Proceedings of 2021 IEEE 10th Data Driven Control and Learning Systems Conference (DDCLS'21)

Chief-Editors: Mingxuan Sun, Huaguang Zhang

Suzhou, China

May 14–16, 2020

Organized by

Technical Committee on Data Driven Control, Learning and Optimization, Chinese Association of Automation

Qingdao University

Locally Organized by

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IEEE Beijing Section

2021 IEEE 10th Data Driven Control and Learning Systems Conference (DDCLS) | 978-1-6654-2423-3/21/$31.00 ©2021 IEEE | DOI: 10.1109/DDCLS52934.2021.9455714

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Welcome Message from General Chairs

Zhongsheng Hou
General Chair of DDCLS'21

Pengming Jiang
General Chair of DDCLS'21

Dear Friends and Colleagues,

On behalf of the Organizing Committee, it is our greatest pleasure to welcome you to the 2021 IEEE 10th Data Driven Control and Learning Systems Conference (DDCLS'21), which is organized by Technical Committee on Data Driven Control, Learning and Optimization (DDCLO), Chinese Association of Automation and Qingdao University, locally organized by Suzhou University of Science and Technology, and sponsored by IEEE Beijing Section. The conference is held at Tongli Lakeview Hotel, Suzhou, Jiangsu Province, China, May 14–16, 2021.

Data driven control and learning systems, together with model-based control methods for the target of forming the complete control theory, is an emerging hot research area in the field of automation engineering and in systems & control. It focuses on all the issues of control, learning and optimization for the plants whose models are unavailable. Although the study on data driven control and learning is still in the embryonic stage, it has attracted a great amount of attention within the systems and control community, such as the special issues published in the top journals: *ACTA AUTOMATICA SINICA* (2009), *IEEE Transactions on Neural Networks* (2011), *Information Sciences* (2013), *IEEE Transactions on Industrial Informatics* (2013), *IEEE Transactions on Industrial Electronics* (2015, 2017), and *IET Control Theory & Applications* (2015, 2016). Further, the problems in the data driven control and learning systems would be fundamental challenges in the coming age of the *Internet of Things*, *Cyber-Physical Systems*, *Industry 4.0*, *China Manufacturing 2025*, and *Artificial Intelligence 2.0* under the big data environment, which is already on our road ahead but beyond the traditional systems & control methods.

As an inheritance of previous nine conferences, DDCLS'21 continues to attract broad interest throughout the world, with the submission of 351 papers. This reflects the increasing interest in our field, and meanwhile creates a difficult workload in evaluating the papers and organizing a cohesive program. We are

fortunate to have an exceptional Technical Program Committee (TPC) that sorted through the evaluations and integrated the individual submissions into the final technical program described in the proceedings. We want to thank our Organizing Committee for their invaluable assistance in arranging the diverse offerings at the conference, from registration and local arrangements to technical programs. Last but not least, we would like to express our deep appreciation to Suzhou University of Science and Technology for their great support.

The Technical Program Committee has assembled a comprehensive technical program that covers a broad spectrum of topics in data driven control and learning systems. The DDCLS'21 technical program comprises 10 regular sessions, 22 invited sessions, 1 best paper award session and 2 poster sessions. Besides the technical sessions, the highlights of the DDCLS'21 are the keynote addresses given by world-class level scholars, Prof. Zongli Lin from USA, Prof. Thomas Parisini from UK, Prof. Yaonan Wang from China, Prof. Bin Jiang from China, and the distinguished lectures given by active young scholars. They are Prof. Xiao He, Prof. Zhengguang Wu, Prof. Hongyi Li, Prof. Yalin Wang, Prof. Quan Quan, all from China. During the conference, the other academic activities, including Panel Discussion on the coming control science, Industrial Control Practice Forum, Pre-Conference Workshop and Laoshan Academic Forum are also held for various research interests of the conference participants. These activities provide high quality research and professional interactions on the subject of mode-free adaptive control, artificial intelligence, automation and industrial applications. We sincerely appreciate all the contributors, especially the keynote address speakers, distinguished lecture speakers, invited session organizers, and session chairs for their tremendous efforts towards a top-quality conference.

We also want to thank the young lovely volunteers who have made this conference possible. Without you, the monumental task ahead of us for organizing this conference would be significantly beyond our capabilities.

May you have a wonderful and fascinating stay in Suzhou, Jiangsu Province, China, and enjoy the colorful scenery and magic foods.

Best wishes

Zhongsheng Hou
General Chair of DDCLS'21

Pengming Jiang
General Chair of DDCLS'21

Message from Technical Program Chairs

Mingxuan Sun
Technical Program Chair

Huaguang Zhang
Technical Program Chair

Dear Friends and Colleagues,

On behalf of the Technical Program Committee, it is our great honor to welcome you to the 2021 IEEE 10th Data Driven Control and Learning Systems Conference (DDCLS'21) in Suzhou, China.

