The 16th IEEE International Conference on Control, Automation, Robotics and Vision

Shenzhen, China

13-15 December, 2020

Organised by

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CONFERENCE GUIDE

The 16th International Conference on Control, Automation, Robotics and Vision

(ICARCV 2020)

December 13-15, 2020

Shenzhen
China

ICARCV 2020

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Control, Automation, Robotics and Vision

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HISTORY OF ICARCV

ICARCV 1990
First International Conference on Automation, Robotics and Computer Vision
September 1990, Singapore

ICARCV 1992
Second International Conference on Automation, Robotics and Computer Vision
15 - 18 September 1992, Singapore

ICARCV 1994
Third International Conference on Automation, Robotics and Computer Vision
8 - 11 November 1994, Singapore

ICARCV 1996
Fourth International Conference on Control, Automation, Robotics and Vision
3 - 6 December 1996, Singapore

ICARCV 1998
Fifth International Conference on Control, Automation, Robotics and Vision
8 - 11 December 1998, Singapore

ICARCV 2000
Sixth International Conference on Control, Automation, Robotics and Vision
5 - 8 December 2000, Singapore

ICARCV 2002
Seventh International Conference on Control, Automation, Robotics & Vision
2 - 5 December 2002, Singapore

ICARCV 2004
Eighth International Conference on Control, Automation, Robotics & Vision
6 - 9 December 2004, Kunming, China

ICARCV 2006
Ninth International Conference on Control, Automation, Robotics & Vision
5 - 8 December 2006, Singapore

ICARCV 2008
Tenth International Conference on Control, Automation, Robotics & Vision
17 - 20 December 2008, Hanoi, Vietnam

ICARCV 2010
Eleventh International Conference on Control, Automation, Robotics & Vision
7 - 10 December 2010, Singapore

ICARCV 2012
Twelfth International Conference on Control, Automation, Robotics & Vision
5 - 7 December 2012, Guangzhou, China

ICARCV 2014
Thirteenth International Conference on Control, Automation, Robotics & Vision
10 - 12 December 2014, Marina Bay Sands, Singapore

ICARCV 2016
Fourteenth International Conference on Control, Automation, Robotics & Vision
13 - 15 November 2016, Phuket, Thailand

ICARCV 2018
Fifteenh International Conference on Control, Automation, Robotics & Vision
18 - 21 November 2018, Marina Bay Sands, Singapore

ICARCV 2020
Sixteenth International Conference on Control, Automation, Robotics & Vision
13 - 15 December 2020, Shenzhen, China
https://www.icarcv.sg/

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Changyun Wen

Hongye Su

Message from General Chairs of ICARCV 2020

Dear Friend and Colleagues,

On behalf of the organizing committee, we are pleased to welcome you to the 16th International Conference on Control, Automation, Robotics and Vision (ICARCV 2020)!

The biennial event of ICARCV has proven to be a premium forum for researchers and engineers from all around the world to share their latest research results and accelerating the exploitation of new technologies in Control, Automation, Robotics and Computer Vision. ICARCV 2020 is organized by School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, co-organized by Zhejiang University, China, locally co-organized by Shenzhen Polytechnic, China and technically co-sponsored by IEEE Control Systems Society. Due to the unexpected outbreak of COVID-19, the organizing committee encountered lots of uncertainties. Nevertheless, this did not stop us from organizing ICARCV 2020. With the efforts from all the members of the organizing committee, ICARCV 2020 continues to attract broad interest throughout the world, with over 300 submissions received from 30 countries/regions. The strong support from the Technical Program Committee has enabled us to put together a very solid technical program that consists of 40 technical sessions for the delegates. Besides the parallel technical sessions, there are also keynote addresses and panel discussions on the state-of-art development in Control, Automation, Robotics and Computer Vision to be delivered by eminent professors and researchers.

We are indeed honored to have Professor Ben M. Chen from Chinese University of Hong Kong & National University of Singapore, Professor Xilin Chen from Chinese Academy of Sciences, Professor Warren Dixon from University of Florida, as the keynote speakers for ICARCV 2020. Their presence together with that of the plenary panelists would undoubtedly act prestige to the conference. We would like to express our sincere appreciation to all of them for their contributions and supports to ICARCV 2020.

We would like to thank all the organizers of invited sessions and the numerous researchers worldwide who helped to review the submitted papers. We are also grateful to the distinguished International Advisory Committee members for their invaluable supports and assistances. We would like to gladly acknowledge the technical sponsorship provided by the IEEE Control Systems Society. We also wish to place our hearty thanks to all the members of the Organizing Committee for their hard work to make this conference possible, and to many friends, colleagues and indeed family members who have helped the conference directly or indirectly. Last but not least, we are grateful for the strong and enthusiastic support of all delegates from around the world.

Due to the impact of COVID-19 and considering that all delegates' health and safety should be the most important, ICARCV 2020 is conducted fully online. We hope that you will find your participation in this online conference stimulating, rewarding, enjoyable and memorable. We also wish all of you stay safe and healthy.

Changyun Wen and Hongye Su
General Chairs, ICARCV 2020

MESSAGE FROM TECHNICAL CHAIR

Rong Su

Lei Xie

On behalf of the Technical Program Committee, we welcome you to ICARCV 2020. The worldwide COVID-19 pandemic has caused tremendous confusions among potential contributors and our local organizers, forcing us to abandon the original plan of having the conference in Shenzhen, China, and turn the conference into a virtual event. This unprecedented situation has led to a great challenge for the local organizing team in terms of soliciting contributions and arranging the reviewing process. With all the efforts from our fellow colleagues, we proudly announce that, this year, we have received a total submission of 307 papers from about 30 countries and regions. Each full paper has gone through rigorous peer reviews to ensure the quality of accepted papers. A total of 224 papers were selected for presentations in 40 oral sessions. We have also made significant efforts in organizing invited sessions. A total of 16 invited sessions are included. The technical program also includes two panel sessions and three plenary speeches.

We shall be presenting the Best Paper Award during the conference. Based on the recommendation by the reviewers and program committee, we have selected 10 shortlisted papers for consideration of two best paper awards: ICARCV 2020 Best Paper Award and ICARCV 2020 Best Student Paper Award. The winners will be chosen by the Conference Award Committee after a final evaluation of the oral presentations during the conference, and will be announced on the last day of the conference.

We would like to thank the international advisory committee, conference award committee, technical program committee, invited sessions organizers and reviewers for their help and contributions to the conference. This year, due to COVID-19, ICARCV 2020 has become fully virtual, which has added tremendous workload on our local support team. Here we would like to mention Mr Alvin Tan who has always been there when help is needed. Finally, our gratitude goes to each member in the technical program committee. It is them who make this conference a high standard one.

Rong Su and Lei Xie
Technical Program Chairs, ICARCV 2020

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INFORMATION ABOUT SHENZHEN

Shenzhen is a coastal city in the south of Guangdong Province, neighboring Daya Bay and Dapeng Bay to the east, Pearl River Estuary and Lingdingyang to the west, and Dongguan and Huizhou to the north and Hong Kong to the south. It is only 41 kilometers (25 miles) from Hong Kong. Benefiting from the superior location and China's reform and opening-up policy, Shenzhen has become a modern and international metropolis since 1978. Dubbed as 'China Silicon', today's Shenzhen gathers more than 14,000 high-tech companies including Huawei, Lenovo and Tencent. It also becomes the innovation hub as a new generation of start-ups emerging, which makes it the most competitive and innovative city in China.

CONFERENCE INFORMATION

Organizer

School of Electrical and Electronic Engineering, Nanyang Technological University

Co-Organizers

Zhijiang University
Shenzhen Polytechnic

Technical Sponsors

IEEE Control Systems Society

Language

The conference and all its activities will be conducted in English.

Video Recording and Uploading

Authors are required to upload:

(1) A video of your presentation. Please note that the file must be a video file in the following format: mp4 (more details below). Please do not try to upload powerpoint or PDF files.

(2) A release form which grants us the permission to host the presentation video online to be accessed by virtual conference attendees, together with other requirements from the IEEE as stipulated in the release form. If the release form is not uploaded together with the presentation video, the presentation will not be hosted in the online proceedings. The form can be downloaded from

https://controls.papercept.net/images/icarcv/PRF.doc

There are two possible methods to record your video. 1) Record a slide show using Microsoft PowerPoint, and then convert the PowerPoint slides into a video in mp4 format. 2）record a compatible video from content displayed on your computer screen and voice recorded via the computer microphone using Zoom. You may also explore other tools to record your video.

Please use the following guidelines for preparing your video.

Video length for all contributed and invited papers:
18 minutes
File size limit for video: 50MB file
File format: mp4
Minimum height: 480 pixels
Aspect ratio: 16:9

If your video exceeds the file size limit, you may use thefree online compression tool at the following URL:https://www.freeconvert.com/video-compressor

EVENT SCHEDULES

Sunday, 13 December		
08:30 – 09:00	Opening Ceremony	Room 1 (Virtual)
09:00 – 10:00	Plenary 1	
10:00 – 10:30	***Tea and Coffee Break***	
10:30 – 12:30	Plenary Panel in Control	Room 1 (Virtual)
12:30 – 13:30	***Lunch***	
13:30 – 15:30	Technical Sessions SuB	Room 1 – 6 (Virtual)
15:30 – 16:00	***Tea and Coffee Break***	
16:00 – 18:00	Technical Sessions SuC	Room 1 – 6 (Virtual)
Monday, 14 December		
08:30 – 09:30	Plenary 2	Room 1 (Virtual)
09:30 – 10:00	***Tea and Coffee Break***	
10:00 – 12:00	Technical Sessions MoA	Room 1 – 6 (Virtual)
12:00 – 13:00	***Lunch***	
13:00 – 15:00	Technical Sessions MoB	Room 1 – 6 (Virtual)
15:00 – 15:30	***Tea and Coffee Break***	
15:30 – 17:30	Technical Sessions MoC	Room 1 – 6 (Virtual)
Tuesday, 15 December		
09:00 – 11:00	Plenary Panel in Robotics and AI	Room 1 (Virtual)
11:00 – 11:30	***Tea and Coffee Break***	
11:30 – 12:30	Plenary 3	Room 1 (Virtual)
12:30 – 13:30	***Lunch***	
13:30 – 15:30	Technical Sessions TuB	Room 1 – 6 (Virtual)
15:30 – 16:00	***Tea and Coffee Break***	
16:00 – 18:00	Technical Sessions TuC	Room 1 – 6 (Virtual)

(Beijing/Hong Kong/Singapore time)

BEST PAPERS SELECTION

Best Papers Award will be presented during the conference. Based on the recommendation by the reviewers and program committee, we have selected 10 shortlisted papers for consideration of two best paper awards: ICARCV2020 Best Paper Award and ICARCV2020 Best Student Paper Award. The winners will be chosen by the Conference Award Committee after a final evaluation of the oral presentations during the conference, and will be announced during the conference banquet.

PLENARY SPEECHES

Title: Research Trends in Developing Intelligent Unmanned Systems

13 December 2020, 09:00 – 10:00 (Beijing/Hong Kong/Singapore time)

Venue: Room 1 (Virtual)

Speaker:

Ben M. Chen
Department of Mechanical and Automation Engineering
Chinese University of Hong Kong
Department of Electrical and Computer Engineering
National University of Singapore

Chaired by:

Changyun Wen, Nanyang Technological University, Singapore

Abstract

The research and market for the unmanned aerial systems (UAS), or drones, has greatly expanded over the last few years. It is expected that the currently small civilian unmanned aircraft market is likely to become one of the major technological and economic stories of the modern age, due to a wide variety of possible applications and added value related to this potential technology. Modern unmanned aerial systems are gaining promising success because of their versatility, flexibility, low cost, and minimized risk of operation. In this talk, we highlight some key techniques involved and research trends in developing intelligent autonomous unmanned aerial vehicles, which include task and motion planning, flight control systems, perception and data processing. Some industrial application examples will be used as illustrations.

Biography:

Prof. Ben M. Chen is currently a Professor of Mechanical and Automation Engineering at the Chinese University of Hong Kong and a Professor of Electrical and Computer Engineering (ECE) at the National University of Singapore (NUS). He was a Provost's Chair Professor in the NUS ECE Department, where he also served as the Director of Control, Intelligent Systems and Robotics Area, and Head of Control Science Group, NUS Temasek Laboratories. He was an Assistant Professor at the State University of New York at Stony Brook, in 1992–1993. His current research interests are in unmanned systems, robust control and control applications.

Dr. Chen is an IEEE Fellow. He has authored/co-authored more than 450 journal and conference articles, and a dozen research monographs in control theory and applications, unmanned systems and financial market modeling. He had served on the editorial boards of a dozen international journals including *Automatica* and *IEEE Transactions on Automatic Control*. He currently serves as an Editor-in-Chief of *Unmanned Systems*. Dr. Chen has received a number of research awards. His research team has actively participated in international UAV competitions and won many championships in the contests.

Title: The Intermittent Joy of Intermittent Feedback

14 December 2020, 09:00 – 10:00 (Beijing/Hong Kong/Singapore time)

Venue: Room 1 (Virtual)

Speaker:

Warren Dixon
Mechanical and Aerospace Engineering Department
University of Florida, USA

Chaired by:

Danwei Wang, Nanyang Technological University, Singapore

Abstract

Autonomous systems use closed-loop feedback of sensed or communicated information to meet desired objectives. Meeting such objectives is more challenging when autonomous systems are tasked with operating in uncertain complex environments with intermittent feedback. This presentation explores different analysis methods that quantify the effects of intermittent feedback with respect to stability and performance of the autonomous agent. Various scenarios are considered where the intermittency results from natural phenomena or adversarial actors, including purposeful intermittency to enable new capabilities. Specific examples include intermittency due to occlusions in image-based feedback and intermittency resulting from various network control problems.

Biography:

Prof. Warren Dixon received his Ph.D. in 2000 from the Department of Electrical and Computer Engineering from Clemson University. He worked as a research staff member and Eugene P. Wigner Fellow at Oak Ridge National Laboratory (ORNL) until 2004, when he joined the University of Florida in the Mechanical and Aerospace Engineering Department where he currently holds the Newton C. Ebaugh professorship. His main research interest has been the development and application of Lyapunov-based control techniques for uncertain nonlinear systems. He has authored or co-authored approximately 500 peer-reviewed articles, including four research monographs. His work has been recognized by a number of early career, best paper, and student mentoring awards. He is a Fellow of ASME and IEEE for his contributions to control of uncertain nonlinear systems.

Title: Towards Understandable Computer Vision

15 December 2020, 11:30 – 12:30 (Beijing/Hong Kong/Singapore time)

Venue: Room 1 (Virtual)

Speaker:

Xilin CHEN
The Institute of Computing Technology
Chinese Academy of Sciences, China

Chaired by:

Prof. Yap Peng TAN, Nanyang Technological University, Singapore

Abstract:

In the past decades, computer vision has become the hottest area in artificial intelligence due to it reaches similar or even better results in some typical tasks, such as object recognition, than human being. However, most current computer vision systems are designed for specific task(s) in the close world, and hard to deal with open world cases. Flat structure for specific task(s) without reasoning and lack of knowledge are the major barriers toward a flexible computer vision system. For this purpose, a key factor is understandable or interpretable. Therefore, objects should be processed in a contextual environment rather than a solo one with a simple identity, and objects should also be associated with relevant concepts. A conceptual mapping of a given image brings enhanced representation, which can support versatile tasks. In this talk, I will briefly review the current state of computer vision, and talk about some open problems. I will then share my points on these relevant problems. Some of our efforts towards understandable computer vision are reported, including hierarchical object detection and categorization, scene graph construction and its application, unseen object inference, etc.

Biography:

Prof. Xilin Chen is a professor with the Institute of Computing Technology, Chinese Academy of Sciences. His research interests include computer vision, pattern recognition, multimedia and multimodal interfaces. His research topics cover face perception, sign language recognition, object recognition, and scene understanding. Recent works focus on explainable object recognition and scene understanding, including hierarchical modeling, vision and language, face perception for education, etc. He is currently a Senior Editor of the Journal of Visual Communication and Image Representation, and an associate editor-in-chief of the Chinese Journal of Computers, and Chinese Journal of Pattern Recognition and Artificial Intelligence. He served as an organizing committee member for multiple conferences, including general co-chair of IEEE FG13 / FG18, program co-chair of ACM ICMI 2010. He has co-authored one book and more than 300 papers. He received the Outstanding Achievement Award from Computer Vision Technical Committee of China Computer Federation (CCF) in 2019. He is a fellow of the ACM, IEEE, IAPR, and CCF.

PLENARY PANEL IN CONTROL

PLENARY PANEL IN CONTROL

Control Theory and Applications: The Presence and The Future

Time: 10:30am-12:30pm, Sunday, 13 December 2020 (Beijing/Hong Kong/Singapore time)

Venue: Venue: Room 1 (Virtual)

Panelists: Prof. Minyue Fu, University of Newcastle, Australia

Prof. Zhong-Ping Jiang, New York University, USA

Prof. Ian R. Petersen, Australian National University, Australia

Prof. Lihua Xie, Nanyang Technological University, Singapore

Prof. Ji-Feng Zhang, Institute of Systems Science, Chinese Academy of Sciences, China

Chairs: Prof. Guoqiang Hu, Nanyang Technological University, Singapore

Prof. Rong Su, Nanyang Technological University, Singapore

ICARCV 2020 proudly presents the plenary panel session on *Control Theory and Applications: The Presence and The Future*. We are honored to be able to invite five prominent experts and educators in the field to be the panelists.

The objective of the plenary panel session is to provide an opportunity for researchers, especially young researchers, to interact with world renowned experts in systems and control and to seek their advice on issues relating to control research such as current status, challenges and opportunities, future perspectives, as well as how to start a career as a control researcher and how to approach challenging research issues, etc. During the session, panel members will share their vast experiences and visions with audience through effective dialogues.

We introduce our panelists in the alphabetic order.

Prof. Minyue Fu received his Bachelor's Degree in Electrical Engineering from the University of Science and Technology of China, Hefei, China, in 1982, and M.S. and Ph.D. degrees in Electrical Engineering from the University of Wisconsin-Madison in 1983 and 1987, respectively. From 1987 to 1989, he served as an Assistant Professor in the Department of Electrical and Computer Engineering, Wayne State University, Detroit, Michigan. He joined the Department of Electrical and Computer Engineering, the University of Newcastle, Australia, in 1989 and was promoted to a Chair Professor in Electrical Engineering in 2002. He was elected to Fellow of IEEE in 2003. He is also a Fellow of Engineers Australia and a Fellow of Chinese Association of Automation. His main research interests include control systems, signal processing and communications. His current research projects include networked control systems, multi-agent systems, smart electricity networks and super-precision positioning control systems. He has been an Associate Editor for the IEEE Transactions on Automatic Control, IEEE Transactions on Signal Processing, Automatica, and Journal of Optimization and Engineering.

Prof. Zhong-Ping Jiang received the M.Sc. degree in statistics from the University of Paris XI, France, in 1989, and the Ph.D. degree in automatic control and mathematics from the Ecole des Mines de Paris (now, called ParisTech-Mines), France, in 1993, under the direction of Prof. Laurent Praly. Currently, he is a Professor of Electrical and Computer Engineering at the Tandon School of Engineering, New York University. His main research interests include stability theory, robust/adaptive/distributed nonlinear control, robust adaptive dynamic programming, reinforcement learning and their applications to information, mechanical and biological systems. In these fields, he has written five books and is author/co-author of over 450 peer-reviewed journal and conference papers. Dr. Jiang has served as Deputy Editor-in-Chief, Senior Editor and Associate Editor for numerous journals. Prof. Jiang is a Fellow of the IEEE, a Fellow of the IFAC, a Fellow of the CAA and is among the Clarivate Analytics Highly Cited Researchers.

Prof. Ian R. Petersen was born in Victoria, Australia. He received a Ph.D in Electrical Engineering in 1984 from the University of Rochester. From 1983 to 1985 he was a Postdoctoral Fellow at the Australian National University. From 1985 until 2016 he was with UNSW Canberra where he was most recently a Scientia Professor and an Australian Research Council Laureate Fellow in the School of Engineering and Information Technology. He has previously been ARC Executive Director for Mathematics Information and Communications, Acting Deputy Vice-Chancellor Research for UNSW and an Australian Federation Fellow. From 2017 he has been a Professor at the Australian National University. He was the Interim Director of the Research School of Electrical, Energy and Materials Engineering at the Australian National University from 2018-2019. He has served as an Associate Editor for the IEEE Transactions on Automatic Control, Systems and Control Letters, Automatica, IEEE Transactions on Control Systems Technology and SIAM Journal on Control and Optimization. Currently he is an Editor for Automatica. He is a fellow of IFAC, the IEEE and the Australian Academy of Science. His main research interests are in robust control theory, quantum control theory and stochastic control theory.

Prof. Lihua Xie received the Ph.D. degree in electrical engineering from the University of Newcastle, Australia, in 1992. Since 1992, he has been with the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore, where he is currently a professor and Director, Delta-NTU Corporate Laboratory for Cyber-Physical Systems. He served as the Head of Division of Control and Instrumentation from July 2011 to June 2014. He held teaching appointments in the Department of Automatic Control, Nanjing University of Science and Technology from 1986 to 1989.

Dr Xie's research interests include robust control and estimation, networked control systems, multi-agent networks, localization and unmanned systems. He is an Editor-in-Chief for Unmanned Systems and an Associate Editor for IEEE Transactions on Network Control Systems. He has served as an editor of IET Book Series in Control and an Associate Editor of a number of journals including IEEE Transactions on Automatic Control, Automatica, IEEE Transactions on Control Systems Technology, and IEEE Transactions on Circuits and Systems-II. He was an IEEE Distinguished Lecturer (Jan 2012 – Dec 2014) and an elected member of Board of Governors, IEEE Control System Society (Jan 2016-Dec 2018). Dr Xie is Fellow of IEEE, Fellow of IFAC and Fellow of Academy of Engineering Singapore.

Prof. Ji-Feng Zhang received his B.S. degree in mathematics from Shandong University, China, in 1985, and the Ph.D. degree from the Institute of Systems Science (ISS), Chinese Academy of Sciences (CAS), China, in 1991. Since 1985, he has been with the ISS, CAS, and now is the Director of ISS. His current research interests include system modeling, adaptive control, stochastic systems, and multi-agent systems.

He is an IEEE Fellow, IFAC Fellow, member of the European Academy of Sciences and Arts, and Academician of the International Academy for Systems and Cybernetic Sciences. He received twice the Second Prize of the State Natural Science Award of China in 2010 and 2015, respectively. He is a Vice-President of the Chinese Association of Automation, Vice-President of the Chinese Mathematical Society, Associate Editor-in-Chief of *Science China Information Sciences*, and Senior Editor of *IEEE Control Systems Letters*. He was a Vice-Chair of the IFAC Technical Board, member of the Board of Governors, IEEE Control Systems Society; Convenor of Systems Science Discipline, Academic Degree Committee of the State Council of China; Vice-President of the Systems Engineering Society of China; and Editor-in-Chief or Associate Editor of more than 10 journals, including *Journal of Systems Science and Mathematical Sciences, IEEE Transactions on Automatic Control* and *SIAM Journal on Control and Optimization* etc. He was General Co-Chair or IPC Chair of many control conferences.

PLENARY PANEL IN ROBOTICS AND AI

PLENARY PANEL IN ROBOTICS AND AI

Robotics and AI: The Presence and The Future

Time: 9:00-11:00am, Tuesday, 15 December 2020 (Beijing/Hong Kong/Singapore time)

Venue: Venue: Room 1 (Virtual)

Panelists: Prof. Magnus Egerstedt, Georgia Institute of Technology, USA

Prof. Yun-Hui Liu, The Chinese University of Hong Kong, China

Prof. Tong Boon Quek, Ministry of Trade and Industry, Singapore

Prof. Costas J. Spanos, University of California, Berkeley, USA

Prof. Yonggang Wen, Nanyang Technological University, Singapore

Chair: Prof. Guoqiang Hu, Nanyang Technological University, Singapore

ICARCV 2020 proudly presents the plenary panel session on *Robotics and AI: The Presence and The Future*. We are honored that five prominent experts and educators in the field will join this panel to share their expertise and visions, and to discuss challenges and opportunities in robotics and AI. Through direct dialog with these world-renowned panelists, we aim to gain a deeper insight into some fundamental and emerging problems in robotics and AI and a broader picture on their application and commercialization potentials.

This plenary panel session will also provide an opportunity for researchers, especially young researchers, to interact with world renowned experts in robotics and AI. During the session, the panel members will share their vast experiences and visions with audience through effective dialogues.

We introduce our panelists in the alphabetic order.

Prof. Magnus Egerstedt is the School Chair and Professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology, where he previously served as the Executive Director for the Institute for Robotics and Intelligent Machines. He received the M.S. degree in Engineering Physics and the Ph.D. degree in Applied Mathematics from the Royal Institute of Technology, Stockholm, Sweden, the B.A. degree in Philosophy from Stockholm University, and was a Postdoctoral Scholar at Harvard University. Dr. Egerstedt conducts research in the areas of control theory and robotics, with particular focus on control and coordination of complex networks, such as multi-robot systems. Magnus Egerstedt is a Fellow of the IEEE and of IFAC, a foreign member of the Royal Swedish Academy of Engineering Sciences, and has received a number of teaching and research awards, including the Ragazzini Award from the American Automatic Control Council.

Prof. Yun-Hui Liu received his Ph.D. degree from the University of Tokyo. After working at the Electrotechnical Laboratory of Japan as a Research Scientist, he joined The Chinese University of Hong Kong (CUHK) in 1995 and is currently Choh-Ming Li Professor of Mechanical and Automation Engineering and the Director of the T Stone Robotics Institute. He also serves as the Director/CEO of Hong Kong Centre for Logistics Robotics sponsored by the InnoHK programme of the HKSAR government. He is an adjunct professor at the State Key Lab of Robotics Technology and System, Harbin Institute of Technology, China. He has published more than 500 papers in refereed journals and refereed conference proceedings and was listed in the Highly Cited Authors (Engineering) by Thomson Reuters in 2013. His research interests include visual servoing, logistics robotics, medical robotics, multi-fingered grasping, mobile robots, and machine intelligence. Dr. Liu has received numerous research awards from international journals and international conferences in robotics and automation and government agencies. He was the Editor-in-Chief of Robotics and Biomimetics and served as an Associate Editor of the IEEE TRANSACTION ON ROBOTICS AND AUTOMATION and General Chair of the 2006 IEEE/RSJ International Conference on Intelligent Robots and Systems. He is an IEEE Fellow.

Prof. Tong Boon Quek has held public sector appointments in Singapore over the last few decades. He is currently the Chief Scientific Advisor of the Ministry of Trade and Industry and also the Chief Executive of National Robotics Program, since 2017. He is also a member of the Committee of Government Scientific Advisors, Republic of Singapore.

Prior to his current appointments, Prof Quek was the Chief Defence Scientist of the Ministry of Defence (MINDEF), Singapore. Over a period of more than 35 years in the defence technology community, he had worked on various aspects of defence technology, including research and development, system acquisition, strategic technology planning and management, technology policy and technology collaboration with both Singapore and international partners.

In 1990s and 2000s, Prof Quek helmed both the Defence Materiel Organization (predecessor organization to today's DSTA (Defence Science and Technology Agency), and the DSO National Laboratories as Director and Chief Executive Officer respectively. He also held appointments in MINDEF as its Deputy Secretary (Technology & Transformation), Chief Research and Technology Officer and Chief Information Officer. He was also a member of the Boards of DSTA and DSO and Chairman of the Temasek Laboratories at the National University of Singapore (NUS), Nanyang Technological University (NTU) and Singapore University of Technology and Design (SUTD). His contributions to the defence technology community in various capacities have been instrumental in shaping the capability edge for Singapore's defence over the years.

Beyond defence, he had previously been a member of the Boards of SingTel, Singapore Technologies, PUB (the National Water Agency), Building and Construction Authority (BCA), and Productivity and Standards Board (PSB), Agency for Science, Technology and Research (A*STAR) and SUTD. He was also a member of the Board of the Intellectual Property Office of Singapore (IPOS) from 2007 to 2009, and its Chairman from 2009 to 2013.

Professor Quek is currently a member of the Board of Temasek Foundation Innovates, a non-profit philanthropic foundation of Temasek Holdings, Republic of Singapore.

In 1989, a project that he led won the inaugural Defence Technology Prize. The honors that he had been conferred over the years included Public Administration Medal (Bronze) in 1989, Public Administration Medal (Silver) in 1996, Public Administration Medal (Gold) in 2011, Honorary IES Fellow in 2009, Fellow of the Academy of Engineering Singapore in 2012, and Chevalier (Knight) of the French Legion of Honor in 2011.

In 2016, he was given the NUS Outstanding Service Award for his sustained and exceptional contributions to the University and the society. Prof Quek is currently an Adjunct Professor at the National University of Singapore.

Prof. Costas J. Spanos (Fellow, 2000) received the EE Diploma from the National Technical University of Athens, Greece, and the M.S. and Ph.D. degrees in ECE from Carnegie Mellon University. In 1988 he joined the department of Electrical Engineering and Computer Sciences (EECS) at the University of California, Berkeley, where he is now the Andrew S. Grove Distinguished Professor and the Director of the Center for Information Technology Research in the Interest of Society and the Banatao institute (CITRIS). He is also the Founding Director and CEO of the Berkeley Education Alliance for Research in Singapore (BEARS), and the Lead Investigator of a large research program on smart buildings based in California and Singapore. Prior to that, he has been the Chair of EECS at UC Berkeley, the Associate Dean for Research in the College of Engineering at UC Berkeley, and the Director of the UC Berkeley Microfabrication Laboratory. His research focuses on Sensing, Data Analytics, Modeling and Machine Learning, with broad applications in semiconductor technologies, and cyber-physical systems.

Prof. Yonggang Wen (M’08-S’14-F’20) is the Professor of Computer Science and Engineering at Nanyang Technological University (NTU), Singapore. He has also served as the Associate Dean (Research) at College of Engineering at NTU Singapore since 2018. He served as the Acting Director of Nanyang Technopreneurship Centre (NTC) at NTU from 2017 to 2019, and the Assistant Chair (Innovation) of School of Computer Science and Engineering (SCSE) at NTU from 2016 to 2018. He received his PhD degree in Electrical Engineering and Computer Science (minor in Western Literature) from Massachusetts Institute of Technology (MIT), Cambridge, USA, in 2008. He has worked extensively in learning-based system prototyping and performance optimization for large-scale networked computer systems. Previously he led product development in content delivery network at Cisco, which had a revenue impact of 3 Billion US dollars globally. His work in Multi-Screen Cloud Social TV has been featured by global media (more than 1600 news articles from over 29 countries) and received 2013 ASEAN ICT Awards (Gold Medal). His recent work on Cloud3DView, as the only academia entry, has won 2016 ASEAN ICT Awards (Gold Medal) and 2015 Datacentre Dynamics Awards 2015 – APAC (‘Oscar’ award of data centre industry). He was the sole winner of 2016 Nanyang Awards in Innovation and Entrepreneurship at NTU. He is a co-recipient of multiple best papers awards, including 2019 IEEE TCSVT Best Paper Award, 2015 IEEE Multimedia Best Paper Award, 2016 IEEE Globecom, 2016 IEEE Infocom MuSIC Workshop, 2015 EAI/ICST Chinacom, 2014 IEEE WCSP, 2013 IEEE Globecom and 2012 IEEE EUC. He received 2016 IEEE ComSoc MMTC Distinguished Leadership Award. He serves on editorial boards for multiple transactions and journals, including IEEE Transactions on Circuits and Systems for Video Technology, IEEE Wireless Communication Magazine, IEEE Communications Survey & Tutorials, IEEE Transactions on Multimedia, IEEE Transactions on Signal and Information Processing over Networks, IEEE Access Journal and Elsevier Ad Hoc Networks, and was elected as the Chair for IEEE ComSoc Multimedia Communication Technical Committee (2014-2016). His research interests include cloud computing, green data center, distributed machine learning, blockchain, big data analytics, multimedia network and mobile computing. He is a Fellow of IEEE.

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Jiang, Zhong-Ping — New York University
Petersen, Ian R. — Australian National University
Xie, Lihua — Nanyang Technological University
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Kermorgant, Olivier — Ecole Centrale Nantes
Belouaer, Lamia — E-COBOT

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Dantanarayana, Lakshitha — University of Technology Sydney

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Boyd, Shelley — St. George's Medical Center

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Laconte, Johann — Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pascal, F-63000 CLERMONT-FERRAND, FRANCE
AUFRERE, Romuald — Institut Pascal - Clermont Auvergne University
THEODOSE, Ruddy — Sherpa Engineering
DENIS, Dieumet — SHERPA ENGINEERING
Chapuis, Roland — Institut Pascal

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Zhang, Liyan — Wuhan University of Technology
Chen, Qihong — Wuhan University of Technology

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Fu, Minyue	University of Newcastle

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Nguyen, Dac Dang Khoa	University of Technology Sydney
Lai, Yujun	University of Technology Sydney (UTS)
Sutjipto, Sheila	University of Technology, Sydney
Paul, Gavin	UTS

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SARRAS, Ioannis	ONERA-The French Aerospace Lab
Eudes, Alexandre	ONERA
Marzat, Julien	ONERA - the French Aerospace Lab

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Koung, Daravuth	Ecole Centrale De Nantes, E-COBOT
Fantoni, Isabelle	CNRS
Kermorgant, Olivier	Ecole Centrale Nantes
Belouaer, Lamia	E-COBOT

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Wang, Xin	Harbin Institue of Technology (Shenzhen)
Xiao, Zhenlong	Harbin Institute of Technology (Shenzhen)
Lan, Rongfu	Harbin Institute of Technology, Shenzhen
Liu, Xiaodi	Harbin Institute of Technology, Shenzhen
Cai, Xiaotian	Harbin Institute of Technology (Shenzhen)

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Su, Rong	Nanyang Technological University

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Xu, Yuecong	Nanyang Technological University
Shi, Ziji	Nanyang Technological University
Luo, Ruikang	Nanyang Technological University
Xie, Lihua	Nanyang Technological University
Su, Rong	Nanyang Technological University

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Li, Feng	Beijing Jiaotong University
Chen, Xiaojing	Beijing Jiaotong University
Tian, Le	Beijing Jiaotong University
Song, Dongdong	Beijing Jiaotong University

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Sheng, Zihao	Shanghai Jiao Tong University
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Xu, Yunwen	Shanghai Jiao Tong University
Li, Dewei	Shanghai Jiao Tong University

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Jin, Yinli	Chang'an University
Wang, Jun	Toll Collection Center for Shaanxi Freeway

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Han, Wanshui	Chang'an University
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Organizer: Feng, Zhi	Nanyang Technological University

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Chen, Yangyang	Southeast University

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Tongxiang, Li	Zhejiang University of Technology
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Yu, Li	Zhejiang University of Technology

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Jeffrey, Soon — Delat

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Organizer: Wang, Han — Nanyang Technological University

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PING, GUIJU — Nanyang Technological University
Abolfazli Esfahani, Mahdi — Nanyang Technological University
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zhou, hui — Nanyang Technological University
Wang, Han — Nanyang Technological University
Zhang, Handuo — Nanyang Technological University
Karunasekera, Hasith — Nanyang Tech. Univ

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Wang, Han — Nanyang Technological University
Wu, Keyu — Nanyang Technological University
YUAN, SHENGHAI — Nanyang Tech. Univ

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Allibert, Guillaume — Universite Cote d'Azur, CNRS, I3S
Martinet, Philippe — INRIA

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Li, Zhidong — UTS
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Zhang, Jun	Nanyang Technological University

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Liu, Chang	Beijing Jiaotong University
LIU, tao	Shenzhen Changlong Railway Electronic Engineering Company Co, Lt
Xiong, Qihui	BeijingJiaoTong University

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Orlowski, Przemyslaw	West Pomeranian University of Technology in Szczecin

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Stoven-Dubois, Alexis	VEDECOM
Dziri, Aziz	VEDECOM
Leroy, Bertrand	VEDECOM
Chapuis, Roland	Institut Pascal

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Guerrero Mata, Jose Alfredo	CEMAGREF (IRSTEA)
Chapuis, Roland	Institut Pascal
AUFRERE, Romuald	Institut Pascal - Clermont Auvergne University
Malaterre, Laurent	Institut Pascal
Marmoiton, Francois	Institut Pascal

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HRUSTIC, Emir	ISAE-SUPAERO
Vivet, Damien	ISAE-SUPAERO

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Li, Yanhao	Shanghai Jiao Tong University
LI, HAO	Shanghai Jiao Tong University

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Yang, Yang	Nanjing University of Posts and Telecommunications
Zhao, Dengli	CRRC Wind Power (Shandong) Co., Ltd
Wu, Jinran	Queensland University of Technology

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Yiwei, Chen	Zhejiang University
Wang, Yiqin	Zhejiang University
Pan, Yu	Zhejiang University

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Cong, Cong	University of News South Wales
Yang, Zhichao	University of News South Wales
Song, Yang	University of New South Wales
Pagnucco, Maurice	University of News South Wales

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Hameed, Khurram	Edith Cowan University
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Rassau, Alex	Edith Cowan University

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weng, zhenyu	Peking University Shenzhen Graduate School
zhu, yuesheng	Peking University Shenzhen Graduate School
Lin, Zhiping	School of Electrical &ElectronicEng., NanyangTechnologicalUnivers
li, haizhou	National University of Singapore

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Yang, Xiaoyong	Alibaba-Group
Ou, Wenwu	Alibaba-Group
Cui, Lizhen	Shandong University
Guo, Wei	Shandong University
Miao, ChunYan	Nanyang Technological University

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sara, bouraine	Center for Development of Advanced Technologies (CDTA)
Bougouffa, Abdelhak	Université Paris-Saclay
ouahiba, azouaoui	Center for Development of Advanced Technologies (CDTA)

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Petrovsky, Alexander	Skolkovo Institute of Scince and Technology
Kalinov, Ivan	Skolkovo Institute of Science and Technology
Karpyshev, Pavel	Skoltech
Kurenkov, Mikhail	Skolkovo Institute of Science and Technology
Ilin, Valery	Skolkovo Institute of Science and Technology

Ramzhaev, Vladimir	Skoltech
Tsetserukou, Dzmitry	Skolkovo Institute of Science and Technology

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Li, Yanjun	Zhejiang University City College
xiang, ji	Zhejiang University, Yuquan Campus
Gui, Ling	Zhejiang University City College; Zhejiang University
Suo, Feiyang	Zhejiang University City College; Zhejiang University

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Tao, Qiuyang	Georgia Institute of Technology
Hou, Mengxue	Georgia Institute of Technology
Zhang, Fumin	Georgia Institute of Technology

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Andonovski, Bojan	Nanyang Technological University
Li, Jianqiang	Nanyang Technological University
Jeyaraj, Sherine	Nanyang Technological University
Ang, Zi Quan	Nanyang Technological University
Kumhom, Pinit	King Mongkut's University of Technology Thonburi
Ang, Wei Tech	Nanyang Technological University

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Laneurit, Jean	INRAE
Roux, Jean-Christophe	Inrae
Lenain, Roland	INRAE

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Organizer: Wang, Danwei	Nanyang Technological University
Organizer: Laugier, Christian	INRIA

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MELBOUCI, kathia	INRIA
NASHASHIBI, FAWZI	INRIA

16:20-16:40 SuCT5.2

VAGAN: Vehicle-Aware Generative Adversarial Networks for Vehicle Detection in Rain (I), pp. 363-368.

Wang, Jian-Gang	Institute for Infocomm Research
WAN, Kong Wah	Institute for Infocomm Research
Yau, Wei Yun	Institute for Infocomm Research
Pang, Chun Ho	Institute for Infocomm Research
Lai, Fon Lin	Institute for Infocomm Research

16:40-17:00 SuCT5.3

Multi-Robot Collaborative Reasoning for Unique Person Recognition in Complex Environments (I), pp. 369-374.

Yang, Chule	Academy of Military Science
Yue, Yufeng	Nanyang Technological University
Wen, Mingxing	Nanyang Technological University
Wang, Yuanzhe	Nanyang Technological University
Deng, Baosong	Academy of Military Science

17:20-17:20 SuCT5.4

Human-Robot Teaming and Coordination in Day and Night Environments (I), pp. 375-380.

Yue, Yufeng	Nanyang Technological University
Liu, Xiangyu	Nanyang Technological University
Wang, Yuanzhe	Nanyang Technological University
Zhang, Jun	Nanyang Technological University
Wang, Danwei	Nanyang Technological University

17:20-17:40 SuCT5.5

RSAN: A Retinex Based Self Adaptive Stereo Matching Network for Day and Night Scenes (I), pp. 381-386.

Zhang, Haoyuan	Nanyang Technological University
Chau, Lap-Pui	Nanyang Technological University
Wang, Danwei	Nanyang Technological University

17:40-18:00 SuCT5.6

HILPS: Human-In-Loop Policy Search for Mobile Robot Navigation (I), pp. 387-392.

Wen, Mingxing	Nanyang Technological University
Yue, Yufeng	Nanyang Technological University
WU, ZHENYU	Nanyang Technological University
MIHANKHAH, Ehsan	Nanyang Technological University
Wang, Danwei	Nanyang Technological University

SuCT6 Room 6

Intelligent Perception and Control for Autonomous Systems/robots 1Intelligent Perception and Control for Autonomous Systems/robots 2 (Invited Session)

Organizer: Zhang, Ya	Southeast University
Organizer: Feng, Zhi	Nanyang Technological University

16:00-16:20 SuCT6.1

Safe Geometric Speed Planning Approach for Autonomous Driving through Occluded Intersections (I), pp. 393-399.

Poncelet, Renaud	Inria
Verroust-Blondet, Anne	Inria
NASHASHIBI, FAWZI	INRIA

16:20-16:40 SuCT6.2

LiDAR Observations by Motion Compensation and Scan Accumulation (I), pp. 400-405.

Lima, Antoine	Université De Technologie De Compiègne
Welte, Anthony	Université De Technologie De Compiègne, Sorbonne Universités
Xu, Philippe	Université De Technologie De Compiègne

Bonnifait, Philippe	Université De Technologie De Compiègne, Sorbonne Universités

16:40-17:00	SuCT6.3

Multi-Sensor-Based Predictive Control for Autonomous Parking in Presence of Pedestrians (I), pp. 406-413.

Pérez-Morales, David	École Centrale De Nantes, LS2N
Kermorgant, Olivier	Ecole Centrale Nantes
Dominguez, Salvador	Ecole Centrale Nantes
Martinet, Philippe	INRIA

17:20-17:20	SuCT6.4

Recognize Moving Objects Around an Autonomous Vehicle Considering a Deep-Learning Detector Model and Dynamic Bayesian Occupancy (I), pp. 414-420.

Gómez Hernandez, Andrés Eduardo	Inria
Erkent, Ozgur	Inria
Laugier, Christian	INRIA

17:20-17:40	SuCT6.5

Instance Segmentation with Unsupervised Adaptation to Different Domains for Autonomous Vehicles (I), pp. 421-427.

Diaz-Zapata, Manuel Alejandro	Inria
Erkent, Ozgur	Inria
Laugier, Christian	INRIA

17:40-18:00	SuCT6.6

Behavioral Decision-Making for Urban Autonomous Driving in the Presence of Pedestrians Using Deep Recurrent Q-Network (I), pp. 428-433.

Deshpande, Niranjan	Inria
Vaufreydaz, Dominique	Univ. Grenoble Alpes, CNRS, Inria, Grenoble INP, LIG, 38000 Gren
Spalanzani, Anne	Inria - Grenoble Alpes University

MoKN	Room 1
Plenary 2 (Plenary Session)	

08:30-09:30 MoKN.1

*The Intermittent Joy of Intermittent Feedback**.

Dixon, Warren E. — University of Florida

MoAT1	Room 1
Medical Image Analysis 1 (Regular Session)	

10:00-10:20 MoAT1.1

Near-Infrared-To-Visible Vein Imaging Via Convolutional Neural Networks and Reinforcement Learning, pp. 434-441.

