed on the client, while it sends pictures captured from the mobile device inside the Card Board to the server. This server processes the hand pose information and sends it to the client.  
keywords: {Solid modeling;Machine vision;Conferences;Pipelines;Neural networks;Virtual environments;Mobile handsets;Neural Networks;Deep Learning;Virtual Reality;Real-time Systems;Image Processing;Pose Detection;Computer Vision},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453573&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453534  
Abstract: Currently, the global health system is suffering from an overwhelming issue affecting a large number of individuals all around the world. The novel coronavirus, called COVID-19, has continued to claim more than one million lives. In such cases, it is of vital importance to develop alternatives addressing this health issue and saving more lives. Artificial Intelligence were among the efficient tools that can address this global threat. In this study, we propose to test a recurrent neural network named Long Short-Term Memory (LSTM-RNN) for estimating the number of future fatality cases in USA, India and Italy. Our experimentations proved the effectiveness of LSTM-RNN in predicting the number of deceased cases with minimum of loss ranging from 1.37% to 2.7%.  
keywords: {COVID-19;Recurrent neural networks;Temperature;Pandemics;Organizations;Humidity;Tools;Artificial Intelligence;LSTM;LightGBM;Forecasting models},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453534&isnumber=9453463>  
  
J. A. Braun Neto, J. L. Lima, A. I. Pereira and P. Costa, "Low-cost 3D LIDAR-based scanning system for small objects," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 907-912.  
doi: 10.1109/ICIT46573.2021.9453657  
Abstract: Three-dimensional scanning is a task that is highly important for our modern society and this is translated by a wide area of knowledge that contains numerous approaches to this task. As this process is non-trivial, most of the technologies are expensive, with even the low-cost ones being a great investment for the regular user. Therefore, this work presents a low-cost LIDAR-based 3D scanning system that can perform 3D scans of small objects and reconstruct their digital STL models. The system consists of one rotating platform and a scanning arc-shaped structure, which both are actuated by stepper motors.  
keywords: {Solid modeling;Three-dimensional displays;Conferences;Task analysis;Investment;3D scanning;LIDAR;digital reconstruction;Simulation;STL},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453657&isnumber=9453463>  
  
Y. Pawar, M. Amayri and N. Bouguila, "Performance Evaluation of Adversarial Learning for Anomaly Detection using Mixture Models," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 913-918.  
doi: 10.1109/ICIT46573.2021.9453513  
Abstract: With the rapid advancement in wireless technology and with the introduction of next-generation 5G-wireless networks, a huge amount of data is generated and transmitted across computer networks worldwide. As a result, we have seen a continuous increase in new network threats and anomalies that creates a significant research challenge to handle the vulnerability along with data integrity, confidentiality, and reliability. More precisely, wireless networks are considered to be highly vulnerable to advanced persistent threat (APT) actors. In this paper, we evaluate an adversarial mechanism for anomaly detection using different statistical mixture models. Indeed, to prevent attacks like data poisoning and evasion from affecting the performance of anomaly detection systems, adversarial learning has proven to be very effective in many research studies. The performance of the mechanism, in which several recently proposed mixture models are integrated, was evaluated using both NSL-KDD and UNSW-NB15 data sets, in terms of accuracy, Detection Rates (DRs), False Positive Rates (FPRs), and computational time.  
keywords: {Performance evaluation;High-speed networks;Computational modeling;Wireless networks;Mixture models;Computer architecture;Reliability;Mixture models;adversarial learning;variational learning;anomaly detection},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453513&isnumber=9453463>  
  
J. Male and U. Martinez-Hernandez, "Recognition of human activity and the state of an assembly task using vision and inertial sensor fusion methods," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 919-924.  
doi: 10.1109/ICIT46573.2021.9453672  
Abstract: Reliable human machine interfaces is key to accomplishing the goals of Industry 4.0. This work proposes the late fusion of a visual recognition and human action recognition (HAR) classifier. Vision is used to recognise the number of screws assembled into a mock part while HAR from body worn Inertial Measurement Units (IMUs) classifies actions done to assemble the part. Convolutional Neural Network (CNN) methods are used in both modes of classification before various late fusion methods are analysed for prediction of a final state estimate. The fusion methods investigated are mean, weighted average, Support Vector Machine (SVM), Bayesian, Artificial Neural Network (ANN) and Long Short Term Memory (LSTM). The results show the LSTM fusion method to perform best, with accuracy of 93% compared to 81% for IMU and 77% for visual sensing. Development of sensor fusion methods such as these is key to reliable Human Machine Interaction (HMI).  
keywords: {Support vector machines;Visualization;Measurement units;Sensor fusion;Network architecture;Reliability;Task analysis},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453672&isnumber=9453463>  
  
K. Li, H. Luo, X. Li and S. Yin, "Recursive Subspace-aided Frequency Estimator Based on the Propagator Method," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 925-930.  
doi: 10.1109/ICIT46573.2021.9453613  
Abstract: In this paper, a subspace-aided frequency estimator is developed using the subspace identification method (SIM) based on a formulated state space model. More importantly, two recursive subspace-aided frequency estimators are proposed for online frequency tracking purpose. The recursive frequency estimators are both realized based on the propagator method (PM), where one estimator updates the propagator using the recursive least squares (RLS) with forgetting factor and the other estimator updates the propagator using the sliding window technique with the forgetting factor. Finally, the performance of the proposed algorithms is demonstrated and illustrated through numerical simulations.  
keywords: {Conferences;Numerical simulation;Frequency estimation;Eigenvalues and eigenfunctions;Numerical models},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453613&isnumber=9453463>  
  
P. Lv, X. Wang and C. Xue, "Research on Automatic Recognition Method of Icon Style," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 931-935.  
doi: 10.1109/ICIT46573.2021.9453509  
Abstract: Icon is an important element in human-computer interaction, and icon style is the most intuitive visual expression of icon design. Aiming at the problem of material classification in the icon style design process, this paper proposes an icon style recognition method based on deep learning. This paper first established the icon style dataset, and then used Visual Geometry Group Network (VGGNet), AlexNet and self-built neural network for training. The results show that the accuracy of the trained icon style recognition model is up to 100%. In addition, convolved features were visualized for explaining the recognition progress. This method can help designers quickly collect and filter a large number of icons of the same type, sequentially improving and accelerating the icon design process.  
keywords: {Training;Deep learning;Human computer interaction;Geometry;Visualization;Image recognition;Filtering;Icon Style;Deep Learning;Human-computer Interaction Interface;Computer Aided Design},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453509&isnumber=9453463>  
  
M. Azam, J. P. Singh and N. Bouguila, "Spatial image segmentation based on Beta-Liouville mixture models and Markov Random Field," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 936-941.  
doi: 10.1109/ICIT46573.2021.9453487  
Abstract: Finite mixture models are one of the most widely used probabilistic methods for image segmentation. In this paper, we propose and investigate a mixture model based on Beta-Liouville distributions, which offers more flexibility than previously proposed models. The proposed approach is based on integration of mixture models with Markov Random Field (MRF) with a novel factor that is induced to reduce noise and illumination in images. The model is learned using Expectation Maximization (EM) algorithm based on Newton-Raphson approach. The proposed approach is compared with mixtures of Gaussian, Dirichlet and generalized Dirichlet distributions with integrated MRF. The experimental results demonstrate that proposed segmentation framework gives better performance and better results as compared to mixtures of Gaussian, Dirichlet and generalized Dirichlet with MRF.  
keywords: {Image segmentation;Databases;Lighting;Mixture models;Probabilistic logic;Object recognition;Noise measurement;Image segmentation;MRF;Beta-Liouville;Dirichlet;Generalized Dirichlet;EM algorithm;Mixture model},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453487&isnumber=9453463>  
  
F. Zoghlami et al., "ToF/Radar early feature-based fusion system for human detection and tracking," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 942-949.  
doi: 10.1109/ICIT46573.2021.9453703  
Abstract: Industry 4.0 has become a general keyword over the last years. It is based on the inclusion of automation by increasing connectivity in various tasks during the production process. This fact did not exclude the human's effort whose presence remains important, especially the interaction between humans and robots will be a key element in the future manufacturing. In automated production lines, we find both humans and robots operating side-by-side in hybrid workplaces. The major focus for this workplaces today and in the future is to establish a safe work environment. However, what if safety meets "collaborative efficiency"? The system presented in this paper relies on the fusion of data coming from a Time of Flight (ToF) sensor and a 60 GHz radar sensor. The data are analyzed and evaluated using deep learning (DL) algorithms. The purpose is to detect humans and track their movements in the observed area. The resulted perception system can be installed somewhere in a room or on a moving system. A first demonstrator has been developed, tested and evaluated. An additional graphical interface was developed to show in real time the capability of the data fusion system. The system can detect up to 5 persons in a selected area with 98% confidentiality. The so-described system is able as well to estimate each person DoM and the person's instantaneous speed and position. Based on the output of our developed system, it is possible to define industrial use cases as well as many other different applications in different fields.  
keywords: {Three-dimensional displays;Tracking;Employment;Radar;Production;Radar tracking;Robot sensing systems;sensor fusion;human/robotic collaboration;deep learning;industry 4.0;machine learning;automated fabrication;radar sensor;time of flight camera},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453703&isnumber=9453463>  
  
Z. Jiang, H. Taira, N. Miyashita and M. Okutomi, "VIO-Aided Structure from Motion Under Challenging Environments," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 950-957.  
doi: 10.1109/ICIT46573.2021.9453630  
Abstract: In this paper, we present a robust and efficient Structure from Motion pipeline for accurate 3D reconstruction under challenging environments by leveraging the camera pose information from a visual-inertial odometry. Specifically, we propose a geometric verification method to filter out mismatches by considering the prior geometric configuration of candidate image pairs. Furthermore, we introduce an efficient and scalable reconstruction approach that relies on batched image registration and robust bundle adjustment, both leveraging the reliable local odometry estimation. Extensive experimental results show that our pipeline performs better than the state-of-the-art SfM approaches in terms of reconstruction accuracy and robustness for challenging sequential image collections.  
keywords: {Visualization;Solid modeling;Three-dimensional displays;Structure from motion;Pipelines;Estimation;Cameras;3D Reconstruction;Structure from Motion;Visual-Inertial Odometry},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453630&isnumber=9453463>  
  
"Industrial Automation, Communication,Networking and Informatics," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 958-960.  
doi: 10.1109/ICIT46573.2021.9453464  
Abstract: Start of the above-titled section of the conference proceedings record.  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453464&isnumber=9453463>  
  
S. Centomo, A. Avogaro, M. Panato, C. Tadiello and F. Fummi, "A Design Methodology of Multi-level Digital Twins," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 961-966.  
doi: 10.1109/ICIT46573.2021.9453523  
Abstract: This paper proposes a design methodology of Digital Twins enabling multi-level simulation of equipment in a manufacturing plant. In this context, the Digital Twin covers a central role where it can perform analysis of the current state of the plant and, more importantly, prediction regarding its future state. This requires the use of complex models for all the nodes that compose the entire production, to obtain a more accurate estimation of future equipment states. Furthermore, most of the commercial tools provided by different vendors do not consider this dimension of the problem and allows to perform simulations of the plant with a very high level of abstraction, or with the use of statistical approximation. On the other hand, several physical process simulators allow to model and simulate single equipment, but without considering the production line perspective. Multi-Level modeling considers different levels of abstraction of the same model, allowing to switch from a model to another. This paper proposes a design flow methodology based on multi-level approach, that allows to obtain a unique environment where physical and production simulators are integrated automatically. The entire design flow is validated with a real use case scenario. The obtained results show different simulation strategies using multi-level approach with different synchronization granularity.  
keywords: {Adaptation models;Design methodology;Digital twin;Production;Switches;Kinematics;Tools;Digital-Twin;Design Methodology;Automatic Generation;Multi-level;Industry 4.0},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453523&isnumber=9453463>  
  