The annual event of DDCLS has proven to be one of the excellent forums for scientists, researchers, engineers, and industrial practitioners to present and discuss the latest technological advancements as well as future directions and trends in Data Driven Control, Learning and Optimization, and to set up useful links for their works. DDCLS'21 has received enthusiastic responses with a total of 351 submissions. All the submissions had been processed by the Technical Program Committee. All committee members worked professionally, responsibly, and diligently. Besides evaluations from reviewers, each member also provided his/her own assessments on the assigned papers, so as to ensure that only high-quality papers would be accepted. Their commitment and hard work have enabled us to put together a very solid proceeding for our conference. The proceeding includes 305 accepted papers which are divided into 33 oral sessions and 2 poster sessions for presentation.

Ahead of the parallel technical sessions, we will have four keynote talks to be delivered by eminent scientists. These lectures will address the state-of-the-art developments and leading-edge research topics in both theory and applications in Data Driven Control, Learning and Optimization. We are most honored to have Prof. Zongli Lin (University of Virginia), Prof. Thomas Parisini (Imperial College London), Prof. Yaonan Wang (Hunan University), and Prof. Bin Jiang (Nanjing University of Aeronautics and Astronautics) as the keynote address speakers. Besides, we are very fortunate to have the distinguished lectures given by the five outstanding young scholars, Prof. Xiao He (Tsinghua University), Prof. Zhengguang Wu (Zhejiang University), Prof. Hongyi Li (Guangdong University of Technology), Prof. Quan Quan (Beihang University), and Prof. Yalin Wang (Central South University). DDCLS'21 is also rich in all kinds of academic activities, including Panel Discussion, Industrial Control Practice Forum, Pre-Conference Workshop and Laoshan Academic Forum. More than eighteen distinguished scholars will present their new research findings, in the field of artificial intelligence, data-driven automatic control and industrial applications, such as Prof. Chenghong Wang, Prof. Long Wang, et al. We are confident that their presence would undoubtedly act prestige to the conference. We would like to express our sincere appreciations to all of them for their

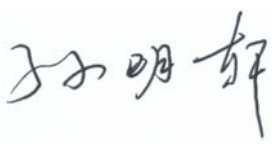
enthusiastic contributions and strong supports to DDCLS'21.

To promote the development of the society of Data Driven Control, Learning and Optimization, the highest quality papers will be rewarded with the Best Paper Award at DDCLS'21. Based on reviewers' comments and nominations as well as the evaluations of Technical Program Committee members, 21 papers were selected for the consideration of the award by the Best Paper Award Committee. These papers were sent to some distinguished experts in the relevant areas for additional evaluations in a double-blind manner. Based on their comments and recommendations, six papers were shortlisted as the finalists for the award. During the conference, the oral presentations of the six finalists will be further assessed by the DDCLS'21 Best Paper Award Committee. The winner of the "DDCLS Best Paper Award" will be selected by the committee after assessing the oral presentations. Furthermore, the interactive presentations of 93 papers in 2 poster sessions will be assessed by the DDCLS'21 Best Poster Award Committee during the conference, and one or two papers will be conferred to the "DDCLS Best Poster Award" by the committee after assessing the interactive presentations.

A U-disk containing the PDF files of all papers scheduled in the program and an Abstract Book will be provided at the conference to each registered participant as part of the registration material. The official conference proceedings will be published by the IEEE and included in the IEEE Xplore Database.

On behalf of the Technical Program Committee, we would like to thank all reviewers for giving time and expertise to provide comments, which are contributive to the Committee in making a fair decision on the acceptance/rejection of each paper. Thanks also go to the dedication, diligence, and commitments of the Invited Session Chairs Prof. Zengqiang Chen, Prof. Darong Huang, Prof. Jing Na, Prof. Fei Qiao, Prof. Senping Tian, Prof. Qinglai Wei, Prof. Zhanshan Wang, Prof. Jinpeng Yu, Prof. Weiwei Che, Prof. Yi Liu, and Dr. Zhengtian Wu, Subject Session Chairs Prof. Zhihuan Song, Prof. Dongbin Zhao, Prof. Xin Xu, and all the members of the Technical Program Committee. We would like to gladly acknowledge the technical sponsorship provided by the Organizing Committee of DDCLS'21 and Technical Committee on Data Driven Control, Learning and Optimization, Chinese Association of Automation. We also convey our heartfelt thanks to friends, colleagues, and families who have helped us in completing the technical program directly or indirectly. Last but not least, we are grateful for the strong and enthusiastic support of all delegates, especially those old faces around the world.

We do hope that you will find your participation in DDCLS'21 in Suzhou is really stimulating, rewarding, enjoyable, and memorable.



