

IEEE RASSE 2021

IEEE International Conference on Recent Advances in Systems Science and Engineering
December 12–14, 2021 // Shanghai University, Shanghai, China



RASSE 2021 CONFERENCE PROGRAM

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Welcome Message from the Chair

Greetings! Ladies and gentlemen. 各位贵宾·你们好! Welcome to the IEEE International Conference on Recent Advances in Systems Science and Engineering (RASSE) 2021. This is the inaugural event for the new IEEE Systems Council flagship conferences in the Asia region. The planning of this event started in June of 2019. Tremendous hard work and resilience by the key conference organizers who overcome many challenges amidst the global pandemic to make this event a reality. Similar to other Systems Council's flagship conferences in 2021, this conference will be available entirely on-demand. All registered participants will be able to stream the entire conference proceedings at their leisure. The aim of this conference is to create a high-profile, leading-edge, interactive forum for researchers, engineers, practitioners, and educators to exchange state-of-the-art research results and innovations, to discuss industrial practice, and to define the future research topics in all aspects of systems science and engineering.

My name is Andy Chen. I am the IEEE Systems Council's Vice President Conferences; President of IEEE Technology and Engineering Management Society and past members of IEEE Computer Society Board of Governors.

We are delighted to report that we have reviewed and accepted 40% more research papers than we had originally planned. Each submission has been reviewed by at least two expert reviewers. Only 70 papers were accepted, which means that the acceptance rate for this conference is 60%. The accepted and presented papers will be published in this conference proceedings and submitted for inclusion in the IEEE Xplore Digital Library. On behalf of the IEEE Systems Council, we would like to express our sincere thanks to all the experts involved in this process. We also featured 4 special sessions, one industry research tutorial and a PHD Forum in this conference.

I wish to thank the amazing lineup of keynote speakers for taking the time to sharing their invaluable thoughts and insights. I would also like to acknowledge the exceptional work of our conference team:

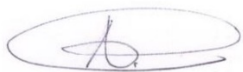
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Tutorial Chairs - Jose Lastra, Fanbiao Li, Xin Li
Ph.D. Forum Chairs - Junlong Zhou, Luis Ribeiro, Jose Barata

Another big thanks go to Conference Catalysts which had dedicated a team of competent staff lead by Shelby Lussier to provide conference administration and technical support around the clock. Special thanks go to Dean Minrui Fei and Professor Xin Du of Shanghai University to host this conference and recommended knowledge partners to contribute to the conference proceedings. Finally, we would like to thank all the authors for submitting their papers to the conference, and for their presentations and discussions during the conference. I sincerely hope you will enjoy the keynote speeches, research paper presentations, special sessions, PHD Forum and tutorial that this conference has to offer.

The Systems Council integrates IEEE societies, covering multiple disciplines and specialty areas of systems engineering. The purpose of the Council is to advance and coordinate work in the field of System design, development and management carried throughout the IEEE worldwide. If you are not already a IEEE Systems Council member, I would encourage you to check out our website ieeesystemscouncil.org to learn more about the value and benefits of joining our global community.

I am extremely excited to announce that the IEEE RASSE 2022 will be held in Tainan, Taiwan on November 2-4, 2022. Tainan is Taiwan's oldest city and former capital. Its traditional narrow alleys, gorgeous old houses and old temples are world renowned. Tainan is a vibrant city, with layer upon layer of heritage from different nations and cultures. We are planning to be an in-person conference hosted by the National Cheng Kung University. Hope to see you all in Tainan, Taiwan in next November for the IEEE RASSE 2022.

Thank you all and enjoy the conference. 谢谢大家



Andy Chen

IEEE RASSE 2021 General Chair

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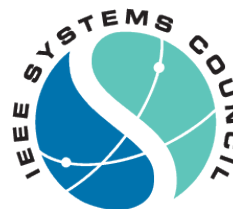
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Keynote Speakers



Professor Sarah Spurgeon OBE, FEng, FIEEE, FIET
Department of Electronic and Electrical Engineering, University College London, UK

Biography: Sarah Spurgeon OBE, FEng, FIEEE, FIET is Professor of Control Engineering and Head of the Department of Electronic and Electrical Engineering at University College London. Sarah Spurgeon's research interests are in the area of systems modelling and analysis, robust control and estimation in which areas she has published over 270 refereed research papers. She was awarded the Honeywell International Medal for 'distinguished contribution as a control and measurement technologist to developing the theory of control' in 2010 and an IEEE Millennium Medal in 2000. She is currently Vice President Publications of the International Federation of Automatic Control (IFAC), an elected member of the Board of Governors of the IEEE Control Systems Society and a member of the General Assembly of the European Control Association. Within the UK she is currently a Vice President of the IET and is a past President of the Engineering Professor Council, the representative body for engineering in higher education.



Guoping Lu
Chengdu University of Science and Technology

Biography: Guoping Lu received the B.S. degree from the Department of Applied Mathematics, Chengdu University of Science and Technology, China, in 1984, and the M.S. and Ph.D. degrees from the Department of Mathematics, East China Normal University, China, in 1989 and 1998, respectively. He is currently a Professor at the School of Electrical Engineering, Nantong University, Jiangsu, China. His research interests include singular systems, multiagent systems, and networked control.



Chen Peng
Shanghai University

Biography: Chen Peng received the Ph.D. degree in control theory and control engineering from the Chinese University of Mining Technology, Xuzhou, China, in 2002. From November 2004 to January 2005, he was a Research Associate with the University of Hong Kong, Hong Kong. From July 2006 to August 2007, he was a Visiting Scholar with the Queensland University of Technology, Brisbane, QLD, Australia. From July 2011 to August 2012, he was a Postdoctoral Research Fellow with Central Queensland University, Rockhampton, QLD, Australia. From 2009 to 2012, he was the Department Head with the Department of Automation, and a Professor with the School of Electrical and automation Engineering, Nanjing Normal University, Nanjing, China. In 2012, he was appointed as an Eastern Scholar with the Municipal Commission of Education, Shanghai, China, and joined Shanghai University, Shanghai, where he is currently the Director with the Centre of Networked Control Systems and a Distinguished Professor. In 2018, he was appointed as an Outstanding Academic Leader with the Municipal Commission of Science and Technology, Shanghai. His current research interests include networked control systems, distributed control systems, smart grid, and intelligent control systems.



Schahram Dustdar
TU Wien, Austria

Biography: Schahram Dustdar is Full Professor of Computer Science heading the research Division of Distributed Systems at the TU Wien, Austria. He has an H-index of 80. He holds several honorary positions: University of California (USC) Los Angeles; Monash University in Melbourne, Shanghai University, Macquarie University in Sydney, University Pompeu Fabra, Barcelona, Spain. From Dec. 2016 until Jan. 2017 he was a Visiting Professor at the University of Sevilla, Spain and from January until June 2017 he was a Visiting Professor at UC Berkeley, USA. From 1999 – 2007 he worked as the co-founder and chief scientist of Caramba Labs Software AG in Vienna (acquired by ProjectNetWorld AG), a venture capital co-funded software company focused on software for collaborative processes in teams. He is co-founder and chief scientist of Sinoaus.net, a Nanjing based R&D organization focusing on IoT and Edge Intelligence. He is founding co-Editor-in-Chief of ACM Transactions on Internet of Things (ACM TIoT) as well as Editor-in-Chief of Computing

(Springer). He is an Associate Editor of IEEE Transactions on Services Computing, IEEE Transactions on Cloud Computing, ACM Computing Surveys, ACM Transactions on the Web, and ACM Transactions on Internet Technology, as well as on the editorial board of IEEE Internet Computing and IEEE Computer. Dustdar is recipient of multiple awards: IEEE TCSVC Outstanding Leadership Award (2018), IEEE TCSC Award for Excellence in Scalable Computing (2019), ACM Distinguished Scientist (2009), ACM Distinguished Speaker (2021), IBM Faculty Award (2012). He is an elected member of the Academia Europaea: The Academy of Europe, where he is chairman of the Informatics Section, as well as an IEEE Fellow (2016), an Asia-Pacific Artificial Intelligence Association (AAIA) Fellow (2021) and a Member of the Academy of the United Nations Sciences and Technology Organization (2021).

Tutorial Presentation



Complex Simulation Specification: Do your simulations meet their needs?

Henri Sohier
IRT SystemX

Abstract: A simulation can be a complex architecture of simulation models, simulation tools, and computing hardware. However, its development often relies on informal procedures and can begin without a clear, complete, and formal definition of simulation needs. Simulation traceability is then compromised, which prevents from easily validating whether a simulation meets the needs, or understanding the purpose of a simulation model that can be reused. In this tutorial, we will discuss in light of current standards all the aspects of simulation needs: (1) the part of the system to be simulated; (2) the objective of the simulation; (3) the simulation quality, cost, and delivery; (4) the test scenarios; (5) the data for simulation calibration and validation; and (6) the verification and validation of the simulation. Using the design of an autonomous car as an example (thanks to the contribution of several automotive companies), we will see

how MBSE and artificial intelligence can improve agility by allowing the partial automatization of the definition and analysis of simulations needs. This tutorial is a 60-minute lecture. Come and let's make sure that you start your simulations with clear, complete, and formal simulation needs which can then be efficiently used in simulation validation and reuse.

Biography: H. Sohier is a researcher in Mechanical and Systems Engineering at IRT SystemX, a research center dedicated to digital transformation in Palaiseau, France. He earned a Master's degree with high honors from INSA de Lyon in 2011, and a PhD (funded by CNES and Onera) from ISAE Supaero in 2014. Prior to joining IRT SystemX in 2016, he worked on the integration of high-power lasers at the ELI-ALPS research institute. He is an INCOSE Certified Systems Engineering Professional.

Technical Program

Autonomous Systems

Formation Control for Unmanned Surface Vehicles Based on Minimum Snap Trajectory Generation

Min Cheng (Shanghai University, China)

Formation control of unmanned surface vehicles (USVs) can perform numerous complex tasks effectively which are difficult or impossible for a single USV in highly dynamic waters. In this paper, a new formation control method based on the leader-follower method considering the heading angle of leader has been proposed. Specifically, due to the characteristics of large inertia and underdrive, the formation is divided into inner side and outer side when turning, naturally. USVs on the inside have a shorter desired trajectory so that untimely braking can lead to the collision of members. On the contrary, USVs located on the outside need to travel longer. Inappropriate control strategy is easy to cause the failure or even damage of the whole formation control system. First, the virtual structure of the formation was determined based on the number and shape of formation. Then, the track points of followers have been generated by linear translation combining formation structure and heading angle of leader. Further, the smooth and continuous of trajectory generated have been guaranteed by constructing an optimization function of minimum snap between adjacent trajectory points. When the formation travels in a straight line, the algorithm does not work, but works when turning. Finally, the proposed method has been verified by simulation experiments.