Leli, Vito Michele — Skolkovo Institute of Science and Technology
Rubashevskii, Aleksandr — Skolkovo Institute of Science and Technology
Sarachakov, Aleksandr — Skolkovo Institute of Science and Technology
Rogov, Oleg — Skolkovo Institute of Science and Technology
Dylov, Dmitry V. — Skolkovo Institute of Science and Technology

10:20-10:40 MoAT1.2

Quantifying Tissue-Stiffening Behaviour of the Cervix in Shear-Wave Elastography, pp. 442-447.

Ge, Weirong — Central Clinical School, University of Sydney
Brooker, Graham — Australian Centre for Field Robotics
Hyett, Jon — Central Clinical School, University of Sydney

10:40-11:00 MoAT1.3

Unsupervised Positron Emission Tomography Tumor Segmentation Via GAN Based Adversarial Auto-Encoder, pp. 448-453.

wu, xinheng — The University of Sydney
Bi, Lei — The University of Sydney
Fulham, Michael — Royal Prince Alfred Hospital
Kim, Jinman — The University of Sydney

11:00-11:20 MoAT1.4

Robust Texture Features for Breast Density Classification in Mammograms, pp. 454-459.

Li, Haipeng — University of Canterbury
Mukundan, Ramakrishnan — University of Canterbury
Boyd, Shelley — St. George's Medical Center

11:20-11:40 MoAT1.5

Deep Learning and Late Fusion Technique in Medical X-Ray Image Classification, pp. 460-465.

Alebiosu, David — Monash University, Malaysia
Dharmaratne, Anuja — Monash University Malaysia
Muhammad, Fermi Pasha — Monash University

11:40-12:00 MoAT1.6

A Bifocal Classification and Fusion Network for Multimodal Image Analysis in Histopathology, pp. 466-471.

Bao, Guoqing — The University of Sydney
Graeber, Manuel — The University of Sydney
Wang, Xiuying — The University of Sydney

MoAT2	Room 2
Networked Control Systems 1 (Regular Session)	

10:00-10:20 MoAT2.1

Adaptive Control for a Class of Uncertain Nonlinear Systems Subject to Saturated Input Quantization, pp. 472-477.

Xing, Lantao — Nanyang Technological University
Wen, Changyun — Nanyang Tech. Univ
Liu, Zhitao — Zhejiang University
Cai, Jianping — Zhangzhou Normal University
Zhang, Meng — Xi'an Jiaotong University

10:20-10:40 MoAT2.2

On Reductions among Observation Properties of Discrete Event Systems, pp. 478-482.

Gong, Chaohui — University of Shanghai for Science and Technology
Zhang, Hanran — University of Shanghai for Science and Technology
Guo, Zhong — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Yan, Zihai — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Wang, Weilin — PowerChina Huadong Engineering Corporation Limited

10:40-11:00 MoAT2.3

Event-Triggered Remote Dynamic Control for Network Control Systems, pp. 483-488.

Li, Haoyun — Anhui University
FAN, Yuan — Anhui University
Pan Gaofeng, Pan Gaofeng — Anhui University
Song, Cheng — Nanjing University of Science and Technology

11:00-11:20 MoAT2.4

On Stability of Multi-Agent Systems on Time Scales under Denial-Of-Service Attacks, pp. 489-496.

Girejko, Ewa — Bialystok University of Technology
Malinowska, Agnieszka B. — University of Aveiro

11:20-11:40 MoAT2.5

Multi-Objective Optimization of Two Control Strategies for Congestion Avoiding in Computer Network, pp. 497-504.

Grzyb, Slawomir — Atos Global Delivery Center Poland
Orlowski, Przemyslaw — West Pomeranian University of Technology in Szczecin

11:40-12:00 MoAT2.6

Multi-Sensor H-Infinity Filter Design for Networked Control Systems with Unknown Communication Delays, pp. 505-510.

Nartey, George — Zhengzhou University
Zhang, Duanjin — Zhengzhou University

MoAT3	Room 3
Robot Sensing (Regular Session)	

10:00-10:20 MoAT3.1

Development of a Millinewton FBG-Based Distal Force Sensor for Intravascular Interventions, pp. 511-515.

Akinyemi, Toluwanimi — Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Omisore, Olatunji — Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Wenke, Duan — Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Gan, LU — Shenzhen Institutes of Advanced Technology, Chinese Academy of S

Du, Wenjin	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Alhanderish, Yousef	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Lei, Wang	Shenzhen Institutes of Advanced Technology, Chinese Academy of S

10:20-10:40 MoAT3.2

Visual-IMU State Estimation with GPS and OpenStreetMap for Vehicles on a Smartphone, pp. 516-521.

He, Guohan	Shanghai Jiaotong University
Cao, Qi xin	Shanghai Jiao Tong University
Zhu, Xiao xiao	Shanghai Jiao Tong University
Miao, Haoyuan	Shanghai Jiaotong University

10:40-11:00 MoAT3.3

An Information Driven Approach for Ego-Lane Detection Using Lidar and OpenStreetMap, pp. 522-528.

KASMI, ABDERRAHIM	Sherpa Engineering/ Institut Pascal - Clermont Auvergne Universi
Laconte, Johann	Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pas
AUFRERE, Romuald	Institut Pascal - Clermont Auvergne University
THEODOSE, Ruddy	Sherpa Engineering
DENIS, Dieumet	SHERPA ENGINEERING
Chapuis, Roland	Institut Pascal

11:00-11:20 MoAT3.4

6D Object Pose Estimation with Color/Geometry Attention Fusion, pp. 529-535.

Yuan, Honglin	Utrecht University
Veltkamp, Remco C.	Utrecht University

11:20-11:40 MoAT3.5

3D Point-To-Keypoint Voting Network for 6D Pose Estimation, pp. 536-541.

Hua, Weitong	Zhejiang University
Guo, Jiaxin	Zhejiang University
WANG, yue	Zhejiang University
Xiong, Rong	Zhejiang University

11:40-12:00 MoAT3.6

Fish Keypoints Detection for Ecology Monitoring Based on Underwater Visual Intelligence, pp. 542-547.

Suo, Feiyang	Zhejiang University City College; Zhejiang University
huang, kangwei	Zhejiang University City Collage
Gui, Ling	Zhejiang University City College; Zhejiang University
Li, Yanjun	Zhejiang University City College
xiang, ji	Zhejiang University, Yuquan Campus

MoAT4 Room 4

Nonlinear Systems (Regular Session)

10:00-10:20 MoAT4.1

Symbolic Self-Triggered Control of Continuous-Time Non-Deterministic Systems without Stability Assumptions for 2-LTL Specifications, pp. 548-554.

Pruekprasert, Sasinee	National Institute of Informatics
Eberhart, Clovis	National Institute of Informatics
Dubut, Jeremy	National Institute of Informatics

10:20-10:40 MoAT4.2

A Parameter Tuning Method for Fractional Order PD Controllers, pp. 555-560.

OZYETKIN, MUNEVVER MINE	Aydin Adnan Menderes University
Bekiroglu, Korkut	SUNY Polytechnic Institute
Srinivasan, Seshadhri	Berekeley Education Alliance for Research in Singapore

10:40-11:00 MoAT4.3

Decoupled Load Swing Control of an Overhead Crane Using Arduino Controller, pp. 561-566.

Garcia, F. Javier	Universidad De Valladolid ESQ4718001C
Gonzalez, Luis R.	Universidad De Valladolid
Poncela, Alfonso V.	Universidad De Valladolid
Moya, Eduardo	ITAP - Universidad De Valladolid

11:00-11:20 MoAT4.4

Practical Stability of Positive Switched Nonlinear Time-Varying Systems, pp. 567-571.

Li, Ruonan	Shandong Normal University
Zhao, Ping	Shandong Normal University

11:20-11:40 MoAT4.5

Modeling and Hovering Control of 5-DoF Tilt-Birotor Robot, pp. 572-577.

Hu, Anyuan	School of Automation, Nanjing University of Science and Technolog
Zhao, Xizhen	Nanjing University of Science and Technology
Xu, Dabo	Nanjing University of Science and Technology

11:40-12:00 MoAT4.6

Robustness of Neural-Network-Based Nonlinear Iterative Learning Control, pp. 578-583.

Patan, Krzysztof	University of Zielona Gora
Patan, Maciej	University of Zielona Gora

MoAT5 Room 5

Distributed Sensing, Learning and Coordination of Multi-Agent Systems (Invited Session)

Organizer: Li, Xianwei	Shanghai Jiao Tong University
Organizer: Tang, Yang	East China University of Science and Technology

10:00-10:20 MoAT5.1

Control Barrier Function Based Nonlinear Controller for Automatic Carrier Landing (I), pp. 584-589.

Zhou, Haitong	The Seventh Research Division, School of Automation Science And
Zheng, Zewei	Beihang University
Guan, Zhiyuan	Beihang University
Ma, Yunpeng	Beihang University

10:20-10:40 MoAT5.2

Consensus of Second-Order Matrix-Weighted Multi-Agent Networks (I), pp. 590-595.

Wang, Chongzhi	Shanghai Jiao Tong University
Pan, Lulu	Shanghai Jiao Tong University
Li, Dewei	Shanghai Jiao Tong University
Shao, Haibin	Shanghai Jiao Tong University
Xi, Yugeng	Shanghai Jiao Tong University

10:40-11:00 MoAT5.3

Enhancing Adaptive Event-Triggered Protocols for Multi-Agent Consensus with External Disturbances (I), pp. 596-601.

Li, Xianwei	Shanghai Jiao Tong University
Tang, Yang	East China University of Science and Technology

Zhu, Bing	Beihang University
Li, Shaoyuan	Shanghai Jiao Tong University

11:00-11:20	MoAT5.4

Enclose a Target with Multiple Nonholonomic Agents (I), pp. 602-607.

Zhu, Lin	Shanghai University
Wei, Jieqiang	KTH Royal Institute of Technology
Ren, Xiaoqiang	KTH
Wang, Xiaofan	Shanghai Jiao Tong University

11:20-11:40	MoAT5.5

Containment Control of Second-Order Multi-Agent Systems Via Asynchronous Sampled-Data Control (I), pp. 608-613.

Chen, Hongjian	University of Electronic Science and Technology of China
Chen, Lulu	University of Electronic Science and Technology of China
Shao, Jinliang	University of Electronic Science and Technology of China

MoAT6 Room 6

Modelling, Fault Diagnosis and Control of Complex System (Invited Session)

Organizer: Huang, Jun	Soochow University
Organizer: Shi, Yuanhao	North University of China
Organizer: Xu, Zhezhuang	School of Electrical Engineering and Automation, Fuzhou University
Organizer: Zhu, Shanying	Shanghai Jiao Tong University

10:00-10:20	MoAT6.1

Robust Model Predictive Control for Markovian Jump Systems with All Unstable Modes (I), pp. 614-619.

Zhang, Bin	University of Shanghai for Science and Technology
Song, Yan	University of Shanghai for Science and Technology

10:20-10:40	MoAT6.2

Research on Gray Prediction of Heated Surface Combining Empirical Mode Decomposition and Long Short-Term Memory Network (I), pp. 620-624.

Li, Mengwei	North University of China
Shi, Yuanhao	North University of China
Cui, Fangshu	North University of China
Wen, Jie	North University of China
Zeng, Jianchao	Taiyuan University of Science and Technology

10:40-11:00	MoAT6.3

Dynamic Event-Triggered Control for Discrete-Time Markov Jump Systems (I), pp. 625-630.

Zhang, Yueyuan	Soochow University
Chen, Yiyang	Soochow University

11:00-11:20	MoAT6.4

Application of Non-Local Mean Algorithm in Non-Contact Interactive Control System (I), pp. 631-635.

Cao, Ziqi	Soochow University
Lu, Fan	Soochow University
Yu, Lei	Soochow University

11:20-11:40	MoAT6.5

Further Research on Optimal Interval Observer Design for Switched Systems (I), pp. 636-641.

Zhang, Haoran	Soochow University
Huang, Jun	Soochow University
Che, Haochi	Soochow University
Zhang, Yueyuan	Soochow University

11:40-12:00	MoAT6.6

Fault Detection for Nonstationary Process with Decomposition and Analytics of Gaussian and Non-Gaussian Subspaces, pp. 642-647.

Zhao, Yi	Zhejiang University
Zhao, Chunhui	Zhejiang University
Sun, Youxian	Zhejiang University

MoBT1 Room 1

Medical Image Analysis 2 (Regular Session)

13:00-13:20	MoBT1.1

Extracting Fetal Heart Rate from Abdominal ECGs Based on Fast Multivariate Empirical Mode Decomposition, pp. 648-653.

Zhang, Jiayue	Zhejiang University
Xu, Xiaozhou	Zhejiang University
Chen, Qiming	Zhejiang University
Xie, Lei	Zhejiang University
Su, Hongye	Zhejiang University

13:20-13:40	MoBT1.2

An Improved Micro-Calcification Detection Algorithm Using a Novel Multifractal Texture Descriptor and CNN, pp. 654-659.

Li, Haipeng	University of Canterbury
Mukundan, Ramakrishnan	University of Canterbury
Boyd, Shelley	St. George's Medical Center

13:40-14:00	MoBT1.3

Multi-Atlas Based Hip Bone Segmentation from Routine Clinical Hip MRIs of Osteoarthritis Patients, pp. 660-665.

Harischandra, Najini	Monash University
Dharmaratne, Anuja	Monash University Malaysia
Cicuttini, Flavia	Monash University
Wang, Yuanyuan	Monash University

14:00-14:20	MoBT1.4

Multi-Level Topological Analysis Framework for Multifocal Diseases, pp. 666-671.

Xin, Bowen	The University of Sydney
Zhang, Lin	School of Computer Science, University of Sydney
Huang, Jing	Department of Radiology, Xuanwu Hospital
Lu, Jie	Department of Radiology, Xuanwu Hospital
Wang, Xiuying	The University of Sydney

14:20-14:40	MoBT1.5

CT Images Segmentation Method of Rectal Tumor Based on Modified U-Net, pp. 672-677.

标, 郑	南京理工大学
Cai, Chenxiao	Nanjing University of Science and Technology
Ma, Lei	China University of Mining and Technology

14:40-15:00	MoBT1.6

Hybrid Feature Network Driven by Attention and Graph Features for Multiple Sclerosis Lesion Segmentation from MR Images, pp. 678-683.

Chen, Zhanlan	Northwestern Polytechnical University
Wang, Xiuying	The University of Sydney
Zheng, Jiangbin	Northwestern Polytechnical University

MoBT2 Room 2

Adaptive Control (Regular Session)

13:00-13:20 MoBT2.1

Pilot Misoperation Control Based on L1 Adaptation and INDI Methods, pp. 684-688.

Wang, Jin — Shanghai Jiao Tong University
Huang, Dan — Shanghai Jiao Tong University
Song, Lei — Shanghai Jiao Tong University
Ding, Lu — Shanghai Jiao Tong University
Fu, Shan — Shanghai Jiao Tong University

13:20-13:40 MoBT2.2

Adaptive Secure Control of Uncertain Second-Order Nonlinear Cyber-Physical System against Intermittent DoS Attacks, pp. 689-694.

yu, mengze — Beihang University
Wang, Wei — Beihang University
Wen, Changyun — Nanyang Tech. Univ

13:40-14:00 MoBT2.3

Optimal Control for Continuous-Time Scalar Nonlinear Systems with Known Dynamics, pp. 695-700.

Tymoshchuk, Pavlo — Silesian University of Technology

14:00-14:20 MoBT2.4

Interpolating Control Based Trajectory Tracking, pp. 701-706.

Boucek, Zdenek — University of West Bohemia
Flídr, Miroslav — University of West Bohemia

14:20-14:40 MoBT2.5

Formation Control of Time-Varying Multi-Agent System Based on BP Neural Network, pp. 707-712.

Wang, Jiaqi — Zhejiang Sci-Tech University
Gao, Jinfeng — Zhejiang Sci-Tech University
Zhang, Xujie — Faculty of Mechanical Engineering and Automation, Zhejiang Sci-T
He, Jiajun — Faculty of Mechanical Engineering and Automation, Zhejiang Sci-T

14:40-15:00 MoBT2.6

GA Cascaded P-PD Control on Ball and Beam System with Two-Stage Objective Function, pp. 713-718.

Tsoi, Kit Pui — University of Auckland
Patel, Nitish — Univ. of Auckland
Swain, Akshya — The University of Auckland
Xu, Huang — University of Auckland

MoBT3 Room 3
Image/video Analysis (Regular Session)

13:00-13:20 MoBT3.1

Self-Supervised Visual Feature Learning and Classification Framework: Based on Contrastive Learning, pp. 719-725.

Wang, Zhibo — University of Central Florida
Zhang, Xiaoyu — University of Central Florida
Yan, Shen — Michigan State University
Da Vitoria Lobo, Niels — University of Central Florida

13:20-13:40 MoBT3.2

Loss Constrains Added Squeeze and Excitation Blocks for Pruning Deep Neural Networks, pp. 726-731.

Wang, Yiqin — Zhejiang University
Li, Ming — Zhejiang University
Su, Hongye — Institute of Cyber-Systems and Control, ZhejiangUniversity
Xie, Lei — Zhejiang University
Li, Xiaochen — Institute of Cyber-Systems and Control, Zhejiang University
Xu, Weihua — Zhejiang Univ
Xu, Xiaozhou — Zhejiang University

13:40-14:00 MoBT3.3

Towards Drowsiness Driving Detection Based on Multi-Feature Fusion and LSTM Networks, pp. 732-736.

HongLin, Hong — Harbin Institute of Technology
Wang, Xin — Harbin Institue of Technology (Shenzhen)

14:00-14:20 MoBT3.4

Deep Convolutional Network for Steganalysis of HUGO, WOW, and UNIWARD Algorithms, pp. 737-740.

Lichy, Krzysztof — Lodz University of Technology
Lipinski, Piotr — Lodz University of Technology
Grzelak, Michal — Lodz University of Technology

14:20-14:40 MoBT3.5

Extracting Temporal Features by Key Points Transfer for Effective Action Recognition, pp. 741-746.

Liao, Chenxi — North University of China
Xu, Yuecong — Nanyang Technological University

14:40-15:00 MoBT3.6

Depthwise Multiception Convolution for Reducing Network Parameters without Sacrificing Accuracy, pp. 747-752.

Bao, Guoqing — The University of Sydney
Graeber, Manuel — The University of Sydney
Wang, Xiuying — The University of Sydney

MoBT4 Room 4
Human-Machine System (Regular Session)

13:00-13:20 MoBT4.1

End-To-End Joint Intention Estimation for Shared Control Personal Mobility Navigation, pp. 753-758.

Katuwandeniya, Kavindie — University of Technology Sydney
Valls Miro, Jaime — University of Technology Sydney
Dantanarayana, Lakshitha — University of Technology Sydney

13:20-13:40 MoBT4.2

SRG3: Speech-Driven Robot Gesture Generation with GAN, pp. 759-766.

YU, Chuang — ENSTA Paris
Tapus, Adriana — ENSTA ParisTech

13:40-14:00 MoBT4.3

Intuitive Virtual Reality Based Control of a Real-World Mobile Manipulator, pp. 767-772.

Le, Dinh Tung — University of Technology Sydney
Sutjipto, Sheila — University of Technology, Sydney
Lai, Yujun — University of Technology Sydney (UTS)
Paul, Gavin — UTS

14:00-14:20 MoBT4.4

Upper Extremity Load Reduction for Lower Limb Exoskeleton Trajectory Generation Using Ankle Torque Minimization, pp. 773-778.

Wong, Yik Ben — Hong Kong University of Science and Technology
CHEN, Yawen — Hong Kong University of Science and Technology
Tsang, Kam Fai Elvis — Hong Kong University of Science and Technology
Leung, Winnie — Hong Kong Univ. of Sci. & Tech
Shi, Ling — Hong Kong Univ. of Sci. and Tech

14:20-14:40 MoBT4.5

Robust Real-Time Face Tracking for People Wearing Face Masks, pp. 779-783.

Peng, Xinggan — Nanyang Technological University

Zhuang, Huiping — Nanyang Technological University

Huang, Guang-Bin — Nanyang Technological University

li, haizhou — National University of Singapore

Lin, Zhiping — School of Electrical &ElectronicEng., NanyangTechnologicalUnivers

14:40-15:00 — MoBT4.6

Nonovershooting Regulation of an Under-Sensed and Under-Actuated Linear Inverted Pendulum, pp. 784-788.

Chen, Chao — The Hong Kong University of Science and Technology

Zhao, Di — The Hong Kong University of Science and Technology

Qiu, Li — Hong Kong Univ. of Sci. & Tech

MoBT5 — Room 5

Modeling, Control and Estimation in Unmanned Systems
(Invited Session)

Organizer: Hu, Jinwen — Northwestern Polytechnical University

Organizer: Hou, Xiaolei — Northwestern Polytechnical University

Organizer: Xu, Zhao — Northwestern Polytechnical University

13:00-13:20 — MoBT5.1

Strategy Generation Based on Reinforcement Learning with Deep Deterministic Policy Gradient for UCAV (I), pp. 789-794.

Ma, Yunhong — Northwestern Polytechnical University

Bai, Shuyao — Northwestern Polytechnical University

Zhao, Yifei — Northwestern Polytechnical University

Song, Chao — Northwestern Polytechnical University

Yang, Jie — Northwestern Polytechnical University

13:20-13:40 — MoBT5.2

Collaborative Task Allocation of Heterogeneous Multi-UAV Based on Improved CBGA Algorithm (I), pp. 795-800.

Ma, Yunhong — Northwestern Polytechnical University

Zhao, Yifei — Northwestern Polytechnical University

Bai, Shuyao — Northwestern Polytechnical University

Zhang, Yimin — Northwestern Polytechnical University

Yang, Jie — Northwestern Polytechnical University

13:40-14:00 — MoBT5.3

Hybrid FCM Learning Algorithm Based on Particle Swarm Optimization and Gradient Descent Algorithm (I), pp. 801-806.

Chen, Jun — Northwestern Polytechnical University

Zhang, Yue — Northwestern Polytechnical University

Gao, Xudong — Northwestern Polytechnical University

14:00-14:20 — MoBT5.4

Implement of a Multi-AGV Platform with Formation Control Algorithm (I), pp. 807-810.

樊, 卫华 — Nanjing University of Science and Technology

14:20-14:40 — MoBT5.5

Path Planning of Mobile Robot Based on Improved Differential Evolution Algorithm (I), pp. 811-816.

Chen, Jun — Northwestern Polytechnical University

Liang, Jing — Northwestern Polytechnical University

Tong, Yan — Northwestern Polytechnical University

14:40-15:00 — MoBT5.6

Design and Verification of UAV Maneuver Decision Simulation System Based on DQN Network (I), pp. 817-823.

Chen, Yuyang — Northwestern Polytechnical University

Zhang, Jiandong — Northwestern Polytechnical University

Yang, Qiming — Northwestern Polytechnical University

Zhou, Yu — China Research and Development Academy of Machinery Equipment

Shi, Guoqing — Northwestern Polytechnical University

Wu, Yong — Northwestern Polytechnical University

MoBT6 — Room 6

Secure Estimation and Control in Cyber-Physical Systems
(Invited Session)

Organizer: Chen, Bo — Zhejiang University of Technology

Organizer: Dong, Shijian — Zhejiang University of Technology

13:00-13:20 — MoBT6.1

Distributed State Estimation for State-Saturated Power Systems under Denial-Of-Service Attacks (I), pp. 824-829.

Chen, Wei — University of Shanghai for Science and Technology

Wang, Xueli — University of Shanghai for Science and Technology

Mao, Jingyang — University of Shanghai for Science and Technology

Ding, Derui — University of Shanghai for Science and Technology, Shanghai, Chi

13:20-13:40 — MoBT6.2

False Data Injection Attacks in Smart Grid Using Gaussian Mixture Model (I), pp. 830-837.

Wang, Zhiwen — College of Electrical and Information Engineering, Lanzhou Unive

Hu, Jiqiang — College of Electrical and Information Engineering, Lanzhou Unive

Sun, Hongtao — College of Engineering, Qufu Normal University

13:40-14:00 — MoBT6.3

Fault Detection Method Based on Multi-Scale Convolutiona Neural Network for Wind Turbine Gearbox (I), pp. 838-842.

Shen, Yijun — Zhejiang University of Technology

Wu, Qi — Zhejiang University of Technology

Huang, Dajian — Zhejiang University of Technology

Dong, Shijian — Zhejiang University of Technology

Chen, Bo	Zhejiang University of Technology

14:00-14:20	MoBT6.4

H∞ Fusion Detection of FDI Attacks for Nonlinear Cyber-Physical Systems (I), pp. 843-847.

Shen, Jiahui	Zhejiang University of Technology
Gao, Lingjie	Zhejiang University of Technology
Chen, Bo	Zhejiang University of Technology
Yu, Li	Zhejiang University of Technology
Chen, Qiuxia	Zhejiang Shuren University

14:20-14:40	MoBT6.5

To Embody or Not: A Cross Human-Robot and Human-Computer Interaction (HRI/HCI) Study on the Efficacy of Physical Embodiment, pp. 848-853.

Herath, Damith	University of Canberra
Binks, Nicole	University of Canberra
Grant, Janie Busby	University of Canberra

14:40-15:00	MoBT6.6

Path Planning for Robot Based Radial Advanced Manufacturing Using Print Space Sampling, pp. 854-859.

Munasinghe, Nuwan	University of Technology Sydney
Paul, Gavin	UTS

MoCT1 — Room 1
Vision for Robots (Regular Session)

15:30-15:50	MoCT1.1

Efficient Objects Identification for a KidSize Humanoid Soccer Robot: Using Feedforward Neural Networks with Image Segmentation, pp. 860-865.

Correia Jeronimo, Gilmar	Federal University of ABC
Tanaka Botelho, Wagner	Federal University of ABC
PIMENTEL, EDSON	Federal University of ABC
Cristina Maia dos Santos, Thaynara	Federal University of ABC

15:50-16:10	MoCT1.2

Parameter Optimization of Feature Matching-Based Object Recognition Algorithm by Using CMA-ES, pp. 866-873.

Hagihara, Daisuke	Hitachi, Ltd
Taiki, Yano	Hitachi, Ltd
Kimura, Nobutaka	Hitachi, Ltd

16:10-16:30	MoCT1.3

SurfaceNet: A Surface Focused Network for Pedestrian Detection and Segmentation in 3D Point Clouds, pp. 874-879.

zhang, yongcong	University
Chen, Minglin	University of Chinese Academy of Sciences
ao, sheng	Sun Yat-Sen University
Zhang, Xing	Sun Yat-Sen University
Guo, Yulan	Sun Yat-Sen University

16:30-16:50	MoCT1.4

An Improved Method for Rotation Estimation Using Photometric Spherical Moments, pp. 880-885.

Du, Yao	VIBOT ERL CNRS 6000, ImViA, Université De Bourgogne Franche-Comt
TAHRI, Omar	Université Bourgogne Franche-Comté
HADJ-ABDELKADER, Hicham	University of Evry - Paris Saclay

16:50-17:10	MoCT1.5

Comparison of Camera-Based and 3D LiDAR-Based Place Recognition across Weather Conditions, pp. 886-891.

Żywanowski, Kamil	Poznan University of Technology
Banaszczyk, Adam Andrzej	Poznan University of Technology
Nowicki, Michal, R.	Poznan University of Technology

17:10-17:30	MoCT1.6

Analytical Change Detection on the KITTI Dataset, pp. 892-897.

Schauer, Johannes	Julius-Maximilians-Universität Würzburg
Nüchter, Andreas	Uni Würzburg

MoCT2 — Room 2
Control Applications (Regular Session)

15:30-15:50	MoCT2.1

Dynamic Fuzzy Membership Intervals with Two-Stage Objective Function for Ball and Beam System Based on GA Tuning, pp. 898-903.

Tsoi, Kit Pui	University of Auckland
Patel, Nitish	Univ. of Auckland
Swain, Akshya	The University of Auckland
Xu, Huang	University of Auckland

15:50-16:10	MoCT2.2

Fractional PI Controller for Integrating Plants, pp. 904-909.

Azid, Sheikh Izzal	The University of the South Pacific
Shankaran, Vivek Pawan	The University of the South Pacific
Mehta, Utkal	The University of the South Pacific, Suva

16:10-16:30	MoCT2.3

Minimax Optimization of a Fractional-Order Controller for the Furuta Pendulum Uncertain System with an Output Disturbance, pp. 910-916.

Cholodowicz, Ewelina	West Pomeranian University of Technology in Szczecin
Orlowski, Przemyslaw	West Pomeranian University of Technology in Szczecin

16:30-16:50	MoCT2.4

LPV Unknown Input Observer for Attitude of a Mass-Varying Quadcopter, pp. 917-924.

PHAM, The Hung	University of Évry Val D'Essonne
ICHALAL, Dalil	Université d'Evry Val D'Essonne
Mammar, Said	University of Evry, IBISC Lab

16:50-17:10	MoCT2.5

Control of a 2R Planar Horizontal Underactuated Manipulator, pp. 925-931.

Chen, Tan	University of Notre Dame
Goodwine, Bill	University of Notre Dame

17:10-17:30	MoCT2.6

Robust Iterative Learning Control for Ladder Circuits with Mixed Uncertainties, pp. 932-937.

Sulikowski, Bartlomiej	University of Zielona Gora, Inst. Control and Computation Eng
Galkowski, Krzysztof	Univ. of Zielona Gora
Rogers, Eric	Univ. of Southampton
Kummert, Anton	University of Wuppertal

MoCT3 — Room 3
Object Recognition (Regular Session)

15:30-15:50	MoCT3.1

PBDE: An Effective Method for Filtering False Positive Boxes in Object Detection, pp. 938-943.

Li, Zhishan	Zhejiang University

Jia, Baozhi	Reconova Technologies
Chen, Mingmu	Reconova Technologies
Xu, Shaokai	Reconova Technologies
He, Yifan	Reconova Technologies
Xie, Lei	Zhejiang University

15:50-16:10 MoCT3.2

Application of CNN-Based Method for Automatic Detection and Classification of the IC Packages, pp. 944-950.

Maliński, Kamil Marek	West Pomeranian University of Technology in Szczecin
Okarma, Krzysztof	West Pomeranian University of Technology in Szczecin

16:10-16:30 MoCT3.3

Batch-Normalization-Based Soft Filter Pruning for Deep Convolutional Neural Networks, pp. 951-956.

Xu, Xiaozhou	Zhejiang University
Chen, Qiming	Zhejiang University
Xie, Lei	Zhejiang University
Su, Hongye	Zhejiang University

16:30-16:50 MoCT3.4

An Efficient and Light-Weight Detector for Wine Bottle Defects, pp. 957-962.

Liu, Mingyuan	Zhejiang University
Ma, Long-hua	Zhejiang University
Yu, Bin Chao	Zhejiang Zheneng Natural Gas Operation Co

16:50-17:10 MoCT3.5

Data Augmentation with Generative Adversarial Networks for Grocery Product Image Recognition, pp. 963-968.

Wei, Yuchen	Discipline of ICT, School of TED, University of Tasmania
Xu, Shuxiang	Discipline of ICT, School of TED, University of Tasmania
Tran, Son	Discipline of ICT, School of TED, University of Tasmania
Kang, Byeong	Discipline of ICT, School of TED, University of Tasmania

17:10-17:30 MoCT3.6

A Latent Variables Augmentation Method Based on Adversarial Training for Image Categorization with Insufficient Training Samples, pp. 969-975.

Lin, Luyue	Guangdong University of Technology
Liu, Dacai	Guangdong University of Technology
Liu, Bo	Guangdong University of Technology
Xiao, Yanshan	Guangdong University of Technology

MoCT4 Room 4

Robotics and Robot Control (Regular Session)

15:30-15:50 MoCT4.1

Real-Time Obstacle Avoidance in Robotic Manipulation Using Imitation Learning, pp. 976-981.

Huang, Jie	Maintenance Branch of State Grid Anhui Electric Power Company Li
Wei, Ge	University of Science and Technology of China
Cheng, Hualong	State Grid Anhui Electric Power Company Limited
Xi, Chun	Maintenance Branch of State Grid Anhui Electric Power Company Li
Zhu, Jun	Maintenance Branch of State Grid Anhui Electric Power Company Li
Zhang, Fei	University of Science and Technology of China
Shang, Weiwei	University of Science and Technology of China

15:50-16:10 MoCT4.2

An Efficient Real-Time NMPC for Quadrotor Position Control under Communication Time-Delay, pp. 982-989.

Barros Carlos, Barbara	Sapienza Università Di Roma
Sartor, Tommaso	University of Freiburg
Zanelli, Andrea	University of Freiburg
Frison, Gianluca	Technical University of Denmark
Burgard, Wolfram	University of Freiburg
Diehl, Moritz	Albert-Ludwigs-Universität Freiburg
Oriolo, Giuseppe	Sapienza Università Di Roma

16:10-16:30 MoCT4.3

Towards Semantic Scene Segmentation for Autonomous Agricultural Vehicles, pp. 990-995.

Mujkic, Esma	Technical University of Denmark
Hermann, Dan	AGCO A/S
Ravn, Ole	Technical University of Denmark
Bilde, Morten L.	AGCO A/S
Andersen, Nils A.	Tech. Univ. of Denmark

16:30-16:50 MoCT4.4

Design of a Master-Slave Robotic System for Intravascular Catheterization During Cardiac Interventions, pp. 996-1000.

Omisore, Olatunji	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Akinyemi, Toluwanimi	Shenzhen Institutes of Advanced Technology, Chinese Academy of S

16:50-17:10 MoCT4.5

Inverse Kinematics Determination and Trajectory Tracking Algorithm Development of a Robot with 7 Joints, pp. 1001-1007.

Kreft, Wojciech	AGH University of Science and Technology

17:10-17:30 MoCT4.6

An End-To-End Approach for Learning and Generating Complex Robot Motions from Demonstration, pp. 1008-1014.

Kordia, Ali	INESC-ID
Melo, Francisco S.	INESC-ID

MoCT5 Room 5

Synthesis of Discrete Event Systems for Correct-By-Construction Cyber Physical Systems (Invited Session)

Organizer: Lin, Liyong	Nanyang Technological University

15:30-15:50 MoCT5.1

A Topological Approach for Computing Supremal Sublanguages (I), pp. 1015-1019.

Lin, Liyong	Nanyang Technological University
Zhu, Yuting	Nanyang Technological University
Su, Rong	Nanyang Technological University

15:50-16:10 MoCT5.2

Data Logging and Reconstruction of Discrete-Event System Behavior (I), pp. 1020-1026.

Reijnen, Ferdie	Eindhoven University of Technology
Van de Mortel-Fronczak,	Eindhoven University of

Joanna Maria	Technology
Rooda, J.E.	Eindhoven University of Technology

16:10-16:30	MoCT5.3

Supervisor Synthesis for Networked Discrete Event Systems with Delays against Non-FIFO Communication Channels (I), pp. 1027-1032.

Zhu, Yuting	Nanyang Technological University
Lin, Liyong	Nanyang Technological University
Tai, Ruochen	Nanyang Technological University
Su, Rong	Nanyang Technological University

16:30-16:50	MoCT5.4

Nonblocking Supervisory Control Synthesis of Timed Automata Using Abstractions and Forcible Events (I), pp. 1033-1040.

Rashidinejad, Aida	Eindhoven University of Technology
van der Graaf, Patrick	Eindhoven University of Technology
Reniers, Michel	TU/e

16:50-17:10	MoCT5.5

Optimal Control Approach for Rational Expectations Models with Longer Forward-Looking Time, pp. 1041-1048.

Ma, Tianfu	Shandong University
xu, juanjuan	Shandong University
Zhang, Huanshui	Shandong University
Basar, Tamer	Univ. of Illinois at Urbana-Champaign

17:10-17:30	MoCT5.6

Feasible Schedule under Faults in the Assembly System, pp. 1049-1054.

Majdzik, Pawel	University of Zielona Gora

MoCT6	Room 6
Intelligent Control of Complex Systems (Invited Session)	
Organizer: Li, Jinna	Liaoning Shihua University
Organizer: Wang, Chunyan	Beijing Institute of Technology
Organizer: Liu, Shuai	Shandong University

15:30-15:50	MoCT6.1

Intelligent Health Management of Fixed-Wing UAVs: A Deep-Learning-Based Approach (I), pp. 1055-1060.

Cui, Aiya	Beijing Institute of Technology
Zhang, Ying	China Aerospace Science and Technology Corporation
Zhang, Pengyu	Science and Technology on Space Physics Laboratory
Dong, Wei	Beijing Institute of Technology
Wang, Chunyan	Beijing Institute of Technology

15:50-16:10	MoCT6.2

Consensus Achievement of Multi-Agent Systems under Delayed State Information (I), pp. 1061-1065.

Zhu, Yanli	School of Information Science and Engineering, Shandong Normal U
Wang, Zhenhua	School of Information Science and Engineering, Shandong Normal U
Liu, li	School of Information Science and Engineering, Shandong Normal U
Zhang, Huaxiang	School of Information Science and Engineering, Shandong Normal U

16:10-16:30	MoCT6.3

Data-Driven Tracking Control Approach for Linear Systems by On-Policy Q-Learning Approach (I), pp. 1066-1070.

Zhang, Yihan	Liaoning Shihua University, School of Information and Control Eng
Xiao, Zhenfei	Liaoning Shihua University
Li, Jinna	Liaoning Shihua University

16:30-16:50	MoCT6.4

Adaptive Affine Formation Maneuver Control of Second-Order Multi-Agent Systems with Disturbances (I), pp. 1071-1076.

Luo, Zhengxin	Beijing Institute of Technology
Zhang, Pengyu	Science and Technology on Space Physics Laboratory
Ding, Xiangjun	Beijing Institute of Technology
TANG, ZEZHI	Guangdong Bozhilin Robotics
Wang, Chunyan	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology

16:50-17:10	MoCT6.5

Higher-Order Polynomial Signal Tracking Control of Unknown Systems Using Off-Policy Integral Reinforcement Learning (I), pp. 1077-1081.

Cheng, Weiran	Liaoning Shihua University
Li, Jinna	Liaoning Shihua University

17:10-17:30	MoCT6.6

A Predictor-Like Controller for Linear Ito Stochastic Systems with Input Delays (I), pp. 1082-1087.

wang, hongxia	Zhejiang University of Technology
Fu, Minyue	University of Newcastle
lu, xiao	Shandong University of Science and Technology

TuPP Room 1
Plenary Panel in Robotics and AI (Plenary Session)

09:00-11:00 TuPP.1

*Robotics and AI: The Presence and the Future**.

Egerstedt, Magnus — Georgia Institute of Technology
Liu, Yunhui — Chinese University of Hong Kong
Quek, Tong Boon — Ministry of Trade and Industry
Spanos, Costas — University of California, Berkeley
Wen, Yonggang — Nanyang Technological University

TuKN Room 1
Plenary 3 (Plenary Session)

11:30-12:30 TuKN.1

*Towards Understandable Computer Vision**.

CHEN, Xilin — Chinese Academy of Sciences

TuBT1 Room 1
Intelligent Systems (Regular Session)

13:30-13:50 TuBT1.1

An ANN Based Human Walking Distance Estimation with an Inertial Measurement Unit, pp. 1088-1092.

Huang, Loulin — Auckland University of Technology
Liu, Yu — Auckland University of Technology

13:50-14:10 TuBT1.2

Diagnostic of the State of the Cutting Tool of Metal-Cutting Machines Using Bidirectional Recurrent Neural Networks with a Long Short-Term Memory, pp. 1093-1097.

Kamil, Masalimov — Ufa State Aviation Technical University
Munasypov, Rustem — Ufa State Aviation Technical University

14:10-14:30 TuBT1.3

Parallelized Hardware Rough Set Processor Architecture in FPGA for Core Calculation in Big Datasets, pp. 1098-1103.

Kopczynski, Maciej — Bialystok University of Technology
Grześ, Tomasz — Politechnika Białostocka

14:30-14:50 TuBT1.4

Autonomous Curriculum Generation for Self-Learning Agents, pp. 1104-1111.

KURKCU, ANIL — Nanyang Technological University
CAMPOLO, Domenico — Nanyang Technological University
Tee, Keng Peng — Inst. for Infocomm Research, ASTAR

14:50-15:10 TuBT1.5

Gene Prediction by the Scale-Limited Gabor Wavelet Transform for Identifying the Protein Coding Regions, pp. 1112-1116.

Zheng, Qian — ZheJiang University
WenXiang Zhou, Zhou — Beijing University of Aeronautics and Astronautics
Chen, Tao — South West Jiao Tong University
Xie, Lei — Zhejiang University
Su, Hongye — Institute of Cyber-Systems and Control, ZhejiangUniversity

15:10-15:30 TuBT1.6

Binary Spectrum Feature for Improved Classifier Performance (I), pp. 1117-1122.

Ulapane, Nalika — The University of Melbourne
Thiyagarajan, Karthick — University of Technology Sydney
Kodagoda, Sarath — University of Technology, Sydney

TuBT2 Room 2
Modeling and Identification (Regular Session)

13:30-13:50 TuBT2.1

Furuta Pendulum Real-Time System with Brushless DC Motor and Cascade Hybrid Control, pp. 1123-1130.

Cholodowicz, Ewelina — West Pomeranian University of Technology in Szczecin
Orlowski, Przemyslaw — West Pomeranian University of Technology in Szczecin

13:50-14:10 TuBT2.2

Black-Box Identification of a Robotic Flight Simulator, pp. 1131-1136.

Matheus, Aline da Conceição — Aeronautics Institute of Technology
Villani, Emília — ITA - Instituto Tecnológico De Aeronáutica
Oliveira, Wesley Rodrigues — Aeronautics Institute of Technology

14:10-14:30 TuBT2.3

Statistical and Physiologically Analysis of Using a Duffing-Van Der Pol Oscillator to Modeled Ictal Signals, pp. 1137-1142.

Szuflitowska, Beata — West Pomeranian University of Technology
Orlowski, Przemyslaw — West Pomeranian University of Technology in Szczecin

14:30-14:50 TuBT2.4

String Plucking and Touching Sensing Using Transmissive Optical Sensors for Guzheng, pp. 1143-1149.

Oszutowska-Mazurek, Dorota — Pomeranian Medical University
Mazurek, Przemyslaw — West Pomeranian University of Technology in Szczecin

14:50-15:10 TuBT2.5

Mid-Level Features for Categorization of Social Interactions in Public Spaces, pp. 1150-1155.

Zitouni, M. Sami — Khalifa University
SLUZEK, ANDRZEJ — Warsaw University of Life Sciences - SGGW

15:10-15:30 TuBT2.6

Transient Stability of Grid-Forming Inverters in Microgrids: Nonlinear Analysis, pp. 1156-1159.

Eskandari, Mohsen — University of New South Wales
Savkin, Andrey V. — Univ. of New South Wales

TuBT3 Room 3
Networked Control Systems 2 (Regular Session)

13:30-13:50 TuBT3.1

A Geometrical Criterion for the Synchronization of Dynamic Networks with Input Saturation, pp. 1160-1164.

Ye, Juncen — Zhe-Jiang University
Haoyi, Que — Shenzhen Polytechnic
Ma, Long-hua — Zhejiang University
Su, Hongye — Institute of Cyber-Systems and Control, ZhejiangUniversity

13:50-14:10 TuBT3.2

A Residual Network for De Novo Peptide Sequencing with Attention Mechanism, pp. 1165-1170.

Liu, Zihang | Zhejiang University
Zhao, Chunhui | Zhejiang University

14:10-14:30 TuBT3.3

Speech Recognition System for a Service Robot - a Performance Evaluation, pp. 1171-1176.

Alibegović, Besim | University of Tuzla
Prljaca, Naser | University of Tuzla
Kimmel, Melanie | Technische Universität München
Schultalbers, Matthias | IAV GmbH

14:30-14:50 TuBT3.4

Fault-Tolerant Architecture for Real-Time Control of Distributed Medical Devices, pp. 1177-1181.