Mingxuan Sun
Technical Program Chair

Huaguang Zhang
Technical Program Chair

Keynote Address

Keynote Address 1

多机器人协作关键技术应用与发展趋势

Applications and Development Trend of Key Technologies for Multi-robots Collaboration

Prof. Yaonan Wang
Hunan University, China

Saturday, May 15, 2021
08:30-09:20
International Hall & Function room ABC / 国际会议厅+ABC 厅

Abstract

多机器人协作是具有协同感知、规划决策、优化控制、执行功能的智能系统技术，它是信息技术和人工智能的深度融合。多机器人协作系统在国防、工业、农业等领域都具有重要的应用价值和广泛的应用前景。1.报告概述了多机器人研究背景及意义，国内外研究现状，对现有人工智能技术提出的巨大挑战，亟需研究多机器人协同感知与控制技术。2.详细介绍了多机器人协作的技术难题及解决方案。3.探讨了协同视觉感知、高效规划、多机协同控制等关键技术，并应于智能制造、国防等领域。4.总结与展望多机器人发展与前景。

Multi-robots collaboration is an intelligent system technology, which has the function of collaborative perception, planning and decision, optimization and control, and execution. It is a deep integration of information technology and artificial intelligence. It has important value and broad prospect for application in the fields of national defense, industry, and agriculture. 1. In this report, the background and significance and state of art of multi-robot research is overviewed. In face of the challenges to the existing artificial intelligence technology, there is an urgent need for studying multi-robots collaborative sensing and control technology. 2. The technical problems and solutions of multi-robot collaboration are introduced in detail. 3. The key technologies such as collaborative visual perception, high-efficiency planning and multi-agent collaborative control are discussed and applied to intelligent manufacturing, national defense and other fields. 4. A summary and outlook on the development and prospects of multi-robots is given.

Biography

王耀南，中国工程院院士，机器人技术与智能控制专家。湖南大学教授、博士生导师、机器人视觉感知与控制技术国家工程实验室主任。2001-2020年湖南大学电气与信息工程学院院长，2016-2020年湖南大学机器人学院院长。德国洪堡学者、欧盟第五框架国际合作重大项目首席科学家，入选国家"百千万人才工程"、中国自动化学会会士、中国计算机学会会士、中国人工智能学会会士、国家863计划智能机器人领域主题专家。兼任中国自动化学会常务理事、中国人工智能学会监事、教育部科技委能源与交通学部委员、湖南省自动化学会理事长等。成果获国家技术发明二等奖1项、国家科技进步二等奖4项、国际IEEE机器人与自动化领域"工业应用最高奖"。培养博士60余名（含IEEE Fellow、长江学者、国家杰青等），发表SCI论文170余篇，出版著作9部，获国家发明专利80余项。获得全国高等学校优秀教师、全国五一劳动奖章、全国先进工作者、全国创新争先奖等荣誉称号。

Yaonan Wang, Academician of Chinese Academy of Engineering, the expert of robotics and intelligent control. He is Professor, doctoral supervisor, and director of the National Engineering Laboratory for Robot

Visual Perception and Control at Hunan University. He was the dean of the School of Electrical and Information Engineering at Hunan University from 2001 to 2020, and the dean of the School of Robotics at Hunan University from 2016 to 2020. He was a Humboldt Fellow in Germany, the chief scientist of an international cooperation major project under EU's Fifth Framework. He is a national candidate for the “New Century Talents Project”. Prof. Wang is a fellow of Chinese Association of Automation, a fellow of the China Computer Federation, a fellow of the Chinese Association for Artificial Intelligence, and a principal expert of the National 863 Program in the field of intelligent robots. He is also an Executive Director of Chinese Association of Automation, a Supervisor of Chinese Association for Artificial Intelligence, a member of Energy and Transportation Department in Science and Technology Commission of Ministry of Education, and the Chairman of Hunan Association of Automation.

Keynote Address 2

Control of Linear Systems Subject to Actuator Saturation: From Model-Based Design to Reinforcement Learning Control

Prof. Zongli Lin
University of Virginia, USA

Saturday, May 15, 2021
09:40-10:30
International Hall & Function room ABC / 国际会议厅+ABC 厅

Abstract

This talk will discuss the problem of controlling a linear system subject to actuator saturation through reinforcement learning. In particular, it is illustrated how the model-based control design techniques motivate the design of iterative Q-learning algorithms for global asymptotic stabilization of discrete-time linear systems that are asymptotically null controllable with bounded control. It is hoped that the discussion will stimulate interest in constrained control problems among the data driven control and learning systems research community.

Biography

Zongli Lin is the Ferman W. Perry Professor in the School of Engineering and Applied Science and a Professor of Electrical and Computer Engineering at the University of Virginia. He received his B.S. degree in Mathematics and Computer Science from Xiamen University, Xiamen, China, in 1983, his Master of Engineering degree in automatic control from Chinese Academy of Space Technology, Beijing, China, in 1989, and his Ph.D. degree in electrical and computer engineering from Washington State University, Pullman, Washington, in 1994. His current research interests include nonlinear control, robust control, and control applications.

