FINAL PROGRAM
&
BOOK OF ABSTRACTS

19TH IEEE INTERNATIONAL CONFERENCE ON CONTROL AND AUTOMATION

(IEEE ICCA 2025)

Tallinn, Estonia

June 30 to July 3, 2025

Organizers

IEEE Singapore Control Systems Chapter

Hong Kong Centre for Logistics Robotics

Technical Sponsors

IEEE Control Systems Society

IEEE Estonia Section

Technical Committee on Control Theory (TCCT), Chinese Association of Automation.

IEEE International Conference Series on Control and Automation

Past and Present

- Singapore International Conference on Intelligent Control and Instrumentation (SICICI 1992)
  February 17–21, 1992, Marina Mandarin Hotel, Singapore
- Singapore International Symposium on Control Theory and Applications (SISCTA 1997)
  July 29–30,1997, Hilton International, Singapore
- 3rd International Conference on Control Theory and Applications (ICCTA 2001)
  December 12–14, 2001, University of Pretoria, South Africa
- 4th International Conference on Control and Automation (ICCA 2003)
  June 10–12, 2003, Concordia University, Montreal, Canada
- 5th International Conference on Control and Automation (ICCA 2005)
  June 27–29, 2005, Hungarian Academy of Science, Budapest, Hungary
- 6th IEEE International Conference on Control and Automation (IEEE ICCA 2007)
  May 30–June 1, 2007, Baiyun International Convention Center, Guangzhou, China
- 7th IEEE International Conference on Control and Automation (IEEE ICCA 2009)
  December 9–11, 2009, Hotel Grand Chancellor, Christchurch, New Zealand
- 8th IEEE International Conference on Control and Automation (IEEE ICCA 2010)
  June 9–11, 2010, Asia Gulf Hotel, Xiamen, China
- 9th IEEE International Conference on Control and Automation (IEEE ICCA 2011)
  December 19–21, 2011, Park Plaza Hotel, Santiago, Chile
- 10th IEEE International Conference on Control and Automation (IEEE ICCA 2013)
  June 12–14, 2013, Zhejiang Hotel, Hangzhou, China
- 11th IEEE International Conference on Control and Automation (IEEE ICCA 2014)
  June 18–20, 2014, Evergreen Laurel Hotel, Taichung, Taiwan
- 12th IEEE International Conference on Control and Automation (IEEE ICCA 2016)
  June 1–3, 2016, Soaltee Crowne Plaza Hotel, Kathmandu, Nepal
- 13th IEEE International Conference on Control and Automation (IEEE ICCA 2017)
  July 3–6, 2017, Metropol Lake Resort, Ohrid, Macedonia
- 14th IEEE International Conference on Control and Automation (IEEE ICCA 2018)
  June 12–15, 2018, Sheraton Hotel, Anchorage, Alaska, USA
- 15th IEEE International Conference on Control and Automation (IEEE ICCA 2019)
  July 16–19, 2019, Royal College of Physicians, Edinburgh, Scotland
- 16th IEEE International Conference on Control and Automation (IEEE ICCA 2020)
  October 9-11, 2020, Virtual Conference
- 17th IEEE International Conference on Control and Automation (IEEE ICCA 2022)
  June 27-30, 2022, Ramada Naples City Centre, Naples, Italy (Hybrid Conference)
- 18th IEEE International Conference on Control and Automation (IEEE ICCA 2024)
  June 18-21, 2024, University of Iceland, Reykjavík, Iceland
- 19th IEEE International Conference on Control and Automation (IEEE ICCA 2025)
  June 30 to July 3, 2025, Tallinn, Estonia

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Welcome Message

On behalf of the conference organizing committee, it is with great pleasure that we present the Final Program and Proceedings of the 19th IEEE International Conference on Control and Automation (IEEE ICCA 2025). Set against the captivating backdrop of Tallinn, Estonia, from June 30 to July 3, 2025, the conference is jointly organized by IEEE Singapore Control Systems Chapter, Hong Kong Centre for Logistics Robotics, technically co-sponsored by IEEE Control Systems Society, IEEE Estonia Section, and the Technical Committee on Control Theory (TCCT), Chinese Association of Automation. Our aim is to create a forum for scientists and practising engineers throughout the world to present the latest research findings and ideas in the areas of control and automation, and possible contributions toward sustainable development and environment preservation.

The capital of Estonia is a charming city on the northern coast of the country, facing the Gulf of Finland. Known for its well-preserved medieval architecture, Tallinn's Old Town is a UNESCO World Heritage Site, featuring cobblestone streets, ancient city walls, and historical landmarks.

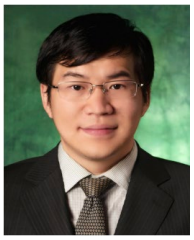
This year's conference boasts an enriching program featuring 33 sessions, including 5 invited sessions, 4 keynote speeches, and a plenary panel session delivered by distinguished experts in the field. Additionally, we are excited to showcase two special sessions dedicated to the Best Paper Award and the Best Student Paper Award, with 5 finalists identified for each category. The winners will be revealed during the conference banquet, adding an element of anticipation to our gathering.

IEEE ICCA 2025 represents yet another significant milestone in the evolution of our conference series. Over the years, it has traversed borders, being hosted in diverse locales such as South Africa, Canada, Hungary, USA, Italy, Scotland and more, steadily growing into a pivotal international event in the realms of systems, control, and automation. This year, we received 199 submissions from academic researchers and engineers spanning 35 countries and regions worldwide. Following a rigorous review process by our esteemed program committee and reviewers, we are proud to include 163 high-quality manuscripts in our final technical program and conference proceedings.

We extend our heartfelt gratitude to all members of the organizing committee and the program committee as well as the reviewers for their unwavering dedication and tireless efforts over the past few months. Their commitment has been instrumental in bringing this conference to fruition and ensuring its success. We are deeply appreciative of their contributions.

Last but certainly not least, we extend our sincere thanks to all our esteemed delegates for their keen interest, valuable contributions, and active participation in IEEE ICCA 2025. It is our earnest hope that this conference proves to be both intellectually stimulating and enjoyable for all attendees. We eagerly anticipate your continued support in future editions of IEEE ICCA.Wishing you all a truly memorable and enriching experience in Tallinn!


Minyue Fu, Lin Zhao
General Chairs
IEEE ICCA 2025

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General Conference Information

The 19th IEEE International Conference on Control & Automation (IEEE ICCA 2025) will be held Tuesday through Friday, June 30~July 3, 2025, in Tallinn, Estonia. The conference is jointly organized by IEEE Singapore Control Systems Chapter, Hong Kong Centre for Logistics Robotics, technically co-sponsored by IEEE Control Systems Society, IEEE Estonia Section, and the Technical Committee on Control Theory (TCCT), Chinese Association of Automation.
It aims to create a forum for scientists and practising engineers throughout the world to present the latest research findings and ideas in the areas of control and automation, and possible contributions toward sustainable development and environment preservation.

Language

The official language of the conference is English.

Registration Fees

Registration Categories	Early Registration (by April 25)	Late Registration (after April 25)	Paper Uploads with registration	Banquet	Lunches	Receptions
Full Registration, IEEE Member	SG$1,200	SG$1,500	Two (2)	Included	Included	Included
Full Registration, Nonmember	SG$1,300	SG$1,600	Two (2)	Included	Included	Included
Reduced Registration, Student	SG$600	SG$750	One (1)	Not Included	Included	Included
Reduced Registration, Retiree	SG$600	SG$750	One (1)	Not Included	Included	Included
Reduced Registration, IEEE Life Member	SG$600	SG$750	One (1)	Not Included	Included	Included

A conference registration covers admission to all technical sessions, welcome reception, coffee/tea breaks, lunches, conference dinner and conference banquet (except Student). It also includes one Program Book and one Conference Proceedings (USB) and all taxes.

Onsite Registration Hours (in Tallinn, Estonia) and Location

Date: June 30, 2025 (Monday)
Time: 17:00–20:00

Venue:Viru väljak 4, 10111 Tallinn, Estonia

Welcome Reception

Date: June 30, 2025 (Monday)
Time: 18:00–20:00
Venue: Viru väljak 4, 10111 Tallinn, Estonia

Welcome Address
Date: July 1, 2025 (Tuesday)
Time: 08:30–08:45
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Keynote Speech

Date: July 1, 2025 (Tuesday)
Time: 08:45–14:30
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Plenary Panel Session

Date: July 2, 2025 (Wednesday)
Time: 16:00–17:30
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Conference Banquet

Date: July 2, 2025 (Wednesday)
Time: 19:00–22:30
Venue: Viru väljak 4, 10111 Tallinn, Estonia

Conference Lunches

Date: July 1–2, 2025
Time: 12:15–13:30 (Tuesday), 12:00-14:00 (Wednesday)

Conference Tea Breaks

Date: July 1, 2025 (Tuesday)
Time: 9:45–10:15, 14:30–14;45, 16:15–16:30

Date: July 2, 2025 (Wednesday)
Time: 10:00–10:30, 15:30–16:00

Date: July 3, 2025 (Thursday)
Time: 10:00–10:30

Technical Sessions

Date: July 1–3, 2025 (Tuesday to Thursday)
Time: 14:45–18:00 (Tuesday), 08:30–15:30 (Wednesday), 08:30–12:00 (Thursday)
Rooms: Grande 1&2, Grande 3, Bolero 1, Bolero 2, Viru väljak 4, 10111 Tallinn, Estonia

Program at a Glance

ICCA 2025 Technical Program Tuesday July 1, 2025

ICCA 2025 Technical Program Tuesday July 1, 2025			
Track T1	Track T2	Track T3	Track T4
08:30-08:45 GRANDE 1&2 Keynote Session TuWT8 *Welcome Address*			
08:45-09:45 GRANDE 1&2 Keynote Session TuP1T5 *Keynote Speech 1: Shallow Waters, Deep Problems: Challenges of Controlling Underwater Robots in the Shallows*			
10:15-11:15 GRANDE 1&2 Keynote Session TuP2T6 *Keynote Speech 2: Intelligent Decision and Control Integrating System Based on End-Edge-Cloud Collaboration*			
11:15-12:15 GRANDE 1&2 Keynote Session TuP3T7 *Keynote Speech 3: AI-Empowered Robot Perception and Manipulation*			
13:30-14:30 GRANDE 1&2 Keynote Session TuP4T9 *Keynote Speech 4: Longitude*			
14:45-16:15 GRANDE 1&2 Regular Session TuAT1 *Best Paper Session*	14:45-16:15 GRANDE 3 Regular Session TuAT2 *Motion Control I*	14:45-16:15 BOLERO 1 Regular Session TuAT3 *Nonlinear Systems and Control*	14:45-16:15 BOLERO 2 Regular Session TuAT4 *Control Applications I*
16:30-18:00 GRANDE 1&2 Regular Session TuBT1 *Best Student Session*	16:30-18:00 GRANDE 3 Regular Session TuBT2 *Motion Control II*	16:30-18:00 BOLERO 1 Regular Session TuBT3 *Networked Control*	16:30-18:00 BOLERO 2 Regular Session TuBT4 *Control Applications II*

ICCA 2025 Technical Program Wednesday July 2, 2025

ICCA 2025 Technical Program Wednesday July 2, 2025			
Track T1	Track T2	Track T3	Track T4
08:30-10:00 GRANDE 1&2 Invited Session WeAT1 *Modeling, Optimization, and Control for Unmanned Autonomous Systems I*	08:30-10:00 GRANDE 3 Regular Session WeAT2 *Learning-Based Control I*	08:30-10:00 BOLERO 1 Regular Session WeAT3 *Robotics*	08:30-10:00 BOLERO 2 Invited Session WeAT4 *Intelligent Decision-Making and Applications I*
10:30-12:00 GRANDE 1&2 Invited Session WeBT1 *Modeling, Optimization, and Control for Unmanned Autonomous Systems II*	10:30-12:00 GRANDE 3 Regular Session WeBT2 *Learning-Based Control II*	10:30-12:00 BOLERO 1 Regular Session WeBT3 *Fault Detection and Diagnostics*	10:30-12:00 BOLERO 2 Regular Session WeBT4 *Intelligent Decision-Making and Applications II*
14:00-15:30 GRANDE 1&2 Invited Session WeCT1 *Modeling, Optimization, and Control for Unmanned Autonomous Systems III*	14:00-15:30 GRANDE 3 Regular Session WeCT2 *Intelligent and AI Based Control*	14:00-15:30 BOLERO 1 Regular Session WeCT3 *Multi-Agent Systems I*	14:00-15:30 BOLERO 2 Invited Session WeCT4 *Optimal Control*
16:00-17:30 GRANDE 1&2 Plenary Session WeDT5 *Automation vs. Artificial Intelligence*			

ICCA 2025 Technical Program Thursday July 3, 2025

ICCA 2025 Technical Program Thursday July 3, 2025			
Track T1	Track T2	Track T3	Track T4
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10:30-12:00 GRANDE 1&2 Invited Session ThBT1 *Sensor/Data Fusion*	10:30-12:00 GRANDE 3 Regular Session ThBT2 *Energy Efficiency*	10:30-12:00 BOLERO 1 Regular Session ThBT3 *Multi-Agent Systems III*	10:30-12:00 BOLERO 2 Invited Session ThBT4 *Estimation and Identification II*

Keynote Addresses

Shallow Waters, Deep Problems: Challenges of Controlling Underwater Robots in the Shallows

Professor Maarja Kruusmaa
Fellow of IEEE
Tallinn Technical University, Estonia
Time: 08:45–09:45,July 1, 2025
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Chairs: Zhao, Lin, National University of Singapore

Abstract: Underwater robotics has traditionally focused on deep-sea exploration using large, heavy vehicles. In contrast, near-surface and shallow-water environments remain relatively underexplored — not due to lack of interest, but because of the unique challenges they present.
This talk will explore why operating in shallow water is often more difficult than going deep. Using the example of U-CAT, a highly maneuverable, overactuated, fin-propelled prototype robot, I will demonstrate how underwater robots can be designed to be agile, robust, and fault-tolerant in these complex and disturbance-rich environments.

Maarja Kruusmaa is a professor of Biorobotics inTallinn University of Technology (TalTech) leading a research group of bio-inspired underwater technologies. She investigates how to gain flow information (e.g. currents, turbulence) in natural field conditions and how to use this information for navigating robots. She also works on novel actuation and control methods for underwater robot and robots for low-yield environments.

Intelligent Decision and Control Integrating System Based on End-edge-cloud Collaboration

Professor Tianyou Chai
Fellow of IEEE
Northeastern University, China
Time: 10:15–11:15, July 1, 2025
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Chairs: Yang, Tao, Northeastern University

Abstract: To address the challenges in operation optimization decision and control of complex industrial system, this talk proposes the design method of intelligent optimal decision and control integrating system of complex industrial process. The design method of the system combines control and optimization with prediction, mechanism analysis with deep learning, and digital twin with reinforcement learning, realizing the self-adaption, self-learning, and self-optimization of the system.

Tianyou Chai received the Ph.D. degree in control theory and engineering in 1985 from Northeastern University, Shenyang, China, where he became a Professor in 1988. He is the founder and Director of the Center of Automation, which became a National Engineering and Technology Research Center and a State Key Laboratory. He is a member of Chinese Academy of Engineering, IFAC Fellow and IEEE Fellow. He has served as director of Department of Information Science of National Natural Science Foundation of China from 2010 to 2018.

His current research interests include modeling, control, optimization and integrated automation and intelligence of complex industrial processes.

He has published 356 peer reviewed international journal papers. His paper titled Hybrid intelligent control for optimal operation of shaft furnace roasting process was selected as one of three best papers for the Control Engineering Practice Paper Prize for 2011-2013. He has developed control technologies with applications to various industrial processes. For his contributions, he has won 5 prestigious awards of National Natural Science, National Science and Technology Progress and National Technological Innovation, the 2007 Industry Award for Excellence in Transitional Control Research from IEEE Multiple-conference on Systems and Control, and the 2017 Wook Hyun Kwon Education Award from Asian Control Association.

AI-empowered Robot Perception and Manipulation

Professor Yunhui Liu
Fellow of IEEE
The Chinese University of Hong Kong, China
Time: 11:15–12:15, July 1, 2025
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Chairs: Chen, Fei, The Chinese University of Hong Kong

Abstract: The rapid development of AI, in particular embodied AI, present a lot of opportunity for robotics research and applications. In this talk, we will introduce our on-going research efforts on AI-empowered robots with the aim of developing AI technologies for perception, robot motion planning, manipulation and control of robots. The topics to be covered include AI-powered 3D perception, LLM-driven robot planning and control, robot skill learning, AI-powered robot manipulation, etc. Applications of the technologies in logistics robots and surgical automation will be demonstrated as well.

Yun-hui Liu received B. Eng. degree in Applied Dynamics from Beijing Institute of Technology, M. Eng. degree in Mechanical Engineering from Osaka University, and Ph.D. degree in Applied Mathematics from the University of Tokyo. After working at the national Electrotechnical Laboratory of Japan as a Research Scientist, he joined The Chinese University of Hong Kong (CUHK) and is currently a Choh-Ming Li Professor of Mechanical and Automation Engineering, the Director of the CUHK T Stone Robotics Institute, and the Director/CEO of Hong Kong Centre for Logistics Robotics funded by the InnoHK clusters of the HKSAR government. He has published more than 500 papers in refereed journals and conference proceedings and was listed in the Highly Cited Authors (Engineering) by Thomson Reuters.

His research interests include vision-based robotics, machine intelligence and their applications in manufacturing, logistics, healthcare and constructions. Prof. Liu has received numerous research awards from international journals and international conferences in robotics and automation, and from government agencies. In recent years, he has been actively transferring robotics technologies developed at university labs to industries, and co-founded VisionNav Robotics, CornerStone Robotics, etc. He was the Editor-in-Chief of Robotics and Biomimetics and served as an Associate Editor of the IEEE Transactions on Robotics and Automation. He is Fellow of IEEE, HKIE and HKAE.

Longitude

Professor Alessandro Astolfi
Fellow of IEEE
Imperial College of London, UK
Time: 13:30–14:30, July 1, 2025
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Chair: Fu, Minyue, Southern University of Science and Technology

Abstract: The Longitude problem, and its solution by Harrison, are briefly discussed to highlight the role of coordinates, geometry, interconnection and energy in the solution of complex problems. These are in turn used to define moments and phasors for nonlinear systems and circuits; to discuss the role of interconnection in model reduction and network systems; and to provide a solution to the optimal nonlinear filtering problem. Future perspectives and directions in the areas of constrained optimal control, modelling and control of dynamics sets, and multimedia are also discussed.

Alessandro Astolfi (Fellow, IEEE) graduated in electronic engineering from the University of Rome in 1991. In 1992 he joined ETH-Zurich where he obtained a M.Sc. in Information Theory in 1995 and the Ph.D. degree with Medal of Honor in 1995 with a thesis on discontinuous stabilization of nonholonomic systems. In 1996 he was awarded a Ph.D. from the University of Rome "La Sapienza" for his work on nonlinear robust control. Since 1996 he has been with the Electrical and Electronic Engineering Department of Imperial College London, London (UK), where he is currently Professor of Nonlinear Control Theory and College Consul for the Faculty of Engineering and Business School. From 2010 to 2022 he served as Head of the Control and Power Group at Imperial College London and from 1998 to 2003 he was an Associate Professor at the Dept. of Electronics and Information of the Politecnico of Milano. Since 2005 he has also been a Professor at Dipartimento di Ingegneria Civile e Ingegneria Informatica, University of Rome Tor Vergata.

His research interests are focused on mathematical control theory and control applications, with special emphasis for the problems of discontinuous stabilization, robust and adaptive control, observer design and model reduction. He is the author of over 180 journal papers; 30 book chapters; and over 270 papers in refereed conference proceedings. He is the author (with D. Karagiannis and R. Ortega) of the monograph "Nonlinear and Adaptive Control with Applications" (Springer-Verlag).

He is the recipient of the IEEE CSS A. Ruberti Young Researcher Prize (2007), the IEEE RAS Googol Best New Application Paper Award (2009), the IEEE CSS George S. Axelby Outstanding Paper Award (2012), the Automatica Best Paper Award (2017), and the IEEE Trans, on Control Systems Technology Best Paper Award (2023).

He is a "Distinguished Member" of the IEEE CSS, IEEE Fellow, IFAC Fellow and Member of the Academia Europaea. He served as Associate Editor for Automatica, Systems and Control Letters, the IEEE Trans. on Automatic Control, the International Journal of Control, the European Journal of Control and the Journal of the Franklin Institute; as Area Editor for the Int. J. of Adaptive Control and Signal Processing; as Senior Editor for the IEEE Trans. on Automatic Control; and as Editor-in Chief for the European Journal of Control. He is currently Editor-in-Chief of the IEEE Trans. on Automatic Control (2018–). He served as Chair of the IEEE CSS Conference Editorial Board (2010-2017) and in the IPC of several international conferences. He has served as Chair of the IEEE CSS Antonio Ruberti Young Researcher Prize (2015-2021); he is Vice Chair of the IFAC Technical Board (2020-2023) and he has been/is a Member of the IEEE Fellow Committee (2016), (2019-2022). He is currently a member of the IEEE PSPB Strategic Planning Committee and of the IEEE Fellow Nomination & Appointment Committee.

Plenary Panel Session

Automation vs. Artificial Intelligence

Time: 16:00–17:30pm, July 2, 2025
Venue: Grande 1&2, Viru väljak 4, 10111 Tallinn, Estonia

Panelists: Professor Tongwen Chen, University of Alberta, Canada
Professor Martin Guay, Queen's University, Canada
Professor Zongli Lin, University of Virginia, USA
Professor Petlenkov, Eduard, Tallinn University of Technology, Estonia

Chairs: Professor Ben M. Chen, Chinese University of Hong Kong, China
Professor Zhengtao Ding, University of Manchester, UK

The theme of this year's IEEE ICCA plenary session revolves around Automation vs. Artificial Intelligence. We are privileged to have four distinguished experts and educators in this field join our panel, where they will share their expertise, insights, and visions. Together, we will delve into the challenges facing research in control and automation, both current and emerging. Through direct dialogue with these esteemed panelists, our goal is to gain a deeper understanding of fundamental issues and emerging trends in the field.

Furthermore, this panel will serve as a platform for exchanging ideas and engaging in discussions on broader topics in control and automation. It also provides an invaluable opportunity for the audience, especially students and junior researchers, to glean insights from senior members of our community on challenges commonly encountered in the early stages of our careers or studies.

We introduce our panelists in the alphabetic order as follows.

Dr Tongwen Chen is presently a Professor and Tier 1 Canada Research Chair in Intelligent Monitoring and Control in the Department of Electrical and Computer Engineering at the University of Alberta, Edmonton, Canada. In the past, he received the PhD and MASc degrees in Electrical Engineering from the University of Toronto and BEng degree in Automation and Instrumentation from Tsinghua University. His research interests include computer- and network-based control systems, process safety and alarm systems, and their applications to the process and power industries. He has served as an Associate Editor for several international journals, including IEEE Transactions on Automatic Control and Automatica. He received the 2021 Outstanding Engineer Award from IEEE Canada. He is a Fellow of IEEE, IFAC, the Royal Society of Canada, and the Canadian Academy of Engineering.

Dr Martin Guay is a professor in the Department of Chemical Engineering at Queen's University. Dr. Guay's research interests are in the area of process control, control theory and applied statistics. Dr. Guay received the Queen's University Chancellor Research Award and the Premier Research Excellence Award. He also received the Syncrude Innovation Award and the D.G. Fisher Award from the Canadian Society of Chemical Engineers. He is the Editor-in-Chief of Journal of Process Control and Senior Editor of the IEEE Transactions on Automatic Control. He is an Associate Editor for Automatica and the Canadian Chemical Engineering Journal.

Dr Zongli Lin is the Ferman W. Perry Professor in the School of Engineering and Applied Science and a Professor of Electrical and Computer Engineering at the University of Virginia. He received his B.S. degree in mathematics and computer science from Xiamen University, Xiamen, China, in 1983, his Master of Engineering degree in automatic control from Chinese Academy of Space Technology, Beijing, China, in 1989, and his Ph.D. degree in electrical and computer engineering from Washington State University, Pullman, Washington, in 1994. His current research interests include nonlinear control, robust control, time delay systems, and control applications. He was elected a member of the Board of Governors of the IEEE Control Systems Society (2008–2010, 2019– 2021) and chaired the IEEE Control Systems Society Technical Committee on Nonlinear Systems and Control (2013–2015). He has served on the operating committees of several conferences and will be the General Chair of the 2028 American Control Conference. He has served on the editorial boards of several journals and is the Editor of the Birkhauser book series Control Engineering. He is a Fellow of IEEE, IFAC, AAAS and CCA.

Eduard Petlenkov received hisPhD degree in Computer and Systems Engineering from Tallinn University of Technology. He is a Tenured Full Professor of Intelligent Control Systems at the Department of Computer Systems, Tallinn University of Technology and the Head of the Centre for Intelligent Systems.
His main research interests lie in the domain of nonlinear control, system analysis, computational intelligence, fractional order systems and energy informatics. He is also actively involved in development of intelligent energy efficient control algorithms for commercial buildings.