Intelligent Path Planning System for Shallow Submerged Unmanned Ship Based on MS-FA Method

Lei Zhao (Jiangsu University of Science and Technology & School of Electronic and Information Engineering, China)

Pengfei Zhi (Jiangsu University of Science and Technology, China)

Wanlu Zhu (Jiangsu University of Science and Technology, China)

Haiyang Qiu (Jiangsu University of Science and Technology, China)

Hui Wang (Jiangsu University of Science and Technology, China)

Weiran Wang (Jiangsu University of Science and Technology, China)

Multi-Sensorfusion (MS) has the characteristics of acquiring accurate and real-time information. Firefly Algorithm (FA) has strong local search capabilities, and it has certain advantages to find the optimal path, but its solution speed is slow. Therefore, on the basis of optimizing the Firefly algorithm, this paper proposes a shallow submersible unmanned ship intelligent path planning system based on the combination of multi-sensor information fusion (MS) and Firefly optimization algorithm (FA). This system solves the problem of traditional unmanned ship path planning, and can achieve the expected effect of shallow submersible unmanned ship avoiding underwater obstacles and shortening the path planning time and distance. The article uses the machine vision and sonar sensors on the unmanned ship to obtain real-time data for information fusion, and establish a real-time model of the environment. Secondly, the FA algorithm is optimized to increase the calculation speed. After that, the real-time model based on MS is combined with the FA optimization algorithm to form a shallow submersible unmanned ship intelligent path planning system based on the MS-FA method. Finally, using Matlab as a simulation tool, based on the establishment of the grid method real-time water environment model, the method proposed by me was verified through simulation analysis.

An Importance Weighted Model Predictive Control Method for Complex Industrial Process

Huiping Liang (Central South University, China)

Model predictive control (MPC) uses a large number of historical data to establish a predictive model of the controlled system through system identification or machine learning methods, and then based on this predictive model to minimize the cost function to find the optimal control signal. However, due to parameter changes or performance degradation in complex industrial processes, the data obtained in different time periods may follow different distributions. When the predictive model based on historical data is used for online control, the model mismatch between predictive model and real controlled system will appear. For this reason, an importance weighted model predictive control (IWMPC) method is proposed in this paper. The method firstly regards the historical data and online data as the source domain and target domain in transfer learning. Then by leaning the distribution mapping function of the source domain to target domain, the importance weight of all the source domain data is obtained. Finally, the accurate online predictive model is learned by weighted kernel ridge regression, besides error compensation and rolling optimization are added to realize the stable control for complex industrial process. In order to verify the effectiveness of the proposed method, comparative experiments are carried out in numerical simulation. The results show that the proposed method can effectively reduce the model mismatch caused by the distribution divergence between the historical data and online data, the control effect is better than baselines.

Continuous Angle Prediction of Lower Limb Knee Joint Based on sEMG

C. Li (Shanghai Normal University, China)

Haiyan He (Shanghai Normal University, China)

Shiyi Yin (Shanghai Normal University, China)

Huiyin Deng (Shanghai Normal University, China)

Yanfei Zhu (Shanghai Normal University, China)

With the development of rehabilitation robots in the field of medical rehabilitation, the human action classification based on surface electromyography (sEMG) has been widely used in robot human-computer interaction. Since the estimation of continuous joint angle can be employed to improve the performance of human-machine coordination, the accurate extraction of continuous joint angle from sEMG is one of the research difficulties in the field. This paper presents an Attention-LSTM model based on the electromyographic fusion. The sEMG of the lower limb in four channels and the corresponding knee angles of the lower limb during normal walking are collected by the sEMG acquisition system and the motion capture system. The Butterworth band-pass filter is used to reduce the out-of-band high-frequency and low-frequency noise of the data, and then the data are normalized. The sliding window is utilized to extract the time advance features and time delay features of sEMG. After the smoothing, the data are input into the Attention-LSTM model. The mean square error of prediction accuracy is used as the evaluation index. Finally, the data are analyzed by one-way analysis of variance (ANOVA) for significant difference ($p < 0.05$). The experimental results show that the difference in RMSE of the model is significantly smaller than that of the control group, which can accurately predict the knee angle of the lower limb from 75ms to 200ms in the future (RMSE=1.7444±0.2031), thus achieving the better human-computer interaction.

Application of Digital Lock-In Amplifier in Nonlinear Ultrasonic Inspection

ChuanYu Zhu (CGN Inspection Technology Co. Ltd, China)
Guanbing Ma (CGN Inspection Technology Co. Ltd, China)
Shaobin Shen (CGN Inspection Technology Co. Ltd, China)
Yikun Lei (CGN Inspection Technology Co. Ltd, China)
Songhua Huang (CGN Inspection Technology Co. Ltd, China)
Haiyan He (Shanghai Normal University, China)

In view of the difficulty in obtaining the amplitude of the signal within a specific bandwidth near the set frequency by the current digital signal processing method, this paper proposes to use the digital lock-in amplifier, use discrete equipment to obtain the digital waveform signal, adopt the signal processing idea of the lock-in amplifier in RAM 5000 SNAP, and use the digital phase sensitive detector, two sinusoidal / cosine modulated signals with specific frequency are obtained, the frequency is shifted to DC and the signals in the nearby frequency band are shifted to the low frequency band near DC; the two output signals of the phase sensitive detector will go through the digital low-pass filter, the out of band noise and the signal shifted to a higher frequency band will be filtered out. The output signals of the two low-pass digital filters go through the digital integrator to obtain the integral signal, and the integral signals go through the synthesizer to obtain the signal amplitude and phase within a specific bandwidth near the final setting frequency. Experiments show that this method, with single excitation, can obtain the spectrum distribution in the full band bandwidth with specified frequency resolution, and can more quickly obtain the accurate sub harmonic, fundamental frequency and second harmonic signal amplitude.

Non-Assembly Spherical Joint 3D-Printed for Soft Robotics Applications

Ali Zolfagharian (Deakin University & School of Engineering, Deakin University, Australia)

Rather than being restricted to industrial settings, robots are now being utilized in a variety of contexts, including homes, schools, and medical centers. However, in contrast to traditionally designed robots, these robots are flexible and have a high number of degrees of freedom (DOF), allowing them to perform a wide range of tasks. With the hyper-redundant DOF, the robot has the capacity to elongate, shorten, and bend, as well as regulate the force that the robot applies to its surroundings in a safer mode. In this study, a tendon-driven soft robot skeleton with an elastic constant curvature bone structure is developed using a non-assembly additive manufacturing approach. A spherical joint is 3D-printed using a non-assembly technique with an elastic constant curvature bone structure. The workspace of the 3D-printed tendon-driven soft robot is analyzed by understanding the actuated tendons and how they interfere with the backbone structure. A criterion for evaluating robot designs has been established. The criterion is developed by utilizing an optimization function to find the best possible solution. Through the use of the optimization method in MATLAB simulation, the optimal internal space radius and bending angle in the workspace are determined. The proposed approach could be used for non-assembly 3D printing fabrication of soft robotic joints and their workspace optimization in diverse applications such as human-machine interaction systems and medical instruments.

Network Latency Classification for Computer Games

Albert Wong (Langara College, Canada)
Chun Chiu (Langara College, Canada)
Gaétan J. D. R. Hains (Université Paris-Est Créteil (UPEC), France)
James Behnke (Okanagan College, Canada)
Youry Khmelevsky (Okanagan College, Canada)
Tyler Sutherland (WTFast, Canada)

WTFast's Gamers Private Network (GPN) technology improves and stabilizes network latency of communication between players and servers in online video games, especially when players are distributed worldwide. Latency is known to be the most critical factor in gaming quality of experience. We investigate the classification of game sessions based on their features to five "playability" levels of latency using a large data set collected from the GPN network in 2019-2020. Various machine learning models were developed using this data set and evaluated using conventional and new performance metrics. The results confirm that such a classifier could be developed with reasonable average accuracy. The correct classification and hence "playability" of a game session based on its environmental, sizing, game type, and physical features is important for the operation and continuous management of a game-focused network such as the GPN. The use of an effective machine learning classifier will pave the way for building an effective and productive pipeline for game traffic routing and dynamic network reconfiguration. While the proposed measure of classifier performance shows promise, more research work would be required to understand its mathematical and statistical properties and its relationships to existing metrics: (a) because it's a very specific type of application area (gaming+networking) for which there is relatively little ML research; (b) what very-high quality classifiers could mean for a real-time GPN management system that would provide QoE feedback to the GPN routing heuristics.

A Nonlinear Adaptive Predictive Control Method Based on WT-BiLSTM

Chengzhu Wang (Csu, China)

Industrial processes usually have strong nonlinearity and dynamics, which lead to extreme difficulties in traditional control method for effective control. In this study, a nonlinear adaptive predictive control method based on wavelet transform and bi-directional long short-term memory (WT-BiLSTM) is proposed. Wavelet transform is firstly conducted to decompose the original data of system output into multiple sub-sequences in different frequency bands, which can reduce the non-stationarity of the original time series. Secondly, the prediction input matrix is constructed by combining the decomposed sub-sequences and the system inputs as multi-dimensional features. Then, BiLSTM, a powerful tool which can effectively extract the bi-directional temporal features, is implemented to build the prediction model, called WT-BiLSTM. Finally, for the problem of difficulty in solving the objective function using WT-BiLSTM as the prediction model, a nonlinear adaptive predictive control method optimized by particle swarm (PSO) algorithm is proposed. In order to verify the effectiveness of the proposed control method, this paper uses a typical Hammerstein system with nonlinearity and dynamics as the numerical simulation case, the experiments of predictive performance analysis and control performance analysis are designed respectively. The experimental results show that the proposed method can significantly improve prediction performance and control stability compared with some state-of-the-arts methods.

Bus Voltage Stability Control of Distributed Photovoltaic and Energy Storage DC Microgrid Based on ADRC

Tengfei Dai (Nantong University, China)
Jingfeng Mao (Nantong University, China)
Xiaotong Zhang (Nantong University, China)
Chunyun Yin (Nantong University, China)
Yinjia Ding (Nantong University, China)

This paper proposes a fast and efficient MPPT photovoltaic control strategy and a BESS bus stabilized power control method for the high-performance operation control requirements of the distributed photovoltaic and energy storage DC microgrid. The distributed photovoltaic and energy storage DC microgrid is composed of solar photovoltaic power generation system, battery energy storage system and DC load. First, the principle of power balance of photovoltaic and energy storage in DC micro-grid is analyzed, and the mathematical model of distributed power generation in DC microgrid is derived. In order to improve the high-efficiency absorption capacity of photovoltaic energy, the MPPT photovoltaic controller of the exponential variable step disturbance observation method based on the variable smoothing factor is designed. Considering the impact of photovoltaic power generation and load power fluctuations on the bus voltage stability, applying the active disturbance rejection control (ADRC) theory, the BESS DC bus voltage stability controller is designed to realize the reasonable distribution of the optical storage power in the network and the dynamic and stable control of the bus voltage. Using MATLAB/Simulink software, a system simulation model is established. Through a variety of simulation condition tests, and comparing with traditional PID control performance, the correctness and effectiveness of the proposed method are verified.

Intelligent Transportation Systems

Optimal Dispatching of Transport Orders Using Genetic Algorithm for Decentralized Order Management System of AGVs

Jie Zhang (Salzdahlumer Str. 46/48, Germany)
Ostfalia Hochschule (Institut für Mechatronik, Germany)
Xiaobo Liu-Henke (Ostfalia University of Applied Sciences, Germany)

This paper describes an assistant function to support the management of transport orders from production line based on genetic algorithm (GA) for AGVs, with the help of which the transport orders are classified taking into account their priority and predefined deadline and assembled in a certain order into a new order for AGVs. Its aim is to optimize the intralogistics in the situation of insufficient transport performance using AGVs in the run-up to the execution of the transport order, particularly to minimize the transport delay and thus increase the punctuality rate of the transport order goods transport. Based on the defined objectives, the functional modules of the assistant function are specified: 1. Dynamic adjustment of the priority of transport orders and 2. Classification and regrouping of transport orders. Based on the mechatronic development cycle, the assistant function is model-based developed. Based on conventional GA, the optimization approaches are used in this paper. To accelerate the convergence of the GA to an optimal solution and at the same time ensure the individual quality in the iterative development process of GA, the elitism strategy is employed so that the worst offspring of the current generation should be replaced by the best individuals of the previous generation. The number of elitists is carefully determined, considering the specificity of the use case. To keep the diversity of individuals in the late stage of the evolutionary process of GA and to avoid the risk of convergence to a local optimum, the recombination and mutation probability shall be dynamically adjusted in the train of the evolutionary process. In the further course, the developed assistant function will be integrated into the existing decentralized order management system of AGVs. Its functionality will be secured and demonstrated through model-in-the-loop (MiL) simulation with an application example.