P. Jhunjhunwala, J. O. Blech, A. Zoitl, U. D. Atmojo and V. Vyatkin, "A Design Pattern for Monitoring Adapter Connections in IEC 61499," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 967-972.  
doi: 10.1109/ICIT46573.2021.9453685  
Abstract: Today's software developments are frequently structured into different components with well defined interfaces. IEC 61499 comes with well defined interface mechanisms such as adapters that group data and event exchange between different subsystems. Compliance with interface specifications can be monitored at run-time. In this paper we present a design pattern to monitor adapters thereby observing whether communication specifications are fulfilled. We present an example demonstrating monitoring of a handshaking mechanism used between control application components.  
keywords: {Automation;Conferences;Software;IEC Standards;Monitoring;Component automation architecture;IEC 61499;standard interfaces;monitors},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453685&isnumber=9453463>  
  
S. Wang and J. Zhang, "A Fault Diagnosis Strategy based on Qualitative Trend Analysis Integrating Andrews Plot for Industrial Processes," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 973-978.  
doi: 10.1109/ICIT46573.2021.9453507  
Abstract: This paper proposes an enhanced neural network based fault diagnosis system by integrating Andrews plot and qualitative trend analysis. Andrews plot is used to first extract features from on-line measurements. The extracted features are transformed into qualitative trend forms, which are then fed to a neural network for fault classification. Application to a simulated CSTR process indicates that the proposed method can give more reliable and earlier diagnosis than the traditional neural network based fault diagnosis method.  
keywords: {Fault diagnosis;Conferences;Neural networks;Feature extraction;Market research;Complexity theory;Chemical reactors;Neural Network;Process Monitoring;Fault Diagnosis;Andrews Plot;Trend Analysis},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453507&isnumber=9453463>  
  
C. Lee and S. Lee, "A Practical Deep Reinforcement Learning Approach to Semiconductor Equipment Scheduling," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 979-985.  
doi: 10.1109/ICIT46573.2021.9453533  
Abstract: The efficiency of utilizing semiconductor equipment is critical to maximizing profits. The design work of a semiconductor equipment scheduler becomes a difficult task because it requires efficient operation in various situations. In this paper, we propose an approach based on deep reinforcement learning to overcome the difficulties of scheduling. This new approach designs a scheduler that controls the wafer transport robot inside the equipment. A deep neural network applied with a Q-network is used to calculate the benefit of the robot's motion under various conditions. The experimental results show the feasibility of applying deep reinforcement learning to the equipment scheduler. It also shows that pre-trained models can increase productivity by further learning in a variety of production environments.  
keywords: {Semiconductor device modeling;Training;Productivity;Deep learning;Job shop scheduling;Conferences;Neural networks;semiconductor manufacturing;deep reinforcement learning;deep learning;Q-learning},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453533&isnumber=9453463>  
  
W. Alsabbagh and P. Langendörfer, "A Stealth Program Injection Attack against S7-300 PLCs," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 986-993.  
doi: 10.1109/ICIT46573.2021.9453483  
Abstract: Industrial control systems (ICSs) consist of programmable logic controllers (PLCs) which communicate with an engineering station on one side, and control a certain physical process on the other side. Siemens PLCs, particularly S7-300 controllers, are widely used in industrial systems, and modern critical infrastructures heavily rely on them. But unfortunately, security features are largely absent in such devices or ignored/disabled because security is often at odds with operations. As a consequence of the already reported vulnerabilities, it is possible to leverage PLCs and perhaps even the corporate IT network. In this paper we show that S7-300 PLCs are vulnerable and demonstrate that exploiting the execution process of the logic program running in a PLC is feasible. We discuss a replay attack that compromises the password protected PLCs, then we show how to retrieve the Bytecode from the target and decompile the Bytecode to STL source code. Afterwards we present how to conduct a typical injection attack showing that even a very tiny modification in the code is sufficient to harm the target system. Finally we combine the replay attack with the injection approach to achieve a stronger attack - the stealth program injection attack - which can hide the previous modification by engaging a fake PLC, impersonating the real infected device. For real scenarios, we implemented all our attacks on a real industrial setting using S7-300 PLC. We eventually suggest mitigation approaches to secure systems against such threats.  
keywords: {Conferences;Programmable logic devices;Process control;Critical infrastructure;Security;Password;S7-300 PLCs;Injection Attack;Stealthy Attack;Replay Attack;Fake PLC},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453483&isnumber=9453463>  
  
S. Abilkassov, M. Kairgaliyev, B. Zhakanov and B. Abibullaev, "A System For Drivers’ Cognitive Load Estimation Based On Deep Convolutional Neural Networks and Facial Feature Analysis," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 994-1000.  
doi: 10.1109/ICIT46573.2021.9453521  
Abstract: The driver's cognitive load estimation on the road is a critical factor for safety measurement that can reduce the overall number of road accidents. Factors such as distraction from driving, being "lost in thought," conversation, cell phone use, and drowsiness, can be used to compute a driver's attention level on driving. To minimize the number of fatal and critical circumstances on the road, this work investigates a decision tree-based deep-learning algorithm focusing on the estimation of the driver's cognitive load. We construct and evaluate the performance of multimodal deep learning approaches, which combine two separately trained ResNet50 convolutional neural networks on data acquired from the driver's side and front face images. Further, we compare two different approaches for driver drowsiness level estimation using different computer vision algorithms. The first approach is implemented via the blinking ratio method using 68-landmarks of the face by calculating the blinking and yawning ratio. In contrast, the second one uses the contour area approach for drowsiness identification using morphological operations. As differences between driver behavioral classes are more distinct from side camera images than from the frontal image, the former has been chosen to be used for deep learning classification, and eventually, the accuracy of 92% has been achieved. On the other hand, the frontal image was successfully used to robustly detect the driver's drowsiness level by using computer vision techniques on facial landmarks. As a result, the decision tree was constructed to estimate the driver's driving safety level based on deep learning side posture classification and blinking ratio methods.  
keywords: {Deep learning;Computer vision;Road accidents;Roads;Estimation;Safety;Decision trees},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453521&isnumber=9453463>  
  
J. Tian, Y. Jiang, H. Luo and S. Yin, "Adaptive Boosting Based on Multi-class Neural Networks for IGBT Health Parameter Prediction," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1001-1006.  
doi: 10.1109/ICIT46573.2021.9453695  
Abstract: Insulated gate bipolar transistor (IGBT) has important applications in industrial development. However, the IGBT has a complex integrated structure and works in a harsh environment, so it is prone to fault and therefore causes economic losses. Considering this, it is of great significance to use data-driven fault prediction. The fault prediction of IGBT aging parameters based on device data can avoid complex modeling procedure and the workload, so it has wider applicability. In this paper, an adaptive boosting approach based on a multi-class neural network is proposed to realize the analysis of the fault prediction of the aging parameters of IGBTs. This paper uses the IGBT accelerated aging test data released by NASA for processing. In order to improve the quality of data processing, exponentially weighted moving average (EWMA) and outlier processing are used to preprocess. Various neural network approaches are used for time series prediction. Finally, the adaptive boosting algorithm based on single-class and multi-class neural networks is used to achieve better prediction performance compared to the neural network algorithms. The results show that the adaptive boosting approach to integrating multi-class neural networks has a good prediction performance.  
keywords: {Insulated gate bipolar transistors;Training;Adaptive systems;Simulation;Neural networks;Time series analysis;Boosting;Adaptive boosting;Fault prediction;Neural network;IGBT},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453695&isnumber=9453463>  
  
M. Schüngel, S. Dietrich, L. Leurs, D. Ginthör, S. -P. Chen and M. Kuhn, "Advanced Grandmaster Selection Method for Converged Wired and Wireless Networks," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1007-1014.  
doi: 10.1109/ICIT46573.2021.9453490  
Abstract: In Time-Sensitive Networking the Best Master Clock Algorithm is the specified mechanism for reference time source, i.e. Grandmaster, selection. The Best Master Clock Algorithm was originally designed for wired communication networks and uses a rigid comparison of predetermined clock attributes to select the Grandmaster. It lacks the required consideration of essential network information for Grandmaster selection in converged wired and wireless networks. We propose an Advanced Grandmaster Selection method which, unlike to the Best Master Clock Algorithm, considers sophisticated network information for the Grandmaster selection. The network information is used to model the impact of architectural aspects on the emerging synchronization quality. We found that the proposed method delivers more qualified solutions compared to the Best Master Clock Algorithm under probabilistic network parameterization and is suited for the application in large scale converged wired and wireless networks.  
keywords: {5G mobile communication;Wireless networks;Conferences;Probabilistic logic;Synchronization;Communication networks;3GPP;5G;BMCA;Ethernet;grandmaster;TSN;real-time communication;synchronization;wireless communication},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453490&isnumber=9453463>  
  
F. Gehlhoff, L. Wiegandt and A. Fay, "Agent-Based Decentralised Process Planning and Evolutionary Change Propagation," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1015-1020.  
doi: 10.1109/ICIT46573.2021.9453529  
Abstract: The increasing dynamics of manufacturing systems promote the utilization of decentral system architectures, such as Multi-agent Systems (MAS). These are especially applicable for dynamic systems that exhibit structural and behavioural changes during runtime. This paper develops a MAS that is capable of decentralised process planning that does not require any a priori definition of compatibility or interfaces between machines. Furthermore, the paper outlines how the producibility graph that is derived by the agents during process planning is updated and shared between the agents to keep the knowledge bases of the agents updated at all times.  
keywords: {Adaptation models;Runtime;Conferences;Process planning;Knowledge based systems;Systems architecture;Dynamical systems;Multi-agent System;Decentralised Process Planning;Cooperative Evolution;Change Propagation},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453529&isnumber=9453463>  
  
D. Reguera-Bakhache, I. Garitano, R. Uribeetxeberria and C. Cernuda, "An Industrial HMI Temporal Adaptation based on Operator-Machine Interaction Sequence Similarity," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1021-1026.  
doi: 10.1109/ICIT46573.2021.9453580  
Abstract: The incorporation of Artificial Intelligence (AI) into Industrial Environments has brought about a Smart Industry revolution, improving efficiency and simplifying complex industrial processes. However, these technological advances remain primarily focused on the process, and pay little attention to industrial Human-Machine Interfaces (HMI), the bridge between the operator and the industrial process.Current industrial HMIs have a static design, and are focused exclusively on the control and visualization of process information. They fail to take into account user behaviour and skills, information key to understanding how the operator interacts with the production process. Thus, the potential beneficial outcomes of considering operator-machine interaction in terms of efficiency and productivity, make a compelling case for industrial HMIs that can adapt to different operators based on their skills and process knowledge.This paper proposes a Machine Learning (ML) based method-ology capable of analysing operator-machine interaction and detecting the variability of interaction patterns for repetitive similar sequences in monitoring and control tasks. The method-ology generates a set of adaptation rules that improve Usability and User Experience, and hence operator working performance. To validate the proposed methodology, an experiment with real operators was conducted.  
keywords: {Productivity;Industries;Visualization;Process control;Machine learning;User experience;Usability;Industrial HMI;Adaptive Interfaces;Sequence Similarity;Interaction Patterns},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453580&isnumber=9453463>  
  
G. Schneider, S. Keil and F. Lindner, "Benefits of Digitalization for Business Processes in Semiconductor Manufacturing," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1027-1033.  
doi: 10.1109/ICIT46573.2021.9453611  
Abstract: The global semiconductor industry is increasingly transforming manufacturing to highly automated and digitized processes. Various novel technologies based on the Internet of Things (IoT) that allow competitive advantages in the European industry emerged thanks to the advancements of digitization and its possibilities supporting the development processes within the semiconductor industry. Digitization, virtualization, digital twins and simulation applications offer the opportunity to create a smart fabrication facility. In this paper, three use cases applying new digitization technologies at the semiconductor front-end facility of Infineon Technologies Dresden supporting the digital transformation in important business processes of the factory are presented. The wafer facilities are already highly automated with respect to the material flows using hundreds of robotics, so that digitization is the next consequent step to improve the performance of the business and speed up processes within the company, especially with the help of digital twins. Besides fabrication automation using only simple robotics for tool loading and unloading, digitization of repetitive, administrative processes implies very high potentials to enhance the competitiveness of a fabrication facility or even a whole fabrication network, not only technically but also in terms of human factors.  
keywords: {Fabrication;Semiconductor device modeling;Digital twin;Electronics industry;Tools;Production facilities;Internet of Things;digitization;digital twin;blockchain;virtual fabrication facility},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453611&isnumber=9453463>  
  