Best Paper Award Finalists

1. **ESEM: A Visual Topological Navigation Method Integrating Edge Semantic Enhancement in Challenging Environment**

   Qin Haijian, Beijing Information Science and Technology University
   Shen Wangtian, Tsinghua University
   Meng Ziyang, Tsinghua University
   Li Xiaolei, Beijing Information Science and Technology University

2. **Distributed Data-Driven Nash Equilibrium Seeking in Linear Multi-Agent Systems with External Disturbances**

   Wang Linqi, Beijing Institute of Technology
   Liu Wenjie, Beijing Institute of Technology
   Li Yifei, Beijing Institute of Technology
   Sun Jian, Beijing Institute of Technology
   Peng Zhihong, Beijing Institute of Technology

3. **A Graph-Relaxed Method for Byzantine-Resilient Distributed Multidimensional Consensus**

   Qu Zhihai, Tongji University
   Li Xiuxian, Tongji University
   Meng Min, Tongji University
   Yi Xinlei, Tongji University
   You Keyou, Tsinghua University

4. **Sampled-Data Boundary Stabilization of PDE-ODE Cascade Systems with Long Delay**

   Qiu Ruiyang, City University of Hong Kong
   Xu Xiang, Southern University of Science and Technology
   Liu Lu, City University of Hong Kong
   Feng Gang, City University of Hong Kong

5. **Keeping Digital Twin in Sync without Blocking the Physical Motion Stage**

   Jain Vibhor, Eindhoven University of Technology
   von Meijenfeldt Cézan, Eindhoven University of Technology
   Mohamed Sajid, ITEC B.V., Netherlands
   Stuijk Sander, Eindhoven University of Technology
   Goswami Dip, Eindhoven University of Technology

Best Student Paper Award Finalists

1. **Safe Near-Optimal Reinforcement Learning for Robotic Motion Planning Using High Order Control Barrier Functions**

   Jiang Yuhe, Shanghai University
   Zhao Guoxiang, Shanghai University
   Ren Xiaoqiang, Shanghai University

2. **CRL-KEA: A Deep Reinforcement Learning Assisted Evolutionary Algorithm for Multipath Routing Optimization Problem**

   Jiang Jingchen, Beijing Institute of Technology
   Shi Xiang, Beijing Institute of Technology
   Zhou Xuan, Beijing Institute of Technology
   Han Geng, Beijing Institute of Technology
   Deng Fang, Beijing Institute of Technology

3. **Learning-Based Uncertainty-Aware Predictive Control of Truck-Trailer Systems in Rough Terrain**

   Hartmann Philipp, Friedrich-Alexander-Universität Erlangen-Nürnberg
   Graichen Knut, University Erlangen-Nürnberg

4. **DefectGPT: An Automatic Retrieval-Augmented Framework for Digital Twin-Based Defect Information Management and Analytics**

   Huang Yijun, The Chinese University of Hong Kong
   Zhang Jihan, The Chinese University of Hong Kong
   Chen Xi, The Chinese University of Hong Kong
   Lam Alan Hiu-Fung, The Chinese University of Hong Kong
   Chen Ben M. , The Chinese University of Hong Kong

5. **Autonomous UAV Path Planning in Dynamic Environments: A Hybrid Framework of Trajectory Prediction and Priority-Aware DWA**

   Ran Fengrui, Beijing Institute of Technology
   Yu Chengpu, Beijing Institute of Technology
   Xu Erpei, Beijing Institute of Technology
   Feng Yunji, Beijing Institute of Technology

Technical Program

Technical Program for Tuesday July 1, 2025

TuAT1	GRANDE 1&2
Best Paper Session	Regular Session
Chair: Xie, Lihua	Nanyang Technological University
Co-Chair: Lin, Zongli	University of Virginia
14:45-15:00, Paper TuAT1.1	Online presentation (OL)
A Graph-Relaxed Method for Byzantine-Resilient Distributed Multidimensional Consensus (I)	
Qu, Zhihai	Tongji University
Li, Xiuxian	Tongji University
Meng, Min	Tongji University
Yi, Xinlei	Tongji University
You, Keyou	Tsinghua University
15:00-15:15, Paper TuAT1.2	
Keeping Digital Twin in Sync without Blocking the Physical Motion Stage	
Jain, Vibhor	Eindhoven University of Technology
von Meijenfeldt, Cézan	Eindhoven University of Technology
Mohamed, Sajid	ITEC B.V., Netherlands
Stuijk, Sander	Eindhoven University of Technology
Goswami, Dip	Eindhoven University of Technology
15:15-15:30, Paper TuAT1.3	Online presentation (OL)
Sampled-Data Boundary Stabilization of PDE-ODE Cascade Systems with Long Delays	
Qiu, Ruiyang	City University of Hong Kong
Xu, Xiang	Southern University of Science and Technology
Liu, Lu	City University of Hong Kong
Feng, Gang	City University of Hong Kong
15:30-15:45, Paper TuAT1.4	Online presentation (OL)
Distributed Data-Driven Nash Equilibrium Seeking in Linear Multi-Agent Systems with External Disturbances	
Wang, Linqi	Beijing Institute of Technology
Liu, Wenjie	Beijing Institute of Technology, Beijing, China
Li, Yifei	Beijing Institute of Technology
Sun, Jian	Beijing Institute of Technology
Peng, Zhihong	Beijing Institute of Technology
Wang, Gang	Beijing Institute of Technology
15:45-16:00, Paper TuAT1.5	
ESEM: A Visual Topological Navigation Method Integrating Edge Semantic Enhancement in Challenging Environment	
Qin, Haijian	Beijing Information Science and Technology University
Shen, Wangtian	Tsinghua University
Meng, Ziyang	Tsinghua University
Li, Xiaolei	Beijing Information Science and Technology University

TuAT2	GRANDE 3
Motion Control I	Regular Session
Chair: Yang, Xiaoyu	The Hong Kong Polytechnic University
14:45-15:00, Paper TuAT2.1	
Tracking Error Reduction Using Model-Based Input Shaping	
Lichtsinder, Arkady	RAFAEL
15:00-15:15, Paper TuAT2.2	
Definition and Property Analysis of State Entropy in Control Systems	
Zhang, Xiangteng	Tsinghua University
Liu, Shiqi	Tsinghua University
Shuai, Bin	Tsinghua University
Li, Shengbo Eben	Tsinghua University
15:15-15:30, Paper TuAT2.3	
Trajectory Tracking of Micro Linear Piezoelectric Actuator Based on Variable Forgetting Factor Iterative Learning Method	
Feng, Zhiqiang	Tsinghua University
Wang, Ze	Tsinghua University
15:30-15:45, Paper TuAT2.4	
UAV Formation Safety Transformation Strategy for Aerial Refueling	
Li, Jinbai	Beihang University
Wang, Honglun	Beihang University
Wang, Yanxiang	Beihang University
Yan, Guocheng	School of Automation Science and Electrical Engineering, Beihang
Zhu, Junfan	Beihang University

15:45-16:00, Paper TuAT2.5	
Enhancing Motion Performance for CNC Machine Tools Based on AI-Driven Hybrid Model	
Chen, You-Cheng	National Formosa University
Lin, Ming-Tsung	National Formosa University
Li, Yong-Zhong	National Formosa University
Wang, Ya-Hsuan	National Formosa University
Lin, Guan-Yi	National Formosa University
16:00-16:15, Paper TuAT2.6	
3D Clothoid-Based Decoupled Trajectory Planning for Fixed-Wing UAV	
Yang, Xiaoyu	The Hong Kong Polytechnic University
Ai, Zhouxing	The Hong Kong Polytechnic University
Qi, Juntong	Shanghai University
Huang, Hailong	The Hong Kong Polytechnic University
TuAT3	BOLERO 1
Nonlinear Systems and Control	Regular Session
Chair: Liu, Guojun	Hubei University
14:45-15:00, Paper TuAT3.1	
Joint State and Disturbance Estimation Based on the Generalized Observer Form	
Kaldmäe, Arvo	Tallinn University of Technology
Kaparin, Vadim	Tallinn University of Technology
Kotta, Ülle	Institute of Cybernetics at TUT
Tõnso, Maris	Tallinn University of Technology
15:00-15:15, Paper TuAT3.2	
Orbital Station-Keeping in the Earth-Moon System Via Nonlinear Backstepping	
Nunes, António	Instituto Superior Técnico, Universidade De Lisboa
Batista, Pedro	Instituto Superior Técnico
Brás, Sérgio	Instituto Superior Técnico
15:15-15:30, Paper TuAT3.3	
Input-Output Feedback Linearization: Case Study on 2-Contractive Zero Dynamics	
Bora, Riddhi Mohan	Indian Institute of Technology, Delhi
Kar, Indra Narayan	Indian Institute of Technology, Delhi
15:30-15:45, Paper TuAT3.4	
H ∞ Filtering for Continuous-Time Takagi-Sugeno Fuzzy Systems	
Wang, Fan	Hubei University
Liu, Guojun	Hubei University
Yi Liu, Y. Liu	Hubei University
Zhang, Wei	Hubei University
Sun, Jinghui	Hubei University
Xiao, Ting	Hubeiuniversity
Tang, Chao	Hubei University
15:45-16:00, Paper TuAT3.5	
Resilient Safe Optimized Backstepping Control for High-Order Strict-Feedback System	
Zhang, Yuxiang	Natioanl University of Singapore
Ji, Ruihang	National University of Singapore
Ge, Shuzhi Sam	National Univ. of Singapore
16:00-16:15, Paper TuAT3.6	
Pseudolinear Kalman Filter Algorithm for Target Tracking with Doppler-Bearing Measurements	
Zhang, Kanghao	Beihang University
Zhang, Zheng	Beihang University
Dong, Xiwang	Beihang University
Wang, Hong	Beijing Institute of Control Engineering

TuAT4	BOLERO 2
Control Applications I	Regular Session
Chair: Vansovits, Vitali	TalTech University
14:45-15:00, Paper TuAT4.1	
Shared Steering Using Interpolating Control	
Sternberg, Omri	Ben-Gurion University of the Negev
Arogeti, Shai	Ben-Gurion University of the Negev
15:00-15:15, Paper TuAT4.2	
Accurate Control under Voltage Drop for Rotor Drones	
Liu, Yuhang	Beihang University
Jia, Jindou	Beihang University
Yang, Zihan	Beihang University
Guo, Kexin	Beihang University
Yang, Bin	Beihang University
Xu, Lidan	Beihang University
Chen, Taihang	Beihang University
15:15-15:30, Paper TuAT4.3	

Collaborative Safety-Critical Scaling Formation Control of VTOL UAVs: An NMPC-CLF-CBF Approach	
Yang, Ziyi	Xiamen University
Guo, Zhengyu	National Key Laboratary of Air-Based Information Perceptian And
Zhang, Jian	School of Aeronautics, Changji University, Changji, 831100, Chin
Cao, Langcai	Xiamen University
Xu, Yang	Northwestern Polytechnical University
Luo, Delin	Xiamen University
15:30-15:45, Paper TuAT4.4	
An Advanced Process Control Application Framework: Development and Test-Bench Validation	
Vansovits, Vitali	TalTech University
Petlenkov, Eduard	Tallinn University of Technology
Tepljakov, Aleksei	Tallinn University of Technology
Vassiljeva, Kristina	Tallinn University of Technology
15:45-16:00, Paper TuAT4.5	
Adaptive Nonlinear Controller for High-Speed Marine Vehicle Trajectory Tracking: Theory and Practice	
Lehodey, João	Instituto Superior Técnico
Cabecinhas, David	Instituto Superior Técnico
Batista, Pedro	Instituto Superior Técnico
16:00-16:15, Paper TuAT4.6	
Control of Vehicle Lateral Dynamics on Race Circuits with Variable Speeds	
Pauca, Georgiana-Sinziana	Gheorghe Asachi Technical University of Iasi
Pauca, Ovidiu	"Gheorghe Asachi" Technical University of Iasi
Caruntu, Constantin-Florin	Gheorghe Asachi Technical University of Iasi
TuBT1	GRANDE 1&2
Best Student Session	Regular Session
Chair: Lin, Zongli	University of Virginia
Co-Chair: Xie, Lihua	Nanyang Technological University
16:30-16:45, Paper TuBT1.1	Online presentation (OL)
CRL-KEA: A Deep Reinforcement Learning Assisted Evolutionary Algorithm for Multipath Routing Optimization Problem	
Jiang, Jingchen	Beijing Institute of Technology
Shi, Xiang	Beijing Institute of Technology
Zhou, Xuan	Beijing Institute of Technology
Han, Geng	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
16:45-17:00, Paper TuBT1.2	Online presentation (OL)
Autonomous UAV Path Planning in Dynamic Environments: A Hybrid Framework of Trajectory Prediction and Priority-Aware DWA	
Ran, Fengrui	Beijing Institute of Technology
Yu, Chengpu	Beijing Institute of Technology
Xu, Erpei	Beijing Institute of Technology
Feng, Yunji	Beijing Institute of Technology
17:00-17:15, Paper TuBT1.3	
DefectGPT: An Automatic Retrieval-Augmented Framework for Digital Twin-Based Defect Information Management and Analytics	
Huang, Yijun	The Chinese University of Hong Kong
Zhang, Jihan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Lam, Alan Hiu-Fung	The Chinese University of Hong Kong g
Chen, Ben M.	The Chinese University of Hong Kong
17:15-17:30, Paper TuBT1.4	
Learning-Based Uncertainty-Aware Predictive Control of Truck-Trailer Systems in Rough Terrain	
Hartmann, Philipp	Friedrich-Alexander-Universität Erlangen-Nürnberg
Graichen, Knut	University Erlangen-Nürnberg (FAU)
17:30-17:45, Paper TuBT1.5	Online presentation (OL)
Safe Near-Optimal Reinforcement Learning for Robotic Motion Planning Using High Order Control Barrier Functions	
Jiang, Yuhe	Shanghai University
Zhao, Guoxiang	Shanghai University
Ren, Xiaoqiang	Shanghai University
TuBT2	GRANDE 3
Motion Control II	Regular Session
Chair: Vinha, Sérgio	Universidade Do Porto
16:30-16:45, Paper TuBT2.1	
Resilient Control Strategy for a VTOL UAV Achieving Safe Transition Flight under Actuator Faults and Disturbances	

Fu, Yifang	Northwestern Polytechnical University
Wang, Ban	Northwestern Polytechnical University
Zhou, Mengqi	Northwestern Polytechnical University
Zhao, Huimin	Northwestern Polytechnical University
Li, Ni	Northwestern Polytechnical University
16:45-17:00, Paper TuBT2.2	
A Path Planning Method for A-UAV Based on the CGRUA Model	
Qi, Jiahao	Zhengzhou University
Xia, Xing	Zhengzhou University
Guo, Jinjun	Zhengzhou University
Qin, Xiangnan	Zhengzhou University
17:00-17:15, Paper TuBT2.3	
Motion Primitives on a Spherical Surface with Application to Tethered Aircraft Guidance	
Vinha, Sérgio	Universidade Do Porto
Fernandes, Gabriel M.	Universidade Do Porto
Fernandes, Manuel C. R .M.	Universidade Do Porto
Fontes, Fernando A. C. C.	Universidade Do Porto
17:15-17:30, Paper TuBT2.4	
Vehicle Trajectory Planning Using Model Predictive Control in Environments with Dynamic and Static Obstacles	
Pauca, Ovidiu	"Gheorghe Asachi" Technical University of Iasi
Vacaru, Alexandru-Ioan	Gheorghe Asachi Technical University of Iasi
Caruntu, Constantin-Florin	Gheorghe Asachi Technical University of Iasi
17:30-17:45, Paper TuBT2.5	
IRSAI: Integrating Remote Sensing and Artificial Intelligence to Monitor Maritime Activities across Lemesos Bay	
Demetriou, Georgios	Frederick University
Menelaou, Angelos	Frederick University
Kletou, Demetris	Marine & Environmental Research (MER) Lab Ltd
Kleitou, Periklis	Marine and Environmental Research (MER) Lab
Kakoulli, Christina	Marine & Environmental Research (MER) Lab
Artusi, Alessandro	Cyenss CoE
Milidonis, Xenios	CYENS Centre of Excellence
Angelini, Mattia	Cyens Center of Excellence
Trimithiotis, Georgios	Frederick University
Lazaridis, Stefanos	Frederick University
TuBT3	BOLERO 1
Networked Control	Regular Session
Chair: Yin, Xunyuan	Nanyang Technological University
16:30-16:45, Paper TuBT3.1	
Event-Triggered Polynomial Control for Trajectory Tracking by Unicycle Robots	
V, Harini	Indian Institute of Science, Bangalore
Rajan, Anusree	Indian Institute of Science
Amrutur, Bharadwaj	Indian Institute of Science
Tallapragada, Pavankumar	Indian Institute of Science
16:45-17:00, Paper TuBT3.2	
Distributionally Robust Model Predictive Control with Koopman Operators	
Zhang, Wenhao	School of Aeronautics and Astronautics, Sichuan University
Li, Bin	Sichuan University
17:00-17:15, Paper TuBT3.3	
Towards Event-Triggered NMPC for Efficient 6G Communications: Experimental Results and Open Problems	
Püttschneider, Jens	TU Dortmund University
Golembiewski, Julian	TU Dortmund University
Wagner, Niklas A.	TU Dortmund University
Wietfeld, Christian	TU Dortmund University, Communication Networks Institute (CNI)
Faulwasser, Timm	Hamburg University of Technology
17:15-17:30, Paper TuBT3.4	
Adversarial Reinforcement Learning Based IoT Honeypot	
Zhang, Hao	Zhejiang University
Zhang, Siyuan	Zhejiang University
He, Chengrun	Hangzhou Hikvision Digital Technology Co., Ltd
Zhao, Chengcheng	Zhejiang University
17:30-17:45, Paper TuBT3.5	

Collision-Free and Guaranteed Capture Winning Strategies for Reach-Avoid Games with Two Heterogeneous Pursuers and One Evader	
Shu, Peixuan	Beihang University
Yan, Rui	Beihang University
Hua, Yongzhao	Beihang University
Dong, Xiwang	Beihang University
17:45-18:00, Paper TuBT3.6	
Learning and Predictive Control of Nonlinear Systems with Multi-Modal Uncertainties Using Koopman Operator and Gaussian Mixture Model	
Qi, Jialin	Nanyang Technological University
Li, Xiaojie	Nanyang Technological University
Han, Minghao	Nanyang Technological University
Yin, Xunyuan	Nanyang Technological University
TuBT4	BOLERO 2
Control Applications II	Regular Session
16:30-16:45, Paper TuBT4.1	
Mission Planning of Continuous Tracking Moving Targets by Earth Observation Satellite in Unknown Scenarios	
Li, Xiang	Harbin Institute of Technology
Han, Xiaofeng	Harbin Institute of Technology
Ma, Ping	Harbin Institute of Technology
Yang, Ming	Harbin Institute of Technology
Chao, Tao	Harbin Institute of Technology
16:45-17:00, Paper TuBT4.2	
Co-Design of Functional Interval Observer-Based Control for Uncertain Linear Parameter Varying Switched Systems	
Nguyen, Duc To	University of Évry-Val d'Essonne - University of Paris-Saclay
Mammar, Said	University of Evry, IBISC Lab
Ichalal, Dalil	Université d'Evry Val D'Essonne
Ait Oufroukh, Naima	Université d'Evry - Laboratoire IBISC
17:00-17:15, Paper TuBT4.3	
Positive Observer Design for Positive Linear Systems with Applications in Cascaded Symmetric RC Network	
Chaudhary, Bhargavi	Indian Institute of Technology Delhi
Patel, Neetish	Indian Institute of Technology Delhi, New Delhi
Datta, Subashish	Indian Institute of Technology Delhi
Kar, Indra Narayan	Indian Institute of Technology Delhi
17:15-17:30, Paper TuBT4.4	
Incremental Verification of Inference Observability in Decentralized Discrete-Event Control	
Yoon, Sung Ho	Mount Allison University
Ricker, S. Laurie	Mount Allison University
Marchand, Herve	INRIA, Centre Rennes Bretagne-Atlantique
17:30-17:45, Paper TuBT4.5	
Distributed Resilient Consensus and Demand Tracking in Battery Energy Storage Systems under Adversarial Attacks	
Zhang, Shiheng	The Hong Kong University of Science and Technology (Guangzhou)
Ji, Yiding	The Hong Kong University of Science and Technology (Guangzhou)
17:45-18:00, Paper TuBT4.6	
Detecting and Resolving Feature Interactions in Cyber-Physical Systems Using Formal Methods	
Walker, Hayden Douglas	Mount Allison University
Ricker, S. Laurie	Mount Allison University
Marchand, Herve	INRIA, Centre Rennes Bretagne-Atlantique

WeAT1	GRANDE 1&2
Modeling, Optimization, and Control for Unmanned Autonomous Systems I	Invited Session
Chair: Tao, Weizhi	The Hong Kong Polytechnic University
Organizer: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Shao, Jinliang	University of Electronic Science and Technology of China
Organizer: Su, Zikang	Nanjing University of Aeronautics and Astronautics
08:30-08:45, Paper WeAT1.1	
Two-Stage AL-iLQR-Based Trajectory Planning for Special-Shaped Curb Cleaning of Sweeper (I)	
Lin, Ke	Harbin Institute of Technology Shenzhen
Li, Yanjie	Harbin Institute of Technology Shenzhen
08:45-09:00, Paper WeAT1.2	
Human-Robot Interaction, Robotics, Machine Learning (I)	
Zhang, Xuan	The Hong Kong Polytechnic University
Zhou, Guanzhong	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University
09:00-09:15, Paper WeAT1.3	
Evaluating Player Performance and Tactical Decision-Making in Racket Sports Using Deep Reinforcement Learning (I)	
Tao, Weizhi	The Hong Kong Polytechnic University
Liu, Mingjiang	The Hong Kong Polytechnic University
Sun, Wuzhou	Southwest Jiaotong University
Huang, Hailong	The Hong Kong Polytechnic University
09:15-09:30, Paper WeAT1.4	
Leveraging Obstacles for Strategic Evasion in Quadrotor Pursuit-Evasion Games (I)	
Lam, Yat Long	The Hong Kong Polytechnic University
Ip, Chun Man Ben	The Hong Kong Polytechnic University
Zhang, Chengchen	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University
09:30-09:45, Paper WeAT1.5	
Performance-Guaranteed Trajectory Tracking Control for Mobile Manipulation (I)	
Fan, Jialiang	Nanjing University of Aeronautics and Astronautics/Ecole Centra
Su, Zikang	Nanjing University of Aeronautics and Astronautics
Jiang, Changhui	Nanjing University of Aeronautics and Astronautics
Xing, Zhuolin	Nanjing University of Aeronautics and Astronautics
09:45-10:00, Paper WeAT1.6	
A Novel Anti-Disturbance Control Framework for Bidirectional Quadrotors (I)	
Zhao, Yibo	The Hong Kong Polytechnic University (PolyU)
Lyu, Mingyang	The Hong Kong Polytechnic University (PolyU)
Huang, Hailong	The Hong Kong Polytechnic University (PolyU)

WeAT2	GRANDE 3
Learning-Based Control I	Regular Session
Chair: Lin, Liquan	The Chinese University of Hong Kong
08:30-08:45, Paper WeAT2.1	
Adaptive Output Regulation Via Internal Model Principle and Policy Iteration	
Lin, Liquan	The Chinese University of Hong Kong
Huang, Jie	The Chinese University of Hong Kong
08:45-09:00, Paper WeAT2.2	
Distributed Nash Equilibrium Seeking in Aggregative Games for High-Order Integrator Dynamics Over Switching Networks	
Liu, Zhaocong	Shanghai Jiao Tong University
Huang, Jie	Chinese Univ. of Hong Kong
09:00-09:15, Paper WeAT2.3	
Iterative-Learning-Based Image Servo Aerial Docking Control	
Huang, Yuantan	Beihang University
Liu, Runxiao	Beihang University
Quan, Quan	Beihang University

09:15-09:30, Paper WeAT2.4	
Interference-Resistant Control of Fixed-Wing UAV Based on Enhanced Pigeon-Inspired Optimization	
Su, Hang	Beihang University
Duan, Haibin	Beihang University
Huo, Mengzhen	School of Automation Science and Electrical Engineering, Beihang
Luo, Delin	Xiamen University
09:30-09:45, Paper WeAT2.5	
A Learning-Based Stochastic Model Predictive Control Method for Online Trajectory Control of Autonomous Vehicles at an Unsignalized Intersection	
Yang, Yang	Shanghai Jiaotong University
Xu, Yunwen	Shanghai Jiaotong University
Zhang, Chen	Shanghai Jiaotong University
Li, Dewei	Shanghai Jiaotong University
Li, Ning	Shanghai Jiaotong University
09:45-10:00, Paper WeAT2.6	
Robust Iterative Learning Model Predictive Control for Uncertain Nonlinear Systems with Time Delays	
Zhang, Shuyu	Sun Yat-Sen University
Li, Xiao-Dong	Sun Yat-Sen University
Li, Xuefang	Sun Yat-Sen University
WeAT3	BOLERO 1
Robotics	Regular Session
Chair: Tendulkar, Swaraj	Schmalkalden University of Applied Sciences
08:30-08:45, Paper WeAT3.1	
Development of Self-Strength Variable Mechanism Using External Material	
Matsuo, Shotaro	University of Electro-Communications
Matsumoto, Mitsuharu	University of Electro-Communications
08:45-09:00, Paper WeAT3.2	
Vision-Force Guided Robotic EV Charging: Learning-Based Localization and 6-DoF Hybrid Compliance Control for High-Precision Insertion	
Li, Zihao	Zhejiang University
Wang, Siqi	Anhui University
Li, Xiaocong	Easter Institute of Technology, Ningbo
Zhu, Yiming	Zhejiang University
Zhong, Zhe	Zhejiang University
Lang, Yilin	Zhejiang University
Ren, Qinyuan	Zhejiang University
09:00-09:15, Paper WeAT3.3	
Impact of Path Width and Pedestrian Density on Human-Robot Interaction: A Study in Outdoor and Retail Environments	
Tendulkar, Swaraj	Schmalkalden University of Applied Science
Strigina, Yekaterina	Schmalkalden University of Applied Science
Uppalapati, Venkata Prashanth	Schmalkalden University of Applied Science
Ehlers, Jan	Bauhaus-Universität Weimar
Zug, Sebastian	TU Bergakademie Freiberg
Schrödel, Frank	University of Applied Science Schmalkalde
09:15-09:30, Paper WeAT3.4	
End-To-End Learning for Monocular 3D Human Pose Estimation	
Xie, Bowei	Beijing Institute of Technology
Liu, Geyuan	Beijing Institute of Technology
Lu, Maobin	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
Chen, Jie	Tongji University
09:30-09:45, Paper WeAT3.5	
Unified Model Predictive Interaction Control Integrating Impedance Matching and Constraint Optimization	
Chen, Yiming	The Chinese University of Hong Kong
Li, Chenzui	The Chinese University of Hong Kong
Teng, Tao	The Chinese University of Hong Kong
Wu, Xi	The Chinese University of Hong Kong
Xu, Dongyan	The Chinese University of Hong Kong
Liu, Yunhui	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong

WeAT4	BOLERO 2
Intelligent Decision-Making and Applications I	Invited Session
Chair: Li, Xiuxian	Tongji University
Organizer: Li, Xiuxian	Tongji University
Organizer: Xu, Liang	Shanghai University

Organizer: Xu, Jinming	Zhejiang University
Organizer: Zhu, Shanying	Shanghai Jiao Tong University
08:30-08:45, Paper WeAT4.1	
Multi-Agent Distributed Cooperative Localization Based on Ultra-Wideband (I)	
Lv, Mingwei	China Aviation Industry Shenyang Aircraft Design Institute
Wang, Yuxiang	Northwestern Polytechnical University
Dong, Yuxiang	Northwestern Polytechnical University
Hu, Jinwen	Northwestern Polytechnical University
Xu, Zhao	Northwestern Polytechnical University
08:45-09:00, Paper WeAT4.2	
Distributed Neural Network-Based Control for Multi-Agent Lagrangian Systems with Stability Guarantees (I)	
Qian, Jiajun	Shanghai University
Xu, Liang	Shanghai University
Ren, Xiaoqiang	Shanghai University
Wang, Xiaofan	Shanghai Jiao Tong University
09:00-09:15, Paper WeAT4.3	
Warm-Up Gradient Tracking for Distributed Nonconvex Optimization with Data Heterogeneity (I)	
Zhang, Ziyang	Zhejiang University
Huang, Yan	KTH - Kungliga Tekniska Högskolan
Xu, Jinming	Zhejiang University
09:15-09:30, Paper WeAT4.4	
Privacy-Preserving Consensus for Multiagent Networks Via Weight Iteration (I)	
Wu, Yiming	Hangzhou Dianzi University
Zhang, Chong	Hangzhou Dianzi University
Zhu, Chenrui	Hangzhou Dianzi University