Design of Dynamic Obstacle Avoidance System for Self-Driving Sweeper Based on Lattice-Planner

Hailong Chen (Nantong University)
Quan Shi (Nantong University, China)
Peng Ping (Nagoya University, Japan & Southeast University, China)
Yufan Liu Yuan (Nantong University, China)
Ping Peng (The Hunan Electric Power Research Institute, China)
Zhou Hang (Nantong University of Testing, China)
Yue Zhang (Nantong University of Testing, China)

In this paper, a dynamic obstacle avoidance control system of self-driving sweeping vehicle based on lattice planner algorithm in robot operating system (ROS) is designed. Based on the chassis of traditional manual sweeper, an obstacle avoidance method in line with the driving characteristics of sweeper is designed. Firstly, the planning starting point of this frame is calculated according to the mileage points of the previous frame, then the summary information of static and dynamic obstacles is obtained according to the point cloud data of lidar, and then the horizontal and vertical trajectories are generated according to ST and SL diagrams. After the feasibility analysis of the trajectory, a large number of trajectory bundles are eliminated, the cost detection is carried out for the trajectory bundles that meet the rules, and then the collision detection is carried out for the only few remaining trajectories. Finally, through real vehicle debugging, the scientificity and safety of the algorithm in application are verified. In this paper, the lattice planner algorithm is improved. According to the characteristics of slow running speed and edge cleaning of self-driving sweeper, the roadside and small obstacles are accurately identified during collision detection, and then the transverse and longitudinal trajectories are generated according to ST diagram and SL diagram. The track bundle that meets the rules is cost detected, and the path that meets the conditions is output to the chassis. Firstly, the proposed obstacle avoidance algorithm is verified on the Gazebo simulation platform in the ROS robot operating system, and finally the real vehicle is debugged.

Model-Driven Application Development for Evaluation and Optimization of Automotive E/E-Architectures

Maximilian Hammer (Technische Universität Ilmenau, Germany)

Ralph Maschotta (Ilmenau University of Technology, Germany)

Armin Zimmermann (Ilmenau University of Technology & Systems and Software Engineering, Germany)

Over the last decades, automobiles have developed from predominantly mechanical machines to driving computers, that consist of a large number of sensors, actuators, and electronic control units that use various types of communication busses to form large and complex cyber-physical systems which provide a variety of comfort and safety features for the driver. Such E/E-systems (electric/electronic systems) do not only require high availability and reliability, but also overall efficient architectures and topologies. Because of the already high (and constantly increasing) level of complexity of such systems, the evaluation and optimization of their corresponding architectures has become a big challenge. The need for evaluation and optimization methods that are capable of abstracting the systems' complexity is evident for the automotive industry. In general, when it comes to designing and developing hard- and software systems, the paradigm of model-driven engineering emphasizes and supports the measures of abstraction, flexibility, and reusability to be able to grasp the complexity of modern systems. This paper presents a model-driven application for analyzing, evaluating and optimizing automotive E/E-architectures based on real automotive architecture models. The presented application was developed as part of an integrated, model-based toolchain, developed with the Eclipse Modeling Framework and the Eclipse Sirius project.

Model-Driven Aspect-Specific Systems Engineering in the Automotive Domain

Ralph Maschotta (Ilmenau University of Technology, Germany)

Maximilian Hammer (Technische Universität Ilmenau, Germany)

Tino Jungebloud (Ilmenau University of Technology, Germany)

Mehreen Khan (TU Ilmenau, Germany)

Armin Zimmermann (Ilmenau University of Technology & Systems and Software Engineering, Germany)

The design and development of modern automobiles have become a big challenge for the automotive industry. The complexity of automotive hard- and software systems constantly increases due to the development and advancement of various kinds of safety, security, and comfort features. Even though various tools for model-based systems engineering exist in the automotive domain, some of them cover every phase and every aspect of the whole development process. The extent and complexity of the resulting models make it difficult to efficiently analyze, evaluate and possibly optimize corresponding architectures with respect to specific aspects. An approach to overcome these barriers is the development of aspect-specific toolchains based on automotive architectural models. Such toolchains must be specially tailored to certain aspects of interest, and at the same time, be sufficiently adaptable to offer flexibility and reusability. Modern model-driven approaches can be used to achieve these goals. This paper presents a model-driven development workflow for aspect-specific tools for analyzing, evaluating, and optimizing specific measures of automotive hard- and software architectures and presents some details of an aspect-specific application, which was developed as a proof of concept for the suggested workflow. Moreover, it presents some challenges using the suggested workflow and using the developed tool for a complex real-world automotive system model.

A Two-Stage Stochastic Model for Intermodal Transportation Operational Planning Problem Under Capacity Shortage

Yifan Huang (Shanghai University, China)

The huge freight demand and the shortage of shipping capacity highlight the current dilemma of international intermodal transportation. Due to the various uncertain information, it may not be the best way to choose the transportation orders which have the highest bidder when the available capacity is limited. Therefore, which orders should be accepted and how to serve them effectively has become a critical problem to be solved. In this paper, considering uncertainties of the capacity and the travel time of the transportation services, a two-stage stochastic programming model is developed to maximize the expected profit of the intermodal transportation operator by choosing the optimal order portfolio and planning intermodal routes. By utilizing the sample average approximation method, the two-stage stochastic model is transformed into a mixed integer linear programming model, integrated with large sampled scenarios. Computational experiments are conducted and results are analyzed to explore the influence of the uncertainty on the operator's operational plans. Several managerial implications for the practical intermodal transportation operation are derived: uncertainties lead to different optimal order selecting plans compared with the deterministic situation; orders offering high quotations tend to be preferred by the intermodal transportation operator under capacity shortage in the deterministic condition; but in uncertain environments, the degree of urgency and transportation demand quantity of orders play important roles.

Trust, Security, and Reliability

False Data Injection Attack Testbed of Industrial Cyber-Physical Systems of Process Industry and a Detection Application

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False data injection (FDI) attack is a common and destructive attack method in Industrial Cyber-Physical Systems (ICPSs), which is mounted in the cyber layer, compromises the measurement data and interferes the physical system at last, especially in the process industry and smart grid. In response, researchers developed many detection method rely on simulation, but the real situations are not ideal simulation environment. This leads to situation in which the high-level methods cannot applied to industrial sites directly. In this paper, we design a testbed of process industry, which is a hard-in-loop platform, to simulate the real industrial production and applied a FDI attack on the platform. The physical process is simulated by a host, and the cyber items are real industrial controller or engineer station. Next, we design an efficient FDI attack detection method, DRIF. Based on our proposed framework, the optimal potential features of high-dimensional industrial process data can be fully extracted, which is conducive to the stage of accurate detection. In addition, it makes our proposed method practicable in real-world scenarios where data instances in normal condition can be used for model training only. The proposed method is applied on the designed platform, and the promising case studies show our framework can achieve satisfactory detection performance, which sheds light on the industrial security to some extent.

Model-Based Performance Evaluation of Safety-Critical POMDPs

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Partially Observable Markov Decision Processes (POMDPs) have been successfully employed for planning and control in safety-critical applications (e.g., autonomous vehicles) with uncertain environments. POMDP development is a subjective process and depends on assumptions inferred from available information from system-environment interactions. This subjective process can result in different designs (e.g., different state-spaces) where one needs to analyze their performance and robustness to choose the POMDP that best satisfies safety and performance requirements. The robustness and performance depend on accurately inferring states and providing optimal and safe responses in presence of uncertainties, such that the goal can be achieved without violating safety requirements. These properties are typically evaluated by extensive, end-to-end testing of the developed POMDPs in simulated environments and measuring their average performance in simulated scenarios, where the measured performance relies entirely on the end results (e.g., crash or no crash) obtained from the simulated scenarios. To avoid this suboptimal process, we propose a model-based, probabilistic technique to evaluate performance and robustness of a class of POMDPs, where states are designed to represent various high-level situations in the environment, including both the goal and failure states. In this technique, the robustness and performance of designed POMDPs are evaluated by mapping POMDPs to their belief-space and estimating the extreme and expected probability of transitioning to failure states. Finally, we employ our technique to compare and evaluate two different POMDPs designed for controlling an AV in a safety-critical use-case scenario (lane-keeping with risky situations and corner-cases). By comparing the results obtained from our technique to end-to-end simulation-based evaluation, we show that the proposed technique can correctly identify the POMDP with best performance.

A Model-Based Systems Engineering Approach to Obtain Fault Trees for Failure Analysis Using SysML

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Industries are constantly being challenged with project and system complexity and the different processes and approaches these convey. In addition, there may be a different number of stakeholders, areas of interest, and ambiguous communication among each of the interested shareholders. When new projects and systems are under development, there are decisions that need to be made related to the reliability of it that may rise issues and it is essential to be able to reduce and mitigate risks in the early stages before the cost of fixing them increases. As systems continue to grow in scale, Model-Based Systems Engineering (MBSE) has become the main approach to manage complexity and maintain consistency in system development. MBSE is an approach that is becoming particularly popular because it allows the generation of system models that help formally establish specification, system requirements, analysis, design, and verification and validation (V&V) activities throughout the development of the system life cycle while ensuring traceability. In this paper, a detailed review of an Automated Teller Machine (ATM) System design process implementation as a use case is presented using Systems Modeling Language (SysML) to support system semantics through an MBSE approach, and later develop a reliability analysis - Fault Tree Analysis (FTA) to help in system improvements and facilitate decision-making in the development of the system.

Anomaly Detection Using LSTM Neural Networks: An Application to VoIP Traffic

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Voice communications nowadays are largely dominated by VoIP, which substituted the Plain Old Telephone Network over the years. Telephone exchanges are thus software-based rather than electromechanical, and a whole set of new methods for analyzing anomalies has been introduced. This paper addresses the implementation of an AI application, based on the LSTM model, whose aim is to learn to predict the VoIP traffic shape given what happened in the past, to compare it with the normal or expected traffic, and eventually state whether the system is going to fall into an anomalous situation or not. In the paper we use data from a real working system instead of synthetic data or pre-built datasets. We consider a system in a real production environment, and we deployed the model we developed on the system itself, comparing its forecasts with the actual VoIP traffic flow. We verified that the forecasts and the actual traffic do not significantly differ in the general case. In one case, however, our model contributed to find a configuration problem in the system, allowing to correct it before it could generate further issues. These results confirm the usefulness of the model in detecting malfunctions or anomalies in VoIP based systems. Further applications of the proposed methodology include video conferencing and other IP-based communication systems.