Professor Lin has served on the editorial boards of several journals, including those of IEEE Transactions on Automatic Control, IEEE/ASME Transactions on Mechatronics, IEEE Control Systems Magazine, and IEEE/CAA Journal Automatica Sinica. He was elected a member of the Board of Governors of the IEEE Control Systems Society (2008-2010 and 2019-2021) and chaired the IEEE Control Systems Society Technical Committee on Nonlinear Systems and Control (2013-2015). He has also served on the operating committees of several conferences and was the program chair of the 2018 American Control Conference and a general chair of the 13th and 16th International Symposia on Magnetic Bearings, held in 2012 and 2018, respectively. He currently serves on the editorial boards of several journals and book series, including Automatica, Systems & Control Letters, Science China Information Sciences, and Springer/Birkhauser book series Control Engineering. He is a Fellow of IEEE, IFAC, AAAS and CAA.

Keynote Address 3

高速列车牵引传动系统故障诊断、预测与容错控制技术

Fault Diagnosis, Prediction and Fault-Tolerant Control Technology for Traction Drive System of High-Speed Train

Prof. Bin Jiang
Nanjing University of Aeronautics and Astronautics, China

Saturday, May 15, 2021
10:30-11:20
International Hall & Function room, ABC / 国际会议厅+ABC 厅

Abstract

作为高效便捷运输工具之一高速列车，随着其全世界的普及，其安全性和可靠性也越来越受到重视。牵引传动系统为高速列车提供动力，其包含整流器，逆变器，牵引电机，中间电容等电气设备，一旦发生故障会导致列车损失动力，造成减速、停车甚至事故。因此，开展基于模型和数据驱动的牵引系统故障诊断、剩余寿命预测与容错控制研究具有重要的意义。针对高速列车牵引系统和设备级故障进行建模和传播机理分析，考虑到列车运行中的干扰和噪声，研究干扰下故障诊断、预测与容错控制方法，基于半物理仿真实验平台和车载实验开展了牵引传动系统的故障诊断应用研究。

As one of the efficient and convenient means of transportation, with its popularity all over the world, safety and reliability of high-speed train have been paid more and more attention. Traction drive system, which includes rectifier, inverter, traction motor, intermediate capacitor and other electrical equipment, provides power for high-speed train. In case of failure, the train will lose power, resulting in deceleration, parking and even accidents. Therefore, it is of great significance to carry out the research on fault diagnosis, prediction of residual life and fault-tolerant control of traction system based on model and data-driven. In this paper, the modeling and propagation mechanism analysis of high-speed train traction system and equipment-level faults are carried out. Considering the interference and noise in train operation, the fault diagnosis, prediction and fault-tolerant control method under interference are studied. Based on semi physical simulation experimental platform and on-board experiment, research on application of fault diagnosis on traction drive system is carried out.

Biography

姜斌，南京航空航天大学教授、博导、副校长，IEEE Fellow，教育部“长江学者”特聘教授， 中国自动化学会会士。曾经先后在新加坡、法国、美国、加拿大做博士后、研究员、邀请教授和访问教授。目前担任国际期刊 IEEE Trans. on Cybernetics， Neurocomputing，J. of Franklin Institute, 和国内期刊《宇航学报》、《控制与决策》、《系统工程与电子技术》等多个学术期刊的编委、Int. J. Control, Automation and Systems 领域主编，《控制工程》副主编，IEEE南京分部控制系统分会主席，中国航空学会导航、制导与控制分会副主任，中国自动化学会技术过程故障诊断与安全性专业委员会副主任， 中国自动化学会数据驱动控制与学习系统专委会委员，江苏省自动化学会副理事长。从事故障诊断和容错控制及其在飞控系统和高铁牵引系统中的应用研究，主持获得国家自然科学二等奖、教育部自然科学一等奖、江苏省科技一等奖等科研奖励；获得授权发明专利28项，出版学术专著8部，在IEEE Transactions, Automatica, AIAA JGCD，中国科学，自动化学报等国内外学术期刊发表论文80余篇。

Jiang Bin is, professor, doctoral supervisor and vice president of Nanjing University of Aeronautics and Astronautics, IEEE fellow, distinguished professor of Cheung Kong Scholar Program in the Ministry of

Education, and member of Chinese Association of Automation. He has been postdoctoral, researcher, invited professor and visiting professor in Singapore, France, the United States and Canada.