Reis, Tiago | Maxdata Software, SA
Correia, Alexandre | Maxdata Software, SA - Carregado, Portugal
Sousa, Paulo | Maxdata Software, SA - Carregado, Portugal
Cecílio, José | FCiências.ID - VAT PT514187808

14:50-15:10 TuBT3.5

Sparse Causal Residual Neural Network for Linear and Nonlinear Concurrent Causal Inference and Root Cause Diagnosis, pp. 1182-1187.

Chen, Jiawei | Zhejiang University
Zhao, Chunhui | Zhejiang University
Sun, Youxian | Zhejiang University

15:10-15:30 TuBT3.6

Leveraging Dynamic Occupancy Grids for 3D Object Detection in Point Clouds (I), pp. 1188-1193.

Sierra-Gonzalez, David | Inria Grenoble Rhone-Alpes
paigwar, Anshul | INRIA
Erkent, Ozgur | Inria
Dibangoye, Jilles | INSA-Lyon, Inria
Laugier, Christian | INRIA

TuBT4 Room 4

Sensor Networks (Regular Session)

13:30-13:50 TuBT4.1

Short-Term Time Series Forecasting of Concrete Sewer Pipe Surface Temperature, pp. 1194-1199.

Thiyagarajan, Karthick | University of Technology Sydney
Kodagoda, Sarath | University of Technology, Sydney
Ulapane, Nalika | The University of Melbourne

13:50-14:10 TuBT4.2

Iterative Learning Control for Distributed Parameter Systems Using Sensor-Actuator Network, pp. 1200-1205.

Patan, Maciej | University of Zielona Gora
Klimkowicz, Kamil | University of Zielona Góra
Patan, Krzysztof | University of Zielona Gora

14:10-14:30 TuBT4.3

Optimum Partition of Sensing Field with Given Probability on Event Locations, pp. 1206-1209.

Gong, Chaohui | University of Shanghai for Science and Technology
Guo, Zhong | Zhejiang Research Center on Smart Rail Transportation, PowerChin
Yan, Zihai | Zhejiang Research Center on Smart Rail Transportation, PowerChin
Yu, Miao | Zhejiang Research Center on Smart Rail Transportation, PowerChin
Wang, Weilin | PowerChina Huadong Engineering Corporation Limited

14:30-14:50 TuBT4.4

Self-Intersection Attention Pooling Based Classification for Rock Recognition, pp. 1210-1215.

Chen, Liang | Zhejiang University
Zheng, Qian | Fudan University
Liu, Zhitao | Zhejiang University
Mao, Wei-Jie | Zhejiang University
Lin, Fulong | China Railway Engineering Equipment Group Co., LTD

14:50-15:10 TuBT4.5

An Optical Flow Based Multi-Object Tracking Approach Using Sequential Convex Programming, pp. 1216-1221.

Xu, Qingwen | ShanghaiTech University
He, Zhenpeng | ShanghaiTech University
Chen, Zhang | ShanghaiTech University
Jiang, Yuning | ShanghaiTech University

15:10-15:30 TuBT4.6

Floor Extraction and Door Detection for Visually Impaired Guidance, pp. 1222-1229.

Berenguel-Baeta, Bruno | Instituto De Investigación En Ingeniería De Aragón
Guerrero-Viu, Manuel | Instituto De Investigación En Ingeniería De Aragón
Nova, Alejandro | Instituto De Investigación En Ingeniería De Aragón
Bermudez-Cameo, Jesus | Instituto De Investigación En Ingeniería De Aragón
Perez-Yus, Alejandro | Instituto De Investigación En Ingeniería De Aragón
Guerrero, Jose J | Universidad De Zaragoza

TuBT5 Room 5

Distributed Secure Control for Cyber-Physical Systems with Industrial Applications (Invited Session)

Organizer: Deng, Chao | Nanyang Technological University
Organizer: Wang, Yan-Wu | Huazhong University of Science and Technology

13:30-13:50 TuBT5.1

Optimal Trajectory Tracking for Cyber-Physical Marine Vessel: Reinforcement Learning Approach (I), pp. 1230-1235.

Li, Xiaolei | Nanyang Technological University
Wang, Jiange | Yanshan University
Li, Xinyao | Nanyang Technological University
Yan, Jiaqi | Nanyang Technological University

13:50-14:10 TuBT5.2

Event Triggered Fault Tolerant Control for Nonlinear Systems Based on Adaptive Fault Estimation (I), pp. 1236-1241.

Fan, Quan-Yong | Northwestern Polytechnical University
Xu, Shuoheng | Northwestern Polytechnical University
Deng, Chao | Nanyang Technological University
Wang, Cai-Cheng | North Automatic Control Technology Institute

14:10-14:30 TuBT5.3

Connectivity Preservation and Collision Avoidance of Multi-Unmanned Surface Vehicles Via Adaptive Sliding Control (I), pp. 1242-1249.

Ma, Hongjun | Northeastern University

14:30-14:50	TuBT5.4

Smooth Adaptive Leader-Following Consensus Control for Uncertain Fractional-Order Nonlinear Multi-Agent Systems with Time-Varying Reference (I), pp. 1250-1255.

Li, Xinyao	Nanyang Technological University
Wen, Changyun	Nanyang Tech. Univ
Li, Xiaolei	Nanyang Technological University

14:50-15:10	TuBT5.5

Hierarchical Decomposition and Prescribed Performance Bound Based Adaptive Control for Leader-Follower Formation of Uncertain Nonholonomic Mobile Robots (I), pp. 1256-1261.

Shen, Jiajun	Beihang University
Wang, Wei	Beihang University
Lu, Jinhu	Academy of Mathematics and Systems Science, ChineseAcademyof Sci
Deng, Chao	Nanyang Technological University

15:10-15:30	TuBT5.6

Robust Adaptive Fault-Tolerant Coordinated Control for Biaxial Gantry System with Friction Compensation (I), pp. 1262-1267.

Wang, Kangjun	Beijing Jiaotong University
Liu, Xiangbin	School of Electronics and Information Engineering, Beijing Jiaot
Su, Hongye	Institute of Cyber-Systems and Control, ZhejiangUniversity

TuBT6 — Room 6

Recent Advances in Cooperative Control of Swarm Systems (Invited Session)

Organizer: Dong, Xiwang	Beihang University
Organizer: Li, Zhongkui	Peking University

13:30-13:50	TuBT6.1

Cooperative Control Based on Distributed Attack Identification and Isolation (I), pp. 1268-1273.

Liu, Hailing	Southeast University
Huang, Dalin	Southeast University
Zhang, Ya	Southeast University

13:50-14:10	TuBT6.2

Predefined Finite-Time Output Containment of Nonlinear Multi-Agent Systems with Undirected Topology (I), pp. 1274-1279.

Wang, Qing	Beihang University
Zhou, Shiyu	Beihang University, School of Automation Science and Electrical
Zhou, Siquan	Beihang University
Dong, Xiwang	Beihang University
Yu, Jianglong	Beihang University
Ren, Zhang	Beihang University

14:10-14:30	TuBT6.3

Attack-Free Protocol Design with Distributed Noncontinuous Appointed-Time Unknown Input Observer (I), pp. 1280-1285.

Lv, Yuezu	Southeast University
Zhou, Jialing	Nanjing University of Science and Technology
Wang, Qishao	Beihang University
Wen, Guanghui	Southeast University

14:30-14:50	TuBT6.4

Event-Triggered Optimal Adaptive Control for Robot Trajectory Tracking (I), pp. 1286-1291.

Chen, Shuo	Anhui University
FAN, Yuan	Anhui University
Yuchao, Guo	Anhui University
Zhu, Mingjian	Anhui University

14:50-15:10	TuBT6.5

Distributed State Estimation for Nonlinear Networked System with Correlated Noises (I), pp. 1292-1297.

Liang, Yuan	Beihang University
Hu, Sibo	Beihang University
Dong, Xiwang	Beihang University
Li, Qingdong	Beihang University
Ren, Zhang	Beihang University

15:10-15:30	TuBT6.6

Active Disturbance Rejection Time-Varying Formation Tracking for Unmanned Aerial Vehicles (I), pp. 1298-1303.

Ran, Maopeng	Nanyang Technological University
Li, Juncheng	Nanyang Technological University
Xie, Lihua	Nanyang Technological University

TuCT1 — Room 1

Application of Robotics and Autonomous Control in Construction Sites (Invited Session)

Organizer: Leung, Kim-Wan, Joshua	Hong Kong University of Science and Technology

16:00-16:20	TuCT1.1

Perception System – from Autonomous Driving to Autonomous Logistic (I), pp. 1304-1304.

LIU, MING	Hong Kong University of Science and Technology

16:20-16:40	TuCT1.2

A Passive Radiant Cooler for Energy-Efficient Building (I), pp. 1305-1305.

Huang, Bao Ling	Hong Kong University of Science and Technology

16:40-17:00	TuCT1.3

Data-Driven Computational Design, Acquiring and Understanding 3D Visual Data (I), pp. 1306-1306.

Yeung, Sai Kit	Hong Kong University of Science and Technology

17:00-17:20	TuCT1.4

AI Technologies for Image and Video Enhancement (I), pp. 1307-1307.

Chen, Qifeng	Hong Kong University of Science and Technology

17:20-17:40	TuCT1.5

Research on Design and Forming Technology of Large Size Continuous Fiber Reinforced Composites for Building Formwork and Light-Weight Robots (I), pp. 1308-1308.

Lu, Dong	Hong Kong University of Science and Technology

17:40-18:00	TuCT1.6

Application of Robotics and Autonomous Control in Construction Sites (I), pp. 1309-1310.

Leung, Kim-Wan, Joshua	Hong Kong University of Science and Technology
Qiu, Li	Hong Kong Univ. of Sci. & Tech

TuCT2 — Room 2

Internet of Things (Regular Session)

16:00-16:20	TuCT2.1

A Data Driven Approach for Leak Detection with Smart Sensors (I), pp. 1311-1316.

Liang, Bin	University of Technology Sydney
VERMA, SUNNY	University of Technology Sydney
Xu, Jie	University of Technology Sydney
Liang, Shuming	University of Technology Sydney
Li, Zhidong	UTS
Wang, Yang	University of Technology Sydney
Chen, Fang	University of Technology Sydney

16:20-16:40 TuCT2.2

Searching for High Accuracy Mix-Bitwidth Network Architecture, pp. 1317-1322.

Lan, Haochong	Nanyang Technological University
Lin, Zhiping	School of Electrical &ElectronicEng., NanyangTechnologicalUnivers
Lai, Xiaoping	Hangzhou Dianzi University

16:40-17:00 TuCT2.3

BOSON - Application-Specific Instruction Set Processor (ASIP) for Educational Purposes, pp. 1323-1328.

Mazurek, Przemyslaw	West Pomeranian University of Technology in Szczecin

17:00-17:20 TuCT2.4

Robust CSI-Based Human Activity Recognition Using Roaming Generator, pp. 1329-1334.

WANG, DAZHUO	Nanyang Technological University
Yang, Jianfei	Nanyang Technological University
CUI, WEI	Institute for Infocomm Research (I2R), Agency for Science, Techn
Xie, Lihua	Nanyang Technological University
SUN, SUMEI	Institute for Infocomm Research (I2R), Agency for Science, Techn

TuCT4 Room 4

Internet of Things (IoT) Based Indoor/Outdoor Localization and Tracking (Invited Session)

Organizer: Chen, Zhenghua	Nanyang Technological University
Organizer: Jiang, Chaoyang	Beijing Institute of Technology

16:00-16:20 TuCT4.1

A Multi-Hop Distributed Indoor Localization Algorithm for Ultra-Wide-Band Sensor Network (I), pp. 1335-1340.

He, Chengyang	Beijing Institute of Technology Chongqing Innovation Center
Xia, Yinqiu	Beijing Institute of Technology
Yu, Chengpu	Beijing Institute of Technology Chongqing Innovation Center
Jiang, Chaoyang	Beijing Institute of Technology

16:20-16:40 TuCT4.2

Adaptive Kalman Filter with Linear Equality Road Constraints for Autonomous Vehicle Localization (I), pp. 1341-1346.

Xu, Yanjie	Beijing Institute of Technology
Wang, Xingqi	Beijing Institute of Technology
Jiang, Chaoyang	Beijing Institute of Technology

16:40-17:00 TuCT4.3

Integrated BLE and PDR Indoor Localization for Geo-Visualization Mobile Augmented Reality (I), pp. 1347-1353.

Zhou, Baoding	Shenzhen University
Gu, Zhining	Shenzhen University
ma, Wei	Shenzhen University
Liu, Xu	Shenzhen University

17:00-17:20 TuCT4.4

Indoor Mobile Localization Based on a Tightly Coupled UWB/INS Integration (I), pp. 1354-1359.

Yang, Haoran	Southeast University
Yujin, Kuang	Southeast University
Manyi, Wang	Nanjing University
Xiaoyu, Bao	Southeast University
Yang, Yuan	Southeast University

17:20-17:40 TuCT4.5

Linear Features Observation Model for Autonomous Vehicle Localization, pp. 1360-1365.

SHIPITKO, OLEG	Institute for Information Transmission Problems – IITP RAS
kibalov, vladislav	Institute for Information Transmission Problems – IITP RAS, Bol'
Abramov, Maxim	Institute for Information Transmission Problems – IITP RAS

17:40-18:00 TuCT4.6

No-Attachment Head Tracking Method of Robotic Transcranial Magnetic Stimulation Based on Vision Sensor, pp. 1366-1371.

Yu, Chen	Harbin Institute of technology(Shen Zhen)
Wang, Xin	Harbin Institue of Technology (Shenzhen)
Lu, ZongJie	Harbin Institute of technology(Shen Zhen)
Su, HuanRan	Harbin Institute of technology(Shen Zhen)

TuCT5 Room 5

Modeling, Monitoring, Control, and Signal Processing in Intelligent Manufacturing Systems (Invited Session)

Organizer: Que, Haoyi	Shenzhen Polytechnic
Organizer: Lu, Shan	Zhejiang University
Organizer: Xu, Zhaowen	Shenzhen Polytechnic

16:00-16:20 TuCT5.1

Leader Tracking in Constant Spacing Policy with Parasitic Delays and Lag (I), pp. 1372-1376.

Su, Zhiyuan	The Army Military Transportation University
Li, Yongle	The Army Military Transportation University
Xue, Yuanfei	Shenzhen Polytechnic, Mingde Building 503

16:20-16:40 TuCT5.2

Oscillating Scanning FPCB Micromirror Integrated with Angle Detecting (I), pp. 1377-1381.

Li, Liangtian	Shenzhen Polytechnic

16:40-17:00 TuCT5.3

Asynchronous H-Infinity Control of Markov Jump Nonlinear Systems Using Sliding Mode Approach and Its Application to an Electric Circuit (I), pp. 1382-1387.

Xu, Ming	NingboTech University
Xu, Zhaowen	Shenzhen Polytechnic
Ma, Long-hua	Zhejiang University
Que, Haoyi	Shenzhen Polytechnic
cui, dan	School of Information and Control Engineering, Liaoning Shihua U

17:00-17:20 TuCT5.4

Gaussian Process Model Predictive Control Based Cooperative Motion Planning Structure for UAGVS (I), pp. 1388-1393.

Sun, Pei	Shenzhen Polytechnic
Que, Haoyi	Shenzhen Polytechnic
Zhou, Yiming	Shenzhen Polytechnic

17:20-17:40 TuCT5.5

Improvement of Ant Colony Method Track Planning Based on Artificial Potential Field Method (I), pp. 1394-1398.

Yanze, Zhu	Northwesten Polytechnical University
Rong, Ma	Northwesten Polytechnical University
Quan, Yihong	XianYang Natural GAS Corporation

17:40-18:00 TuCT5.6

Resilient Privacy-Preserving Average Consensus for Multi-Agent Systems under Attacks (I), pp. 1399-1405.

Wang, Dong	Hangzhou Dianzi University
Zheng, Ning	Hangzhou Dianzi University
Xu, Ming	Hangzhou Dianzi University
Wu, Yiming	Hangzhou Dianzi University
Hu, Qinling	Hangzhou Dianzi University
Wang, Gangyang	Hangzhou Dianzi University

ABSTRACTS

Book of Abstracts of 2020 16th International Conference on Control, Automation, Robotics and Vision (ICARCV)

Technical Program for Sunday December 13, 2020

SuKN	Room 1
Plenary 1 (Plenary Session)	

09:00-10:00	SuKN.1

*Research Trends in Developing Intelligent Unmanned Systems**

Chen, Ben M. — Chinese University of Hong Kong

The research and market for the unmanned aerial systems (UAS), or drones, has greatly expanded over the last few years. It is expected that the currently small civilian unmanned aircraft market is likely to become one of the major technological and economic stories of the modern age, due to a wide variety of possible applications and added value related to this potential technology. Modern unmanned aerial systems are gaining promising success because of their versatility, flexibility, low cost, and minimized risk of operation. In this talk, we highlight some key techniques involved and research trends in developing intelligent autonomous unmanned aerial vehicles, which include task and motion planning, flight control systems, perception and data processing. Some industrial application examples will be used as illustrations.

SuPP	Room 1
Plenary Panel in Control (Plenary Session)	

10:30-12:30	SuPP.1

*Control Theory and Applications: The Presence and the Future**

Fu, Minyue — University of Newcastle
Jiang, Zhong-Ping — New York University
Petersen, Ian R. — Australian National University
Xie, Lihua — Nanyang Technological University
Zhang, Ji-Feng — Chinese Academy of Sciences

ICARCV 2020 proudly presents the plenary panel session on Control Theory and Applications: The Presence and The Future. We are honored to be able to invite five prominent experts and educators in the field to be the panelists.

The objective of the plenary panel session is to provide an opportunity for researchers, especially young researchers, to interact with world renowned experts in systems and control and to seek their advice on issues relating to control research such as current status, challenges and opportunities, future perspectives, as well as how to start a career as a control researcher and how to approach challenging research issues, etc. During the session, panel members will share their vast experiences and visions with audience through effective dialogues.

SuBT1	Room 1
Best Student Paper Award Finalist Presentations (Regular Session)	

13:30-13:50	SuBT1.1

Consensus-Based Formation Control and Obstacle Avoidance for Nonholonomic Multi-Robot System, pp. 1-6

Koung, Daravuth — Ecole Centrale de Nantes, E-COBOT
Fantoni, Isabelle — CNRS
Kermorgant, Olivier — Ecole Centrale Nantes
Belouaer, Lamia — E-COBOT

13:50-14:10	SuBT1.2

End-To-End Joint Intention Estimation for Shared Control Personal Mobility Navigation, pp. 7-12

Katuwandeniya, Kavindie — University of Technology Sydney
Valls Miro, Jaime — University of Technology Sydney
Dantanarayana, Lakshitha — University of Technology Sydney

14:10-14:30	SuBT1.3

Fault Detection for Nonstationary Process with Decomposition and Analytics of Gaussian and Non-Gaussian Subspaces, pp. 13-18

Zhao, Yi — Zhejiang University
Zhao, Chunhui — Zhejiang University
Sun, Youxian — Zhejiang University

14:30-14:50	SuBT1.4

Robust Texture Features for Breast Density Classification in Mammograms, pp. 19-24

Li, Haipeng — University of Canterbury
Mukundan, Ramakrishnan — University of Canterbury
Boyd, Shelley — St. George's Medical Center

14:50-15:10	SuBT1.5

An Information Driven Approach for Ego-Lane Detection Using Lidar and OpenStreetMap, pp. 25-31

KASMI, ABDERRAHIM — Sherpa Engineering/ Institut Pascal - Clermont Auvergne University
Laconte, Johann — Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pascal, F-63000 CLERMONT-FERRAND, FRANCE
AUFRERE, Romuald — Institut Pascal - Clermont Auvergne University
THEODOSE, Ruddy — Sherpa Engineering
DENIS, Dieumet — SHERPA ENGINEERING
Chapuis, Roland — Institut Pascal

SuBT2	Room 2
Electric Vehicles and Intelligent Transportation 1 (Invited Session)	

13:30-13:50	SuBT2.1

Switching Process Analysis and Drive Circuit Simulation of SiC MOSFET in Dynamic Wireless Charging for Electric Vehicles, pp. 32-37

Li, Zongwen — Wuhan University of Technology
Long, Rong — Huazhong Agricultural University
Zhang, Liyan — Wuhan University of Technology
Chen, Qihong — Wuhan University of Technology

In order to solve the problem of device impact and switching speed in dynamic wireless charging device for electric vehicles (EVs), first, a new SiC MOSFET model was established based on manufacturer's model and datasheet. Combined with this model, the hard-switching and soft-switching processes of SiC MOSFETs are compared and analyzed. Although soft-switching can solve the problems of changing switching speed and reducing device impact, it needs to modify the hardware circuit, which is not practical in the changeable environment of dynamic wireless charging of EVs. Based on this question, a new multi-grade voltage drive circuit is designed to meet the various requirements of the drive circuit in the wireless charging process of EVs. Finally, the drive circuit is simulated in Pspice, and its feasibility is explored according to its waveforms.

13:50-14:10	SuBT2.2

Analysis and Design of Four-Phase Interleaved Parallel

Buck Converter Based on High-Power Charging System for Electric Vehicles, pp. 38-43

Li, Haozhe	Wuhan University of Technology
Long, Rong	Huazhong Agricultural University
Zhang, Liyan	Wuhan University of Technology
Chen, Qihong	Wuhan University of Technology

The DC-DC circuit is widely discussed in Electric Vehicle Charging Systems (EVCS).In this paper, a high-power, high-voltage four-phase interleaved parallel Buck converter topology structure is designed, which is suitable for both contact and contactless charging systems. A small-signal mathematical model of a four-phase interleaved parallel Buck converter is established by constructing the state variables of the converter; a Proportion Integration (PI) controller is designed by analyzing the Bode diagram to compensate the system and ensure the control performance of the closed-loop system; a control strategy based on PI control and maximum current sharing control is proposed. The simulation results show that, the output ripple of this new type of converter cancels each other, the currents of each phase are balanced, and a large output power can be achieved

14:10-14:30 SuBT2.3

Optimization of Magnetic Core Structure Based on DD Coils for Electric Vehicle Wireless Charging, pp. 44-49

Ni, Xin	Wuhan University of Technology
Long, Rong	Huazhong Agricultural University
Zhang, Liyan	Wuhan University of Technology
Chen, Qihong	Wuhan University of Technology

Coupling system has great influence on the transmission performance of wireless charging system. Improving the mutual inductance between coupling coils can effectively improve the transmission efficiency. Using magnetic core is an effective way to enhance mutual inductance of coupling coils. The introduction of magnetic core also leads to core loss. Based on the DD coil structure and considering the magnetic core weight and coupling coefficient, a method for ferrite core design and optimization is proposed, which can reduce the core loss between transmitter and receiver and improve the average utilization ratio of the magnetic core. MAXWELL simulated and analyzed the coupling coil before and after optimization, and discussed its feasibility.

14:30-14:50 SuBT2.4

Model Predictive Control Based on Spider Monkey Optimization Algorithm of Interleaved Parallel Bidirectional DC-DC Converter, pp. 50-55

Lan, Yueyang	Wuhan University of Technology
Chen, Qihong	Wuhan University of Technology
Zhang, Liyan	Wuhan University of Technology
Long, Rong	Huazhong Agricultural University

Taking the high real-time performance, good stability and high reliability of DC-DC converter in electric vehicles as the research target, a constrained model predictive control (MPC) based on spider monkey optimization algorithm was proposed. Taking the Buck mode for an example, the equivalent circuit model is obtained under different switching states, and the state space model is established, then the prediction model is established through discretization. Define the appropriate cost function according to the control requirements and add the constraints of the control variables. The spider monkey optimization algorithm(SMO) is introduced to solve optimization problem of the constrained MPC in order to get the optimal solution more quickly and accurately. the simulation was carried out by MATLAB/Simulink, and the simulation results of PI control,MPC based on Particle Swarm Optimization(PSO-MPC) and SMO-MPC was compared. The simulation show that the converter using MPC has better control effect, and SMO is feasible and effective.

14:50-15:10 SuBT2.5

Impact of Electric Vehicle Battery Parameters on the Large-Scale Electric Vehicle Charging Loads in Power Distribution Network (I), pp. 56-60

Yang, Chen	Wuhan Electric Power Technical College
Tang, Jinrui	Wuhan University of Technology
Shen, Qing	Wuhan Electric Power Technical College

Existing large-scale electric vehicle (EV) charging loads forecasting methods have taken account of numerous factors to make a prediction, including EV traffic information and EV power battery information. In this paper, the EV charging loads were analyzed in-depth based on the EV battery parameters and the probability density functions of the EV arrival time and the driving distance. Then different EV battery parameters were applied to obtain the large-scale EV charging loads results. The analysis results show that the significant parameter affecting the charging loads is the EV power consumption per hundred kilometres. Contrary to our intuitions, the rated EV charging power has a slight influence on the large-scale EV charging loads.

15:10-15:30 SuBT2.6

Double Closed Loop Controller with Current Sharing of Interleaved DC/DC Converter for Dynamic Wireless Power Transfer System (I), pp. 61-66

Chen, Wenjie	Zhejiang University
Liu, Zhitao	Zhejiang University
Su, Hongye	Zhejiang University
Zhang, Liyan	Wuhan University of Technology

Dynamic wireless power transfer (DWPT) of elec- tric vehicles (EVs) is considered as an economic and effective solution on traffic electrification. However, the coupling coef- ficient between the transmitting and receiving coils changes dynamically with the movement of EV, resulting in a sharp drop in energy transfer power and efficiency. In this case, the double closed loop controller with current sharing of interleaved DC/DC converter is proposed to against coupling coefficient variation. And two layers double D coil structure is presented to make the distribution of magnetic density and temperature more uniform. Moreover, Simulation studies are carried out in PLECS to verify the proposed strategy in DWPT system. Results show that the proposed algorithm can not only significantly improve the energy transfer power and efficiency, but also ensure the current sharing of interleaved DC/DC converter, so as to enhance the robustness and stability of DWPT system.

SuBT3 Room 3

Multi-Agent Systems (Regular Session)

13:30-13:50 SuBT3.1

UWB System Based UAV Swarm Testbed, pp. 67-72

weihua, zhao	Sky Magic Ptd. Ltd
Chiew, Soon Hooi	Sky Magic Ptd. Ltd

Swarming of unmanned aerial vehicles (UAVs) has become a popular topic for its practicability in many scenarios. However an easy-to-use yet powerful swarm testbed is not widely available for most of the research labs globally. In this paper, a UAV swarm testbed is presented, which consist of an ultra-wide-band (UWB) positioning system, multiple UAVs and finite state machine based on Stateflow/Simulink. There are three important features that make this system standing out: the one is the tracking accuracy is the best as far as we know in the UWB positioning category; the second is that the system can resist magnetometer interference, i.e. the yaw angle is not effected by magnetic interferences.; the last one is that the finite state machine is ready for the general swarm experiments. The system is easy to setup with auto calibration, not limited by the size of the testing space, and can be used for both indoor and outdoor. It is believed that the proposed testbed can be adopted by swarm research labs in different scenarios in multiple scales

13:50-14:10 SuBT3.2

Mean Field LQ Games with a Finite Number of Agents, pp. 73-78

Wang, Bingchang	Shandong University
Zhang, Huanshui	Shandong University
Fu, Minyue	University of Newcastle

In this paper, we are concerned with a new class of mean field

games which involve a finite number of agents.With help of conditional mathematical expectation, we obtain necessary and sufficient conditions for the existence of the decentralized open-loop Nash equilibrium for finite-population games. By decoupling a non-standard forward-backward stochastic differential equation, we design a set of decentralized strategies in term of two differential Riccati equations. Instead of the ε-Nash equilibrium, the set of decentralized strategies is shown be a Nash equilibrium. Furthermore, we examine the infinite-horizon problem and give a neat condition for solvability of the related algebraic Riccati equation.

14:10-14:30 SuBT3.3

Hybrid Multi-Robot System for Drilling and Blasting Automation, pp. 79-84

Nguyen, Dac Dang Khoa — University of Technology Sydney
Lai, Yujun — University of Technology Sydney (UTS)
Sutjipto, Sheila — University of Technology, Sydney
Paul, Gavin — UTS

Multi-robot systems possess the potential of becoming the next generation of robots in the mining industry due to their robustness and scalability. However, they present challenges for the system to efficiently allocate tasks to each robot and allow them to navigate toward their targets safely. This paper introduces a hybrid approach method for a multi-robot system, alongside with a case study in drilling and blasting automation. A Centralized Control Unit delegates tasks and information among the robots in the system, each equipped with a decentralized motion planner that supports cooperative inter-robot collision avoidance. The proposed system inherits the advantage of a centralized multi-robot system in providing a time-wise optimal solution; while also possessing the computational benefit and scalability of a decentralized system. Simulations were conducted to validate the proposed method and discuss insights into the efficacy and performance of the proposed method.

14:30-14:50 SuBT3.4

Voronoi-Based Geometric Distributed Fleet Control of a Multi-Robot System, pp. 85-91

Bertrand, Sylvain — ONERA
SARRAS, Ioannis — ONERA-The French Aerospace Lab
Eudes, Alexandre — ONERA
Marzat, Julien — ONERA - the French Aerospace Lab

A new distributed algorithm is presented for waypoint navigation of a multi-robot system. The proposed two-level architecture (reference generator and local controller) exploits Voronoi partitioning and purely geometric considerations to distributively generate references for each robot in order to ensure collision avoidance and convergence of the fleet to the waypoint. Flexibility in the obtained formation pattern is made possible by the algorithm, by not pre-fixing as usually done its geometric form. In addition, the gain tuning is easy and the setting allows to naturally obtain certain formation patterns and adjust the rigidity of the fleet. Moreover the distributed nature of the algorithm also allows robustness to online modification of the number of vehicles (in the fleet or within range of communication), also addressing the 2-robot scenario. Field experiments on ground mobile robots are provided to illustrate the performances of the algorithm.

14:50-15:10 SuBT3.5

Consensus-Based Formation Control and Obstacle Avoidance for Nonholonomic Multi-Robot System, pp. 92-97

Koung, Daravuth — Ecole Centrale De Nantes, E-COBOT
Fantoni, Isabelle — CNRS
Kermorgant, Olivier — Ecole Centrale Nantes
Belouaer, Lamia — E-COBOT

Managing multiple robots into a formation can be beneficial, especially in logistics sectors where multiple robots can work together to transport larger loads. This paper presents a consensus control law for formation with navigation and obstacle avoidance of multiple wheeled mobile robots. The formation control is based on adapting a consensus algorithm from flocking, and we propose an obstacle avoidance methodology that ensures the formation while navigating around obstacles. Simulations of the control law using four wheeled mobile robots as well as experiments using actual industrial robots are shown in order to validate the theory.

15:10-15:30 SuBT3.6

Underwater Robot Formation Control Based on Leader-Follower Model, pp. 98-103

Fang, Renjie — Harbin Institute of Technology (Shenzhen)
Wang, Xin — Harbin Institue of Technology (Shenzhen)
Xiao, Zhenlong — Harbin Institute of Technology (Shenzhen)
Lan, Rongfu — Harbin Institute of Technology, Shenzhen
Liu, Xiaodi — Harbin Institute of Technology, Shenzhen
Cai, Xiaotian — Harbin Institute of Technology (Shenzhen)

The multi-robot formation is a key technology for underwater searching and other tasks. This paper aims to use underactuated underwater robots to establish a leader-follower formation model. Firstly, the kinematics and dynamics characteristics of the single AUV are analyzed and the coordinate transformation is introduced to decouple the dynamics of the AUV. Then the leader-follower model is obtained and the linear feedback controller is proposed, and the Lyapunov direct method is applied in the stability analysis. The simulation experimental results show that the formation of two AUVs was controlled effectively by the leader-follower formation model. We also design hardware platform to verify the reliability of the simulation. Moreover, the experimental results of expanding from two AUVs formation to three AUVs formation also prove the applicability of the method for the multi-AUVs system.

SuBT4 Room 4

Intelligent Transportation Systems (Regular Session)

13:30-13:50 SuBT4.1

Traffic Signal Transition Time Prediction Based on Aerial Captures During Peak Hours (I), pp. 104-110

Luo, Ruikang — Nanyang Technological University
Su, Rong — Nanyang Technological University

Owing to flexibility of Unmanned Aerial Vehicles (UAVs) and high efficiency of image processing technology, the combined systems become increasingly popular and important in the smart city operations. However, the application scenarios of this technology, especially on the traffic system prediction and multi-vehicle information extraction, still need to be explored. Besides, vehicle's detailed attributes need to be considered when building models. The smart traffic system can be broadly divided into two parts, traffic facilities (e.g. traffic signals, signs and sensors) and participants (e.g. vehicles and pedestrians). Many related works are presented about traffic parameters measurements using UAVs. In this paper, the prediction and traffic signal system analysis through different categories of vehicles' dynamic characteristics extracted from UAVs is presented. The motivation and related work is introduced. A stochastic process framework is presented for multi-vehicle speed extraction and signal transition time distributions at a signalized intersection. Detection and tracking methods/algorithms are proposed. To verify the mathematical model, the experimental data is collected at one intersection, in the city of Singapore during peak hours. After data collection, aerial images are processed to extract information. The regression method and processed parameters help to fit the required dynamic functions for different types vehicles. The estimated distributions reflect the traffic signal transition time provided by ground truths nicely. Moreover, the future research is presented on enhancing the system prediction accuracy and

robustness.

13:50-14:10	SuBT4.2

Domain Adaptation for Degraded Remote Scene Classification (I), pp. 111-117

Chen, Hailin	Nanyang Technological University
Yang, Jianfei	Nanyang Technological University
Xu, Yuecong	Nanyang Technological University
Shi, Ziji	Nanyang Technological University
Luo, Ruikang	Nanyang Technological University
Xie, Lihua	Nanyang Technological University
Su, Rong	Nanyang Technological University

Remote scene classification serves a vital role in many applications. However, satellite images are often blurred and degraded due to aerosol scattering under fog, haze, and other weather conditions, reducing the image contrast and color fidelity. State-of-the-art remote sensing classification models building upon convolutional neural networks (CNNs) are mostly trained on annotated datasets of clear satellite images. When applied to blurred images, they will suffer a great degradation in performance. To address this problem, we adopt the domain adaptation algorithm TADA and propose Transferable Attention enhanced Adversarial Adaptation Network (TA3N), which utilizes annotated data in clear images by applying knowledge transferring from clear image domain to blurred image domain. Our TA3N first integrates spatial attention to focus on salient areas which are discriminative and transferable. In addition, domain discriminator and adversarial training via gradient reversal layer are used to minimize the discrepancies in extracted features from clear and degraded domains. We synthesize degraded remote scene classification dataset SSI based on FoHIS model. Experiments on degraded SSI showed that TA3N significantly outperforms baseline and other state-of-the-art domain adaptation methods.

14:10-14:30	SuBT4.3

A Two-Stage Improving Scheme on Intelligent Aircraft Trajectory Optimization (I), pp. 118-123

Wang, Hui	Beijing Jiaotong University
Li, Feng	Beijing Jiaotong University
Chen, Xiaojing	Beijing Jiaotong University
Tian, Le	Beijing Jiaotong University
Song, Dongdong	Beijing Jiaotong University

This paper focuses on the Intelligent Aircraft Trajectory Optimization (IATO) problem. A two-stage mixed integer programming model is proposed to minimize the travel route of the aircraft (the shortest path, SP) and the visited correction points. Two strategies called SP-MNCP and MNCPSP are presented to reflect the actual engineering requirements in the intelligent aircraft controlling. The trade-off between the shortest path and the minimum correction points is investigated in detail based on the numerical experiments in the real-world scenarios.

14:30-14:50	SuBT4.4

Real-Time Queue Length Estimation with Trajectory Reconstruction Using Surveillance Data (I), pp. 124-129

Sheng, Zihao	Shanghai Jiao Tong University
Xue, Shibei	Shanghai Jiao Tong University
Xu, Yunwen	Shanghai Jiao Tong University
Li, Dewei	Shanghai Jiao Tong University

This paper presents a new method to estimate real-time queue lengths at a signalized intersection by utilizing limited data extracted from surveillance videos. This method focuses on reconstructing vehicles' trajectories on an entire road segment. The real-time queue length can be derived from these reconstructed trajectories. In order to improve the accuracy of the trajectory reconstruction, a built-up car-following model is proposed to reconstruct the trajectories of vehicles joining and leaving the queue, respectively, which are further corrected by a fusion algorithm. The proposed method was validated in the Next Generation Simulation dataset, and the queue length for each signal cycle can be estimated with a high accuracy. The results show that the proposed method has a higher precision compared to three baseline models.

14:50-15:10	SuBT4.5

Research on Allocation and Dispatching Strategies of Rescue Vehicles in Emergency Situation on the Freeway (I), pp. 130-135

Wang, Ping	Chang'an University
Yang, Jingwen	Chang'an University
Jin, Yinli	Chang'an University
Wang, Jun	Toll Collection Center for Shaanxi Freeway

Allocation and dispatching strategies of rescue vehicles in emergency situation on the freeway are investigated in this paper. Three steps are proposed for rescue vehicles to arrive traffic accident point as fast as possible. Firstly, traffic accident level are cataloged based on severity of accident and other influencing factors. Then, which types and how many rescue vehicles are required for the specific traffic accident according to corresponding accident level. Finally, three dispatching methods are proposed and verified in a case study. This paper selected a traffic accident randomly happened on Hanning Freeway in Shaanxi Province as a case study. The result shows the application of the three methods in case study and contains optimal rescue vehicle dispatching method. This paper provides suggestions for emergency handling of traffic accidents on the freeway and gives an intelligent way to improve the management of the freeway.

15:10-15:30	SuBT4.6

Improved Deep Learning Method to Fast Detect Vehicles Driving on a Long Span Cable-Stayed Bridge (I), pp. 136-141

Zhang, Shuying	Chang'an University
Wang, Ping	Chang'an University
Yang, Gan	Chang'an University
Han, Wanshui	Chang'an University
Yang, Jingwen	Chang'an University

The dynamic load on the bridge is normally generated by the traffic flow. It is therefore the acquisition of spatiotemporal information for vehicles driving on a bridge is of great significance to assess bridge structures. In this paper, we proposed an improved deep learning network, which is inspired from YOLOv4 (You only look once) network structure. The transfer learning method is applied in training, and designated nine sets of anchor values are obtained by the K-means clustering. The Soft-NMS (Non-Maximum Suppression) algorithm is fused to improve the detection effect of overlapping targets. At the same time, the SENet (Squeeze-and-Excitation Networks) is used to assign weights to the features of each channel to learn the correlation between different channels. Data set are established with video clips cut from the surveillance system currently used on a long span cable-stayed bridge in China. The proposed method is compared with SSD (Single Shot MultiBox Detector), YOLOv3 and YOLOv4 algorithms. Experimental proves that the proposed method can detect vehicle information more accurately, efficiently and stably. The result could extend to other bridge monitoring applications in future.

SuBT5	Room 5

Cooperation and Security in Network-Connected Systems
(Invited Session)

Organizer: Zhang, Ya	Southeast University
Organizer: Feng, Zhi	Nanyang Technological University

13:30-13:50	SuBT5.1

Formation Tracking Control with Adaptive Neural Networks Estimation (I), pp. 142-147

huang, rong	Southeast University

Chen, Yangyang — Southeast University

This paper considers the planar formation tracking control problem of second-order agents with model uncertainties. A novel adaptive neural network (ANN) estimation method based on neighborhood information is designed to estimate model uncertainties. By using the tools of the backstepping method and ANN, a robust formation tracking control law is given. The formation tracking errors are guaranteed to be uniformly bounded under connected topologies. Numerical simulation results verify the validity of the analysis results.

13:50-14:10 SuBT5.2

A Switched System Approach against Time-Delay Attacks in Cyber-Physical Systems (I), pp. 148-153

Tongxiang, Li — Zhejiang University of Technology

Chen, Bo — Zhejiang University of Technology

Yu, Li — Zhejiang University of Technology

This paper investigates the modeling and stabilization problem for cyber-physical systems (CPSs) under time-delay attacks. First of all, the attack-induced delays are divided into multiple equilong subintervals and each subinterval is separated into a nominal part and an uncertain part. Then, the system is considered to dwell in different subsystems when the attack-induced delays fall into different subintervals. In this way, the CPS is modeled as a discrete-time switched system with norm-bounded uncertainties. Moreover, the mode-dependent controller is designed to defend the time-delay attacks and guarantee the exponential stability of the closed-loop CPS, which is switched according to the attack-induced delays and implemented combined with the packet-based control strategy. Finally, the experiments of a networked inverted pendulum control system are given to demonstrate the effectiveness of the proposed method.

14:10-14:30 SuBT5.3

Delay Margin for Containment Control of Second-Order Multi-Agent Systems Over Directed Graphs (I), pp. 154-159

Ma, Xueyan — Northeastern University

Ma, Dan — Northeastern University

In this paper, we mainly study the delay robustness on containment control of second-order multi-agent systems with uncertain communication delays over directed graphs. Our purpose is to find the maximal delay range that can be tolerated under which the multi-agent system can maintain containment robustly. We consider a second-order multi-agent system under position and velocity feedback protocols in which each agent has two unstable real poles. We derive the exact expression of the delay margin for multi-agent system containment. Furthermore, based on the analysis of the exact delay margin, we obtain its explicit upper bound. The results show that the position of poles and the network connectivity will affect the bound of delay margin. Finally, a numerical example is used to illustrate the effectiveness of the proposed theoretical results.

14:30-14:50 SuBT5.4

Consensus Kalman Filtering for Sensor Networks Based on FDI Attack Detection (I), pp. 160-165

Hao, Jiali — Southeast University

Zhang, Ya — Southeast University

This paper studies the consensus Kalman filtering algorithm with distributed attack detection for reducing the effects of false data injection attacks in wireless sensor networks. The FDI attacks are randomly injected into communication channels or sensors with certain probabilities, which undermines the accuracy of the transmission data and the accuracy of measurement data respectively. X^2 detector is applied, and if the received data is determined to be attacked, it is omitted in consensus Kalman filtering. It is proved that if the FDI attack is randomly injected into communication channels, under the consensus Kalman filtering algorithm with adaptive weighting protocol and attack detection, the estimation errors of the sensor network can be bounded in probability. If the FDI attack is randomly injected into sensors, a probability condition on the attacks is given to guarantee the estimation errors of the sensor network bounded in mean square sense. Numerical simulations are conducted to demonstrate the performance of the proposed algorithms.

14:50-15:10 SuBT5.5

A Novel Method Combining Leader-Following Control and Reinforcement Learning for Pursuit Evasion Games of Multi-Agent Systems (I), pp. 166-171

Zhu, Zheyang — Jiangnan University

Liu, Cheng-Lin — Jiangnan University

In the existing literature, many methods have been utilized in solving the pursuit evasion game. However, most of these methods have one thing in common: all pursuers have to know the evader's position. This paper presents a method combining the multi-agent leader-following control and reinforcement learning, which aims at addressing a pursuit evasion game only when partial pursuers have the knowledge of the position of the evader who moves randomly in two-dimensional grid space. Through decomposing the team task, pursuers realize the encirclement of the evader. Simulation experiment validates the effectiveness of our method.

15:10-15:30 SuBT5.6

Task-Space Cooperative Tracking of Manipulators Via a Unified Inner/Outer-Loop Distributed Design (I), pp. 172-177

Feng, Zhi — Nanyang Technological University

Hu, Guoqiang — Nanyang Technological University

Jeffrey, Soon — Delat

This paper addresses task-space adaptive coordinated tracking of networked manipulators with an inner/outerloop closed control architecture, considering all the uncertain kinematics, dynamics, disturbances, and unavailable task-space velocities. One observation is that modern robotic applications may encounter situations that task-space controllers cannot be implemented on robots with a closed control architecture. In addition, it assumes that the combination of the inner/outer-loop is stable and effects of unknown robotic dynamics are neglected. Existing papers in [9]–[12] provide task-space synchronization with an open control architecture and require each robot to fully access a desired global task, and to communicate via undirected or strongly connected digraphs. In contrast, this paper proposes a distributed framework over a directed graph so that a robust, distributed, outer-loop control scheme is developed to achieve task-space coordination with dynamic effects being considered and not modifying the inner control loop. Numerical simulations are presented to show the effectiveness of proposed designs.