Machine Learning

DOA Estimation of Underwater Acoustic Signals Based on Deep Learning

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Direction of arrival (DOA) estimation is an essential part of array signal processing and it is also one of the main tasks in the field of sonar arrays. The most commonly used method in the DOA estimation problem is to perform subspace decomposition of the array covariance matrix. Since traditional neural networks can only deal with real numbers, they cannot handle real and imaginary numbers at the same time, so the input of the neural network is very limited. Based on the extensive application of the residual network (Resnet) in the field of computer vision, this paper proposes a method of using the covariance matrix as an image processing, which uses a two-channel matrix image containing the imaginary covariance matrix and the real covariance matrix as the residual network input to go on estimating DOA of the underwater acoustic array. The existing mature solutions are used to solve the sound field problem and provide a new perspective for DOA estimation. In terms of estimation accuracy and estimation time, the Resnet algorithm is compared with the traditional MUSIC algorithm. Simulation experiments prove that the Resnet algorithm has higher accuracy and shorter prediction time in a low signal-to-noise ratio environment, it is better than the traditional MUSIC algorithm.

Series Dynamic Hybrid Model Based on Material Conservation and Neural Networks for Oxidation Leaching Process

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Oxidation leaching process is an important stage of the hydrometallurgy of zinc, and the establishment of its mathematical model is of great significance to the implementation of optimal control and monitoring. As a result, a series dynamic hybrid model based on material conservation and neural network for oxidation leaching process is developed in this work. On the one hand, in order to eliminate the shortcoming that traditional first principle models are easy to fall into the local working condition, based on the traditional mechanism framework of material conservation, this paper proposes the solid phase mass conservation equation. On the other hand, for obtaining the reaction rate model more conveniently and discovering the deep information which is difficult to explain by mechanism, the neural network is introduced to replace the original complex kinetic reaction rate equation. In addition, for the purpose of reducing the influence of noise amplification and transmission induced by derivative operation, this paper introduces integration regularization method to estimate the reaction rate, thus it further increases the accuracy and anti-noise ability of the proposed model. Finally, extensive experiments are conducted to verify the accuracy and efficiency of the proposed model, the numerical results indicated that the proposed method is superior than the traditional first principle model and data-driven model.

A Novel Zinc Price Forecasting Method Based on Multi-Factor Selection and LSTM Network

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Zinc is an indispensable base material for the development of national economy and the construction of national defense industry, and the price forecasting is of great significance for investors, policy makers and researchers. Considering the complexity, dynamic and strong nonlinearity of zinc price changes, and it is usually affected by a variety of external factors, it is difficult to obtain a satisfactory forecasting effect only by analyzing the underlying pattern of historical price data changing. To solve the aforementioned problem, a novel zinc price forecasting method based on factor selection and long short-term memory network is proposed. First, a number of factors that may be related to price changes are collected and Granger causality test is employed to remove the non-causal factors. Then, XGBoost is used to analyze and sort the remaining factors by importance, and the factors with high importance for forecasting are selected. Finally, utilizing the historical price of zinc and the selected external factors, a multivariable forecasting model based on long short-term memory network is established to forecast the future price of zinc. Compared with other state-of-the-art methods from value and direction prediction accuracy and fitting ability, the proposed model has superior performance for zinc price forecasting.

Modelling Network Latency and Online Video Gamers' Satisfaction With Machine Learning

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The Gamer's Private Network (GPN) technology improves and stabilizes the latency of communication between players and servers in online video games, especially when players are distributed worldwide. Latency is known to be the most critical factor in gaming quality of experience. We investigate GPN latency improvement over the normal internet and its relationship to player satisfaction using complex, massive data sets, machine learning techniques, and game genres or types. The conclusions confirm the added value of GPN technology for players but also quantify how it meets the exact needs of specific game types. Latency reduction is both the heart of WTFast's business and the key quality feature of games networks. This dimension has been studied for many years and in their recent paper, Saldana and Suznjevic confirm the necessity of low latency, even above that of bandwidth throughput, for player engagement in almost every kind of online game. The main genres/types for online video games according to are: First-Person shooters (FPS), Massively Multiplayer Online Role-Playing Games (MMORPG), Real-Time Strategy (RTS), Multiplayer Online Battle Arena (MOBA) and Sports games that simulate team sports such as racing. Authors in quote existing surveys that for FPS games, a one-way delay of 80ms can be acceptable for most game users. For MMORPG games, players started rating the game quality from "excellent" to "good" when one-way latency raised above 120ms. The geographical location of servers is correlated with latency due to transmission delays. From the point of view of the routing technology, we confirm the value of GPN for players but quantify its current imperfections in meeting the exact needs of specific game types. We also confirm that high-quality predictors for latency are possible and that random forest algorithm seems to perform better than neural nets or support vector machines in this setting.

Intelligent Identification of Rotor Axis Trajectory Based on Anti-Grayscale Preprocessing and Convolutional Neural Networks

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Different shapes of rotor axis trajectory can reflect different fault states of the rotating machinery. However, the current data processing methods cannot extract the information characteristics of rotor axis trajectory as a symptom of intelligent fault diagnosis of the rotating equipment. In this paper, the image recognition method is used to transform the problem of vibration signal analysis in the orthogonal direction into the problem of pattern recognition of the two-dimensional image. The anti-grayscale preprocessing method can effectively prevent the image from losing contour information after the max pooling operation. The convolutional neural network is used to extract the local and global topological features of the rotor axis trajectory images to eliminate the influence of plane position on recognition. Finally, the information description of different rotor axis trajectory shapes is obtained, which is used as the feature of intelligent fault diagnosis of rotating equipment. The experimental results show that the rotor axis trajectory images pretreated by the anti-grayscale preprocessing method have more advantages in the process of training the convolutional neural network. Compared with the traditional methods of recognizing the rotor axis trajectory, the intelligent recognition method based on the convolutional neural network has higher accuracy and better robustness.

Scheduling Security-Critical Workflow Tasks in Mobile Edge Computing

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Mobile edge computing can deliver high-throughput and low-latency computing services by means of offloading computation tasks of mobile devices to edge servers. This paper aims at scheduling security-critical workflow tasks, which require data encryption and decryption during the offloading procedure and have precedence relations among each other, in a mobile edge computing environment. The scheduling problem is formulated as an optimization problem that minimizes workflow execution time and total energy consumption under precedence constraints upon security-critical tasks. The optimization model takes into account the time and energy overhead for data encryption and decryption. We propose a new particle swarm optimization algorithm to solve the resultant optimization problem. This algorithm uses a position-based mapping operator to convert each particle into a high-quality feasible solution, which is represented by a task sequence. For each converted solution, we develop a greedy search strategy to offload workflow tasks onto edge servers such that the completion time and energy consumption can be evaluated. In addition, we incorporate Levy flight into the standard movement scheme for updating particle positions, in order to improve the computational efficiency of the particle updating procedure. Experimental results show that the proposed algorithm outperform baseline approaches in terms of both effectiveness and efficiency when solving the considered scheduling problem.

A Novel Cuckoo Search Algorithm for Solving Permutation Flowshop Scheduling Problems

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The permutation flowshop scheduling problem (PFSP) is a classical optimization problem in the field of system engineering. In this paper, different from the traditional PFSP, we take into account the fact that all jobs in PFSPs may have different speed levels. That is, each job uses its own speed level on all machines and its processing time can be different with the assigned speed levels. We propose a novel cuckoo search algorithm to solve this PFSP by means of obtaining a Pareto-optimal solution set to jointly minimize the total flow time and the total energy consumption. The proposed algorithm establishes a new movement strategy to improve the diversity of scheduling solutions and to avoid being trapped into local optima. In addition, we develop a new speed scaling strategy that is capable of expanding the Pareto-optimal solution set. The proposed algorithm is compared with an energy-efficient iterated greedy algorithm, which is the best existing algorithm for the PFSP studied in this paper. We conduct extensive simulations on various benchmark instances for comprehensive performance evaluation. Evaluation results show that the proposed algorithm outperforms the competing algorithm in terms of both effectiveness and efficiency. The new movement strategy is also verified to be advantageous over the traditional one.

A Novel Binary Black Hole Algorithm for Feature Selection of Scientific and Technical Text

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Selecting effective features from the raw attributes is an important step in scientific and technical text classification. Feature selection aims to pick the best subset of candidate attributes to achieve superior performance of the learning algorithm. Recently, many meta-heuristic algorithms were widely developed for feature selection in classification problems. Black Hole Algorithm (BHA) is an emerging meta-heuristic algorithm, inspired by the mechanism of star motion around black holes, which has achieved excellent performance on a variety of optimization problems. A novel Binary Black Hole Algorithm (BinBHA) was proposed in this work, to enhance the efficiency of searching optimal features from the high-dimensional attributes of scientific and technical texts. In BinBHA, all operators are binary encoded without continuous-binary transformation, which makes it better for exploring the solution space of discrete problems and finding globally optimal solutions. The proposed algorithm has been compared with several alternative state-of-art methods for feature selection, and the effectiveness of the approach was evaluated on several benchmark datasets. In this paper, BinBHA was successfully implemented on an actual scientific and technical text dataset, and achieved the best performance results among other algorithms. The experimental results demonstrated that the proposed binary encoding method can improve the prediction accuracy significantly while finding the optimal solution effectively.

Multiserver System Configuration Scheme for Profit Maximization

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As a promising and valuable IT commercial model, Cloud computing has been paid considerable attention by academia and industry, which makes the configuration of storage, computing, and communication resources a common commodity for pay-as-you-go management. Thanks to the rapid development of virtualization techniques, an increasing number of users can expediently receive cloud services, which spawns a group of excellent cloud service providers (e.g., Ali Cloud, Google, and Amazon). The increasing number and variety of cloud service providers also promote the sustainable development of cloud computing. The pursuit of profit maximization is a natural goal for service providers. To realize this goal, cloud service providers are supposed to fully understand the relationship between the economics of cloud services and the system resource management of the cloud platform (also called the multiserver system), especially in a geographically distributed multiserver system, and serve the intermittent cloud service requests. There are two kinds of resource schedule methods categorized by the decision information for a cloud data center, which are average-based scheduling and instantaneous-based scheduling. Although instantaneous-based schemes usually perform better than average-based schemes, instantaneous-based schemes schedule every service request, resulting in high administrative costs, especially when the computing resources are geographically distributed. Moreover, an elastic multiserver system requires performance and cost predictable, auto-scalable, which means the resource management scheme uses a small number of system parameters to satisfy elasticity conditions (i.e., quantitative descriptibility and analytical traceability). Hence, in this paper, we give a short review of the multiserver system configuration scheme for profit maximization in different ways.

Stochastic Scheduling for Bag-Of-Tasks Applications With Uncertain Task Durations in Cloud Computing Environments

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Scheduling bag-of-tasks (BoT) applications, which consist of many independent tasks, has been a challenging problem in cloud computing environments. Most existing BoT scheduling algorithms fail to consider the uncertainty of the task duration in actual situations, and regard task durations as fixed values that are pre-determined. Taking uncertain task durations into account, this paper establishes a stochastic optimization model for the BoT scheduling problem with the optimization objective of minimizing user's cost for using cloud computing resources. The optimization model formulates each task's duration time as a normally distributed random variable, and imposes a stochastic deadline constraint on each BoT application's makespan, under which the application must be completed before a user-specified deadline in a probabilistic sense. We further design a stochastic BoT scheduling (SBS) metaheuristic algorithm to solve this stochastic scheduling problem. For each candidate scheduling solution, the proposed SBS employs a task assignment strategy to designate BoT tasks onto virtual machine instances under uncertain task durations as well as probabilistic deadline constraints. In this manner, the quality of each solution can be evaluated. An iterative procedure is performed to explore the best solution with the highest quality. Experimental results justify that the uncertainty-aware SBS algorithm can not only guarantee the satisfaction of probabilistic deadline constraints but also substantially reduce the user's cost.