WeBT1 **Modeling, Optimization, and Control for Unmanned Autonomous Systems II**	GRANDE 1&2 Invited Session
Chair: Tao, Weizhi	The Hong Kong Polytechnic University
Organizer: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Shao, Jinliang	University of Electronic Science and Technology of China
Organizer: Su, Zikang	Nanjing University of Aeronautics and Astronautics
10:30-10:45, Paper WeBT1.1	
Automated Landing of Quadrotors on an Unmanned Aerial Vehicle Carrier Via Real-Time Trajectory Planning and Nonlinear Model Predictive Control (I)	
Zhang, Chengchen	The Hong Kong Polytechnic University
Lam, Yat Long	The Hong Kong Polytechnic University
Ip, Chun Man Ben	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University
10:45-11:00, Paper WeBT1.2	
Adaptive Load Position Control for Quadrotor with a Cable-Suspended Payload by Considering Quadrotor As an Actuator (I)	
Zheng, Zhiyuan	University of Electronic Science and Technology of China
Sun, Xuwei	University of Electronic Science and Technology of China
Zhu, Yang	University of Electronic Science and Technology of China
Zhao, Wanbing	University of Electronic Science and Technology of China
Shao, Jinliang	University of Electronic Science and Technology of China
11:00-11:15, Paper WeBT1.3	
Optimization and Tracking Control for UAV Spot Landing Trajectory on Sloped Runway (I)	
Wang, Xinru	Nanjing University of Aeronautics and Astronautics
Su, Zikang	Nanjing University of Aeronautics and Astronautics
Jiang, Changhui	Nanjing University of Aeronautics and Astronautics
Li, Chuntao	Nanjing University of Aeronautics and Astronautics
Li, Xuebing	Nanjing University of Aeronautics and Astronautics
11:15-11:30, Paper WeBT1.4	
Robust Cooperative Control of Quadrotor Cooperative Transportation System Via Time-Varying Disturbance Estimation (I)	
Tong, Shiji	University of Electronic Science and Technology of China

Liu, Qiang	University of Electronic Science and Technology of China
Zhu, Yang	University of Electronic Science and Technology of China
Li, Tieshan	Dalian Maritime University
Shao, Jinliang	University of Electronic Science and Technology of China
11:30-11:45, Paper WeBT1.5	
Li, Chen	University of Technology Sydney
Qi, Xuelei	Northeastern University
Wu, Kai	University of Technology Sydney
Yuan, Xin	Commonwealth Scientific and Industrial Research Organisation
Ni, Wei	Commonwealth Scientific and Industrial Research Organisation
Liu, Ren Ping	University of Technology Sydney
Ma, Hongjun	South China University of Technology
11:45-12:00, Paper WeBT1.6	
Control Saturation Analysis of Second-Order Integral System for the Application of EVTOL (I)	
Su, Jiangcheng	The Hong Kong Polytechnic University
Hao, Cao	The Hong Kong Polytechnic University
Cheng, Li	The Hong Kong Polytechnic University
Qi, Juntong	Shanghai University
Huang, Hailong	The Hong Kong Polytechnic University
WeBT2 **Learning-Based Control II**	GRANDE 3 Regular Session
10:30-10:45, Paper WeBT2.1	
Unit Commitment Incorporating Active Distribution Grids with Learning-Based Power Flow Constraints	
Xu, Kun	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Jiang, Jingxiao	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Li, Lili	NARI Group Corporation, State Grid Electric Power Research Insti
Wu, Shuomin	NARI Group Corporation, State Grid Electric Power Research Insti y
Xu, Han	Southeast University
Zhang, Kaifeng	Southeast University
10:45-11:00, Paper WeBT2.2	
Constrained Adaptive Dynamic Programming for PID Controllers	
Lala, Timotei	Politehnica University of Timisoara, Department of Automation An
11:00-11:15, Paper WeBT2.3	
An Efficient Bayesian Policy Exploration Approach for Reinforcement Learning Model Predictive Control	
Qin, Yihao	The Hong Kong University of Science and Technology (Guangzhou)
Ji, Yiding	The Hong Kong University of Science and Technology (Guangzhou)
11:15-11:30, Paper WeBT2.4	
Design of a Hexacopter Attitude Controller Based on Reinforcement Learning with Transfer Learning Application	
Ko, Donghyeon	Korea Aerospace Research Institute
11:30-11:45, Paper WeBT2.5	
Research on UAV 3D Path Planning Method Based on Deep Reinforcement Learning	
Hu, Ruiguang	Northwestern Polytechnical University
Li, Ni	Northwestern Polytechnical University
Tang, Chong	University of Southampton
Bouderrah, Ramzi	Northwestern Polytechnical University
11:45-12:00, Paper WeBT2.6	
A Comprehensive Framework for Automated Facade Defect Evaluation Using Deep Learning	
Han, Bingxin	The Chinese University of Hong Kong
Gao, Chuanxiang	The Chinese University of Hong Kong
Zhao, Zuoquan	The Chinese University of Hong Kong
Zhang, Jihan	The Chinese University of Hong Kong

Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	The Chinese University of Hong Kong
WeBT3	BOLERO 1
Fault Detection and Diagnostics	Regular Session
Chair: Badihi, Hamed	Tampere University, Tampere 33720, Finland
10:30-10:45, Paper WeBT3.1	
Topological Data Analysis Applied to Wind Turbine Vibration Spectra for Blade Icing Detection	
Martin Gomez, Alvaro	Aalborg University
Haugaard, Thomas	Emerson Electric Co
Ajenjo de Torres, Oier	Aalborg University
Bokor Bleile, Yossi	University of Sydney
Knudsen, Torben	Aalborg University, Denmark
Wisniewski, Rafael	Section for Automation and Control, Aalborg University
10:45-11:00, Paper WeBT3.2	
A Deep Transfer Learning Approach to Few-Shot Fault Diagnosis in Underwater Manipulators	
Zhu, Huaishi	Beijing Institute of Technology
Fang, Xu	Nanyang Technological University
Zhu, Mingyan	Hunan University
Cao, Fangfei	Beijing Institute of Technology
11:00-11:15, Paper WeBT3.3	
Remaining Useful Life Prediction of Hybrid Drive and CWT-CDC Deep-Coupled Rolling Bearing	
Ding, Wanmeng	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Zhang, Kaifeng	Southeast University
Xu, Kun Xu, Kun	Southeast University
11:15-11:30, Paper WeBT3.4	
DT-FTA-ARM: A Collaborative Framework for Real-Time Fault Diagnosis in Subway Environmental Control Systems	
Hong, Wenxing	Xiamen University
Xu, Yuechao	Xiamen University
Huang, ZhenFeng	Xiamen University, Department of Automation
Fang, Xing	Guangdong Midea HVAC Equipment Co., Ltd
Hong, Duanqin	Xiamen University
Zhang, Jihan	The Chinese University of Hong Kong
11:30-11:45, Paper WeBT3.5	
MoE-TransDLD: A Transformer-Driven Mixture of Experts for Cyber-Attack Detection in Power Systems	
Wang, Luyu	Southeast University
Sikdar, Biplab	National University of Singapore
Zhang, Kaifeng	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
11:45-12:00, Paper WeBT3.6	
An Automated SCADA Alarm Analysis in Wind Turbines for Improving Reliability and Downtime – a Solution for Operators	
Chatterjee, Subhajit	Faculty of Engineering and Natural Sciences, Tampere University
Badihi, Hamed	Tampere University, Tampere 33720, Finland
WeBT4	BOLERO 2
Intelligent Decision-Making and Applications II	Invited Session
Chair: Xu, Liang	Shanghai University
Organizer: Li, Xiuxian	Tongji University
Organizer: Xu, Liang	Shanghai University
Organizer: Xu, Jinming	Zhejiang University
Organizer: Zhu, Shanying	Shanghai Jiao Tong University
10:30-10:45, Paper WeBT4.1	
Hierarchical Reinforcement Learning for Adaptive Control and Continuous Target TraDcking in Cooperative Air Combat Scenarios with Unmanned Wingmen (I)	
Wang, SiYuan	Northwestern Polytechnical University
Liu, Jian	AVIC Shenyang Aircraft Design and Research Institute
Zhang, Jiandong	Northwestern Polytechnical University
Shi, Guoqing	Northwestern Polytechnical University
Yang, Qiming	Northwestern Polytechnical University
10:45-11:00, Paper WeBT4.2	
Design of Kill Chain Reconstruction Method Based on Particle Swarm Optimization Algorithm (I)	
Jiang, Yongxin	Northwestern Polytechnical University

Yang, Qiming	Northwestern Polytechnical University
Yan, Wenli	The AVIC Luoyang Electro-Optical Equipment Research Institute
Zhang, Jiandong	Northwestern Polytechnical University
Shi, Guoqing	Northwestern Polytechnical University
11:00-11:15, Paper WeBT4.3	
LLM-Enhanced MARL for Smarter Traffic Control (I)	
Chen, Xingmei	Guangdong University of Technology
Meng, Wei	NTU
11:15-11:30, Paper WeBT4.4	
Data-Enabled Predictive Temperature and Humidity Control in a Historical Museum Building	
Zehner, Marcel	University of Applied Sciences Fulda
Cavaterra, Alessio	Fulda University of Applied Sciences
Lambeck, Steven	University of Applied Sciences Fulda
11:30-11:45, Paper WeBT4.5	
GP-L1 NMPC for Quadrotors Agile Flight (I)	
Chen, Mingxi	Guangdong University of Technology
Luo, Peifen	Guangdong University of Technology
Lian, Shikang	Guangdong University of Technology
Meng, Wei	NTU
WeCT1	GRANDE 1&2
Modeling, Optimization, and Control for Unmanned Autonomous Systems III	Invited Session
Chair: Tao, Weizhi	The Hong Kong Polytechnic University
Organizer: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Shao, Jinliang	University of Electronic Science and Technology of China
Organizer: Su, Zikang	Nanjing University of Aeronautics and Astronautics
14:00-14:15, Paper WeCT1.1	
Game-Theoretical MPC for Quadrotor Pursuit: Strategic Anticipation and Efficient Capture (I)	

Ip, Chun Man Ben	The Hong Kong Polytechnic University
Lam, Yat Long	The Hong Kong Polytechnic University
Zhang, Chengchen	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University
14:15-14:30, Paper WeCT1.2	
Drone Ego-Noise-Based Passive Acoustic Sensing for Obstacle Detection (I)	
Lyu, Mingyang	Hong Kong Polytechnic Univerisity
Zhao, Yibo	The Hong Kong Polytechnic University (PolyU)
Huang, Chao	The Hong Kong Polytechnic University
14:30-14:45, Paper WeCT1.3	
The Fault Detection and Isolation Design for 4WS Vehicles Based on Directional Residuals under External Disturbance (I)	
Hu, Jingyu	Southeast University
Bai, Shuo	Southeast University
Fang, Ruiqi	Southeast University
Li, Yuxue	Southeast University
Zhu, Xiaoyuan	Southeast University
Yin, Guodong	Southeast University
14:45-15:00, Paper WeCT1.4	
Road Adhesion Coefficient Estimatior Using Adaptive UKF with Model Parameter Perturbation and Unknown Time-Varying Noise (I)	
Bai, Shuo	Southeast University
Gao, Junzhe	Southeast University
Fang, Ruiqi	Southeast University
Liu, Zilong	Southeast University
Zhang, Jiatong	Southeast University
Yin, Guodong	Southeast University
15:00-15:15, Paper WeCT1.5	
Adaptive Neural Networks Control of Intelligent Vehicle under Physical Fault and Stealthy Replay Attack Threats (I)	
Qiu, Zhaoyu	Southeast University
Bai, Shuo	Southeast University
Bai, Xin	Southeast University

Hu, Jingyu	Southeast University
Zhu, Xiaoyuan	Southeast University
Yin, Guodong	Southeast University

15:15-15:30, Paper WeCT1.6
UAV-Collected Multi-Class Instance Segmentation Dataset for Building Facades Defects

Yan, Jiayin	The Chinese University of Hong Kong
Zhao, Benyun	The Chinese University of Hong Kong
Yang, Guidong	The Chinese University of Hong Kong
Wen, Junjie	The Chinese University of Hong Kong
Duan, Qigeng	The Chinese University of Hong Kong
Chen, Ben M.	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong

WeCT2	GRANDE 3
Intelligent and AI Based Control	Regular Session
Chair: Barbu, Tudor	Institute of Computer Science of the Romanian Academy

14:00-14:15, Paper WeCT2.1
Autonomous Decision Making for High-Speed Vehicle in Interception Scenario Via Individual Similarity Pigeon-Inspired Optimization

Chen, Rujia	Beihang University
Duan, Haibin	Beihang University

14:15-14:30, Paper WeCT2.2
Novel Multi-Pedestrian Detection and Tracking Framework Combining Machine and Deep Learning Schemes to Anisotropic Diffusion-Based Models

Barbu, Tudor	Institute of Computer Science of the Romanian Academy
Bejinariu, Silviu Ioan	Institute of Computer Science, Romanian Academy, Iasi Branch

14:30-14:45, Paper WeCT2.3
Enhanced Intelligent Fault-Tolerant Control for Hypersonic Gliding Vehicles: Combing DRL and Transfer Learning

Ren, Bin	Beihang University
Wang, Honglun	Beihang University
Wu, Xingyu	School of Automation Science and Electrical Engineering, Beihang
Yan, Guocheng	School of Automation Science and Electrical Engineering, Beihang

14:45-15:00, Paper WeCT2.4
Collaborative Penetration Algorithm with Dominant Region Analysis Embedded in Deep Reinforcement Learning

Luo, Jiong	Beihang University
Yan, Rui	Beihang University
Hua, Yongzhao	Beihang University
Li, Xiaoduo	Beihang University
Dong, Xiwang	Beihang University

15:00-15:15, Paper WeCT2.5
EnteroMatch: A Sparse MoE Model for FMT Matching

Zhou, Mingkang	Xiamen University
Deng, Tingzhi	Xiamen University
Wang, Ying	Xiamen University

15:15-15:30, Paper WeCT2.6
An Open-Source Projectile Launching Device for MAV Pursuit-Evasion and Dogfighting Research

Wang, Chunyu	Westlake University
Zheng, Canlun	Westlake University
Wang, Zhikun	Westlake University
Zhao, Shiyu	Westlake University

WeCT3	BOLERO 1
Multi-Agent Systems I	Regular Session

14:00-14:15, Paper WeCT3.1
Enhancing Event-Separation Properties for Event-Triggered Consensus with Disturbances

Zhan, Sikang	Shanghai Jiao Tong University
Li, Xianwei	Shanghai Jiao Tong University
Yin, Xiang	Shanghai Jiao Tong University
Li, Shaoyuan	Shanghai Jiao Tong University

14:15-14:30, Paper WeCT3.2
Distributed Time-Varying Optimization Over a Strongly Connected and Weight-Balanced Digraph

Sheikhahmadi, Seyed Hemin	University of Texas at Arlington

Xie, Yijing	University of Texas at Arlington
Lin, Zongli	University of Virginia

14:30-14:45, Paper WeCT3.3	
Game-Based Strategy to Cooperative Localization with Input Constraints	
Gao, Mengjing	Northwestern Polytechnical University
Chen, Kang	Northwestern Polytechnical University
Chang, Xiaofei	Northwestern Polytechnical University
Huang, Jingyao	Northwestern Polytechnical University
Wu, Zihao	Beihang University
Fu, Wenxing	Northwestern Polytechnical University

14:45-15:00, Paper WeCT3.4	
Resilient Leader-Follower Consensus of Discrete-Time High-Order Multi-Agent Systems with Time-Varying Graphs	
Luo, Zihang	Central South University
Hu, Wenfeng	Central South University

15:00-15:15, Paper WeCT3.5	
How Do Robot Swarms Behave Compliantly?	
Zhang, Xiaozhen	Beijing Institute of Technology
Zhao, Zeming	Beijing Institute of Technology
Yang, Qingkai	Beijing Institute of Technology
Fang, Hao	Beijing Institute of Technology
Chen, Jie	Tongji University

15:15-15:30, Paper WeCT3.6	
A Lightweight and Secure Access Authentication Scheme for UAV Formation	
Lu, Chaojie	Beihang University
Liu, Yishi	Beihang University
Jin, Kai	Institute of Data Communication Science and Technology
Zhang, Yanli	Institute of Data Communication Science and Technology
Dong, Xiwang	Beihang University

WeCT4	BOLERO 2
Optimal Control	Regular Session

14:00-14:15, Paper WeCT4.1	
Adaptive Distributed Observer-Based Model Predictive Control for Multi-Agent Formation with Resilience to Communication Link Faults	
Xu, Binyan	University of Guelph
Dai, Yufan	University of Victoria
Suleman, Afzal	University of Victoria
Shi, Yang	Canada

14:15-14:30, Paper WeCT4.2	
Robust Model Predictive Control for Offshore Wind Turbine	
Carreno Zagarra, Jose Jorge	Universidad Industrial De Santander
Reyes Ardila, Jorge Carlos	Universidad Industrial De Santander
Poveda, Diana Katheryn	Universidad Industrial De Santander
Villamizar, Rodolfo	Universidad Industrial De Santander

14:30-14:45, Paper WeCT4.3	
Design of Active Suspension LQGI Control of a Half Car Vehicle Model	
Pacek, Daniel	Slovak University of Technology in Bratislava
Rosinová, Danica	Slovak University of Technology, Faculty of Electrical
Račkay, Juraj	Faculty of Electrical Engineering and Information Technology Of

14:45-15:00, Paper WeCT4.4	
An Efficient Convex Optimization Pattern for Model Predictive Control of Hydraulic Servo Systems	
Cui, Zhexin	Tongji University
Yue, Jiguang	Tongji University
Liu, Haichuan	Tongji University
Wu, Chenhao	Shanghai University

15:00-15:15, Paper WeCT4.5	
Tow-Layer Data-Driven Model Predictive Control for Coal Blending System of Coking Process	
Hou, Xiangyu	Shanghai Jiao Tong University
Li, Dewei	Shanghai Jiao Tong University
He, Shaoying	Shanghai Jiao Tong University
Ma, Aoyun	Shanghai Jiao Tong University

15:15-15:30, Paper WeCT4.6	
An HTCPN-Based Self-Adaptive Optimal Control Method for Multi-Level Collaborative Manufacturing Networks	
Guo, Zhengang	Northwestern Polytechnical University
Li, Xiaohua	Chengdu Aircraft Industrial (Group) Co., Ltd
Liang, Weicong	Chengdu Aircraft Industrial (Group) Co., Ltd
Zhang, Yingfeng	Https://controls.papercept.net/conferences/scripts/start.pl#WODE
WeDT5	GRANDE 1&2
Automation vs. Artificial Intelligence	Plenary Session
Chair: Chen, Ben M.	Chinese University of Hong Kong
Co-Chair: Ding, Zhengtao	The University of Manchester
16:00-17:30, Paper WeDT5.1	
Automation vs. Artificial Intelligence	
Chen, Tongwen	University of Alberta
Guay, Martin	Queen's University
Lin, Zongli	University of Virginia
Petlenkov, Eduard	Tallinn University of Technology

ThAT1	GRANDE 1&2
Automated Guided Vehicles	Regular Session
Chair: Zhang, Youmin	Concordia University

08:30-08:45, Paper ThAT1.1	
Lateral Control of Holonomic Platoons Via Spatial Vehicle-To-Vehicle Learning	
Wang, Wenxian	Beihang University
Meng, Deyuan	Beihang University (BUAA)
Yang, Tao	Northeastern University
Wang, Jing	North China University of Technology

08:45-09:00, Paper ThAT1.2	
A Nonlinear Pursuit-Evasion Game Trajectory Planning Method for Spacecrafts with Low Sensitivity on the Initial Value	
Yang, Zhiyuan	Beihang University
Wang, Honglun	Beihang University
Zhang, Menghua	Beijing Institute of Control Engineering
Wu, Jianfa	Beijing Institute of Control Engineering

09:00-09:15, Paper ThAT1.3	
An Intelligent Algorithm for Determining Optimal Wildfire Suppression Zone Using UAVs	
Wu, Xiaobo	Concordia University
Fu, Yufei	Concordia University
Qiao, Linhan	Concordia University
Dong, Huajun	Concordia University
Qin, Qiaomeng	Concordia University
Dilfanian, Erfan	Concordia University
Taherzadeh, Amin	Concordia University
Zhang, Youmin	Concordia University
Benzerrouk, Hamza	Rotors&Wings Aerogroup
Guiddir, Hakim	Rotors&Wings Aerogroup

09:15-09:30, Paper ThAT1.4	
Towards Real-Time 3D Monocular-Based Reconstruction in Support of UAS Missions	
Walczak, Ryan	The Naval Postgraduate School
Yakimenko, Oleg A.	Naval Postgraduate School

09:30-09:45, Paper ThAT1.5	
Time Cooperative Guidance Law with the Maximum Consensus Algorithm of Time-To-Go	
Lin, Zhi	Beihang University
Shi, Zhexin	Beihang University
Yu, Jianglong	Beihang University
Jiang, Hong	Beihang University
Dong, Xiwang	Beihang University
Ren, Zhang	Beihang University

09:45-10:00, Paper ThAT1.6	
Enhancing Driver-Automation Interaction Using RL-Based Shared Control	
Koritala, Naveen Kumar	Kyungpook National University
Defoort, Michael	Valenciennes Univ
Tsai, Chun-Wei	National Sun Yat Sen University
Veluvolu, Kalyana C	Kyungpook National University

ThAT2	GRANDE 3
Modeling and Control of Complex Systems	Regular Session
Chair: Li, Zhi	Technical University of Munich

08:30-08:45, Paper ThAT2.1	
Accelerating Control Design for Quasi-Resonant Mode Boost Converters through State Machine Modelling Approach	
Li, Zhi	Technical University of Munich
Schwabe, Benjamin	Infineon Technologies AG
Servadei, Lorenzo	Technical University of Munich
Wille, Robert	Technical University of Munich

08:45-09:00, Paper ThAT2.2	
AI-Supported Dynamic System Identification: Recognizing a Differential Equation from Response Data	
Kruzenshtern, Anna	LUT
Dodonov, Viktor	LUT University
Chechurin, Leonid	Lappeenranta University of Technology

09:00-09:15, Paper ThAT2.3	
Establishing Models for Digital Twin of Hydropower Systems Using Probability Density Function Shaping	
Yin, Zhun	The Department of Electrical and Computer Engineering at New Yor

Wang, Hong	Oak Ridge National Laboratory
Jiang, Zhong-Ping	New York University
Jia, Wenbo	Chelan County PUD

09:15-09:30, Paper ThAT2.4	
Piecewise-Affine Jump State Estimator Design within Reachable Target Regions under Noisy Measurements	
Ning, Zepeng	Nanyang Technological University
Geng, Junyi	Pennsylvania State University
Fang, Xu	Nanyang Technological University
Xie, Lihua	Nanyang Technological University

09:30-09:45, Paper ThAT2.5	
Modeling for a Hydrofoil Marine Vehicle in Gazebo	
Zuoquan, Zhao	The Chinese University of Hong Kong
Yan, Ruixin	The Chinese University of Hong Kong
Wu, Zongzhou	The Chinese University of Hong Kong
Wang, Jialiang	The Chinese University of Hong Kong
Chen, Ben M.	The Chinese University of Hong Kong

09:45-10:00, Paper ThAT2.6	
Framework for a Data-Driven Digital Supply Chain Architecture in Smart Cities	
Liao, Kai	China Industrial Control Systems Cyber Emergency Response Team,
Dou, Keqin	China Industrial Control Systems Cyber Emergency Response Team,
Liu, Shuai	China Industrial Control Systems Cyber Emergency Response Team,
Tan, Lu	China Industrial Control Systems Cyber Emergency Response Team,

ThAT3	BOLERO 1
Multi-Agent Systems II	Regular Session
Chair: Pietrasanta, Rodolfo	Université Paris-Saclay - Univ Evry

08:30-08:45, Paper ThAT3.1	
Robust Integrated Adaptive Event-Triggered Protocols for Multi-Agent Systems	
Zhao, Yinxiang	Beihang University
Luo, Zhibin	Beihang University
Wang, Qishao	Beihang University
Lv, Yuezu	Beijing Institute of Technology
Zhou, Jialing	Beijing Institute of Technology
Yu, Yang	Beihang University

08:45-09:00, Paper ThAT3.2	
Heterogeneous Alignment-Based Spatio-Temporal Graph Reinforcement Learning for Dynamic Multi-UAVs Task Assignment	
Zhu, Haojie	Nanjing University of Aeronautics and Astronautics
Chen, Mou	Nanjing University of Aeronautics and Astronautics
Zhou, Tongle	Nanjing University of Aeronautics and Astronautics
Han, Zengliang	College of Automation Engineering, Nanjing University of Aeronau

09:00-09:15, Paper ThAT3.3	
Finite Time Robust Flocking of Second-Order Linear Agents	
Pietrasanta, Rodolfo	Université Paris-Saclay - Univ Evry
Chadli, M.	University Paris-Saclay Evry
Nouveliere, Lydie	IBISC, Université Paris Saclay, Univ Evry

09:15-09:30, Paper ThAT3.4	
Cooperative Persistent Surveillance with a Multi-UGV System Based on Reinforcement Learning	
Li, GuangZheng	Beijing Institute of Technology
Li, Zhuo	Tsinghua University
Wang, Gang	Beijing Institute of Technology
Chu-ge, Wu	Beijing Institute of Technology
Wang, Jingjing	Beijing University of Technology
Sun, Jian	Beijing Institute of Technology

09:30-09:45, Paper ThAT3.5	
Affine Formation Control from Data	
Fang, Xu	Nanyang Technological University

Ning, Zepeng	Nanyang Technological University
Li, Yifei	Beijing Institute of Technology
Wenjian, Cai	Qingdao University of Science and Technology
Xie, Lihua	Nanyang Technological University

09:45-10:00, Paper ThAT3.6	
Engineering Application Progress of Multi-Agent Deep Reinforcement Learning	
Bao, Kanghua	Southwest Computer Co., Ltd
Shi, Tao	Southwest Computer Co., Ltd
Wang, Shuxu	Southwest Computer Co., Ltd

ThAT4	BOLERO 2
Estimation and Identification I	Regular Session
Chair: Jevuczo, Gabor	HUN-REN Institute for Computer Science and Control