B. Rupprecht, E. Trunzer, S. König and B. Vogel-Heuser, "Concepts for Retrofitting Industrial Programmable Logic Controllers for Industrie 4.0 Scenarios," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1034-1041.  
doi: 10.1109/ICIT46573.2021.9453558  
Abstract: In the course of the fourth industrial revolution, companies are facing considerable challenges, such as retrofitting and integrating existing, mission-critical automated production systems (aPS) into new interconnected environments. To integrate the production data from aPS and to make it available for data analysis and plant monitoring, relevant data from the programmable logic controller (PLC) of each aPS needs to be accessed and forwarded. These PLCs, at a first priority, control the production plants and ensure reliable production. Due to the long life-cycles of aPS of around 30 years, a huge number of legacy PLCs with limited processing and communication capabilities exists in the field. Therefore, retrofitting concepts that aim to allow access to PLC data need to account for this special, mission-critical role of PLCs. In the context of PLC retrofitting approaches, research currently addresses two domains: on the one hand, abstract Industrie 4.0 architectures are proposed that lack of implementation details. On the other hand, specific retrofitting concepts are presented, which are usually not transferable to other application purposes. Hence, this work aims to fill this gap by deriving generally applicable retrofitting strategies for legacy PLCs for data collection. Five technology-neutral retrofitting concepts based on industrially relevant use-cases were proposed. Three concepts were substantiated on an exemplary basis and their validity shown within a proof-of-concept. Altogether, this work can act as a guideline for retrofitting automation technology to facilitate the integration of legacy systems in Industrie 4.0 scenarios.  
keywords: {Industries;Production systems;Protocols;Scalability;Programmable logic devices;Mission critical systems;Companies;Cyber-Physical Systems of Systems;Data Collection;Industrial Internet of Things;Industry 4.0;Programmable Logic Controller (PLC);PLC Retrofitting},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453558&isnumber=9453463>  
  
H. Xu, X. Jin, Q. Jin, K. Luo and W. Han, "Cooperative Jamming Attack Strategy against Power Balance of Wireless Smart Grid Networks," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1042-1047.  
doi: 10.1109/ICIT46573.2021.9453576  
Abstract: Wireless based smart grid networks are widely applied due to its features of efficiency and agility to the power system. However, it is also vulnerable to malicious attacks via the communication channels, which has a great impact on stability of the whole power system. In this paper, a cooperative jamming attack strategy is proposed, in which a team of mobile attackers is tasked to jam the power price signals sent by the control center to power users, and halt jamming operation when the true price value monitored by attackers has been varied noticeably. Based on a dynamic coverage control scheme, attackers optimally coordinate their motion and continually disrupt wireless communication channels between power users and the control center during each jamming operation period. It ensures that the instantaneous imbalance of generated power and consumed power at the control center is gradually up to a maximum level when the true price is updated by local unit of each power user. The effect of such an attack is also discussed analytically. Simulation results are provided to validate the effectiveness of the proposed method.  
keywords: {Wireless communication;Heuristic algorithms;Power system dynamics;Dynamics;Power system stability;Stability analysis;Smart grids;Jamming attack;cyber security;smart gird networks;coverage control;power balance},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453576&isnumber=9453463>  
  
M. S. Abdul Hameed, M. M. Khan and A. Schwung, "Curiosity Based RL on Robot Manufacturing Cell," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1048-1053.  
doi: 10.1109/ICIT46573.2021.9453577  
Abstract: This paper introduces a novel combination of scheduling control on a flexible robot manufacturing cell with curiosity based RL. Reinforcement learning has proved to be highly successful in solving tasks like robotics and scheduling. But this requires hand tuning of rewards in problem domains like robotics and scheduling even where the solution is not obvious. To this end, we apply a curiosity based reinforcement learning, using intrinsic motivation as a form of reward, on a flexible robot manufacturing cell to alleviate this problem. Further, the learning agents are embedded into the transportation robots to enable a generalized learning solution that can be applied to a variety of environments. In the first approach, the curiosity based reinforcement learning is applied to a simple structured robot manufacturing cell. And in the second approach, the same algorithm is applied to a graph structured robot manufacturing cell. Results from the experiments show that the agents are able to solve both the environments with the ability to transfer the curiosity module directly from one environment to another. We conclude that curiosity based learning on scheduling tasks provide a viable alternative to the reward shaped reinforcement learning traditionally used.  
keywords: {Job shop scheduling;Service robots;Microprocessors;Transportation;Computer architecture;Reinforcement learning;Production;reinforcement learning;manufacturing cell;curiosity based learning;planning robots},  
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P. Kajola, J. O. Blech, U. Dwi Atmojo and V. Vyatkin, "Dynamic Adapter Connections for IEC 61499," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1054-1059.  
doi: 10.1109/ICIT46573.2021.9453625  
Abstract: We present work on dynamic adapter connections for IEC 61499. Adapters in IEC 61499 simplify programs by encapsulating different event and data connections. Traditionally the plug and sockets are determined at design time of a system. In contrast, dynamic adapter connections do not statically link subsystems at design time, but allow to exchange interacting subsystems at runtime by retargeting plugs and sockets. This paper presents the dynamic adapter connection concept. In addition, we present an implementation concept based on OPC UA and an example.  
keywords: {Temperature sensors;Runtime;Sockets;Tools;Manufacturing;Object recognition;IEC Standards},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453625&isnumber=9453463>  
  
M. Mayrhofer, C. Mayr-Dorn, O. Guiza and A. Egyed, "Dynamically Wiring CPPS Software Architectures," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1060-1067.  
doi: 10.1109/ICIT46573.2021.9453697  
Abstract: Modern cyber-physical production systems require a software-intensive integration at the shopfloor, such as machines, transport systems, worker assistance systems, and robots. Alongside the interaction of participants at the physical level exists another level of interactions at the software level: the distributed software architecture of the cyber-physical production system (CPPS). Contemporary CPPSs require frequent changes in communication paths and the signals communicated (i.e., rewiring) to flexibly adapt to changing production needs and environmental conditions. The integration of shopfloor participants and their wiring, hence, becomes a critical aspect of a dynamically adaptable production system. Here, incomplete and incorrect wiring is a major source of errors. To this end, this paper presents a light weight approach for wiring shopfloor participants that utilizes decentralized wiring information to extract/recover the distributed software architecture of the CPPS. We demonstrate the feasibility of our approach on a lab-scale production cell model.  
keywords: {Wiring;Production systems;Software architecture;Microprocessors;Unified modeling language;Computer architecture;Software;software architecture;reconfiguration;cyber-physical production systems;adaptability;OPC UA},  
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J. Haxhibeqiri, X. Jiao, M. Aslam, I. Moerman and J. Hoebeke, "Enabling TSN over IEEE 802.11: Low-overhead Time Synchronization for Wi-Fi Clients," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1068-1073.  
doi: 10.1109/ICIT46573.2021.9453686  
Abstract: The ever-increasing need for real-time communication of factory processes in one hand, and the offered flexibility of wireless communication on the other, is pushing Time Sensitive Networking (TSN) evolution towards the wireless networks. By definition, wireless networks are non-deterministic due to their random channel access mechanism. In order to introduce TSN vision to the wireless world, such randomness needs to be controlled. In this paper, we implement a low-overhead beacon-based time synchronization mechanism that offers synchronization accuracy of as low as 10 μs, on average, for low beacon interval. Such accuracy is achieved by implementing a follow-up beacon packet, in addition to beacon mechanism itself, in order to account for any delays in sending beacons. The synchronization mechanism is tested in different intra and inter access point communication settings.  
keywords: {Wireless sensor networks;Job shop scheduling;Wireless networks;Physical layer;Real-time systems;Production facilities;Delays;TSN;time synchronization;WiFi;beacon based},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453686&isnumber=9453463>  
  
D. A. Howard, Z. Ma and B. N. Jørgensen, "Evaluation of Industrial Energy Flexibility Potential: A Scoping Review," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1074-1079.  
doi: 10.1109/ICIT46573.2021.9453652  
Abstract: It is vital to conduct the evaluation of industrial energy flexibility potential to provide knowledge to relevant market players about the energy potential with economic gain through unlocking flexibility. This paper applies a scoping review methodology and presents the findings for uncovering industrial energy flexibility. The scoping review was conducted in the last quarter of 2019, and 855 publications were found through related databases. Through a systematic quantitative and qualitative review, 26 essential publications fulfill the criteria. The result indicates that the field of evaluating the potential of industrial energy flexibility is matured with an increasing research interest. Meanwhile, the results reveal a tendency to focus on evaluating the potentials in a single process within the industrial facility. Furthermore, the result indicates that optimization is the main evaluation method. Based on the scoping review analysis and results, it was found that there is a gap between the evaluation of energy flexibility and the impact on the production flow. Hence, there is a need to focus on solutions that promote a holistic view of the production flow. Through holistic solutions, it is possible to access to which extent introducing energy flexibility measures may propagate through the production system. This can be achieved through simulation-based solutions that also promote solution validation.  
keywords: {Industries;Economics;Production systems;Systematics;Databases;Energy measurement;Industrial facilities;Industrial;Energy;Flexibility;Scoping Review},  
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M. Gundall, C. Glas and H. D. Schotten, "Feasibility Study on Virtual Process Controllers as Basis for Future Industrial Automation Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1080-1087.  
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Abstract: Industry 4.0 offers many possibilities for creating highly efficient and flexible manufacturing. To create such advantages, highly automated and thus digitized processes and systems are required. Here, most technologies known from the office floor are basically suitable for these tasks, but cannot meet the high demands of industrial use cases. Therefore, they cannot replace industrial technologies and devices that have performed well over decades “out of the box”. For this reason, many technologies known from the office floor are being investigated and adapted for industrial environments. An important task is the virtualization of process controls, as more and more devices use computation offloading, e.g. due to limited resources. In this paper we extend the work on our novel architecture that enables numerous use cases and meets industrial requirements by virtualizing process controllers. In addition, a testbed based on a factory scenario is proposed to evaluate the most important features of the presented architecture.  
keywords: {Performance evaluation;Industries;Process control;Computer architecture;Production facilities;Internet;Task analysis;Industry 4.0;Smart Manufacturing;Industrial Internet of Things;Virtualized Process Controller;Reconfiguration;Redeployment;Resilience},  
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T. Shimura, R. Tasaki, H. Sasatake, T. Yamashita and M. Fujimoto, "Flexible Tool Manipulation for High-Accuracy Removal Processing of Unknown Shape Convex parts," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1088-1093.  
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Abstract: The occurrence of convex part on metal surface of the product during casting is unpreventable. The purpose of this research is to propose a robot manipulation algorithm with a feedback control system for automatic removal of convex parts, which consists of a tool tip reaction force and a position feedback control, instead of manual removal as done by craftsmen. Removal experiments are carried out to identify the appropriate value of each of the parameters used in the proposed feedback control system. It is shown that better removal time and high-quality surface can be achieved by applying the proposed feedback control in the removal process of convex parts. Besides, sufficient machining performance obtained from the removal processing experiment of convex part of different shape proves that the proposed method is effective on convex parts of unknown shape. In addition, the generality of this system is proven by applying desired reaction force as reference input to the proposed feedback controller s not only to S50C but also to several metal materials such as SUS303, ANP79 and C2801P.  
keywords: {Shape;Service robots;Force;Metals;Process control;Machining;Tools;removal process;reaction force control;tip position feedback;unknown shape},  
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doi: 10.1109/ICIT46573.2021.9453492  
Abstract: Automation of gravity die casting can be achieved by Numerical Controls (NC). However, NCs are not inherently capable to control every process, but rather have to be extended accordingly. In this paper, we show how a Numerical Control can be extended by a process model for the gravity die casting process. The extension enables either flow rates or machine axes positions to be passed to the NC. Then the NC interpolates those values and they are either fed directly to the machine axes or, when the casting process is running, processed further. We define some more functions for process safety. The implemented behavior is tested with dedicated tests and test software. First results confirm that the presented concept for model integration is valid.  
keywords: {Automation;Conferences;Process control;Software;Numerical models;Safety;Die casting},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453492&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453596  
Abstract: Industrial robots are a technology which is highly present in industry and can perform several tasks, namely machining activities. Different than CNC machines, which work with G-code and have available several software applications to generate the machine code, there is a lack of software for robotic arms, in addition to each application depending on its own language and software. This work studied a way to use different robotic arms for 3D part machining processes, to perform 3D objects reconstruction obtained through a low-cost 3D scanner. Dealing with the 3D reconstruction by integrating 3D acquisition and robotic milling with software available on the market, this paper presents a system that acquires and reconstructs a 3D object, in order to seek greater flexibility with lower initial investments and checking the applicability of robot arm in these tasks. For this, a 3D object is scanned and imported to a CAD/CAM software, to generate the machining toolpath, and a software application is used to convert the G-code into robot code. Several experiments were performed, using an ABB IRB 2600 robot arm, and the results of the machining process allowed to validate the G-code conversion and milling process using robotic arms, according to the proposed methodology.  
keywords: {Solid modeling;Three-dimensional displays;Service robots;Milling;Manipulators;Robot sensing systems;Software;Flexible manufacturing systems;Reconstruction of 3D objects;3D scanning;Skanect;CAM software;Fusion 360;RoboDK;Industrial robots in machining tasks},  
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T. Robert Doebbert, D. Krush, C. Cammin, J. Jockram, R. Heynicke and G. Scholl, "IO-Link Wireless Device Cryptographic Performance and Energy Efficiency," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1106-1112.  
doi: 10.1109/ICIT46573.2021.9453590  
Abstract: In the context of the Industry 4.0 initiative, Cyber-Physical Production Systems (CPPS) or Cyber Manufacturing Systems (CMS) can be characterized as advanced networked mechatronic production systems gaining their added value by interaction with different systems using advanced communication technologies. Appropriate wired and wireless communication technologies and standards need to add timing in combination with security concepts to realize the potential improvements in the production process. One of these standards is IO-Link Wireless, which is used for sensor/actuator network operation. In this paper cryptographic performance and energy efficiency of an IO-Link Wireless Device are analyzed. The power consumption and the influence of the cryptographic operations on the trans-mission timing of the IO-Link Wireless protocol are exemplary measured employing a Phytec module based on a CC2650 system-on-chip (SoC) radio transceiver [2]. Confidentiality is considered in combination with the cryptographic performance as well as the energy efficiency. Different cryptographic algorithms are evaluated using the on chip hardware accelerator compared to a cryptographic software implementation.  
keywords: {Wireless communication;Performance evaluation;Wireless sensor networks;Software algorithms;Energy efficiency;Timing;System-on-chip;IO-Link Wireless;Wireless Security;Industrial Wireless Networks;Wireless Sensor Networks;Energy Efficiency},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453590&isnumber=9453463>  
  