SuBT6 Room 6

Mobile Robot Navigation, Vision and AI (Invited Session)

Organizer: Wang, Han — Nanyang Technological University

13:30-13:50 SuBT6.1

Unsupervised 3D Primitive Shape Detection Using Mathematical Models (I), pp. 178-183

PING, GUIJU — Nanyang Technological University

Abolfazli Esfahani, Mahdi — Nanyang Technological University

Wang, Han — Nanyang Technological University

This study aims to propose the first unsupervised deep learning based framework to detect primitive shapes in unorganized point clouds. The benefits of the proposed modelare as follows: first, modeling primitive shapes mathematically and making the annotation and generation of training data automatically can assist in training a network in an unsupervised manner without using any pre-annotated datasets. The proposed approach is able to expand to other 3D point clouds related tasks when the datasets are not big enough. Experiments and results demonstrate that the proposed unsupervised methods can achieve an accuracy on par with supervised approach for primitive shape detection in 3d point clouds.

13:50-14:10	SuBT6.2

LaCNet: Real-Time End-To-End Arbitrary-Shaped Lane and Curb Detection with Instance Segmentation Network (I), pp. 184-189

zhou, hui	Nanyang Technological University
Wang, Han	Nanyang Technological University
Zhang, Handuo	Nanyang Technological University
Karunasekera, Hasith	Nanyang Tech. Univ

Accurate and robust detection of lane and curb in urban areas is essential to many real-world intelligent vehicle applications. Existing vision-based researches treat lane detection and curb detection separately due to the nature of curb detection problem relying on 3D features, which is not efficient when driving in a real world. This paper presents a unified network to incorporate these two tasks together by taking advantage of the powerful feature learning ability brought by deep convolutional neural networks. The resulting unified network provides valuable road boundary information by curb detection even when lane markings are not visible during vehicle navigation. Another significant capability coming with the proposed method is able to accurately differentiate various lane and curb instances with tiny gaps or complex spatial relationships which are thought as the biggest challenge in real driving situations. To achieve this, the network is specially designed to guide lane and curb instances to learnable kernel through pixel grouping. This learnable kernel is capable to handle any number of arbitrary-shaped lanes and curbs no matter which angle the vehicle is heading at. In the end, the presented approach is evaluated on two datasets (BDD100K and self-collected dataset) scoring 32 FPS processing speed. Results are very encouraging with more than 98% F 1 measure for both lane and curb detection on the self-collected dataset.

14:10-14:30	SuBT6.3

Unsupervised Scene Categorization, Path Segmentation and Landmark Extraction While Traveling Path (I), pp. 190-195

Abolfazli Esfahani, Mahdi	Nanyang Technological University
Wang, Han	Nanyang Technological University
Wu, Keyu	Nanyang Technological University
YUAN, SHENGHAI	Nanyang Tech. Univ

Segmenting the movement path is an essential requirement of intelligent mobile robots. It assists intelligent systems in gaining a better understanding of the scene and identifying re-visited spaces. Moreover, it helps intelligent robots quantize the wide scene into sub-spaces that visually represent the same content—for instance, distinguishing rooms and kitchen in an indoor environment. This paper proposes an unsupervised approach to understand the transition of the scene while a robot is moving and helps to extract sub-spaces that visually represent a similar environment. The proposed approach benefits from a pre-trained deep network architecture to extract a description (feature representation) for the mobile robot's visual information at each time step. Then, based on the pairwise distance of the feature representations, sub-spaces of the scene and transition points are extracted.

14:30-14:50	SuBT6.4

Model Predictive Path Integral Control Framework for Partially Observable Navigation: A Quadrotor Case Study (I), pp. 196-203

S. Mohamed, Ihab	Inria Sophia Antipolis - Méditerranée, Université Côte D'Azur
Allibert, Guillaume	Universite Cote d'Azur, CNRS, I3S
Martinet, Philippe	INRIA

Recently, Model Predictive Path Integral (MPPI) control algorithm has been extensively applied to autonomous navigation tasks, where the cost map is mostly assumed to be known and the 2D navigation tasks are only performed. In this paper, we propose a generic MPPI control framework that can be used for 2D or 3D autonomous navigation tasks in either fully or partially observable environments, which are the most prevalent in robotics applications. This framework exploits directly the 3D-voxel grid acquired from an on-board sensing system for performing collision-free navigation. We test the framework, in realistic RotorS-based simulation, on goal-oriented quadrotor navigation tasks in a cluttered environment, for both fully and partially observable scenarios. Preliminary results demonstrate that the proposed framework works perfectly, under partial observability, in 2D and 3D cluttered environments.

14:50-15:10	SuBT6.5

Near-Parallel Binocular-Like Camera Pair for Multi-Drone Detection and 3D Localization (I), pp. 204-210

Srigrarom, Sutthiphong	National University of Singapore
Yi, Jiahe	Nanyang Technological University

The paper presents the concept of using a pair of cameras that are setup near and almost parallel to each other to do detection and 3D localization of multiple drone at far distance away. These setup of the two cameras resemble the binocular cameras, as such the 3D positions of the detected drones can be estimated by epipolar-like geometry. For the special case of detecting the multiple drones at a distance, quick depth distance approximation based on similar triangles is also proposed. Sample field tests of detecting and tracking multiple drones at near and far distances in open areas are presented. The depth distances obtained are comparable to the actual GPS readings from the detected drones. Index Terms—Near parallel, Binocular-like camera, Multidrone, Optical detection, 3D Localization, Distance drones.

15:10-15:30	SuBT6.6

A State-Of-Charge Estimation Method Based on Bidirectional LSTM Networks for Lithium-Ion Batteries, pp. 211-216

Zhang, Zhen	Zhejiang University
Xu, Ming	NingboTech University
Ma, Long-hua	Zhejiang University
Yu, Bin Chao	Zhejiang Zheneng Natural Gas Operation Co

State-of-charge (SOC) estimation is the key to the BMS of lithium-ion batteries. At present, data-driven methods are more popularly used to estimate the SOC. Among them, the deep learning technology especially recurrent neural networks (RNNs) performed very well. In this paper, we proposed a bidirectional long short-term memory (Bi-LSTM) neural network to perform SOC estimation. The bidirectional LSTM layer is employed to catch the forward and backward temporal dependencies of battery sequential states, and shows better performance in SOC estimation of LiBs. With a public dataset of vehicle driving cycles, we separately train our proposed network at three different constant temperatures (0 celsius, 10 celsius, and 25 celsius), and the evaluated MAEs are 0.498%, 0.411%, 0.738%. Besides, the Bi-LSTM network trained with overall datasets at three temperatures achieves a mean absolute error (MAE) of 0.616% and maximum absolute error (MaxE) of 3.809%. It shows that the proposed method is robust and accurate in SOC estimation.

SuCT1	Room 1
Best Paper Award Finalist Presentations (Regular Session)	

16:00-16:20	SuCT1.1

Symbolic Self-Triggered Control of Continuous-Time Non-Deterministic Systems without Stability Assumptions for 2-LTL Specifications, pp. 217-223

Pruekprasert, Sasinee	National Institute of Informatics
Eberhart, Clovis	National Institute of Informatics
Dubut, Jeremy	National Institute of Informatics

16:20-16:40	SuCT1.2

A Data Driven Approach for Leak Detection with Smart Sensors (I), pp. 224-229

Liang, Bin	University of Technology Sydney
VERMA, SUNNY	University of Technology Sydney
Xu, Jie	University of Technology Sydney
Liang, Shuming	University of Technology Sydney
Li, Zhidong	UTS
Wang, Yang	University of Technology Sydney
Chen, Fang	University of Technology Sydney

16:40-17:00	SuCT1.3

Enhancing Adaptive Event-Triggered Protocols for Multi-Agent Consensus with External Disturbances (I), pp. 230-235

Li, Xianwei	Shanghai Jiao Tong University
Tang, Yang	East China University of Science and Technology
Zhu, Bing	Beihang University
Li, Shaoyuan	Shanghai Jiao Tong University

17:20-17:20	SuCT1.4

Hybrid Feature Network Driven by Attention and Graph Features for Multiple Sclerosis Lesion Segmentation from MR Images, pp. 236-241

Chen, Zhanlan	Northwestern Polytechnical University
Wang, Xiuying	The University of Sydney
Zheng, Jiangbin	Northwestern Polytechnical University

17:20-17:40	SuCT1.5

Multi-Robot Collaborative Reasoning for Unique Person Recognition in Complex Environments (I), pp. 242-247

Yang, Chule	Academy of Military Science
Yue, Yufeng	Nanyang Technological University
Wen, Mingxing	Nanyang Technological University
Zhang, Jun	Nanyang Technological University

SuCT2	Room 2

Electric Vehicles and Intelligent Transportation 2 (Regular Session)

16:00-16:20	SuCT2.1

Research on Anti-Interference Algorithm for Cab Signal Demodulation Based on Deep Learning, pp. 248-254

LIU, Shuxian	Beijing Jiaotong University
YANG, Shiwu	Beijing Jiaotong University
Liu, Chang	Beijing Jiaotong University
LIU, tao	Shenzhen Changlong Railway Electronic Engineering Company Co, Lt
Xiong, Qihui	BeijingJiaoTong University

The cab signal, as the movement authority of train operation, plays a vital role in ensuring the safety of operation. The booming high-speed and heavy-haul railways lead to larger traction current, as well as various types of locomotive, the electromagnetic environment is getting more serious than before. The track circuit and traction current take the rails as common transmission channel. It is difficult to physically filter out mixed noise in the received signal and demodulate the information correctly since harmonic component of the interference may occupy the same frequency spectrum as useful signal. Under this background, the paper proposes a cab signal anti-interference algorithm based on PSO-optimized (Particle Swarm Optimization) DBN (Deep Belief Network) aimed at these FSK (Frequency shift keying) modulation signals which were interfered in useful band to improve the accuracy of cab signal demodulation. After verified by on-site and simulated data and compared with commonly used machine learning, this algorithm performs well in the demodulation of in-band noisy cab signals demodulation, the average accuracy of the algorithm reaches 99.87%, in addition, the average data process time is about 0.5s based on the TensorFlow platform with the GPU of GeForce MX250.

16:20-16:40	SuCT2.2

Hybrid, Discrete-Time Distributed Parameter Mathematical Model for Road Traffic with Control, pp. 255-259

Orlowski, Przemyslaw	West Pomeranian University of Technology in Szczecin

The paper develops improved hybrid, dynamical, discrete-time, distributed parameters mathematical model for traffic flow in urban communication systems. The model allows to: predict states – densities and group velocities in each sector of the road. The model can be used for the implementation and testing of a desirable control strategy. The model-based approach can be used to solve the problem of congested road infrastructure in urban areas. The mathematical concept of the model is illustrated on a numerical simulation carried in Matlab software.

16:40-17:00	SuCT2.3

Graph-Based Approach for Crowdsourced Mapping: Evaluation through Field Experiments, pp. 260-265

Stoven-Dubois, Alexis	VEDECOM
Dziri, Aziz	VEDECOM
Leroy, Bertrand	VEDECOM
Chapuis, Roland	Institut Pascal

Automotive players have recently shown an increasing interest in high-precision mapping, with the aim of enhancing vehicles safety and autonomy. Nevertheless, the acquisiton, processing and updates of accurate maps remains an economic challenge. Collaborative mapping through vehicles crowdsourcing represents a promising solution to tackle this problem. However, the potential accuracy provided by such an approach has yet to be assessed.

In this paper, we evaluate the performances of crowdsourced mapping in real conditions. We build a map of geolocalized landmarks by crowdsourcing observations from multiple vehicles, and applying several successive map updates. We evaluate the map quality through a field-test with multiple vehicle passings. Furthermore, we study the benefits of crowdsourced mapping for vehicles positioning.

17:20-17:20	SuCT2.4

Road Curb Detection Using Traversable Ground Segmentation: Application to Autonomous Shuttle Vehicle Navigation, pp. 266-272

Guerrero Mata, Jose Alfredo	CEMAGREF (IRSTEA)
Chapuis, Roland	Institut Pascal
AUFRERE, Romuald	Institut Pascal - Clermont Auvergne University
Malaterre, Laurent	Institut Pascal
Marmoiton, Francois	Institut Pascal

This work addresses the problem of road curb detection using a LIDAR 3D sensor in urban environments, which is an important task in autonomous vehicle technology. Existing road curb detection methods often rely on a ground segmentation process and geometric features extraction on ground data. Existing ground segmentation methods, used for road curb detection purposes, have been developed with the flat terrain assumption in mind. However, in real applications, the shape of the terrain is not always

flat. Moreover, the surrounding environment (walls, trees, and other obstacles) and the sensor orientation might influence the results of the existing ground segmentation methods. Thus, we propose an efficient ground segmentation algorithm to extract points belonging to the road surface, road curbs, sidewalks, etc. Geometrical features are used to detect road curb like changes in LIDAR 3D points. However, geometrical features cannot distinguish between road curbs, small obstacles and, terrain variations whose shape is similar to road curbs. Then, in addition to geometrical features commonly used in curb detection methods, we use the LIDAR 3D reflectance feature to detect road curbs. Experiments on an autonomous shuttle vehicle demonstrate that the proposed method is capable of detecting road curbs on roads with complicated geometry such as curved roads, roundabouts, and banked turns.

17:20-17:40 SuCT2.5

Using Traffic Signs As Landmarks in Object-Oriented EKF-SLAM, pp. 273-280

HRUSTIC, Emir	ISAE-SUPAERO
Vivet, Damien	ISAE-SUPAERO

Simultaneous localization and mapping (SLAM) is a well-known problem in robotic applications. Many solutions consist in using handcrafted features as landmarks such as SIFT, SURF, ORB... These features are usually edges or corners which are invariant to some specific transformations. However, because of their low-level nature, they are not only non-informative but also not robust under various conditions (lightning, weather, point-of-view) and their track is often lost from one frame to another. To tackle this issue, the main idea of this work is to detect and localize higher-level landmarks such as static semantic objects instead. This paper focuses on the integration of circular traffic signs landmarks into a complete Extended Kalman Filter SLAM framework. The main part of this work consists in the quadric parametrization of the observation function and its inclusion in the Bayesian approach.

17:40-18:00 SuCT2.6

A Collaborative Relative Localization Method for Vehicles Using Vision and LiDAR Sensors, pp. 281-286

Li, Yanhao	Shanghai Jiao Tong University
LI, HAO	Shanghai Jiao Tong University

Inter-vehicle relative positioning is essential to various multi-vehicle collaborative tasks such as environment perception augmentation, long range path planning and communication-assisted driving applications. We propose a real-time collaborative relative positioning framework to estimate inter-vehicle poses via vision and LiDAR sensors. The vision sensor is used for inter-vehicle pose initialization, whereas the LiDAR sensor is used for SLAM and pose refinement. A comparative study between our proposed method and a representative baseline method based on ORB-SLAM2-stereo is performed in the CARLA simulator, which demonstrates advantages of the proposed method in terms of accuracy and robustness in real-time operation.

SuCT3 Room

Learning and Statistical Methods (Regular Session)

16:00-16:20 SuCT3.1

A Robust Decomposition-Ensemble Method for Wind Speed Forecasting, pp. 287-290

Zhang, Bingquan	CRRC Wind Power (Shandong) Co., Ltd
Yang, Yang	Nanjing University of Posts and Telecommunications
Zhao, Dengli	CRRC Wind Power (Shandong) Co., Ltd
Wu, Jinran	Queensland University of Technology

Accurate forecasting of wind speed is vital in renewable power system management. However, wind speed series is an extremely complex system with outliers. Considering the dilemma, we propose a robust extreme learning machine algorithm where a huber loss works as the optimized function for extreme learning machine training. And a decompositionensemble method is developed in modelling wind speed. In our hybrid system, the proposed robust extreme learning machine is employed to model high-frequent sub-signals, while least square extreme learning machine is used to model low-frequent subsignals. Validated by forecasting a 5-minutely wind speed in China, our proposed forecasting framework can provide more accurate predictions.

16:20-16:40 SuCT3.2

Efficient Asynchronous Vertical Federated Learning Via Gradient Prediction and Double-End Sparse Compression, pp. 291-296

Li, Ming	Zhejiang University
Yiwei, Chen	Zhejiang University
Wang, Yiqin	Zhejiang University
Pan, Yu	Zhejiang University

Vertical federated learning is a subset of federated learning whose training dataset is vertically distributed among the federations. However, as a natural synchronous algorithm, classical vertical federated learning suffers from “Liebig's Law”. In this paper, we propose a novel asynchronous vertical federated learning framework with gradient prediction and doubleend sparse compression to accelerate the training process andreduce the intermediate result transmission. Our simulation results show that our framework can achieve 65.41% training acceleration and 86.90% traffic volume reduction at no cost of accuracy compared with the classical framework.

16:40-17:00 SuCT3.3

Towards Enforcing Social Distancing Regulations with Occlusion-Aware Crowd Detection, pp. 297-302

Cong, Cong	University of News South Wales
Yang, Zhichao	University of News South Wales
Song, Yang	University of New South Wales
Pagnucco, Maurice	University of News South Wales

In this paper, we present a video analysis method that automatically detects crowds violating social distancing regulations in public spaces, which is widely accepted to be essential to minimise the spreading of COVID-19. While various approaches have been published online to tackle this problem, our work presents a systematic study with comprehensive quantitative analysis of different deep learning models on multiple datasets. We experimented with two types of one-stage pedestrian detection models and further optimised their performance with a repulsion loss to address occlusions in crowds. We also propose a distance computation technique with locally adaptive threshold to approximate the actual spatial distance between pedestrians in the real world. In addition, since there is no existing dataset providing ground truth annotations of distances, we manually annotated three public datasets with such information to perform quantitative evaluation of our crowd detection method. Our comprehensive evaluation shows that our method achieves good detection performance with improvement provided by repulsion loss. Our code and ground truth annotations can be obtained from https://github.com/thomascong121/SocialDistance.

17:20-17:20 SuCT3.4

A Progressive Weighted Average Weight Optimisation Ensemble Technique for Fruit and Vegetable Classification, pp. 303-308

Hameed, Khurram	Edith Cowan University
Chai, Douglas	Edith Cowan University
Rassau, Alex	Edith Cowan University

Image classification of fruit and vegetables at supermarket self-checkouts is a complex problem. Significant variations in the size, shape and colour of objects are involved, along with potentially large variations in the environmental conditions, must be accommodated to implement such a robust and effective system. Convolution Neural Networks (CNNs) have shown promising results for object classifications. However, the scarcity of training datasets due to the diversity of varieties and applications of fruit and vegetable classification is a significant limitation to the CNN implementation for this task. To overcome this, we propose the use of transfer learning and ensemble technique. Specifically, a transfer learning based weighted average weight optimisation ensemble technique is applied to the weights of GoogleNet and MobleNet by transfer learning the pre-trained CNNs using a custom dataset. Two hyperparameter optimisation techniques have been applied in a sequential way to identify the effective weights progressively. The optimised weights are used as an input to a normalised exponential softmax layer to estimate the final probability distribution for classification. A comparative evaluation among standalone GoogleNet, MobileNet and different levels of ensemble has been presented, which supports the adoption of this technique as a solution in a real-world supermarket environment.

17:20-17:40 SuCT3.5

Real-Time Multiple Object Tracking with Discriminative Features, pp. 309-314

weng, zhenyu — Peking University Shenzhen Graduate School
zhu, yuesheng — Peking University Shenzhen Graduate School
Lin, Zhiping — School of Electrical &ElectronicEng., NanyangTechnologicalUnivers
li, haizhou — National University of Singapore

Tracking-by-detection methods track multiple objects by detecting the objects of interest in each frame and associating the detected objects with the tracks. By allowing object detection and appearance embedding to be learned in a shared network, recent tracking-by-detection methods can implement the tracking task in real time with the power of deep neural networks. However, they just focus on the detection stage and do not take advantage of the embedding features well in the association stage. In this paper, we exploit the discriminative embedding features in the association stage to improve the tracking performance. By combing the embedding features with the bounding boxes to associate the detected objects with the tracks, the number of identity switches during tracking can be reduced. Further, after associating the detected objects with the tracks, the embedding feature of each track is not only updated according to the associated object, but also learned to distinguish the similar detected objects. The experiments show that our method can achieve competitive tracking performance in real time compared to the state-of-the-art tracking methods.

17:40-18:00 SuCT3.6

Commonsense Knowledge Adversarial Set That Challenges ELECTRA, pp. 315-320

Lin, Gongqi — NTU-Alibaba JRI
Miao, Yuan — Victoria University
Yang, Xiaoyong — Alibaba-Group
Ou, Wenwu — Alibaba-Group
Cui, Lizhen — Shandong University
Guo, Wei — Shandong University
Miao, ChunYan — Nanyang Technological University

Commonsense knowledge is critical in human reading comprehension. While machine comprehension has made significant progress in recent years, the ability in handling commonsense knowledge remains limited. Synonyms are one of the most widely used commonsense knowledge. Constructing adversarial dataset is an important approach to find weak points of machine comprehension models and support the design of solutions. To investigate machine comprehension models' ability in handling the commonsense knowledge, we created a Question and Answer Dataset with common knowledge of Synonyms (QADS). QADS are questions generated based on SQuAD 2.0 by applying commonsense knowledge of synonyms. The synonyms are extracted from WordNet. Words often have multiple meanings and synonyms. We used an enhanced lesk algorithm to perform word sense disambiguation to identify synonyms for the context. ELECTRA achieves the state-of-art result on the SQuAD 2.0 dataset in 2019. With about 1/10 scale, ELECTRA can achieve similar performance as BERT does. However, QADS shows that ELECTRA has little ability to handle commonsense knowledge of synonyms. In our experiment, ELECTRA-small can achieve 70% accuracy on SQuAD 2.0, but only 20% on QADS. ELECTRA-large did not perform much better. Its accuracy on SQuAD 2.0 is 88% but dropped significantly to 26% on QADS. In our earlier experiments, BERT, although also failed badly on QADS, was not as bad as ELECTRA. The result shows that even top-performing NLP models have little ability to handle commonsense knowledge which is essential in reading comprehension.

SuCT4 Room 4

Mobile Robotics (Regular Session)

16:00-16:20 SuCT4.1

NDT-PSO, a New NDT Based SLAM Approach Using Particle Swarm Optimization, pp. 321-326

sara, bouraine — Center for Development of Advanced Technologies (CDTA)
Bougouffa, Abdelhak — Université Paris-Saclay
ouahiba, azouaoui — Center for Development of Advanced Technologies (CDTA)

This paper deals with the problem of simultaneous localization and mapping (SLAM). Providing both accurate environment's map and pose estimation is necessary to correctly navigate, which is a key issue for a mobile robot interacting with human beings. It is a line of research that is always active, offering various solutions to this issue. Nevertheless, among many SLAM methods, Normal Distributions Transform (NDT) has shown high performances, where numerous works have been published up to date and many studies demonstrate its efficiency wrt to other methods. In this paper a new NDT based SLAM method using Particle Swarm Optimization called NDT- PSO is proposed. The main contribution is to invest the bio- inspired approach PSO to solve pose estimation problem based on iterative NDT maps. Real experiments have been performed on a car-like mobile robot to confirm the performances of NDT-PSO approach and its efficiency in both static and dynamic environments.

16:20-16:40 SuCT4.2

Customer Behavior Analytics Using an Autonomous Robotics-Based System, pp. 327-332

Petrovsky, Alexander — Skolkovo Institute of Scince and Technology
Kalinov, Ivan — Skolkovo Institute of Science and Technology
Karpyshev, Pavel — Skoltech
Kurenkov, Mikhail — Skolkovo Institute of Science and Technology
Ilin, Valery — Skolkovo Institute of Science and Technology
Ramzhaev, Vladimir — Skoltech
Tsetserukou, Dzmitry — Skolkovo Institute of Science and Technology

This paper suggests a novel method for customer behavior analytics and demand distribution based on RadioFrequency Identification (RFID) stocktaking. Existing solutions lack applicability to real-life situations in retailing, which may result in unobservable loss of sales. The proposed solution provides new parameters of demand distribution to the retailer using a mobile robot for autonomous stocktaking of RFID-equipped shopping rooms. Built models depict location-related demand dependencies, the most and the least purchasable areas in a store, and precise localization of lost and moved items. Our research differs from the related works by the sheer size of the underlying data set collected in a real-world environment for more than ten months.

16:40-17:00 SuCT4.3

Bidirectional Homotopy-Guided RRT for Path Planning, pp. 333-338

Lin, Zhen — ZheJiang University
Li, Yanjun — Zhejiang University City College
xiang, ji — Zhejiang University, Yuquan Campus
Gui, Ling — Zhejiang University City College; Zhejiang University
Suo, Feiyang — Zhejiang University City College;

Zhejiang University

As a popular robot path planning algorithm, RRT (Rapid-exploring Random Tree) and various RRT-based extensions have achieved remarkable results. However, existing algorithms rely too much on randomness and often do not make use of known map information, this makes the growth of trees too blind. To this end, we introduce Bidirectional Homotopy-Guided RRT (BH-RRT) that combines Bidirectional RRT (Bi-RRT) with information obtained from obstacle contours. Compared with the previous methods, BH-RRT can reflect most of the map's information with a small number of feature points, and then form a set of points. This set can provide a better local goal point in each iteration, so that the tree can grow in a more favorable direction, rather than only being affected by the goal point. Experimental results show that BH-RRT outperforms RRT, HRRT and Bi-RRT in the success rate within a limited time.

17:20-17:20 SuCT4.4

Modeling and Identification of Coupled Translational and Rotational Motion of Underactuated Indoor Miniature Autonomous Blimps, pp. 339-344

Tao, Qiuyang	Georgia Institute of Technology
Hou, Mengxue	Georgia Institute of Technology
Zhang, Fumin	Georgia Institute of Technology

Swing oscillation is widely observed among indoor miniature autonomous blimps (MABs) due to their underactuated design and unique aerodynamic shape. A detailed dynamics model is critical for investigating this undesired movement and designing controllers to stabilize the oscillation. This paper presents a motion model that describes the coupled translational and rotational movements of a typical indoor MAB with saucer-shaped envelope. The kinematics and dynamic model of the MAB are simplified from the six-degrees-of-freedom (6-DOF) Newton–Euler equations of underwater vehicles. The model is then reduced to 3-DOF given the symmetrical design of the MAB around its vertical axis. Parameters of the motion model are estimated from the system identification experiments, and validated with experimental data.

17:20-17:40 SuCT4.5

Towards a Development of Robotics Tower Crane System, pp. 345-350

Andonovski, Bojan	Nanyang Technological University
Li, Jianqiang	Nanyang Technological University
Jeyaraj, Sherine	Nanyang Technological University
Ang, Zi Quan	Nanyang Technological University
Kumhom, Pinit	King Mongkut's University of Technology Thonburi
Ang, Wei Tech	Nanyang Technological University

This paper describes the outcomes of a research study of a Robotic Tower Crane (RTC) which is part of a Digital Production Inventory Logistic Management System (DPILMS), that can be viewed as a complex system as it is required to deal with various inputs and perform different tasks in an unpredictable environment such as the construction field. The system has to work day and night, rain or shine under all-weather conditions. The RTC must sense the environment using multiple sensors. The proposed solution consists of various sensors capable to localize the RTC in real-time, detect and track objects within the surroundings, and subsequently make decisions about how to react correctly within the appropriate time in the perceived environment, and several real-time subsystems. To achieve autonomous hoisting in an unpredictable environment, the real-time subsystems must interoperate with sensor processing, perception, localization, planning, and control to process an enormous amount of sensor data via a high complexity computation pipeline.

17:40-18:00 SuCT4.6

Multi-Robots Trajectory Planning for Farm Field Coverage, pp. 351-356

Cariou, Christophe	INRAE
Laneurit, Jean	INRAE
Roux, Jean-Christophe	Inrae
Lenain, Roland	INRAE

In the last few years, fleets of mobile robots have received increased interest in agriculture with the development of master/slaves control approaches. This paper proposes on the contrary a planning strategy enabling to generate beforehand the trajectory of each robot. For that, the fleet is considered as a single mobile entity with its steering and speed constraints. An admissible trajectory for this virtual entity, including maneuver phases, is generated to cover the shape of a given field. This one is next used to plan the trajectories of the actual robots. A panel of actual fields with different fleets of robots enables to highlight the relevance of the strategy proposed.

SuCT5 Room 5

Intelligent Perception and Control for Autonomous Systems/robots 1 (Invited Session)

Organizer: Wang, Danwei	Nanyang Technological University
Organizer: Laugier, Christian	INRIA

16:00-16:20 SuCT5.1

LPG-SLAM: A Light-Weight Probabilistic Graph-Based SLAM (I), pp. 357-362

MELBOUCI, kathia	INRIA
NASHASHIBI, FAWZI	INRIA

Current autonomous navigation solutions critically rely on SLAM systems for localisation, especially in GPSdenied environments. Their efficacy and efficiency thus depend on the ability of the underlying SLAM method to map largescale environments in a data-efficient manner. State of the art systems, while accurate, often require powerful hardware such as GPUs, and need careful tuning of hyperparameters in order to adapt to the user's needs. In this paper, we propose a light-weight but accurate probabilistic 2D graph-based SLAM system. We validate our approach on sequences from the KITTI dataset as well as on data gathered by our experimental platform.

16:20-16:40 SuCT5.2

VAGAN: Vehicle-Aware Generative Adversarial Networks for Vehicle Detection in Rain (I), pp. 363-368

Wang, Jian-Gang	Institute for Infocomm Research
WAN, Kong Wah	Institute for Infocomm Research
Yau, Wei Yun	Institute for Infocomm Research
Pang, Chun Ho	Institute for Infocomm Research
Lai, Fon Lin	Institute for Infocomm Research

Vision-based vehicle detection under bad weather conditions is still a challenging problem. Adhesive raindrops on windshield have been known to diffract light and distort parts of the scene behind them. In this paper, we propose a Vehicle-Aware Generative Adversarial Networks (VAGAN) to improve vehicle detection from rain images. We train a Generative Adversarial Network (GAN) on image pairs, each comprising of an original rain image and one that is manually labelled with colored bounding boxes of the vehicles therein. The latter represents a fake version of the original image emphasizing the regions of interest. To further enhance vehicle awareness, we exploit the fact that the vehicle rear lights are usually turned on during rainy conditions to compute a saliency map of image, and use it formulate a background preserving constrain on the learning vehicle loss function. We show that this novel adversarial framework is able to generate new images with colored regions overlay over vehicles, hence effectively learning to differentiate image background from vehicles. The final vehicle detection in the generated images is not affected by image translation noise because we can simply use color segmentation to localize the vehicles. Experimental results on a large dataset show that our approach is an effective way to solve vehicle detection in rain images, achieving state-of-the-art performance.

16:40-17:00 SuCT5.3

Multi-Robot Collaborative Reasoning for Unique Person

Recognition in Complex Environments (I), pp. 369-374

Yang, Chule	Academy of Military Science
Yue, Yufeng	Nanyang Technological University
Wen, Mingxing	Nanyang Technological University
Wang, Yuanzhe	Nanyang Technological University
Deng, Baosong	Academy of Military Science

The discovery of unique or suspicious people is essential for active surveillance of security or patrol robots, and multi-robot collaboration and dynamic reasoning can further enhance their adaptability in large-scale environments. This paper proposes a hierarchical probabilistic reasoning framework for a multi-robot system to actively identify the unique person with distinct motion patterns in large-scale and dynamic environments. Linear and angular velocities are considered typical motion patterns, which are extracted by using heterogeneous sensors to detect and track people. First, single robot reasoning is performed, each robot judges the uniqueness of people by comparing their motion patterns based on local observations. Meanwhile, multi-robot reasoning is also performed, by fusing the perceptual information from each individual robot to form a global observation and then make another judgment based on it. Finally, each robot can decide which result should be adopted by comparing the beliefs of local and global judgments. Experimental results show that the method is feasible in various environments.

17:20-17:20 SuCT5.4

Human-Robot Teaming and Coordination in Day and Night Environments (I), pp. 375-380

Yue, Yufeng	Nanyang Technological University
Liu, Xiangyu	Nanyang Technological University
Wang, Yuanzhe	Nanyang Technological University
Zhang, Jun	Nanyang Technological University
Wang, Danwei	Nanyang Technological University

As robots are sharing work spaces with human, human-robot teamwork is becoming increasingly important. It is foreseeable that the daily work team will be composed of human and robots. The integration of the appropriate decision-making process is an essential part to design and develop the team. If robots can understand the activities and intents of human, it is convenient for a person to cooperate with robots in a natural manner. This paper proposes a system that enables robots to understand human pose and execute given command. The system provides two options for different hardware systems: the first one is suitable for powerful computational units; the second model is compact and efficient on a normal robot platform. In order to enrich application scenarios, we propose a method to extract human pose from thermal images so that our system can be used in all-weather scenario. In addition, we collected extensive training data and trained a MLP neural network to classify several human poses. The experimental results show the accuracy and efficiency of the proposed MLP neural network in day and night environments.

17:20-17:40 SuCT5.5

RSAN: A Retinex Based Self Adaptive Stereo Matching Network for Day and Night Scenes (I), pp. 381-386

Zhang, Haoyuan	Nanyang Technological University
Chau, Lap-Pui	Nanyang Technological University
Wang, Danwei	Nanyang Technological University

It is essential in many robot tasks to retrieve depth information, while it still remains a challenging problem to get robust depth in unfavorable conditions such as night or rainy environments. With the development of convolutional neural networks (CNNs), a large number of algorithms have emerged to tackle the problem of dark image enhancement and depth estimation, but there are few works focus on recovering depth map in dark environments and normal light condition. To meet this demand, we proposed a neural network which takes the paired stereo images in all light conditions as input and estimates the fully scaled depth map. The network contains a novel feature extractor and a stereo matching module which follows a light-weight manner to guarantee this work practical for real robotic applications. We introduced the Retinex Theory into depth estimation and trained the decomposition module with LOL dataset. Then it is adapted into depth estimation by fusing the decompose module into stereo matching algorithm. The whole network is then trained in an end-to-end manner. To demonstrate the robustness and effectiveness of our proposed method, we perform various studies and compare our results to the state-of-the-art algorithms in depth estimation as well as direct combination of image enhancement and stereo matching algorithm. We also collect stereo images in real night environ- ments and present the improved performance of our network.

17:40-18:00 SuCT5.6

HILPS: Human-In-Loop Policy Search for Mobile Robot Navigation (I), pp. 387-392

Wen, Mingxing	Nanyang Technological University
Yue, Yufeng	Nanyang Technological University
WU, ZHENYU	Nanyang Technological University
MIHANKHAH, Ehsan	Nanyang Technological University
Wang, Danwei	Nanyang Technological University

Reinforcement learning has obtained increasing attention in mobile robot mapless navigation in recent years. However, there are still some obvious challenges including the sample efficiency, safety due to dilemma of exploration and exploitation. These problems are addressed in this paper by proposing the Human-in-Loop Policy Search (HILPS) framework, where learning from demonstration, learning from human intervention and Near Optimal Policy strategies are integrated together. Firstly, the former two make sure that expert experience grant mobile robot a more informative and correct decision for accomplishing the task and also maintaining the safety of the mobile robot due to the priority of human control. Then the Near Optimal Policy (NOP) provides a way to selectively store a similar experience with respect to the preexisting human demonstration, in which case the sample efficiency can be improved by eliminating exclusively exploratory behaviors. To verify the performance of the algorithm, the mobile robot navigation experiments are extensively conducted in simulation and the real world. Results show that HILPS can improve sample efficiency and safety in comparison to state-of-art reinforcement learning.

SuCT6 Room 6

Intelligent Perception and Control for Autonomous Systems/robots 1Intelligent Perception and Control for Autonomous Systems/robots 2 (Invited Session)

Organizer: Zhang, Ya	Southeast University
Organizer: Feng, Zhi	Nanyang Technological University

16:00-16:20 SuCT6.1

Safe Geometric Speed Planning Approach for Autonomous Driving through Occluded Intersections (I), pp. 393-399

Poncelet, Renaud	Inria
Verroust-Blondet, Anne	Inria
NASHASHIBI, FAWZI	INRIA

Autonomous driving in urban environment needs to anticipate a number of dangerous events, such as the presence of moving vehicles in occluded areas. This paper presents an approach computing a safe motion along a fixed path in an urban environment with dynamic vehicles that may be occluded. The method works on the time-path space and uses a visibility graph to compute the

speed profile, considering both safety and comfort. Evaluations performed on CARLA simulator on several typical scenarios show that the approach is able to drive safely in presence of hidden obstacles.

16:20-16:40	SuCT6.2

LiDAR Observations by Motion Compensation and Scan Accumulation (I), pp. 400-405

Lima, Antoine	Université De Technologie De Compiègne
Welte, Anthony	Université De Technologie De Compiègne, Sorbonne Universités
Xu, Philippe	Université De Technologie De Compiègne
Bonnifait, Philippe	Université De Technologie De Compiègne, Sorbonne Universités

In dynamic localization problems, the observations used from exteroceptive sensors are usually obtained from a single measurement. However, there are cases where the current measurement is not sufficient to detect the referenced landmark or to get a sufficient level of accuracy. In this study, a point cloud accumulation strategy is used to improve the resolution of a LiDAR sensor along its sparse axis. In particular, we are interested in the detection of markings transverse to the road axis in order to improve the accuracy of localization of an autonomous vehicle when approaching intersections or roundabouts. We present a method that allows the construction of an accurate observation with an associated observation model based on a High-Definition (HD) map through an accumulation of scans as the vehicle moves, by compensating the vehicle motion. The parameters of the accumulator are studied in terms of detection and accuracy. The quality of the observations and their impact on the localization quality are analyzed using real experiments carried out with an experimental vehicle equipped with a low-cost GNSS receiver, dead-reckoning sensors and a ground truth system.

16:40-17:00	SuCT6.3

Multi-Sensor-Based Predictive Control for Autonomous Parking in Presence of Pedestrians (I), pp. 406-413

Pérez-Morales, David	École Centrale De Nantes, LS2N
Kermorgant, Olivier	Ecole Centrale Nantes
Dominguez, Salvador	Ecole Centrale Nantes
Martinet, Philippe	INRIA

This paper explores the feasibility of a Multi- Sensor-Based Predictive Control (MSBPC) approach in order to have constraint-based backward non-parallel (perpendicular and diagonal) parking maneuvers capable of dealing with moving pedestrians and, if necessary, performing multiple maneuvers. Our technique relies solely in sensor data expressed relative to the vehicle and therefore no localization is inherently required. Since the proposed approach does not plan any path and instead the controller maneuvers the vehicle directly, the classical path planning related issues are avoided. Real experimentation validates the effectiveness of our approach

17:20-17:20	SuCT6.4

Recognize Moving Objects Around an Autonomous Vehicle Considering a Deep-Learning Detector Model and Dynamic Bayesian Occupancy (I), pp. 414-420

Gómez Hernandez, Andrés Eduardo	Inria
Erkent, Ozgur	Inria
Laugier, Christian	INRIA

Perception systems on autonomous vehicles have the challenge of understanding the traffic scene in different situations. The fusion of redundant information obtained from different sources has been shown considerable progress under different methodologies to achieve this objective. However, new opportunities are available to obtain better fusion results with the advance of deep-learning models and computing hardware. In this paper, we aim to recognize moving objects in traffic scenes through the fusion of semantic information with occupancy-grid estimations. Our approach considers a deep-learning model with inference times between 22 to 55 milliseconds. Moreover, we use a Bayesian occupancy frame-work with a Highly-parallelized design to obtain the occupancy-grid estimations.We validate our approach using experimental results with real-world data on urban scenery.

17:20-17:40	SuCT6.5

Instance Segmentation with Unsupervised Adaptation to Different Domains for Autonomous Vehicles (I), pp. 421-427

Diaz-Zapata, Manuel Alejandro	Inria
Erkent, Ozgur	Inria
Laugier, Christian	INRIA

Detection of the objects around a vehicle is important for a safe and successful navigation of an autonomous vehicle. Instance segmentation provides a fine and accurate classification of the objects such as cars, trucks, pedestrians, etc. In this study, we propose a fast and accurate approach which can detect and segment the object instances which can be adapted to new conditions without requiring the labels from the new condition. Furthermore, the performance of the instance segmentation does not degrade in detection of the objects in the original condition after it adapts to the new condition. To our knowledge, currently there are not other methods which perform unsupervised domain adaptation for the task of instance segmentation using non-synthetic datasets. We evaluate the adaptation capability of our method on two datasets. Firstly, we test its capacity of adapting to a new domain; secondly, we test its ability to adapt to new weather conditions. The results show that it can adapt to new conditions with an improved accuracy while preserving the accuracy of the original condition.

17:40-18:00	SuCT6.6

Behavioral Decision-Making for Urban Autonomous Driving in the Presence of Pedestrians Using Deep Recurrent Q-Network (I), pp. 428-433

Deshpande, Niranjan	Inria
Vaufreydaz, Dominique	Univ. Grenoble Alpes, CNRS, Inria, Grenoble INP, LIG, 38000 Gren
Spalanzani, Anne	Inria - Grenoble Alpes University

Decision making for autonomous driving in urban environments is challenging due to the complexity of the road structure and the uncertainty in the behavior of diverse road users. Traditional decision making methods for autonomous driving consist of manually designed rules as the driving policy, which require expert domain knowledge, is difficult to generalize and might give sub-optimal results as the environment gets complex. Whereas, using reinforcement learning, optimal driving policy could be learned and improved automatically through several interactions with the environment. However, current research in the field of reinforcement learning for autonomous driving is mainly focused on highway setup with little to no emphasis on urban environments. In this work, a deep reinforcement learning based decision-making approach for high-level driving behavior is proposed for urban environments in the presence of pedestrians. For this, the use of Deep Recurrent Q-Network (DRQN) is explored, a method combining state-of-the art Deep Q-Network (DQN) with a long term short term memory (LSTM) layer helping the agent gain a memory of the environment. A 3-D state representation is designed as the input combined with a well defined reward function to train the agent for learning an appropriate behavior policy in a real-world like urban simulator. The proposed method is evaluated for dense urban scenarios and compared with a rule-based approach and results show that the proposed DRQN based driving behavior decision maker outperforms the rule-based approach.

MoKN	Room 1
Plenary 2 (Plenary Session)	

08:30-09:30 MoKN.1

*The Intermittent Joy of Intermittent Feedback**

Dixon, Warren E. — University of Florida

The research and market for the unmanned aerial systems (UAS), or drones, has greatly expanded over the last few years. It is expected that the currently small civilian unmanned aircraft market is likely to become one of the major technological and economic stories of the modern age, due to a wide variety of possible applications and added value related to this potential technology. Modern unmanned aerial systems are gaining promising success because of their versatility, flexibility, low cost, and minimized risk of operation. In this talk, we highlight some key techniques involved and research trends in developing intelligent autonomous unmanned aerial vehicles, which include task and motion planning, flight control systems, perception and data processing. Some industrial application examples will be used as illustrations.

MoAT1	Room 1
Medical Image Analysis 1 (Regular Session)	

10:00-10:20 MoAT1.1

Near-Infrared-To-Visible Vein Imaging Via Convolutional Neural Networks and Reinforcement Learning, pp. 434-441

Leli, Vito Michele — Skolkovo Institute of Science and Technology
Rubashevskii, Aleksandr — Skolkovo Institute of Science and Technology
Sarachakov, Aleksandr — Skolkovo Institute of Science and Technology
Rogov, Oleg — Skolkovo Institute of Science and Technology
Dylov, Dmitry V. — Skolkovo Institute of Science and Technology

Peripheral Difficult Venous Access (PDVA) is a commonplace problem in clinical practice which results in repetitive punctures, damaged veins, and significant discomfort to the patients. Nowadays, the poor visibility of subcutaneous vasculature in the visible part of the light spectrum is overcome by near-infrared (NIR) imaging and a returned projection of the recognized vasculature back to the arm of the patient. We introduce the first “smart” engine to govern the components of such imagers in a mixed reality setting. Namely, a closed-loop hardware system that optimizes cross-talk between the virtual mask generated from the NIR measurement and the projected augmenting image is proposed. Such real-virtual image translation is accomplished in several steps. First, the NIR vein segmentation task is solved using U-Net-based network architecture and the Frangi vesselness filter. The generated mask is then transformed and translated into the visible domain by a projector that adjusts for distortions and misalignment with the true vasculature using the paradigm of Reinforcement Learning (RL). We propose a new class of mixed reality reward functions that guarantees proper alignment of the projected image regardless of angle, translation, and scale offsets between the NIR measurement and the visible projection.