08:30-08:45, Paper ThAT4.1	
Design of Bayesian Transfer Filter for Systems with Inequality Constraints	
Huang, Yongjin	Jiangnan University
Zhang, Tianyu	Jiangnan University
Zhao, Shunyi	Jiangnan University
Liu, Fei	Jiangnan University

08:45-09:00, Paper ThAT4.2	
Design and Experimental Test of Datatic Approximate Optimal Filter in Nonlinear Dynamic Systems	
He, Weixian	Tsinghua University
He, Zeyu	Tsinghua University
Cao, Wenhan	Tsinghua University
Gao, Haoyu	Tsinghua University
Liu, Tong	Tsinghua University
Shuai, Bin	Tsinghua University
Liu, Chang	Cornell University
Li, Shengbo Eben	Tsinghua University

09:00-09:15, Paper ThAT4.3	
mathscr{I}-Step-Ahead Active Learning-Based Dual Control for Exploration and Exploitation in Auto-Optimization	
Yu, Yalei	Loughborough University
Jiang, Jingjing	Loughborough University
Chen, Wen-Hua	Loughborough University
Li, Zhongguo	University of Manchester
Lohse, Niels	University of Birmingham

09:15-09:30, Paper ThAT4.4	
Sampled-Data Fractional Sliding Mode Observer Design for Nonlinear Perturbed Fractional Reaction Diffusion Neural Networks with Delay	
Chen, Juan	Changzhou University
Zhang, Chenlong	Changzhou University
Ge, Fudong	Tianjin University
Garone, Emanuele	Université Libre De Bruxelles

09:30-09:45, Paper ThAT4.5	
FO-ORCA: An Optimization-Enhanced Interaction Model with Filtering for Pedestrian Trajectory Prediction in Dense Crowds	
Zhang, Chao	Tongji University
Niu, Dunbiao	Tongji University
Lei, Jinlong	Tongji University
Yi, Peng	Tongji University

09:45-10:00, Paper ThAT4.6	
Comparison of Optical Flow-Based Linear Angular Rate Estimation Methods Considering Real Flight Data	
Jevuczo, Gabor	HUN-REN Institute for Computer Science and Control
Bauer, Peter	Institute for Computer Science and Control

ThBT1	GRANDE 1&2
Sensor/Data Fusion	Regular Session
Chair: Zhang, Youmin	Concordia University

10:30-10:45, Paper ThBT1.1	
A Novel Distributed Fusion Algorithm for Maneuvering Target Tracking with Angle-Only Sensors	
Zhang, Yuge	Northwestern Polytechnical University
Yang, Guangyu	Northwestern Polytechnical University
Zhu, Supeng	Northwestern Polytechnical University
Fu, Wenxing	Northwestern Polytechnical University

10:45-11:00, Paper ThBT1.2	
Dual-Modality Wildfire Detection with Visible and Infrared Images from UAVs	

Dong, Huajun	Concordia University
Fu, Yufei	Concordia University
Zhang, Youmin	Concordia University
Qiao, Linhan	Concordia University
Dilfanian, Erfan	Concordia University
Wu, Xiaobo	Concordia University
Qin, Qiaomeng	Concordia University

11:00-11:15, Paper ThBT1.3	
Cooperative Localization in Vehicular Networks Based on Multimodal Information Fusion	
Wu, Liangkun	Southwest Minzu University
Qu, Xiaomei	Southwest Minzu University
Cao, Ting	Southwest Minzu University
HuaLin, Yao	Southwest Minzu University
Meng, Wei	NTU

11:15-11:30, Paper ThBT1.4	
On Visual-Inertial SLAM Based on Deep Feature Extraction and Matching	
Du, Xinran	Beihang Univercity
Zuo, Zongyu	Beihang Univercity
Zhu, Bing	Beihang Univercity

11:30-11:45, Paper ThBT1.5	
Machine Learning-Based Modeling of Rainfall Impact on FMCW Radar Performance	
Rahbar Ranji, Matina	University of Windsor
Salih, Media	University of Windsor
Lei, Zike	University of Windsor
Chen, Xiang	University of Windsor

ThBT2	GRANDE 3
Energy Efficiency	Regular Session
Chair: Nourollahi Hokmabad, Hossein	Tallinn University of Technology

10:30-10:45, Paper ThBT2.1	
A Study on Comparison of Energy Management Strategies for a Series Hybrid Tracked Vehicle	
Gocer, Ismail	FNSS Savunma Sistemleri A.S
Baslamisli, S. Caglar	Hacettepe üniversitesi

10:45-11:00, Paper ThBT2.2	
Power Control of Switched Wireless Cellular Networks by Probability Transition Rates Optimization	
Zhao, Chengyan	Ritsumeikan University
Ueno, Satoshi	Ritsumeikan University
Zhu, Bohao	The University of Hong Kong
Mei, Wenjie	Southeast University
Zhou, Yan	Shenyang Jianzhu University

11:00-11:15, Paper ThBT2.3	
Customer Baseline Load (CBL) Estimation Method Based on Privacy Protection Scheme Using Blockchain	
Liu, Renkai	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Li, Yaping	China Electric Power Research Institute CO., Ltd
Zhang, Kaifeng	Southeast University

11:15-11:30, Paper ThBT2.4	
Co-Optimization of Motion and Energy Domain for Hydrogen-Powered Hybrid UAVs: A Bi-Directional Coupling Architecture	
Song, Xiaowei	Beihang University
Guo, Xiaoyu	City University of Hong Kong
Liu, Guowei	Beihang University
Yang, Zihan	Beihang University
Liu, Lu	City University of Hong Kong

11:30-11:45, Paper ThBT2.5	
Forecast-Driven and Scenario-Based Building Energy Management Using a Stochastic Optimization Approach	
Nourollahi Hokmabad, Hossein	Tallinn University of Technology
Tala, Hemmati Shahsavar	University of Tabriz
Vergara Barrios, Pedro	Delft University of Technology
Husev, Oleksandr	Gdansk University of Technology
Belikov, Juri	Tallinn University of Technology

ThBT3	BOLERO 1
Multi-Agent Systems III	Regular Session
Chair: Walczak, Ryan	The Naval Postgraduate School

10:30-10:45, Paper ThBT3.1	
Fixed-Relative-Switched Threshold Strategies for Consensus Tracking Control of Nonlinear Multiagent Systems	

Wang, Ziming	The Hong Kong University of Science and Technology (Guangzhou)
Gao, Yun	The Hong Kong University of Science and Technology (Guangzhou)
Rikos, Apostolos I.	The Hong Kong University of Science and Technology (Gz)
Pang, Ning	Shanghai Jiao Tong University
Ji, Yiding	Hong Kong University of Science and Technology (Guangzhou)

10:45-11:00, Paper ThBT3.2	
Enhancing Autonomous Multi-Agent Coordination for Unmanned Ground Vehicle Operations in Denied Urban Environments Using Proximal Policy Optimization	
Moore, Hyatt	U.S. Naval Postgraduate School
Yakimenko, Oleg A.	Naval Postgraduate School

11:00-11:15, Paper ThBT3.3	
DISCO: Diffusion-Based Inter-Agent Swarm Collision-Free Optimization for UAVs	
Bitla, Bhanu Teja	International Institute of Information Technology Hyderabad
Idoko, Simon	University of Tartu
Thokala, Shilpitha Chowdary	Amrita Vishwa Vidyapeetham, Coimbatore
Singh, Arun	University of Tartu
Krishna, Madhava	IIIT-Hyderabad

11:15-11:30, Paper ThBT3.4	
A Neural Network Model Based on Differential Evolution Algorithm for Traveling Salesman Problem	
Yu, Rui	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology

11:30-11:45, Paper ThBT3.5	
A Dynamic Inversion Approach to Time-Varying Optimization	
Keshani, Ali	Queen's University
Guay, Martin	Queen's University

ThBT4	BOLERO 2
Estimation and Identification II	Regular Session
Chair: Faedo, Nicolas	Politecnico Di Torino

10:30-10:45, Paper ThBT4.1	
Cognitive Hierarchy Game-Based Method for Multi-Agent Lane Change Intention Recognition	
Xiao, Suyang	Tongji University
Deng, Di	Tongji University
Lei, Jinlong	Tongji University
Yi, Peng	Tongji University

10:45-11:00, Paper ThBT4.2	
Parametric Interpolants for Frequency-Domain Models of Marine Structures in the Loewner Framework	
Faedo, Nicolas	Politecnico Di Torino
Paduano, Bruno	Politecnico Di Torino

11:00-11:15, Paper ThBT4.3	
A Hierarchical Adaptive Observer Approach for Synchronization in Heterogeneous Multi-Agent Systems	
Abdl Ghani, Hasan	IRSEEM
Thabet, Rihab El Houda	NORMANDY UNIVERSITY Univ, UNIROUEN
Khemmar, Redouane	ESIGELEC
Ahmed Ali, Sofiane	University of Evry, IBISC Lab

11:15-11:30, Paper ThBT4.4	
Data-Based Estimation of Excitation Force in Wave Energy Converters	
Saavedra, Marcos David	Instituto LEICI (UNLP-CONICET), Facultad De Ingeniería, Universi
Faedo, Nicolas	Politecnico Di Torino
Inthamoussou, Fernando Ariel	Universidad Nacional De La Plata, Instituto LEICI (CONICET-UNLP)
Mosquera, Facundo D.	Universidad Nacional De La Plata
Garelli, Fabricio	National University of La Plata

11:30-11:45, Paper ThBT4.5	
Data-Driven Unknown-Input Observers for Continuous-Time Linear Time-Invariant Systems	
Wei, Yuzhou	Beijing Institute of Technology
Liu, Wenjie	Beijing Institute of Technology, Beijing, China
Wang, Linqi	Beijing Institute of Technology
Wang, Gang	Beijing Institute of Technology

Sun, Jian	Beijing Institute of Technology
Cai, Tao	Beijing Institute of Technology
11:45-12:00, Paper ThBT4.6	
Analysis and Design of LTI Full-State Observers: A New Approach to an Old Problem	
Papageorgiou, Panos	University of Patras
Alexandridis, Antonio	University of Patras

Book of Abstracts

Technical Program for Tuesday July 1, 2025

TuAT1	GRANDE 1&2
Best Paper Session	Regular Session
Chair: Xie, Lihua	Nanyang Technological University
Co-Chair: Lin, Zongli	University of Virginia
14:45-15:00, Paper TuAT1.1	
A Graph-Relaxed Method for Byzantine-Resilient Distributed Multidimensional Consensus (I)	
Qu, Zhihai	Tongji University
Li, Xiuxian	Tongji University
Meng, Min	Tongji University
Yi, Xinlei	Tongji University
You, Keyou	Tsinghua University

Keywords: Multi-agent Systems, Networked Control
Abstract: In recent years, multi-agent systems have attracted considerable attention, particularly with regard to their security dimensions in presence of Byzantine attacks. However, existing Byzantine-resilient algorithms rely on relatively strong network connectivity conditions, raising the question of whether these requirements can be relaxed while balancing performance trade-offs. To address this, we partition the full state of each agent into multiple blocks and leverage an essentially cyclic rule for each block update, based on which a filter-based block consensus algorithm is proposed. This approach not only relaxes network connectivity requirements but also reduces bandwidth usage per update, making it suitable for a wider range of networks. Theoretical analysis demonstrates that the algorithm achieves linear consensus speed, ensuring fast and robust aggregation among nodes despite Byzantine agents.

15:00-15:15, Paper TuAT1.2	
Keeping Digital Twin in Sync without Blocking the Physical Motion Stage	
Jain, Vibhor	Eindhoven University of Technology
von Meijenfeldt, Cézan	Eindhoven University of Technology
Mohamed, Sajid	ITEC B.V., Netherlands
Stuijk, Sander	Eindhoven University of Technology
Goswami, Dip	Eindhoven University of Technology

Keywords: Real-time Systems, Flexible Manufacturing Systems, Control Applications
Abstract: Digital Twins (DTs) are virtual representations of physical systems or Physical Twins (PTs) that are used for various data-driven applications in manufacturing industry such as predictive maintenance, diagnostics and condition monitoring. The data in DTs is collected through virtual sensors, which augment the physical sensors by providing additional data that cannot be directly observed. In high-throughput production systems like semiconductor manufacturing equipment, high-speed and high-precision motion stages control the equipment's movement. However, the use of DTs in these systems is limited due to their real-time requirements. To enable real-time applications, the DT must be synchronized with its physical counterpart to ensure

timely data from virtual sensors. The synchronization mechanism should be non-blocking to prevent any impact on the throughput of physical systems. In this paper, we propose a synchronization mechanism for DTs in high-speed high-precision motion control systems. The mechanism involves sharing PT states with DT over a network and compensating for network delays. The synchronization mechanism is validated in a framework comprising an industrial motion stage system and its digital twin. The validation is done for different synchronization delay scenarios, demonstrating its effectiveness of proposed approach in eliminating synchronization delays without blocking the PT operation. The proposed mechanism enables real-time virtual sensing ensuring data timeliness with high accuracy.

15:15-15:30, Paper TuAT1.3	
Sampled-Data Boundary Stabilization of PDE-ODE Cascade Systems with Long Delays	
Qiu, Ruiyang	City University of Hong Kong
Xu, Xiang	Southern University of Science and Technology
Liu, Lu	City University of Hong Kong
Feng, Gang	City University of Hong Kong

Keywords: Nonlinear Systems and Control, Linear Systems, Discrete Event Systems
Abstract: This paper investigates the sampled-data feedback stabilization problem of a PDE-ODE cascade system in which both the actuator and the input experience arbitrarily long delays. The backstepping-forwarding technique is employed to effectively transform the original system with delays into a target system, governed by a linear differential equation with sampled and delayed inputs. A new sampled-data boundary controller is then proposed, extending the applications of truncated predictor feedback to delayed sampling systems, simultaneously compensating for delays and sampling effects while enhancing practicality and robustness. The stability of the target system is established via a small-gain-based analysis, which in turn ensures exponential stability of the original closed-loop system through the input-to-state stability (ISS) framework. Theoretical findings are supported by simulations.

15:30-15:45, Paper TuAT1.4	
Distributed Data-Driven Nash Equilibrium Seeking in Linear Multi-Agent Systems with External Disturbances	
Wang, Lingi	Beijing Institute of Technology
Liu, Wenjie	Beijing Institute of Technology, Beijing, China
Li, Yifei	Beijing Institute of Technology
Sun, Jian	Beijing Institute of Technology
Peng, Zhihong	Beijing Institute of Technology
Wang, Gang	Beijing Institute of Technology

Keywords: Multi-agent Systems, Linear Systems, Networked Control
Abstract: This paper investigates distributed Nash equilibrium (NE) seeking in linear multi-agent network games, where agents with unknown dynamics interact over weakly connected directed graphs under external disturbances. By reformulating the NE seeking problem as a cooperative output regulation problem, we develop a data-driven controln framework that embeds the internal model principle to achieve disturbance rejection and eliminate steady-state errors. Closed-loop stability and convergence to the unique NE are proven under standard assumptions on stabilizability, detectability, and data richness. Numerical experiments with a mobile robot network demonstrate the method's effectiveness in achieving output NE seeking under noisy measurements and external disturbances.

15:45-16:00, Paper TuAT1.5	
ESEM: A Visual Topological Navigation Method Integrating Edge Semantic Enhancement in Challenging Environment	
Qin, Haijian	Beijing Information Science and Technology University
Shen, Wangtian	Tsinghua University
Meng, Ziyang	Tsinghua University
Li, Xiaolei	Beijing Information Science and Technology University

Keywords: Robotics, Learning Systems, Learning-based Control
Abstract: Image-goal navigation ranks among the critical tasks in embodied robotic visual navigation, requiring the robot to navigate to the goal position indicated by the image in an unknown environment. While recent works have made progress in image-goal navigation by constructing image-based topological maps, the complexity of the real world, along with the lack of directional control and semantic information in topological maps, still pose significant challenges to robustness and reliability. To solve this problem, we propose a new strategy that utilizes a semantic topological map to help the robot's navigation in unknown environments. Specifically, we quantitatively analyze the directional relationship between the current and goal nodes to construct the semantic edges of the topological map. This approach enables the robot to make informed decisions by dynamically assigning physically meaningful directional semantics to each edge. We deploy this method on a real-world four-wheeled ground robot, relying solely on visual input (RGB), to realize the image-goal navigation task. The experimental results demonstrate that the proposed approach significantly outperforms other highperformance baseline approaches in terms of navigation success rate, demonstrating excellent robustness.

TuAT2	GRANDE 3
Motion Control I	Regular Session
Chair: Yang, Xiaoyu	The Hong Kong Polytechnic University

14:45-15:00, Paper TuAT2.1	
Tracking Error Reduction Using Model-Based Input Shaping	
Lichtsinder, Arkady	RAFAEL

Keywords: Motion Control, Adaptive Control
Abstract: This paper presents a novel approach to reducing tracking errors using a model-based input shaping algorithm. The proposed method features a specialized pre-filter design that shapes the input to ensure zero steady-state tracking error for higher order polynomial inputs. Unlike conventional methods that may compromise system stability, this algorithm exclusively modifies the input signal, leaving the inherent system stability unaffected. An additional advantage of our approach is the simplification of the main controller design by taking over the handling of steady-state errors. This allows the controller to focus on other performance criteria (BW, GM, PM) without being overly complex. By making the system behave as if it were a higher order "System Type" without the need for multiple pure integrators

in the open loop, our method enhances performance and robustness. The algorithm's potential applicability spans a wide range of fields, including robotics, aerospace, and industrial automation, demonstrating its versatility and effectiveness in improving control system precision and reliability.

15:00-15:15, Paper TuAT2.2

Definition and Property Analysis of State Entropy in Control Systems

Zhang, Xiangteng	Tsinghua University
Liu, Shiqi	Tsinghua University
Shuai, Bin	Tsinghua University
Li, Shengbo Eben	Tsinghua University

Keywords: Control Applications, Motion Control, Intelligent and AI Based Control

Abstract: Information entropy is an important measure that quantifies the uncertainty associated with random variables, and has been widely used in signal processing, machine learning, wireless communication, etc. For a dynamical control system, its behavior can also be measured by information entropy, once we assume its initial state follows a certain distribution. This measure is defined as state entropy, which forms a new basic property of control systems, except for stability, robustness, and adaptability. This paper systematically studies the definition and property of state entropy for deterministic control systems, and introduces the mechanism of its time evolution in continuous-time, discrete-time, linear and non-linear cases. We show that the time derivative of state entropy is the integral of trace of control Jacobian matrix over the initial state distribution, where the control Jacobian matrix is the full derivative of successive state with respect to the initial state. For control systems with constant value of divergence of its vector field, the evolution of state entropy is calculated without the knowledge of precise trajectory, as the trace is independent from the initial distribution. The variation of state entropy is exclusively determined by the positivity of the trace of control Jacobian matrix. We also derive the mathematical form of state entropy for discrete-time control systems. Our work provides a new angle to understand the behavior of dynamical control systems.

15:15-15:30, Paper TuAT2.3

Trajectory Tracking of Micro Linear Piezoelectric Actuator Based on Variable Forgetting Factor Iterative Learning Method

Feng, Zhiqiang	Tsinghua University
Wang, Ze	Tsinghua University

Keywords: Control Applications, Motion Control, Learning-based Control

Abstract: This paper investigates the trajectory tracking problem of a micro linear piezoelectric actuator (LPA) based on a Variable Forgetting Factor Iterative Learning Control (FFILC). Compared to traditional PID control methods, FFILC demonstrates advantages in improving response speed, resistance to disturbances, and smoother tracking curves. Compared to first-order Iterative Learning Control (ILC), FFILC enhances the disturbance rejection capability and tracking accuracy of the iterative learning algorithm by integrating existing data, offering valuable reference for engineering practice. Experimental results show that FFILC has faster convergence and higher tracking accuracy in step signal and sinusoidal signal trajectory tracking compared to PID control and first-order ILC.

15:30-15:45, Paper TuAT2.4

UAV Formation Safety Transformation Strategy for Aerial Refueling

Li, Jinbai	Beihang University
Wang, Honglun	Beihang University
Wang, Yanxiang	Beihang University
Yan, Guocheng	School of Automation Science and Electrical Engineering, Beihang
Zhu, Junfan	Beihang University

Keywords: Motion Control, Multi-agent Systems, Nonlinear Systems and Control

Abstract: Aerial refueling technology utilizes tankers to refuel other aircraft in the air. Before sequential aerial refueling, multiple UAVs (including the tanker and receivers) are expected to perform a formation transformation. In this process, multiple receivers start from the observation area on the left side of the tanker and move to the pre-docking position to prepare for docking. During the transformation, the tanker and receivers maintain a close formation, characterized by small inter-aircraft distances and low safety margins. To ensure inter-aircraft safety during formation transformation, this work first defines the safety envelopes of the tanker and receivers according to their fuselage shapes. Based on these envelopes, a safe flight area for the UAVs is generated. Within this area, relative flight paths for formation transformation are planned using the Rapidly-exploring Random Tree (RRT) algorithm. These planned paths serve as desired positions within the formation, and an appointed-time prescribed performance control (APPC) method is designed to ensure flight safety throughout the transformation. Finally, simulations are conducted to demonstrate the effectiveness of the proposed scheme.

15:45-16:00, Paper TuAT2.5

Enhancing Motion Performance for CNC Machine Tools Based on AI-Driven Hybrid Model

Chen, You-Cheng	National Formosa University
Lin, Ming-Tsung	National Formosa University
Li, Yong-Zhong	National Formosa University
Wang, Ya-Hsuan	National Formosa University
Lin, Guan-Yi	National Formosa University

Keywords: Intelligent and AI Based Control, Motion Control, Control Applications

Abstract: This study presents an AI-driven hybrid model integrating a Deep Q-Network (DQN) and a Backpropagation Neural Network (BPNN) to enhance the motion performance of CNC machine tools. The ANOVA method is applied to analyze experimental data, while Pearson correlation aids in identifying key interpolation parameters. A trained BPNN, designed as a virtual system environment, models the dynamic behavior of CNC machine tools. The DQN interacts with this virtual system, optimizing interpolation parameters by maximizing the rewards. The optimized interpolator parameters are validated through standard CNC speed and accuracy tests. Experimental results demonstrate that the proposed AI-driven approach can further improve motion efficiency while maintaining contour accuracy, outperforming traditional manual tuning and BPNN methods.

16:00-16:15, Paper TuAT2.6

3D Clothoid-Based Decoupled Trajectory Planning for Fixed-Wing UAV

Yang, Xiaoyu	The Hong Kong Polytechnic University
Ai, Zhouxing	The Hong Kong Polytechnic University
Qi, Juntong	Shanghai University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Motion Control, Nonlinear Systems and Control, Optimal Control
Abstract: This paper proposes a 3D Clothoid-based decoupled path and speed planning framework for the fixed-wing UAV to generate smooth and dynamically feasible trajectory in 3D space. Using 3D Clothoid curves, the framework ensures curvature continuity, while the decoupled planning approach lowers computational complexity by separating spatial and temporal optimization. A data association mechanism links path points with attractors, repellers, and barriers. An obstacle avoidance model based on these constraints, combined with repeller potentials and barrier functions, ensures safe navigation in constrained environments. Experimental results validate the ability of the framework to produce safe, smooth, and efficient trajectories, demonstrating its suitability for advanced UAV operations in complex environments.

TuAT3	BOLERO 1
Nonlinear Systems and Control	Regular Session
Chair: Liu, Guojun	Hubei University

14:45-15:00, Paper TuAT3.1	
Joint State and Disturbance Estimation Based on the Generalized Observer Form	
Kaldmäe, Arvo	Tallinn University of Technology
Kaparin, Vadim	Tallinn University of Technology
Kotta, Ülle	Institute of Cybernetics at TUT
Tõnso, Maris	Tallinn University of Technology

Keywords: Nonlinear Systems and Control, Estimation and Identification
Abstract: A method for joint state and disturbance estimation is developed for discrete-time nonlinear reversible control systems. The observer is constructed in two steps. First, the state vector is extended to include also the disturbances. Under the assumption that the disturbances are constant, the extended state equations depend only on the extended state variables and input variables. Thus, a standard state observer can be constructed for the extended state equations. For this, in the second step one transforms the extended state equations into the generalized observer form for which an observer can be easily constructed. Since the extended state includes both the state variables and the disturbance variables, the observer will find the estimates of both. Finally, the developed method is applied to estimate the state and parameter values of type 1 diabetes model.

15:00-15:15, Paper TuAT3.2	
Orbital Station-Keeping in the Earth-Moon System Via Nonlinear Backstepping	
Nunes, António	Instituto Superior Técnico, Universidade De Lisboa
Batista, Pedro	Instituto Superior Técnico
Brás, Sérgio	Instituto Superior Técnico

Keywords: Nonlinear Systems and Control, Control Applications
Abstract: A nonlinear orbital station-keeping solution for the circular and elliptic versions of the Earth-Moon Restricted Three-Body Problem (R3BP) is developed via a backstepping technique. Formal guarantees for global asymptotic stability (GAS) are attained, as shown through Lyapunov's stability theory. The adequacy of the proposed control law is evaluated through the means of numerical trials over closed periodic solutions of the circular and elliptic R3BPs. The ramifications of the control gain choice are carefully studied and simulated.

15:15-15:30, Paper TuAT3.3	
Input-Output Feedback Linearization: Case Study on 2-Contractive Zero Dynamics	
Kar, Indra Narayan	Indian Institute of Technology, Delhi
Bora, Riddhi Mohan	Indian Institute of Technology, Delhi

Keywords: Nonlinear Systems and Control, Control Applications
Abstract: Zero dynamics are essential to the design and analysis of input-output feedback linearization control, particularly in nonlinear systems. This study revisits an input-output feedback linearization problem through an illustrative example where the zero dynamics admits multiple equilibrium points. The effect of such zero dynamics on system performance and control input has also been investigated. Conventional tools such as 1-contraction and Lyapunov theory are not directly applicable to the analysis of zero dynamics with multiple equilibria. Therefore, the theory of 2-contraction is employed to perform the analysis effectively. The impact of such zero dynamics on the external control input, tasked with regulating the system's output is also analyzed. Extensive numerical simulations are conducted to validate and exemplify the theoretical results.

15:30-15:45, Paper TuAT3.4	
$H\infty$ Filtering for Continuous-Time Takagi-Sugeno Fuzzy Systems	
Wang, Fan	Hubei University
Liu, Guojun	Hubei University
Yi Liu, Y. Liu	Hubei University
Zhang, Wei	Hubei University
Sun, Jinghui	Hubei University
Xiao, Ting	Hubei University
Tang, Chao	Hubei University

Keywords: Nonlinear Systems and Control, Fuzzy and Neural Systems, Robust and H infinity Control
Abstract: This paper investigates the problem of H∞ filtering for continuous-time Takagi-Sugeno fuzzy systems. The method adopts the continuous-time model, effectively capturing the complex characteristics of Takagi-Sugeno fuzzy systems. Utilizing integral Lyapunov functions and employing extra free variables, sufficient conditions in the form of linear matrix inequalities are derived. Compared with existing fuzzy filtering methods, this design significantly reduces the conservativeness. Finally, the effectiveness and superiority of the proposed method are verified through two simulation examples.