A Mobile Edge Computing Task Offloading Framework Based on Improved Beetle Antennae Search

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As an indispensable key technology in 5G Internet of Things (IoT), Mobile edge computing (MEC) can provide low-latency and low-energy computing requirements for mobile devices. Moreover, computing offloading is an important part of MEC. It determines how the device offloads tasks to the server and affects the system revenue of edge computing system. However, existing algorithms usually have high complexity and computational time during obtaining a calculation offloading strategy. These would increase the overall time overhead of MEC system. Thus, in the computing offloading scenario for one server and multiple users, this paper proposes a low-complexity computing offloading strategy based on improved Beetle Antennae search (IBAS) to maximize system revenue. First, considering the system delay and energy consumption as optimization objectives, an edge computing system is remodeled into a system revenue optimization with constraints of the maximum number of server cores and longest task delay. Finally, by introducing multi-channel exploration and simulated annealing, an improved Beetle Antennae search algorithm is suggested to solve the optimization problem. Through simulation experiments of different equipment scales, they demonstrate that the proposed framework has lower delay than traditional algorithm without reducing global optimization capabilities and algorithm stability. So, it can effectively improve the user experience.

Attention Based Frequency Adaptation Graph Convolutional Network

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Graph neural networks (GNNs) are widely used in deep learning of graph structured data. These architectures based on assortative network aggregate smooth information from neighbor nodes to achieve feature collection and update. However, these models cannot deal with the disassortative networks. That is, the connection nodes may have different class labels and different characteristics of the networks. Existing studies show that different information between nodes collected from the neighborhood can more effectively represent the characteristics of nodes in different situations. This strategy also shows good effect in heterogeneous network structure. Based on this insight, we propose a novel attention-based frequency adaptation graph convolutional network (AFAGCN) to learn dissimilarity information between nodes more effectively. This proposed network suggests a new attention mechanism through introducing the dot product attention into the traditional attention mechanism. So that it can aggregate the dissimilarity or similarity features from nodes adaptively in the process of feature transfer. Based on the dot product attention, we remove the weight matrices to reduce the memory cost and improve the robustness of the model. A number of experiments on six real networks demonstrate that the proposed approach not only outperforms than the latest technologies on assortative datasets, but also has more advantages on disassortative datasets.

Location Privacy Protection Scheme Without Trusted Third Party

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With the rapid development of the Internet of things (IoT), location-based services (LBS) have become an indispensable tool. It has brought great convenience to people's daily life, such as car navigation, online taxis, takeaway, and ticketing services. However, with the widespread application of LBS, personal location privacy may be leaked, which will limit the development of LBS severely. The system architecture of LBS mainly includes mobile terminal (MT), position system, location service provider (data server and LBS server), and network service provider. When mobile users apply for LBS, they need to submit their real-time location and query requests to the LBS server. However, the users' location trajectory can be formed according to the temporal and spatial relationship of the information submitted by the user. Then the attacker can infer the private information, such as personal whereabouts, home address and work location, health status, religious beliefs, and living habits from the location trajectory. Therefore, it is necessary to protect users' location privacy. In this paper, we summarize the existing work and propose the concept of a predictive caching scheme without a trusted third party. In the proposed scheme, we use the Markov chain to establish the prediction model of the mobile users. We calculate the ability of the scheme to generate the wrong position by the location entropy.

Systems Design and Validation

Seamless Validation of Cyber-Physical Systems Under Real-Time Conditions by Using a Cyber-Physical Laboratory Test Field

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Cyber-physical systems (CPS) form the basis for many future-oriented technologies such as autonomous driving or Industry 4.0. The development and, in particular, the validation of such systems under real-time conditions represent a major challenge despite extensive software tools. Nowadays, the latter can only be done by replicating the system as a model (with corresponding simplifications, which only inadequately reflect the emergent system behavior) or by testing it in the later operational environment (which leads to non-reproducible results and a high hazard potential). A tool for the investigation of the emergent system behavior under consideration of all real influences such as latencies and discretization is missing. The following paper presents the seamless validation of CPS under real-time conditions by using a cyber-physical laboratory Test Field as an approach for addressing the problem outlined above. This allows the CPS, scaled to laboratory size, to be examined under realistic conditions. Based on the recent state of knowledge, the current development and validation methodology for CPS as well as its tool support is analyzed. Based on identified gaps, a concept for the test field is elaborated. The design of the test field for different configurations is performed to fill the identified gaps. With the help of a complex, end-to-end case study -- conflict-free trajectory planning and decentralized order management -- both the extended methodology and the basic functions of the test field are basically verified.

A Survey of Natural Language Processing Implementation for Data Query Systems

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With increasing complexity and volume of collected data continuing to rise, it is becoming ever more important to develop systems with high interactability. Businesses with an interest in big data continue to seek solutions that limit cost while providing effective, simplified solutions to current issues in data retrieval. Combined analysis and application of a multi-factorial system will likely lead to promising results in ease of reporting of complex data by nontechnical end users. This survey is focused on natural language processing (NLP) implementations for data query systems, especially related to massive data sets (1TB+) in OLTP databases, OLAP databases, and data warehouses. We are seeking the most up-to-date and effective uses of NLP for Speech-to-SQL and Text-to-SQL generation, and the most recent advancements in data warehousing to optimize ELT efficiency and data retrieval, focusing on the highest performing code implementations on the Spider and WikiSQL datasets. Many models, including sequence-to-sequence (seq2seq), sequence-to-SQL (Seq2SQL), and fuzzy semantic to SQL (F-Semtosql), among others, are briefly described and compared. As well, recent advancements in data warehousing technology like multi-disk buffering in the ELT process and hybrid multi-dimensional and relational OLAP databases (HOLAPs) are discussed. The learning gathered here is applied to fill a gap in the current industrial knowledge base in service of increased efficiency in data access, retrieval, and reporting in a customer-facing environment.

Multiple-Structure Attention Network for Click-Through Prediction in Recommendation System

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In recent years, the total amount of data generated by people has increased exponentially, which makes it a great problem to recommend for users, so recommendation system (RS) plays an important role in this process, and it has been widely used in many online service fields such as e-commerce system and science and technology (S & T) service platform. As an important part of the RS, CTR prediction has been studied in depth, from the beginning, machine learning methods include logistic regression (LR), factorization machines (FM) and field-aware factorization machines (FFM) models, to deep learning methods such as multi-layer perceptron (MLP), product-based neural network (PNN), deepFM and xdeepFM models, and later attention mechanism-based methods such as AFM and DIN models, they all lack the application of S & T service platform. The multiple-structure attention (Mul-AN) network model is proposed in this paper integrates the low-order as well as explicit and implicit feature interactions without any manual feature engineering for the data, and introduces the attention mechanism into the embedding layer of the model to distinguish the importance of the interaction of different feature, and will be finally applied it to the Hainan Comprehensive S & T Service Platform. Extensive experiments verify that the model can improve the performance and accuracy of S & T service platform CTR prediction.

MobileNet Based Chinese Chess Recognition With Xavis Platform

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The disadvantages of convolutional neural networks are that they cannot run on mobile devices and embedded devices due to their large memory requirements and large amounts of computation. With a small loss of accuracy, the lightweight neural network greatly reduces the number of parameters and the amount of computation compared with the ordinary convolution neural network. In order to use robot arms accurately grasp the chess pieces and place on the right place of the Chinese chess board, the chess pieces should be recognized and classified quickly in real time. In this paper, the MobileNet is embedded into the Xavis platform, which is combined with the robot arms to realize the recognition of Chinese chess. Firstly, convolutional neural network methods are introduced. Then network structure of MobileNet is analyzed, and the pattern recognition method is shown. Xavis platform with MobileNet is further investigated. And the dataset of Chinese Chess is collected. At last, experiments on the self-made Chinese chess data set show that the MobileNet has good chess classification ability. It lays a solid foundation for the grasping work of the robot arms. Next, we will further improve the method of Chinese Chess recognition with Xavis Platform and compare the proposed schedule with state-of-art methods.

Identification of Systems With Similar Chains of Components for Simulation Reuse

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Simulation is an essential tool to evaluate a complex system's behavior. Simulation reuse can potentially improve simulation quality, cost, and delivery. However, identifying reusable simulations is a difficult task, often manual and based on limited information. This paper presents a method to facilitate the reuse of specific parts of past simulations. The system to simulate is compared to systems which have already been simulated. The comparison, which permits to identify similar chains of components in the systems' block diagrams, is formalized with graph theory. The comparison takes into account standardized tags as well as block properties defined by a name, a value, and a unit. Similar systems are identified with a limited computational cost. When two systems are similar, a mapping between their components and interactions can be obtained at a higher computational cost. A software prototype is implemented to perform the necessary computations, visualize the results, and accordingly select the simulation parts to reuse. The software prototype is tested with the block diagram of an autonomous electric car. Similar chains of components are successfully identified in the powertrain of a non-autonomous electric car represented in a past simulation. The corresponding part of the past simulation can then be selected for reuse.

SpinalNet X-Ray: A Novel Deep Learning Tool for Classifying X-Ray Images

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Over the past year, COVID-19 has become a global pandemic and people across the globe have suffered a lot from this pandemic. The rate of transmitting the coronavirus in people is very quick. A rapid diagnosis can potentially help governments in identifying the pattern of transmission. There are some tests available but consumes much time to give the report. So, in this work, we have proposed a model that will distinguish between normal people, COVID affected people, and pneumonia affected people with the help of an X-ray. X-ray images are considered because taking an X-ray image is very little time-consuming. In this work, we have trained the X-ray images with a novel Deep Learning approach with SpinalNet architecture, and that distinguish normal people, COVID affected people, and pneumonia affected people. After training the model we have achieved a very good accuracy for the SpinalNet architecture that is 96.12% while the traditional model provides 95.50% accuracy. We present precision, recall, and F1 scores of COVID and Pneumonia classes. We also present our results and codes with execution details. This paper contains the link to Kaggle notebooks with execution details. The applied Spinalnet transfer learning code is available in our GitHub repository. The link for the repository is as follows: <https://github.com/dipuk0506/SpinalNet>

Design and Implementation of a Target Tracking and Ranging System Based on Binocular Vision

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In order to measure and track a specific target at night and under poor lighting conditions, a target tracking and ranging method based on binocular infrared is proposed, and the corresponding hardware and software systems are designed, including infrared vision subsystem, turntable control subsystem and upper computer monitoring software. The system proposed in this paper is based on the embedded microcontroller and the open-source hardware of MicroPython language. It is equipped with two small infrared thermal imaging sensors to realize the real-time acquisition and processing of the target infrared image. The system measures the distance of the target according to the principle of parallel binocular vision positioning, and uses the detected pixel coordinate information of the target image to track the measured target. Finally, the binocular infrared vision target tracking and ranging system designed in this paper is validated by building an experimental platform in a laboratory environment. The designed system is able to track the target within 18m distance and effectively range the target within 8m range, and the whole system uses an embedded hardware platform without the participation of a general-purpose computer, which has a low cost and can perform real-time ranging and complete real-time tracking of specific targets with limited hardware resources.

A Kind of Model Predictive Control Under Model Mismatch

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On the basis of the equivalent dynamic linearization model (EDLM), we propose a kind of model predictive control (MPC) for single input and single output (SISO) linear systems. Practically, when MPC is designed for the situation of model mismatch, the actual system performance may beyond our expectation. This paper is concerned with the system performance analysis of the proposed method and explains how it works. Most importantly, fewer works are able to analyze the system transient characteristics and steady-state characteristics more clearly than this work, when the system model is offline built inaccurately or the model parameters are online estimated imprecisely. In this paper, we formulate the system characteristics through analyzing the closed-loop function of the system when the system model is inconsistent with the real system, and then we deduce several useful conclusions about the system performance. By this manner we can understand the principle of the controller and know the relationship among the controller, system model and the system characters. This may help us to know how to design the controller to achieve our desired system characteristics. At last, simulations are carried out to verify the conclusions. Index Terms-equivalent-dynamic-linearization model, model predictive control, model mismatch, transient characteristics, steady state characteristics.