N. Fernando Arévalo, C. A. M. Piolo, J. Arens, A. Schwung and M. Hermes, "Knowledge Internalization using Virtual Training on the HoloLens," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1113-1118.  
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Abstract: With the growing complexity of processes in factories, expert knowledge is considered a very valuable asset to have. Expert knowledge is, however, difficult to obtain and to teach. This process requires time, practice and experience from experts, who have obtained it throughout the years. Fortunately, with the rapid technological advancements, many options can help assist with this problem. One of the prominent technologies that companies have been implementing is augmented reality. Since the use of augmented reality as a learning tool is still new, there are many questions about its plausibility and effectiveness. This paper aims to assist in the task of knowledge internalization using augmented reality. This paper proposes a methodology to extract knowledge through the use of questionnaires and pFMEA, as well as its further implementation into the HoloLens. Tests were performed to demonstrate the effectiveness of this approach.  
keywords: {Training;Fault detection;Conferences;Machine learning;Tools;Production facilities;Complexity theory;Knowledge Internalization;pFMEA;HoloLens;Knowledge Validation;Knowledge Transfer},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453603&isnumber=9453463>  
  
C. Yu and X. Chen, "Leader-Follower Formation for UAVs with FOVs Constraint," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1119-1124.  
doi: 10.1109/ICIT46573.2021.9453704  
Abstract: Unmanned Aerial Vehicles (UAVs) with stereo cameras are usually utilized to serve in many engineering applications. Multi-UAVs in formation is an effective way to deal with the complicated industrial tasks, for example visual monitoring, to compensate the limitation of field of view (FOV) of the onboard camera of single UAV. In this paper, a leader-follower UAVs system of which the FOVs of onboard cameras are required to always being overlapped during the flight is proposed to solve the visual monitoring problem. Under this scenario, the images captured by onboard cameras have overlaps such that the entire scene of the environment could be reconstructed via image mosaic technique. To guarantee the visibility constraint, the cost functions related to the relative states of UAVs and then the gradient descent controllers are designed. And at last, a simulation example is given to demonstrate the effectiveness of the proposed algorithm.  
keywords: {Visualization;Conferences;Cameras;Cost function;Unmanned aerial vehicles;Task analysis;Monitoring;Leader-Follower UAVs Formation;FOVs Constraint;Gradient Decent Controller},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453704&isnumber=9453463>  
  
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Abstract: We report on multi-month experiments of a LoRa network deployed in a chemical plant. Using measurement data of nodes distributed (i) inside a building and (ii) over multiple buildings, all sending to a gateway, we estimate the path loss and fading characteristics of the links. Although we operate the system in a harsh environment according to these measurements-with a path loss exponent up to 5.1 and Nakagami fading with m as low as 0.7-the packet loss rate is low for in-building links (2.5% on the average), demonstrating LoRa's suitability for certain industrial applications.  
keywords: {Fading channels;Nakagami distribution;Wireless sensor networks;Buildings;Logic gates;Sensor phenomena and characterization;Propagation losses;industrial sensor networks;LoRa;LoRaWAN;path loss;fading},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453474&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453586  
Abstract: New production architectures and the Time Sensitive Networking extensions of the Ethernet standard enable larger real-time networks with more participants than before. Due to the guaranteed response times of real-time applications, there are limitations in rescheduling. This paper presents operations which allow modification of the schedule of a time-division multiple access (TDMA) real-time network without affecting its proper functionality. For this purpose, both the communication and the involved real-time applications are considered. This allows the active schedule to be modified during the rescheduling. Therefore, failed rescheduling due to fragmentation is less likely.  
keywords: {Schedules;Time division multiple access;Job shop scheduling;Network topology;Production;Jitter;Real-time systems;real-time production network scheduling;communication systems;rescheduling;non-disruptive modification},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453586&isnumber=9453463>  
  
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doi: 10.1109/ICIT46573.2021.9453606  
Abstract: This paper presents a novel approach for modeling the energy consumption of the coupled parallel moulding sand mixers of a foundry as an optimal control problem. The minimization of energy consumption is optimized by scheduling the mixing processes in a linear integer programming scheme. The sand flow through the foundry&#x2019;s sand preparation is characterized by a physical model. This model considers the sand demand of the moulding machine as disturbance, the stored sand masses in the mixer hoppers and machine hoppers, respectively. The novel approach of handling dwell-times for dosing, mixing and transport processes using dead-time systems and constraint pushing allows the application of a linear model. The formulation of the optimal control problem aims at real-time application as model predictive control at the production plant. Initial application results indicate an improvement in energy consumption of approximately 8 %.  
keywords: {Integer programming;Energy consumption;Adaptation models;Computational modeling;Optimal control;Production;Switches;model predictive control;linear integer programming;scheduling;dwell-time;constraint pushing;soft constraint;batch-wise parallel process;foundry},  
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doi: 10.1109/ICIT46573.2021.9453670  
Abstract: This paper introduces RVAF, a runtime verification (RV) extension of the Arrowhead Framework (AF) with container-based service-deployment and runtime-enforcement of a desired quality of service (QoS). AF is a service-oriented middleware architecture for IoT-applications, consisting of a set of core and auxiliary services and systems, respectively. The QoS manager (QoSM) is one AF's most important auxiliary systems, which can be used to guarantee the application's QoS for a wide set of parameters. In RVAF the QoS offered to a particular IoT-application is specified in signal temporal logic, and is continuously monitored by the RVAF-QoSM. In case of an imminent violation, RVAF automatically initiates a container-based reconfiguration, which is ensured to maintain the desired QoS. RVAF is beneficial to large IoT-applications, where the use of continuous-integration and continuous-deployment tools, is not only a recommended practice but also a necessity. Moreover, the use of RVAF is advantageous both during the development of an IoT application, and after its deployment. We describe the architecture of RVAF, provide its formal underpinning, and demonstrate the usefulness of RVAF supported by an industrial IoT application. The main contribution of this work is to show what it takes to incorporate RV concepts into modern SOA frameworks supporting the development of IoT applications.  
keywords: {Runtime;Quality of service;Computer architecture;Tools;Real-time systems;Service-oriented architecture;Internet of Things},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453670&isnumber=9453463>  
  
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Abstract: More and more mobile robots are used within modern production facilities. The interconnection of these robots and their connection to other systems is a major focus, when looking at trends like Industry 4.0. However, industrial environments are very challenging for any communications network, that utilizes wireless transmissions. High mobility, changing propagation channels, interference and highly utilized bandwidth are common occurrences. The dissemination of real-time alarm messages to mobile clients of an industrial network is a challenging use case under these circumstances.The often requested real-time guarantee for message delivery cannot be given in such a dynamic and unpredictable environment. Real-Time Alarm Dissemination System (RTADS) is implemented, which offers the following compromise: It can either transmit the message within a guaranteed time-slot or, inform the receiver, that the real-time connection is lost within the same time-slot. The system is additionally able to implement such connection in complex multi-hop networks with minimal impact on other communication.The RTADS was implemented and tested in different environments. Successful alarm transmissions within 100ms for up to 10 re-transmissions/relays were observed.  
keywords: {Service robots;Wireless networks;Wireless mesh networks;Spread spectrum communication;Tools;Real-time systems;Production facilities;Wireless Real-Time Communication;Continuous Network Monitoring;Multi-Hop Communication;Alarm Transmission},  
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Abstract: Cyber-Physical Systems (CPS) is a key concept in Industry 4.0, acting as a backbone to develop smart processes, machines and products. Multi-Agent Systems (MAS) is a suitable paradigm for the realization of such industrial CPS systems, supporting the distribution of intelligence and decision-making capabilities among a network of autonomous and cooperative agents. Standardization is a key factor for the acceptance of industrial CPS and agent-based systems, assuming a critical role in establishing specifications for the hardware integration, which is an important requirement for industrial agents. This paper focuses on the recently established IEEE 2660.1-2020 standard that defines a recommended practice to solve the interface problem when applying industrial agents, namely integrating intelligent software agents with low-level automation devices in the CPS context. The paper illustrates the applicability of the standard in three different application scenarios related to power and energy systems, factory automation and building automation, and discusses future directions in terms of standardization in the field of industrial agents, that are required for its wider adoption in the realization of industrial CPS solutions.  
keywords: {Conferences;Decision making;Cyber-physical systems;Software agents;Hardware;Standards;Manufacturing automation},  
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Abstract: Consensus-based economic dispatch problem (EDP) is an important distributed optimization problem in power monitoring system, which aims to minimize the total generation cost by controlling local generation units in a distributed way. Due to the vulnerability of distributed algorithm, designing resilient algorithms to ensure the normal operation of power monitoring system under cyber-attacks is of both theoretical merits and practical values. Most existing works are confined to undirected power networks and require the assumption that the tolerable number of attacks is known to all unattacked nodes. In this paper, we relax this assumption and investigate the problem for more general directed networks. A greedy algorithm is designed to obtain the directed connected dominating set as the secure area of network. Then, a resilient consensus-based economic dispatch (RCED) algorithm is proposed to ensure the solvability of EDP under adversarial attacks. Consequently, all the attacked nodes are detected, and the remaining unattacked nodes can reach the optimal solution under a new EDP, in which the incremental cost and total generation cost are decreased. Comprehensive theoretical analysis and simulations are provided to illustrate the effectiveness of the proposed algorithm.  
keywords: {Economics;Greedy algorithms;Simulation;Conferences;Reliability;Security;Distributed algorithms},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453687&isnumber=9453463>  
  