15:45-16:00, Paper TuAT3.5	
Resilient Safe Optimized Backstepping Control for High-Order Strict-Feedback System	
Zhang, Yuxiang	Natioanl University of Singapore
Ji, Ruihang	Natioanl University of Singapore
Ge, Shuzhi Sam	Natioanl University of Singapore

Keywords: Adaptive Control, Learning-based Control, Nonlinear Systems and Control
Abstract: Resilient performance is a critical safety aspect required for the learning-enabled control of safety-critical mechanical systems, which is an additional consideration for standalone static safety sets and currently is not yet well investigated. To address this limitation, this work proposed an adaptive safe optimized backstepping control for the high-order strict-feedback system that realizes resilient performance by flexibly adjusting the safe performance boundary with consideration of the system saturation limitation. Therefore, the concept of safety in the proposed method codifies the inherent safe adaptive learning mechanism and this resilient performance. More specifically, firstly, the adaptive optimized safe control of the overall system is designed with safe optimized backstepping and constraint adaptation mechanism to ensure the ultimate policy within the safe region during the whole learning phase. The constructed adaptive safe learning framework embodies the decomposition design with Barrier Lyapunov Functions-based optimized backstepping control that considers the performance-based state-variables constraints. Secondly, considering the resilient performance, the auxiliary system is designed to adaptively generate flexible performance boundaries based on the input saturation error while conflicts of saturation limitation occur, enabling the overall learning system to attain additional resilient performance during the whole control period. Comparison simulations consider the typical vehicle's longitudinal control problem to verify the effectiveness of the proposed method in showing the resilient performance of learning-enabled control of safety-critical systems.

16:00-16:15, Paper TuAT3.6	
Pseudolinear Kalman Filter Algorithm for Target Tracking with Doppler-Bearing Measurements	
Zhang, Kanghao	Beihang University
Zhang, Zheng	Beihang University
Dong, Xiwang	Beihang University
Wang, Hong	Beijing Institute of Control Engineering

Keywords: Signal Processing, Sensor/Data Fusion, Optimal Control
Abstract: This article addresses the nonlinearity of Doppler-bearing measurements for target tracking with a pseudolinear Kalman filtering (PLKF) scheme. A pseudolinear equation for range rates is derived by taking the Taylor series expansion of the radial unit vector, and a precise model of the corresponding noise is presented along with statistical analysis. To achieve superior estimation performance with low computational complexity, one-step state predictions are employed to construct an instrumental variable-based PLKF (IV-PLKF). A strategy to handle initial uncertainties is developed. Monte Carlo simulations are provided to illustrate the performance by comparing the IV-PLKF with existing algorithms and theoretical bounds.

TuAT4	BOLERO 2
Control Applications I	Regular Session
Chair: Vansovits, Vitali	TalTech University

14:45-15:00, Paper TuAT4.1	
Shared Steering Using Interpolating Control	
Sternberg, Omri	Ben-Gurion University of the Negev
Arogeti, Shai	Ben-Gurion University of the Negev

Keywords: Control Applications, Automated Guided Vehicles
Abstract: This paper presents a novel shared steering control approach aimed at enhancing driver steering performance while adhering to system constraints. The proposed method employs an Interpolating Control (IC) approach to dynamically balance the influence between the human driver and the autonomous controller. Additionally, the methodology incorporates a Simple Interpolation Control (SIC), eliminating the need for online numerical optimization. The SIC generates a sub-optimal interpolation coefficient to weigh control inputs while maintaining system response within predefined constraints. Simulation results demonstrate that the controller improves driver performance across different characteristics when compared to scenarios without shared control.

15:00-15:15, Paper TuAT4.2	
Accurate Control under Voltage Drop for Rotor Drones	
Liu, Yuhang	Beihang University
Jia, Jindou	Beihang University
Yang, Zihan	Beihang University
Guo, Kexin	Beihang University
Yang, Bin	Beihang University
Xu, Lidan	Beihang University
Chen, Taihang	Beihang University

Keywords: Control Applications, Robotics, Motion Control
Abstract: This letter proposes an anti-disturbance control scheme for rotor drones to counteract voltage drop (VD) disturbance caused by voltage drop of the battery, which is a common case for long-time flight or aggressive maneuvers. Firstly, the refined dynamics of rotor drones considering VD disturbance are presented. Based on the dynamics, a voltage drop observer (VDO) is developed to accurately estimate the VD disturbance by decoupling the disturbance and state information of the drone, reducing the conservativeness of conventional disturbance observers. Subsequently, the control scheme integrates the VDO within the translational loop and a fixed-time sliding mode observer (SMO) within the rotational loop, enabling it to address force and torque disturbances caused by voltage drop of the battery. Sufficient real flight experiments are conducted to demonstrate the effectiveness of the proposed control scheme under VD disturbance.

15:15-15:30, Paper TuAT4.3	
Collaborative Safety-Critical Scaling Formation Control of VTOL UAVs: An NMPC-CLF-CBF Approach	
Yang, Ziyi	Xiamen University

Guo, Zhengyu	National Key Laboratary of Air-Based Information Perceptian And
Zhang, Jian	School of Aeronautics, Changji University, Changji, 831100, Chi
Cao, Langcai	Xiamen University
Xu, Yang	Northwestern Polytechnical University
Luo, Delin	Xiamen University

Keywords: Control Applications, Multi-agent Systems, Nonlinear Systems and Control
Abstract: This paper presents a nonlinear model predictive control (NMPC) framework integrated with control barrier functions (CBFs) and control Lyapunov functions (CLFs) for safe formation control of multiple vertical take-off and landing unmanned aerial vehicles in dense environments. In realworld scenarios, UAVs face significant challenges in collision avoidance and safe inter-vehicle distance maintenance. The proposed method integrates formation-keeping constraints with safety-critical constraints, ensuring collision avoidance and dynamic feasibility. By leveraging NMPC's predictive capability alongside the safety guarantees of CBFs and CLFs, our approach effectively generates smooth flight trajectories while maintaining formation and avoiding obstacles. The proposed method demonstrates reliable performance in dynamic and constrained environments, providing a practical solution for real-world applications.

15:30-15:45, Paper TuAT4.4	

An Advanced Process Control Application Framework: Development and Test-Bench Validation

Vansovits, Vitali	TalTech University
Petlenkov, Eduard	Tallinn University of Technology
Tepljakov, Aleksei	Tallinn University of Technology
Vassiljeva, Kristina	Tallinn University of Technology

Keywords: Control Applications, Linear Systems, Process Control & Instrumentation
Abstract: In this paper, we present a software framework implementing Model Predictive Control (MPC), a widely adopted method in industrial automation. Designed for versatility, it operates with a range of target platforms—such as programmable logic controllers and distributed control systems. Notably, beyond its core MPC functionality, the framework supports multiple realtime simulation models, positioning it not merely as a conventional controller but also as a foundational digital twin for industrial processes. This capability facilitates a seamless transition from academic research to real-world application—an area that often proves challenging due to the gap between laboratory settings and practical industry requirements. The experimental validation on a laboratory test bench demonstrates the effectiveness of the proposed solution, underscoring its role as a bridge between academic developments and industrial implementation.

15:45-16:00, Paper TuAT4.5	

Adaptive Nonlinear Controller for High-Speed Marine Vehicle Trajectory Tracking: Theory and Practice

Lehodey, João	Instituto Superior Técnico
Cabecinhas, David	Instituto Superior Técnico
Batista, Pedro	Instituto Superior Técnico

Keywords: Control Applications, Adaptive Control, Robotics
Abstract: This paper addresses the challenge of developing an integrated nonlinear adaptive controller for under-actuated high-speed marine vehicles equipped with a propeller and rudder. Leveraging a previously identified model, the proposed controller is designed to ensure trajectory tracking despite constant external disturbances and unknown dynamical parameters. A detailed description of our cost-effective testing setup based on the PX4 ecosystem is provided, enabling researchers to readily replicate this high-speed ASV research platform capable of speeds up to 12 m/s. Experimental results demonstrate the effectiveness of the proposed system, with the vehicle successfully following a challenging trajectory consisting of arcs and straight lines at speeds up to 3 m/s.

16:00-16:15, Paper TuAT4.6	

Control of Vehicle Lateral Dynamics on Race Circuits with Variable Speeds

Pauca, Georgiana-Sinziana	Gheorghe Asachi Technical University of Iasi
Pauca, Ovidiu	Gheorghe Asachi Technical University of Iasi
Caruntu, Constantin-Florin	Gheorghe Asachi Technical University of Iasi

Keywords: Control Applications, Automated Guided Vehicles, Motion Control
Abstract: In the broader context of the automotive industry, a significant percentage of investments are directed towards the development and implementation of advanced automated driving systems aimed at enhancing the safety of drivers and other road users during driving. This study proposes a control method for an automatic lane-keeping system based on a lateral dynamic model with error correction, specifically targeting the minimization of position and orientation errors. The objective is achieved by implementing a state-feedback control approach combined with feed-forward control, resulting in a combined control strategy that ensures both anticipation of the system dynamics and effective error correction. The framework is augmented by utilizing a trajectory derived from real-world coordinates, complemented by the integration of variable longitudinal speed, which directly influences the vehicle's lateral dynamics. This variable speed approach enhances the realism of the system by closely mimicking the dynamic behavior of a vehicle under actual driving conditions. Overall, the study demonstrates the effectiveness of the proposed control method in minimizing errors encountered during vehicle motion, ensuring precise lane-keeping, and improving both efficiency and safety in driving scenarios.

TuBT1	GRANDE 1&2
Best Student Session	Regular Session
Chair: Lin, Zongli	University of Virginia
Co-Chair: Xie, Lihua	Nanyang Technological University

16:30-16:45, Paper TuBT1.1	

CRL-KEA: A Deep Reinforcement Learning Assisted Evolutionary Algorithm for Multipath Routing Optimization Problem

Jiang, Jingchen	Beijing Institute of Technology
Shi, Xiang	Beijing Institute of Technology

Zhou, Xuan	Beijing Institute of Technology
Han, Geng	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology

Keywords: Intelligent and AI Based Control, Modeling and Control of Complex Systems, Process Automation
Abstract: The rapid growth of Internet traffic necessitates the adoption of effective routing algorithms to ensure faster and more stable network transmission. Single-path routing is insufficient for current demands, and the performance of multipath routing needs enhancement to address the constraints and requirements of practical scenarios. In this paper, we propose a comprehensive reinforcement learning assisted knowledge-based evolutionary algorithm (CRL-KEA) to solve multipath routing problems with the constraints of practical applications. In this method, deep reinforcement learning with a differentiated encoder and decoder (DRL-DC) is utilized to assist in constructing the initial population. By integrating the current network load state, DRL-DC achieves efficient subpaths construction. Moreover, various operators with specific problem knowledge are adopted to guide the solution updates and repair infeasible solutions. In this way, our method enables the rapid provision of high-quality multipath routing schemes for all network flows. Through experiments conducted under various network topologies, we demonstrate that CRL-KEA has significant advantages in both quality and speed.

16:45-17:00, Paper TuBT1.2	

Autonomous UAV Path Planning in Dynamic Environments: A Hybrid Framework of Trajectory Prediction and Priority-Aware DWA

Ran, Fengrui	Beijing Institute of Technology
Yu, Chengpu	Beijing Institute of Technology
Xu, Erpei	Beijing Institute of Technology
Feng, Yunji	Beijing Institute of Technology

Keywords: Motion Control, Real-time Systems, Optimal Control
Abstract: Currently, path planning for unmanned aerial vehicles (UAVs) in dynamic environments still faces risks and challenges such as poor adaptability and high collision risks caused by frequent environmental changes. This paper proposes a hybrid planning framework that integrates trajectory prediction with the Priority-aware Dynamic Window Approach (P-DWA). The framework constructs a trajectory prediction model based on dynamic obstacle position data, integrating time weights and uncertainty quantification. During the path search process, a priority queue mechanism is implemented. This mechanism is combined with a risk-aware collision cost function to avoid local optima. Simulation results demonstrate that the proposed method outperforms EGOv2 and DP in dynamic obstacle scenarios, particularly in terms of planning success rate and obstacle avoidance. Real-world UAV flight tests further validate the method's effectiveness in complex dynamic environments, showcasing its robustness and reliability.

17:00-17:15, Paper TuBT1.3	

DefectGPT: An Automatic Retrieval-Augmented Framework for Digital Twin-Based Defect Information Management and Analytics

Huang, Yijun	The Chinese University of Hong Kong
Zhang, Jihan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Lam, Alan Hiu-Fung	The Chinese University of Hong Kong g
Chen, Ben M.	The Chinese University of Hong Kong

Keywords: Real-time Systems, Learning Systems, Smart Buildings
Abstract: Effective building defect management is vital for the operational safety, longevity, and resilience of modern high-rise structures. However, traditional approaches often rely on a patchwork of inspection logs, manual measurements, and inconsistent documentation, which can complicate maintenance efforts and risk assessments. In this paper, we propose Defect-GPT, a framework that integrates Digital Twin (DT) modeling, Retrieval-Augmented Generation (RAG), and Large Language Models (LLMs) to streamline the lifecycle defect inspection and management. The system collects multi-modal data from Unmanned Aerial Vehicle (UAV) flights, Building Information Models, and Geographic Information Systems (GIS) to build a comprehensive digital twin of a high-rise building. On top of this unified data model, a fine-tuned LLM performs context-aware retrieval and generation, providing defect-related insights and maintenance recommendations that are grounded in up-to-date building data. Periodic field studies in Hong Kong demonstrate that this approach significantly enhances defect data retrieval precision and expedites decision-making workflows by leveraging domain-specific knowledge. These findings open new avenues for AI-driven building management, particularly in large-scale urban environments where efficient, robust, and explainable maintenance systems are increasingly essential.

17:15-17:30, Paper TuBT1.4	

Learning-Based Uncertainty-Aware Predictive Control of Truck-Trailer Systems in Rough Terrain

Hartmann, Philipp	Friedrich-Alexander-Universität Erlangen-Nürnberg
Graichen, Knut	University Erlangen-Nürnberg (FAU)

Keywords: Motion Control, Learning-based Control, Control Applications
Abstract: This paper presents a model predictive controller for truck-trailer systems in off-road environments that takes into account uncertainties of the employed vehicle model. Model predictive controllers are widely used in the field of truck-trailer systems, as they enable to plan complex maneuvers, account for obstacles and consider system limits. A common model is derived from the kinematics of the vehicle. This model is based on the assumptions of flat surfaces and no slip. Driving in harsh environments, however, these assumptions are often violated, resulting in model uncertainties and thus in an impaired tracking accuracy. To address this issue, this paper enhances the kinematic model by Gaussian Process-based correction models that are adapted to the road conditions online. To avoid potentially dangerous maneuvers, the paper further proposes to consider the prevention of high model uncertainties an objective of the controller. The presented methods are evaluated in a high-fidelity simulation environment.

17:30-17:45, Paper TuBT1.5	

Safe Near-Optimal Reinforcement Learning for Robotic Motion Planning Using High Order Control Barrier Functions

Jiang, Yuhe	Shanghai University
Zhao, Guoxiang	Shanghai University
Ren, Xiaoqiang	Shanghai University

Keywords: Nonlinear Systems and Control, Learning-based Control, Optimal Control
Abstract: Motion planning remains a critical research challenge in robotics, particularly for nonlinear systems where balancing safety, optimality, and computational efficiency poses inherent trade-offs. While numerous planners have been proposed to address these competing objectives, reconciling rigorous safety guarantees with real-time performance remains an open problem. This paper investigates safe near-optimal robotic motion planning and introduces a reinforcement learning (RL) framework integrating a neural network (NN)-approximated target navigator and a high order control barrier function (HOCBF)-based safeguarding controller. Lyapunov analysis provides formal guarantees on the near-optimality of the derived controller, the convergence of the robot to its target state, and the forward invariance of the robot within the collision-free set. Experiments on a four-dimensional unicycle-like robot validate the theoretical findings.

TuBT2	GRANDE 3
Motion Control II	Regular Session
Chair: Vinha, Sérgio	Universidade Do Porto

16:30-16:45, Paper TuBT2.1	
Resilient Control Strategy for a VTOL UAV Achieving Safe Transition Flight under Actuator Faults and Disturbances	
Fu, Yifang	Northwestern Polytechnical University
Wang, Ban	Northwestern Polytechnical University
Zhou, Menggi	Northwestern Polytechnical University
Zhao, Huimin	Northwestern Polytechnical University
Li, Ni	Northwestern Polytechnical University

Keywords: Nonlinear Systems and Control, Adaptive Control, Motion Control
Abstract: Hybrid Vertical Takeoff and Landing (VTOL) Unmanned Aerial Vehicles (UAVs) demonstrate more flexible advantages in complex missions due to their capability to VTOL and conduct high-speed horizontal flight. But their ability to achieve safe transition flight still remains a challenge. This paper proposes a resilient transition control strategy for a VTOL UAV under the compounded impact of actuator faults and disturbances. A novel reaching law is introduced in the baseline sliding mode control (SMC) to mitigate the control chattering problem, and SMC is incorporated with a nonlinear disturbance observer to enhance the attenuation capability of external disturbances. On this basis, adaptive SMC is introduced to compensate for adverse effect caused by actuator faults and disturbances. The designed adaptive parameters combine continuous and discontinuous components without merely relying on the discontinuous control parts of SMC. Simulation test is finally carried out to qualitatively and quantitatively validate the superiority of the proposed method.

16:45-17:00, Paper TuBT2.2	
A Path Planning Method for A-UAV Based on the CGRUA Model	
Qi, Jiahao	Zhengzhou University
Xia, Xing	Zhengzhou University
Guo, Jinjun	Zhengzhou University
Qin, Xiangnan	Zhengzhou University

Keywords: Intelligent and AI Based Control, Learning-based Control, Motion Control
Abstract: Amphibious Unmanned Aerial Vehicle (A-UAV), equipped with multi-sensor systems, has significant value in digitization of water body by monitoring both aquatic and aerial domains. Compared to traditional methods, it offers improved multi-dimensional perception but faces challenges like complex operational paths and data fusion difficulties, which increase the risk of system failures. This study proposes a path planning model for A-UAV based on the CGRUA framework, combining drifting and flying paths to enhance endurance and measurement range. Using buoy data from the Global Drifter Program (GDP buoy ID 2101873), the accuracy of the hybrid CGRUA model predictions and the effectiveness of path planning was validated.

17:00-17:15, Paper TuBT2.3	
Motion Primitives on a Spherical Surface with Application to Tethered Aircraft Guidance	
Vinha, Sérgio	Universidade Do Porto
Fernandes, Gabriel M.	Universidade Do Porto
Fernandes, Manuel C. R .M.	Universidade Do Porto
Fontes, Fernando A. C. C.	Universidade Do Porto

Keywords: Motion Control, Robotics
Abstract: This paper proposes and studies motion primitives and its application to control vehicles operating on a spherical surface. Motion primitives are fundamental motion patterns that enable structured control in robotics and motion planning. Here, they are adapted to movement on a spherical surface and utilized in the context of tethered aircraft guidance. The research defines circular motion on the sphere simply by selecting the center of rotation of a circular path. This work also explores the combination of motion primitives with two path-following guidance methods: we develop an adaptation of the L1 and L0 guidance logics to spherical motion using the proposed primitives. Smooth trajectories, preserving curvature continuity, can be guaranteed by imposing an orthogonality condition at the primitive switching points. Simulation results demonstrate the efficacy of the proposed approach, showcasing successful path adherence manoeuvres that can be applied in the take-off of tethered fixed-wing aircraft.

17:15-17:30, Paper TuBT2.4	
Vehicle Trajectory Planning Using Model Predictive Control in Environments with Dynamic and Static Obstacles	
Pauca, Ovidiu	Gheorghe Asachi Technical University of Iasi
Vacaru, Alexandru-Ioan	Gheorghe Asachi Technical University of Iasi
Caruntu, Constantin-Florin	Gheorghe Asachi Technical University of Iasi

Keywords: Motion Control, Control Applications, Nonlinear Systems and Control
Abstract: The ability of automated vehicles to avoid obstacles on the road is one of the most critical functionalities, as it directly impacts passenger safety. The trajectory planning functionality plays a key role in this task, as it uses data from sensors to identify obstacles and plan a free obstacle path. Thus, this paper proposes a trajectory planning method based on a model predictive control (MPC) strategy that takes into account both

static and dynamic obstacles. Additionally, a trajectory tracking controller based on a linear quadratic regulator (LQR) algorithm is designed to ensure the vehicle follows the planned path. To evaluate the proposed control solution for the lateral dynamics of the vehicle, a traffic scenario involving multiple obstacles (both static and dynamic) is used. The results show that the proposed solution effectively controls the vehicle's lateral dynamics and successfully avoids collisions with obstacles.

17:30-17:45, Paper TuBT2.5	
IRSAI: Integrating Remote Sensing and Artificial Intelligence to Monitor Maritime Activities across Lemesos Bay	
Demetriou, Georgios	Frederick University
Menelaou, Angelos	Frederick University
Kletou, Demetris	Marine & Environmental Research (MER) Lab Ltd
Kleitou, Periklis	Marine and Environmental Research (MER) Lab
Kakoulli, Christina	Marine & Environmental Research (MER) Lab
Artusi, Alessandro	Cyenss CoE
Milidonis, Xenios	CYENS Centre of Excellence
Angelini, Mattia	Cyens Center of ExcellenceCyens Center of Excellence
Trimithiotis, Georgios	Frederick University
Lazaridis, Stefanos	Frederick University
Keywords: Multi-agent Systems, Automated Guided Vehicles, Robotics	

TuBT3	BOLERO 1
Networked Control	Regular Session
Chair: Yin, Xunyuan	Nanyang Technological University

16:30-16:45, Paper TuBT3.1	
Event-Triggered Polynomial Control for Trajectory Tracking by Unicycle Robots	
V, Harini	Indian Institute of Science, Bangalore
Rajan, Anusree	Indian Institute of Science
Amrutur, Bharadwaj	Indian Institute of Science
Tallapragada, Pavankumar	Indian Institute of Science

Keywords: Networked Control, Nonlinear Systems and Control, Robotics

Abstract: This paper proposes an event-triggered polynomial control method for trajectory tracking by unicycle robots. In this method, each control input between two consecutive events is a polynomial and its coefficients are chosen to minimize the error in approximating a continuous-time control signal. We design an event-triggering rule that guarantees uniform ultimate boundedness of the tracking error and non-Zeno behavior of inter-event times. We illustrate our results through a suite of numerical simulations and experiments, which indicate that the number of events generated by the proposed controller is significantly less compared to that by a time-triggered controller or a event-triggered controller based on zero-order hold while guaranteeing similar tracking performance.

16:45-17:00, Paper TuBT3.2	
Distributionally Robust Model Predictive Control with Koopman Operators	
Zhang, Wenhao	School of Aeronautics and Astronautics, Sichuan University
Li, Bin	Sichuan University

Keywords: Learning-based Control, Linear Systems, Optimal Control

Abstract: This paper presents a novel methodology for controlling nonlinear systems by integrating Koopman operators with Distributionally Robust Model Predictive Control (K-DRMPC). The proposed approach addresses the challenges posed by external disturbances and model uncertainties by modeling these factors as random variables characterized by their first and second-order moment information, which are estimated from empirical data. Initially, the nonlinear system is linearized using the Koopman operator, transforming the control problem into a linear framework that facilitates control design. Subsequently, K-DRMPC is employed to reformulate state chance constraints into Second-Order Cone (SOC) constraints, ensuring robust performance in the presence of uncertainties. Numerical experiments validate the effectiveness of the proposed approach under disturbances.

17:00-17:15, Paper TuBT3.3	
Towards Event-Triggered NMPC for Efficient 6G Communications: Experimental Results and Open Problems	
Püttschneider, Jens	TU Dortmund University
Golembiewski, Julian	TU Dortmund University
Wagner, Niklas A.	TU Dortmund University
Wietfeld, Christian	TU Dortmund University, Communication Networks Institute (CNI)
Faulwasser, Timm	Hamburg University of Technology

Keywords: Networked Control, Optimal Control, Control Applications

Abstract: Networked control systems enable real-time control and coordination of distributed systems, leveraging the low latency, high reliability, and massive connectivity offered by 5G and future 6G networks. Applications include autonomous vehicles, robotics, industrial automation, and smart grids. Despite networked control algorithms admitting nominal stability guarantees even in the presence of delays and packet dropouts, their practical performance still heavily depends on the specific characteristics and conditions of the underlying network. To achieve the desired performance while efficiently using communication resources, co-design of control and communication is pivotal. Although periodic schemes, where communication instances are fixed, can provide reliable control performance, unnecessary transmissions, when updates are not needed, result in inefficient usage of network resources. In this paper, we investigate the potential for co-design of model predictive control and network communication. To this end, we design and implement an event-triggered nonlinear model predictive controller for stabilizing a Furuta pendulum communicating over a tailored open radio access network 6G research platform. We analyze the control performance as well as network utilization under varying channel conditions and event-triggering criteria. Additionally, we analyze the network-induced

delay pattern and its interaction with the event-triggered controller. Our results show that the event-triggered control scheme achieves similar performance to periodic control with reduced communication demand.

17:15-17:30, Paper TuBT3.4

Adversarial Reinforcement Learning Based IoT Honeypot

Zhang, Hao	Zhejiang University
Zhang, Siyuan	Zhejiang University
He, Chengrun	Hangzhou Hikvision Digital Technology Co., Ltd
Zhao, Chengcheng	Zhejiang University

Keywords: Sensor Networks, Learning Systems, Intelligent and AI Based Control

Abstract: Internet of Things (IoT) honeypots are decoy systems deployed to entice attackers to gather threat intelligence and protect real systems. High-interaction IoT honeypots powered by reinforcement learning (RL) have emerged as a promising solution due to their cost-effectiveness and scalability. However, these systems are typically based on the assumption that attackers exhibit stationary behavior. In reality, attack strategies against IoT can be dynamic and adaptive, creating a non-stationary environment due to the adversarial nature of attacker-honeypot interactions. To solve this issue, we propose an IoT honeypot based on adversarial reinforcement learning, i.e., Repeated-Update-Q-learning (RUQL, a classical RL method for non-stationary environments). It is composed of a data preprocessing module, an RUQL module, and a response database. Experimental results show that compared to honeypots based on random strategies, classical Q-learning, and deep RL, the proposed system can effectively respond to attacks and improve attack capture and analysis capabilities.