10:20-10:40 MoAT1.2

Quantifying Tissue-Stiffening Behaviour of the Cervix in Shear-Wave Elastography, pp. 442-447

Ge, Weirong — Central Clinical School, University of Sydney
Brooker, Graham — Australian Centre for Field Robotics
Hyett, Jon — Central Clinical School, University of Sydney

Shear-wave elastography is a useful tool in imaging mechanical properties of soft-tissue. It has great potential to improve the predictive accuracy of preterm birth. This imaging modality, however, has high inter- and intra- observer variability. This is due its sensitivity to changes in pressure and the natural variation in elasticity across the cervix. The aim of this study is to use the artefacts caused by the pressure-dependent increase in shear-wave speed to derive fourth order hyperelastic elasticity tensor of the tissue. The method proposed is as follows: the strain-map of the tissue is extracted by tracking the deformation of the cervix in two raw B-mode images of the ultrasound. Each B-mode image is correlated to a shear-wave map acquired at the same pressure. The relation of the shear-wave speed to the strain is used to derive the parameters of the hyperelastic material model of cervical tissue. A continuous measure of the cervical elasticity parameters is taken. The maps of the parameters are then used to predict the delivery date. In this paper, this method is demonstrated through simulation in FEBio in preparation for a large-scale clinical study at the Royal Prince Alfred Hospital. In the simulation, a tissue of Mooney Rivilin hyperelastic material is indented from 0 mm to 6 mm using a model of the ultrasound probe. The maximum factor increase in shear modulus was 2.63 times which translates to 62 % increase in measured shear-wave speed. The function of the change in shear-wave speed is unique to the parameters of the model.

10:40-11:00 MoAT1.3

Unsupervised Positron Emission Tomography Tumor Segmentation Via GAN Based Adversarial Auto-Encoder, pp. 448-453

wu, xinheng — The University of Sydney
Bi, Lei — The University of Sydney
Fulham, Michael — Royal Prince Alfred Hospital
Kim, Jinman — The University of Sydney

Fluorodeoxyglucose Positron emission tomography (FDG PET) is the imaging modality of choice for the diagnosis of lung cancer. The automated segmentation of tumors in PET images is a fundamental requirement for image analysis in computer-aided diagnosis systems. Current tumor segmentation in PET generally relies on local features to discriminate tumor from the background. These methods are limited due to poor resolution, and subtle inter-class differences when there is normal FDG uptake region (i.e., in the heart and mediastinum) in the same field of view. We propose a new image-based discriminative method to separate tumor regions from normal regions. We introduce a convolutional adversarial auto-encoder to learn a latent space which models normal (disease-free) variations of PET images, and then to compute a residual map that identifies where the PET image differs from this manifold due to anomalies, i.e., tumors. Our method is tolerant to normal intra-class variations among the PET images but is discriminative of the tumors with high sensitivity. Our experiments with a clinical lung cancer dataset show that our method outperformed the state-of-the-art unsupervised segmentation methods. We also achieved a higher dice score (62.0%) and sensitivity (77.9%) than the supervised U-Net method (59.5% and 59.7%).

11:00-11:20 MoAT1.4

Robust Texture Features for Breast Density Classification in Mammograms, pp. 454-459

Li, Haipeng — University of Canterbury
Mukundan, Ramakrishnan — University of Canterbury
Boyd, Shelley — St. George's Medical Center

This paper proposes an effective and robust texture feature descriptor to classify mammographic images into different breast density categories. Accurate breast density based categorization of images plays an important role in the risk assessment at early stages of breast cancer. Based on the commonly used local binary patterns (LBP), we investigate its variant method local quinary patterns (LQP) for considering more details of texture features. The rotation invariant approach with different concerned numbers of spatial transitions is used to extend LQP to rotation invariant LQP (RILQP). The proposed method recognizes more texture patterns and reduces the high dimensionality of its feature vector significantly, which make it a robust texture descriptor. In addition, in the breast density classification task, this paper also investigates the influence to classifying results by using resized mammogram images. Two mammogram datasets, INBreast and MIAS, are used in our experiments to test the proposed method. Comparing to state-of-the-art methods, competitive classifying results are observed using the RILQP method, with classification accuracies of

82.50% and 80.30% on INBreast and MIAS respectively. Comparative analysis also indicates that the proposed method outperforms other methods statistically.

11:20-11:40 MoAT1.5

Deep Learning and Late Fusion Technique in Medical X-Ray Image Classification, pp. 460-465

Alebiosu, David — Monash University, Malaysia
Dharmaratne, Anuja — Monash University Malaysia
Muhammad, Fermi Pasha — Monash University

Classification of images is essential in medical database because of the different image modalities such as X-ray images, Computed Tomography (CT) images, Magnetic Resonance imaging (MRI) etc. In addition to the varieties of image modalities present in different databases, they are of different body parts and need to be properly classified to enhance effective retrieval for purposes such as medical diagnosis, teaching and research. Most of the hand-crafted techniques have various limitations which reduce their potentials to accurately classify medical X-ray images. For more than a decade, various researchers have employed the use of different handcrafted techniques for medical image classification. However, the major problem associated with the techniques is their inability to extract discriminative features that are relevant enough to accurately classify medical images such as radiographic images. This study focuses on employing deep learning and fusion technique to classify medical X-ray images. The proposed technique uses a single pre-trained neural network and a late fusion technique for the classification of ImageCLEF 2007 and 2015 dataset. The employment of a single pre-trained neural network, both as a feature extractor and as a fine-tuned network, makes the technique unique especially when considering the nature of the dataset used. The combination of the posterior probabilities generated from SVM and Softmax classifiers using a single deep pre-trained neural network produces an overall classification accuracy of 95.54% in classifying the dataset into 116 categories on ImageCLEF 2007. This is the highest when compared to the use of AlexNet + SVM and fine-tuned AlexNet alone which produced 84.35% and 86.47% classification accuracies respectively. On ImageCLEF 2015, it produces an overall classification accuracy percentage of 87.72%.

11:40-12:00 MoAT1.6

A Bifocal Classification and Fusion Network for Multimodal Image Analysis in Histopathology, pp. 466-471

Bao, Guoqing — The University of Sydney
Graeber, Manuel — The University of Sydney
Wang, Xiuying — The University of Sydney

Recognition of key morphological features in histological slides is crucial for pathological diagnosis and monitoring therapeutic progress. However, the typical routine microscopic workflow is conducted by hand which is time consuming and has unavoidable intra- and inter-observer variability like all human work. Therefore, we propose a bifocal classification and fusion network for the automated recognition and cross-modality analysis of diagnostic features in whole-slide multimodal images (WSIs). In brief, paired image tiles cropped from digitized tissue sections were fed into a modified dual-path CNN which accepts asymmetric inputs for classification, and then the inference results were converted to feature distribution heatmaps, which permit qualitative as well as quantitative morphological analyses of entire histological sections, even in combination with adjacent sections that have been stained differently. The multimodal heatmaps were aligned using image registration and fused for cross-modality analysis. Our experiments showed that the network achieved high recognition performance (AUCs of 0.985 and 0.988, and accuracies of 94.7% and 96.1% on two WSI modalities, respectively, against expert markings) and outperformed state-of-the-art methods without training on a large cohort or utilizing domain transfer. In addition, the new method involves a self-contained inference and fusion process and thus harbors significant potential for speeding up microscopic analysis workflows.

MoAT2	Room 2
Networked Control Systems 1 (Regular Session)	

10:00-10:20 MoAT2.1

Adaptive Control for a Class of Uncertain Nonlinear Systems Subject to Saturated Input Quantization, pp. 472-477

Xing, Lantao — Nanyang Technological University
Wen, Changyun — Nanyang Tech. Univ
Liu, Zhitao — Zhejiang University
Cai, Jianping — Zhangzhou Normal University
Zhang, Meng — Xi'an Jiaotong University

In this paper, we study the adaptive tracking control problem for a class of uncertain nonlinear systems with input quantization. Different from the existing results, we propose a new quantizer with saturated quantization levels motivated by the saturation property of practical actuators and sensors. With this new quantizer, we know the exact number and values of the quantization levels in advance, regardless of the magnitude of the designed control signal. Thus, we only need to code these quantization levels accordingly such that less network resources are consumed. It is shown that the proposed control scheme guarantees that all the closed-loop signals are globally bounded and the tracking error converges towards a known compact set.

10:20-10:40 MoAT2.2

On Reductions among Observation Properties of Discrete Event Systems, pp. 478-482

Gong, Chaohui — University of Shanghai for Science and Technology
Zhang, Hanran — University of Shanghai for Science and Technology
Guo, Zhong — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Yan, Zihai — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Wang, Weilin — PowerChina Huadong Engineering Corporation Limited

We present a framework for reduction between different observation properties of discrete event systems modeled by automata under language-based dynamic observations. This framework encapsulates the reduction from coobservability to codiagnosability and from k-codiagnosability to coobservability. Under this framework, we show a reduction from observability to diagnosability, but a general reduction in the opposite direction does not exist.

10:40-11:00 MoAT2.3

Event-Triggered Remote Dynamic Control for Network Control Systems, pp. 483-488

Li, Haoyun — Anhui University
FAN, Yuan — Anhui University
Pan Gaofeng, Pan Gaofeng — Anhui University
Song, Cheng — Nanjing University of Science and Technology

This work studies the event-triggered control problem for networked control systems. The plant is controlled directly by a dynamic local controller, which receives the reference control signal from the remote controller. The measurement signal of the plant and the reference control signal of the remote controller has their separate event trigger, and thus the remote controller and the local controller can decide when to transmit signals on their own. It is proved that with the proposed control approach and the dual event trigger, the closed loop system is globally asymptotically stable, which has been illustrated by simulation results.

11:00-11:20 MoAT2.4

On Stability of Multi-Agent Systems on Time Scales under Denial-Of-Service Attacks, pp. 489-496

Girejko, Ewa — Bialystok University of Technology
Malinowska, Agnieszka B. — University of Aveiro

In the paper, multi-agent system under Denial-of-Service (DoS) attacks is considered. It is assumed that the dynamics of each agent is defined on an arbitrary time scale and during attacks the adversaries can attack part or all channels at any time. Sufficient conditions for the global exponential stability of system under DoS attacks are derived. The effectiveness of the theoretical results is illustrated by numerical examples. Moreover, we propose practical solutions of the deployment of links in a network of cooperative devices (servers, computers, robots and etc.), according to adjacency matrices of quasi-Abelian Cayley graphs, so that the entire system still works in spite of DoS attacks

11:20-11:40	MoAT2.5

Multi-Objective Optimization of Two Control Strategies for Congestion Avoiding in Computer Network, pp. 497-504

Grzyb, Slawomir	Atos Global Delivery Center Poland
Orlowski, Przemyslaw	West Pomeranian University of Technology in Szczecin

Network congestion is a phenomenon strongly impacting the real level of efficiency expected from the modern network environment. It has direct impact on reliability increase and high, stable throughput. It's also one of the main reasons of the end to end delay increase. These characteristics define the quality of communication channels. Optimizing network nodes configuration for only one of the given features can exacerbate the other parameters. This paper focuses on avoiding and alleviating network congestions using multi-objective optimization. This optimization process is used to adjust the controller gain and optimal reference signal. Unlike in other presented approaches, in this case, a dynamical, discrete, non-stationary model of communication channel is applied. It reflects delay conditions in a real environment, which are varying in time. The advantage of such approach rises from the comparison with analogue stationary models, what is also discussed in this research. Two different control strategies have been chosen to be subjected to the optimization process. The first one uses the constant, optimized reference value. The second one is using an adaptive reference value. The proposed strategy of congestion control is adjusting parameters of the presented models to alleviate undesirable results of sudden, network condition changes. It is obtained by maximization of available bandwidth usage combined with the minimization of buffer utilization. This approach supports avoiding harmful congestion effects like retransmission, packet dropping and high network delay, which eventually cause network throughput degradation.

11:40-12:00	MoAT2.6

Multi-Sensor H-Infinity Filter Design for Networked Control Systems with Unknown Communication Delays, pp. 505-510

Nartey, George	Zhengzhou University
Zhang, Duanjin	Zhengzhou University

In this paper,the problem of multi-sensor H-infinity filter for networked control systems with unknown communication delays is investigated. A filter for the unknown communication delays system is developed to guarantee the exponentially mean-square stability of the closed-loop system provided its equivalent robust filter is designed. The measured output is prone to sensor saturation which has sector-nonlinearities capability to measure the physical plant. The unknown communication delays are considered in the sensor to the controller link. Given the limitations in communication delays, a filtering scheme is designed via linear matrix inequalities (LMIs) and Lyapunov stability theory. A simulation result is provided to prove the effectiveness of the proposed method.

MoAT3	Room 3
Robot Sensing (Regular Session)	

10:00-10:20	MoAT3.1

Development of a Millinewton FBG-Based Distal Force Sensor for Intravascular Interventions, pp. 511-515

Akinyemi, Toluwanimi	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Omisore, Olatunji	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Wenke, Duan	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Gan, LU	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Du, Wenjin	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Alhanderish, Yousef	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Lei, Wang	Shenzhen Institutes of Advanced Technology, Chinese Academy of S

Application of intravascular catheterization, a vital task used in minimally invasive vascular surgery, has been hindered by lack of distal force sensor with miniaturized size and millinewton sensing capability. Thus, development of distal sensor for evaluating tool-vessel force interactions during robot-assisted intravascular interventions remains a research area in minimally invasive surgery. In this study, a millinewton force sensor is developed by integrating optical fibers with bragg grating in an isotonic 3D-printed flexure. The miniaturized sensor is calibrated in an experiment for 1D distal force sensing application in PCI procedures, and performance of the sensor is evaluated against that of direct FBG-pasting method. Results from the study shows that the designed sensor shows a higher repeatability and stability with a millinewton resolution in the flexure compartment. Thus, it can be suitably used for distal catheter-tip force sensing during intravascular catheterization.

10:20-10:40	MoAT3.2

Visual-IMU State Estimation with GPS and OpenStreetMap for Vehicles on a Smartphone, pp. 516-521

He, Guohan	Shanghai Jiaotong University
Cao, Qi xin	Shanghai Jiao Tong University
Zhu, Xiao xiao	Shanghai Jiao Tong University
Miao, Haoyuan	Shanghai Jiaotong University

In this paper, we propose an approach for global vehicle localization and ego-motion estimation using low-cost portable sensors. It combines Visual Inertial Odometry with GPS and street map information obtained from OpenStreetMap. For conventional vehicle driving scenarios, we present a lightweight and targeted multi-sensor fusion method based on graph optimization, and implement the entire system on a smartphone. Extensive experiments on the benchmark dataset and real-world data show that the system could achieve robust, accurate and real-time tracking and localization in complex and dynamic scenarios.

10:40-11:00	MoAT3.3

An Information Driven Approach for Ego-Lane Detection Using Lidar and OpenStreetMap, pp. 522-528

KASMI, ABDERRAHIM	Sherpa Engineering/ Institut Pascal - Clermont Auvergne Universi
Laconte, Johann	Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pas
AUFRERE, Romuald	Institut Pascal - Clermont Auvergne University
THEODOSE, Ruddy	Sherpa Engineering
DENIS, Dieumet	SHERPA ENGINEERING
Chapuis, Roland	Institut Pascal

Localizing the vehicle in its lane is a critical task for any autonomous vehicle. By and large, this task is carried out primarily through the identification of ego-lane markings. In recent years, ego-lane marking detection systems have been the subject of various research topics, using several inputs data such as camera or lidar sensors. Lately, the current trend is to use high accurate maps (HD maps) that provide accurate information about the road environment. However, these maps suffer from their availability and their price tag. An alternative is the use of affordable low-accurate maps. Yet, there is relatively little work on it. In this paper, we propose an information-driven approach that takes into account inaccurate prior geometry of the road from OpenStreetMap (OSM) to perform ego-lane marking detection using solely a lidar. The two major novelties presented in this paper are the use of the OSM datasets as prior for the road geometry, which reduces the research area in the lidar space, and the information-driven approach, which guarantees that the outcome of the detection is coherent to the road geometry. The robustness of the proposed method is proven on real datasets and statistical metrics are used to highlight our method's efficiency

11:00-11:20	MoAT3.4

6D Object Pose Estimation with Color/Geometry Attention Fusion, pp. 529-535

Yuan, Honglin	Utrecht University
Veltkamp, Remco C.	Utrecht University

The 6D object pose is widely applied in robot grasp, virtual reality and visual navigation. However, heavy occlusion, changing light conditions and cluttered scenes make this problem challenging. To address these issues, we propose a novel approach that effectively extracts color and depth features from RGB-D images considering the local and global geometric relationships. After that, we apply a graph attention mechanism to fully exploit representations between these features and then fuse them together to predict the 6D pose of a given object. The evaluation results indicate that our method significantly improves the accuracy of the 6D pose and achieves the state-of-the-art performance on pose on LineMOD, YCB-Video, and a new dataset. Ablation studies demonstrate the effect on performance and robustness of our network modules.

11:20-11:40	MoAT3.5

3D Point-To-Keypoint Voting Network for 6D Pose Estimation, pp. 536-541

Hua, Weitong	Zhejiang University
Guo, Jiaxin	Zhejiang University
WANG, yue	Zhejiang University
Xiong, Rong	Zhejiang University

Object 6D pose estimation is an important research topic in the field of computer vision due to its wide application requirements and the challenges brought by complexity and changes in the real-world. We think fully exploring the characteristics of spatial relationship between points will help to improve the pose estimation performance, especially in the scenes of background clutter and partial occlusion. But this information was usually ignored in previous work using RGB image or RGB-D data. In this paper, we propose a framework for 6D pose estimation from RGB-D data based on spatial structure characteristics of 3D keypoints. We adopt point-wise dense feature embedding to vote for 3D keypoints, which makes full use of the structure information of the rigid body. After the direction vectors pointing to the keypoints are predicted by CNN, we use RANSAC voting to calculate the coordinate of the 3D keypoints, then the pose transformation can be easily obtained by the least square method. In addition, a spatial dimension sampling strategy for points is employed, which makes the method achieve excellent performance on small training sets. The proposed method is verified on two benchmark datasets, LINEMOD and OCCLUSION LINEMOD. The experimental results show that our method outperforms the state-of-the-art approaches, achieves ADD(-S) accuracy of 98.7% on LINEMOD dataset and 52.6% on OCCLUSION LINEMOD dataset in real-time.

11:40-12:00	MoAT3.6

Fish Keypoints Detection for Ecology Monitoring Based on Underwater Visual Intelligence, pp. 542-547

Suo, Feiyang	Zhejiang University City College; Zhejiang University
huang, kangwei	Zhejiang University City Collage
Gui, Ling	Zhejiang University City College; Zhejiang University
Li, Yanjun	Zhejiang University City College
xiang, ji	Zhejiang University, Yuquan Campus

This paper introduces a fishery ecology monitoring system for cultivation pools, and proposes a new stereo keypoint detection method followed by curve fitting analysis to estimate the fish posture and length. The system, which can be employed for aquaculture monitoring, is featured by its exploitation of underwater visual intelligence and deep neural-network architecture. As input, stereo image pairs are obtained by underwater binocular camera. A deep neural-network under Faster R-CNN architecture is built to detect fish from the stereo image inputs. Another network under Stacked Hourglass architecture is constructed to detect specific keypoints of each fish. For ecology monitoring, detected keypoints are used in the estimation of the fishes' posture and length. Unlike other size estimation methods which also apply a binocular camera, our method naturally bypasses the pixel-wise matching difficulty in global stereo matching algorithms. Experiment shows that our system is applicable for online fish ecology monitoring, with efficient and accurate estimation performance.

MoAT4	Room 4
Nonlinear Systems (Regular Session)	

10:00-10:20	MoAT4.1

Symbolic Self-Triggered Control of Continuous-Time Non-Deterministic Systems without Stability Assumptions for 2-LTL Specifications, pp. 548-554

Pruekprasert, Sasinee	National Institute of Informatics
Eberhart, Clovis	National Institute of Informatics
Dubut, Jeremy	National Institute of Informatics

We propose a symbolic self-triggered controller synthesis procedure for non-deterministic continuous-time nonlinear systems without stability assumptions. The goal is to compute a controller that satisfies two objectives. The first objective is represented as a specification in a fragment of LTL, which we call 2-LTL. The second one is an energy objective, in the sense that control inputs are issued only when necessary, which saves energy. To this end, we first quantise the state and input spaces, and then translate the controller synthesis problem to the computation of a winning strategy in a mean-payoff parity game. We illustrate the feasibility of our method on the example of a navigating nonholonomic robot.

10:20-10:40	MoAT4.2

A Parameter Tuning Method for Fractional Order PD Controllers, pp. 555-560

OZYETKIN, MUNEVVER MINE	Aydin Adnan Menderes University
Bekiroglu, Korkut	SUNY Polytechnic Institute
Srinivasan, Seshadhri	Berekeley Education Alliance for Research in Singapore

A simple parameter tuning-method for fractional order PD (FO-PD) controllers is investigated in this article. The proposed tuning method is based on the convex-stability-region, defined by peak and the stability boundary locus's corner points. The centroid of convex-stability-region is calculated in the kp-kd plane. After obtaining the stability region of the system, the centroid of the stability region can be determined to develop the proposed method. Comparing with the literature, the proposed method does not require complex graphical or numerical methods. Thus, it is computationally efficient and not time-consuming. Besides, this simple tuning method ensures the stability of the closed-loop system. The effectiveness and robustness of the proposed method is illustrated with some comparative examples. The results given in the final section demonstrate satisfactory results compare to other tuning methods

10:40-11:00	MoAT4.3

Decoupled Load Swing Control of an Overhead Crane Using Arduino Controller, pp. 561-566

Garcia, F. Javier	Universidad De Valladolid ESQ4718001C
Gonzalez, Luis R.	Universidad De Valladolid
Poncela, Alfonso V.	Universidad De Valladolid
Moya, Eduardo	ITAP - Universidad De Valladolid

The paper presents a practical anti-sway crane controller based on classical PID and fuzzy logic as well. The proposed control consists of a position servo control and a load swing control, studying the interaction effects between both controllers. The proposed controllers provides practical gain tuning criteria for easy application. The effectiveness of the proposed control is shown by experiments with a two-dimensional prototype overhead crane, that it is used to serve the learning and practicing needs of the learners.

11:00-11:20 MoAT4.4

Practical Stability of Positive Switched Nonlinear Time-Varying Systems, pp. 567-571

Li, Ruonan — Shandong Normal University
Zhao, Ping — Shandong Normal University

In this paper, practical stability is concerned for positive switched nonlinear time-varying (PSNTV) systems and positive switched linear time-varying (PSLTV) systems with disturbances. Based on a new definition on practical stability which can fully reflect the positivity of every component of the solution, sufficient conditions on practical stability of PSNTV systems are given by using the multiple max-separable Lyapunov function method. As an application of our criterion, sufficient criteria on practical stability are also provided for PSLTV systems with disturbances. Through our criterion, the systems' practical stability can be judged directly from the algebraic characteristics of the systems. At the end, examples are presented to illustrate the effectiveness of our results.

11:20-11:40 MoAT4.5

Modeling and Hovering Control of 5-DoF Tilt-Birotor Robot, pp. 572-577

Hu, Anyuan — School of Automation, Nanjing University of Science and Technolog
Zhao, Xizhen — Nanjing University of Science and Technology
Xu, Dabo — Nanjing University of Science and Technology

This paper explores design, modeling and hovering control of a new under-actuated 5-DoF (degree of freedom) tilt-birotor robot. Specifically, the robot has an assembled inverted pendulum to be an extra actuating input in addition to a pair of tilt wings. Hence, it has a 5-DoF actuator control input vector: two motor thrusts, two tilt angles, and one tunable pendulum angle. We show the model analysis in terms of the Newton-Euler formulation and establish a key equation between the model control inputs and the actuator inputs. Based on that, we are able to achieve the hovering control task using an inner-outer-loop design. We also illustrate the results by numerical and experimental tests.

11:40-12:00 MoAT4.6

Robustness of Neural-Network-Based Nonlinear Iterative Learning Control, pp. 578-583

Patan, Krzysztof — University of Zielona Gora
Patan, Maciej — University of Zielona Gora

The purpose of this work is to develop a robust iterative learning control for nonlinear systems based on neural networks. In order to introduce the robustness to the control scheme the problem of accurate estimation of uncertainties associated with the black-box type model is concerned. An uncertainty of the system is derived in terms of the variance of the model output prediction using a concept of Fisher information matrix well-known in the optimum experimental design theory. Once the bounds of the system response are estimated, they can be directly applied during training of the learning controller by a rigorous definition of the penalty cost function. Then, a neural controller is suitably adopted to the effective design of iterative learning control for nonlinear systems. The proposed approach is experimentally verified on the example of a magnetic levitation system.

MoAT5 Room 5

Distributed Sensing, Learning and Coordination of Multi-Agent Systems (Invited Session)

Organizer: Li, Xianwei — Shanghai Jiao Tong University
Organizer: Tang, Yang — East China University of Science and Technology

10:00-10:20 MoAT5.1

Control Barrier Function Based Nonlinear Controller for Automatic Carrier Landing (I), pp. 584-589

Zhou, Haitong — The Seventh Research Division, School of Automation Science And
Zheng, Zewei — Beihang University
Guan, Zhiyuan — Beihang University
Ma, Yunpeng — Beihang University

This paper proposes a novel control barrier function(CBF) based output constraints path following control method, which is applied to automatic carrier landing system. The 6 degrees-of-freedom of aircraft model is converted to an affine model. Based on the transformed affine model, backstepping is used as the main control frame. In order to meet the demand of output constraints, a novel controller based on CBF is designed to constrian path following error. Due to automatic carrier landing system's relative-degree is 4,the exponential control barrier function(ECBF) which constrian path following error is adopted. The stability of the designed controller is verified by Lyapunov analysis. Simulation results show that the error requirement for path following in the final approach can be achieved, so the controller we designed has good path following performance.

10:20-10:40 MoAT5.2

Consensus of Second-Order Matrix-Weighted Multi-Agent Networks (I), pp. 590-595

Wang, Chongzhi — Shanghai Jiao Tong University
Pan, Lulu — Shanghai Jiao Tong University
Li, Dewei — Shanghai Jiao Tong University
Shao, Haibin — Shanghai Jiao Tong University
Xi, Yugeng — Shanghai Jiao Tong University

This paper investigates consensus problem of second-order multi-agent system on matrix-weighted networks. It is shown that when the null space of the Gauge transformed graph Laplacian is spanned by the Kronecker product of an all-one vector and a set of orthogonal vectors, the algebraic multiplicity of eigenvalue zero cannot exceed the nullity of the graph Laplacian, thus admitting a proper blocking of the system matrix's Jordan normal form. Second-order bipartite consensus is thereby achieved independent of the structural balance of the network. Simulation examples are provided to demonstrate the theoretical results.

10:40-11:00 MoAT5.3

Enhancing Adaptive Event-Triggered Protocols for Multi-Agent Consensus with External Disturbances (I), pp. 596-601

Li, Xianwei — Shanghai Jiao Tong University
Tang, Yang — East China University of Science and Technology
Zhu, Bing — Beihang University
Li, Shaoyuan — Shanghai Jiao Tong University

This paper studies the design of adaptive event-triggered protocols for consensus of linear multi-agent systems (MASs) with external disturbances. Different from most of the existing results that deal with undirected graphs, this paper addresses directed graphs, specifically graphs that are assumed to be strongly connected. Inspired by a recent development [22], this paper devises novel adaptive event-triggered protocols for linear MASs with all agents subject to external disturbances. Two specific designs of composite triggering conditions are analysed and discussed. Compared with the disturbance-free case, additional constraints need to be introduced to deal with external disturbances and moreover the time-dependent terms are allowed to take any finite functions, rather than a class of L1 functions.

11:00-11:20 MoAT5.4

Enclose a Target with Multiple Nonholonomic Agents (I), pp. 602-607

Zhu, Lin	Shanghai University
Wei, Jieqiang	KTH Royal Institute of Technology
Ren, Xiaoqiang	KTH
Wang, Xiaofan	Shanghai Jiao Tong University

In this paper, an algorithm on circular circumnavigation of nonholonomic agents is proposed. The agents are required to enclose a static target with predefined radius and circumferential speed. The algorithm completely relies on local bearing angle measurement. Cyclic pursuit is adapted to coordinate the agents and generate an even formation at the circle. Theoretical analysis on the stability of algorithm is given. The applicability and effectiveness of the algorithm is testified with simulations on the unmanned surface vessel (USV) platform.

11:20-11:40 MoAT5.5

Containment Control of Second-Order Multi-Agent Systems Via Asynchronous Sampled-Data Control (I), pp. 608-613

Chen, Hongjian	University of Electronic Science and Technology of China
Chen, Lulu	University of Electronic Science and Technology of China
Shao, Jinliang	University of Electronic Science and Technology of China

This paper formulates and solves an asynchronous sampled-data containment control problem of second-order multi-agent systems, in which each agent only receives the neighbors' information at certain sampling instants determined by its own clock, not all sampling instants. It is not assumed that the time sequence in which each agent receives its neighbors' information is evenly spaced. A distributed containment control protocol in the asynchronous sampled-data setting is designed. Main research tools, including non-negative matrix theory and the composite of binary relation, are used to derive a necessary and sufficient condition guaranteeing that all the followers asymptotically converge to a convex hull formed by the static leaders. An example is provided to demonstrate the effectiveness of our theoretical result.

MoAT6 Room 6

Modelling, Fault Diagnosis and Control of Complex System (Invited Session)

Organizer: Huang, Jun	Soochow University
Organizer: Shi, Yuanhao	North University of China
Organizer: Xu, Zhezhuang	School of Electrical Engineering and Automation, Fuzhou University
Organizer: Zhu, Shanying	Shanghai Jiao Tong University

10:00-10:20 MoAT6.1

Robust Model Predictive Control for Markovian Jump Systems with All Unstable Modes (I), pp. 614-619

Zhang, Bin	University of Shanghai for Science and Technology
Song, Yan	University of Shanghai for Science and Technology

In this paper, robust model predictive control (RMPC) problem is investigated for a class of Markovian jump systems with unstable modes under polytopic uncertainties and hard constraints. The transition probability matrix and a mode-dependent control strategy in the framework of RMPC are co-designed. Moreover, in order to design a switching rule for the mean-square stability of the jump system, an off-line design scheme is first proposed to facilitate the on-line mode-dependent model predictive controller design. For the ``on-line'' part, a set of mode-dependent state feedback controllers is designed to minimize a certain upper bound of the worst-case infinite horizon cost function in terms of solutions to a series of inequalities constraints. Finally, a simulation example regarding the economic system is implemented to verify the effectiveness of the proposed design scheme.

10:20-10:40 MoAT6.2

Research on Gray Prediction of Heated Surface Combining Empirical Mode Decomposition and Long Short-Term Memory Network (I), pp. 620-624

Li, Mengwei	North University of China
Shi, Yuanhao	North University of China
Cui, Fangshu	North University of China
Wen, Jie	North University of China
Zeng, Jianchao	Taiyuan University of Science and Technology

Aiming at ash and slag of boiler heated surface will reduce the heat transfer efficiency and security. This paper adopts clearness factor as the indicator to monitor healthy condition of the boiler heated surface, and put forward a model combining empirical mode decomposition (EMD) and long short-term memory (LSTM) model to predict boiler ash accumulation in the future. EMD can decompose the time series into a series of frequency-stable intrinsic mode functions. In addition, the special gate structure inside LSTM makes it possible to mine the long-term dependencies in the time series. The combination of the two increases the prediction accuracy of the time series. It is verified by simulation software that the model has a satisfactory accuracy in predicting healthy condition of the boiler heated surface, and the feasibility and effectiveness of the model are verified.

10:40-11:00 MoAT6.3

Dynamic Event-Triggered Control for Discrete-Time Markov Jump Systems (I), pp. 625-630

Zhang, Yueyuan	Soochow University
Chen, Yiyang	Soochow University

This paper concentrates on the dynamic event trigger based controller design for discrete-time Markov jump systems. The rich data transmission within the network channel may cause the collision and the waste of resources, which leads to some kinds of poor system performance. Firstly, a discrete time domain dynamic event trigger mechanism is proposed for controller design. Secondly, for discrete time Markov jump systems, a mode-dependent Lyapunov function is designed to ensure the system state to be exponentially mean-square ultimately bounded by linear matrix inequalities (LMIs). Finally, a numerical simulation example is conducted to illustrate the effectiveness of the provided method.

11:00-11:20 MoAT6.4

Application of Non-Local Mean Algorithm in Non-Contact Interactive Control System (I), pp. 631-635

Cao, Ziqi	Soochow University
Lu, Fan	Soochow University
Yu, Lei	Soochow University

In view of the problems of poor image quality and inaccurate positioning due to interference in interactive control systems, this paper proposes a non-local mean algorithm (NLM) based on adaptive median algorithm (ALM) based on the strategy of salt and pepper noise processing), and applied to non-contact interactive systems based on laser sensors. The main innovations of this paper: 1) In the image preprocessing algorithm, a noise reduction method that is effective for Gaussian noise, salt and pepper noise, and mixed noise of both of them is proposed; 2) The improved denoising algorithm is applied to lidar-based sensor's non-contact interactive system, which significantly improves the interactive performance. Experimental results show that the proposed algorithm has obvious denoising effect, accurate image positioning and good target tracking effect.

11:20-11:40 MoAT6.5

Further Research on Optimal Interval Observer Design for Switched Systems (I), pp. 636-641

Zhang, Haoran	Soochow University
Huang, Jun	Soochow University
Che, Haochi	Soochow University
Zhang, Yueyuan	Soochow University

This paper is devoted to the interval estimate method for discrete-time linear time-invariant switched systems. When the real-time state of the system is estimated, it is necessary to eliminate the influence of external interference on the estimation results and consider the problem of switching modes. For these reasons, the H∞ observer design is combined with reachability analysis. First, we need to design a H∞ observer so as to reduce the impact of external disturbances and find sufficient conditions to prove the existence of the H∞ observer. Then, the method based on reachability analysis is used to obtain the bounds of the system state. Finally, one example is simulated to prove the effectiveness of the designed interval observer.

11:40-12:00	MoAT6.6

Fault Detection for Nonstationary Process with Decomposition and Analytics of Gaussian and Non-Gaussian Subspaces, pp. 642-647

Zhao, Yi — Zhejiang University
Zhao, Chunhui — Zhejiang University
Sun, Youxian — Zhejiang University

Process monitoring is a challenging task for modern industrial processes which are commonly nonstationary in nature, revealing typical non-Gaussian characteristics. Nowadays, data-driven based fault detection methods have drawn increasing attention, most of which work under an assumption that the process is subject to Gaussian distribution. But in practice, the underlying non-Gaussian characteristics may be typical in the complex process, which cannot be properly enclosed by a statistical model with a close confidence region and thus may be insensitive to fault detection. Hence, it is necessary to explore and separate the underlying Gaussian and non-Gaussian distributions in fine-grain. In this work, a Gaussian and non-Gaussian subspace decomposition method is proposed by designing a variant of stationary subspace analysis (VSSA) for nonstationary process monitoring. First, the whole time-wise nonstationary process can be neatly converted to condition-wise slices. Then, a Monte Carlo sampling based VSSA technique is designed to separate Gaussian and non-Gaussian subspaces from each other, which focuses on analyzing sample distribution rather than time series properties. Here the Gaussian subspace, which is readily characterized by a statistical model, is used for revealing similar condition slices and affiliate them into the same condition mode. And two monitoring statistics are developed to explore the Gaussian and non-Gaussian distribution structures, thus providing fine-grained distribution analytics and promoting monitoring performance. The feasibility and performance of the proposed method are demonstrated on a real thermal power plant process.

MoBT1	Room 1
Medical Image Analysis 2 (Regular Session)	

13:00-13:20	MoBT1.1

Extracting Fetal Heart Rate from Abdominal ECGs Based on Fast Multivariate Empirical Mode Decomposition, pp. 648-653

Zhang, Jiayue — Zhejiang University
Xu, Xiaozhou — Zhejiang University
Chen, Qiming — Zhejiang University
Xie, Lei — Zhejiang University
Su, Hongye — Zhejiang University

Abdominal electrocardiogram is an important means to obtain fetal health condition during high-risk pregnancy. In this paper, a novel method for extracting fetal heart rate from multi-channel mother abdomen electrocardiograms is proposed using fast multivariate empirical mode decomposition technique (FMEMD). Firstly, FMEMD decomposes the multichannel ECG signals into a set of modes. Two significant channels are selected according to the standard deviation of the fifth layer. Then the continuous wavelet transform technique (CWT) is applied to these two channels to denoise. The baseline is removed by zero-crossing rate. Following, the interference of the mother QRS complexes and non-overlapped fetal R-peaks can be eliminated and detected by CWT coefficient. The overlapped fetal R-peaks are obtained by combining the dynamic pattern matching program and heuristic algorithm. The proposed method achieves an accuracy of 99.9% on the existing data set, and the calculating time is only 1/6.39 of the MEMD-based method.

13:20-13:40	MoBT1.2

An Improved Micro-Calcification Detection Algorithm Using a Novel Multifractal Texture Descriptor and CNN, pp. 654-659

Li, Haipeng — University of Canterbury
Mukundan, Ramakrishnan — University of Canterbury
Boyd, Shelley — St. George's Medical Center

Detecting individual micro-calcifications (MCs) from mammograms is a challenging problem due to heterogeneous properties and diverse composition of breast tissues. False positives (FPs) are therefore a common occurrence in the outputs of different detectors. This paper focuses on FP reduction and improvement of the final MCs detection accuracy in mammograms. Following a designed MC detector which outputs a patch set containing suspicious MC spots, we use alpha images based on multifractal analysis to enhance texture features of MC spots in each target patch. For further highlighting the texture features, a Weber's law based approach is used to extend the considered multifractal measure and generate new alpha patches. In order to distinguish MC spots from the suspicious candidate set, a convolutional neural network (CNN) classifier is designed to process original mammogram patches and corresponding alpha patches together for classifying suspicious MC spots to true positive group or false positive group. Multifractal features contained in alpha images are fed into the proposed CNN model, which facilitate learning richer representations for MCs in local regions and presenting better classification performance. A digital mammogram dataset, INbreast, is used to test the proposed method. Experimental results are evaluated using free-response receiver operating characteristic (FROC) and area under the FROC curve (AUC). In our experiments, a desirable classification performance is observed after using the new alpha patch set in the designed CNN classifier, and the general MC detection results based on individual mammograms in a test set demonstrate that the proposed method reduces FP numbers and improves the MC detection accuracy effectively.

13:40-14:00	MoBT1.3

Multi-Atlas Based Hip Bone Segmentation from Routine Clinical Hip MRIs of Osteoarthritis Patients, pp. 660-665

Harischandra, Najini — Monash University
Dharmaratne, Anuja — Monash University Malaysia
Cicuttini, Flavia — Monash University
Wang, Yuanyuan — Monash University

Magnetic Resonance Imaging (MRI) scans of the hip joint are used to diagnose hip osteoarthritis (OA) in routine clinical procedures. MRIs provide better visualization of biochemical degeneration patterns of bones and cartilage with the progression of the disease. In advanced stages, quantitative assessments of the hip bones are done utilizing computer-assisted techniques such as 3D models of the bones to plan surgical treatments. Bone segmentation is a vital step in constructing accurate 3D bone models from imaging modalities.This study aims to segment proximal femur and innominate bone from routine clinical hip MRIs taken from elderly and OA patients. Images from both cohorts show degenerated bones with Bone Marrow Lesions (BMLs) and Subchondral Bone Cysts (SBCs) with a high prevalence in the OA patients cohort. This study proposes to utilize a multi-atlas based segmentation framework with an intermediate template to segment the bone areas automatically from hip MR images. The proposed method achieved accurate automated segmentations with the mean Dice Similarity Coefficient (DSC) values of 0.938 and 0.897 for the proximal femur and innominate bone, respectively, on OA patient's MR images. Slightly higher accuracy was recorded for the MRIs from asymptomatic individuals (DSC values: proximal femur 0.959, innominate bone 0.898).

14:00-14:20	MoBT1.4

Multi-Level Topological Analysis Framework for Multifocal Diseases, pp. 666-671

Xin, Bowen — The University of Sydney
Zhang, Lin — School of Computer Science, University of Sydney
Huang, Jing — Department of Radiology, Xuanwu Hospital

Lu, Jie — Department of Radiology, Xuanwu Hospital
Wang, Xiuying — The University of Sydney

Feature engineering and deep learning have been widely used to characterize imaging features in medical applications. However, the importance of geometric structure and spatial relationship of multiple lesions for multifocal diseases are often neglected by these methods. In this paper, we propose a Multi-level Topological Analysis (MTA) framework based on persistent homology, by capturing global-level topological invariants underlying geometric structure and local-level spatial adjacency relationship among lesions and local structure. In particular, a novel Filtration-based Community Discovery algorithm is designed to efficiently partition lesions to local clusters. Experimental results demonstrate that the proposed MTA framework outperforms five state-of-the-art persistent homology methods and achieved AUC 0.824 ± 0.132 on a task of differentiating two multifocal diseases, Multiple Sclerosis and Neuromyelitis Optica.

14:20-14:40 MoBT1.5

CT Images Segmentation Method of Rectal Tumor Based on Modified U-Net, pp. 672-677

标, 郑 — 南京理工大学
Cai, Chenxiao — Nanjing University of Science and Technology
Ma, Lei — China University of Mining and Technology

Computer-assisted rectal clinical diagnosis is of great significance for the early detection and treatment of rectal cancer. In data processing, it is quite challenging to achieve automatic segmentation due to the blurred boundary between lesions and healthy rectal tissue. To overcome such difficulties, we propose a rectal tumor segmentation method by using a modified U-net, thereby improving the diagnostic efficiency and accuracy. Firstly, the central coordinates of the rectal part to extract the region of interest are determined. Then, the tumor region is determined in the CT image via the YOLOv3 algorithm. Finally, the residual connection and attention mechanism are introduced to reduce the possibility of misjudgment of healthy rectal tissue as lesions to improve the accuracy of the traditional U-net model, and we use the modified U-net model to segment the rectal tumor region. The experiments show the Dice coefficient of this method can reach 83.45%, which is about 7% higher than the traditional U-net method, and this shows the validation and merits of the proposed algorithm.

14:40-15:00 MoBT1.6

Hybrid Feature Network Driven by Attention and Graph Features for Multiple Sclerosis Lesion Segmentation from MR Images, pp. 678-683

Chen, Zhanlan — Northwestern Polytechnical University
Wang, Xiuying — The University of Sydney
Zheng, Jiangbin — Northwestern Polytechnical University

Accurate segmentation of multiple sclerosis (MS) from MR images, faces the challenges imposed by the high variability in lesion appearance, and distant and disjoint lesion regions. Previous methods using multi-scale feature fusion or cascade networks, mostly rely on local feature representation learned from limited receptive fields which fail to leverage global context and model relations between multiple regions. To address these issues, we propose a hybrid feature network (HF-Net) driven by attention and graph convolution features, to improve the MS lesion segmentation from MR images. The attention features help to enhance discriminative feature representation. Specifically, the pyramid augmented attention module encodes spatial features into local features, while the channel augmented attention module models channel-wise interdependencies between features. Meanwhile, the graph feature module exploits the global relations between features over local receptive fields. The proposed HF-Net was evaluated on the datasets from the MSSEG Challenge and the ongoing ISBI Challenge, which outperforms several state-of-the-art methods.