An Improved False Data Injection Attack Scheme Considering Operational Risk of Microgrid Group

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This paper establishes a false data injection attack (FDIA) model considering operation risk, which provides a reference for microgrid operators to build defense strategies. Firstly, considering the probability distribution and output characteristics of distributed generation and load in microgrid group, Monte Carlo Sampling Method was used to calculate the voltage off-limit risk value and line overload risk value of the microgrid, and the microgrid operation risk index is established. Then, a FDIA optimization model aiming at the operation risk value of microgrid group is established, and the measurement system is injected with false data including attack time and different tampering degrees, which is solved by particle swarm optimization (PSO) algorithm. Finally, by analyzing the system operation risk value after attacking different nodes, the attack nodes, attack time and attack vector in the attack scheme are determined. The example analysis is carried out in the improved 30 node microgrid group. The results show that the operation risk value of each period of microgrid group increases with the reasonable design of FDIA scheme. For wind power nodes with strong randomness and nodes with large load, the operation risk value of microgrid group increases significantly when FDIA is applied in the time period of large power fluctuation.

Overview of Hierarchical Control of AC and DC Microgrid

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With the widespread application of distributed generation (DG) in microgrids (MG), the concept of hierarchical control (HC) has gradually attracted widespread attention. According to different time scales, HC divides the control of the MG into multiple control levels, which improves the operating efficiency and flexibility of the MG. The article mainly summarizes the HC strategy of AC and DC MG. In view of the relevant existing literature, each control level is discussed in detail. Specifically, first introduce the HC framework of AC and DC MG and the functions of each layer. Then the control is divided into three layers. First, the control process of primary control (PC) with the fastest time response is introduced, and the problems of traditional PC and the corresponding improvement methods are summarized. Then the control objectives and control process of the secondary control (SC) are introduced. According to the different control structures, the SC of the AC and DC MG is divided into centralized, decentralized and distributed. The latest control strategy of SC is summarized. Finally, the TC with the slowest time response and the highest level are divided into two control processes, which are introduced separately. At the end of the article, the possible future research directions of HC of MG are also discussed.

A Novel Dynamic Watermarking-Based Attack Detection Method for Uncertain Networked Control Systems

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Dynamic watermarking scheme can enhance attack detection capability; however, it also fails to detect cyber-attacks due to model uncertainties. This paper proposes a novel dynamic watermarking-based attack detection (DWAD) method to detect attacks for uncertain networked control systems (NCSs). Firstly, the limitation of conventional DWAD method for uncertain NCSs is revealed, where it is found that the model uncertainties cause nonzero cross-covariance between watermarking and residual signals and non-constant auto-covariance of residual signals, leading to possible failure on attack detection. Secondly, to overcome the limitation and develop an effective attack detector, an asymptotic robust DWAD test is proposed according to ergodic theorem of stationary processes, where it is theoretically proved that the additive distortion power of undetected attacks is bounded within infinite window size. Furthermore, to meet industrial application within finite window size, an online statistical robust DWAD test is proposed by approximating the covariance of signals with the healthy data, which guarantees the successful attack detection. Finally, the effectiveness of the proposed method is validated on the real-world experimental platform of inverted pendulum, where specifically we consider the scenario when linear attacks enter a networked inverted pendulum visual servo system (NIPVSS) with the conventional and robust DWAD tests.

Clustering Ensemble via Cluster-Wise Optimization Graph Learning

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Clustering analysis generally has good clustering effect under specific scenarios and specific assumptions. With the advent of the era of big data, the stability and robustness of a single clustering method are greatly challenged. Many researchers have found that fusing multiple clustering methods can face this challenge. In cluster ensemble, the generation method of base cluster and fusion strategy are the two key steps. At present, there are a large number of clustering ensemble methods, but the clustering results cannot guarantee to meet the block diagonal property, resulting in incorrect clustering. In this paper, we propose a clustering ensemble method of cluster level fusion. Base clusters are generated by randomly initializing K-means, but the reliability of the corresponding clusters of each base cluster is not consistent. Therefore, we set different weights for each cluster for cluster level fusion. In addition, we use the block diagonal property as a priori to ensure that the similarity matrix is partitioned. We also learn the optimal structure on graphs, which is helpful to the final consensus learning. Combined with the non-negative decomposition matrix, the final result is decomposed. Experiments show that our method is better than several most advanced baseline methods on different data sets.

Research on Dual Sourcing Strategy With Stochastic Supply Disruptions - A Game-Theoretic Approach

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Chen Peng (Shanghai University, China)

Supply chain management mainly refers to a management mode of product manufacturing, transportation, distribution and sales by integrating suppliers, manufacturers, distributors and warehouses to reduce the cost of the whole supply chain. Supply chain is of vital importance to the development of modern enterprises, it has greatly promoted the development of the economy, besides, it has brought great convenience to our life. However, supply chain is vulnerable to disruption risks, therefore, some essential measures are needed to mitigate potential disruptions. To this end, a game-theoretic approach based dual sourcing strategy with stochastic supply disruptions is proposed in this paper, which aims to analyze the influence of each parameter on system performance. First, a benchmark case without supply disruptions is introduced, of which some fundamental results are obtained and analyzed systematically from a theoretical perspective, e.g., wholesale prices, retail prices, sale volume and profits. Then, under supply disruptions, dual sourcing and direct sale strategies are adopted to mitigate the effects caused by supply disruptions, where dual sourcing includes routine and emergency procurement. Also, the expected profit model consisting of four possible cases is established through a simple case. Finally, simulation results and computational analysis demonstrate that the one who leads the supply chain performs better than follower with emergency procurement.

Research on Supply Chain Safety Inventory Forecast Based on GA-BP Neural Network

Wang Bing (Shanghai University, China)

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An efficient supply chain will bring huge benefits to enterprises, such as integrating resources, reducing logistics costs, improving logistics efficiency, and improving the overall service level. Supply chain management can significantly decrease the costs of the stocks and the physical distribution wealth flows, so as to improve customer satisfaction and improve the capacity of enterprises. Inventory management is an important part of supply chain management. Safety inventory is to reduce the loss caused by inventory shortage in the supply chain. Setting up safety inventory is an important part of inventory management. In this paper, back propagation neural network (BPNN) is used to study the safety inventory prediction problem of supply chain with uncertainty. And to address the defects of BP neural network, using genetic algorithm to enhance it. Firstly, a BP predictive neural network trained by genetic algorithm (GA) is proposed to predict the future inventory changes of external suppliers. Secondly, through data analysis, several groups of data factors which have great influence on inventory are selected, in addition, the network is also trained, thereby the future inventory variation tendency can be obtained by GA-BP neural network. Finally, a company's inventory data is introduced, the effectiveness of the method is verified by simulation results.

Game Decision of a Closed-Loop Supply Chain With Components Remanufacturing

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Xiaomin Zhao (Shanghai University, China)

Base on the game theory, this paper establishes models for a closed-loop supply chain (CLSC) with a manufacturer and its dual supply channels—new component channel and recycle channel. Considering the consumer acceptance difference, we analyze the sales volume, price decision and profit of supply chain members in traditional supply chain system and CLSC system. The result shows when consumer acceptance is above a certain threshold, the manufacturer has an incentive to engage in remanufacturing business. From the perspective of profits, it is found the manufacturer and recycle supplier will gain more profits from remanufacturing activity with the increase of consumer acceptance, while the new component supplier will suffer a negative impact. By comparing the profitability of the two modes, we concluded that the manufacturer and the recycle supplier can get more profits in the CLSC scenario, while the new components supplier is more profitable in the traditional scenario. Therefore, this paper suggests that the manufactures take environmental education, marketing and incentive measures to effectively guide consumers to accept remanufactured products, promoting the development of components remanufacturing industry. Moreover, how to coordinate the interests of the parties to achieve sustainable development of remanufacturing should be valuable to investigate in the future.

Multi-Source Product Change Influence Assessment Based on Similar Node Clustering

Mingqun Liu (China University of Mining and Technology, China)

Accurately assessing and identifying essential nodes in complex product networks is vital to reduce the impact of design changes. Most of existing node influence evaluation methods are for the case of single-source design changes, so that their applications have certain limitations. In view of this, this paper studies a change influence evaluation method for multi-source design changes. First, a decoupling strategy based on Louvain node clustering is given for coupling relationship between multiple change sources; then, a change influence evaluation method based on breadth-first search is proposed by considering the node resistance capability to change brought by design tolerance. Finally, the feasibility of the proposed method is verified on a certain type of Skyworth TV. Accurately assessing and identifying essential nodes in complex product networks is vital to reduce the impact of design changes. Most of existing node influence evaluation methods are for the case of single-source design changes, so that their applications have certain limitations. In view of this, this paper studies a change influence evaluation method for multi-source design changes. First, a decoupling strategy based on Louvain node clustering is given for coupling relationship between multiple change sources; then, a change influence evaluation method based on breadth-first search is proposed by considering the node resistance capability to change brought by design tolerance. Finally, the feasibility of the proposed method is verified on a certain type of Skyworth TV.

Model Construction for Complex Product Design Change With Improved Dendritic Neural Network

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Design changes are widespread during the produce development due to many uncertain factors, e.g., the impact of the epidemic on the supply chain, changes in customer demands, and upgrades demand by the produce production itself. It is very important for companies to predict product's parameter changes and clarify the mechanism of change propagation for saving costs and improving efficiency. However, the current product change methods are often based only on the experience and knowledge of experts, and lack of effective use of the historical data of design changes. Motivated by this, we here propose a data-driven mechanism to construct the design change model with an improved dendritic neural network. A dendritic neural network is first improved to model the design change into a complex network according to the features of the design change data. The method for obtaining the linkage strengthen weights is developed based on the input-output relationship of the units in the trained dendritic neural network. This paper takes the 2D model of a bicycle as an example, and the results show, that the improved dendritic neural network can effectively predict the result of product change, and the complex network can reflect the propagation mechanism of product change.

A Multi-Tier Supply Chain Disruption Recovery Strategy Considering the Product Life Cycle

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Hongfeng Wang (Northeastern University, China)

The global pandemic of COVID-19 has caused severe damage to supply chain such that manufacturers may face long-term supply disruptions. In this paper, a new disruption recovery strategy of a serial supply chain is investigated from the perspective of product change, in which the life cycle and lead time of a new product are both considered in order to minimize the losses of manufacturer after disruption occurs. A mixed-integer linear programming (MILP) model is presented to address the long-term disruption recovery problem for this multi-period, multi-supplier, and multi-stage supply chain system. A heuristic algorithm is designed to solve the model proposed in this paper. In numerical experiments, five disruption scenarios of the developed model are solved. The results show that the proposed disruption recovery strategy can effectively reduce the profit loss of manufacturer due to supply disruption, and demonstrate the role of product life cycle in the selection of new product design planning. For long disruptions, it is superior to adopt a combined strategy that simultaneously includes emergency procurement and product changes in certain periods. This work can offer a potentially useful tool to help the manufacturers decide on the optimal recovery strategy whenever the supply chain system experiences a massive disruption.