17:30-17:45, Paper TuBT3.5

Collision-Free and Guaranteed Capture Winning Strategies for Reach-Avoid Games with Two Heterogeneous Pursuers and One Evader

Shu, Peixuan	Beihang University
Yan, Rui	Beihang University
Hua, Yongzhao	Beihang University
Dong, Xiwang	Beihang University

Keywords: Multi-agent Systems, Networked Control, Optimal Control

Abstract: This paper investigates reach-avoid differential games involving two pursuers and one evader. The pursuers with different capture radii collaborate to protect a target region against the evader whose objective is to reach the target region while avoiding being captured by the pursuers. Previous studies have shown that the cooperation between pursuers can improve their capability of defending the target region against the evader. However, these studies did not account for the collision avoidance between the pursuers when designing pursuit strategies. In this work, the pursuers have different safety radii and must avoid collisions with each other. A feedback capture strategy is proposed to ensure that from a set of states, the pursuers can win the game with collision-free trajectories. This strategy relies on solving an optimization problem induced by the relaxed control barrier function (R-CBF) and a new geometric concept called the alpha-evasion space (alpha-ES). Sufficient conditions to guarantee both the pursuit winning and collision avoidance are presented. Numerical simulations are provided to show the collision-free trajectories of the pursuers under the proposed capture strategy.

17:45-18:00, Paper TuBT3.6

Learning and Predictive Control of Nonlinear Systems with Multi-Modal Uncertainties Using Koopman Operator and Gaussian Mixture Model

Qi, Jialin	Nanyang Technological University
Li, Xiaojie	Nanyang Technological University
Han, Minghao	Nanyang Technological University
Yin, Xunyuan	Nanyang Technological University

Keywords: Learning-based Control, Nonlinear Systems and Control, Process Control & Instrumentation

Abstract: In this paper, we consider learning-based modeling and predictive control of nonlinear systems subject to multi-modal uncertainties. A Gaussian mixture Koopman operator, which learns the evolution of the observable distribution in a higher-dimensional space, is proposed to characterize the dynamics of the underlying nonlinear systems. Based on the learned probabilistic Koopman model, a stochastic model predictive control method with chance constraints is introduced for the nonlinear systems with state constraints. Finally, a simulated chemical process is used to illustrate the effectiveness of the proposed method.

TuBT4 BOLERO 2

Control Applications II Regular Session

16:30-16:45, Paper TuBT4.1

Mission Planning of Continuous Tracking Moving Targets by Earth Observation Satellite in Unknown Scenarios

Li, Xiang	Harbin Institute of Technology
Han, Xiaofeng	Harbin Institute of Technology
Ma, Ping	Harbin Institute of Technology
Yang, Ming	Harbin Institute of Technology
Chao, Tao	Harbin Institute of Technology

Keywords: Factory Modeling and Automation, Multi-agent Systems, Learning Systems

Abstract: Mission planning of continuous tracking moving targets (MPCTMT) by earth observation satellites is a crucial optimization problem in the field of modeling and optimization. However, due to the unknown task scenarios in multi-objective MPCTMT problem, existing optimization algorithms struggle to effectively address MPCTMT problem. In this study, we propose a novel multi-objective optimization algorithm tailored to address MPCTMT problem. To ensure a well-distributed set of solutions in all unknown scenarios, we introduce an anchors adjustment mechanism. Experimental results demonstrate that the proposed algorithm outperforms existing multi-objective evolutionary algorithms in all possible scenarios.

16:45-17:00, Paper TuBT4.2

Co-Design of Functional Interval Observer-Based Control for Uncertain Linear Parameter Varying Switched Systems	
Nguyen, Duc To	University of Évry-Val d'Essonne - University of Paris-Saclay
Mammar, Said	University of Evry, IBISC Lab
Ichalal, Dalil	Université d'Evry Val D'Essonne
Ait Oufroukh, Naima	Université d'Evry - Laboratoire IBISC

Keywords: Linear Systems, Optimal Control
Abstract: This paper presents a novel method for the co-design of observers and controllers for switched linear parameter-varying (LPV) systems subject to unknown but bounded uncertainties, disturbances, and faults. First, a polytopic functional interval observer (FIO) is employed to estimate the lower and upper bounds of the system states. Next, a proportional-integral (PI) observer is designed to estimate fault signals accurately. Building on these estimates, a fault-tolerant control (FTC) strategy is developed to ensure the stability of the closed-loop system and maintain reference model tracking in the presence of faults. The sufficient conditions for the existence of observers and controllers are derived using Linear Matrix Inequalities (LMIs), leveraging multiple Lyapunov functions and ensuring input-to-state stability (ISS) under the average dwell time (ADT) approach. Finally, the effectiveness of the proposed approach is validated through a simulation applied to vehicle lateral dynamics estimation and control.

17:00-17:15, Paper TuBT4.3	
Positive Observer Design for Positive Linear Systems with Applications in Cascaded Symmetric RC Network	
Chaudhary, Bhargavi	Indian Institute of Technology Delhi
Patel, Neetish	Indian Institute of Technology Delhi, New Delhi
Datta, Subashish	Indian Institute of Technology Delhi
Kar, Indra Narayan	Indian Institute of Technology Delhi

Keywords: Linear Systems, Real-time Systems, Control Applications
Abstract: This paper addresses the problem of state observation techniques specifically designed for positive systems, which represent non-negative natural processes prevalent in various fields. Unlike traditional dynamical systems, positive systems necessitate state observers to maintain non-negativity throughout the estimation process. We propose an algebraic framework for synthesizing positive observers for positive linear systems while preserving positivity, accommodating the inherent constraints of positive systems. The proposed design, also provides a systematic and scalable solution for observer design in cascaded symmetric networks of positive systems. Through simulations and experimental validation, we demonstrate the effectiveness and versatility of the proposed approach, contributing to the advancement of theory in positive systems and facilitating the analysis to diverse applications.

17:15-17:30, Paper TuBT4.4	
Incremental Verification of Inference Observability in Decentralized Discrete-Event Control	
Yoon, Sung Ho	Mount Allison University
Ricker, S. Laurie	Mount Allison University
Marchand, Herve	INRIA, Centre Rennes Bretagne-Atlantique

Keywords: Discrete Event Systems, Multi-agent Systems
Abstract: Inference observability is one of the properties that must be satisfied to synthesize solutions to decentralized supervisory control problems. Current verification strategies require the construction of the complete system model. However, when a system model consists of multiple components, these monolithic approaches may be computationally infeasible due to the state-space explosion problem, a situation that arises when the system's state space increases exponentially with the number of its components. Incremental verification algorithms have been proposed to navigate this issue, where verification occurs component-wise. Our proposed solution to this issue involves updating an algorithm for the incremental verification of co-observability and extending it to inference observability.

17:30-17:45, Paper TuBT4.5	
Distributed Resilient Consensus and Demand Tracking in Battery Energy Storage Systems under Adversarial Attacks	
Zhang, Shiheng	The Hong Kong University of Science and Technology (Guangzhou)
Ji, Yiding	The Hong Kong University of Science and Technology (Guangzhou)

Keywords: Control of Distributed Generation Systems, Multi-agent Systems, Control Applications
Abstract: Battery Energy Storage Systems (BESS) is pivotal balancing power supply and demand by dynamically adjusting charging and discharging power. However, their deployment in public networks renders them vulnerable to adversarial attacks, which can disrupt system coordination and potentially lead to failures. To address these challenges, this paper presents a distributed resilient consensus algorithm that integrates the Mean Subsequence Reduced (MSR) method with demand tracking, structured within a leader-follower control framework. The proposed algorithm guarantees that all non-adversarial agents achieve resilient state-of-charge (SoC) consensus and equitable power distribution, even in the presence of malicious battery storage units. Additionally, we introduce an error tracking factor for leader agents to facilitate accurate demand tracking by the BESS. We establish convergence conditions, demonstrating that the system converges to a final value determined by the communication graph, initial values, and BESS parameters. The effectiveness of the proposed algorithm is validated through a numerical simulation, confirming its robustness and reliability in maintaining system performance under adverse conditions.

17:45-18:00, Paper TuBT4.6	
Detecting and Resolving Feature Interactions in Cyber-Physical Systems Using Formal Methods	
Walker, Hayden Douglas	Mount Allison University
Ricker, S. Laurie	Mount Allison University
Marchand, Herve	INRIA, Centre Rennes Bretagne-Atlantique

Keywords: Discrete Event Systems, Control Applications, Smart Structures
Abstract: We investigate the use of formal methods to detect and resolve feature interactions (FI) in cyber-physical systems (CPS). These systems are often made up of multiple components that

may interact with each other in unexpected and unwanted ways, potentially creating a security risk. Specifically, we use supervisory control theory to examine FI in a smart home, an example of a CPS. With the rising adoption of smart home devices, mitigating these interaction threats at the modelling stage is important before they are installed in homes. We present an extended taxonomy of FI threats that affect such a CPS. We demonstrate how one such threat, chaotic device management (Codema), can be detected and resolved in a system comprised of a smart light bulb that supports two disjointed device management channels.

WeAT1	GRANDE 1&2
Modeling, Optimization, and Control for Unmanned Autonomous Systems I	Invited Session
Chair: Tao, Weizhi	The Hong Kong Polytechnic University
Organizer: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Shao, Jinliang	University of Electronic Science and Technology of China
Organizer: Su, Zikang	Nanjing University of Aeronautics and Astronautics

08:30-08:45, Paper WeAT1.1

Two-Stage AL-iLQR-Based Trajectory Planning for Special-Shaped Curb Cleaning of Sweeper (I)

Lin, Ke	Harbin Institute of Technology Shenzhen
Li, Yanjie	Harbin Institute of Technology Shenzhen

Keywords: Robotics, Motion Control, Optimal Control
Abstract: This study addresses the challenge of generating a contiguous sweeping line along an irregular curb edge. The primary method involves utilizing the curb edge line and applying a translation process to it. Subsequently, a higher-order filter is employed to smooth the resulting curve. The curve is then segmented based on curvature, with spiral and Reeds-Shepp curves used to connect the segmented parts. Finally, the entire trajectory is smoothed using the Augmented Lagrangian-iLQR (AL-iLQR) algorithm, yielding the final curve for the sweeping line. This approach ensures a precise and optimized path for cleaning along the irregular curb edge.

08:45-09:00, Paper WeAT1.2

Human-Robot Interaction, Robotics, Machine Learning (I)

Zhang, Xuan	The Hong Kong Polytechnic University
Zhou, Guanzhong	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Robotics, Motion Control, Real-time Systems
Abstract: The development of physically assistive robots for eating assistance has significant potential to improve the quality of life for seniors and individuals with disabilities. Effective autonomous feeding, however, depends on accurately inferring eating intentions. Many existing methods fail to adequately address human intention and the dynamic variability of behavior during eating. This paper presents a method for inferring eating intentions in human-robot interaction (HRI) by combining Residual Networks (ResNet) with Long Short-Term Memory (LSTM) networks, enabling robotic arms to feed autonomously. Inspired by observable facial movements during eating, we extract a key feature: the amplitude of the chin-to-nose distance from facial landmarks, which clearly indicates eating intentions. To mitigate noise and data corruption in input sequences, we use a Gaussian function as the convolutional kernel in the ResNet framework and integrate a variance attention mechanism in the LSTM's hidden layer to capture dynamic changes. Experimental results show our method achieves an accuracy rate 87.0% in intention inference. Real-world tests with a robotic arm and an RGB camera validate our approach's efficacy and real-time predictive performance.

09:00-09:15, Paper WeAT1.3

Evaluating Player Performance and Tactical Decision-Making in Racket Sports Using Deep Reinforcement Learning (I)

Tao, Weizhi	The Hong Kong Polytechnic University
Liu, Mingjiang	The Hong Kong Polytechnic University
Sun, Wuzhou	Southwest Jiaotong University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Robotics, Motion Control, Real-time Systems
Abstract: This paper introduces a novel evaluation network that leverages deep reinforcement learning integrated with advanced modeling and prediction strategies to enhance decision-making in racket sports, drawing parallels to challenges encountered in unmanned autonomous systems (UAS). Traditional performance analysis methods predominantly depend on manual observation and static metrics, which inadequately capturethe dynamic and strategic complexities of game environments. Our approach combines the principles of Markov Decision Processes with the Transformer architecture to manage long sequential tasks, thereby improving the accuracy of correlating states and actions. By modeling turn-based racket sports, the evaluation network assigns Q-values to actions derived from historical match data, demonstrating the impact of each action on potential scoring or loss of points. We evaluated our approach using various hyper-parameters and network architectures, validating it against multiple baselines and performance metrics. The findings suggest promising avenues for advancing data-driven training methodologies and enhancing autonomous system capabilities in complex, task-oriented domains.

09:15-09:30, Paper WeAT1.4

Leveraging Obstacles for Strategic Evasion in Quadrotor Pursuit-Evasion Games (I)

Lam, Yat Long	The Hong Kong Polytechnic University
Ip, Chun Man Ben	The Hong Kong Polytechnic University
Zhang, Chengchen	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Robotics, Control Applications, Motion Control
Abstract: This paper explores a quadrotor pursuit-evasion (PE) game in an environment with obstacles. Existing research typically focuses on evasion strategies that avoid obstacles while increasing the distance from the pursuer, and very few studies have attempted to use obstacles to gain an advantage in winning the PE game. Assuming both quadrotors follow Dubin's car dynamics and the pursuer is less agile due to a larger minimum turning radius, this paper introduces a novel evasion strategy. This strategy leverages the obstacle by having the evader perform agile turns near it, potentially causing the pursuer to collide with the obstacle. Gazebo simulations have been conducted to validate that the evasion strategy can lead to the pursuer colliding with the obstacle under appropriate conditions.

09:30-09:45, Paper WeAT1.5	
Performance-Guaranteed Trajectory Tracking Control for Mobile Manipulation (I)	
Fan, Jialiang	Nanjing University of Aeronautics and Astronautics/Ecole Centra
Su, Zikang	Nanjing University of Aeronautics and Astronautics
Jiang, Changhui	Nanjing University of Aeronautics and Astronautics
Xing, Zhuolin	Nanjing University of Aeronautics and Astronautics

Keywords: Robotics, Nonlinear Systems and Control, Control Applications
Abstract: This paper presents a trajectory tracking control approach for a mobile manipulation (MM) comprising a robotic arm mounted on a mobile platform. To address external disturbances and non-inertial interactions between the two subsystems, a composite trajectory tracking control strategy based on finite-time prescribed performance control (FTPPC) is developed. This method ensures precise trajectory tracking despite rapidly varying and bounded uncertainties. An adaptive sliding mode observer (ASMO) is designed to estimate external disturbances and uncertain system dynamics. Using a Lyapunov-based analysis, the proposed scheme guarantees uniform boundedness and uniform ultimate boundedness of the system. Simulation results validate its effectiveness in achieving high-precision tracking and superior transient performance under uncertain conditions.

09:45-10:00, Paper WeAT1.6	
A Novel Anti-Disturbance Control Framework for Bidirectional Quadrotors (I)	
Zhao, Yibo	The Hong Kong Polytechnic University (PolyU)
Lyu, Mingyang	The Hong Kong Polytechnic University (PolyU)
Huang, Hailong	The Hong Kong Polytechnic University (PolyU)

Keywords: Robotics, Nonlinear Systems and Control, Modeling and Control of Complex Systems
Abstract: Quadrotors frequently encounter sudden external forces during flight, often resulting in loss of control and crashes. Conventional control algorithms typically fail to effectively handle these large external disturbances. To address this issue, we propose a novel control framework that integrates Model Predictive Control (MPC) with Active Disturbance Rejection Control (ADRC), alongside a bidirectional thrust geometric control algorithm. When the external force remains within a predefined threshold, the quadrotor utilizes the disturbance rejection capabilities of ADRC to maintain stability. Conversely, if the force exceeds this threshold, the quadrotor leverages the external force to execute a complete 180-degree flip to regain equilibrium. Simulation results are presented to demonstrate the superior performance of the proposed control framework in handling large external disturbances.

WeAT2	GRANDE 3
Learning-Based Control I	Regular Session
Chair: Lin, Liquan	The Chinese University of Hong Kong

08:30-08:45, Paper WeAT2.1	
Adaptive Output Regulation Via Internal Model Principle and Policy Iteration	
Lin, Liquan	The Chinese University of Hong Kong
Huang, Jie	The Chinese University of Hong Kong

Keywords: Learning-based Control, Linear Systems
Abstract: The data-driven output regulation problem via internal model principle has been studied by both policy-iteration method and value-iteration method. But the results were limited to single-input single-output linear systems with zero input-output transmission matrix. Recently, we extended the existing results to multi-input multi-output linear systems with non-zero input-output transmission matrix by an improved value-iteration method. Since the policy-iteration method is simpler and has a much faster convergence speed than the value-iteration method, in this paper, we further establish the results parallel to the improved value-iteration method by an improved policy-iteration method. Compared with the existing policy-iteration results, we are able to handle multi-input multi-output linear systems with non-zero input-output transmission matrix. Moreover, we further improve the existing policy-iteration algorithm by significantly reducing the computational cost and weakening the solvability conditions. A numerical example is used to illustrate the advantages of the improved algorithm.

08:45-09:00, Paper WeAT2.2	
Distributed Nash Equilibrium Seeking in Aggregative Games for High-Order Integrator Dynamics Over Switching Networks	
Liu, Zhaocong	Shanghai Jiao Tong University
Huang, Jie	Chinese Univ. of Hong Kong

Keywords: Multi-agent Systems, Networked Control, Nonlinear Systems and Control
Abstract: In this paper, we study the distributed Nash equilibrium (NE) seeking problem for aggregative games with players whose actions are governed by high-order integrator dynamics over jointly connected and weight-balanced switching networks. Since the existing approaches critically relied on the every time connected network assumption, they do not apply to jointly connected switching networks, which can be disconnected at any time instant. To deal with the jointly connected and weight-balanced switching networks, we propose an approach that is quite different from the existing approaches, which involves finding a time-varying quadratic Lyapunov function for the closed-loop system by using converse Lyapunov theorem. A numerical example regarding formation control of unmanned aerial vehicles (UAVs) is used to validate our result.

09:00-09:15, Paper WeAT2.3	
Iterative-Learning-Based Image Servo Aerial Docking Control	
Huang, Yuantan	Beihang University
Liu, Runxiao	Beihang University
Quan, Quan	Beihang University

Keywords: Learning-based Control, Automated Guided Vehicles
Abstract: In recent years, with the rapid development of unmanned aerial vehicle (UAV), aerial refueling has garnered

increasing attention. During the critical docking phase of aerial refueling, traditional sensing technologies such as GPS and electro-optical systems may fail when signals are obstructed, drawing attention to vision-based solutions. Conventional image-based visual servo (IBVS) control techniques often overlook the impact of disturbances. In this paper, an iterative-learning-based IBVS (ILB-IBVS) controller is proposed, extending traditional position-based iterative learning to the 2D image plane, making the control more precise and reliable. Simulation results show that the proposed ILB-IBVS controller improves docking success rates and efficiency compared to the original IBVS controller.

09:15-09:30, Paper WeAT2.4	
Interference-Resistant Control of Fixed-Wing UAV Based on Enhanced Pigeon-Inspired Optimization	
Su, Hang	Beihang University
Duan, Haibin	Beihang University
Huo, Mengzhen	School of Automation Science and Electrical Engineering, Beihang
Luo, Delin	Xiamen University

Keywords: Learning-based Control, Robotics, Control Applications
Abstract: In this paper, an active disturbance rejection controller (ADRC) parameter tuning method for a fixed-wing unmanned aerial vehicle (UAV) is proposed. First, a six-degree-of-freedom nonlinear model of a fixed-wing UAV is established, and the attitude controller of the UAV is built based on ADRC. Then, the Pigeon-Inspired Optimization (PIO) is enhanced based on Directional crossover (DC) and Directional variation (DV), and DXPIO is proposed to improve the searching and convergence ability of PIO. Finally, the cost function of ADRC is designed based on sigmoid function for parameter optimization training of DXPIO. In the experiments, the benchmark optimization performance of DXPIO has a significant advantage over the other 7 peers in terms of both search and development capabilities. Additionally, DXPIO is used to optimize the UAV pitch-roll controller separately, and the tuned ADRC controller is compared to the traditional proportional-integral-derivative (PID) controller when gust interference is added on the UAV's body axis. The results demonstrate that the adjusted ADRC controller has improved robustness, anti-interference rejection, and reaction time.

09:30-09:45, Paper WeAT2.5	
A Learning-Based Stochastic Model Predictive Control Method for Online Trajectory Control of Autonomous Vehicles at an Unsignalized Intersection	
Yang, Yang	Shanghai Jiaotong University
Xu, Yunwen	Shanghai Jiaotong University
Zhang, Chen	Shanghai Jiaotong University
Li, Dewei	Shanghai Jiaotong University
Li, Ning	Shanghai Jiaotong University

Keywords: Learning-based Control, Intelligent and AI Based Control, Motion Control
Abstract: This paper proposes an autonomous driving framework for unsignalized intersections. The framework consists of two modules: vehicle state inference and vehicle motion planning. A network based on Graph Convolutional Neural Network (GCN) and Gated Recurrent Unit (GRU) encoderdecoder is established. Relying on the relevant historical states of vehicles within the unsignalized intersection, the interactions among vehicles are fully taken into account, and the future trajectory distributions of all vehicles and the collision risks between each pair of vehicles are predicted together. The motion planning module, based on the prediction results of future states, adopts the Model Predictive Control (MPC) method to obtain the desired acceleration input, improving traffic efficiency while focusing on safety. We have built a simulation platform for an unsignalized intersection that simulates human interactions in the Sumo simulation software, and used it for dataset generation and simulation experiments. The results show that our framework demonstrates high efficiency and safety under different traffic volumes.

09:45-10:00, Paper WeAT2.6	
Robust Iterative Learning Model Predictive Control for Uncertain Nonlinear Systems with Time Delays	
Zhang, Shuyu	Sun Yat-Sen University
Li, Xiao-Dong	Sun Yat-Sen University
Li, Xuefang	Sun Yat-Sen University

Keywords: Learning-based Control, Robust and H infinity Control, Nonlinear Systems and Control
Abstract: This study aims at the robust iterative learning model predictive control (ILMPC) for uncertain nonlinear systems with time delays. In order to achieve the H infinity tracking performance, a novel robust ILMPC scheme is designed based on the two-dimentional (2-D) system theory. To deal with the unknown time delays, an appropriate Lyapunov-Krasovskii functional is constructed, and the stability conditions are derived using linear matrix inequalities (LMIs). Furthermore, a new control gain determination strategy is introduced to improve the efficiency of the proposed ILMPC method. The effectiveness is verified through numerical simulations.

WeAT3	BOLERO 1
Robotics	Regular Session
Chair: Tendulkar, Swaraj	Schmalkalden University of Applied Sciences

08:30-08:45, Paper WeAT3.1	
Development of Self-Strength Variable Mechanism Using External Material	
Matsuo, Shotaro	University of Electro-Communications
Matsumoto, Mitsuharu	University of Electro-Communications

Keywords: Robotics
Abstract: In this research, we propose a mechanism that strengthens the robot itself by incorporating surrounding objects in the natural world. The strength and durability required when using a robot vary greatly depending on the application. Therefore, it is necessary to have a mechanism that can switch its own rigidity according to the surrounding conditions. Many of the stiffness-changing robots reported in the past use the phase transition of materials. Although this approach is useful, but there are not many variable stiffnesses. In this research, we examined two types of robot mechanisms that can take in surrounding objects and change their own rigidity. Operational experiments were performed to evaluate the usefulness of each mechanism. We also conducted stress measurements to confirm how much the stiffness actually changes.

08:45-09:00, Paper WeAT3.2

Vision-Force Guided Robotic EV Charging: Learning-Based Localization and 6-DoF Hybrid Compliance Control for High-Precision Insertion

Li, Zihao	Zhejiang University
Wang, Siqi	Anhui University
Li, Xiaocong	Easter Institute of Technology, Ningbo
Zhu, Yiming	Zhejiang University
Zhong, Zhe	Zhejiang University
Lang, Yilin	Zhejiang University
Ren, Qinyuan	Zhejiang University

Keywords: Robotics, Learning-based Control, Control Applications

Abstract: The automation of electric vehicle (EV) charging is a critical challenge in robotics, requiring high precision and adaptability to handle the complex geometry of charging ports. Traditional methods, such as visual servoing and force control, often struggle to achieve reliable performance due to their inability to simultaneously address positional and force-related uncertainties. To address these limitations, this paper proposes a novel coarse-to-fine framework that integrates visual and force feedback for robust and efficient peg-in-hole operations. Our method leverages a structured light camera for 6-DoF (Degrees of Freedom) pose estimation and an end-mounted force sensor for real-time force feedback. In the coarse localization stage, a learning-based object detection model identifies the charging port, while template alignment refines the pose estimation. In the fine assembly stage, a force-position hybrid control strategy ensures precise alignment and insertion. Extensive real-world experiments demonstrate the effectiveness of our approach, achieving a 96% success rate in inserting the charging gun into EV charging ports.

09:00-09:15, Paper WeAT3.3

Impact of Path Width and Pedestrian Density on Human-Robot Interaction: A Study in Outdoor and Retail Environments

Tendulkar, Swaraj	Schmalkalden University of Applied Science
Strigina, Yekaterina	Schmalkalden University of Applied Science
Uppalapati, Venkata Prashanth	Schmalkalden University of Applied Science
Ehlers, Jan	Bauhaus-Universität Weimar
Zug, Sebastian	TU Bergakademie Freiberg
Schrödel, Frank	University of Applied Science Schmalkalde

Keywords: Robotics, Man-machine Interactions

Abstract: This paper explores how path width and pedestrian density affect human-robot interaction in outdoor and retail environments. A mobile robot, equipped with a depth camera and 2D LIDAR sensor is operated on pavements of varying path widths and in retail areas with different pedestrian densities in Gera-Lusan, Germany. Unobtrusive field measures ensured the collection of raw interaction data, which was analyzed by grouping it based on path width and comparing it across different environment conditions. The findings highlight the complexity of human-robot proximity and show that path width can not be the only factor defining the spatial relationships in robot-human interaction. Parameters such as pedestrian density, environment of operation (outdoor and retail) and predefined rules for entry and exit in retail spaces affect the spatial relationship dramatically. Unconsidered factors such as age, gender, personal experiences, weather, robot speed, time of day, and weekday vs. weekend effects may further shape interactions. By challenging simplified assumptions, this study emphasizes the need for a more nuanced approach to design robots for real-world environments.