MoBT2 Room 2
Adaptive Control (Regular Session)

13:00-13:20 MoBT2.1

Pilot Misoperation Control Based on L1 Adaptation and INDI Methods, pp. 684-688

Wang, Jin — Shanghai Jiao Tong University
Huang, Dan — Shanghai Jiao Tong University
Song, Lei — Shanghai Jiao Tong University
Ding, Lu — Shanghai Jiao Tong University
Fu, Shan — Shanghai Jiao Tong University

The pilot's error is one of the important factors affecting flight safety, which may cause serious consequences. This article mainly discusses the continuous operating deviation and sudden large-scale misoperation during the flight process. For the two types of error models, the controllers are designed to reduce the impact after the misoperation occurs, and simulation verification is performed. Simulation results show that the L1 adaptive controller can effectively suppress the impact of continuous operating deviation on control performance and improve flight comfort; the incremental nonlinear dynamic inverse controller can effectively reduce the impact of large misoperation and restore the original flight state.

13:20-13:40 MoBT2.2

Adaptive Secure Control of Uncertain Second-Order Nonlinear Cyber-Physical System against Intermittent DoS Attacks, pp. 689-694

yu, mengze — Beihang University
Wang, Wei — Beihang University
Wen, Changyun — Nanyang Tech. Univ

Cyber-physical systems (CPSs) are often complexly nonlinear and uncertain. This paper investigates the adaptive output-feedback control problem for CPSs subject to intermittent denial-of-service (DoS) attacks. The considered CPSs are modeled as a class of uncertain second-order strict-feedback nonlinear systems. When a DoS attack is active, the output signal becomes unavailable. To overcome this diffculty, an adaptive observer is constructed. Based on an average-dwelltime (ADT) method incorporated by frequency and duration properties of DoS attacks, convex design conditions of controller parameters are derived by solving a set of linear matrix inequalities (LMI). The proposed controller guarantees that all closed-loop signals remain globally bounded. An illustrative example is included to validate the theoretical results.

13:40-14:00 MoBT2.3

Optimal Control for Continuous-Time Scalar Nonlinear Systems with Known Dynamics, pp. 695-700

Tymoshchuk, Pavlo — Silesian University of Technology

An optimal controller for affine in the inputs scalar continuous-time nonlinear systems with the known dynamics is presented. The controller is described by an algebraic equation with variable structure. The control is derived in analytical way. A functional block-diagram of the controller is presented. The controller does not require any training procedure and is of moderate complexity. It is shown that the state-variable trajectories of the controlled system are globally asymptotically stable and globally asymptotically convergent to steady states. Computer simulations confirming theoretical derivations and illustrating the controller performance are provided.

14:00-14:20 MoBT2.4

Interpolating Control Based Trajectory Tracking, pp. 701-706

Boucek, Zdenek — University of West Bohemia
Flídr, Miroslav — University of West Bohemia

The paper is dealing with a modification of Interpolating Control (IC) for the employment in trajectory tracking problem with inherent constraints. First, the Optimal Control Problem (OCP) with reference trajectory tracking is described. The OCP is hard to solve analytically, thus, two feasible approaches will be presented. The standard method for the trajectory tracking called Model Predictive

Control (MPC), and afterward, a more computationally efficient alternative, the IC will be described. Further, the modification of IC for the tracking of the reference trajectory is presented. Finally, the IC and MPC are compared on a simple example using OCP cost function and computational time.

14:20-14:40 MoBT2.5

Formation Control of Time-Varying Multi-Agent System Based on BP Neural Network, pp. 707-712

Wang, Jiaqi	Zhejiang Sci-Tech University
Gao, Jinfeng	Zhejiang Sci-Tech University
Zhang, Xujie	Faculty of Mechanical Engineering and Automation, Zhejiang Sci-T
He, Jiajun	Faculty of Mechanical Engineering and Automation, Zhejiang Sci-T

In this paper, the formation control problem of time-varying multi-agent system (MAS) based on back propagation neural network (BPNN) is investigated. The system consists of two robots, which effectively improve the system operation efficiency through the coordination of robots. Moreover, leader-follower based strategy is used to formation. Among them, the leader robot can be controlled wirelessly through blue-tooth to share monitoring data in real time. The front image can be captured by the on-board camera mounted on the follower robot and optimized by the least square method (LSM). Then machine vision is used to locate the leader robot and the follower robot's position is adjusted in real time through proportion integral differential (PID) cnotroller based on BPNN to realize the formation. Compared with the traditional PID controller, BPNN PID cnotroller takes the weight coefficient of NN as an adaptive parameter, only few parameters need to be updated online, which can greatly lessen the computational burden. Finally, simulation experiments are given to illustrate the results.

14:40-15:00 MoBT2.6

GA Cascaded P-PD Control on Ball and Beam System with Two-Stage Objective Function, pp. 713-718

Tsoi, Kit Pui	University of Auckland
Patel, Nitish	Univ. of Auckland
Swain, Akshya	The University of Auckland
Xu, Huang	University of Auckland

This paper proposed a two-stage objective function with genetic algorithm (GA) based tuning on two controller schema - a PD/cascaded P-PD control on a traditional ball and beam system, serving as a prototype for a friction fruit conveyor system. The ball and beam system governed under such controllers is excited with step input, the corresponding system performance factors are captured - rise time, settling time and overshoot. A probabilistic random search on optimum controller parameters is carried with GA method, multiple cost functions - ISE, IAE, ITSE and ITAE, with are evaluated to form a performance cost matrix, which is the first stage of the objective function. The optimum parameter search stops with two conditions; one is that the maximum number of chromosome generation is reached, and the other one is that the performance cost stops improving consecutively for ten generations. The second stage of the objective function is proceeded to decide the found optimum controller parameter solution. The result is decided by taking account of the previously captured performance factors. These factors are normalized and combined with a heuristic weight set to determine a minimum decision cost. The minimum cost chromosome, with ITSE, is the optimum from global found solution space. With two-stage objective function, the GA tuned cascaded P-PD control result on the ball and beam system, meets all system requirements and is satisfactory. Such method can be later implemented on the friction fruit conveyor system for fruit position control and sorting applications.

MoBT3 Room 3

Image/video Analysis (Regular Session)

13:00-13:20 MoBT3.1

Self-Supervised Visual Feature Learning and Classification Framework: Based on Contrastive Learning, pp. 719-725

Wang, Zhibo	University of Central Florida
Zhang, Xiaoyu	University of Central Florida
Yan, Shen	Michigan State University
Da Vitoria Lobo, Niels	University of Central Florida

Due to the high (human) cost of image annotation, lack of large-scale annotation data prevents computer vision models from fully solving image classification tasks. On the other hand, the Bert model has shown that training large scale models with non-annotation text data is possible. Inspired by this, we propose a Self-supervised Visual Feature Learning and Classification framework (SVFLC) that can be applied to large scale training data without annotation. This approach is based on the contrastive predictive learning (CPL) method. By refining CPL using special data augmentation and new contrastive learning mechanisms, learning shape-biased features can be emphasized. In the next step, these features are used to produce pseudo labels via a clustering algorithm. Inspired by the recent research on noisy labels, we proceed to employ distance of the sample from cluster centers to eliminate low-confidence labels, and use soft triplet loss and classification loss jointly for achieving robust performance in the final classification. In this unsupervised learning paradigm, on the Imagenet dataset, our framework outperforms commonly used approaches. The unsupervised performance is lower than supervised and semi-supervised learning approaches, but our proposed framework is more suitable for general cases, and serves as a baseline algorithm for future improvement to the unsupervised learning paradigm.

13:20-13:40 MoBT3.2

Loss Constrains Added Squeeze and Excitation Blocks for Pruning Deep Neural Networks, pp. 726-731

Wang, Yiqin	Zhejiang University
Li, Ming	Zhejiang University
Su, Hongye	Institute of Cyber-Systems and Control, ZhejiangUniversity
Xie, Lei	Zhejiang University
Li, Xiaochen	Institute of Cyber-Systems and Control, Zhejiang University
Xu, Weihua	Zhejiang Univ
Xu, Xiaozhou	Zhejiang University

Deep neural networks are proved to be very effective to solve problems on image classification, object detection and segmentation. However, in cases where only limited hardware is acquired, it may be a problem to deploy big models with excellent performance as they are sometimes calculation consuming. To overcome the limits on power, memory and calculation, channel pruning is proposed to compress the model in channel wise and soon become a common approach to have big models compressed. Generally, pruning is a three-stage pipeline containing training, pruning and fine-tuning. In this work, we come up with a new pruning approach that needs no fine-tuning. The major idea is extracting channel salience by squeeze and excitation block and pushing the salience to either 0 or 1 by a sin-based function. Then take the salience as criteria for pruning. As the salience of channels-to-be-pruned in our approach is all zero, fine-tuning is not necessary in our pruning strategy which make the pruning process more stable and time saving. Experiment on flowers demonstrates our new designed pruning method is effective on reducing the model scale while maintaining the overall accuracy.

13:40-14:00 MoBT3.3

Towards Drowsiness Driving Detection Based on Multi-Feature Fusion and LSTM Networks, pp. 732-736

HongLin, Hong	Harbin Institute of Technology
Wang, Xin	Harbin Institue of Technology (Shenzhen)

Drowsiness driving poses a huge threat to the traffic safety. In this paper, a novel drowsiness driving detection method based on multi-feature fusion and long short-term memory (LSTM) recurrent neural networks is proposed to reduce traffic accidents caused by drowsiness driving. Firstly, we collect steering wheel angles (SWAs) of vehicles and facial videos of drivers by a driving simulator and a camera, respectively. Secondly, the drowsiness driving-related

steering features and facial expressions features are extracted from the collected SWAs and facial videos by the One Way ANOVA method and the FEFENet, and they are fused by concatenation operation. Considering that the generation of drowsiness is a long-term dynamic process and the degree of drowsiness accumulates over time, we design LSTM networks to cope with the fused feature sequence in a fixed duration, thereby establishing a effective drowsiness driving detection model. Some experiments are conducted to validate the performance of the proposed method, and the results demonstrate that our method can get robust and high accuracy performance in many different challenging scenarios.

14:00-14:20 MoBT3.4

Deep Convolutional Network for Steganalysis of HUGO, WOW, and UNIWARD Algorithms, pp. 737-740

Lichy, Krzysztof — Lodz University of Technology
Lipinski, Piotr — Lodz University of Technology
Grzelak, Michal — Lodz University of Technology

This paper presents a novel convolutional neural network (CNN) architecture for image steganalysis. The CNN was trained to detect distortions introduced by the state-of-the-art embedding algorithms: WOW, HUGO, and UNIWARD. We used a large database of test images together with a large number of stegomessages, which resulted in a six billion-sample training set. The experimental results show that the resultant CNN, which was trained on such a large dataset, outperforms state-of-the-art steganalysis algorithms in terms of total error rate.

14:20-14:40 MoBT3.5

Extracting Temporal Features by Key Points Transfer for Effective Action Recognition, pp. 741-746

Liao, Chenxi — North University of China
Xu, Yuecong — Nanyang Technological University

The extraction of temporal features in video is an essential task for effective action recognition. Previous networks utilizes optical flow as effective temporal features, which utilizes positional relationship between pixels to extract temporal features. However, not all the pixels are meaningful in a video frame, with most pixels related to background information rather than the action itself. In this paper, we propose a novel temporal feature extraction model, Key points inter-Frame Transfer Module (KFTM), which extracts the temporal feature by extracting the transfer of multiple key points along the temporal axis. Such information can be equivalent to the temporal feature of the video since it also represents the positional relationship between pixels. Yet such methodismoreefficientduetotheuseofkeypoints.Meanwhile , to extract the temporal feature more effectively, we add the attention mechanism which pays more attention to the transfer of key points most relevant to the action. Our proposed module obtains competitive performance on both UCF101 and HMDB51 datasets with 96.49% accuracy on UCF101 and 77.48% accuracy on HMDB51 datasets.

14:40-15:00 MoBT3.6

Depthwise Multiception Convolution for Reducing Network Parameters without Sacrificing Accuracy, pp. 747-752

Bao, Guoqing — The University of Sydney
Graeber, Manuel — The University of Sydney
Wang, Xiuying — The University of Sydney

Deep convolutional neural networks have been proven successful in multiple benchmark challenges in recent years. However, the performance improvements are heavily reliant on increasingly complex network architecture and a high number of parameters, which require ever increasing amounts of storage and memory capacity. Depthwise separable convolution (DSConv) can effectively reduce the number of required parameters through decoupling standard convolution into spatial and cross-channel convolution steps. However, the method causes a degradation of accuracy. To address this problem, we present depthwise multiception convolution, termed Multiception, which introduces layer-wise multiscale kernels to learn multiscale representations of all individual input channels simultaneously. We have carried out the experiment on four benchmark datasets, i.e. Cifar-10, Cifar-100, STL-10 and ImageNet32x32, using five popular CNN models, Multiception achieved accuracy promotion in all models and demonstrated higher accuracy performance compared to related works. Meanwhile, Multiception significantly reduces the number of parameters of standard convolution-based models by 32.48% on average while still preserving accuracy.

MoBT4 Room 4
Human-Machine System (Regular Session)

13:00-13:20 MoBT4.1

End-To-End Joint Intention Estimation for Shared Control Personal Mobility Navigation, pp. 753-758

Katuwandeniya, Kavindie — University of Technology Sydney
Valls Miro, Jaime — University of Technology Sydney
Dantanarayana, Lakshitha — University of Technology Sydney

Advancements in technology propose a future where systems work collaboratively sharing the same workspace as humans. Navigation is one such crucial aspect of daily life where collaborative technologies can offer major assistance. Ageing population dictates a likely increase in personal mobility devices (PMDs), whilst autonomous cars are bringing intelligent vehicles to the road today. However, in such scenarios the expected assistance can only be given if the device is aware of its user's intention, so that controls can be applied in a tightly collaborative manner. Moreover, they should be robust to different environments, users and mobile platforms. A user driven navigation framework is proposed in this work to complement end-to-end sensing-only solutions to estimate controls as joint intention from vehicle states and user inputs. The solution is proven to be an improvement over similar strategies that rely on exteroceptive data and omit inputs from the driving agent. Furthermore, the developed framework is proven capable of transferring the learning into different environments and mobility platforms using a small amount of training data. Data from the autonomous driving community (Udacity dataset) and other obtained in-house with an instrumented power wheelchair are given to demonstrate the validity of the proposed approach.

13:20-13:40 MoBT4.2

SRG3: Speech-Driven Robot Gesture Generation with GAN, pp. 759-766

YU, Chuang — ENSTA Paris
Tapus, Adriana — ENSTA ParisTech

The human gestures occur spontaneously and usually they are aligned with speech, which leads to a natural and expressive interaction. Speech-driven gesture generation is important in order to enable a social robot to exhibit social cues and conduct a successful human-robot interaction. In this paper, the generation process involves mapping acoustic speech representation to the corresponding gestures for a humanoid robot. The paper proposes a new GAN (Generative Adversarial Network) architecture for speech to gesture generation. Instead of the fixed mapping from one speech to one gesture pattern, our end-to-end GAN structure can generate multiple mapped gestures patterns from one speech (with multiple noises) just like humans do. The generated gestures can be applied to social robots with arms. The evaluation result shows the effectiveness of our generative model for speech-driven robot gesture generation.

13:40-14:00 MoBT4.3

Intuitive Virtual Reality Based Control of a Real-World Mobile Manipulator, pp. 767-772

Le, Dinh Tung — University of Technology Sydney
Sutjipto, Sheila — University of Technology, Sydney
Lai, Yujun — University of Technology Sydney (UTS)
Paul, Gavin — UTS

This paper presents an integration of Virtual Reality (VR) interfaces with the control system of a real-world mobile manipulator, ultimately facilitating a natural and intuitive method for human-robot interaction. VR's ability to track movements in 3D space and translate performed motions provide an intuitive platform for users to explore and interact with the virtual environment. Coupled with

intuitive controls, such as grabbing and pointing, the VR platform provides a compelling advantage that can be used to solve limitations of traditional remote robot teleoperation methods. This paper summarises the system implemented, which includes a simulation of the robot in Unity3d, as well as analyses critical results of accuracy and performance, from experiments with users of various experience levels. The method used for measuring accuracy with a simulated robot presented a utilitarian validation for contrasting the difference between 2D and VR 3D interfaces. Users' performance and experience under various levels of control latency, which is a crucial factor in remote online robot control, were also measured.

14:00-14:20	MoBT4.4

Upper Extremity Load Reduction for Lower Limb Exoskeleton Trajectory Generation Using Ankle Torque Minimization, pp. 773-778

Wong, Yik Ben	Hong Kong University of Science and Technology
CHEN, Yawen	Hong Kong University of Science and Technology
Tsang, Kam Fai Elvis	Hong Kong University of Science and Technology
Leung, Winnie	Hong Kong Univ. of Sci. & Tech
Shi, Ling	Hong Kong Univ. of Sci. and Tech

Recently, the lower limb exoskeletons which provide mobility for paraplegic patients to support their daily life have drawn much attention. However, the pilots are required to apply excessive force through a pair of crutches to maintain balance during walking. This paper proposes a novel gait trajectory generation algorithm for exoskeleton locomotion on flat ground and stair which aims to minimize the force applied by the pilot without increasing the degree of freedom (DoF) of the system. First, the system is modelled as a five-link mechanism dynamically for torque computing. Then, an optimization approach is used to generate the trajectory minimizing the ankle torque which is correlated to the supporting force. Finally, experiment is conducted to compare the different gait generation algorithms through measurement of ground reaction force (GRF) applied on the crutches.

14:20-14:40	MoBT4.5

Robust Real-Time Face Tracking for People Wearing Face Masks, pp. 779-783

Peng, Xinggan	Nanyang Technological University
Zhuang, Huiping	Nanyang Technological University
Huang, Guang-Bin	Nanyang Technological University
li, haizhou	National University of Singapore
Lin, Zhiping	School of Electrical &ElectronicEng., NanyangTechnologicalUnivers

Due to the outbreak of the novel coronavirus (or known as COVID-19), people are advised to wear masks when they stay outdoors in many countries. This could result in difficulty for some public safety surveillance systems involving face detection or tracking. Therefore, the development of face detection and tracking algorithms for people wearing face masks is particularly important. In this paper, a real-time tracking algorithm for people with or without face masks is proposed. This algorithm is trained on public face datasets with faces without masks. Although the training does not involve face images of people wearing face masks, we show that the proposed algorithm is robust as it is able to perform well in face tracking for people wearing face masks. We also discuss the possible scenarios where the algorithm could lose track of the target when experimenting in tracking masked faces. This can motivate future research in this area.

14:40-15:00	MoBT4.6

Nonovershooting Regulation of an Under-Sensed and Under-Actuated Linear Inverted Pendulum, pp. 784-788

Chen, Chao	The Hong Kong University of Science and Technology
Zhao, Di	The Hong Kong University of Science and Technology
Qiu, Li	Hong Kong Univ. of Sci. & Tech

This paper studies a nonovershooting regulation problem of an under-sensed and under-actuated system using two-degree-of-freedom (2DOF) control. An under-sensed and under-actuated linear inverted pendulum, which only has a single position sensor unlike the standard set-up, is investigated. For this system, first we present a regulation task that comprises three requirements, namely a nonovershooting step response, the largest robust stability margin and a 2DOF controller of the minimum order. Then we study the issue of controller design and develop a fourth-order 2DOF controller via the Youla-parameterization and the loop-shaping approaches. Finally, the proposed 2DOF controller is demonstrated to be effective.

MoBT5	Room 5

Modeling, Control and Estimation in Unmanned Systems
(Invited Session)

Organizer: Hu, Jinwen	Northwestern Polytechnical University
Organizer: Hou, Xiaolei	Northwestern Polytechnical University
Organizer: Xu, Zhao	Northwestern Polytechnical University

13:00-13:20	MoBT5.1

Strategy Generation Based on Reinforcement Learning with Deep Deterministic Policy Gradient for UCAV (I), pp. 789-794

Ma, Yunhong	Northwestern Polytechnical University
Bai, Shuyao	Northwestern Polytechnical University
Zhao, Yifei	Northwestern Polytechnical University
Song, Chao	Northwestern Polytechnical University
Yang, Jie	Northwestern Polytechnical University

Unmanned Combat Aerial Vehicles (UCAVs) are essential participants in the future air-combat. Due to high dynamics and randomness of air-combat process, traditional methods are difficult to obtain the optimal maneuvering strategy. The reinforcement learning (RL) is used to solve this problem. Deep deterministic policy gradient (DDPG) is used in reinforcement learning to deal with high-dimensional and continuous action space in this paper. And a method using a temporary replay buffer is proposed to improve the efficiency of neural network training. A 3-D air-combat environment is built to verify the algorithm proposed in this paper. Result shows that the agent with strategy obtained by the RL with DDPG is able to get high advantage during the confrontation, and the training efficiency of neural network is highly improved by using temporary replay buffer.

13:20-13:40	MoBT5.2

Collaborative Task Allocation of Heterogeneous Multi-UAV Based on Improved CBGA Algorithm (I), pp. 795-800

Ma, Yunhong	Northwestern Polytechnical University
Zhao, Yifei	Northwestern Polytechnical University
Bai, Shuyao	Northwestern Polytechnical University
Zhang, Yimin	Northwestern Polytechnical University
Yang, Jie	Northwestern Polytechnical University

In the complex and dynamic cooperation mission of heterogeneous multi-UAVs , UAV must response quickly to the new situation. A task allocation algorithm based on improved CBGA (Consensus-Based

Grouping Algorithm) is proposed in this paper to solve the task assignment for the collaborative heterogeneous UAVs. The task allocation model is constructed considering the time constraints of task and tasks' requirements for heterogeneous UAVs. This paper introduces a task bundle revision method to improve the computational efficiency of the CBGA algorithm. The effectiveness of the task allocation is verified through simulation examples. Simulation result also demonstrates the quality of the improved algorithm is improved strongly.

13:40-14:00	MoBT5.3

Hybrid FCM Learning Algorithm Based on Particle Swarm Optimization and Gradient Descent Algorithm (I), pp. 801-806

Chen, Jun	Northwestern Polytechnical University
Zhang, Yue	Northwestern Polytechnical University
Gao, Xudong	Northwestern Polytechnical University

The learning algorithm of fuzzy cognitive map(FCM) is mainly based on expert intervention or effective historical data to learn the weight value in weight matrix W. With the increase of the number of nodes, the number of weights need to be learned will also increase square, the performance of the learning algorithm will decline sharply. Therefore, it is an important task to design a high-performance learning algorithm which depends on expert knowledge as little as possible. A single learning algorithm has some limitations, such as easy local optimization, slow learning rate and so on. Among them, particle swarm optimization algorithm has strong global optimization ability, which can quickly optimize the weight matrix to a certain accuracy, but the follow-up optimization time is too long. For the gradient descent algorithm, when the initial value is chosen properly, its can approach the global optimal solution quickly. In this paper, we design particle swarm optimization (PSO) and gradient descent algorithm (GDA) to learn FCM respectively. According to the characteristics of the two algorithms, a hybrid algorithm(HA) is proposed: first, the PSO algorithm is used to optimize weight matrix to a certain accuracy, then the gradient descent method is added, which makes up for the disadvantage that the error of single PSO algorithm decreases slowly in the later stage. Experimental results show that the hybrid algorithm proposed in this paper has a significant improvement in both accuracy and speed.

14:00-14:20	MoBT5.4

Implement of a Multi-AGV Platform with Formation Control Algorithm (I), pp. 807-810

樊, 卫华	Nanjing University of Science and Technology

Aimed at the multi-agent system's research demand, a multi-AGV platform is developed in this paper and a formation control algorithm is verified on the proposed platform. Firstly, a multiple AGVs platform services for MAS research is introduced, the AGV is implemented with embedded system, and can track reference input signal. Then the models for both individual AGV and MAS are proposed. Based on the model, a second order consistency protocol for the formation control problem is present. And the asymptotic convergence condition is present. A formation control algorithm is given and implement on the embedded AGV. Finally, simulation and experiments are done to validate the proposed algorithm.

14:20-14:40	MoBT5.5

Path Planning of Mobile Robot Based on Improved Differential Evolution Algorithm (I), pp. 811-816

Chen, Jun	Northwestern Polytechnical University
Liang, Jing	Northwestern Polytechnical University
Tong, Yan	Northwestern Polytechnical University

With the rapid development of intelligent algorithms, it has become an inevitable trend to use intelligent algorithm with high intelligence and strong adaptability for robot path planning. Differential evolution algorithm (DE) is a typical intelligent algorithm applied in the robot path planning, yet there still exist some disadvantages, such as local optimum and computational redundancy. Aiming at these defects, this paper proposed an improved differential evolution algorithm (IDE) for robot path planning problem. In the proposed algorithm, chaos initialization population method is used to improve the ergodicity of search, and a judgment mechanism is introduced to ensure that the paths are available. Furthermore, the control parameters are updated according to a modified parameter adaptation strategy in each generation. Finally, the simulation results show that the IDE has better performance in convergence speed, optimization precision and stability compared with DE. Moreover, the experimental results of global path planning based on the robot operating system (ROS) further verify the feasibility and validity of the proposed algorithm.

14:40-15:00	MoBT5.6

Design and Verification of UAV Maneuver Decision Simulation System Based on DQN Network (I), pp. 817-823

Chen, Yuyang	Northwestern Polytechnical University
Zhang, Jiandong	Northwestern Polytechnical University
Yang, Qiming	Northwestern Polytechnical University
Zhou, Yu	China Research and Development Academy of Machinery Equipment
Shi, Guoqing	Northwestern Polytechnical University
Wu, Yong	Northwestern Polytechnical University

With the development of artificial intelligence technology and the demand of air combat, autonomous maneuver decision of UAV has become a popular research direction. Scholars at home and abroad have researched on autonomous air combat maneuver decision of UAV in depth based on various technologies and have achieved some results, among which the maneuver decisions based on the reinforcement learning are more efficient. But at present, the simulation targets used to test the effectiveness of the UAV autonomous maneuver decision method are relatively fixed, which cannot reflect the complexity of the enemy's maneuver strategy under real air combat conditions. This paper designs and develops a set of UAV autonomous maneuver decision man-machine air combat system based on deep Q-learning network, which is built from three subsystem: air combat environment simulation subsystem, the manned aircraft operation simulation subsystem and UAV self-learning subsystem. It has been verified that the man-machine air combat system proposed in this paper can effectively simulate real air combat and verify the effectiveness of the UAV autonomous maneuver decision.

MoBT6	Room 6

Secure Estimation and Control in Cyber-Physical Systems
(Invited Session)

Organizer: Chen, Bo	Zhejiang University of Technology
Organizer: Dong, Shijian	Zhejiang University of Technology

13:00-13:20	MoBT6.1

Distributed State Estimation for State-Saturated Power Systems under Denial-Of-Service Attacks (I), pp. 824-829

Chen, Wei	University of Shanghai for Science and Technology
Wang, Xueli	University of Shanghai for Science and Technology
Mao, Jingyang	University of Shanghai for Science and Technology
Ding, Derui	University of Shanghai for Science and Technology, Shanghai, Chi

In this paper, the distributed state estimation problem is studied for a class of state-saturated power systems subject to Denial-of-

Service (DoS) attacks. The randomly occurring DoS attacks is modeled by a series of Bernoulli distributed stochastic variables with known probability distributions. The aim of this paper is to design a distributed estimator ensure, in the presence of both cyber-attacks and state saturations, the desired estimation performance is satisfied. By virtue of some typical matrix inequalities, a tight upper bound of estimation error covariance is derived. The estimation parameters are obtained with the help of the solution of a set of Riccati-like difference equations. The developed recursive algorithm is independent of the global information and thus satisfies the requirements of scalability and online application. Finally, a practical example is developed to verify the validity of the designed estimator.

13:20-13:40 MoBT6.2

False Data Injection Attacks in Smart Grid Using Gaussian Mixture Model (I), pp. 830-837

Wang, Zhiwen — College of Electrical and Information Engineering, Lanzhou Unive
Hu, Jiqiang — College of Electrical and Information Engineering, Lanzhou Unive
Sun, Hongtao — College of Engineering, Qufu Normal University

The application of network technology and high-tech equipment in power systems has increased the degree of grid ntelligence, and malicious attacks on smart grids have also increased year by year. The wrong data injection attack launched by the attacker will destroy the integrity of the data by changing the data of the sensor and controller, which will lead to the wrong decision of the control system and even paralyze the power transmission network. This paper uses the measured values of smart grid sensors as samples, analyzes the attack vectors maliciously injected by attackers and the statistical characteristics of system data, and proposes a false data injection attack detection strategy. It is considered that the measured values of sensors have spatial distribution characteristics, the Gaussian mixture model of grid node feature vectors is obtained by training sample values, the test measurement values are input into the Gaussian mixture model, and the knowledge of clustering is used to detect whether the power grid is malicious data attacks. The power supplies of IEEE-18 and IEEE-30 simulation systems was tested, and the influence of the system statistical measurement characteristics on the detection accuracy was analyzed. The results show that the proposed strategy has better detection performance than the support vector machine method.

13:40-14:00 MoBT6.3

Fault Detection Method Based on Multi-Scale Convolutiona Neural Network for Wind Turbine Gearbox (I), pp. 838-842

Shen, Yijun — Zhejiang University of Technology
Wu, Qi — Zhejiang University of Technology
Huang, Dajian — Zhejiang University of Technology
Dong, Shijian — Zhejiang University of Technology
Chen, Bo — Zhejiang University of Technology

This paper is concerned with the fault detection problem of planetary gearbox in wind energy conversion systems (WECSs). An effective method based on empirical mode decomposition (EMD) and multi-scale convolutional neural network (MSCNN) is proposed. Specifically, the non-stationary vibration signals of the gearbox are decomposed by using the EMD, so that its signal-to-noise ratio (SNR) and characteristic information are improved. Then, a hierarchical convolutional neural network is applied to adaptively extract multi-scale features from the decomposed signal components. Finally, a binary classifier based on cross entropy is employed to automatically realize the classification of the obtained multi-scale features.The effectiveness and superiority of the proposed method are verified on the experiments with vibration data sets from a true WECS.

14:00-14:20 MoBT6.4

H∞ Fusion Detection of FDI Attacks for Nonlinear Cyber-Physical Systems (I), pp. 843-847

Shen, Jiahui — Zhejiang University of Technology
Gao, Lingjie — Zhejiang University of Technology
Chen, Bo — Zhejiang University of Technology
Yu, Li — Zhejiang University of Technology
Chen, Qiuxia — Zhejiang Shuren University

This paper studies the alarm response problem of false data injection (FDI) attack detection for nonlinear physical dynamical process in cyber-physical systems. Considering the real-time anomaly detecting, multi-sensor fusion strategy is used to enhance the reliabilty which can also potentially improve the detection speed. Multiple finite-level logarithmic quantizers are used for estimators to reduce the size of data packages containing residual message due to the limited bandwidth. Then the optimal weight for each local estimator is derived by solving a predefined convex optimal problem, which makes a more accurate residual evaluation threshold and a more effective response. At last, a civil aircraft example is used to illustrate the effectiveness of the proposed method.

14:20-14:40 MoBT6.5

To Embody or Not: A Cross Human-Robot and Human-Computer Interaction (HRI/HCI) Study on the Efficacy of Physical Embodiment, pp. 848-853

Herath, Damith — University of Canberra
Binks, Nicole — University of Canberra
Grant, Janie Busby — University of Canberra

A plethora of commercial social robots and social robotics startups have risen over the last few years. At a cursory glance, most such robots are merely conversational agents, essentially offering a similar or subset of the capabilities of a smart communication device embodied in a mobile/semi-mobile robotic platform. This raises the question of the efficacy of such an approach. In this paper, we explore embodiment using a social, in-the-wild interaction scenario, comparing a Human-Computer and Human-Robot context. A public site has been deliberately chosen to highlight the importance of conducting such user studies in unconstrained social settings as opposed to in controlled lab settings. Increasing evidence suggest the lack of generalizability of lab-based results in the wild, which we argue as a reason for misguided commercialization of social robots and their eventual commercial failures. The results have implications for the long-term commercial viability of such social robots.

14:40-15:00 MoBT6.6

Path Planning for Robot Based Radial Advanced Manufacturing Using Print Space Sampling, pp. 854-859

Munasinghe, Nuwan — University of Technology Sydney
Paul, Gavin — UTS

The world is embracing the fourth industrial revolution, Industry 4.0, which is enabling businesses to improve efficiency and optimise operations. The authors are part of a team that is researching and developing a large-scale industrial 3D printer to print smart, bespoke equipment called Gravity Separation Spirals (GSS). GSS are used in mining to separate minerals from the slurry. The printer under development employs two industrial robot arms mounted on vertical rails and the print direction is around a vertical rotating column in a radial direction. This paper presents a cost-based path planning method using print-space sampling to optimise distance error and manipulability during a printhead's radial path as it travels outwards from the central column. Manipulability, distance error and rotation error have been calculated for each sampled point and a weighted cost function has been used to determine the optimal path. Simulated results show that this method reduces the instances of print failure and improves the overall manipulability of the robot during printing.

MoCT1	Room 1
Vision for Robots (Regular Session)	

15:30-15:50	MoCT1.1

Efficient Objects Identification for a KidSize Humanoid Soccer Robot: Using Feedforward Neural Networks with Image Segmentation, pp. 860-865

Correia Jeronimo, Gilmar	Federal University of ABC
Tanaka Botelho, Wagner	Federal University of ABC
PIMENTEL, EDSON	Federal University of ABC
Cristina Maia dos Santos, Thaynara	Federal University of ABC

One of the biggest problems faced in robot soccer tournaments is related to object identification in the soccer field. The ball, field marks, crossbars of the goal, the opponent players or teammates are considered objects and should be identified by the robot soccer player in the category of KidSize RoboCup Humanoid League. The main target of this paper is to present a robotic architecture composed of the Software and Hardware Modules responsible for identifying these objects. The Software Module was composed of a DataBase (DB) with images of the objects to be identified and a Feedforward Neural Network (FNN) trained by the Neural Network Toolbox (NNT) of the MATrix LABoratory (MATLAB). In order to integrate the identification process with the Hardware Module, it was necessary to develop the NeuralNet library. This library was implemented in JAVA, making it compatible with multiple platforms. The purpose of this library was to transfer the FNN already trained by the NNT to the Raspberry Pi 3B. The Raspberry Pi 3B was responsible for processing the images captured by the Vision System of the robotic player. Also, all the objects in the field were identified through the trained FNN and the Open Source Computer Vision (OpenCV) library. The results showed an efficiency of about 82% in ball identification, 92% in field marks, 81% in crossbars of the goal, and 93% in opponent players or teammates.

15:50-16:10	MoCT1.2

Parameter Optimization of Feature Matching-Based Object Recognition Algorithm by Using CMA-ES, pp. 866-873

Hagihara, Daisuke	Hitachi, Ltd
Taiki, Yano	Hitachi, Ltd
Kimura, Nobutaka	Hitachi, Ltd

Estimating object pose is crucial for developing autonomous robots. One popular object recognition method is based on feature matching, leveraging so-called keypoint detectors and descriptors. To achieve high performance, however, it requires parameter tuning for each target object, and such a task has often been conducted by human experts, which makes it difficult to introduce robots into industrial facilities (for example, factories and warehouses) that contain various kinds of objects. In this study, we aim for automatic parameter optimization of feature matching-based object recognition algorithms. As a search algorithm, we propose using the covariance matrix adaptation evolution strategy (CMA-ES), which is a promising candidate for our problem where the objective function involves a number of parameters and its evaluation is computationally expensive. Furthermore, we also introduce a novel criterion for the convergence of the algorithm, which enables a robust parameter to be selected from multiple optimal candidates. Experimental results show that our proposed method can successfully find not only optimal but also robust parameters even with a small number of annotated scene images necessary for our optimization.

16:10-16:30	MoCT1.3

SurfaceNet: A Surface Focused Network for Pedestrian Detection and Segmentation in 3D Point Clouds, pp. 874-879

zhang, yongcong	University
Chen, Minglin	University of Chinese Academy of Sciences
ao, sheng	Sun Yat-Sen University
Zhang, Xing	Sun Yat-Sen University
Guo, Yulan	Sun Yat-Sen University

Pedestrian detection is an important problem for autonomous driving. It is still chanllenging to detect and segment pedestrians from point clouds. In this paper, we propose a method named SurfaceNet to detect and segment pedestrians from point clouds. Specifically, we propose a novel representation, named surface map, to represent a point cloud as a 2D pseudo-image. For pedestrian detection, the proposed method comprises of four modules: 1) a grid feature encoder that can processes arbitrary number of points within each grid; 2) a surface feature convolutional module that employs a set of 2D convolutional layers to extract high level features; 3) a view transform module that transforms features from front view to bird's eye view; and 4) an anchor-free 3D object detection head that produces rotated 3D bounding box predictions. For semantic segmentation, the 2D pseudo-image is used for semantic segmentation and the segmentation results are re-projected to the original point cloud to achieve point cloud segmentation. Experimental results on the KITTI dataset show that our method achieves promising performance on pedestrian detection and segmentation in point clouds.

16:30-16:50	MoCT1.4

An Improved Method for Rotation Estimation Using Photometric Spherical Moments, pp. 880-885

Du, Yao	VIBOT ERL CNRS 6000, ImViA, Université De Bourgogne Franche-Comt
TAHRI, Omar	Université Bourgogne Franche-Comté
HADJ-ABDELKADER, Hicham	University of Evry - Paris Saclay

Using spherical moments to estimate the rotation of camera is an effective method. However, after the camera rotates, the scene in the captured image will change, which will cause a certain error. This paper proposes a method to reduce this error by removing the non-common part between the two images during rotation. Through multiple iterations, the error caused by scene changing will become very small. The results of experiments using manual generated image are provided to show the efficiency of this proposed method.

16:50-17:10	MoCT1.5

Comparison of Camera-Based and 3D LiDAR-Based Place Recognition across Weather Conditions, pp. 886-891

Żywanowski, Kamil	Poznan University of Technology
Banaszczyk, Adam Andrzej	Poznan University of Technology
Nowicki, Michal, R.	Poznan University of Technology

Place recognition based on camera images provides excellent results on benchmarking datasets but might struggle in real-world adverse weather conditions like direct sun, rain, fog, or just darkness at night. In automotive applications, the sensory setups include 3D LiDARs that provide information complementary to cameras. The presented article focuses on the evaluation of camera-based, LiDAR-based, and joint camera-LiDAR-based place recognition. The processing for all data inputs is performed using a similar architecture of a neural network and is evaluated under varying weather conditions using the newly available USyd dataset. The experiments performed on the same trajectories in diverse weather conditions over 50 weeks prove that a 16-line 3D LiDAR can be used to supplement image-based place recognition to increase its performance. This proves that there is a need for more research into place recognition performed with multi-sensory setups.

17:10-17:30	MoCT1.6

Analytical Change Detection on the KITTI Dataset, pp. 892-897

Schauer, Johannes	Julius-Maximilians-Universität Würzburg
Nüchter, Andreas	Uni Würzburg

We present an algorithm for explicit change detection on 3D point cloud data from a mobile mapping scenario, namely the KITTI dataset. Our method is able to partition a 3D point cloud into static and dynamic points using ray traversal of a 3D voxel grid. We are thus not using a machine learning approach or RGB camera data but instead compute the intersections of the scene volume with the lines-of-sight between the sensor and the measured points. Our

approach does thus not require any object detection or tracking and has comparatively low requirements on the hardware. While our earlier work focused on dense point clouds from terrestrial 3D laser scans, here we investigate its application on the sparse 3D point clouds produced by a Velodyne 3D laser range finder in a mobile mapping scenario and compare our results to two competing implementations using the ground truth annotation from FuseMODNet for a quantitative analysis. We also introduce spherical quadtree point cloud reduction as a way to only work on less than 1% of the original data, making processing multiple times faster while at the same time producing results with equivalent F_1 scores.

MoCT2	Room 2
Control Applications (Regular Session)	

15:30-15:50 MoCT2.1

Dynamic Fuzzy Membership Intervals with Two-Stage Objective Function for Ball and Beam System Based on GA Tuning, pp. 898-903

Tsoi, Kit Pui — University of Auckland
Patel, Nitish — Univ. of Auckland
Swain, Akshya — The University of Auckland
Xu, Huang — University of Auckland

This paper proposed a two-stage objective function with genetic algorithm (GA) to refine an additional fuzziness layer on dynamic membership intervals of Type-I fuzzy logic control(FLC). The refined dynamic membership intervals Type-I FLC is applied on a traditional ball and beam system, serving as a prototype for a friction fruit conveyor system. The ball and beam system governed under Type-I FLC is excited with step input, the corresponding system performance factors are captured - rise time, settling time and overshoot. A probabilistic random search on optimum controller parameters is carried with GA method, multiple cost functions - ISE, IAE, ITSE and ITAE, with are evaluated to form a performance cost matrix, which is the first stage of the objective function. The optimum parameter search stops with two conditions; one is that the maximum number of chromosome generation is reached, and the other one is that performance cost stops improving consecutively for ten generations. The second stage of the objective function is proceeded to decide the found optimum controller parameter solution. The result is decided by taking account of the previously captured performance factors. These factors are normalized and combined with a heuristic weight set to determine a minimum decision cost. The minimum cost chromosome, with ITAE, is the optimum from global found solution space and sets fixed intervals on the dynamic membership range of Type-I FLC. With two-stage objective function, improved rise time and settling time performance are indicated on the GA tuned Type-I FLC dynamic membership intervals on the ball and beam system than the conventional Type-I FLC, and is satisfactory.

15:50-16:10 MoCT2.2

Fractional PI Controller for Integrating Plants, pp. 904-909

Azid, Sheikh Izzal — The University of the South Pacific
Shankaran, Vivek Pawan — The University of the South Pacific
Mehta, Utkal — The University of the South Pacific, Suva

This paper verifies a fractional-order PI controller to stabilize integrating time delay plants. Firstly, the stability region by non-integer order controller namely, PI^{lambda} is illustrated using boundary condition. This is achieved using complex root boundary domains. The controller parameters are calculated using the ITAE criterion for integrating plant with time delay. The twin rotor MIMO system (TRMS) as an integrating plant is verified in our study. Another example with large time delay is studied to check the validity of fractional-order integrator. Both simulation and experimental results are discussed and compared by PI^{lambda} with classical PI. The result proves the effectiveness of the fractional order controller.

16:10-16:30 MoCT2.3

Minimax Optimization of a Fractional-Order Controller for the Furuta Pendulum Uncertain System with an Output Disturbance, pp. 910-916

Cholodowicz, Ewelina — West Pomeranian University of Technology in Szczecin
Orlowski, Przemyslaw — West Pomeranian University of Technology in Szczecin

In this paper, the task of stabilizing the Furuta pendulum in an upright position is solved by fractional-order based linear quadratic regulator (FOLQR). The nonlinear model of a pendulum includes uncertainty of motor torque. Values of state-feedback gains are optimized by a genetic algorithm using a minimax optimization method. A comparative analysis, including simulations and experiments, whereby the advantages and effectiveness of the proposed fractional regulator are included. The obtained results show advantages of fractional-order controllers in stabilizing the uncertain Furuta pendulum system with the presence of the additive white Gaussian output noise.

16:30-16:50 MoCT2.4

LPV Unknown Input Observer for Attitude of a Mass-Varying Quadcopter, pp. 917-924

PHAM, The Hung — University of Évry Val D'Essonne
ICHALAL, Dalil — Université d'Evry Val D'Essonne
Mammar, Said — University of Evry, IBISC Lab

In this paper, a Linear Parameter Varying (LPV) Unknown Input Observer (UIO) design for the attitude subsystem of a mass-varying quadcopter is proposed by using algebraic matrix manipulation. First, the design of UIO for LPV systems is discussed. Then, by applying the design process of UIO for the general LPV system, an LPV UIO is designed for the attitude of a mass-varying quadcopter. Simulation results in Matlab are conducted for illustrating the promising results of the paper.