Attack-Defense Game Based Security Analysis for Supply Chain System Subject to Change Design

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Supply chain system (SCS) is essential a network control system integrated with a series of facilities, suppliers, manufactures, distributors and retailers, that procure raw materials, process them into intermediate goods and the final products, and then are distributively delivered to customers. It is an important task to guarantee the stability when the system is suffering external attacks and interference signals, which leads to the system status change accordingly. This paper aims to study the security of the supply chain system with attack and external interference signals. In order to guarantee the stability of the system, zero-sum game framework is constructed, in which the system defense control signal, external attack signal and external interference signal are regarded as participants in the game. The performance index function is constructed through the Hamiltonian function, and the conditional generative countermeasure network fitting is introduced to solve the control gain, in which the deep learning technique is introduced to give the numerical solution of the Hamiltonian function. And then the optimal control signal is further obtained. Finally, a simulation example is given to verify that the control signal designed by this method can make the supply chain system reach stability subject to change design when the system is suffering attacks.

Special Session: Network-Based Control and Autonomous Systems

Fault-Tolerant Control for Trajectory Tracking of Underactuated Unmanned Surface Vehicles With Actuator Faults

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Lin-Xing Xu (Shanghai University, China)

As an effective equipment for ocean resources exploration, USVs have a wide range of applications in civil and military fields, which undertake long-term, large-scale, and low-cost marine scientific research and engineering tasks. In practical applications, USVs are usually underactuated, which means these USVs equipped with fewer actuators than degrees of freedom. When carrying out tasks such as target tracking or stalking, USVs are usually needed to track the target as soon as possible, which results in a high requirement to the tracking speed and accuracy of USVs. In this paper, by taking into account the actuator fault tolerant control (FTC), a tracking control scheme is proposed for an underactuated unmanned surface vehicle (USV). Firstly, a uniform actuator fault model is constructed, which can be used to fully describe three actuator faults including stuck, outage, and loss-of-effectiveness. Secondly, a controller, which is based on the backstepping method and a tan-type barrier Lyapunov function (BLF), is designed to constrain the errors of position and heading angle between an underactuated unmanned surface vehicle and a virtual leader. Moreover, to solve the "explosion of complexity" problem caused by the virtual control variable differentiation, a biological inspiration model is established. Finally, simulation results demonstrate the effectiveness of the designed control scheme.

Improved TDOA Two-Stage UWB Localization Algorithm for Indoor Mobile Robot

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Guojun Ma (JUST, China)

Jin Zhu (Jiangsu University of Science and Technology & College of Electronic and Information, China)

Hongpeng Ma (Jiangsu University of Science and Technology, China)

In order to improve the service quality of indoor mobile robots, ultra-wideband (UWB) is used as the research object, and the two-stage UWB positioning algorithm for indoor mobile robots with time difference is studied; The basic principle and error source of UWB localization algorithm based on TDOA for mobile robot are analyzed; two UWB positioning algorithms of improved time difference ranging and weighted position calculation are proposed. In the time difference ranging stage, the clock distribution measurement model and Gaussian filtering calculates the measured value of the distance difference of arrival (DDOA). In the weighted position calculation stage, the final target position coordinates are calculated according to the multiple measured values and the coordinates of the distance measuring point, which effectively reduces the time caused by the clock measurement. The static positioning is compensated separately to reduce the measurement error caused by the crystal oscillator of the hardware itself; the physical UWB module is built for experimental testing, the UWB device's ranging value is simulated, analyzed and evaluated, and the positioning accuracy is performed. After the evaluation and error compensation, the two-stage UWB positioning algorithm is tested on the actual indoor robot. The experimental results show that the DDOA ranging value can be maintained within $\pm 30\text{cm}$ based on the time difference ranging scheme, and the positioning accuracy after error compensation can meet the positioning requirements. It can be seen that the proposed two-stage UWB positioning algorithm for mobile robots without difference can meet the needs of indoor positioning, and has the advantages of low cost, low energy consumption, and high stability.

Research on Robot SLAM of RBPF Improved With Weight Accumulation

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Jiajun Leng (JUST, China)

The research of mobile robots is progressing rapidly. The use of lidar to realize simultaneous positioning and mapping (SLAM) is a hot spot in the field of robotics research. It is a hot spot in the field of robotics research. RBPF-SLAM is a SLAM algorithm based on particle filtering. It is an important algorithm in the field of laser SLAM. When creating a map, each particle represents a separate environmental map. During the iteration process, errors will continue to accumulate, causing serious particle degradation problems. The mapping result is far away from the true value. Although many algorithms that optimize particle resampling alleviate the problem of particle degradation, the process of resampling will cause loss of particle diversity and loss of mapping information. In response to this problem, this paper proposes an improved RBPF-SLAM algorithm for weight accumulation. The sampling area is equally divided by the set boundary, and then the continuously accumulated weight information is used to determine whether the cumulative weight breaks through the partition boundary as the judgment condition, and then the particles to be sampled are resampled in stages, and finally the new Monte Carlo method is used to construct a new Particles, rather than simply copying particles with significant weight. The weight accumulation improvement algorithm in this paper makes the RBPF-SLAM algorithm need not sample a large number of particles, alleviating the problem of particle degradation. After resampling, the particles can better reflect the posterior probability density function of the true state, which enhances the accuracy of the algorithm's estimation and can maintain the diversity of particles and improve the quality of mapping. The experimental results show that the method in this paper still improves the completeness of the mapping and reduces the computing time when the number of particles is reduced. Keywords-laser SLAM, RBPF-SLAM, weight accumulation, particle degradation, particle degradation

Design of a Portable Array PCR Instrument

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The PCR gene amplification instrument can replicate the gene sequence of the virus, and it can be used in the clinical medical and biology research of the virus. A new portable array PCR amplifier was designed to meet the shortcomings of large demand, large size and single amplification type in China. First, the hardware part of the system takes MSP430 single-chip computer as the main controller, it mainly contains modules such as temperature measuring, variable temperature, reaction tank, human-computer interaction and so on. Second, the designed reaction tank is arranged in a 4×2 array, enabling independent amplification of up to eight types of target DNA fragments. Then, the software part adopts modular design idea and fuzzy PID algorithm as the temperature control algorithm of the system, which can realize accurate temperature control of the reaction tank. The temperature of the designed system can be controlled between 20°C - 100°C . Finally, the designed portable array PCR amplification instrument is tested. The experimental results show that the system can amplify many target DNA fragments with a temperature accuracy of about 0.3°C , and the warming and cooling rates are approximately 2°C/s . The system has small volume, light weight and easy to carry, and has a good prospect in application.

Design of PID Temperature Control System for RNA Virus Detection

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In the RNA virus laboratory, in order to realize the characteristics of small temperature fluctuation and high precision in the process of RNA virus detection, a high-precision temperature control system based on fuzzy PID temperature control algorithm is designed. The system takes MSP430 as the main controller, and controls the temperature through NTC acquisition circuit and TEC driven circuit. The system first adopts the incremental PID algorithm for preliminary design, second determines the incremental PID parameters, and then obscures the algorithm on this basis to make it an adaptive fuzzy PID algorithm, which further improves the stability and response speed of the system. Finally, through the physical test, the incremental PID algorithm is compared with the adaptive fuzzy PID algorithm, and the design of fuzzy PID temperature control system for RNA virus detection is realized. The test results show that the system error of the improved fuzzy PID is less than 0.2°C, the working time is shortened by nearly 70 seconds, and has the characteristics of high precision, fast response speed and small temperature fluctuation. Through the PID temperature control system for RNA virus detection designed by comparison, the system has high precision and low temperature fluctuation, and can be well used in RNA virus laboratory.

Research on Intelligent Charging Management System of Electric Vehicle Based on Low Power Bluetooth Technology

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The emission of automobile exhaust is undoubtedly one of the reasons for the degradation of the ecological environment. The increase in the price of non-renewable energy gasoline has limited the implementation of ordinary commercial vehicles. With the development of the Internet of Things technology, electric cars have become the transportation carrier promoted by significant cities based on their low cost of energy and electricity and their friendliness to the environment. As the source of electric vehicle power supply, the construction cost, network access capacity, and charging time of charging pile have become the focus of the problem. Currently, charging piles are used for infrastructure construction in the form of laying communication cables, which has a long construction period and high construction cost, and is not suitable for large-scale construction of charging stations, limiting the popularity of charging piles. The charging operation management system for users adopts the card swiping mode for man-machine interaction, which has few functions for users, increasing the user's cost and reducing the user's sense of experience. In this paper, the intelligent charging management system of electric vehicles based on low power Bluetooth technology is studied and improved from three aspects. (1) In terms of charging pile Communication, Power Line Communication technology is adopted for information transmission through existing Power lines, which eliminates the need to lay the Communication cables and transform charging piles, thus reducing construction period, strong anti-interference ability and comprehensive total cost; (2) Using low power Bluetooth technology to build a charging operation management system, relying on the wechat platform with a large number of users to expand user groups, reduce the difficulty of system operation, and make the system more widely promoted; (3) Study the influence of time interval and device delay on Bluetooth transmission power consumption, and find the most suitable time interval to ensure communication rate and reduce power consumption. The intelligent charging management system for electric vehicles based on low-power Bluetooth technology has the characteristics of low cost, easy operation and convenient control of charging piles by mobile phones, which is conducive to the promotion and popularization of charging banks.

Research on PCI Data Acquisition and Processing of Parallel FIR Filter

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Digital signal processing technology is an extremely important part of modern information technology. It is widely used in data acquisition and processing. With the development of electronic information technology, the frequency and bandwidth of signals are increasing, and the running frequency of various signal processors is also increasing. The design of using digital signal processing chip as the core of the system is not flexible enough, and many additional external system resources are needed. In order to deal with data with a high sampling rate and low complexity, a PCI data acquisition, and processing system based on parallel FIR filters is studied in this paper. The system takes FPGA as the main control core and uses the window function method to design the 32-order parallel linear phase FIR filter in the FPGA chip. The 4-channel ADS7945 is used as the analog data acquisition chip, and the data is collected and sent to the FPGA for processing. Finally, with the PCI9052 interface chip as the medium, the FPGA transmits the data to the PC through the PCI bus. The experimental results show that, especially in the case of high sampling frequency, the data acquisition and processing system can realize high-speed and high-precision data acquisition and filtering, greatly reduce hardware resources and save development costs.

Research on Embedded Integrated Circuit Test System

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Integrated circuit testing is a key technology in the development of integrated circuit industry and an important means to analyze whether there are defects in integrated circuits. With the continuous improvement of the integration of IC devices, the number of chip pins is also increasing, and the test speed is becoming higher and higher. The previous pin by pin test cannot adapt to the rapid development of IC, and the simultaneous measurement of multiple pins and multiple stations has become the basic function of the test system. At the same time, for large-scale IC testing, it is necessary to develop more high-speed, low power consumption, multi-channel effective testing scheme. In this paper, an integrated circuit test scheme based on embedded system is proposed. The method takes STM32 as the control module of the test system and combines AD5522 and AD7685 hardware circuits to design and implement the INTEGRATED circuit DC parameter test system. In the design, THE SPI interface of AD5522 is used for data transmission, and the measurement can be completed through the 29-bit control word to control the internal register of the chip, which can complete the measurement mode of driving voltage measurement current and driving current measurement voltage, and combined with the internal calibration of the chip and external software calibration to reduce the measurement error. The experimental results show that the system has the characteristics of compact structure, fast speed, high precision and strong applicability.