09:15-09:30, Paper WeAT3.4

End-To-End Learning for Monocular 3D Human Pose Estimation

Xie, Bowei	Beijing Institute of Technology
Liu, Geyuan	Beijing Institute of Technology
Lu, Maobin	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
Chen, Jie	Tongji University

Keywords: Robotics, Learning Systems, Signal Processing

Abstract: 3D human pose estimation (3DHPE) from a single RGB image is a crucial task in computer vision. The estimation accuracy and speed of 3DHPE directly affect the practical applicability. However, existing methods often improve accuracy by using complex network architectures or multi-stage processing. These approaches result in more computational overhead and slower estimation speed. To balance estimation accuracy and speed, we need a more efficient approach. To address this issue, we propose an end-to-end model called I-KDnet, which achieves high estimation accuracy with fast estimation speed. Specifically, we design an Idealized Knowledge Distillation (IKD) training approach, a idealized variant of online knowledge distillation. During training, I-KD enhance the training process, similarly to online knowledge distillation. During inference, it does not introduce any additional computational overhead. Additionally, compared to online knowledge distillation, the I-KD approach is easier to implement and more effective. Based on this approach, I-KDNet sets a new benchmark for single-frame monocular 3DHPE, achieving best accuracy on the Human3.6M dataset with fast inference speed.

09:30-09:45, Paper WeAT3.5

Unified Model Predictive Interaction Control Integrating Impedance Matching and Constraint Optimization

Chen, Yiming	The Chinese University of Hong Kong
Li, Chenzui	The Chinese University of Hong Kong
Teng, Tao	The Chinese University of Hong Kong
Wu, Xi	The Chinese University of Hong Kong
Xu, Dongyan	The Chinese University of Hong Kong
Liu, Yunhui	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong

Keywords: Robotics, Optimal Control, Control Applications

Abstract: This paper proposes a model predictive interaction control (MPIC) framework based on impedance matching, embedding impedance regulation into the predictive optimization

process. The proposed approach ensures seamless transitions between impedance control in unconstrained situations and optimal control adaptation under task-specific and physical constraints, enhancing interaction safety, robustness, and adaptability. A unified robot-environment interaction model is formulated by incorporating series-parallel interaction properties to simultaneously consider the impact of external perturbations and robot reference position variations on force prediction and optimization. Simulation and experimental results validate the effectiveness of MPIC over conventional impedance control (IC) in terms of constraint handling, disturbance rejection, and balancing compliance and precision, providing a scalable and adaptable solution for complex robot-environment interaction.

WeAT4	BOLERO 2
Intelligent Decision-Making and Applications I	Invited Session
Chair: Li, Xiuxian	Tongji University
Organizer: Li, Xiuxian	Tongji University
Organizer: Xu, Liang	Shanghai University
Organizer: Xu, Jinming	Zhejiang University
Organizer: Zhu, Shanying	Shanghai Jiao Tong University

08:30-08:45, Paper WeAT4.1

Multi-Agent Distributed Cooperative Localization Based on Ultra-Wideband (I)

Lv, Mingwei	China Aviation Industry Shenyang Aircraft Design Institute
Wang, Yuxiang	Northwestern Polytechnical University
Dong, Yuxiang	Northwestern Polytechnical University
Hu, Jinwen	Northwestern Polytechnical University
Xu, Zhao	Northwestern Polytechnical University

Keywords: Automated Guided Vehicles, Robotics
Abstract: In modern warfare, unmanned aerial vehicle (UAV) swarms frequently encounter signal interference or denial from adversaries, posing significant challenges to localization accuracy. Nevertheless, the large-scale advantage of UAV swarms enables interfered UAVs to utilize relative navigation techniques by leveraging communication and relative measurements. Thus, we discuss a multi-agent distributed cooperative localization method based on ultra-wideband (UWB) modules. First, a distributed Kalman filtering-based multi-UAV cooperative localization algorithm is proposed, achieving high-precision localization under partial GNSS-denied conditions. Second, a multi-agent distributed cooperative localization algorithm incorporating an analysis of UWB non-stationary measurement noise characteristics is introduced, enhancing the robustness of swarm navigation in dynamic formations. Finally, a UWB based distributed multi-UAV cooperative localization prototype system is developed, comprising five small UAVs equipped with inertial measurement unit (IMU), GPS modules, and UWB modules. Experimental evaluations under various scenarios compare and analyze swarm navigation performance under different conditions.

08:45-09:00, Paper WeAT4.2

Distributed Neural Network-Based Control for Multi-Agent Lagrangian Systems with Stability Guarantees (I)

Qian, Jiajun	Shanghai University
Xu, Liang	Shanghai University
Ren, Xiaoqiang	Shanghai University
Wang, Xiaofan	Shanghai Jiao Tong University

Keywords: Learning-based Control, Multi-agent Systems, Intelligent and AI Based Control
Abstract: Since deep neural networks (DNNs) are inherently black-box models, providing formal stability and performance guarantees for DNN-based controllers remains a challenge. In this paper, we address the formation control problem of multi-agent Lagrangian systems and propose a distributed structured deep neural network (DSNN) controller with inherent stability guarantees. By leveraging the backstepping technique and carefully designing the neural network structures, our controller ensures stability for any set of neural network parameters. Additionally, we derive an explicit upper bound on the formation error in the presence of disturbances, which can be adjusted by tuning the neural network parameters. The effectiveness of the proposed controller is validated through multiple simulations.

09:00-09:15, Paper WeAT4.3

Warm-Up Gradient Tracking for Distributed Nonconvex Optimization with Data Heterogeneity (I)

Zhang, Ziyang	Zhejiang University
Huang, Yan	KTH - Kungliga Tekniska Högskolan
Xu, Jinming	Zhejiang University

Keywords: Multi-agent Systems, Learning Systems
Abstract: This paper considers solving distributed stochastic optimization problems with smooth, nonconvex objective functions over peer-to-peer networks with non-i.i.d. datasets. While existing studies suggest that gradient tracking methods can mitigate the impact of data heterogeneity among nodes, our analysis shows that in nonconvex cases, it can degrade convergence performance due to the consensus error in the initialization of gradient tracking, which inherently reflects non-negligible data heterogeneity. To address this issue, we propose an improved warm-up distributed stochastic gradient tracking algorithm, termed W-DSGT, and theoretically show that reducing the consensus error of the gradient tracking during the initial phase can effectively alleviate the impact of data heterogeneity, leading to enhanced convergence performance.

09:15-09:30, Paper WeAT4.4

Privacy-Preserving Consensus for Multiagent Networks Via Weight Iteration (I)

Wu, Yiming	Hangzhou Dianzi University
Zhang, Chong	Hangzhou Dianzi University
Zhu, Chenrui	Hangzhou Dianzi University

Keywords: Networked Control, Multi-agent Systems, Control of Distributed Generation Systems
Abstract: In this paper, we propose a novel consensus algorithm for multiagent networks (MANs) operating under deception attacks and privacy disclosures. First, to address the exposure of real-time agent state information during transmission, a time-varying weighted iteration mechanism is developed based on the PushSum algorithm, ensuring secure protection of agent privacy. Second, to mitigate the impact of external attackers on

consensus, the weighted iteration mechanism is integrated with the W-MSR algorithm, enabling secure system convergence. Finally, through mathematical theory analysis proved that the algorithm can effectively protect the privacy of agent initial state information and ensure the MAN to achieve resilient consensus under the deception attacks.

WeBT1	GRANDE 1&2
Modeling, Optimization, and Control for Unmanned Autonomous Systems II	Invited Session
Chair: Tao, Weizhi	The Hong Kong Polytechnic University
Organizer: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Shao, Jinliang	University of Electronic Science and Technology of China
Organizer: Su, Zikang	Nanjing University of Aeronautics and Astronautics

10:30-10:45, Paper WeBT1.1	
Automated Landing of Quadrotors on an Unmanned Aerial Vehicle Carrier Via Real-Time Trajectory Planning and Nonlinear Model Predictive Control (I)	
Zhang, Chengchen	The Hong Kong Polytechnic University
Lam, Yat Long	The Hong Kong Polytechnic University
Ip, Chun Man Ben	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Robotics, Control Applications, Motion Control
Abstract: This paper explores the deployment of a mobile unmanned aerial vehicle carrier (UAVC) system, facilitating the landing of unmanned aerial vehicles (UAVs) on a moving platform, thereby enhancing their operational range and flexibility. The primary contributions of this study include the development of an advanced trajectory planner that integrates Jump Point Search (JPS) with gradient-based trajectory optimization to ensure efficient and collision-free navigation in complex environments. Furthermore, a Nonlinear Model Predictive Control (NMPC) framework is employed to achieve precise and stable trajectory tracking for both the UAV and UAVC. Extensive simulations conducted in Gazebo validate the efficacy of the proposed approach, demonstrating successful landings on a UAV carrier under a complex environment.

10:45-11:00, Paper WeBT1.2	
Adaptive Load Position Control for Quadrotor with a Cable-Suspended Payload by Considering Quadrotor As an Actuator (I)	
Zheng, Zhiyuan	University of Electronic Science and Technology of China
Sun, Xuwei	University of Electronic Science and Technology of China
Zhu, Yang	University of Electronic Science and Technology of China
Zhao, Wanbing	University of Electronic Science and Technology of China
Shao, Jinliang	University of Electronic Science and Technology of China

Keywords: Nonlinear Systems and Control, Robotics, Adaptive Control
Abstract: The payload position control problem for the quadrotor with a cable-suspended system is challenging due to its underactuated nature, particularly when the actuation dynamics are considered. To address these limitations, we transform the payload system into a fully actuated system by modeling the quadrotor as an equivalent actuator. We then design a hierarchical control framework based on the backstepping technique, which consists of the payload position controller, the swing angle controller, and the adaptive actuator controller to control both the payload position and quadrotor actuation. The asymptotic stability of the overall system is proved by the Lyapunov method. Finally, the feasibility of the proposed methodology is demonstrated through simulations.

11:00-11:15, Paper WeBT1.3	
Optimization and Tracking Control for UAV Spot Landing Trajectory on Sloped Runway (I)	
Wang, Xinru	Nanjing University of Aeronautics and Astronautics
Su, Zikang	Nanjing University of Aeronautics and Astronautics
Jiang, Changhui	Nanjing University of Aeronautics and Astronautics
Li, Chuntao	Nanjing University of Aeronautics and Astronautics
Li, Xuebing	Nanjing University of Aeronautics and Astronautics

Keywords: Nonlinear Systems and Control, Optimal Control, Robotics
Abstract: Aiming at the issues of touchdown overshoot or low-altitude floating caused by mismatches in the landing trajectory angle or sink rate during UAV spot landing on sloped runways, which may affect landing accuracy and safety, this paper proposes a landing trajectory optimization and tracking control strategy adapted to sloped terrain. First, a segmented optimization method for spot landing trajectory adapted to sloped runway terrain is proposed based on the Gauss Pseudospectral Method (GPM). Then, a position and attitude decoupled flight control method for spot landing on a sloped runway is proposed based on the direct lift control concept. Additionally, controllers are designed using Dynamic Surface Control (DSC) technology, along with Extended State Observer (ESO) to estimate system states and disturbances during the landing process. Simulation results validate the feasibility and effectiveness of the proposed landing strategy.

11:15-11:30, Paper WeBT1.4	
Robust Cooperative Control of Quadrotor Cooperative Transportation System Via Time-Varying Disturbance Estimation (I)	
Tong, Shiji	University of Electronic Science and Technology of China
Liu, Qiang	University of Electronic Science and Technology of China
Zhu, Yang	University of Electronic Science and Technology of China

Li, Tieshan	Dalian Maritime University
Shao, Jinliang	University of Electronic Science and Technology of China

Keywords: Nonlinear Systems and Control, Robotics
Abstract: Controlling a cooperative transportation system transporting a cable-suspended payload is challenging due to highly coupled dynamics and unpredictable disturbances. In this paper, a novel time-varying uncertainty and disturbance estimator (TV-UDE) is introduced to estimate and compensate for disturbances in real time dynamically. Unlike conventional fixed-gain UDE observers, the proposed TV-UDE method smoothly adjusts its gain over time: starting large to mitigate transient spikes and increasing to a small gain for accurate steady-state disturbance rejection. This strategy enhances robustness and stability by avoiding the peaking phenomenon associated with high-gain estimators. The asymptotic stability of the overall system is proved by the Lyapunov method. Finally, the feasibility of the proposed methodology is demonstrated through simulations.

11:30-11:45, Paper WeBT1.5	

DPOFEC: A Dynamic UAV-Based Path Planning Optimization Framework with Federated Learning and Edge Computing in Complex Environments (I)

Li, Chen	University of Technology Sydney
Qi, Xuelei	Northeastern University
Wu, Kai	University of Technology Sydney
Yuan, Xin	Commonwealth Scientific and Industrial Research Organisation
Ni, Wei	Commonwealth Scientific and Industrial Research Organisation
Liu, Ren Ping	University of Technology Sydney
Ma, Hongjun	South China University of Technology

Keywords: Motion Control, Learning-based Control, Nonlinear Systems and Control
Abstract: In complex map environments, the Rapidly-exploring Random Tree (RRT) algorithm is recognized as an efficient initial path planning method for unmanned aerial vehicles (UAVs). Relying solely on centralized computation or the planning capabilities of a single node often faces challenges such as limited device resources, vulnerability of navigation points to interception, and insufficient real-time adaptability. This paper proposes a distributed path optimization framework based on federated learning (FL) and edge computing (EC), referred to as DPOFEC, which formulates the path optimization problem as a global optimization task within the framework of FL. First, edge nodes of the server execute initial path planning using the RRT algorithm to generate local path segments. Then, the FL framework aggregates the weights uploaded by each edge node and optimizes the path points. Finally, the enclosed and safe sphere-shaped corridors are designed around the optimized global path points, with the size of these corridors dynamically adjusted to accommodate obstacle distributions and the UAV's flight state. Experiments demonstrate that in a simple scenario (Case 1), the proposed method improves path generation processing time by approximately 38% and 43%, compared to traditional RRT algorithm attempts 1 and 2, respectively. In a complex scenario (Case 2), the improvements are approximately 51% and 40%, respectively. Leveraging distributed collaboration, the algorithm enhances the performance and robustness of path planning while effectively protecting the privacy of path point data.

11:45-12:00, Paper WeBT1.6	

Control Saturation Analysis of Second-Order Integral System for the Application of EVTOL (I)

Su, Jiangcheng	The Hong Kong Polytechnic University
Hao, Cao	The Hong Kong Polytechnic University
Cheng, Li	The Hong Kong Polytechnic University
Qi, Juntong	Shanghai University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Linear Systems, Control Applications, Motion Control
Abstract: Electric Vertical Takeoff and Landing (eVTOL) aircrafts have garnered considerable interest as a fundamental component of urban air mobility. However, the saturation is likely to happen due to the large mass and rotational inertia, especially when motor failure occurs in the eVTOL system. Therefore, this article tries to analyze the characteristics of saturation performance of control systems, particularly the second-order integral system, which is the most common system in trajectory following and control. Firstly, the overshoot condition of the saturation system is derived by phase portrait analysis. Then, the relation of the overshoot ratio with the command input, control bandwidth, and input constraints is given. After analyzing the saturation characteristics, the conclusion is applied to design the eVTOL controller for enhancing control performance and satisfying airworthiness.

WeBT2	GRANDE 3
Learning-Based Control II	Regular Session

10:30-10:45, Paper WeBT2.1	

Unit Commitment Incorporating Active Distribution Grids with Learning-Based Power Flow Constraints

Xu, Kun	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Jiang, Jingxiao	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Li, Lili	NARI Group Corporation, State Grid Electric Power Research Insti
Wu, Shuomin	NARI Group Corporation, State Grid Electric Power Research Insti y
Xu, Han	Southeast University
Zhang, Kaifeng	Southeast University

Keywords: Learning-based Control, Control of Distributed Generation Systems, Control of Smart Power Delivery Systems
Abstract: Abstract— Traditional unit commitment (UC) does not consider distribution grid constraints, while common transmission-distribution coordination methods require substantial computational costs. As the distributed energy resources (DERs) in distribution grids continue to grow, traditional distribution grids are gradually transforming into active distribution grids (ADGs), when solving UC, it is necessary to consider the constraints of the distribution grid to ensure the operational safety of the transmission and distribution grids. This paper proposes a UC approach with ADGs by using learning-based power flow constraints substitution which can accelerate the computation and promote the integration of DERs while ensuring the safe operation of the distribution grid. We trained two multi-layer perceptrons (MLPs) and converted them into binary variable linear constraints equivalent to substitute for power flow constraints. The experiment confirms that the suggested strategy performs better in power scheduling when based on the IEEE118-bus system as the transmission grid, and ten IEEE33-bus systems as distribution girds.

10:45-11:00, Paper WeBT2.2

Constrained Adaptive Dynamic Programming for PID Controllers

Lala, Timotei — Politehnica University of Timisoara, Department of Automation An

Keywords: Learning-based Control, Learning Systems, Optimal Control
Abstract: In this paper, a model-free off-policy constrained adaptive dynamic programming (CADP) algorithm is developed for discrete-time general nonlinear systems. By using an adaptive learning rate, the controller update is constrained in a well-defined neighborhood to avoid performance degradation in case of high convergence uncertainty of the CADP mechanism. The learning mechanism is used to tune a Proportional-Integrative-Derivative (PID) controller parameters in a model-free offline fashion. The Markovian assumption is proved for the closed-loop system with a general PID controller to show its applicability in Adaptive Dynamic Programming (ADP) like algorithms. The validation performed on a nonlinear process highlighting the stability-preserving attributes of the proposed method using the constrain mechanism.

11:00-11:15, Paper WeBT2.3

An Efficient Bayesian Policy Exploration Approach for Reinforcement Learning Model Predictive Control

Qin, Yihao — The Hong Kong University of Science and Technology (Guangzhou)
Ji, Yiding — The Hong Kong University of Science and Technology (Guangzhou)

Keywords: Learning-based Control, Optimal Control, Learning Systems
Abstract: Reinforcement Learning Model Predictive Control (RL-MPC) has achieved significant progress in recent years. However, existing approaches still have some limitations. This paper proposes a Bayesian policy exploration method for RL-MPC that substantially enhances its performance. Specifically, we implement Bayesian posterior estimation of value functions and introduce an optimistic exploration strategy tailored for efficient exploration of RL-MPC, which improves the sample efficiency of RL policy exploration. Then an optimistic Bayesian exploration strategy is proposed, which encourages the agent to leverage existing model information to achieve superior control performance. The soundness and effectiveness of our method are evaluated through an empirical study of controlling a drone to reach targets subject to uncertain model parameters and environmental perturbations. The results validate that our approach has superior performance compared with benchmarks.

11:15-11:30, Paper WeBT2.4

Design of a Hexacopter Attitude Controller Based on Reinforcement Learning with Transfer Learning Application

Ko, Donghyeon — Korea Aerospace Research Institute

Keywords: Learning-based Control, Learning Systems, Nonlinear Systems and Control
Abstract: A method utilizing reinforcement learning and transfer learning for hexacopter attitude control is proposed. The reinforcement learning approach employs Proximal Policy Optimization (PPO), which enables continuous output and prevents abrupt policy updates, ensuring stable learning. Transfer learning, which accelerates learning by adapting a previously trained agent to a similar environment, is applied to develop a fast and efficient hexacopter attitude controller. The research process consists of three major phases. In the first phase, a quadcopter attitude control policy is trained using reinforcement learning to achieve stable flight and maneuvering. In the second phase, the output of the pre-trained quadcopter control model is modified to facilitate its transfer to a hexacopter. In the final phase, the pre-trained model is used as the initial learning model, and transfer learning is applied to extend the quadcopter controller to a hexacopter attitude control system. The performance of the transfer-learned hexacopter controller is validated through dynamic simulations. To evaluate the effectiveness of transfer learning, a comparative study is conducted by measuring the time required for a hexacopter controller to reach full training completion using standard PPO and comparing it to the training time when transfer learning is applied. Instead of a single measurement, multiple training sessions are performed, and the average required training time is analyzed. The results demonstrate that transfer learning enables the hexacopter to achieve similar performance in a shorter amount of time compared to training from scratch using PPO.

11:30-11:45, Paper WeBT2.5

Research on UAV 3D Path Planning Method Based on Deep Reinforcement Learning

Hu, Ruiguang — Northwestern Polytechnical University
Li, Ni — Northwestern Polytechnical University
Tang, Chong — University of Southampton
Bouderrah, Ramzi — Northwestern Polytechnical University

Keywords: Learning-based Control, Motion Control, Intelligent and AI Based Control
Abstract: Efficient path planning is crucial for autonomous UAV navigation in dynamic environments. Traditional 3D path planning methods rely on precise environmental models while simultaneously facing challenges in handling high-dimensional complexity and discontinuous speed control. To overcome these challenges, we propose a UAV path planning approach for 3D obstacle spaces based on the Proximal Policy Optimization (PPO) algorithm. Our method integrates a recurrent neural network into the PPO framework to process time-series data effectively, enabling the UAV to leverage historical information for improved

decision-making in dynamic scenarios. The exploration is further enhanced by designing an environmental reward scheme that combines angle-based rewards with a curiosity module, which helps the UAV rapidly discover optimal paths. To ensure a smooth flight trajectory, the planned path is optimized using the Minimum Snap method. The overall approach is validated on the UE4+AirSim platform demonstrating its practical applicability for real-world UAV flight decision-making. The experimental results demonstrate the superiority of this method.

11:45-12:00, Paper WeBT2.6	
A Comprehensive Framework for Automated Facade Defect Evaluation Using Deep Learning	
Han, Bingxin	The Chinese University of Hong Kong
Gao, Chuanxiang	The Chinese University of Hong Kong
Zhao, Zuoquan	The Chinese University of Hong Kong
Zhang, Jihan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	The Chinese University of Hong Kong

Keywords: Smart Buildings, Smart Structures
Abstract: Evaluation of facade degradation is crucial to determining the need for further examination and maintenance, safeguarding the structural health of the building. Traditional evaluation methods rely on visual inspection and subjective judgment by surveyors, which requires working at heights and manual detection and severity assessment. This process is time-consuming, poses safety risks, and may result in potential errors. To address these challenges, unmanned vehicles have been deployed for building inspection tasks, saving time and minimizing safety concerns. Additionally, diverse deep learning techniques have been utilized to automate the visual evaluation process and reduce subjective errors to classify, detect, and segment defects. However, previous research has primarily focused on improving image processing accuracy without incorporating the entire evaluation process into industry evaluation standards. In this paper, we propose a framework for automated building facade defect evaluation that can be applied to both unmanned and manned data collection systems. Our approach employs the deep neural network for defect segmentation. The trained model accurately recognizes individual defects and extracts their properties, such as width, length, and area using morphological operations. Following ISO standards, evaluation results are automatically obtained within defined effective evaluation areas. Furthermore, defect information and evaluation results are registered to a model generated with 3D reconstruction techniques, providing a valuable reference for experts in formulating maintenance plans. Finally, experiments are conducted on a tall building to verify the effectiveness of our proposed method.

WeBT3	BOLERO 1
Fault Detection and Diagnostics	Regular Session
Chair: Badihi, Hamed	Tampere University, Tampere 33720, Finland

10:30-10:45, Paper WeBT3.1	
Topological Data Analysis Applied to Wind Turbine Vibration Spectra for Blade Icing Detection	
Martin Gomez, Alvaro	Aalborg University
Haugaard, Thomas	Emerson Electric Co
Ajenjo de Torres, Oier	Aalborg University
Bokor Bleile, Yossi	University of Sydney
Knudsen, Torben	Aalborg University, Denmark
Wisniewski, Rafael	Section for Automation and Control, Aalborg University

Keywords: Fault Detection and Diagnostics, Signal Processing, Estimation and Identification
Abstract: Ice build-up on wind turbine blades is a significant issue, leading to operational risks and reduced efficiency. Traditional detection methods, such as visual inspection, power curve analysis or specialized sensors, are often slow, inefficient, or costly. This paper proposes an approach using 0-dimensional persistence homology from topological data analysis (TDA) on tower and blade vibration spectra to extract key features representing the lifespan of the sub-level sets to formulate a clearer supervised learning problem. Persistence diagrams are embedded in persistence images and rank functions, enabling ice detection through convolutional neural networks (CNN), and functional principal component analysis (FPCA) with support vector machines (SVM). This approach shows promise for reducing equipment and maintenance costs, leading to more efficient blade monitoring and maintenance processes.

10:45-11:00, Paper WeBT3.2	
A Deep Transfer Learning Approach to Few-Shot Fault Diagnosis in Underwater Manipulators	
Zhu, Huaishi	Beijing Institute of Technology
Fang, Xu	Nanyang Technological University
Zhu, Mingyan	Hunan University
Cao, Fangfei	Beijing Institute of Technology

Keywords: Fault Detection and Diagnostics, Control Applications
Abstract: This paper presents a deep transfer learning-based approach for diagnosing multiplicative faults in underwater manipulators using limited operational data. Given the limited availability of data, transfer learning is utilized to enhance model performance. A pre-trained model from conventional manipulators is adapted to the underwater domain through model-based transfer learning. The convolutional neural networks (CNNs) and long short-term memory (LSTM) networks are used to retain both local and temporal fault characteristics, improving fault feature extraction. The source domain model is fine-tuned using a small sample dataset from the target domain, where lower layers are frozen and the top layers are fine-tuned for fault diagnosis, achieving improved accuracy. The results from the case study demonstrate that the proposed approach delivers high accuracy in diagnosing actuator faults in underwater manipulators.

11:00-11:15, Paper WeBT3.3	
Remaining Useful Life Prediction of Hybrid Drive and CWT-CDC Deep-Coupled Rolling Bearing	
Ding, Wanmeng	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed

Zhang, Kaifeng	Southeast University
Xu, Kun	Southeast University

Keywords: Fault Detection and Diagnostics, Learning Systems, Signal Processing
Abstract: Prognostics and Health Management integrated bearing remaining life prediction not only supports condition-based maintenance decision closed loop, moreover, the on-time task rate is improved by dynamic scheduling of maintenance resources, and the continuous improvement of equipment comprehensive efficiency is promoted. In this paper, a hybrid-driven Remaining Useful Life (RUL) evaluation way of bearing is constructed, which innovatively realizes the deep coupling of data-driven and mechanism model by fusing improved DenseNet and nonlinear least square degradation modeling. First of all, the time-domain statistical features of vibration signals are selected by using monotonicity and robustness, and the degradation trajectory index(DI) is established to determine the Fault Incipience Point (FIP). Secondly, a joint feature learning framework of Continuous Wavelet Transform and Causal Dilated Convolution (CWT-CDC) was constructed: the time-frequency map was generated by Morlet wavelet kernel function, and the local damage feature was enhanced by causal dilated convolution, and the nonlinear mapping from equipment Health Indicators (HI) to RUL value was realized. Finally, the superiority of the proposed appoach are verified by the XJTU-SY bearing data set.