At present, he is member of editorial board of several academic journals. There are international academic journals such as IEEE Trans. on Cybernetics, Neurocomputing, J. of Franklin Institute, and domestic academic journals such as Journal of Astronautics, Control and Decision, System Engineering and Electronic Technology. He has been chief editor of Int. J. Control, Automation and Systems, deputy editor of Control Engineering, chairman of control system branch of Nanjing branch of IEEE, deputy director of Guidance, Navigation and Control branch of CSAA, deputy director of Technical Process Fault Diagnosis and Safety Professional Committee of CAA, member of Data Driven Control and Learning System Special Committee of CAA, vice president of Jiangsu Association of Automation.

He works for research on application of fault diagnosis and fault-tolerant control in flight control system and high-speed railway traction system. He has won the second prize of National Natural Science Award, the first prize of Natural Science Award of Ministry of Education, the first prize of Science and Technology of Jiangsu Province and other scientific research awards. He has obtained 28 authorized invention patents and published 8 academic monographs. More than 80 papers have been published in IEEE Transactions, Automatica, AIAA JGCD, Science China, Acta Automatica Sinical and other academic journals.

Keynote Address 4

Digital Twins for Distributed Fault Detection in the Process Industry

Prof. Thomas Parisini
Imperial College London, UK

Saturday, May 15, 2021
13:30-14:20
Function room ABC / ABC 厅

Abstract

In an increasingly "smarter" planet, it is expected that interconnected process systems will be safe, reliable, available 24/7, and of low-cost maintenance – the Industry 4.0 vision. Therefore, health monitoring, fault diagnosis and fault-tolerant control are of customary importance to ensure high levels of safety, performance, reliability, dependability, and availability. In the lecture, the process industry I considered as a paradigmatic context in which, faults and malfunctions can result in off-specification production, increased operating costs, production line shutdown, danger conditions for humans, detrimental environmental impact, and so on. Faults, malfunctions and cyber-attacks need to be detected promptly and their source and severity should be diagnosed so that corrective actions can be taken as soon as possible. Once a fault is detected, the faulty subsystem can be unplugged to avoid the propagation of the fault in the interconnected large-scale system. Analogously, once the issue has been solved, the disconnected subsystem can be re-plugged-in.

High-fidelity digital twins represent a game-changing key enabling technology to design effective and accurate distributed fault diagnosis systems in the absence of reliable process data under faulty scenarios. A real industrial use-case is addressed in the lecture.

Biography

Thomas Parisini received the Ph.D. degree in electronic engineering and computer science from the University of Genoa, Genoa, Italy, in 1993. He was with Politecnico di Milano and since 2010, he has been

holding the Chair of Industrial Control and is the Director of Research with Imperial College London, London, U.K. He is a Deputy Director of the KIOS Research and Innovation Centre of Excellence, University of Cyprus, Nicosia, Cyprus. Since 2001, he has also been the Danieli Endowed Chair of Automation Engineering with University of Trieste, Trieste, Italy. In 2009–2012, he was the Deputy Rector of University of Trieste. In 2018, he received an Honorary Doctorate from University of Aalborg, Aalborg, Denmark. He authored or coauthored more than 320 research papers in archival journals, book chapters, and international conference proceedings. His research interests include neural-network approximations for optimal control problems, distributed methods for cyber-attack detection and cyber-secure control of large-scale systems, fault diagnosis for nonlinear and distributed systems, nonlinear model predictive control systems, and nonlinear estimation.

Dr. Parisini was the Co-recipient of the IFAC Best Application Paper Prize of the Journal of Process Control, Elsevier, for the three-year period 2011–2013 and of the 2004 Outstanding Paper Award of the IEEE Transactions on Neural Networks. He was also the Recipient of the 2007 IEEE Distinguished Member Award. In 2016, he was awarded as Principal Investigator at Imperial of the H2020 European Union flagship Teaming Project KIOS Research and Innovation Centre of Excellence led by University of Cyprus with an overall budget of over 40 Million Euro. In 2012, he was awarded an ABB Research Grant dealing with energy-autonomous sensor networks for self-monitoring industrial environments.

He is currently the 2020 President-Elect of the IEEE Control Systems Society and will serve as thre 2021-2022 President. He has served as Vice-President for Publications Activities and during 2009–2016, he was the Editor-in-Chief for the IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY. Since 2017, he has been the Editor for Control Applications of Automatica and since 2018 he has been the Editor-in-Chief for the European Journal of Control. He served as Chair of the IFAC Technical Committee on Fault Detection, Supervision and Safety of Technical Processes–SAFEPROCESS. He was the Chair of the IEEE Control Systems Society Conference Editorial Board and a Distinguished Lecturer of the IEEE Control Systems Society. He was an elected member of the Board of Governors of the IEEE Control Systems Society and of the European Control Association and a Member of the board of evaluators of the 7th Framework ICT Research Program of the European Union and member the ERC Advanced and Consolidator Grant board of Reviewers.He is currently an Associate Editor for the International Journal of Control and was an Associate Editor for the IEEE TRANSACTIONS ON AUTOMATIC CONTROL, IEEE TRANSACTIONS ON NEURAL NETWORKS, Automatica, and International Journal of Robust and Nonlinear Control.