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Abstract: We present work on structuring robotics simulation scenarios into components. Components can comprise simulation entities with a physical counterpart such as automated guided vehicles, drones, robots and machines. Components are typically further structured into sub-components, e.g., a robot arm or a gripper, and can be used to build digital twins. Different aspects for classifying components can be distinguished; here we concentrate on composability, performance and fidelity.In this paper, we are mainly concerned with components in the robotics simulation tool Gazebo used with Robot Operating System. Several structured scenario case studies are described. We investigate how these scenarios behave in Gazebo with respect to performance and fidelity for selected cases.  
keywords: {Operating systems;Digital twin;Conferences;Tools;Manipulators;Real-time systems;Delays},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453594&isnumber=9453463>  
  
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Abstract: The water distribution network is one of the fundamental and expensive infrastructures to sustain the urban life. The aging of these infrastructures and pipe deterioration are becoming major issues to tackle as it leads to massive water loss and environmental adversities. To combat the aforementioned issues, the water municipalities have included condition assessment programs to assess the internal condition of the pipelines. The assessment is usually carried out through the in-pipe inspection device with closed-circuit television (CCTV) system to videotape inside the pipelines. However, the in-pipe inspection device faces challenges to navigate through the butterfly valves inside the pipelines. This impedes the videotaping process and disrupts the condition assessment process as well. Hence, this paper proposes a smart valve detection system to detect valves in real-time by adopting NASNet architecture combined with a Faster R-CNN object detector. The experimental results from the proposed system show that the integration of valve detection into the in-pipe inspection tool can help the device to enable the control mechanism and navigate through the butterfly valves and also, aid in the efficient management of the water infrastructure.  
keywords: {TV;Navigation;Pipelines;Distribution networks;Detectors;Inspection;Tools;smart infrastructure;asset management;deep neural network;valve detection;water pipeline},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453541&isnumber=9453463>  
  
J. Tu, Q. Xu, L. Xu and C. Chen, "SSL-SP: A Semi-Supervised-Learning-Based Stream Partitioning Method for Scale Iterated Scheduling in Time-Sensitive Networks," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1182-1187.  
doi: 10.1109/ICIT46573.2021.9453599  
Abstract: The demands of reliable and real-time communication in industrial automation systems drive growing attention on Time-Sensitive Networks (TSNs) due to its guarantee of low latency and deterministic transmission. Current works explore iterated scheduling of time-triggered (TT) streams in TSNs mainly by random stream partitioning and graph-based stream partitioning. However, random partitioning obtains limited performance, while the edge weights of graph-based partitioning heavily depend on prior domain knowledge. In this article, we propose a semi-supervised-learning-based stream partitioning (SSL-SP) method for scale iterated scheduling of TT streams in TSNs. SSL-SP automatically discovers stream dependence and clusters streams of similar representation. Besides, we design an evaluation metric for TT stream relevance with no requirements on prior knowledge. Furthermore, we construct a low-rank representation of each stream by sparse encoding. A T2S2 dataset on time-triggered stream scheduling is constructed as a comparison benchmark. Simulations demonstrate that SSL-LP achieves the best schedulability rate (86.6%) compared with the state-of-the-art stream partitioning methods.  
keywords: {Measurement;Job shop scheduling;Automation;Conferences;Benchmark testing;Routing;Encoding;iterated scheduling;stream partitioning;semi-supervised learning;Time-Sensitive Networks},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453599&isnumber=9453463>  
  
A. Prabhakara, B. Steinwender and W. Elmenreich, "Statistical analysis of execution time profile for temporal validation of a distributed hard real-time system," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1188-1192.  
doi: 10.1109/ICIT46573.2021.9453493  
Abstract: This paper addresses modelling and assessing of worst-case execution times of tasks in a distributed real-time system. The presented case study is based on a stress test system for power semiconductors. Typical distributed systems involve inherent inter-dependencies that have to be handled with minimized delays. Studying the computing task's timing behavior becomes necessary to understand the timing violations. Modelling the temporal behaviour of the system using probabilistic Worst-Case Execution Time (WCET) analysis aids to overcome the timing faults. This paper focuses on (1) the study of the temporal behaviour through the execution time profile of the distributed hard real-time system; (2) the statistical analysis by performing probability distribution modelling on the measured data. Measurement-based probabilistic timing analysis is an emerging and reliable method used to arrive at industry quality estimates. This method is used here in the paper to carry out temporal validation of the real-time computing tasks on our case study.  
keywords: {Semiconductor device measurement;Analytical models;Statistical analysis;Computational modeling;Probabilistic logic;Real-time systems;Data models;Real-Time Distributed System;Timing Failure;WCET Analysis;Measurement-based Probabilistic Timing Anal-ysis;Statistical Analysis;Probability Distribution;Fault-Tolerant System},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453493&isnumber=9453463>  
  
D. Ginthör, M. -T. Suer, M. Schüngel, R. Guillaume and H. D. Schotten, "Survival Time-aware Dynamic Multi-connectivity for Industrial Control Applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1193-1199.  
doi: 10.1109/ICIT46573.2021.9453498  
Abstract: Achieving high reliability while maintaining low-latency is one key challenge to make wireless technologies suitable for critical applications in the industrial domain. In 5G, multi-connectivity (MC) in combination with packet duplication (PD) has been identified as a viable solution to meet the stringent reliability requirements. However, this approach can quickly lead to an inefficient usage of scarce radio resources. We present a dynamic PD model tailored for deterministic control applications with known survival times. Based on the risk of exceeding the survival time, our model controls redundancy efficiently on demand. We validate our model via system-level simulation and analyze the effectiveness of MC under correlated slow fading channels. The results reveal that with our proposed dynamic scheme, we are able to achieve outages very close to standard PD while only utilizing approximately 50% the radio resources in comparison.  
keywords: {Wireless communication;Analytical models;Industrial control;Redundancy;Probability;Production facilities;Power system reliability},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453498&isnumber=9453463>  
  
S. Gao, H. Wang and C. Xue, "The Effects of Brightness Difference on Visual Perception of Characters," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1200-1204.  
doi: 10.1109/ICIT46573.2021.9453647  
Abstract: The visual perception of characters depends on the color contrast difference between the foreground and the background. In the human-machine interface, the black characters on a white background or white characters on a black background are the most commonly used color combinations. However, with the increase in the amount of information and the requirement of information layering, interface elements need to be presented through multiple foregrounds and backgrounds. Therefore, it is significant to ensure the overall optimization of multiple information in the human-machine interface. The study was conducted from the perspective of brightness and aimed to explore the influence of color combinations between characters and backgrounds on visual perception from the dimensions of polarity, background, and brightness difference. By analyzing the comparison time and accuracy in the visual comparison experiment, the study found that black background had shorter comparison time and better visual performance than grey and white backgrounds on the whole. Besides, visual perception of negative polarity was better than positive polarity. Furthermore, the layering of visual perception at different brightness levels was also obtained, which was beneficial to improve the efficiency of information cognition in the human-machine interface.  
keywords: {Visualization;Image color analysis;Conferences;Brightness;Color;Cognition;Man-machine systems;Visual perception;human-machine interface;brightness difference;polarity;background},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453647&isnumber=9453463>  
  
P. Denzler, D. Ramsauer and W. Kastner, "Tunnelling and Mirroring Operational Technology Data with IP-based Middlewares," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1205-1210.  
doi: 10.1109/ICIT46573.2021.9453658  
Abstract: Accessing runtime information originated from Operational Technology (OT) communication protocols by Information Technology (IT) applications remains a challenging task. Middlewares and gateways could provide a possible solution to bridge this OT/IT gap. In this context, this paper examines the feasibility of interconnecting legacy OT protocols via different middlewares and gateways by presenting two simplified scenarios. Each scenario exemplifies a possible use-case by either mimicking bidirectional tunnelling or propagating (mirroring) of automation data. Both scenarios use OPC Unified Architecture (OPC UA) and Message Queuing Telemetry Transport (MQTT) and a respective gateway prototype. The paper concludes by outlining future research challenges by discussing the limitations of the selected scenarios related to configuration, deployment and scalability.  
keywords: {Protocols;Automation;Runtime;Scalability;Prototypes;Logic gates;Tunneling;Industrial communication;Industrial Internet of Things;middleware;gateway},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453658&isnumber=9453463>  
  
T. Wagner, J. Seitz and G. Schneider, "Vibration Measurement and Visualization in Semiconductor AMHS on the basis of IoT," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1211-1216.  
doi: 10.1109/ICIT46573.2021.9453604  
Abstract: In this paper, we present an approach to automate a legacy measurement device used for offline vibration measurement within automated material handling systems (AMHS) of semiconductor manufacturing plants by using a modern, state of the art IoT framework. After outlining the drawbacks of the existing, time-consuming procedure of offline measurement, the decision of automating the device using the IoT is explained and the necessary steps and framework services are introduced. Finally, the results and benefits of using an IoT framework as well as the new, automated workflow are documented.  
keywords: {Vibrations;Semiconductor device measurement;Visualization;Conferences;Materials handling;Vibration measurement;Manufacturing;vibration analysis;factory automation;IoT;Arrowhead Framework;AMHS},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453604&isnumber=9453463>  
  
"Industrial Electronics and Education," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1217-1218.  
doi: 10.1109/ICIT46573.2021.9453570  
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T. Lei, X. Zhang and J. Chang, "Development of Aerospace Power System Laboratory for Advanced Research and Undergraduate Education," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1219-1226.  
doi: 10.1109/ICIT46573.2021.9453684  
Abstract: This paper presents the theory, implementation, and assessment of a laboratory course designed to teach aircraft electrical power system and Multi-energy to engineering students. A key element of the course is the use of electrical power generation and distribution systems in the laboratory setting. The Aerospace Electrical power system course (AEPS) is the core topics for today's electrical engineering students in the aerospace background University. With the rapid development of More Electrical Aircraft /All Electrical Aircraft, today's electrical engineers need the ability to design multi-energy integrated electrical systems. In order to train such engineers, this course is needed to highlight the unique engineering challenges of more-electrical energy systems. It is hoped that after paying attention to the use of power generation and distribution systems in the laboratory environment, the students' grades in this course will be improved to a certain extent. Students design, test, and analyze electrical power system with tools used widely in industry (such as MATLAB/Simulink and RT-LAB 5700 Hard-In-Loop platform). Several typical electrical power system experiments are presented, as well as detailed descriptions of several open-ended design projects: a digital controller for aerospace synchronized generator and a full PWM converter for HVDC power system, solid state power distribution, electrical power system testing and power quality analyzing or assessing. The experimental project has a positive impact on the student's course learning, and to some extent improves their academic performance, and makes the distribution of their performance more reasonable.  
keywords: {Pulse width modulation converters;Statistical analysis;Education;Tools;Power systems;Aircraft manufacture;Synchronization;Aircraft Electrical Power System;electrical engineering education;More Electrical Aircraft;modeling and simulation;HIL experiments platform},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453684&isnumber=9453463>  
  
L. Dunai, J. Martins, K. Umetani, O. Lucia, Y. Ibrahim and G. K. Appuhamillage, "E-Learning in Industrial Electronics during Covid-19," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1227-1233.  
doi: 10.1109/ICIT46573.2021.9453467  
Abstract: The educational methodologies employed in Industrial Electronics have been affected by Covid-19. In many cases, conventional learning methods relying on face-to-face lectures have been replaced by online methodologies. The whole process has required a fast adaptation and development of the e-learning tools to ensure a quality of theoretical, practical and laboratory lectures, as well as the development of new methods for the reliable assessment of the learning process. From this perspective, the present paper deals with the different strategies that have been implemented in institutions of several countries located in different geographical areas, including Portugal, Spain, Japan and Australia. It is shown that the use of methodologies, such as flip teaching, has provided a wide variety of possibilities to adapt to the new educational context. Moreover, for Industrial Electronics degrees, the use of virtual or remote laboratories, portable learning tools and advanced information and communication technologies have also risen as valuable resources. The paper also reports the problems arising during the development of the e-learning tools, their implementation constraints, and the evaluation of their results.  
keywords: {Industrial electronics;COVID-19;Remote laboratories;Learning management systems;Electronic learning;Pandemics;Tools;industrial electronics;e-Learning tools;Virtual/remote laboratories;Management Systems;Flip Learning;Portable learning tools},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453467&isnumber=9453463>  
  