16:50-17:10 MoCT2.5

Control of a 2R Planar Horizontal Underactuated Manipulator, pp. 925-931

Chen, Tan — University of Notre Dame
Goodwine, Bill — University of Notre Dame

This paper presents a new method for trajectory planning and control of a 2R planar horizontal robotic arm with only the first joint actuated, which is known to be controllable but not asymptotically stabilizable with smooth feedback controllers. The main idea is to first determine an admissible trajectory that satisfies both the constraints of system dynamics and boundary value conditions, and then design a feedforward controller for the system. For complex and highly nonlinear systems, an optimization method is applied to determine the trajectory. Moreover, a time-scaling method can be used to control the magnitude of the inputs and also make it easier to find a solution in the optimization procedure. To further improve the robustness of the controller, a feedback controller is designed along the planned trajectory. Position to position control of the robot is simulated to demonstrate the effectiveness of the method.

17:10-17:30 MoCT2.6

Robust Iterative Learning Control for Ladder Circuits with Mixed Uncertainties, pp. 932-937

Sulikowski, Bartlomiej — University of Zielona Gora, Inst. Control and Computation Eng
Galkowski, Krzysztof — Univ. of Zielona Gora
Rogers, Eric — Univ. of Southampton
Kummert, Anton — University of Wuppertal

This paper develops iterative learning control laws for a subclass of uncertain spatially interconnected systems. Model uncertainties appear both in the state (represented by the norm bounded description) and the output equation (represented by a polytopic description) of the dynamics modeled in the 2D systems setting. A particular example of an RLC ladder circuit with norm bounded uncertainty provides an example to motivate the analysis. The first stage is to write the ladder dynamics in 2D model form and then the stability theory for a distinct class of 2D systems known as repetitive processes is used to develop the ILC law in the case of differential dynamics. This results in a design algorithm that

considers the mixed uncertainties in the model and can be applied using linear matrix inequalities.

MoCT3 Room 3

Object Recognition (Regular Session)

15:30-15:50 MoCT3.1

PBDE: An Effective Method for Filtering False Positive Boxes in Object Detection, pp. 938-943

Li, Zhishan — Zhejiang University
Jia, Baozhi — Reconova Technologies
Chen, Mingmu — Reconova Technologies
Xu, Shaokai — Reconova Technologies
He, Yifan — Reconova Technologies
Xie, Lei — Zhejiang University

An inevitable problem in the practice of object detection is the existence of false positive detection boxes. False detection boxes greatly reduce precision of object detection model and compromise the desired effect. In this paper, we propose a method named Prediction Box Density Evalution (PBDE). We summarize box density characteristics of true positive (TP) and false positive (FP) boxes to filter out a large number of FP boxes. After PBDE, we can obtain a significant improvement in precision with a low recall loss, and increase F1-score by up to 9 percentage when the confidence threshold is 0.1. The entire algorithm is carried out on the post-processing of object detection, and there is no need to change the original training method and network structure, which is of great practical importance.

15:50-16:10 MoCT3.2

Application of CNN-Based Method for Automatic Detection and Classification of the IC Packages, pp. 944-950

Maliński, Kamil Marek — West Pomeranian University of Technology in Szczecin
Okarma, Krzysztof — West Pomeranian University of Technology in Szczecin

Automatic detection and classification of integrated circuits' packages is one of the methods supporting the traditional production of electronic parts based on through-hole technology, typical for Printed Circuit Boards (PCBs), utilizing the advantages of modern machine vision solutions. As a result of the growing availability of cameras and 3D printers, as well as the popularity of IoT systems, prototyping of some electronic circuits with the use of simpler robotic systems may be supported by an automatic analysis of electronic components based on machine vision. Considering recent advances in the applications of Convolutional Neural Networks (CNNs) in computer vision, their applicability for this task has been analyzed and experimentally verified in this paper, also in comparison to previously proposed approach based on handcrafted features.

16:10-16:30 MoCT3.3

Batch-Normalization-Based Soft Filter Pruning for Deep Convolutional Neural Networks, pp. 951-956

Xu, Xiaozhou — Zhejiang University
Chen, Qiming — Zhejiang University
Xie, Lei — Zhejiang University
Su, Hongye — Zhejiang University

As convolutional neural network contains many redundant parameters, a lot of methods have been developed to compress the network for accelerating inference. Among these, network pruning, which is a kind of widely used approaches, can effectively decrease the memory capacity and reduce the computation cost. Herein, we propose a competitive pruning approach based on Soft Filter Pruning (SFP) by taking account of the scaling factors γ of Batch Normalization (BN) layers as the criterion of filter selection strategy. During the soft pruning procedure, in each epoch only γ values of BN layers less than threshold are set to zero instead of setting the weights of selected filters in convolutional layers to zero. Compared to the existing approaches, the proposed method can obtain a highly increased accuracy on image recognition. Notably, on CIFAR-10, the proposed method reduces the same 40.8% FLOPs as SFP on ResNet-110 with even 0.87% top-1 accuracy improvement.

16:30-16:50 MoCT3.4

An Efficient and Light-Weight Detector for Wine Bottle Defects, pp. 957-962

Liu, Mingyuan — Zhejiang University
Ma, Long-hua — Zhejiang University
Yu, Bin Chao — Zhejiang Zheneng Natural Gas Operation Co

Detecting defects on the wine bottle surface is a challenging task due to these factors: (1) tiny defects on the surface, (2) visually similar defects with design patterns on bottles, (3) reflective (metallic) bottle surface, (4) real-time requirement. In this paper, we propose an efficient and light-weight detector for the defects. To this end, we adopt EfficientNet-B3 as the backbone of the detector and YOLO as the detection head. In addition, we use channel pruning approach to obtain a more compact model. In the experiments, we obtain a score of 0.77 on the validation dataset, similar performance comparing to the two-stage methods. The parameters of our detector are only 5.8M, which are about one tenth of the YOLO's. The proposed detector achieves a good balance between speed and accuracy.

16:50-17:10 MoCT3.5

Data Augmentation with Generative Adversarial Networks for Grocery Product Image Recognition, pp. 963-968

Wei, Yuchen — Discipline of ICT, School of TED, University of Tasmania
Xu, Shuxiang — Discipline of ICT, School of TED, University of Tasmania
Tran, Son — Discipline of ICT, School of TED, University of Tasmania
Kang, Byeong — Discipline of ICT, School of TED, University of Tasmania

Image recognition tasks have gained enormous progress with a tremendous amount of training data. However, it isn't easy to obtain such training datasets that contain numerous annotated images in the domain of grocery product recognition. A small number of training data always results in a less than stellar recognition accuracy. Here we attempt to address this challenge by using generative adversarial networks (GAN), which can generate natural images for data augmentation. This paper aims to investigate the feasibility of using GAN to create synthetic training data, and thus to improve grocery product recognition accuracy. In this work, different GAN variants and image rotation are employed to enlarge the fruit datasets. Then, we train the CNN classifier using different data augmentation methods and compare the top-1 accuracy results. Finally, our experiments demonstrate that Auxiliary Classifier GAN (ACGAN) has achieved the best performance, which obtains 1.26%~3.44% increase in recognition accuracy. As an additional contribution, the results show that the effectiveness of using generated data is very close to that of using real data, which in our best experimental case, are 93.85% and 94.25%, respectively.

17:10-17:30 MoCT3.6

A Latent Variables Augmentation Method Based on Adversarial Training for Image Categorization with Insufficient Training Samples, pp. 969-975

Lin, Luyue — Guangdong University of Technology
Liu, Dacai — Guangdong University of Technology
Liu, Bo — Guangdong University of Technology
Xiao, Yanshan — Guangdong University of Technology

In the past few years, people have made great progress in image categorization based on convolutional neural networks (CNN) with the large-scale training set. However, in real-world applications, we may only have insufficient training samples for training CNN. To solve this problem, in this paper, we propose a latent variable augmentation method based on adversarial training (Lagat) to

increase the categorization accuracy of CNN with insufficient training samples. In the proposed Lagat model, we propose a uniform loss function, where we take the following two tasks into account. Firstly, we consider the task that we augment latent variables (LVs) from a set of class-specific adaptive distributions and we propose constraints to adjust these LVs distributions. Secondly, we use these sampled LVs to train a predictive image classifier. Moreover, we present an alternative two-play minimization game to optimize this uniform loss function. In addition, the experiment results also demonstrate that the proposed Lagat method delivers higher accuracy than the existing state-of-the-art methods. The source code of the Lagat algorithm will be available in Github.

MoCT4	Room 4
Robotics and Robot Control (Regular Session)	

15:30-15:50 MoCT4.1

Real-Time Obstacle Avoidance in Robotic Manipulation Using Imitation Learning, pp. 976-981

Huang, Jie	Maintenance Branch of State Grid Anhui Electric Power Company Li
Wei, Ge	University of Science and Technology of China
Cheng, Hualong	State Grid Anhui Electric Power Company Limited
Xi, Chun	Maintenance Branch of State Grid Anhui Electric Power Company Li
Zhu, Jun	Maintenance Branch of State Grid Anhui Electric Power Company Li
Zhang, Fei	University of Science and Technology of China
Shang, Weiwei	University of Science and Technology of China

We propose a novel trajectory planning algorithm to avoid obstacles in robotic manipulation by using imitation learning method. It focuses on how to plan feasible trajectories in the manipulation environment by imitating human experience. The main components of our algorithm include a path point prediction network and a trajectory generation strategy. The network is primarily composed of several Long Short-Term Memory (LSTM) layers and a Mixture Density Network (MDN) layer with Gaussian functions, thus it can cope with sequential information and fit the multimodal dataset well. To improve the smoothness of the trajectories generated by the networks, trajectory points are sampled from the Gaussian function which has the minimal change in the configuration space. Besides, multiple trajectories are generated for a given input and the best one can be selected to accomplish the task by improving the precision of the planning algorithm. Finally, simulation experiments conducted in Gazebo simulator verify that our planning algorithm has good performance in robotic manipulation with obstacle avoidance.

15:50-16:10 MoCT4.2

An Efficient Real-Time NMPC for Quadrotor Position Control under Communication Time-Delay, pp. 982-989

Barros Carlos, Barbara	Sapienza Università Di Roma
Sartor, Tommaso	University of Freiburg
Zanelli, Andrea	University of Freiburg
Frison, Gianluca	Technical University of Denmark
Burgard, Wolfram	University of Freiburg
Diehl, Moritz	Albert-Ludwigs-Universität Freiburg
Oriolo, Giuseppe	Sapienza Università Di Roma

The advances in computer processor technology have enabled the application of nonlinear model predictive control (NMPC) to agile systems, such as quadrotors. These systems are characterized by their underactuation, nonlinearities, bounded inputs and time-delays. Classical control solutions fall short to overcome these difficulties and to fully exploit the capabilities offered by such platforms. This paper presents the design and implementation of an efficient position controller for quadrotors based on real-time NMPC with time-delay compensation and bounds enforcement on the actuators. To deal with the limited computational resources onboard, an offboard control architecture is proposed. It is implemented using our high-performance software package acados which exploits the real-time iteration (RTI) scheme with Gauss-Newton Hessian approximation. The quadratic problems arising in the NMPC formulation are solved with HPIPM, an interior-point method solver, built on our linear algebra library BLASFEO, hand-optimized for the latest CPU architectures. We demonstrate the capabilities of our architecture using the Crazyflie 2.1 nanoquadrotor.

16:10-16:30 MoCT4.3

Towards Semantic Scene Segmentation for Autonomous Agricultural Vehicles, pp. 990-995

Mujkic, Esma	Technical University of Denmark
Hermann, Dan	AGCO A/S
Ravn, Ole	Technical University of Denmark
Bilde, Morten L.	AGCO A/S
Andersen, Nils A.	Tech. Univ. of Denmark

The development of autonomous agricultural vehicles depends on accurate visual interpretation of the environment. Semantic pixel-wise segmentation plays an important role in achieving a more detailed description of the scene and understanding of the spatial-relationship between different objects. In this paper, a deep architecture for road scene and indoor scene segmentation, SegNet, is applied in solving the scene recognition problem for the agricultural environment. The network is trained on an agriculture image dataset collected during field operation. The problem focuses on the segmentation of five classes of structures commonly found in the fields: vegetation, grass, ground, crop field and obstacles. We apply frequency balancing to address the challenge of class imbalance and transfer learning technique. The quantitative performance of the network is evaluated using pixel accuracy and intersection over union metrics. Moreover, we present an approach for an infield qualitative validation of the trained network.

16:30-16:50 MoCT4.4

Design of a Master-Slave Robotic System for Intravascular Catheterization During Cardiac Interventions, pp. 996-1000

Omisore, Olatunji	Shenzhen Institutes of Advanced Technology, Chinese Academy of S
Akinyemi, Toluwanimi	Shenzhen Institutes of Advanced Technology, Chinese Academy of S

Recently, applications of robotic device is showing greater advances in surgery. While robotic catheterization has been embraced to reduce the operational challenges (radiation and orthopedic hazards) inherent with percutaneous coronary interventions (PCIs), robot-based cardiac interventions are still limited to very few clinical centers in the world. In this paper, the development and application of a robotic PCI system for intravascular catheterization is presented. The robotic system is setup with underactuated master-and-slave devices and a direct control model designed based on mapping unit scales of the master displacement to trigger the slave robot for intravascular catheterization. To validate the robotic system, in-vitro trials are observed in a human-like silicone-based vascular pathway with aortic stenosis. The master-slave robotic system was successfully used to cannulate the stenotic vascular pathway with guidewire and catheter. Thus, it can be suitably adapted for intravascular catheterization during PCI and related cardiac interventions.

16:50-17:10 MoCT4.5

Inverse Kinematics Determination and Trajectory Tracking Algorithm Development of a Robot with 7 Joints, pp. 1001-1007

Kreft, Wojciech	AGH University of Science and Technology

The analyzed robot has 7 actuators and therefore it is a redundant robot whose position and orientation of the end-effector can

generally be set in an infinite number of ways. Determination of joint angles that implement a set position and orientation of the end-effector is difficult for this robot. The paper presents the method of determining analytical formulas for the inverse kinematics problem of the analyzed robot and presents the idea of selection a particular solution. The basic idea of the trajectory tracking algorithm is that a slight change in the position and orientation of the end-effector must also be associated with a slight change in angular positions on individual joints. The paper shows the operation of the tracking algorithm of an exemplary trajectory, both simulation and for real KINOVA® Gen3 Ultra lightweight robot.

17:10-17:30 MoCT4.6

An End-To-End Approach for Learning and Generating Complex Robot Motions from Demonstration, pp. 1008-1014

Kordia, Ali — INESC-ID
Melo, Francisco S. — INESC-ID

This paper proposes an end-to-end framework that can learn and decompose complex movements provided by a human demonstrator and generate new complex motions. Our approach analyzes the demonstration by the human expert and uses geometric criteria to decompose the observed movement into segments that are stored as dynamic movement primitives (DMPs) in a library. Then, given a new environment configuration, our system autonomously composes different motion primitives to construct an optimized trajectory that meets the constraints imposed by the new environment. Our system is therefore able to construct new DMPs to execute complex motions in environments that differ from the one where the original motions were taught. Our approach is also compatible with existing run-time obstacle avoidance approaches. We illustrate the application of our approach both in simulation and with a Baxter robot.

MoCT5 Room 5

Synthesis of Discrete Event Systems for Correct-By-Construction Cyber Physical Systems (Invited Session)

Organizer: Lin, Liyong — Nanyang Technological University

15:30-15:50 MoCT5.1

A Topological Approach for Computing Supremal Sublanguages (I), pp. 1015-1019

Lin, Liyong — Nanyang Technological University
Zhu, Yuting — Nanyang Technological University
Su, Rong — Nanyang Technological University

In this paper, we provide a tutorial introduction to a topological approach for the computation of some supremal sublanguages, often specified by language equations, that arise in the study of the supervisory control theory. As an illustration, we show that the supremal sublanguages for properties such as normality, prefix-closedness, trace-closedness, L-closedness and prefix-closed controllability are supremal open subsets of certain topologies. Thus, the supremal sublanguages correspond to the interiors and can be directly expressed.

15:50-16:10 MoCT5.2

Data Logging and Reconstruction of Discrete-Event System Behavior (I), pp. 1020-1026

Reijnen, Ferdie — Eindhoven University of Technology
Van de Mortel-Fronczak, Joanna Maria — Eindhoven University of Technology
Rooda, J.E. — Eindhoven University of Technology

In case of malfunctions or accidents related to an infrastructural system, it is useful to reconstruct and analyze the behavior that led to such an undesired situation. Understanding the behavior can help in improving the plant and the supervisory controller such that this situation is not encountered again. Many computer-controller mechanical systems use programmable logic controllers (PLCs) to implement the supervisory controller and to collect data from the system. Currently, incident analysis for PLCs often consists of plotting actuator and sensor signals to reconstruct and analyze the behavior. This way of analyzing is laborious and difficult to interpret for engineers not familiar with the system. In this paper, a different behavioral reconstruction and analysis method is proposed. In this method, models developed during the design of the supervisory controller are reused. From the collected data, a finite-state automaton is constructed. This automaton can be used for behavioral reconstruction via simulation, which is simpler and more intuitive. Moreover, by comparing the logged behavior with the behavior defined in the available models, faults can be identified. As a proof of concept, the behavior of a real movable bridge has been logged from a PLC, reconstructed, simulated, and analyzed.

16:10-16:30 MoCT5.3

Supervisor Synthesis for Networked Discrete Event Systems with Delays against Non-FIFO Communication Channels (I), pp. 1027-1032

Zhu, Yuting — Nanyang Technological University
Lin, Liyong — Nanyang Technological University
Tai, Ruochen — Nanyang Technological University
Su, Rong — Nanyang Technological University

In this work, we study the problem of supervisory synthesis for networked discrete event systems against non-FIFO communication channels with bounded delays. Both the observation and control communication channels are represented by finite state automata under the assumption that all communication delays are bounded, the resilient networked supervisor synthesis problem is then reduced to supervisor synthesis for non-deterministic automata. We firstly analyze the structure of networked discrete-event systems with delays, and then describe the message transmission process through the communication channels which connect the plant and the supervisor. The assumption of the networked discrete event systems: 1)The buffer size of the communication channels is limited; 2)There is a maximum delay boundary for each event in the communication channel; 3)The number of multiple copies of the same event in the communication channel is limited. The content of the observation and control channel will be represented by the timed finite state automata. Finally, an example will illustrate how the networked resilient supervisor will be synthesized.

16:30-16:50 MoCT5.4

Nonblocking Supervisory Control Synthesis of Timed Automata Using Abstractions and Forcible Events (I), pp. 1033-1040

Rashidinejad, Aida — Eindhoven University of Technology
van der Graaf, Patrick — Eindhoven University of Technology
Reniers, Michel — TU/e

Conventional supervisory control synthesis techniques are not adequate for timed automata (TA) due to their infinite state space. This paper presents a supervisory control synthesis technique for TA with the objective of satisfying controllability and nonblockingness. The synthesis method consists of three steps. First, a TA is abstracted to a finite automaton (FA). The event set of the FA includes the discrete events of the TA as well as an event representing the passage of a significant amount of time. Time passage is considered to be preemptable by events from a given set of forcible events. Second, an algorithm is presented to synthesize a controllable and nonblocking supervisor for the FA. Finally, a time-refinement technique is proposed to convert the supervisor to a TA.

16:50-17:10 MoCT5.5

Optimal Control Approach for Rational Expectations Models with Longer Forward-Looking Time, pp. 1041-1048

Ma, Tianfu — Shandong University
xu, juanjuan — Shandong University

Zhang, Huanshui	Shandong University
Basar, Tamer	Univ. of Illinois at Urbana-Champaign

This paper is concerned with the optimal control of rational expectations models in the general case of longer forward-looking time (d 2). The main contribution is the necessary and sufficient condition for the solvability of the finite-horizon problem. In particular, explicit characterizations of the optimal solution and the optimal cost are given in terms of difference equations. The key technique is to solve the forward and backward stochastic difference equations (FBSDEs) obtained by the stochastic maximum principle.

17:10-17:30 MoCT5.6

Feasible Schedule under Faults in the Assembly System, pp. 1049-1054

Majdzik, Pawel	University of Zielona Gora

This paper addresses an application of a faulttolerant control to a cubes ' packing system. The core issue concerns a control of a set of parallel manipulators which transport cubes from various points to a final storage. The main contribution of this paper is an analytical description of a set of manipulators by means of the max-plus algebra equations. The task of these manipulators is a handling of transport of cubes in accordance with a reference schedule. The proposed mathematical approach has to take into consideration both synchronization and choice issues as well as faults. In addition, diagnostics and fault-tolerant control strategy are developed and applied to the system of cubes' packing being considered. All constraints are defined and incorporated into this control strategy. The proposed approach is able to compensate or eliminate the influence of some faults, e.g., delays occurring in the manipulators or reduced velocities of transportation means. Finally, an example exhibiting effectiveness of the proposed control scheme is presented.

MoCT6 Room 6

Intelligent Control of Complex Systems (Invited Session)

Organizer: Li, Jinna	Liaoning Shihua University
Organizer: Wang, Chunyan	Beijing Institute of Technology
Organizer: Liu, Shuai	Shandong University

15:30-15:50 MoCT6.1

Intelligent Health Management of Fixed-Wing UAVs: A Deep-Learning-Based Approach (I), pp. 1055-1060

Cui, Aiya	Beijing Institute of Technology
Zhang, Ying	China Aerospace Science and Technology Corporation
Zhang, Pengyu	Science and Technology on Space Physics Laboratory
Dong, Wei	Beijing Institute of Technology
Wang, Chunyan	Beijing Institute of Technology

In this paper, the fault diagnosis and health management of fixed-wing UAVs are investigated based on the deep learning technique. The proposed method includes 5 models: flight data generation model, sample training prediction model based on the Long Short-Term Memory (LSTM) network, prediction model based on the grey model, combined prediction model and health calculation and management model. The real-time output of the health prediction value of the fixed-wing UAVs can be obtained, which makes it possible to take remedial action before the fault occurs. And numerical simulations demonstrate the feasibility of the proposed method.

15:50-16:10 MoCT6.2

Consensus Achievement of Multi-Agent Systems under Delayed State Information (I), pp. 1061-1065

Zhu, Yanli	School of Information Science and Engineering, Shandong Normal U
Wang, Zhenhua	School of Information Science and Engineering, Shandong Normal U
Liu, li	School of Information Science and Engineering, Shandong Normal U
Zhang, Huaxiang	School of Information Science and Engineering, Shandong Normal U

In this paper, the consensus achievement for first-order multi-agent systems is researched over undirected graph. Suppose that the system is unstable and exactly knows the communication delay that affects the actually transmitted information, consensus gain in the protocol is designed with the delay information. Then, conditions are obtained to guarantee consensus for any large yet bounded communication delay. At the end of the article, an example is given to demonstrate the validity of the conclusion.

16:10-16:30 MoCT6.3

Data-Driven Tracking Control Approach for Linear Systems by On-Policy Q-Learning Approach (I), pp. 1066-1070

Zhang, Yihan	Liaoning Shihua University, School of Information and Control Eng
Xiao, Zhenfei	Liaoning Shihua University
Li, Jinna	Liaoning Shihua University

This paper develops an improved tracking control approach for discrete-time (DT) linear system. It's combining the on-policy Q-learning and an extended state space formulation of systems. The main merit of the proposed approach lies in the optimal tracking controller can be found using the measured augmented variables including input, output and their past values together tracking errors rather than utilizing the system model parameters or state of systems, since they are hard to be available in practice. First, the optimal tracking problem of linear system is formulated as minimizing a specific cost function containing the objective of tracking a reference signal with respect to an extended state space realization. Therefore, we present on-policy Q-learning method, only utilizing the measured data without need of designing state observer, and the optimal tracking problem can be solved, which under consideration can track the reference signal via the optimal approach. Finally, the validity of the simulation results is proved.

16:30-16:50 MoCT6.4

Adaptive Affine Formation Maneuver Control of Second-Order Multi-Agent Systems with Disturbances (I), pp. 1071-1076

Luo, Zhengxin	Beijing Institute of Technology
Zhang, Pengyu	Science and Technology on Space Physics Laboratory
Ding, Xiangjun	Beijing Institute of Technology
TANG, ZEZHI	Guangdong Bozhilin Robotics
Wang, Chunyan	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology

This paper studies adaptive affine formation maneuver control problem in the presence of external disturbances. The proposed control algorithm consists of a component for disturbances estimating and a component for formation tracking. To address the disturbances, an adaptive control strategy is designed for each follower to estimate external disturbances. Then, a formation control law is adopted to achieve desired formation maneuvers, such as translation, scaling and rotation with the external disturbances compensated. Sufficient conditions for stability of the proposed control algorithm are identified using Lyapunov method. Finally, simulations are presented to demonstrate the effectiveness of the theoretical results.

16:50-17:10 MoCT6.5

Higher-Order Polynomial Signal Tracking Control of Unknown Systems Using Off-Policy Integral Reinforcement Learning (I), pp. 1077-1081

Cheng, Weiran	Liaoning Shihua University
Li, Jinna	Liaoning Shihua University

This paper aims at using an off-policy integral reinforcement learning (IRL) algorithm to solve the linear quadratic tracking (LQT) control problem of completely unknown continuous-time systems, such that an arbitrary higher-order polynomial signal can be followed via an optimal approach. Firstly, a linear continuous-time system with unknown model matrices is introduced with a target of tracking the reference signal with higher-order polynomials. Secondly, based on the knowledge of the on-policy IRL, an off-policy IRL algorithm is used to solve the derived iterative Bellman equation and update the control policy resulting in the optimal control policy. Finally, a simulation example is given to show the efficiency of the proposed approach.

17:10-17:30 MoCT6.6

A Predictor-Like Controller for Linear Ito Stochastic Systems with Input Delays (I), pp. 1082-1087

wang, hongxia Zhejiang University of Technology
Fu, Minyue University of Newcastle
lu, xiao Shandong University of Science and Technology

Linear quadratic regulation (LQR) is very fundamental in modern control theory. The theory has been developing for several decades. However, a more general problem, the LQR problem for stochastic systems with multiple control channels and delays still remains outstanding. To simplify our derivation, the paper focuses on dealing with the problem with two control channels and a delay, which is more difficult than the one with a single delayed control channel since the former actually encounters interaction of control channels besides the delay. A new value function is proposed, which is key for finding the predictor-like controller. The idea is also suitable for handling the LQR problem for Ito stochastic systems with multi-control-channel and multi-delay.

TuPP Room 1
Plenary Panel in Robotics and AI (Plenary Session)

09:00-11:00 TuPP.1

*Robotics and AI: The Presence and the Future**

Egerstedt, Magnus — Georgia Institute of Technology
Liu, Yunhui — Chinese University of Hong Kong
Quek, Tong Boon — Ministry of Trade and Industry
Spanos, Costas — University of California, Berkeley
Wen, Yonggang — Nanyang Technological University

ICARCV 2020 proudly presents the plenary panel session on Robotics and AI: The Presence and The Future. We are honored that five prominent experts and educators in the field will join this panel to share their expertise and visions, and to discuss challenges and opportunities in robotics and AI. Through direct dialog with these world-renowned panelists, we aim to gain a deeper insight into some fundamental and emerging problems in robotics and AI and a broader picture on their application and commercialization potentials.

This plenary panel session will also provide an opportunity for researchers, especially young researchers, to interact with world renowned experts in robotics and AI. During the session, the panel members will share their vast experiences and visions with audience through effective dialogues.

TuKN Room 1
Plenary 3 (Plenary Session)

11:30-12:30 TuKN.1

*Towards Understandable Computer Vision**

CHEN, Xilin — Chinese Academy of Sciences

In the past decades, computer vision has become the hottest area in artificial intelligence due to it reaches similar or even better results in some typical tasks, such as object recognition, than human being. However, most current computer vision systems are designed for specific task(s) in the close world, and hard to deal with open world cases. Flat structure for specific task(s) without reasoning and lack of knowledge are the major barriers toward a flexible computer vision system. For this purpose, a key factor is understandable or interpretable. Therefore, objects should be processed in a contextual environment rather than a solo one with a simple identity, and objects should also be associated with relevant concepts. A conceptual mapping of a given image brings enhanced representation, which can support versatile tasks. In this talk, I will briefly review the current state of computer vision, and talk about some open problems. I will then share my points on these relevant problems. Some of our efforts towards understandable computer vision are reported, including hierarchical object detection and categorization, scene graph construction and its application, unseen object inference, etc.

TuBT1 Room 1
Intelligent Systems (Regular Session)

13:30-13:50 TuBT1.1

An ANN Based Human Walking Distance Estimation with an Inertial Measurement Unit, pp. 1088-1092

Huang, Loulin — Auckland University of Technology
Liu, Yu — Auckland University of Technology

Estimation of the walking distance including stride length of a pedestrian is an essential part of a motion tracking and monitoring devices used in applications such as health care, search and rescue and games. One popular approach is to derive it through processing the acceleration signals output from the inertia measurement unit (IMU) attached to a foot or another part of the body of the pedestrian. This approach is well known for its large accumulative errors in integration of the signals with noises of a sensor and the difficult to accurately determine the time duration of a stride. This paper presents a novel approach to estimate walking distance from IMU sensor readings based on an artificial neural network (ANN). Experiments show that the proposed approach is more accurate and effective than traditional methods relying on double integral method.

13:50-14:10 TuBT1.2

Diagnostic of the State of the Cutting Tool of Metal-Cutting Machines Using Bidirectional Recurrent Neural Networks with a Long Short-Term Memory, pp. 1093-1097

Kamil, Masalimov — Ufa State Aviation Technical University
Munasypov, Rustem — Ufa State Aviation Technical University

The paper presents a method for diagnosing the condition of a cutting tool of metal-cutting machines, which allows determining the amount of tool wear according to information received from force and vibration sensors. To fix the dependence of the amount of wear on the values of vibration and cutting forces, it is proposed to use a diagnostic model based on bidirectional recurrent neural networks with a long short-term memory. The article presents and describes the architecture of such neural networks. We have developed several diagnostic models based on various neural network architectures and conducted a comparative analysis of the accuracy of the obtained models.

14:10-14:30 TuBT1.3

Parallelized Hardware Rough Set Processor Architecture in FPGA for Core Calculation in Big Datasets, pp. 1098-1103

Kopczynski, Maciej — Bialystok University of Technology
Grześ, Tomasz — Politechnika Białostocka

This paper presents parallelized Field Programmable Gate Array (FPGA) and softcore Central Processing Unit (CPU) based solution for large datasets core calculation using rough set methods. Architectures shown in this paper have been tested on two real datasets running presented solutions inside FPGA unit. Tested datasets had 1000 to 1000000 objects. The same operations were performed in software implementation. Obtained results show the big acceleration in computation time using hardware supporting core generation in comparison to pure software implementation.

14:30-14:50 TuBT1.4

Autonomous Curriculum Generation for Self-Learning Agents, pp. 1104-1111

KURKCU, ANIL — Nanyang Technological University
CAMPOLO, Domenico — Nanyang Technological University
Tee, Keng Peng — Inst. for Infocomm Research, ASTAR

The applicability of deep reinforcement learning algorithms to the domain of robotics is limited by the issue of sample inefficiency. As in most machine learning methods, more samples generally mean better learning effectiveness. Sample collection for robotics application is a time-consuming process in addition to safety issues for both the robot itself and the environment surrounding it that come into play for real-world scenarios. Because of these limitations, sample efficiency plays a very vital role in the field of robotic learning. To deal with this, curriculum learning offers a methodology that allows robots to suffer less from the sample collection burden required, trying to keep it at a minimum. This study aims to tackle the sample inefficiency that deep reinforcement learning algorithms face in the domain of robotics by designing a curriculum. We propose an algorithm which decides on the sequence of tasks that the agent must learn to enable the transfer of knowledge in a sample-efficient manner towards the target task. Our algorithm performs a parameter-space task representation for the purpose of deciding on the difficultiness of the tasks. Once the difficulty level of each is determined, easy tasks are learned first before the final target task. We perform a study on a double inverted pendulum setup. Simulation results showed that transfer of knowledge via curriculum is more sample efficient than a direct transfer.

14:50-15:10	TuBT1.5

Gene Prediction by the Scale-Limited Gabor Wavelet Transform for Identifying the Protein Coding Regions, pp. 1112-1116

Zheng, Qian — ZheJiang University
WenXiang Zhou, Zhou — Beijing University of Aeronautics and Astronautics
Chen, Tao — South West Jiao Tong University
Xie, Lei — Zhejiang University
Su, Hongye — Institute of Cyber-Systems and Control, ZhejiangUniversity

The identification of protein coding regions is one of the important applications of genome sequence analysis. Many digital signal processing (DSP) based methods, which rely on the 3-base periodicity of DNA sequences, have been proposed. However, in almost all previously published methods, their performance is still limited by the window length in terms of the identification accuracy. In this paper, we propose a novel method based on Scale-limited Gabor Wavelet Transform (SLGWT) for identifying protein coding regions. Our proposed method can fit with the changes of window length, which eliminates the reliance of the window lengths. In addition, compared with other wavelet-based methods, SLGWT achieves higher identification accuracy under narrower scale range, thereby improving the computational efficiency and reducing the background noise. The experimentations in the sequence and dataset levels verify the superiority of our proposed method.

15:10-15:30	TuBT1.6

Binary Spectrum Feature for Improved Classifier Performance (I), pp. 1117-1122

Ulapane, Nalika — The University of Melbourne
Thiyagarajan, Karthick — University of Technology Sydney
Kodagoda, Sarath — University of Technology, Sydney

Classification has become a vital task in modern machine learning and Artificial Intelligence applications, including smart sensing. Numerous machine learning techniques are available to perform classification. Similarly, numerous practices, such as feature selection (i.e., selection of a subset of descriptor variables that optimally describe the output), are available to improve classifier performance. In this paper, we consider the case of a given supervised learning classification task that has to be performed making use of continuous-valued features. It is assumed that an optimal subset of features has already been selected. Therefore, no further feature reduction, or feature addition, is to be carried out. Then, we attempt to improve the classification performance by passing the given feature set through a transformation that produces a new feature set which we have named the “Binary Spectrum”. Via a case study example done on some Pulsed Eddy Current sensor data captured from an infrastructure monitoring task, we demonstrate how the classification accuracy of a Support Vector Machine (SVM) classifier increases through the use of this Binary Spectrum feature, indicating the feature transformation's potential for broader usage.

TuBT2	Room 2
Modeling and Identification (Regular Session)	

13:30-13:50	TuBT2.1

Furuta Pendulum Real-Time System with Brushless DC Motor and Cascade Hybrid Control, pp. 1123-1130

Cholodowicz, Ewelina — West Pomeranian University of Technology in Szczecin
Orlowski, Przemyslaw — West Pomeranian University of Technology in Szczecin

The inverted pendulum is one of the popular testbeds in the control theory education, owning to its complex characteristics (nonlinear, underactuated), along with its real-world applications, for example in transportation, walking of robots etc. This paper is dedicated to the problem of Furuta pendulum control. It describes a mathematical model of the Furuta pendulum, the linearization process and the results of the identification experiment. Two methods for the brushless DC motor control have been proposed. The last section is dedicated to the achievements of experimental research on control systems implementation. The main aim of this work is to present the achievements of the designed stand and to compare two different approaches of Furuta pendulum control with brushless DC motor. On the basis of the conducted research, it is stated that a magnetic encoder control allows a more effective and better tracking of the setpoint with respect to the modelling inaccuracy in comparison to the sinusoidal generator controller.

13:50-14:10	TuBT2.2

Black-Box Identification of a Robotic Flight Simulator, pp. 1131-1136

Matheus, Aline da Conceição — Aeronautics Institute of Technology
Villani, Emília — ITA - Instituto Tecnológico De Aeronáutica
Oliveira, Wesley Rodrigues — Aeronautics Institute of Technology

Optimization of motion cueing algorithms is a relevant topic in flight simulation industry. To achieve this goal, a representative model of the motion platform is needed. With this intent, this work presents a black-box approach to identify a model for the SIVOR flight simulator. The model receives position/orientation inputs in Cartesian space and streams out accelerations/angular speeds measured on the pilots' head. A comprehensive experimental analysis is carried out using a dataset based on isolated positional and rotational inputs. A frequency domain analysis is performed to evaluate signal measurement noise and to determine the model structure. As a result, a combination of continuous time linear transfer functions were identified to represent each of the direct and cross relations mapped throughout the process.

14:10-14:30	TuBT2.3

Statistical and Physiologically Analysis of Using a Duffing-Van Der Pol Oscillator to Modeled Ictal Signals, pp. 1137-1142

Szuflitowska, Beata — West Pomeranian University of Technology
Orlowski, Przemyslaw — West Pomeranian University of Technology in Szczecin

Electroencephalography reflects the averaged electrical activity of neurons associated with physiological and disease neural processes, i.e. epilepsy. In this study, EEG signals recorded during a complex partial seizure are modeled using coupled Duffing-van der Pol oscillator. The purpose of the paper is the statistical analysis of parameter variability during three phase of seizure: pre-, ictal, and post-ictal. In order to determine the impact of intra -variability on parameter values during seizure spread, in the study signals from 10 patients are analyzed. Our data are reliable in terms of each patient's sex, age, and medical history. For the first time, the results of the optimal values model parameter are explained based on physiological phenomena. Nonlinear models' parameters may be useful for pre-and post-ictal sequences differentiation.

14:30-14:50	TuBT2.4

String Plucking and Touching Sensing Using Transmissive Optical Sensors for Guzheng, pp. 1143-1149

Oszutowska-Mazurek, Dorota — Pomeranian Medical University
Mazurek, Przemyslaw — West Pomeranian University of Technology in Szczecin

The article presents a solution for recording individual vibrations of the string for the guzheng zither. An optical transmission sensor was used inside which the string vibrates. The analytical solution is presented to describe the string in this type of sensor. The classification of sensors is proposed, which classes are characterized by different properties of vibration conversion into an optical signal. A prototype solution for guzheng is presented. The measuring method allows to register the touch of the string, which is important for further estimation of the string's state.

14:50-15:10	TuBT2.5

Mid-Level Features for Categorization of Social Interactions in Public Spaces, pp. 1150-1155

Zitouni, M. Sami — Khalifa University
SLUZEK, ANDRZEJ — Warsaw University of Life Sciences - SGGW

The paper proposes mid-level features for socio-cognitive classification of crowd behavior in public spaces, particularly in the context of monitoring social interactions during, e.g., pandemic restrictions. The classification method follows a recently proposed categorization [37]. The features are built using statistics obtained from detection and tracking results forc crowd components, i.e. individuals and their groups (any typical detectors and trackers can be used). The features are defined by static (if obtained from the current frame) or dynamic (if derived from consecutive frames) parameters characterizing the crowd. Subsequently, the features extracted from a number of most recent frames are fed into a fully-connected shallow neural network to identify the type of social interactions in the monitored space. The experimental feasibility study shows encouraging performances of the approach. In particular, the results are far more discriminative than in the other solution (which, at the moment, is the only publicly known benchmark).

15:10-15:30 — TuBT2.6

Transient Stability of Grid-Forming Inverters in Microgrids: Nonlinear Analysis, pp. 1156-1159

Eskandari, Mohsen — University of New South Wales
Savkin, Andrey V. — Univ. of New South Wales

A current limiting scheme is employed for Inverter-Interfaced Distributed Generation (IIDG) units, mostly in the control loops, to limit the current within the tolerable range and to facilitate the IIDG units being connected to the grid during the transient. However, current-limiting/saturation of the droop-controlled grid-forming inverters affects their transient stability and may make them unstable, which yet has not been explored in the literature in the context of autonomous microgrids (MGs). It is disclosed in this paper that the sharp phase angle variation and the arbitrary resistive output impedance of grid-forming inverters in the current limiting mode make the autonomous MGs unstable. Time-domain simulations prove the idea.

TuBT3 — Room 3

Networked Control Systems 2 (Regular Session)

13:30-13:50 — TuBT3.1

A Geometrical Criterion for the Synchronization of Dynamic Networks with Input Saturation, pp. 1160-1164

Ye, Juncen — Zhe-Jiang University
Haoyi, Que — Shenzhen Polytechnic
Ma, Long-hua — Zhejiang University
Su, Hongye — Institute of Cyber-Systems and Control, ZhejiangUniversity

The paper investigated the global synchronization control problem of dynamic networks with discrete-time communications and input saturation. Based on a geometrical criterion of certain non-linear non-autonomous systems, we proposed a sufficient condition for stability of saturating linear control for a linear networked system. The stability could be ensured simply from a range of gains rather than a complex Lyapunov function. A numerical example is offered to show the effectiveness and the relative analysis.

13:50-14:10 — TuBT3.2

A Residual Network for De Novo Peptide Sequencing with Attention Mechanism, pp. 1165-1170

Liu, Zihang — Zhejiang University
Zhao, Chunhui — Zhejiang University

De novo peptide sequencing via tandem mass spectrometry is one of the most powerful tools for identifying proteins, especially for novel sequences without any database information. Due to the incomplete fragmentation information and the high complexity of the experimental spectra, the accuracy and efficiency of de novo peptide sequencing is a considerable challenge. In this study, a novel residual network structure integrated with attention mechanism is proposed for de novo peptide sequencing, called RANovo. On one hand, the residual structure enables the network to go deeper, therefore more features can be extracted from the input data. On the other hand, attention mechanism is designed to adaptively recalibrate dynamic channel-wise information, which makes better use of the hidden features. Taking these advantages, the proposed method shows superior prediction accuracy on both amino acid level and peptide level in a series of experiments.

14:10-14:30 — TuBT3.3

Speech Recognition System for a Service Robot - a Performance Evaluation, pp. 1171-1176

Alibegović, Besim — University of Tuzla
Prljaca, Naser — University of Tuzla
Kimmel, Melanie — Technische Universität München
Schultalbers, Matthias — IAV GmbH

In this work we adapt and evaluate different solutions for automatic speech recognition (ASR) to be used as an HMI for the assistant robot. Two on-device solutions: Kaldi (DNN-HMM) and Mozilla's DeepSpeech (end-to-end), and three internet service APIs: IBM Watson, Microsoft Azure and Google Speech to Text are evaluated. The systems are adapted to the domain of robot commands and evaluated on a set of expected inputs. As the goal is to retain the ability to recognise general language, the systems are also evaluated on out of domain data.

14:30-14:50 — TuBT3.4

Fault-Tolerant Architecture for Real-Time Control of Distributed Medical Devices, pp. 1177-1181

Reis, Tiago — Maxdata Software, SA
Correia, Alexandre — Maxdata Software, SA - Carregado, Portugal
Sousa, Paulo — Maxdata Software, SA - Carregado, Portugal
Cecílio, José — FCiências.ID - VAT PT514187808

Clinical laboratories use a myriad of medical devices (e.g., automated analyzers) to determine the results of its tests. Modern laboratories have evolved towards almost complete automation, by making use of laboratory information systems (LIS) that interact with medical devices in an automatic way using real-time communication protocols. However, laboratories have been increasing in terms of size and complexity mostly due to economic reasons: large groups of geographically distributed laboratories have been replacing small laboratories. This trend poses challenges for traditional LIS architectures based on a centralized system, given that the distributed nature of modern laboratories has a negative impact on the performance of the communication between medical devices and LIS, and also increases the risk of temporary network disconnection. In this paper we address these challenges by proposing a novel architecture that seamlessly integrates distributed medical devices using mechanisms that provide real-time operation and ensure fault-tolerance. The proposed system is expected to continuously provide trustworthy services even in critical scenarios.

14:50-15:10 — TuBT3.5

Sparse Causal Residual Neural Network for Linear and Nonlinear Concurrent Causal Inference and Root Cause Diagnosis, pp. 1182-1187

Chen, Jiawei — Zhejiang University
Zhao, Chunhui — Zhejiang University
Sun, Youxian — Zhejiang University

Reliable and effective fault diagnosis methods are necessary for complex industrial processes that consists of various units. After a process fault is detected, it remains a challenging task to locate the root cause unit and determine the propagation path of the fault. In this paper, a novel method, termed Sparse Causal Residual Neural Network (SCRNN), is proposed and applied for modern industrial root cause diagnosis. The advantage of SCRNN lies in that it can not only recognize linear and nonlinear causal relationships in parallel, but also automatically determine the causality lags and

deduce the time delay of causal transmission. Besides, due to the specially designed sparse constraint and optimization algorithm, the SCRNN model can realize the function of key dependent variable selection, avoiding the high computational complexity and complicated procedure brought by pairwise comparison. The feasibility of the proposed method is illustrated through the benchmark TE process.