Among other activities, he was the Program Chair of the 2008 IEEE Conference on Decision and Control and General Co-Chair of the 2013 IEEE Conference on Decision and Control. He is a Fellow of the IEEE and the IFAC.

Distinguished Lecture

Distinguished Lecture 1

Fault Diagnosis Technology for Brake Control System of High-Speed Trains

Prof. Xiao He
Tsinghua University, China

Saturday, May 15, 2021
14:20-15:00
Function room B / B 厅

Abstract

In order to improve the safety of the brake control system of high-speed railway in China, some key problems of state estimation and fault diagnosis are studied. Aiming at the challenges of non-ideal channels such as bandwidth constraint and data link failure to distributed state estimation, we proposed a series of new distributed filtering methods based on innovation measurement and performance upper bound optimization. These techniques reduce the excessive consumption of bandwidth and energy in existing distributed estimation, and provide a new way for the transmission and utilization of high frequency sampling data. Aiming at the open problem of closed-loop fault diagnosis, we discussed the failure reason of open loop fault diagnosis method in closed-loop system, and an effective improvement method based on historical observation data is proposed and shown. Aiming at the diagnosis bottleneck caused by small amplitude and short duration of intermittent fault, we gave a diagnosability criterion of intermittent fault, and systematic research framework of intermittent fault diagnosis for stochastic dynamic systems is established. Relevant results have been applied to the fault diagnosis of high-speed train brake control system.

Biography

He Xiao, with the Department of automation, Tsinghua University, is a tenured associate professor, doctoral advisor and deputy head of the Department. The research direction is networked system, fault diagnosis and fault tolerant control. More than 180 papers have been published in domestic and foreign journals and conferences, of which more than 80 have been retrieved by SCI, with more than 1300 times citation in web of science data base. He presided over one key project and two general projects of NSFC, participated in two major projects of NSFC and one major international cooperation project of NSFC, and was funded by excellent youth fund of NSFC in 2015. He is now a senior member of China Association of Automation (CAA), IEEE senior member, sigma Xi full member, and the editorial board member of Control Engineering Practice and other international journals. At present, he is a member of Technical Committee on fault detection, supervision and safety (tc6.4) of IFAC, and Secretary General of Professional Committee on fault diagnosis and safety of CAA. He has won the GIAR award of Sigma Xi - the Scientific Research Society in 2010, Frank best theoretical paper nomination award of SAFEPROCESS International Conference in 2012, the first prize of science and technology progress award of Jilin Province in 2018, and the first prize of Natural Science Award of CAA in 2015 and 2020.

Distinguished Lecture 2

Stabilization of Boolean Control Networks

Prof. Zhengguang Wu
Zhejiang University, China

Saturday, May 15, 2021
14:20-15:00
Function room A / A 厅

Abstract

The purpose of this report is to use some new techniques to discuss the stabilization of Boolean control networks. First, stabilization and finite time stabilization of probabilistic Boolean control networks is investigated. A complete family of reachable sets is defined, based on which, state feedback control stabilization conditions are obtained. Secondly, pinning control is studied to be applied to the Boolean networks to achieve the stabilization control objective. A necessary and sufficient condition is given for the stability of BNs with stochastic disturbances. Thirdly, sampled-data state feedback control with stochastic sampling periods is considered to stabilize Boolean control networks. At last, sampled-data state feedback control with Lebesgue sampling is considered to stabilize Boolean control networks. A necessary and sufficient condition for stabilization is obtained for the considered Boolean control networks.

Biography

Zheng-Guang Wu was born in 1982. He received the B.S. and M.S. degrees in mathematics from Zhejiang Normal University, Jinhua, China, in 2004 and 2007, respectively, and the Ph.D. degree in control science and engineering from Zhejiang University, Hangzhou, China, in 2011. He is currently a Professor of Institute of Cyber-Systems and Control, Zhejiang University. His research interests include networked systems, intelligent control, Markov jump systems, smart grid, cyber-physical systems, and reinforcement learning. He has published 100+ papers in IEEE Transactions. He was a recipient of the Highly Cited Researcher Award by Clarivate Analytics. He is an Invited Reviewer of Mathematical Review of the American Mathematical Society. He serves (or has served) as the Associate Editor/Editorial Board Member for some international journals, such as the IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS; SCIENCE CHINA Information Sciences; Journal of Systems Science and Complexity; Journal of the Franklin Institute; Neurocomputing; International Journal of Control, Automation, and Systems; IEEE ACCESS; International Journal of Sensors, Wireless Communications and Control; Cyber-Physical Systems; Sensors; Symmetry; and IEEE Control Systems Society Conference Editorial Board.