A. R. S. Faria, L. S. Marques, J. Gaspar, F. S. Alves and J. M. N. S. Cabral, "High precision, geometry independent analytical method for self-inductance calculation in planar coils," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1234-1239.  
doi: 10.1109/ICIT46573.2021.9453559  
Abstract: This paper presents a versatile tool for the self-inductance calculation of planar coils. Due to the growing interest in planar coils in the past few years, the possibility of using an analytical model as a valid alternative to FEM simulations, regarding versatility and result reliability, would be of great interest. The ideal scenario would be to combine speed, precision, easy interaction and understanding, while adding versatility in terms of geometry. To achieve that, a tool, based on Grover equations, that calculates the self-inductance of planar coils with a general geometry has been developed. The results achieved using this method, considering different coil geometries and dimensions, were compared with the main analytical methods that can be found in the literature, proving the reliability of the proposed method. This model has the novelty of not having any limitation on the coil geometry or dimension, which is not the case for the other existing methods.  
keywords: {Coils;Geometry;Analytical models;Conferences;Tools;Finite element analysis;Mathematical model;planar coil;auto-inductance;versatile tool},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453559&isnumber=9453463>  
  
J. Pontes et al., "Relationship between Trends, Job Profiles, Skills and Training Programs in the Factory of the Future," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1240-1245.  
doi: 10.1109/ICIT46573.2021.9453584  
Abstract: Industry 4.0 is promoting the digitisation of manufacturing sectors towards smart products, machines, processes and factories. The adoption of disruptive technologies associated to this industrial revolution is re-shaping the manufacturing environment, decreasing low-skilled activities and increasing high-skill activities. These technological trends are affecting the job profiles and the skills required by the workforce, which demand proper training programs to address upskilling and reskilling needs. Having this in mind, this work proposes a model that contributes to understand how technological trends may impact the new job profiles and relevant skills, as well as how these skills may be upskilled by the workforce through available training programs according to their gaps and impact. The applicability of the proposed model was illustrated by considering two trends, the connectivity and the value of the data, and a catalogue of compiled new job profiles and training programs.  
keywords: {Training;Learning systems;Conferences;Data visualization;Tools;Market research;Production facilities},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453584&isnumber=9453463>  
  
J. Marot and M. Bensoam, "Telepresence robot, nano-computers and advanced cameras as educational tools," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1246-1251.  
doi: 10.1109/ICIT46573.2021.9453588  
Abstract: This paper describes a project course and a classroom course, performed in collaboration with the firm Axyn Robotics, where students aim at improving the autonomy of a telepresence robot. In this research, firstly, the students had to get familiar with the robot and control it remotely with WiFi and bluetooth communication protocols. Secondly, the students had to explore the abilities of new advanced cameras constructed by Intel. They had to show to the industrial partner that the chosen cameras were adequate to enable the robot to perform autonomous navigation. A classroom lesson is proposed where three parts of the robot are studied through smaller setups. We strongly believe that the measured positive academic impact of such a project and course is due to the university-industry collaboration, and the use of information and communication technologies as educational tools.  
keywords: {Telepresence;Protocols;Service robots;Power supplies;Robot vision systems;Collaboration;Tools;education;robotics;cameras;university-industry collaboration},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453588&isnumber=9453463>  
  
"SS Advanced Technology on Human Factors in Real World," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1252-1254.  
doi: 10.1109/ICIT46573.2021.9453503  
Abstract: Start of the above-titled section of the conference proceedings record.  
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K. Yamada, S. Yokota, A. Matsumoto, D. Chugo and H. Hashimoto, "Development of a Walking Promotion Device using Arm Swing Induced by Parametric Excitation : Second report: Design of second prototype," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1255-1260.  
doi: 10.1109/ICIT46573.2021.9453543  
Abstract: This research proposes a walking promotion device using arm swing induced by parametric excitation. Generally, amplification of arm swing promotes a walking. The proposed device is worn on forearm. It has weight, linear rail and motor. Parametric excitation occurs moving the weight in the longitudinal direction of the forearm. The feasibility of the system is confirmed by the simulation by modeling the upper limbs and proposed device as serial links mechanism. Additionally, this simulation is conducted so that designing the mass of the device and movement of weight. Based on the result, the mass of the device is 0.43 kg, the movement of weight is 0.14 m, and the amplification rate is confirmed at 129.27%. In order to verify the simulation in the real system, 2-link pendulum was prepared. Comparing with two states of disabled and enabled, the shoulder joint angle increased 11.83° in average. In addition to this experiment, an evaluation experiment with human arm was performed. As the results, compared with simulation, the device can increase the arm swing at 10°.  
keywords: {Legged locomotion;Rails;Performance evaluation;Conferences;Shoulder;Prototypes;Focusing;walking promotion;upper limbs;parametric excitation;arm swing;wearable device},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453543&isnumber=9453463>  
  
J. Liu, R. van der Vlist and E. Verseput, "Leveraging machine learning approaches to estimate the impact of thermostat setpoints on individual household gas consumption," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1261-1266.  
doi: 10.1109/ICIT46573.2021.9453677  
Abstract: Given the world's current climate change challenge and residential gas consumption being a major end-use of energy, people more than ever need to minimize their household's energy footprint. Personalised, actionable advice can give people tips on which actions they can take to reduce residential energy usage, such as lowering the thermostat temperature. For this advice to be relevant it is important to understand the quantitative impact of thermostat setpoints on daily gas usage for each individual household. In this article, this impact is estimated by comparing three machine learning approaches. Linear regression, deep learning and gradient boosting machine are applied to a multi-dimensional time series dataset for 300 Dutch households. The three approaches are compared based on three metrics: root mean square error (RMSE), explainability and scalability. The results of the best model (gradient boosting machine) are explained using a technique called SHapley Additive exPlanations (SHAP). This interpretation method can quantify the contribution of all inputs, among which thermostat setpoints, to the daily gas usage prediction of the model for different individual households. This article adds to the current state of the art by focusing on the impact of influenceable thermostat setpoints, as opposed to less actionable factors such as house size, insulation status of the house and weather. By applying SHAP, the personal impact and differences between individual households are estimated, in contrast to only learning trends. Moreover, a machine learning model, trained on a representative dataset, is applicable at scale to other households for estimating a personal, quantified impact of setpoint choices.  
keywords: {Measurement;Machine learning algorithms;Scalability;Time series analysis;Predictive models;Boosting;Market research;energy conservation;heating;thermostats;buildings;machine learning algorithms;big data applications},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453677&isnumber=9453463>  
  
N. Cinay, T. Häring, A. Rosin, T. Korõtko, R. Ahmadiahangar and H. Biechl, "Lifetime-Oriented Control Strategies for Hybrid Energy Storage Systems in an Islanded Microgrid," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1267-1272.  
doi: 10.1109/ICIT46573.2021.9453617  
Abstract: Alternative energy sources are becoming more important to ensure the supply of adequate and reliable energy. This forecloses environmental damage by outdated power plants and fossil fuel stocks, which are finite and have to be produced laboriously. Thus, energy management strategies for an islanded smart grid with combined energy storage systems, namely flywheel and battery storage, have been investigated in this paper. Mathematical models for these storage systems were developed in Matlab by analysing typical parameters and characteristics and were derived from simplified equations. Other microgrid components, the load profile, and photovoltaic (PV) system, were based on existing measurement data. Various control algorithms based on the battery's state of charge (SOC), load profile, and available PV power were developed in this paper. The simulations were done for a detached house and settlement for different scenarios including control strategies with and without different flywheel control algorithms. Finally, a reduction of the battery cycles and an increase of maximum off-grid mode time was achieved.  
keywords: {Photovoltaic systems;Microgrids;Batteries;Flywheels;Smart grids;Mathematical model;State of charge;flywheel;battery storage;energy management system;SOC;microgrid;islanded mode;smart grid},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453617&isnumber=9453463>  
  
M. Cevallos, A. Plua and J. Urquizo, "Respiratory control design to improve body haemoglobin levels," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1273-1279.  
doi: 10.1109/ICIT46573.2021.9453525  
Abstract: In respiratory control design there is a demand for technologies that integrate control systems with equipment efficiently. This research presents the model of a respiratory control to improve the levels of oxidation mainly due to quality of the air or for atmospheres with deficiencies of oxygen. In general, there is a complexity to obtain the mathematical models of a physiological breathing system associated to the concentration of the oxygen in the brain and in the body tissues. However, the model is designed by taking data into experimental tests for the plant or equipment modelling. In this research the control was developed in an Open-source electronic prototyping platform system. The control has two inputs and an output. In the methodology we obtain the transfer function of the plant controller. For the analysis of the closed loop control a system high-level model description was developed. Through these tools the controller selection and the stability analysis were made for a better performance. With the application of these methodologies the percentage overshoot and the settling time of the system were optimized. Finally, with a single-input, single-output (SISO) tool for controllers in feedback systems, the frequency responses of the close-loop system were analysed using the Nichols criteria. The present results are significant in at least one major respect that performance of the artificial respiration equipment was improved using these combined technologies.  
keywords: {Control design;Atmospheric modeling;Transfer functions;Tools;Brain modeling;SISO communication;Data models;Body tissue;Brain tissue;haemoglobin level;model prototyping;respiratory control},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453525&isnumber=9453463>  
  
"Advanced Control of GridConnected Inverters for Distributed Generation and Power Quality," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1280-1282.  
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R. Babojelić, Š. Ileš, V. Šunde and J. Matuško, "Computationally Efficient Set-based Predictive Control for Grid-tied Inverters," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1283-1288.  
doi: 10.1109/ICIT46573.2021.9453631  
Abstract: This paper presents a fast gradient projection model predictive control algorithm based on a sequence of 1-step controllable sets for controlling a grid-tied converter with an LCL filter. The proposed method uses a set membership constraint on the first state, which ensures finite time convergence to the terminal set. To use the fast gradient projection method to solve the finite-time optimal control problem with state constraints, we adopted an approach where the set membership constraint is transformed into the corresponding input constraint as a function of the current state. In this way, no significant additional computational load was introduced, allowing the MPC algorithm to be solved efficiently.  
keywords: {Computational modeling;Predictive models;Filtering algorithms;Prediction algorithms;Set theory;Inverters;Filtering theory;power converters;model predictive control;finite control set;robust control;fast gradient projection method},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453631&isnumber=9453463>  
  
A. RAMMAL and H. Y. KANAAN, "Design of a Model Predictive Control for a Boost Type Matrix Converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1289-1296.  
doi: 10.1109/ICIT46573.2021.9453648  
Abstract: This document describes the Model Predictive Control MPC for a three-phase to three-phase direct matrix converter with an L filter at the input and a C filter at the output for networks connection applications and wind turbines. This AC/AC converter allows the generation of sinusoidal output voltages with variable frequency, input currents with low harmonic distortion and a unit power factor at the source. The work begins by developing the equations of the system, designing the predictive control of the system in the DQ rotating frame. The proposed MPC control uses a cost function J to select the switching state to be applied to the next switching. This gives a sinusoidal output voltage and input currents in phase with the input voltage. Simulations using Matlab/Simulink are presented to validate the proposed control scheme.  
keywords: {Switches;Predictive models;Control systems;Numerical models;Harmonic distortion;Mathematical model;Matrix converters;Direct Matrix Converter (DMC);Model Predictive Control (MPC);Cost Function;Total Harmonic Distortion (THD)},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453648&isnumber=9453463>  
  