15:10-15:30 TuBT3.6

Leveraging Dynamic Occupancy Grids for 3D Object Detection in Point Clouds (I), pp. 1188-1193

Sierra-Gonzalez, David — Inria Grenoble Rhone-Alpes
paigwar, Anshul — INRIA
Erkent, Ozgur — Inria
Dibangoye, Jilles — INSA-Lyon, Inria
Laugier, Christian — INRIA

Traditionally, point cloud-based 3D object detec- tors are trained on annotated, non-sequential samples taken from driving sequences (e.g. the KITTI dataset). However, by doing this, the developed algorithms renounce to exploit any dynamic information from the driving sequences. It is reasonable to think that this information, which is available at test time when deploying the models in the experimental vehicles, could have significant predictive potential for the object detection task. To study the advantages that this kind of information could provide, we construct a dataset of dynamic occupancy grid maps from the raw KITTI dataset and find the correspondence to each of the KITTI 3D object detection dataset samples. By training a Lidar-based state-of-the-art 3D object detector with and without the dynamic information we get insights into the predictive value of the dynamics. Our results show that having access to the environment dynamics improves by 27% the ability of the detection algorithm to predict the orientation of smaller obstacles such as pedestrians. Furthermore, the 3D and bird's eye view bounding box predictions for pedestrians in challenging cases also see a 7% improvement. Qualitatively speaking, the dynamics help with the detection of partially occluded and far-away obstacles. We illustrate this fact with numerous qualitative prediction results.

TuBT4 Room 4

Sensor Networks (Regular Session)

13:30-13:50 TuBT4.1

Short-Term Time Series Forecasting of Concrete Sewer Pipe Surface Temperature, pp. 1194-1199

Thiyagarajan, Karthick — University of Technology Sydney
Kodagoda, Sarath — University of Technology, Sydney
Ulapane, Nalika — The University of Melbourne

Microbial corrosion is considered the main reason for multi-billion dollar sewer asset degradation. Sewer pipe surface temperature is a vital parameter for predicting the micro-biologically induced concrete corrosion. Due to this important measure, a surface temperature sensor suite was recently developed and tested in an aggressive sewer environment. The sensors can fail and they may also put offline during the period of scheduled maintenance. In such situations, time series forecasting of sensor data can be an alternative measure for the operators managing the sewer network. In this regard, this paper focuses on the short-term forecasting of sensor measurements. The evaluation was carried out by forecasting the sensor measurements for different time periods and evaluated with different forecasting models. The ETS model leads to high short-term forecasting accuracy and the ARIMA model leads to high long-term forecasting accuracy. The models were evaluated on real data captured in a Sydney sewer.

13:50-14:10 TuBT4.2

Iterative Learning Control for Distributed Parameter Systems Using Sensor-Actuator Network, pp. 1200-1205

Patan, Maciej — University of Zielona Gora
Klimkowicz, Kamil — University of Zielona Góra
Patan, Krzysztof — University of Zielona Gora

The paper discusses an effective approach to iterative learning control synthesis for an important class of distributed parameter systems described by partial differential equations of diffusion-advection type. Such systems are frequently encountered in mathematical modelling of numerous physical processes. The optimal tracking problem is formulated in the spirit of the optimum experimental design theory for a measuring procedure provided with a sensor network over the multidimensional spatial domain. For such a general experimental setup, the convergence of the iterative control law is provided and decentralized control synthesis discussed as well. The study is illustrated with the application of the developed numerical scheme to the process of laser heating of a silicon wafer example.

14:10-14:30 TuBT4.3

Optimum Partition of Sensing Field with Given Probability on Event Locations, pp. 1206-1209

Gong, Chaohui — University of Shanghai for Science and Technology
Guo, Zhong — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Yan, Zihai — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Yu, Miao — Zhejiang Research Center on Smart Rail Transportation, PowerChin
Wang, Weilin — PowerChina Huadong Engineering Corporation Limited

We investigate how to distribute large quantity of sensors in such a way that workload is evenly shared by sensors. These techniques can also be used for regulating agile mobile sensors, such as UAVs, when the workload of sensors rather than the energy for mobility is the primarily concern. An algorithm is developed for partitioning sensing field such that different partitions have different sensor densities. The goal is to minimize unevenness of the workload to sensor density ratio. The output of the algorithm proved to be the global optimum for serving this purpose.

14:30-14:50 TuBT4.4

Self-Intersection Attention Pooling Based Classification for Rock Recognition, pp. 1210-1215

Chen, Liang — Zhejiang University
Zheng, Qian — Fudan University
Liu, Zhitao — Zhejiang University
Mao, Wei-Jie — Zhejiang University
Lin, Fulong — China Railway Engineering Equipment Group Co., LTD

Rock recognition is a critical step for intelligent control system in tunnel boring machine (TBM). We build the rock recognition dataset by the visual monitoring system in TBM. After that, we present an attention-fusion network (AFN) for rock recognition classification. Our model is trained with the recognition object (rock) image, and gets the rock attention map through the self-intersection operation. To complete the classification task, we propose the attention block in the attention-fusion classifier, which is effective to fuse and encode the feature and attention in an end-to-end manner. We confirm the effectiveness of the self-intersection operation and attention block by visualized experiment and contrast experiment. At the same time, experimental results of the rock recognition dataset indicate that AFN outperforms state-of-the-art methods, including LSTM (mask-guided), ABN (attention-based), ResNet50 (global-feature), both in accuracy and real-time on the rock recognition tasks.

14:50-15:10 TuBT4.5

An Optical Flow Based Multi-Object Tracking Approach Using Sequential Convex Programming, pp. 1216-1221

Xu, Qingwen — ShanghaiTech University
He, Zhenpeng — ShanghaiTech University
Chen, Zhang — ShanghaiTech University
Jiang, Yuning — ShanghaiTech University

Object tracking, as one of the open topics in the past few decades,

has been widely applied in the field of video processing. Although there have been massive researches, some challenges still exist, such as occlusions, clutter and dynamic scenarios. In this paper, we propose a new multi-layer formulation for multi-object tracking, which incorporates the traditional optical flow constraints with a new product term. Then, a sequential convex programming (SCP) based method is presented to solve the resulting non-convex optimization problem. The proposed method can achieve linear convergence rate, which is demonstrated in our numerical results. In order to illustrate the performance of our approach, it is implemented for composite videos, where two objects move in opposite directions. Different experimental settings based on noise-free, occlusions, clutter and dynamic scenarios show that the method can robustly recover multiple layers and the velocity of the objects. Moreover, the experiments indicate considerable potential for handling more complex scenarios.

15:10-15:30 TuBT4.6

Floor Extraction and Door Detection for Visually Impaired Guidance, pp. 1222-1229

Berenguel-Baeta, Bruno — Instituto De Investigación En Ingeniería De Aragón
Guerrero-Viu, Manuel — Instituto De Investigación En Ingeniería De Aragón
Nova, Alejandro — Instituto De Investigación En Ingeniería De Aragón
Bermudez-Cameo, Jesus — Instituto De Investigación En Ingeniería De Aragón
Perez-Yus, Alejandro — Instituto De Investigación En Ingeniería De Aragón
Guerrero, Jose J — Universidad De Zaragoza

Finding obstacle-free paths in unknown environments is a big navigation issue for visually impaired people and autonomous robots. Previous works focus on obstacle avoidance, however they do not have a general view of the environment they are moving in. New devices based on computer vision systems can help impaired people to overcome the difficulties of navigating in unknown environments in safe conditions. In this work it is proposed a combination of sensors and algorithms that can lead to the building of a navigation system for visually impaired people. Based on traditional systems that use RGB-D cameras for obstacle avoidance, it is included and combined the information of a fish-eye camera, which will give a better understanding of the user's surroundings. The combination gives robustness and reliability to the system as well as a wide field of view that allows to obtain many information from the environment. This combination of sensors is inspired by human vision where the center of the retina (fovea) provides more accurate information than the periphery, where humans have a wider field of view. The proposed system is mounted on a wearable device that provides the obstacle-free zones of the scene, allowing the planning of trajectories for people guidance.

TuBT5 Room 5

Distributed Secure Control for Cyber-Physical Systems with Industrial Applications (Invited Session)

Organizer: Deng, Chao — Nanyang Technological University
Organizer: Wang, Yan-Wu — Huazhong University of Science and Technology

13:30-13:50 TuBT5.1

Optimal Trajectory Tracking for Cyber-Physical Marine Vessel: Reinforcement Learning Approach (I), pp. 1230-1235

Li, Xiaolei — Nanyang Technological University
Wang, Jiange — Yanshan University
Li, Xinyao — Nanyang Technological University
Yan, Jiaqi — Nanyang Technological University

In this paper, we consider the optimal trajectory tracking control problem for a cyber-physical marine surface vessel system with unknown dynamics by using a reinforcement learning (RL) algorithm. The main contributions of the paper are threefold: (1) The dynamics of the marine vessel system considered in this paper is partially unknown. (2) The actor-critic-identifier (ACI) architecture based on fuzzy logical system (FLS) approximation is designed to handle the optimal tracking control problem; (3) The same Bellman error is chosen to update the actor and critic FLS weights at the same time. To be more specific, by using FLS approximating the unknown optimal value function, optimal policy, and partial unknown dynamic, a reinforcement learning algorithm is used to solve the optimal tracking problem of the marine surface vessel system. By designing a fuzzy identifier, the actor-critic weights are adaptively updated simultaneously. The rigorous proof is given to verify the correctness of the algorithm.

13:50-14:10 TuBT5.2

Event Triggered Fault Tolerant Control for Nonlinear Systems Based on Adaptive Fault Estimation (I), pp. 1236-1241

Fan, Quan-Yong — Northwestern Polytechnical University
Xu, Shuoheng — Northwestern Polytechnical University
Deng, Chao — Nanyang Technological University
Wang, Cai-Cheng — North Automatic Control Technology Institute

In this paper, the problem of event triggered fault-tolerant control for nonlinear systems based on neural network learning technique is investigated. To achieve the main objective, a novel dynamic fault estimation method is proposed so that the fault mode of the system considered can be determined quickly.Then, one appropriate reference dynamics is selected. Based on the model reference control mechanism, the neural network is employed to learn the desired control policy when the event triggering condition is met. The stability of the closed-loop system is proved based on Lyapunov stability theory. Moreover, there does not exist the Zeno phenomenon using the proposed event triggered control method. Finally, the the effectiveness of the proposed method is verified on a single-joint manipulator system.

14:10-14:30 TuBT5.3

Connectivity Preservation and Collision Avoidance of Multi-Unmanned Surface Vehicles Via Adaptive Sliding Control (I), pp. 1242-1249

Ma, Hongjun — Northeastern University

This paper investigates the connectivity preservation and collision avoidance problems of a multi-unmanned surface vehicle (USV) system. In order to achieve these two goals more effectively, an improved artificial potential function (APF) is de- signed. For the sake of solving the issue of nonlinear disturbance, a fuzzy sliding mode control method combined with fuzzy radial basis function neural network (Fuzzy-RBFNN) is introduced. Then by Lyapunov method, it can be proved that the system which employs the control scheme proposed in this paper is stable. In addition, the theoretical deduction proves that the USV can track a given ideal signal, and the connectivity preservation and collision avoidance of the multi-USV system can be achieved during formation. Finally, a multi-USV system model including four USVs is established, and the control strategy designed in this paper is adopted to conduct simulation experiments with MATLAB. The results testify that this control project is valid.

14:30-14:50 TuBT5.4

Smooth Adaptive Leader-Following Consensus Control for Uncertain Fractional-Order Nonlinear Multi-Agent Systems with Time-Varying Reference (I), pp. 1250-1255

Li, Xinyao — Nanyang Technological University
Wen, Changyun — Nanyang Tech. Univ
Li, Xiaolei — Nanyang Technological University

In this paper, the leader-following consensus control problem is studied for fractional-order nonlinear multi-agent systems in the

presence of system uncertainties and unknown external disturbances. An adaptive distributed control scheme is proposed for each agent with a local controller that contains a filter and estimators for estimating the bounds of the fractional-order derivatives of desired trajectory. All the control signals resulted from the control scheme are smooth and they are still able to achieve asymptotic output consensus tracking while ensuring global boundedness of all the closed-loop signals. Simulation results are provided to illustrate the effectiveness of the proposed control protocol and verify the obtained results.

14:50-15:10 TuBT5.5

Hierarchical Decomposition and Prescribed Performance Bound Based Adaptive Control for Leader-Follower Formation of Uncertain Nonholonomic Mobile Robots (I), pp. 1256-1261

Shen, Jiajun — Beihang University
Wang, Wei — Beihang University
Lu, Jinhu — Academy of Mathematics and Systems Science, ChineseAcademyof Sci
Deng, Chao — Nanyang Technological University

In this paper, the cooperative formation control problem is investigated for multiple two-wheeled mobile robots with unknown parameters. By combining the hierarchical decomposition and prescribed performance bound (PPB) technique, distributed adaptive formation controllers are designed based on dynamic surface control. It is proved in the Lyapunov sense that all the closed-loop signals are semi-globally bounded and the tracking error converges to a compact set, which can be made arbitrarily small by adjusting the design parameters appropriately. Furthermore, formation maintenance, connectivity preservation and collision avoidance can be achieved with the proposed control scheme. Simulations are also given to verify the effectiveness of the theoretical results.

15:10-15:30 TuBT5.6

Robust Adaptive Fault-Tolerant Coordinated Control for Biaxial Gantry System with Friction Compensation (I), pp. 1262-1267

Wang, Kangjun — Beijing Jiaotong University
Liu, Xiangbin — School of Electronics and Information Engineering, Beijing Jiaot
Su, Hongye — Institute of Cyber-Systems and Control, ZhejiangUniversity

In this paper, a novel robust adaptive fault-tolerant coordinated control is proposed for the contour tracking problem of unknown biaxial linear-motor-driven gantry system subject to time-varying actuator faults. Firstly, the dynamic model of the contour error is established by coordinate transformation. The time-varying actuator faults including loss of effectiveness and bias faults with unknown failure time are considered in controller design. The robust adaption law with smooth projection modification is developed to handle for the effect of parametric uncertainties on the system. The proposed control scheme can guarantee that all the signals in the closed-loop system are ultimately bounded even if time-varying actuator faults of the gantry system occur. Finally, two numerical simulations are conducted to show the effectiveness of the proposed control method.

TuBT6 Room 6

Recent Advances in Cooperative Control of Swarm Systems (Invited Session)

Organizer: Dong, Xiwang — Beihang University
Organizer: Li, Zhongkui — Peking University

13:30-13:50 TuBT6.1

Cooperative Control Based on Distributed Attack Identification and Isolation (I), pp. 1268-1273

Liu, Hailing — Southeast University
Huang, Dalin — Southeast University
Zhang, Ya — Southeast University

This paper studies the secure consensus control of multi-agent systems where some agents are injected into malicious attacks and compromised.We focus on the distributed detection and identification of attacks on agents and the realization of consensus of agents against attacks. Firstly, we design monitors that can perform precise distributed attack detection. Then, we propose a distributed attack identification algorithm by constructing distributed observers. After that, a cooperative controller is proposed which ensures the normal control of systems by means of isolating the agents which are attacked. Finally, we validate our results through simulation examples.

13:50-14:10 TuBT6.2

Predefined Finite-Time Output Containment of Nonlinear Multi-Agent Systems with Undirected Topology (I), pp. 1274-1279

Wang, Qing — Beihang University
Zhou, Shiyu — Beihang University, School of Automation Science and Electrical
Zhou, Siquan — Beihang University
Dong, Xiwang — Beihang University
Yu, Jianglong — Beihang University
Ren, Zhang — Beihang University

This paper focuses on the finite-time output containment problem for a kind of nonlinear multi-agent systems with multiple dynamic leaders. Firstly, considering the topological structure among the followers, a kind of adaptive distributed observer is designed to estimate the whole states of all the leaders. By utilizing common Lyapunov theory, the finite-time convergence of proposed distributed observer is proved. On the basis of this conclusion, a containment control protocol including the desired convex combinations of the leaders is developed for each follower by using the given weights. With the help of the output regulation theory, the finite-time output containment criterion for nonlinear multi-agent systems is derived. Finally, a numerical example is presented to demonstrate the effectiveness of the theoretical results.

14:10-14:30 TuBT6.3

Attack-Free Protocol Design with Distributed Noncontinuous Appointed-Time Unknown Input Observer (I), pp. 1280-1285

Lv, Yuezu — Southeast University
Zhou, Jialing — Nanjing University of Science and Technology
Wang, Qishao — Beihang University
Wen, Guanghui — Southeast University

This paper considers the output-feedback consensus problem of linear multi-agent systems under directed communication topologies. To avoid the network attack from potential malicious attacker, the concept of attack-free protocol is proposed, wherein the information transmission via communication channel is forbidden. Under this circumstance, only relative output measurement can be utilized to generate the observer and the protocol. In this paper, by viewing the relative input of neighboring agents as the unknown input, novel distributed unknown input observer is presented for each agent to achieve appointed-time estimation of the consensus error, where only measured relative output information is used. The fully distributed adaptive protocol is then designed based on the proposed observer. The distributed observer takes a pulsative form at some time instants, which is noncontinuous; while such form takes the advantage of reducing computational cost, compared with the pairwise observer design structure. Simulation results are also conducted to illustrate the effectiveness of the proposed attack-free protocol.

14:30-14:50 TuBT6.4

Event-Triggered Optimal Adaptive Control for Robot Trajectory Tracking (I), pp. 1286-1291

Chen, Shuo — Anhui University
FAN, Yuan — Anhui University
Yuchao, Guo — Anhui University

Zhu, Mingjian Anhui University

In this paper, an event-triggered optimal adaptive control is developed for robot trajectory tracking system. Due to the nonlinearity of Hamilton function, we apply the actor-critic neural network structure to solve it. Firstly, the critic network is used to estimate the cost function and the actor network is used to estimate the optimal event-triggered control law. Due to the advantage of event-triggered method, the weight update rate of actor-critic neural network only occurs when the triggering condition is violated, which save a lot of communication resources. Then, the event-triggered robot trajectory tracking system is ultimately bounded by Lyapunov stability analysis. Finally, the simulation show that the proposed method is effective.

14:50-15:10 TuBT6.5

Distributed State Estimation for Nonlinear Networked System with Correlated Noises (I), pp. 1292-1297

Liang, Yuan Beihang University
Hu, Sibo Beihang University
Dong, Xiwang Beihang University
Li, Qingdong Beihang University
Ren, Zhang Beihang University

In this paper, the problem of distributed state estimation for nonlinear networked system with correlated noises is investigated. First, a distributed weighted consensus-based cubature information filtering algorithm is designed, of which the goal is to achieve accurate and stable estimated states with the presence of correlated noises in a fully distributed fashion. Then based on statistical linear approximation method, it is further proved that, both the estimation error and prediction error of the proposed filtering algorithm are exponentially convergent in the mean square sense. Finally, the convergence and improved performance of the proposed filtering algorithm are confirmed by the numerical simulation.

15:10-15:30 TuBT6.6

Active Disturbance Rejection Time-Varying Formation Tracking for Unmanned Aerial Vehicles (I), pp. 1298-1303

Ran, Maopeng Nanyang Technological University
Li, Juncheng Nanyang Technological University
Xie, Lihua Nanyang Technological University

Time-varying formation tracking problem for unmanned aerial vehicle (UAV) swarm systems subject to unknown nonlinear dynamics, external disturbances, and switching topologies is studied. The states of the following UAVs are required to form a predefined time-varying formation while tracking the state of the leading UAV. For each following UAV, the unknown nonlinear dynamics and external disturbance are regarded as an extended state of the UAV, and then an extended state observer (ESO) is correspondingly designed. Based on the output of the ESO, a novel time-varying formation tracking protocol is proposed. Rigorous theoretical analysis is given to show that, with the application of the proposed protocol, the ESO estimation error and the time-varying formation tracking error can be made arbitrarily small. A numerical simulation demonstrates the effectiveness of the proposed approach.

TuCT1 Room 1

Application of Robotics and Autonomous Control in Construction Sites (Invited Session)

Organizer: Leung, Kim-Wan, Joshua Hong Kong University of Science and Technology

16:00-16:20 TuCT1.1

Perception System – from Autonomous Driving to Autonomous Logistic (I), pp. 1304-1304

LIU, MING Hong Kong University of Science and Technology

We deal with robotic perception, and our mission and dedication are to create intelligent systems that can autonomously operate in a complex and diverse environment, with multiple perception approaches. We are fascinated by novel robot concepts that are best adapted for acting with large-scale and dynamic environments and different terrains. We are furthermore keen to give them the intelligence to autonomously navigate in challenging environments. This includes novel methods and tools for human-robot interaction, perception, cognition, knowledge abstraction, mapping, learning, representation, planning, and execution. In this talk, I will introduce the recent development of the robotic perception systems from autonomous driving to delivery robots.

16:20-16:40 TuCT1.2

A Passive Radiant Cooler for Energy-Efficient Building (I), pp. 1305-1305

Huang, Bao Ling Hong Kong University of Science and Technology

Daytime radiative cooling exhibits great potential in realizing space cooling with zero energy consumption, which is desirable especially in tropical and subtropical areas. So far few coolers can achieve satisfactory cooling performance in humid climates. Here, we present a solution-processed all-inorganic radiative cooler, which consists of a gradient ceramic layer on reflective substrate and a self-assembly monolayer of SiO_2 microspheres. High solar reflectance (>96%) and close-ideal IR-selective emission ($\varepsilon_{8-13\mu m}>0.94$, $\eta_\varepsilon=1.44$) make it efficient and applicable in different climates for daytime cooling. Temperature drops of up to 5 °C were achieved in field tests without any solar shading or convection shield at noontime in Hong Kong, where the annual average relative humidity is around 80%. The stable inorganic structure endows the emitter with outstanding durability against sunlight and rain. These merits render this solution-processed inorganic film a promising candidate for passive space cooling.

16:40-17:00 TuCT1.3

Data-Driven Computational Design, Acquiring and Understanding 3D Visual Data (I), pp. 1306-1306

Yeung, Sai Kit Hong Kong University of Science and Technology

The goal of this project is to create a real-time and comprehensive scene understanding system for indoor environments. Compared with traditional scene understanding approaches where fundamental tasks, e.g., 3D reconstruction, semantic segmentation are performed separately and sequentially, our system jointly carries out those tasks in an efficient way, resulting not only the 3D model of a scene but also the semantic label for every vertex in the scene. The techniques developed in our work establish a foundation for many real-world applications including 1) Robotics application that requires accurate fine-grained local manipulation, e.g., opening door, place items in specific locations. 2) Augmented Reality (AR) application that involves different non-flat surfaces, for example, a real-time display of information for a construction site, e.g., pipe, different machines. Furthermore, since the problem is highly ill-posed, we propose to get users involved into the scene understanding process, e.g., users can provide corrections to machine-generated interim results. This will make the system more robust.

17:00-17:20 TuCT1.4

AI Technologies for Image and Video Enhancement (I), pp. 1307-1307

Chen, Qifeng Hong Kong University of Science and Technology

We will share our recent research on image and video enhancement with AI technologies. With our technologies, a camera can clearly see the world at night as if it is daytime. Our method can produce high-quality images and videos at the luminance about 1 lux. Furthermore, our research can also enable cameras to see further with enhanced AI-based digital zoom. With our AI imaging technologies, we can enable various practical applications including abnormal event detection such as illegal parking and theft, especially in a dark environment.

17:20-17:40 TuCT1.5

Research on Design and Forming Technology of Large

Size Continuous Fiber Reinforced Composites for Building Formwork and Light-Weight Robots (I), pp. 1308-1308

Lu, Dong — Hong Kong University of Science and Technology

Continuous fiber reinforced thermoplastics (CFRTPs) are very suitable for robots, unmanned system manufacturing due to their high mechanical properties, light weight and high productivity. However, there are several challenges on large size and complicated structure CFRTPs, such as processing, dimensional stability and accuracy et al. This report focused on a continuous glass fiber reinforced polypropylene composite for a large size building formwork, and proposes a numerical method for materials, structure and processing design of the CFRTP. We employed finite element methods to simulate and predict defects in the design stage. In this work, Moldex3D, Digmat and Abaqus were combined used to analyze all key parameters of the material molding and injection process as a whole. The accuracy and effectiveness of the proposed numerical methods were verified through actual engineering product, which showed that this numerical design and optimization method can obviously reduce product development costs and shorten the cycle.

17:40-18:00 TuCT1.6

Application of Robotics and Autonomous Control in Construction Sites (I), pp. 1309-1310

Leung, Kim-Wan, Joshua — Hong Kong University of Science and Technology
Qiu, Li — Hong Kong Univ. of Sci. & Tech

Use of robots and autonomous control in modern construction sites will bring obvious advantages to improve the efficiencies and ensure the workers' safety. However, high contrast and monotonous light condition, diversified and ever-changing environment in construction sites complicated the design and control of robot to perform its duty. There are problems in many different aspects need to be resolved in order to maximize the advantage of using robot to supplement human labors. In this session, results in attempts to address some of these problems will be presented, including the method in creating intelligence in autonomous control, using AI technologies to enhance visual capture and computational design for human-robot understanding. Topics on the material to enhance robots and construction will also be addressed.

TuCT2 Room 2

Internet of Things (Regular Session)

16:00-16:20 TuCT2.1

A Data Driven Approach for Leak Detection with Smart Sensors (I), pp. 1311-1316

Liang, Bin — University of Technology Sydney
VERMA, SUNNY — University of Technology Sydney
Xu, Jie — University of Technology Sydney
Liang, Shuming — University of Technology Sydney
Li, Zhidong — UTS
Wang, Yang — University of Technology Sydney
Chen, Fang — University of Technology Sydney

Preventing water pipe leaks and breaks has high priority for water utilities. It is a critical task for the utility to reduce water loss through leaks and breaks detection in water mains. The failure prediction and data analytics research have been conducted for an Australian water utility over the last few years to enhance the prediction of leaks and breaks detection in water mains. Intelligent sensing at sensitive locations with current research aids in prioritising investigation and prevention of potential breaks and leaks in water mains. The purpose of this work is to integrate the predictive analytics and intelligent sensing applications to identify high risk mains prior to failures. Predictive analytics and minimum night flow (MNF) analysis have been utilised to prioritise risky zones over the whole water network, and then risky pipes are identified to optimise sensors deployment. The sensing data is being collected for analysis and validation, and a machine learning model is being built based on the analysis results. This work is currently under progress and the planned outcomes will help the utility reduce water loss, improve leak detection, and enhance customer satisfaction by automating the process of leak detection using a data driven approach with smart sensors.

16:20-16:40 TuCT2.2

Searching for High Accuracy Mix-Bitwidth Network Architecture, pp. 1317-1322

Lan, Haochong — Nanyang Technological University
Lin, Zhiping — School of Electrical &ElectronicEng., NanyangTechnologicalUnivers
Lai, Xiaoping — Hangzhou Dianzi University

The quantization of deep neural networks has drawn great research interest as well as industrial support for its tremendous advantages on boosting the inference speed of convolutional neural network models, especially on resource-constrained devices. Emerging research work and software framework for low-bit quantization, i.e., quantization under 8 bits, also shows strong potential. However, extreme low-bit neural network, e.g., binary neural network (BNN), suffers from significant accuracy loss. A previous work tried to improve the performance of extreme low-bit neural networks by adjusting channel numbers but achieves a poor balance between accuracy and model size. Alternatively, adjusting bitwidth for each layer gains a higher return on accuracy with an acceptable increase in model size. In this work, we employ a genetic algorithm to find the optimal bitwidth assignment for layers in VGG-Small and ResNet18. Both searched mix-bitwidth network architectures achieve higher accuracy with lower time and memory consumption, compared to their fix-bitwidth counterparts. A further investigation on the combination of BNN and the intermediate layer of higher bitwidth is also conducted.

16:40-17:00 TuCT2.3

BOSON - Application-Specific Instruction Set Processor (ASIP) for Educational Purposes, pp. 1323-1328

Mazurek, Przemyslaw — West Pomeranian University of Technology in Szczecin

This paper describes the Boson - Application-Specific Instruction Set Processor (ASIP), which is intended for educational purposes at the university. ASIP allows ISA (Instruction Set Architecture) optimization for a specific task, which is important for project optimization. Considered soft processor allows step-by-step learning of ASIP technology and microcontroller using the Logisim simulator, as well as a FPGA synthesis tool such as Quartus. Presented project shows the main ideas and design choices that were verified in the education process in the third semester of engineering studies "Information and Communication Technologies".

17:00-17:20 TuCT2.4

Robust CSI-Based Human Activity Recognition Using Roaming Generator, pp. 1329-1334

WANG, DAZHUO — Nanyang Technological University
Yang, Jianfei — Nanyang Technological University
CUI, WEI — Institute for Infocomm Research (I2R), Agency for Science, Techn
Xie, Lihua — Nanyang Technological University
SUN, SUMEI — Institute for Infocomm Research (I2R), Agency for Science, Techn

Channel State Information (CSI) based human activity recognition has received great attention in recent years due to its advantages in privacy protection, insensitive to illumination and no requirement for wearable devices. However, for practical deployment, it needs to greatly enhance the performance robustness against dynamic changes of the surrounding environment. To address this problem, we propose a novel CSI based activity recognition using Roaming Generator (CSIRoG) system for human activity detection. CSIRoG leverages existing WiFi infrastructures and monitors human behaviours from CSI measurements. It utilizes the generative adversarial network (GAN) to transfer the CSI information from one environment to another with dynamic changes such as people passing by, furniture layout changes, etc. The proposed method aims to approximate the CSI distribution in the new environment setting which has very limited CSI data. Therefore, the system can learn to handle multiple environment dynamics. Compared to the existing works, CSIRoG leverages a multimodal system model for better diversity of the generated CSI data for knowledge transfer. This improves the ability of CSIRoG to recognize various kinds of CSI information for one specific user activity caused by various dynamic conditions, thus enhancing system robustness. We have tested CSIRoG under multiple environment settings at different places. The experimental results demonstrate that our algorithm overcomes environmental dynamics and outperforms existing human activity recognition systems.

TuCT4 Room 4

Internet of Things (IoT) Based Indoor/Outdoor Localization and Tracking (Invited Session)

Organizer: Chen, Zhenghua — Nanyang Technological University

Organizer: Jiang, Chaoyang — Beijing Institute of Technology

16:00-16:20 TuCT4.1

A Multi-Hop Distributed Indoor Localization Algorithm for Ultra-Wide-Band Sensor Network (I), pp. 1335-1340

He, Chengyang — Beijing Institute of Technology, Chongqing Innovation Center
Xia, Yinqiu — Beijing Institute of Technology
Yu, Chengpu — Beijing Institute of Technology, Chongqing Innovation Center
Jiang, Chaoyang — Beijing Institute of Technology

This paper proposes a multi-hop distributed sensor network localization method based on UWB ranging measurements. Different from the positioning algorithm suitable for known indoor environments, this algorithm is designed for the exploration needs of unknown areas. Based on the barycentric coordinates of the tetrahedron, the expansion of the sensor network is realized through the multi-hop of the UWB sensor. The proposed algorithm can be applied for three-dimensional space. By designing time-varying weight coefficients and combining Taylor expansion, the localization performance is enhanced. Finally, a numerical simulation is given to verify the effectiveness of the proposed algorithm.

16:20-16:40 TuCT4.2

Adaptive Kalman Filter with Linear Equality Road Constraints for Autonomous Vehicle Localization (I), pp. 1341-1346

Xu, Yanjie — Beijing Institute of Technology
Wang, Xingqi — Beijing Institute of Technology
Jiang, Chaoyang — Beijing Institute of Technology

This paper proposes a positioning method using an adaptive Kalman filter (AKF) with linear equality road constraints. The AKF algorithm used in vehicle localization can adaptively adjust the covariance matrices of both the system noise and the measurement noise based on the innovation sequence. Linear equality road constraints incorporated into AKF architecture can restrict the unconstrained position estimates to the constraint set via projection method and then give the final positioning results. Finally, two simulation cases based on segmented straight roads are provided to show the effectiveness of the proposed method.

16:40-17:00 TuCT4.3

Integrated BLE and PDR Indoor Localization for Geo-Visualization Mobile Augmented Reality (I), pp. 1347-1353

Zhou, Baoding — Shenzhen University
Gu, Zhining — Shenzhen University
ma, Wei — Shenzhen University
Liu, Xu — Shenzhen University

Spatial data visualization technology allows users to understand Geographic Information System (GIS) applications. Unlike traditional visualization methods, Augmented Reality (AR) inserts virtual objects and information directly into digital representations of the real world, which makes these objects and data more easily understood and interactive. However, effective AR-GIS systems and rich spatial information visualization is still a challenging task. In addition, indoor AR-GIS systems are further impeded by the limited capacity of these systems to detect and display geometry and semantic information. To address this problem, a novel AR and indoor map fusion method is proposed that automatically registers spatial information onto a live camera view of a mobile phone. We fused Bluetooth low energy (BLE) and pedestrian dead reckoning (PDR) localization techniques to track the camera positions. The proposed algorithm extracts and matches a bounding box of the indoor map to a real world scene. We render the indoor map and semantic information into the real world, based on the real-time computed spatial relationship between the indoor map and live camera view. Experimental results demonstrate that our approach accurately and richly visualizes spatial information. Our augmented reality and indoor map fusion technique effectively links rich indoor spatial information to real world scenes in AR integrated GIS.

17:00-17:20 TuCT4.4

Indoor Mobile Localization Based on a Tightly Coupled UWB/INS Integration (I), pp. 1354-1359

Yang, Haoran — Southeast University
Yujin, Kuang — Southeast University
Manyi, Wang — Nanjing University
Xiaoyu, Bao — Southeast University
Yang, Yuan — Southeast University

A growing research effort has been dedicated to indoor localization specifically the integration of multiple local positioning techniques, allowing to profit from their advantages. However, integration methods that rely mainly on practicable measurement models or algorithm efficiency. This paper proposes a tightly coupled UWB/INS method for indoor pedestrian applications. In indoor environments, wireless signal outage and severe multipath propagation very often lead to large ranging errors and make Ultra-Wide Band (UWB) based localization barely possible. On the other hand, Micro-Electro-Mechanical System (MEMS) Inertial Navigation System (INS) is necessary to conquer its constant bias, drift, and accumulated errors with time. Based on the characteristics of UWB and inertial measurements, a loosely coupled model using an Extended Kalman Filter (EKF) and a tightly coupled model using another EKF are put forward, which aims to reduce the accumulated error and multipath effects for the indoor mobile tracking. The experiment results demonstrate that, when compared with the accuracy of UWB, the combination of UWB/INS increases by 60.61% with the tight integration model and 31.47% with the loose integration.

17:20-17:40 TuCT4.5

Linear Features Observation Model for Autonomous Vehicle Localization, pp. 1360-1365

SHIPITKO, OLEG — Institute for Information Transmission Problems – IITP RAS
kibalov, vladislav — Institute for Information Transmission Problems – IITP RAS, Bol'
Abramov, Maxim — Institute for Information Transmission Problems – IITP RAS

Precise localization is a core ability of an autonomous vehicle. It is a prerequisite for motion planning and execution. The well-established localization approaches such as Kalman and particle filters require a probabilistic observation model to compute a likelihood of measurement given a system state vector, usually vehicle pose, and a map. The higher precision of the localization system may be achieved through the development of a more sophisticated observation model considering various measurement error sources. Meanwhile model needs to be simple to be computable in real-time. This paper proposes an observation model for visually detected linear features. Examples of such features include, but not limited to, road markings and road boundaries. The proposed observation model depicts two core detection error sources: shift error and angular error. It also considers the probability of false-positive detection. The main contribution of the paper is an angular part of the model which corrects bias in the likelihood estimation of existing models. The structure of the proposed observation model allows precomputing and incorporating the measurement error directly into the map represented by a multichannel digital image. Measurement error precomputation and storing the map as an image speeds up observation likelihood computation and in turn localization system. The experimental evaluation on real autonomous vehicle demonstrates that the proposed angular component of the model increases localization quality and the whole model structure allows for precise and reliable localization in a wide range of scenarios.

17:40-18:00 TuCT4.6

No-Attachment Head Tracking Method of Robotic Transcranial Magnetic Stimulation Based on Vision Sensor, pp. 1366-1371

Yu, Chen — Harbin Institute of technology(Shen Zhen)
Wang, Xin — Harbin Institue of Technology (Shenzhen)
Lu, ZongJie — Harbin Institute of technology(Shen Zhen)
Su, HuanRan — Harbin Institute of technology(Shen Zhen)

A vision-based head tracking method for robotic transcranial magnetic stimulation (TMS), requiring no attachments to patient, is proposed to track the movements of patient's head during treatment. First, a facial landmark detection method based on Constrained Local Neural Field (CLNF) algorithm is used. Second, a method of head location and pose estimation is presented and a filter for image restoration is used for a higher accuracy. Finally, calibration approaches are proposed based on the coordinates of the robot arm and camera and real-time motion tracking system. Experiment results indicate that the accuracy and real-time performance of this head tracking method satisfy the requirements of TMS treatment.

TuCT5 Room 5

Modeling, Monitoring, Control, and Signal Processing in Intelligent Manufacturing Systems (Invited Session)

Organizer: Que, Haoyi — Shenzhen Polytechnic
Organizer: Lu, Shan — Zhejiang University
Organizer: Xu, Zhaowen — Shenzhen Polytechnic

16:00-16:20 TuCT5.1

Leader Tracking in Constant Spacing Policy with Parasitic Delays and Lag (I), pp. 1372-1376

Su, Zhiyuan — The Army Military Transportation University
Li, Yongle — The Army Military Transportation University
Xue, Yuanfei — Shenzhen Polytechnic, Mingde Building 503

In the paper, the effect of the actuator lag and communication delays on the stability of a vehicle platoon, which adopts a constant spacing policy and predecessor-leader following type information flow is discussed. While using spacing error transfer function, we analyzed the string stability in frequency domain, and the upper bounds on the allowable parasitic lag and communication delays could be confirmed. Also, With the larger post-sequence delay, the limited string scalability would be shown by the communication delay of the leader.

16:20-16:40 TuCT5.2

Oscillating Scanning FPCB Micromirror Integrated with Angle Detecting (I), pp. 1377-1381

Li, Liangtian — Shenzhen Polytechnic

Monitoring the rotation angle of oscillation mirrors is critical in providing feedback information to control the laser scanning's accuracy and fast response, as well as synchronize with other information such as the measurement result in mirror-based scanning LiDAR. A measuring model for wide range rotating angle scanning, using a single photodiode detector integrated with a FPCB micromirror is proposed. It measures only one discrete mirror rotation angle, as well as the time interval between twice the mirror's rotation passing this angle such as to obtain the mirror's oscillation angle at any time. A sine wave with amplitude of 0.5v is used as the driving signal at resonant frequency region from 90HZ to 103HZ. The results of the experiments indicate that the optical scanning angle of the micromirror can be well controlled and measured at the range of 60 degree, where the optical scanning angle is equal to 4 times of single side mechanical angle of micromirror.

16:40-17:00 TuCT5.3

Asynchronous H-Infinity Control of Markov Jump Nonlinear Systems Using Sliding Mode Approach and Its Application to an Electric Circuit (I), pp. 1382-1387

Xu, Ming — NingboTech University
Xu, Zhaowen — Shenzhen Polytechnic
Ma, Long-hua — Zhejiang University
Que, Haoyi — Shenzhen Polytechnic
cui, dan — School of Information and Control Engineering, Liaoning Shihua U

This note investigates the asynchronous control issue for Markov jump nonlinear systems using sliding mode approach. An interesting hidden Markov model based mapping mechanism is used to simulate the asynchronous phenomenon and quantify its degree. It is extended to the continuous-time case for Markov jump nonlinear systems by utilizing sliding mode approach. Sufficient conditions are derived ensuring the stochastic stability of the closed loop dynamic and its H-infinity noise attenuation performance. The obtained results are verified by a LCR circuit in the end.

17:00-17:20 TuCT5.4

Gaussian Process Model Predictive Control Based Cooperative Motion Planning Structure for UAGVS (I), pp. 1388-1393

Sun, Pei — Shenzhen Polytechnic
Que, Haoyi — Shenzhen Polytechnic
Zhou, Yiming — Shenzhen Polytechnic

Unmanned Aerial and Ground Vehicle System (UAGVS) has attracted much attention recently because of its complementary between unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs). Gaussian process (GP) models based model predictive control (MPC) structure is proposed for motion planning in this article. The GP models are firstly trained to describe the dynamics of UAVs and UGVs with their uncertainties. Stochastic optimization problems are designed for motion planning and controlling based on the GP models' probabilistic predictions. And as there may be interaction among agents, the predicted motion information is also communicated with each other, so that they can obtain others' future planned behaviors. Simulation results show that the proposed method exhibit promising effects of motion planning for UAVGS.

17:20-17:40 TuCT5.5

Improvement of Ant Colony Method Track Planning Based on Artificial Potential Field Method (I), pp. 1394-1398

Yanze, Zhu — Northwesten Polytechnical University
Rong, Ma — Northwesten Polytechnical University
Quan, Yihong — XianYang Natural GAS Corporation

In this paper, Ant Colony Method is combined with Artificial Potential Field Method, to propose a new optimization method to enhance the robustness of t original algorithm. The core of new algorithm is aim to improve original path planning of ant colony method by using artificial potential field method, and to complete the allocation of primary data of ant colony algorithm. And the optimization method is applied to 3D track planning of UAV, and it is proved to be

effective by simulation.

17:40-18:00	TuCT5.6

Resilient Privacy-Preserving Average Consensus for Multi-Agent Systems under Attacks (I), pp. 1399-1405

Wang, Dong	Hangzhou Dianzi University
Zheng, Ning	Hangzhou Dianzi University
Xu, Ming	Hangzhou Dianzi University
Wu, Yiming	Hangzhou Dianzi University
Hu, Qinling	Hangzhou Dianzi University
Wang, Gangyang	Hangzhou Dianzi University

Security of consensus control is of key significance in multi-agent systems. In this paper we investigate the resilient consensus problem for multi-agent systems under the specific attack scenarios where the attacker can eavesdrop on initial information of agents among the system, and modifies the values in the communication links to interfere in the consensus process. To protect the privacy of node' value, we employ the cryptography of homomorphic encryption to encrypt initial integer state of each agent, without revealing to other agents the real value in the network. When the communication network meets the necessary connectivity, we develop a variation of so-called ratio consensus algorithm that deal with malicious attacks. The numerical example of directed network is conducted to illustrate the effectiveness of our proposed algorithm.

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ICARCV 2020 PROGRAM AT A GLANCE

Sunday, 13 December2020						
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1030 - 1230	**Plenary Panel in Control (Room1)**					
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1330 - 1530	**SuBT1** Best Paper Award Finalist Presentations	**SuBT2** Electric Vehicles and Intelligent Transportation 1	**SuBT3** Multi-Agent Systems	**SuBT4** Intelligent Transportation Systems	**SuBT5** Cooperation and Security in Network-Connected Systems	**SuBT6** Mobile Robot Navigation, Vision and AI
1600 - 1800	**SuCT1** Best Student Paper Award Finalist Presentations	**SuCT2** Electric Vehicles and Intelligent Transportation 2	**SuCT3** Learning and Statistical Methods	**SuCT4** Mobile Robotics	**SuCT5** ntelligent Perception and Control for Autonomous Systems/robots 1	**SuCT6** ntelligent Perception and Control for Autonomous Systems/robots 1Intelligent Perception and Control for Autonomous Systems/robots 2
Tuesday, 14 December 2020						
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Wednesday, 15 December 2020						
0900 - 1100	**Plenary Panel in AI and Robotics (Room1)**					
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