Distinguished Lecture 3

Cooperative Control and Its Applications of Unmanned Autonomous Systems

Prof. Hongyi Li
Guangdong University of Technology, China

Saturday, May 15, 2021
14:20-15:00
Function room C / C 厅

Abstract

Unmanned autonomous systems are quite important applications in the artificial intelligence yield. The research of cooperative control has received considerable attention due to extensive applications of unmanned autonomous systems. In this talk, firstly, the background and current research status of cooperative control for unmanned autonomous systems are reported. Then, the main cooperative control problems are addressed for a class of unmanned autonomous systems. Furthermore, the above theories are applied to unmanned autonomous systems. Finally, some future challenges in this area are introduced.

Biography

Hongyi Li (SM'17) received the Ph.D. degree in intelligent control from the University of Portsmouth, Portsmouth, U.K., in 2012. He was a Research Associate with the Department of Mechanical Engineering, University of Hong Kong, Hong Kong and Hong Kong Polytechnic University, Hong Kong. He was a Visiting Principal Fellow with the Faculty of Engineering and Information Sciences, University of Wollongong, Wollongong, Australia. He is currently a professor with the Guangdong University of Technology, Guangdong, China. His research interests include intelligent control, cooperative control, sliding mode control and their applications. He was a recipient of the 2016 and 2019 Andrew P. Sage Best Transactions Paper Awards from IEEE System, Man, Cybernetics Society, the Best Paper Award in Theory from ICCSS 2017 and the Zadeh Best Student Paper from IEEE ICCSS 2019, respectively. He has been in the editorial board of several international journals, including IEEE Transactions on Neural Networks and Learning Systems, IEEE Transactions on Fuzzy Systems, IEEE Transactions on Systems, Man and Cybernetics: Systems, IEEE Transactions on Cognitive and Developmental Systems, SCIENCE CHINA Information Sciences, IEEE/CAA Journal of Automatica Sinica, Neural Networks, Asian Journal of Control, Circuits, Systems and Signal Processing, and International Journal of Control, Automation and Systems. He has been Guest Editors of IEEE Transactions on Cybernetics and IET Control Theory and Applications. He is a member of the IFAC Technical Committee on Computational Intelligence in Control.

Distinguished Lecture 4

Filtered Repetitive Control with Nonlinear Systems

Prof. Quan Quan
Beihang University, China

Saturday, May 15, 2021
15:00-15:40
Function room B / B 厅

Abstract

In practice, many control tasks are also often of a periodic nature. For these periodic control tasks, repetitive control (RC, or repetitive controller, also designated RC) can achieve high precision control performance. RC often suffers the robustness problem, including stability robustness against uncertain parameters of systems and performance robustness against uncertain or time-varying period-time of external signals. Filters and frequency domain analysis are the primary tools to solve such a problem, resulting in filtered RCs. But, they can be applied only with difficulty, if at all, to nonlinear systems. This talk aims at providing five methods to explore the potential of RC. Commonly-used methods like the feedback linearization method and adaptive-control-like method will be introduced first. However, feedback linearization or error dynamics derived is often difficult for other various types of problems. To this end, three new methods parallel to the two ways mentioned above will also be shared, which are the additive-state-decomposition based method, the actuator-focused design method, and the contraction mapping method.

Biography

Quan Quan received the B.S. and Ph.D. degrees from Beihang University, Beijing, China, in 2004 and 2010, respectively. He was a research fellow in National University of Singapore from June 2011 to October 2011. Since 2013, he has been an Associate Professor with Beihang University, currently with the School of Automation Science and Electrical Engineering. He was also a visiting professor of the University of Toronto in 2017, hosted by Professor W.M. Wonham. His research interests include repetitive control, reliable flight control, and swarm control. He completed the first book about repetitive control for nonlinear systems entitled "Filtered Repetitive Control with Nonlinear Systems." Also, he published two other books on multicopter systems. He led his group to develop a performance evaluation website flyeval.com for multicopters and a simulation platform RflySim (rflysim.com).

Distinguished Lecture 5

Online Operating Performance Assessment of Hydrocracking Process Under Uncertain Information

Prof. Yalin Wang
Central South University, China

Saturday, May 15, 2021
15:00-15:40
Function room A / A厅

Abstract

In order to timely adjust its production operations and ensure long-term optimized running, it is of great significance for the hydrocracking process to accurately assess whether its current production deviates from the optimal operating performance and determine the deviation degree. However, due to the harsh detection environment and limited detection technology, it is difficult to detect the key operating performance assessment indicators online. The complexity of the process and data also increases the difficulty of online prediction of these key assessment indicators. Moreover, suffer from three uncertainties of operating acknowledge, data measurement and the information interaction of hierarchical operating structure, the accurate online assessment of operating performance is still difficult. Therefore, driven by big data, we have carried in-depth research on the online operating performance assessment method of hydrocracking process under uncertain information. This report summarizes our relevant research results, and introduces them from the aspects of assessment indicator system construction and modeling preprocessing, online prediction of key assessment indicators, and online assessment of operating performance.