Y. Chen and L. Xu, "Sequence-Frame Coupling Admittance Analysis and Stability of VSC Connected to Weak Grid," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1297-1303.  
doi: 10.1109/ICIT46573.2021.9453542  
Abstract: This paper develops small-signal admittance of grid-connected voltage source converter (VSC) in the positive-negative (pn) sequence-frame for ease of stability analysis. Based on the converter admittance in pn frame, the stability problems associated with the coupling admittance created by the phase-locked loop (PLL) and outer loop controllers are studied. To overcome the disadvantage of the traditional outer loop controller and improve system stability, an improved outer loop controller that can reduce the coupling admittance is proposed. VSC system connected to a weak grid is modelled in MATLAB-SIMULINK to validate the theoretical study and demonstrate the effectiveness of the improve outer controller.  
keywords: {Couplings;Simulation;Power system stability;Control systems;Stability analysis;Admittance;Phase locked loops;Coupling admittance;stability;weak grid;PLL;outer loop},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453542&isnumber=9453463>  
  
"Teaching and Promoting Electronics Classes Including Online Classes," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1305-1306.  
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M. Novak, S. Nemcova and P. Pisarik, "Laser Distance Meter and LIDAR Demonstrator Module for Teaching of Sensors," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1307-1312.  
doi: 10.1109/ICIT46573.2021.9453501  
Abstract: This paper presents a demonstrator for live in class demonstrations and experiments of the principle of a time of flight (TOF) laser rangefinder and LIDAR. The demonstrator is designed to be used for sensor teaching classes for students of mechanical engineering. It can be used to perform live experiments on lectures and lab classes. The device can operate in several modes: stand alone transmitter and receiver for connection to an oscilloscope, autonomous rangefinder and LIDAR. As the construction has been made as a lab demonstrator, the electronics is manufactured as three separate boards to simplify the lab setup testing. The used wavelength is 905 nm, the optical system provides focus of the laser LED signal, band pass filtering and focus of received reflected pulse. The electronics and optics is mounted on a mechanical assembly allowing rotation in LIDAR mode.  
keywords: {Semiconductor device measurement;Laser radar;Measurement by laser beam;Laser modes;Optical receivers;Optical transmitters;Optical sensors;Laser distance meter;LIDAR;distance measurement;GaN semiconductors},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453501&isnumber=9453463>  
  
"Industrial and Power Electronics for Transactive Energy Systems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1313-1314.  
doi: 10.1109/ICIT46573.2021.9453598  
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J. F. A. Martins, G. Santos, V. F. Pires and A. Gonçalves Pronto, "Energy Routers in Transactive Energy Communities," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1315-1319.  
doi: 10.1109/ICIT46573.2021.9453531  
Abstract: This paper presents a study on transactive energy inside an Energy Community. Being the Energy Community a legal entity where citizens, that is, final consumers of energy, sharing the same geographic location come together to cooperate in the generation and distribution of energy, it is important to understand the sharing of benefits between nZEB type of buildings (the ones that locally produce energy) and the other community members. Being this energy transaction process enabled by the usage of power electronics Energy Routers, this study analysis the financial benefits for all Energy Community members when a transactive energy process is establish between nZEB and non-nZEB community members. The return of investment is also analysed for nZEB members.  
keywords: {Transactive energy;Law;Conferences;Buildings;Power electronics;Investment;Transactive Energy;nZEB;Energy Community;Energy Router},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453531&isnumber=9453463>  
  
S. Sánchez-Cruz, E. Romero-Cadaval, B. Montes Cabrera, E. González Romera, M. I. Milanés Montero and F. Barrero González, "Modulation strategy and control of Modular Cascade H-Bridge Converters as Input-side of a Multi-port Smart Transformer," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1320-1325.  
doi: 10.1109/ICIT46573.2021.9453545  
Abstract: This article is about the cascade connection of several H-bridges as the input side of a multi-port Smart Transformer. The paper discusses its unipolar control strategy with two different modulation techniques by connecting different loads in each module or port. The operation of both techniques and the distribution of voltage and current is analyzed using co-simulation with PSIM and SIMULINK. The best technique is determined with the study from the harmonic and efficiency point of view.  
keywords: {Software packages;Conferences;Modulation;Harmonic analysis;Inverters;Voltage control;multilevel;Multi-port Smart Transformer;Cascade Modular Converters;Unipolar H-Bridge Inverters},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453545&isnumber=9453463>  
  
"Electric Drives for Electrical Mobility and Green Energy," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1326-1328.  
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Abstract: Start of the above-titled section of the conference proceedings record.  
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A. K. Mohapatra and A. V. R. Teja, "A Novel Fault Tolerant Smart System for BLDC motor based Electric Vehicles," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1329-1334.  
doi: 10.1109/ICIT46573.2021.9453620  
Abstract: This paper presents a generalized smart Fault Detection (FD) and Gate Pulse Correction (GPC) system to enhance the BLDC drive system's reliability to the binary hall sensor faults. Therefore, this drive system ensures a continual motor run if one of the hall sensors gets damaged. The whole drive control system is a simple digital logic circuit. The drive system with the proposed control scheme is simulated in MATLAB/Simulink environment first and extended to hardware. And the corresponding results are presented.  
keywords: {Motor drives;Brushless DC motors;Microprocessors;Logic circuits;Fault tolerant systems;Logic gates;Electric vehicles;BrushLess Direct Current (BLDC);Fault Detection (FD);Gate Pulse Correction (GPC);Hall Sensor;Electric Vehicles (EV)},  
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Q. Chen, Q. Li, P. Stolze, R. Kennel and D. Schröder, "Anisotropy-based Sensorless Control for Electrical Drives – Part I: Basic Principle," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1335-1340.  
doi: 10.1109/ICIT46573.2021.9453562  
Abstract: This paper covers the basic principle related to the anisotropy-based1 sensorless control for electrical drives. Several anisotropy-based methods were developed to solve the failure problem of fundamental model based methods in the lower speed, and at zero speed of electric machine. The objective of this paper is to help the reader develop a systematic understanding of this technique that has been developed over the past three decades.  
keywords: {Systematics;Anisotropic magnetoresistance;Electric machines;Conferences;Sensorless control;Mathematical model;Frequency control;Sensorless control;anisotropy and isotropy;electric machine;INFORM;high frequency injection},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453562&isnumber=9453463>  
  
M. Tousizadeh, H. S. Che and N. Abd Rahim, "Current Trajectory-Based Fault Detection and Fault Tolerant Control for Three-phase Induction Drives," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1341-1347.  
doi: 10.1109/ICIT46573.2021.9453527  
Abstract: In this paper, a simple and fast open-phase fault (OPF) detection and fault tolerant control method is proposed for three-phase induction machine. Instead of using integrators or low pass filter, this method utilizes the phase current magnitude and trajectory to detect open phase fault in three-phase motor drive. This significantly increases the speed of fault detection, allowing an OPF to be detected and compensated within several sampling cycles, which is advantageous for safety-critical applications. In addition, a double synchronous reference frame PI (DSRF-PI) controller method is adopted as the fault tolerant controller. Compared to previous methods that utilizes feedforward voltage compensation, the DSRF-PI does not require prior knowledge on the machine parameters and operating condition, and therefore is easier to implement. The proposed fault detection and fault tolerant control method are simulated using MATLAB Simulink simulation where the results confirms the high speed and robustness of the proposed methods.  
keywords: {Motor drives;Phase measurement;Event detection;Software packages;Fault detection;Fault tolerant systems;Low-pass filters;fault detection;fault tolerant controller;induction motor drive;synchronous reference frame},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453527&isnumber=9453463>  
  
C. Hackl, J. Kullick and N. Monzen, "Generic loss minimization for nonlinear synchronous machines by analytical computation of optimal reference currents considering copper and iron losses," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1348-1355.  
doi: 10.1109/ICIT46573.2021.9453497  
Abstract: The unified theory introduced in [1] allows to solve analytically the optimal feedforward torque control (OFTC) problem of anisotropic synchronous machines (SMs). In this paper, the theory is extended by considering relevant machine nonlinearities and incorporating copper and iron losses, thus minimizing the overall (steady-state) losses in the machine. Instead of the well known maximum torque per current (MTPC) operation strategy, maximum torque per losses (MTPL) is realized. The unified theory for the derivation of the analytical solution is briefly recapitulated. Moreover, current and speed dependent iron losses, as well as magnetic saturation and cross-coupling effects are considered. The resulting nonlinear optimization problem is solved via online linearization of the relevant expressions. The linearization is exemplified for flux linkages and machine torque, respectively. Furthermore, a decision tree is presented, which guarantees an optimal operation management and smooth transitions between all operation strategies such as MTPL, field weakening (FW), maximum current (MC) and maximum torque per voltage (MTPV). Finally, the extended unified theory is validated in simulations for a highly nonlinear SM.  
keywords: {Couplings;Torque;Computational modeling;Torque control;Iron;Steady-state;Decision trees;maximum torque per losses (MTPL);maximum torque per voltage (MTPV);maximum current (MC);field weakening (FW);analytical solution;efficiency;copper & iron losses;anisotropy;synchronous machine;quadrics;quartics;Lagrangian optimization;operation management},  
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M. Y. Metwly, M. S. Abdel-Majeed, A. Hemeida, A. S. Abdel-Khalik and S. Ahmed, "Nine-Phase-based Fractional-Slot Winding Layouts for Integrated EV On-board Battery Chargers," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1356-1361.  
doi: 10.1109/ICIT46573.2021.9453476  
Abstract: Permanent magnet (PM) machines configured with fractional slot concentrated winding (FSCW) have recently been employed in electric vehicle (EV) powertrains thanks to their myriad merits over conventional designs. The concept of integrated on-board battery chargers (OBCs), where the propulsion components are employed in the battery charging process, has also shown promise to provide a cost-effective alternative to conventional on-board and/or off-board chargers. This technology highly depends on the machine type as well as the employed winding design. Most of the up-to-date research covering this topic has mainly focused on multiphase machines with conventional distributed winding owing to their high-quality flux distribution. Despite the outstanding features of FSCW, their inevitable flux distortion constitutes the main drawback of this winding layout. This paper evaluates the performance of two nine-phase-based integrated OBCs using surface-mount permanent magnet (SPM) synchronous machines equipped with two different fractional-slot layouts, namely, the non-overlapped FSCW 18-slot/16-pole and overlapped fractional-slot winding 18-slot/10-pole with two-slot coil pitch. The design optimization of the two machines has been obtained based on analytical magnetic equivalent circuit (MEC) models. While, finite element simulation has been used to evaluate the two designs under both charging and propulsion operational modes.  
keywords: {Torque;Windings;Layout;Core loss;Rotors;Propulsion;Permanent magnets;FSCW;Multiphase Machines;Battery Chargers;Electric Vehicles;Finite Element Analysis (FEA)},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453476&isnumber=9453463>  
  
A. Gonzalez-Prieto, I. Gonzalez-Prieto, A. G. Yepes, M. J. Duran and J. Doval-Gandoy, "Symmetrical Six-Phase Induction Machines: A Solution for Multiphase Direct Control Strategies," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1362-1367.  
doi: 10.1109/ICIT46573.2021.9453649  
Abstract: Six-phase induction machines are considered an interesting multiphase option because they can benefit from the well-known three-phase converter technology. These multiphase machines can be classified according to the spatial distribution of their windings into two main groups: asymmetrical and symmetrical six-phase machines. In the case of symmetrical six-phase machines, some sets of voltage vectors show an important advantage from the point of view of the x-y current mitigation. They provide an active production in the α - β plane with a completely null injection of x-y components. This fact is a desired feature for direct control strategies, such as standard model predictive control (MPC), where a single switching state is applied during the entire sampling period. Based on these statements, this work proposes an MPC strategy for symmetrical six-phase induction machines using voltage vectors with null x-y voltage production in order to obtain the flux/torque generation with minimum x-y currents. Simulated results have been included to validate the goodness of the developed control scheme.  
keywords: {Support vector machines;Total harmonic distortion;Windings;Production;Switches;Control systems;Induction machines;Model predictive control;symmetrical six-phase induction machine;voltage vectors},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453649&isnumber=9453463>  
  