Research on Robot Path Planning Based on A*-Weighted JPS Algorithm

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Mobile robots are entering daily life quietly. How mobile robots can walk more efficiently in environments with complex obstacles has become a hot topic. For robot path planning, there are currently a variety of research algorithms, which can be divided into global-based robot path planning and local-based robot path planning. Commonly used algorithms for robot path planning include artificial potential field method, ant colony algorithm, and genetic algorithm, Annealing algorithms, etc., because these heuristic algorithms have a large amount of calculation and are difficult to apply to path planning with complex obstacles, they are easy to fall into local optimal solutions, the search period is long, and the search path does not reach the global optimal. For the above problems, this article A global path planning-weighted JPS algorithm based on A* algorithm is proposed, which optimizes the expansion of sub-nodes, reduces the number of expansions of sub-nodes, and reduces the time for the robot to reach the target point. At the same time, the five-term interpolation method is used to plan the exit path is smoothed to reduce the probability of collision due to avoiding obstacles and cornering at dead corners during the robot's travel. Experimental results show that the weighted JPS algorithm intersects with the A* algorithm, and the calculation time is increased by 20% to 27%, and the length of the path to be explored is also reduced by 2% to 4%.

Solution to the Active SLAM Problem for Autonomous Vehicles Based on ADMM

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The increasing requirement of autonomy in various industry, intelligent transport systems and daily life etc. has brought the great potential to the autonomous vehicles. However, to realize different levels of autonomy of autonomous vehicles, accurate and reliable environment mapping, navigation and localization techniques are essential, where the vehicles need acting efficiently such that they can localize themselves while avoiding collisions successfully. For the unknown environment exploration problem in an search and rescue scenario for example, active simultaneous localization and mapping (Active SLAM) plays a key role, whose objective can be regarded as the generation of a collision-free trajectory. A reasonable trajectory for the environment exploration may improve the efficiency of unknown environment exploring greatly. Notice that the tasks of active SLAM involve area coverage and uncertainty minimization that associated with the estimation of both robot poses and environment features. In particular, to minimize the mapping uncertainty, an uncertainty minimization index is proposed which is then converted into a non-convex constrained least-squares problem, and is then transformed into a Quadratically Constrained Quadratic Programming (QCQP) problem. Further, different from the existing semi-definite relaxation (SDR) method, the Alternating Direction Method of Multipliers (ADMM) is utilized to solve the QCQP problem, which is suitable for large-scale structured optimization. Simulation results verify the method proposed in this paper.

Research on Flexible Parallel/Off-Grid Control Technology of Daily Inverter Power Supply System Based on Ship DC Network

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The daily inverter power supply system of ship DC network is connected with ship daily load and shore power grid through daily load converter. When the ship DC netting daily inverter power supply system is connected / disconnected from the shore power grid, it will produce impulse current and impulse voltage at the moment of connection / disconnection. Moreover, ship DC network parallel / off is a complex process with multiple operating conditions and multiple working modes. Most previous studies have not taken this into account. Only one control strategy is used in the process of parallel / off-grid, which is difficult to achieve good results. In this paper, the flexible parallel / off-grid control technology of daily inverter power supply system is studied according to various working states of daily load converter in ship DC networking. The technology adopts different control strategies in different periods to stabilize the impulse voltage and impulse current at the moment of parallel / off grid. Finally, the effectiveness of the control method is verified by building a simulation model. The simulation results show that the voltage distortion can be suppressed by adding synchronous control; The introduction of grid connected control can alleviate the impact current at the moment of grid connected. According to the different working conditions of ship docking / offshore grid connection process, synchronous control and grid connection control are adopted in time-sharing, which can realize the smooth connection / separation of DC network electric propulsion ship from shore power.

A Mixed Strategy Game-Based Local Equilibrium Cluster Routing Protocol for Wireless Sensor Networks

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In the study of wireless sensor networks, energy savings through optimization of different network hierarchies is an important task. In many relevant routing algorithms, it is assumed or required that each node is able to know useful information about the global nodes during the networking cycle, and obtaining this information requires huge additional consumption. Thus, it is necessary to design a routing algorithm that relies only on local information to improve the energy balance of the network. In order to improve the uniformity of energy consumption of wireless sensor networks when nodes are not able to know global information, a local equilibrium cluster routing protocol based on a mixed strategy game is proposed. The algorithm constructs a utility function by defining the gain and loss of nodes in the game through their residual energy and using a penalty mechanism to shorten the campaign iteration time. Based on this, the equilibrium probability of the game model is obtained by defining an iterative operation to maximize the utility of local nodes. In order to avoid more than one cluster head in the neighborhood as much as possible, a second round of campaigning mechanism for candidate cluster heads is used. Simulation experimental results show that the protocol can reduce the network energy consumption to a certain extent and thus extend the network lifetime.

A COVID-19 Medical Image Segmentation Method Based on U-NET

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COVID-19 covers many countries around the world, Chest X-ray is the mainstream method for identifying COVID-19 infection. Traditional Chest X-ray detection requires professional medical personnel, which is time-consuming and laborious. Accurate medical segmentation can be used as an auxiliary means to detect COVID-19, which not only greatly reduces the cost and time, but also greatly improves the applicability. With the rapid development of deep learning, a network model based on U-NET has been proposed and widely used in medical image segmentation in recent years. However, in U-NET network, multiple convolutional pooling operations cause the loss of image spatial information features, and each channel of output features is treated equally, thus lacking flexibility in processing different information. Therefore, in this paper, we add gray bars to the samples to avoid the distortion and feature reduction caused by clipping and resize. the U-NET model architecture is taken as the main body to improve the weight of each channel in the U-NET encoding layer to increase the semantic information of the feature map and improve the segmentation accuracy of the network. In the decoding channel, feature information is restored by up-sampling. Finally, convolution and Softmax function are used to obtain the predictive segmentation image with the same size as the original image. The results show that the improved model has better performance than the traditional U-NET network.

CT Image Classification and Detection of COVID-19 Based on Convolutional Neural Network

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As Corona Virus Disease (COVID-19) emerged at the end of 2019, traditional detection is mainly carried out using four methods: coronavirus screening detection strips, COVID-19 antibody detection kits, COVID-19 nucleic acid detection and CT detection. In order to solve these problems, slow speed, low efficiency, high cost, complex algorithm structure and low accuracy of detection of large data sets at present. In this paper, by collecting known public COVID-19CT image data sets, a convolutional neural network algorithm based on residual network is proposed to reduce parameter complexity, modify weights and biases associated with neurons, and simplify the overall network structure. This algorithm is used to improve the accuracy of COVID-19 case classification detection. Through model verification, the accuracy of the proposed algorithm model is 0.985, the precision is 0.805, the area under the curve (AUC) of the ROC curve is found to be 0.852, and the recall rate is 0.897. The results show that the classification detection algorithm model proposed in this paper has higher accuracy than the general image classification model, is more concise in the network model, reduces the complexity, and can be more effectively applied to the detection of COVID-19. The combination of traditional medical imaging diagnosis and deep learning technology helps medical personnel to make more rapid, accurate and effective diagnosis.

Plasmonic Resonance Characteristics of Silver Nanorod Dimer on MIS Tunnel Junction

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In this paper, the extinction spectrum and electric field distribution of silver nanorod dimer on MIS tunnel junction are calculated by finite element simulation method, and the mode of peak position in the spectrum is analyzed. In the simulation, SPPs are excited by the inelastic electron tunneling in the MIS tunnel junction and this excitation method can overcome the disadvantage of integration difficulty caused by the demand of additional optical elements in the traditional optical excitation. The results show that when two identical silver nanorods in silver nanorod dimer are placed end-to-end parallel or T-shaped vertically, there are two resonance peaks in the extinction spectrum, which correspond to the vertical mode and the vertical mode of the nanorods, respectively. When the dimer is composed of two identical silver nanorods placed side-to-side in parallel, there is only one resonance peak in the extinction spectrum, which corresponds to the vertical mode of the nanorods. When the gap distance between the silver nanorod dimer structure and the MIS tunnel junction increases, the resonant peak position in the extinction spectrum will appear blue shift. By calculating the field distribution, it is found that an obvious "hot spot" distribution exists in the gap between the nanorods and the MIS tunnel junction, which indicates that the local electric field at the gap is enhanced. The above results have certain reference significance for the design of small biomolecule measurement sensors based on electrically excited SPPs.

VFH+ Based Local Path Planning for Unmanned Surface Vehicles

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In marine engineering, the path planning problem of unmanned surface vehicles (USVs) is particularly important, especially in complex marine environments. Path planning for a USV is to regulate it to find an optimal or near-optimal path from the starting state to the target state. It should guarantee that the USV can avoid obstacles based on one or more performance indicators (such as the lowest working cost, the shortest navigation route, the shortest navigation time, etc.). Path planning methods can be divided into two types: global path planning and local path planning. Generally, a USV with only global path planning ability cannot adapt to real-time changing marine environments, while local path planning is more effective for real-time path planning. By introducing an improved VFH+ method, this paper proposes a local path planning framework for a USV equipped with a laser radar. It improves the USV dynamic obstacle avoidance ability from two aspects: (i) It identifies dynamic obstacles by polar obstacle densities, which can quickly identify dynamic obstacles; (ii) It optimizes candidate directions by considering velocity vectors of the USV and dynamic obstacles. The effectiveness of the proposed method is verified through an experiment. The experimental results demonstrate that the proposed method can guarantee safe autonomous navigation of a USV in unknown static and dynamic marine environments.

Torque Control Strategy for New Energy Commercial Vehicles Without Tilt Sensors When Hill-Stop
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In order to further improve the performance of the permanent magnet synchronous motor of new energy pure electric commercial vehicles under some severe working conditions, a torque control strategy for the standing slope mode of new energy commercial vehicles without tilt sensors is proposed. Combined with the mathematical model of the permanent magnet synchronous motor, the motor drive control system of the new energy commercial vehicle is established, and the torque requirement of the permanent magnet synchronous motor in the standing slope mode is studied. It is proposed that the torque compensation of the motor under severe operating conditions can be accomplished by adaptively adjusting the parameters given in the control loop to solve the problems of continuous high current output and low efficiency of the pure electric commercial vehicle motor under severe operating conditions. The experimental results show that the PI control and adaptive regulation system can quickly respond to the torque output and meet the requirements of the hill-stop function when the experimental vehicle with the improved hill-stop control strategy is unloaded or fully loaded on the 12% and 15% slope ramps. The experimental results of the whole vehicle verify the effectiveness and reliability of the proposed torque control strategy.

A New Watermark Method for Networked Inverted Pendulum Visual Servo Systems
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The larger payload of existing fragile watermark embedded in images will cause the lower quality of images with the watermark, and zero-watermark is generally suitable for copyright authentication, which is a limitation for Watermark application. This paper proposes a novel watermark method integrating fragile watermark and zero-watermark. Firstly, a novel fragile zero watermark (FZW) method is proposed to provide the large payload of watermark and guarantee the high quality of images. The FZW method mainly include two parts: 1) a binary original watermark is constructed, two least significant bits (LSBs) of pixel values of before-transmission images are extracted as image features, and the image features are embedded into the binary original watermark by XOR operation to generate register watermark; and 2) two LSBs of pixel values of after-transmission images are extracted as image features, and the image features are also embedded into the existing binary original watermark by XOR operation to generate reconstructed watermark. Secondly, the register watermark and reconstructed watermark are compared bit-wise to detect image attack, where if the same register and reconstructed watermark are obtained, then there is no attack, otherwise there is an attack. Finally, real-time control experiments based on the inverted pendulum platform verify the feasibility and effectiveness of the proposed method.