Biography

Yalin Wang is a second-level professor, doctoral supervisor and associate dean at the School of Automation, Central South University, and she is an outstanding talent in the new century of the Ministry of Education. Her current research activity addresses complex industrial process modeling and optimization, industrial big data analysis, intelligent scheduling and optimization decision making. Wang is a member of the IFAC Industry Committee, the Process Control Committee of the Chinese Society of Automation, the Technical Process Fault Diagnosis and Safety Committee of the Chinese Society of Automation, and a vice chairman of the Hunan Society of Automation. She presided over 4 major projects or subjects of the National Science and Technology Plan, 18 other research projects, and participated in more than 20 projects of the National Science and Technology Plan. Won 1 second prize of National Technology Invention Award, 1 second prize of National Science and Technology Progress Award, 6 first prizes and 4 second prizes of provincial and ministerial science and technology awards (including Innovation Team Award, Nature Award, Technology Invention Award, and Science and Technology Progress Award). In the past 5 years, she has published 45 SCI papers as the first or corresponding author, including 3 hot papers and 6 highly cited papers; applied for 42 national invention patents and holds 31.

Industrial Control Practice Forum

Industrial Control Practice Forum

Sunday, May 16, 2021
8:00-10:00
Function room B / B厅

Forum speaker

Speaker 1：Dr. Yuanming Zhu (East China University of Science and Technology)
Title：Data-Driven Control Technology in Cement Industry
Biography：Yuanming Zhu received his B.S. and Ph. D. degree in BJTU and work as a vice professor in ECUST. The candidate of "Sailing Plan Project" in Shanghai. He has undertaken more than 10 national scientific research projects. His research interest includes data-driven control, robust control and intelligent control for industry process. Recent years, his research direction is aimed at the national major strategic demands, committed to the research of key theories and technologies for cement green manufacturing. He has published more than 20 academic papers, including in TNNLS, TII, IJRNC, IECR, etc.; applied for more than 10 national invention patents and obtained 6 software copyrights in the field of optimization and control for cement manufacturing.

Speaker 2：Dr. Minglei Yang (East China University of Science and Technology)
Title：Value Chain Evaluation and Optimization for Petrochemical Process
Biography：Minglei Yang was born in 1985. He received his B.S. and Ph. D. degree in Chemical Engineering from East China University of Science and Technology. He is now the vice director of automation research institute. For the past 10 years, he has been devoted to the steady / dynamic state of complex petrochemical processes, multi-scale mechanism modeling, process optimization and decision making. As the project leader, he undertook 2 National Natural Science Foundation Projects and 1 basic scientific research project of Central University project. As the technical director, he undertook over 10 projects from industry and MIIT, such as the development of large-scale petrochemical process mechanism modeling, plan optimization, profit maximization for reforming process, etc. The developed technics have been successfully applied in Sinopec Jiujiang Branch, Zhenhai Branch, Shanghai Branch and Yangzi Branch. He has published over 30 papers in Chemical Engineering journals, and authorized over 20 Chinese patents. In 2019, he won the First prize of Shanghai Science and Technology Progress Award and Technological Invention.

Speaker 3：Dr. Hao Chen (Haixi Institute, Chinese Academy of Sciences)
Title：Exploration on the Application of Industrial Big Data in Manufacturing Industry
Biography: Hao Chen, a researcher of Haixi Institute, Chinese Academy of Sciences & PI. He received his Bachelor degree in the major of automation from National University of Defense Technology in 2006, Master degree in the major of control system from The University of Sheffield, UK in 2009, Doctor's degree in the major of Cybernetic from University of Reading, UK in 2013. From January 2014 to July 2015, he engaged in industrial data analysis and soft-sensor research in the University of Alberta, Canada / Syncrude oil company. Now he is the director of Fujian Provincial key laboratory for Intelligent Identification and Control of Complex Dynamic System, the committee member of data driven control, learning and optimization Committee of Chinese Association of Automation, the vice director of

Fujian Provincial Industrial Internet Intelligent Sensing and Decision Engineering Research Center. He presided over nearly 30 national / Chinese Academy of Sciences / local scientific research projects, applied for / authorized 36 national invention patents, and published nearly 50 academic papers. He has won the Youth Promotion Association of Chinese Academy of Sciences, Fujian Natural Science Foundation for Distinguished Young Scholars and Fujian May 4th Youth medal. He committed to the research road of combining theory with application. The production optimization series technology and industrial software that developed by the team have been successfully applied in nearly ten leading enterprises in the industry, such as Sunner Group, Seven Group, Shuhua Sports, etc.