"Advanced Topologies and Control Techniques for Multilevel Converters," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1368-1370.  
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M. Babaie, M. Mehrasa and K. Al-Haddad, "Direct Active and Reactive Power Control for Grid-Connected PEC9 Inverter Using Finite Control Set Model Predictive Method," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1371-1376.  
doi: 10.1109/ICIT46573.2021.9453660  
Abstract: This paper is dealing with designing an advanced Direct Power Control (DPC) technique for a grid-connected nine-level Packed E-Cell (PEC9) inverter through Finite Control Set Model Predictive Control (FCSMPC) and Single-phase Direct-Quadrature (s-d-q) frame. Generating a nine-level voltage waveform using minimum active and passive components count makes PEC9 a cost-effective compact multilevel converter in single-phase applications. FSMPC symmetrically stabilizes the nine-level voltage waveform and accurately synchronizes the inverter current with the grid voltage by applying direct control to the switching operation of PEC9 inverter. The phase and the amplitude of the reference current in the proposed DPC are adjusted regarding the desired level of active and reactive power through s-d-q frame. In order to address the FCSMPC weighting factors tuning difficulty, some new adaptive functions using the error value of the capacitors voltages and the inverter current are also proposed. The experiments and simulations approve that PEC9 accurately generates the desired amounts of active and reactive power with standard level of THD and dc voltage ripple.  
keywords: {Reactive power;Multilevel converters;Switches;Tools;Inverters;Synchronization;Voltage control;Direct Power Control;Finite Control Set Model Predictive Control (FCSMPC);Nine-Level Packed E-Cell (PEC9) Inverter;Total Harmonic Distortion (THD);Multilevel Compact Converters;Grid-Connected Systems},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453660&isnumber=9453463>  
  
L. -A. Gomez, L. G. Alves Rodrigues, G. Gateau and S. Sanchez, "On the potential of parallel multilevel Current Source Inverter using SiC devices for renewable applications," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1377-1382.  
doi: 10.1109/ICIT46573.2021.9453689  
Abstract: Nowadays, renewable energy conversion systems are mainly realized through a double-stage topology, which often combines a Boost chopper (DC-DC) and a three-phase Voltage Source Inverter (DC-AC). Although widely employed, this configuration presents some major drawbacks. New wide-bandgap (WBG) semi-conductors as SiC devices have led to consider alternative topologies, as the Current Source Inverter (CSI). When implementing WBG devices, the high level of conduction losses in the CSI are vastly improved. Moreover, an interleaved CSI is an extra solution to reduce the constraints on passives and semiconductor components, in addition to providing modularity. The aim of this paper is to analyze a parallel multilevel CSI using SiC devices for renewable energy applications. A dedicated tool to evaluate semiconductor losses is developed with this purpose.  
keywords: {Semiconductor device modeling;Couplings;Renewable energy sources;Silicon carbide;Voltage source inverters;Tools;Topology;CSI;interleaving;SiC devices},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453689&isnumber=9453463>  
  
S. Arazm and K. Al-Haddad, "Z Packed U-cell (ZPUC) topology, configuration of single DC Source single-phase and three-phase Multilevel Converter," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1383-1388.  
doi: 10.1109/ICIT46573.2021.9453515  
Abstract: Single module of ZPUC topology is presented in this paper which can be operated with single DC source. Although ZPUC has one more capacitor compared to its counterpart PUC converter, it requires single DC source instead of three isolated DC sources in three-phase system which is a great advantages to reduce the cost and bulkiness of the system. It also reduces the total components counts of the converters in comparison to the most popular types of multilevel converters. Active voltage balancing through Phase shift pulsed width modulation (PS-PWM) strategy has been used to balance the voltages of three flying capacitors. ZPUC topology based on the 5-L inverter is investigated in Matlab-Simulink to validate the performance of the single module of ZPUC topology.  
keywords: {Multilevel converters;Renewable energy sources;Simulation;Capacitors;Rectifiers;Switches;Inverters;ZPUC;Multilevel converter;Active voltage balancing;power quality},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453515&isnumber=9453463>  
  
"Advances in Digital Transformation of Manufacturing Environments. Integrated Development 4.0," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1389-1390.  
doi: 10.1109/ICIT46573.2021.9453678  
Abstract: Start of the above-titled section of the conference proceedings record.  
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H. Isakovic, S. Dangl, Z. Tucakovic and R. Grosu, "Adaptive Signal Filtering Platform for a CPS/IoT Ecosystem," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1391-1396.  
doi: 10.1109/ICIT46573.2021.9453496  
Abstract: The rapid increase in number of devices in Internet-of-Things generates astronomic amounts of data. Dealing with noisy and low quality data uses more effort than the data analysis itself. Dealing with noisy data at the source would significantly reduce the effort of pre-processing during analysis, as well as the storage and bandwidth overhead. In this paper we introduce an Adaptive Signal Processing Platform (ASPF) for CPS/IoT Ecosystems. It provides ability to dynamically detect noise variation in a signal and successfully filter these components out of the signal leaving only clean and useful data. The paper shows two approaches with different requirements on effort and scalability.  
keywords: {Tensors;Data analysis;Filtering;Scalability;Conferences;Ecosystems;Data acquisition},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453496&isnumber=9453463>  
  
E. Brandt, F. Brandt, K. Clemens and D. Reichelt, "AI-Supported Marketplace For Industrial Capabilities," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1397-1402.  
doi: 10.1109/ICIT46573.2021.9453489  
Abstract: The current efforts to digitize production processes in the industrial environment are associated with several challenges. While there is already a wide range of standards for mapping components and products, there is still a lack of solutions for communicating concrete product requirements and given capabilities of a plant or production hall. Previous approaches, which rely on standardized feature catalogs or rigidly defined semiotics, do not offer a satisfactory solution. More desirable is an intervention-free data exchange and a negotiation process that mediates between product requirements and setup conditions. To this end, this paper proposes an architecture of a marketplace whose components compare the capabilities of an industrial system with the product requirements and evaluate them in terms of their suitability to meet the desired requirements. An approach for the rapid recognition of equality in chemical compounds using GCN is examined in detail and transferred to an industrial context.  
keywords: {Semantics;Taxonomy;Production;Tools;Ontologies;Solids;Data models;plug and produce;industrial internet of things},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453489&isnumber=9453463>  
  
P. Boden, S. Rank and T. Schmidt, "Control of heterogenous AMHS in semiconductor industry under consideration of dynamic transport carrier transfers," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1403-1408.  
doi: 10.1109/ICIT46573.2021.9453585  
Abstract: Wafer transport by Automated Material Handling Systems is essential in modern semiconductor front-end factories to efficiently supply the manufacturing tools. Most common are ceiling mounted Overhead Hoist Transport Systems that allow high throughput and fast delivery times. These systems are increasingly supplemented by various types of Automated Guided Vehicle Systems that enable high flexibility. This development requires new approaches for transport system dispatching.We denote such Automated Material Handling Systems that combine several types of transport systems as heterogeneous. Here, vehicles with different characteristics can execute either a complete or a part of a transport order. Until now, this task allocation process for the vehicles is executed based on predefined rules. A dynamic exchange between the transport systems based on the current system state is not yet considered.This paper presents a formalization of the related planning problem by a mathematical model for transport system scheduling. The approach is not suitable for real-time decision making. However, on the one hand, it may help to identify and evaluate the solution quality of heuristic approaches. On the other hand, it allows the evaluation of the effect of transfers.  
keywords: {Materials handling;Tools;Dynamic scheduling;Throughput;Real-time systems;Production facilities;Resource management;Automated Material Handling System;Automated Guided Vehicle;Overhead Hoist Transport System;Scheduling;Pickup and Delivery Problem with Transfers},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453585&isnumber=9453463>  
  
D. Fischer, P. Moder and H. Ehm, "Investigation of Predictive Maintenance for Semiconductor Manufacturing and its Impacts on the Supply Chain," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1409-1416.  
doi: 10.1109/ICIT46573.2021.9453481  
Abstract: In the course of Industry 4.0, Predictive Maintenance (PdM) continues to arouse strong interest as a research topic. In particular semiconductor manufacturers could capitalize on the broad availability of data from pervasive Advanced Process Control (APC) systems regarding the conduct of maintenance. Analysis of related work has shown that research primarily concentrates on the technical implementation of PdM, but lacks antecedent consideration of its potential impacts on a supply chain with respect to operations and economics. The presented work, therefore, aims to investigate the operational and economic impacts of PdM for semiconductor manufacturing on the corresponding supply chain by means of discrete-event simulation.  
keywords: {Semiconductor device modeling;Fabrication;Economics;Conferences;Supply chains;Process control;Tools;Semiconductor Manufacturing;Predictive Maintenance;Discrete-Event Simulation;Supply Chain Management},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453481&isnumber=9453463>  
  
F. Zoghlami, M. Kaden, T. Villmann, G. Schneider and H. Heinrich, "Sensors data fusion for smart decisions making: A novel bi-functional system for the evaluation of sensors contribution in classification problems," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1417-1423.  
doi: 10.1109/ICIT46573.2021.9453551  
Abstract: Sensor fusion has gained a lot of attention during the recent years. It is used as an application tool in different fields including semiconductor-, automotive-, medicine industries. However, finding the right sensor combination for the dedicated application is still very challenging. In this paper, we focus on applying the sensor fusion concept in reference to the prototype-based learning for object classification purposes. In fact, we present a bi-functional system architecture. The system has the feature to evaluate each sensor's contribution in a predefined classification task. The developed system will preserve the effort and the time spent by engineers to collect a huge quantity of preprocessed samples from each sensor and to try different training configurations. Our approach consists of training a model. The model learns both the predefined classes and additional parameters that represent the contribution of each sensor used in the fusion system for fulfilling the predefined classification task. We illustrate the functionality of our developed system by referring to two different application scenarios. Results validate the dual functionality of our approach as well as the simplicity of the integration of our evaluation system in any further fusion application regardless sensors inputs and classification outputs.  
keywords: {Training;Three-dimensional displays;System performance;Systems architecture;Sensor fusion;Tools;Feature extraction;sensor fusion;sensor evaluation;prototype-based learning;classification;artificial intelligence},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453551&isnumber=9453463>  
  
S. Anger, F. Klingert, V. Häublein, M. Pfeffer and M. Schellenberger, "Smart Platform for Rapid Prototyping: Solutions in the Dilemma of Flexibility and Standardization," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1424-1431.  
doi: 10.1109/ICIT46573.2021.9453566  
Abstract: Fraunhofer IISB offers prototyping services for electron devices. To meet economic requirements despite a unique flexibility in regard to wafer size, semiconductor material, and processes in manufacturing, a smart platform for rapid prototyping is under development. This paper reports on three embedding solution approaches: The implementation of stable baseline modules, smart experiments including data analytics, and smart logistics with a flexible MES. All were developed and partially implemented within the iDev40 project. The interaction of the solution approaches has the overall goal of reducing the integration time of novel processes into the manufacturing line by about 20%.  
keywords: {Semiconductor materials;Process control;Production;Standardization;Tools;Rapid prototyping;Throughput;Rapid Prototyping;Baseline Module;Smart Experiments;Smart Logistics;Data Analytics},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453566&isnumber=9453463>  
  
I. Stogniy and W. Scholl, "Using representative process flows for simulation model simplification," 2021 22nd IEEE International Conference on Industrial Technology (ICIT), Valencia, Spain, 2021, pp. 1432-1437.  
doi: 10.1109/ICIT46573.2021.9453535  
Abstract: Infineon Technologies Dresden has been using a long-term simulation model to support production planning for a long time. There is a need to reduce efforts to create and maintain models. There are two ways of doing this: using representative process flows and substituting tool sets for constant delays. This paper considers both approaches as well as their combination. The main idea is to evaluate them and find the appropriate level of model complexity in terms of model accuracy. Therefore, a gradual simplification is used. The MIMAC dataset 5 was the data source for this study.  
keywords: {Conferences;Production planning;Tools;Dispatching;Delays;Calibration;Manufacturing;simulation model simplification;representative process flows;semiconductor manufacturing simulation},  
URL: <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9453535&isnumber=9453463>