11:15-11:30, Paper WeBT3.4	

DT-FTA-ARM: A Collaborative Framework for Real-Time Fault Diagnosis in Subway Environmental Control Systems

Hong, Wenxing	Xiamen University
Xu, Yuechao	Xiamen University
Huang, ZhenFeng	Xiamen University, Department of Automation
Fang, Xing	Guangdong Midea HVAC Equipment Co., Ltd
Hong, Duanqin	Xiamen University
Zhang, Jihan	The Chinese University of Hong Kong

Keywords: Fault Detection and Diagnostics, Smart Buildings
Abstract: Abstract—Digital Twin (DT) introduces a novel paradigm of autonomous virtual-physical integration for fault diagnosis in Environmental Control Systems (ECS), with its core lying in the self-adaptive optimization of diagnostic capabilities through dynamic data mapping and logical evolution. Despite the progress made by existing DT-driven fault diagnosis methods in hybrid modeling, rule mining, and adaptive analysis, significant challenges persist. These challenges include the effective fusion of heterogeneous sensor data and the evolution of diagnostic logic under dynamic conditions. This paper systematically reviews core technical pathways for fault diagnosis, analyzes theoretical limitations based on current research, and proposes an innovative Digital Twin-Fault Tree Analysis-Association Rule Mining (DT-FTA-ARM) collaborative diagnostic frame- work. The proposed framework employs advanced algorithms to balance its computational efficiency with interpretability, addressing critical issues in multi-source data alignment and cross-system knowledge transfer. Field validation in subway ECS applications demonstrates the framework's potential to enhance operational reliability while adhering to strict latency and energy constraints. Index Terms—Digital Twin, Fault Diagnosis, Environmental Control Systems, Hybrid Modeling

11:30-11:45, Paper WeBT3.5	

MoE-TransDLD: A Transformer-Driven Mixture of Experts for Cyber-Attack Detection in Power Systems

Wang, Luyu	Southeast University
Sikdar, Biplab	National University of Singapore
Zhang, Kaifeng	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed

Keywords: Fault Detection and Diagnostics, Sensor/Data Fusion, Intelligent and AI Based Control
Abstract: The collaborative analysis of both cyber-layer and physical-layer data is crucial for improving detection accuracy and timeliness of cyber-attack. Cyber-layer features provide early indicators of attacks, while physical-layer features reflect the actual impact on the power system. To leverage this synergy, a cross-attention mechanism is introduced to generate cross-layer features to capture these cross-layer interactions. Furthermore, based on the traditional Mixture of Experts (MoE), a novel framework MoE-Transformer Dual Layers Detection (MoE-TransDLD) is proposed, which dynamically fuses multi-layer features to model cyber-physical dependencies. Specially, MoE-TransDLD assigns a dedicated expert to each layer, including a cyber-layer expert, a physical-layer expert, and a cross-layer expert, to more accurately model multi-layer data relationships in power systems. Notably, both the expert network and the gating network share a common Transformer architecture to extract global features, while maintaining corresponding independent feed-forward network (FFN), where each expert focuses on its respective domain and the gating network achieves adaptive and dynamic selection in decision making. The synthetic Texas 2000-bus model system is used as an experimental model and its physical-layer data and cyber-layer data are collected. The experimental results show that the MoE-TransDLD significantly outperforms the existing methods and achieves superior classification metrics and faster attack detection time.

11:45-12:00, Paper WeBT3.6	

An Automated SCADA Alarm Analysis in Wind Turbines for Improving Reliability and Downtime – a Solution for Operators

Chatterjee, Subhajit	Faculty of Engineering and Natural Sciences, Tampere University
Badihi, Hamed	Tampere University, Tampere 33720, Finland

Keywords: Fault Detection and Diagnostics, Real-time Systems, Intelligent and AI Based Control
Abstract: Supervisory Control and Data Acquisition (SCADA) signals such as wind speed and power output are frequently used for fault detection in wind turbine (WT) condition monitoring. However, there has been limited attention on SCADA alarm analysis, despite its importance in managing turbine reliability. This paper presents an automated methodology to analyze SCADA alarm signals for identifying patterns predictive of turbine faults and minimizing downtime. To minimize downtime and identify turbine fault patterns, this paper proposes an automated methodology for analyzing SCADA alarm signals. First, alarms are classified into normal, abnormal, and questionable events using a structured taxonomy. These categories are linked to instances of downtime in a later analysis. Alarms are ranked according to their operational impact and criticality using a prioritization method that was modified from industry standards. The results show that even low-volume alarm data holds significant diagnostic and prognostic value. The suggested event-and pattern-based alarm analysis improves the ability to identify faults and provides proactive

maintenance planning. This work underscores the value of intelligent alarm handling to reduce downtime and improve operational reliability in wind farms.

WeBT4	BOLERO 2
Intelligent Decision-Making and Applications II	Invited Session
Chair: Xu, Liang	Shanghai University
Organizer: Li, Xiuxian	Tongji University
Organizer: Xu, Liang	Shanghai University
Organizer: Xu, Jinming	Zhejiang University
Organizer: Zhu, Shanying	Shanghai Jiao Tong University

10:30-10:45, Paper WeBT4.1	
Hierarchical Reinforcement Learning for Adaptive Control and Continuous Target TraDcking in Cooperative Air Combat Scenarios with Unmanned Wingmen (I)	
Wang, SiYuan	Northwestern Polytechnical University
Liu, Jian	AVIC Shenyang Aircraft Design and Research Institute
Zhang, Jiandong	Northwestern Polytechnical University
Shi, Guoqing	Northwestern Polytechnical University
Yang, Qiming	Northwestern Polytechnical University

Keywords: Intelligent and AI Based Control, Learning-based Control
Abstract: This study addresses the limited autonomous target-acquisition capabilities exhibited by unmanned wingman systems in beyond-visual-range (BVR) combat scenarios. We propose a hierarchical reinforcement learning framework based on Proximal Policy Optimization (PPO). The dual-layer framework integrates six-degree-of-freedom (6-DoF) flight dynamics with radar lock-on control systems, where the low-level controller achieves precise tracking of attitude parameters (heading, airspeed, altitude) with steady-state errors below 1%. Extensive simulations conducted on the JSBSim platform show an 89% success rate in target acquisition across three combat scenarios: random maneuver engagement, head-on interception, and target pursuit. The proposed geometric mean reward formulation with roll angle constraints effectively reduces stall risk. This framework provides an interpretable decision-making architecture for cooperative UAV operations in modern aerial combat systems, overcoming dynamic adaptability constraints in conventional expert systems.

10:45-11:00, Paper WeBT4.2	
Design of Kill Chain Reconstruction Method Based on Particle Swarm Optimization Algorithm (I)	
Jiang, Yongxin	Northwestern Polytechnical University
Yang, Qiming	Northwestern Polytechnical University
Yan, Wenli	The AVIC Luoyang Electro-Optical Equipment Research Institute
Zhang, Jiandong	Northwestern Polytechnical University
Shi, Guoqing	Northwestern Polytechnical University

Keywords: Modeling and Control of Complex Systems, Sensor/Data Fusion
Abstract: In this paper, the problem of rapidly reconstructing the kill chain for tasks due to the frequent changes of battlefield situation in the current beyond-visual-range cooperative air combat is studied. The kill chain is approximated as a series of action combinations arranged in chronological order for the target. Based on the idea of sequential decision-making, the reconstruction problem is transformed into a task redistribution problem at each stage of the kill chain. When the reconstruction condition is triggered, the full-chain reconstruction is performed, which reduces the complexity of the problem. By using the improved particle swarm optimization algorithm and relying on the kill chain effectiveness evaluation as the objective function, the combat resources and combat tasks are screened and matched. Through simulation experiments, the results obtained by the algorithm are compared with the results obtained by the enumeration method, which verifies that the algorithm can improve the speed of problem solving while ensuring the effectiveness of the results.

11:00-11:15, Paper WeBT4.3	
LLM-Enhanced MARL for Smarter Traffic Control (I)	
Chen, Xingmei	Guangdong University of Technology
Meng, Wei	NTU

Keywords: Intelligent and AI Based Control, Learning Systems, Learning-based Control
Abstract: The rapid advancement of artificial intelligence has driven the application of Deep Reinforcement Learning in multi-agent systems, offering new opportunities for complex collaborative scenarios in transportation, energy, and communications. As urban traffic congestion intensifies, adaptive traffic signal control based on Multi-Agent Reinforcement Learning (MARL) has emerged as an effective approach to optimize traffic flow and reduce intersection delays. However, existing research largely focuses on single-intersection control, with limited exploration of coordinated multi-intersection scheduling. This study proposes a MARL-based method for coordinated traffic signal optimization, utilizing Multi-Agent Proximal Policy Optimization (MAPPO), which demonstrates superior stability and convergence over other algorithms. To address MARL's dimensionality challenges, we introduce two key innovations: (1) optimizing the MAPPO network architecture by integrating a Transformer module to enhance model expressiveness and accelerate convergence; and (2) incorporating Large Language Models (LLMs) to leverage their reasoning capabilities for improved multi-agent collaboration. Experimental results show significant improvements in traffic control efficiency, laying a solid foundation for intelligent transportation systems.

11:15-11:30, Paper WeBT4.4	
Data-Enabled Predictive Temperature and Humidity Control in a Historical Museum Building	
Zehner, Marcel	University of Applied Sciences Fulda
Cavaterra, Alessio	Fulda University of Applied Sciences

Lambeck, Steven	University of Applied Sciences Fulda

Keywords: Control Applications, Optimal Control, Smart Buildings
Abstract: The following paper examines Data-Enabled Predictive Control (DeePC) for combined temperature and humidity control in a historical museum building. Bypassing classical offline system identification techniques, DeePC uses a nonparametric model only based on previously collected closed loop input-output data. Within a co-simulation consisting of MATLAB and EnergyPlus, the control performance while ensuring the preventive conservation requirements is evaluated. The impact of both the hyperparameters and measurement noise is investigated. The results show that DeePC maintains temperature and humidity within the limits for cultural asset protection. Integrating disturbances and weather forecasts into DeePC to enhance control performance and energy efficiency could be considered in future work.

11:30-11:45, Paper WeBT4.5	
GP-L1 NMPC for Quadrotors Agile Flight (I)	
Chen, Mingxi	Guangdong University of Technology
Luo, Peifen	Guangdong University of Technology
Lian, Shikang	Guangdong University of Technology
Meng, Wei	NTU

Keywords: Optimal Control, Adaptive Control, Learning-based Control
Abstract: Quadrotor's agile flight in complex environments has numerous potential applications such as search and rescue. Recently, nonlinear model predictive control (NMPC) has shown more advantageous results in agile quadrotor control. However, it relies on highly accurate models for maximum tracking accuracy and lacks the capability to reject external disturbances. Model uncertainties, including unmodeled complex aerodynamic effects and external disturbances, will degrade the system's performance. In this paper, we propose gaussian process-L1-nonlinear model predictive control (GP-L1-NMPC), a novel hybrid adaptive NMPC approach that leverages gaussian process regression to learn complex unmodeled aerodynamic effects and employs L1 adaptive control to compensate for external disturbances in real time. Specifically, we use the nominal model enhanced with the gaussian process model as a reference model for the L1 adaptive control to reduce tracking error. The proposed method demonstrates immense tracking accuracy and robustness, with more than 90% tracking error reduction over baseline NMPC without any gain tuning at a speed of 10 m/s.

WeCT1	GRANDE 1&2
Modeling, Optimization, and Control for Unmanned Autonomous Systems III	Invited Session
Chair: Tao, Weizhi	The Hong Kong Polytechnic University
Organizer: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Shao, Jinliang	University of Electronic Science and Technology of China
Organizer: Su, Zikang	Nanjing University of Aeronautics and Astronautics

14:00-14:15, Paper WeCT1.1	
Game-Theoretical MPC for Quadrotor Pursuit: Strategic Anticipation and Efficient Capture (I)	
Ip, Chun Man Ben	The Hong Kong Polytechnic University
Lam, Yat Long	The Hong Kong Polytechnic University
Zhang, Chengchen	The Hong Kong Polytechnic University
Huang, Hailong	The Hong Kong Polytechnic University

Keywords: Optimal Control, Multi-agent Systems, Modeling and Control of Complex Systems
Abstract: This paper proposes a pursuit-centric Game-Theoretical MPC (GT-MPC) framework for quadrotors, leveraging Nash equilibrium to anticipate evader maneuvers and optimize pursuit strategies. Unlike conventional MPC or reinforcement learning (RL) methods, GT-MPC explicitly models bidirectional adversarial interactions, enabling 63.03% faster average capture times in symmetric pursuit scenarios. By focusing on strategic parity—where pursuer and evader share identical dynamics—we demonstrate that superior decision-making, not hardware advantages, can also drive capture efficiency. Simulations across 50 randomized trials validate GT-MPC's robustness, with a 93% success rate under perfect information, outperforming state-of-the-art baseline.

14:15-14:30, Paper WeCT1.2	
Drone Ego-Noise-Based Passive Acoustic Sensing for Obstacle Detection (I)	
Lyu, Mingyang	Hong Kong Polytechnic Univerisity
Zhao, Yibo	The Hong Kong Polytechnic University (PolyU)
Huang, Chao	The Hong Kong Polytechnic University

Keywords: Signal Processing, Control Applications
Abstract: Sound carries rich information, yet its utilization in drone-based applications, particularly in extracting environmental information from ego-noise, has received limited attention. This paper researches the interaction between drone ego-noise and its corresponding echoes, exploiting phase cancellation effects to detect obstacles. A waveform detection algorithm has been developed, integrating the Root Mean Square (RMS) of sound energy to enhance obstacle detection rates. The performance indicates that it is feasible to use acoustic information in autonomous robotics for obstacle detection, especially in high-noise mobile platforms such as drones.Future research will focus on increasing detection accuracy and enabling precise obstacle distance estimation.

14:30-14:45, Paper WeCT1.3	
The Fault Detection and Isolation Design for 4WS Vehicles Based on Directional Residuals under External Disturbance (I)	
Hu, Jingyu	Southeast University
Bai, Shuo	Southeast University
Fang, Ruiqi	Southeast University

Li, Yuxue	Southeast University
Zhu, Xiaoyuan	Southeast University
Yin, Guodong	Southeast University

Keywords: Fault Detection and Diagnostics, Estimation and Identification
Abstract: This paper proposes a fault detection and isolation method to deal with actuator fault in four-wheel steering (4WS) vehicles. First, a lateral dynamic model for 4WS vehicles is developed by incorporating the T-S fuzzy model, while accounting for external disturbance and sensor measurement noise. This improved model is designed to address the unmodeled dynamics caused by variation in longitudinal velocity. Then, a novel residual generation observer based on the H_-and L_∞ performance indices is designed, aiming to balance the fault sensitivity and disturbance robustness. Furthermore, the concept of directional residuals is introduced, and the isolation of faulty actuator is achieved by analyzing the directional correlations between the fault feature vectors and the generated residual vectors. Finally, the effectiveness of the proposed method is validated through simulation experiments.

14:45-15:00, Paper WeCT1.4	

Road Adhesion Coefficient Estimatior Using Adaptive UKF with Model Parameter Perturbation and Unknown Time-Varying Noise (I)

Bai, Shuo	Southeast University
Gao, Junzhe	Southeast University
Fang, Ruiqi	Southeast University
Liu, Zilong	Southeast University
Zhang, Jiatong	Southeast University
Yin, Guodong	Southeast University

Keywords: Estimation and Identification, Modeling and Control of Complex Systems
Abstract: Distributed driving electric vehicles (DDEV) has become one of the research hotspots in automobile industry due to its fully decoupled chassis configuration. Accurate and timely estimation of road adhesion coefficient (RAC) is the premise of vehicle active safety, which will greatly improve the driving comfort and handling stability of DDEV. In this research, an adaptive unscented Kalman filter (AUKF) is proposed for RAC estimation to deal with issues of model parameter perturbation and unknown time-varying noise. Fading coefficient matrix is used to enhance the utilization of new observation data. Meanwhile, Sage-Husa noise estimator is adopted to refresh system noise dynamically. Results indicate that AUKF method has a higher precision, faster convergence and better stability than EKF and UKF. The proposed AUKF method also shows strong robustness to different pavement coefficients and has fortissimo generalization ability to multiple driving scenarios.

15:00-15:15, Paper WeCT1.5	

Adaptive Neural Networks Control of Intelligent Vehicle under Physical Fault and Stealthy Replay Attack Threats (I)

Qiu, Zhaoyu	Southeast University
Bai, Shuo	Southeast University
Bai, Xin	Southeast University
Hu, Jingyu	Southeast University
Zhu, Xiaoyuan	Southeast University
Yin, Guodong	Southeast University

Keywords: Adaptive Control, Fault Detection and Diagnostics
Abstract: With the continuous advancement of intelligent connected vehicle technology, the presence of vehicle faults and network attacks poses significant threats to the reliability and security of electric vehicle. This paper proposes an adaptive neural network (NN) fault-tolerant controller design for vehicle, and employs the dynamic watermarking method to detect stealthy replay attacks. First, a vehicle dynamics model is established considering actuator faults and unknown disturbances. Then, a fault-tolerant controller is designed by integrating an adaptive NN and a nonlinear disturbance observer (DO) to handle faults and external disturbances. Next, by incorporating dynamic watermarking into the controller, a residual-based detection function is designed to detect stealthy replay attacks. Subsequently, the convergence of the proposed control algorithm is proven using the direct Lyapunov method. Finally, hardware-in-the-loop (HIL) tests validate the effectiveness of the proposed control method.

15:15-15:30, Paper WeCT1.6	

UAV-Collected Multi-Class Instance Segmentation Dataset for Building Facades Defects

Yan, Jiayin	The Chinese University of Hong Kong
Zhao, Benyun	The Chinese University of Hong Kong
Yang, Guidong	The Chinese University of Hong Kong
Wen, Junjie	The Chinese University of Hong Kong
Duan, Qigeng	The Chinese University of Hong Kong
Chen, Ben M.	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong

Keywords: Smart Buildings, Learning Systems, Real-time Systems
Abstract: Current building inspections are mainly relied on human, making the process time-consuming and labor-intensive. Therefore, the development of deep-learning-based automated inspection systems has become a growing trend. However, the lack of a comprehensive training dataset is the majority challenge in developing deep-learning models. To bridge this gap, we introduce CUBIT-CW, a human-annotated dataset containing 10871 high-resolution images collected via drone, with multiscale ranging from 800 x 600 to 8000 x 6000 pixels. Our CUBIT-CW covers 9 distinct defect categories, which are line cracks, map cracks, rust stains, delamination, spalling, cement loss, seepage, damp patches, efflorescence and mold. It also works for instance segmentation, allowing for the models to have a detailed understanding of defect boundaries and features. To evaluate its effectiveness, we test CUBIT-CW by 6 stateof-the-art(SOTA) computer vision models. The corresponding experimental results illustrate that our dataset enhances the robustness and generalizability of the models, making them to inspect more complex defects on building surfaces with greater accuracy.

WeCT2	GRANDE 3
Intelligent and AI Based Control	Regular Session

Chair: Barbu, Tudor	Institute of Computer Science of the Romanian Academy

14:00-14:15, Paper WeCT2.1	

Autonomous Decision Making for High-Speed Vehicle in Interception Scenario Via Individual Similarity Pigeon-Inspired Optimization

Chen, Rujia	Beihang University
Duan, Haibin	Beihang University

Keywords: Intelligent and AI Based Control, Learning-based Control, Control Applications
Abstract: In this paper, an autonomous interception method is presented for intelligent high-speed vehicles (HSV) with matrix game theory, incorporating an enhanced pigeon-inspired optimization. Considering attackers with equal levels of intelligence, the matrix game is applied to describe the real-time one-to-one interception process. Subsequently, a maneuver library based on a simplified overload model is introduced to predict the motion tendency of a 6-degree-of-freedom (6-DOF) model. In this regard, individual similarity pigeon-inspired optimization (ISPIO) is proposed to search for optimal maneuvers. The experiments demonstrate the effectiveness of the proposed framework in face-to-face interception and initial disadvantage scenarios, and analyze the influences of different optimization algorithms for both scenarios.

14:15-14:30, Paper WeCT2.2	

Novel Multi-Pedestrian Detection and Tracking Framework Combining Machine and Deep Learning Schemes to Anisotropic Diffusion-Based Models

Barbu, Tudor	Institute of Computer Science of the Romanian Academy
Bejinariu, Silviu Ioan	Institute of Computer Science, Romanian Academy, Iasi Branch

Keywords: Learning Systems, Fuzzy and Neural Systems, Intelligent and AI Based Control
Abstract: An automatic multiple pedestrian detection and counting framework is introduced in this research paper. The proposed technique combines successfully several computer vision and nonlinear anisotropic diffusion-based models. Its detection component performs a boosted cascade classifier-based walking person localization process that is followed and improved by a segmentation of the detected sub-images, which is performed applying a novel partial differential equation (PDE) - based geodesic active contour (GAC) model. The obtained pedestrian detections are then counted successfully in the analyzed traffic video by applying a tracking-by-detection scheme using a deep learning-based feature extraction to them. The detection and tracking simulation results that are finally discussed illustrate the effectiveness of the proposed framework.

14:30-14:45, Paper WeCT2.3	

Enhanced Intelligent Fault-Tolerant Control for Hypersonic Gliding Vehicles: Combing DRL and Transfer Learning

Ren, Bin	Beihang University
Wang, Honglun	Beihang University
Wu, Xingyu	School of Automation Science and Electrical Engineering, Beihang
Yan, Guocheng	School of Automation Science and Electrical Engineering, Beihang

Keywords: Intelligent and AI Based Control, Learning-based Control, Nonlinear Systems and Control
Abstract: To improve the fault-tolerant adaptability of hypersonic gliding vehicles (HGVs) in diverse environments and actuator faults, an enhanced intelligent fault-tolerant control (FTC) scheme is proposed based on the deep reinforcement learning (DRL) and transfer learning (TL) method. First, the HGV model with multiple disturbances and diverse actuator faults is constructed. On this basis, a fundamental FTC system is designed under the active disturbance rejection control (ADRC) framework to provide theoretical stability and basic FTC capability. Then, a DRL-based intelligent FTC scheme is proposed to autonomously adapt the FTC parameters to different environments and faults. Furthermore, to address the discrepancies between the actual flight environments and virtual training environments, as well as the issue that the actual faults exceed the knowledge of the FTC agent, a TL-based enhanced intelligent FTC scheme is proposed to ensure that the FTC agent can continuously update its policy using actual flight data, thereby improving its adaptability to more complex and unknown conditions.

14:45-15:00, Paper WeCT2.4	

Collaborative Penetration Algorithm with Dominant Region Analysis Embedded in Deep Reinforcement Learning

Luo, Jiong	Beihang University
Yan, Rui	Beihang University
Hua, Yongzhao	Beihang University
Li, Xiaoduo	Beihang University
Dong, Xiwang	Beihang University

Keywords: Intelligent and AI Based Control, Multi-agent Systems, Robotics
Abstract: The problem of UAV attack-defense confrontation is a hot research direction in the field of unmanned systems at present. However, in an environment with threat areas or obstacles, when the enemy is a defender with higher mobility or pursuit ability, the cooperative penetration problem of multiple UAVs is still lack of effective solutions. Therefore, this paper combines the theoretical analysis of game theory and the advantages of reinforcement learning in complex scenes, and designs an algorithm framework for embedding dominant region analysis into deep reinforcement learning. On the premise of sacrificing strategy, we analytically derive the attacker's dominance region through geometric optimization and integrate this framework into the Deep Deterministic Policy Gradient (DDPG) algorithm by enhancing state space formulation, reward function design, and termination criteria. Numerical simulations demonstrate the algorithm's superior efficacy over baseline reinforcement learning approaches, exhibiting reduced training time (42.8%), increased penetration success rate (31%), and optimized trajectory lengths (4.9%).

15:00-15:15, Paper WeCT2.5	

EnteroMatch: A Sparse MoE Model for FMT Matching

Zhou, Mingkang	Xiamen University

Deng, Tingzhi	Xiamen University
Wang, Ying	Xiamen University

Keywords: Intelligent and AI Based Control
Abstract: Fecal Microbiota Transplantation (FMT) has emerged as a promising therapeutic approach for various gastrointestinal and systemic diseases. However, optimizing donor-recipient matching remains a critical challenge that constrains its clinical efficacy. In this study, we propose EnteroMatch, a deep learning-based Sparse Mixture of Experts (Sparse MoE) model designed for FMT donor-recipient matching. By integrating a dynamic routing mechanism, EnteroMatch effectively captures the complex ecological characteristics of the gut microbiota. Furthermore, we employ k-means clustering to partition both donors and recipients into two distinct enterotypes, allowing the model to adaptively adjust to their unique microbial profiles and better reflect the influence of microbiome diversity on FMT outcomes. Extensive experimental evaluations on large-scale datasets demonstrate that EnteroMatch outperforms other state-of-the-art deep learning architectures in terms of matching accuracy, generalization, and robustness. This work not only provides a novel computational framework for personalized FMT strategies but also lays a solid foundation for future research in microbiome-based therapies.

15:15-15:30, Paper WeCT2.6	

An Open-Source Projectile Launching Device for MAV Pursuit-Evasion and Dogfighting Research

Wang, Chunyu	Westlake University
Zheng, Canlun	Westlake University
Wang, Zhikun	Westlake University
Zhao, Shiyu	Westlake University

Keywords: Intelligent and AI Based Control, Robotics, Smart Structures
Abstract: This paper introduces an open-source, lightweight, compact projectile launching device designed to fill the gap in target acquisition systems for micro aerial vehicle (MAV) pursuit-evasion and dogfighting research. This device unifies projectile storage, feeding, and launching functions in a single integrated design. When fully loaded with projectiles, it weighs only 70.5 g, making it highly compatible with small MAVs (e.g., 3.5-inch MAVs). The device features a single friction wheel mechanism and a spring-slide rail design for projectile feeding, enabling stable launches in all orientations. Furthermore, we developed a trajectory prediction model by integrating aero- dynamic principles and the Magnus effect, specifically adapted to full-pose launch conditions. Based on the projectile impact dispersion, we proposed a noise model which can enhances the accuracy and portability of the capture. Experimental validation confirms the stability of launching projectiles and the accuracy of the trajectory predictions. This study achieves, for the first time, a hardware-model co-design for full-orientation projectile launching in MAVs, advancing close-range MAV combat technologies towards practical applications. The related results have been made publicly available via GitHub.

WeCT3	BOLERO 1
Multi-Agent Systems I	Regular Session
14:00-14:15, Paper WeCT3.1	

Enhancing Event-Separation Properties for Event-Triggered Consensus with Disturbances

Zhan, Sikang	Shanghai Jiao Tong University
Li, Xianwei	Shanghai Jiao Tong University
Yin, Xiang	Shanghai Jiao Tong University
Li, Shaoyuan	Shanghai Jiao Tong University

Keywords: Multi-agent Systems, Networked Control
Abstract: In the event-triggered control of multi-agent systems (MASs), external disturbances are prevalent in practice and may lead to excessive triggering events (often referred to as Zeno behavior), which poses problems for practical implementation. Therefore, it is essential to enhance event-separation properties when the MAS is subjected to disturbances. In this context, this article is concerned with the event-triggered consensus of MASs in the presence of external disturbances. Distributed dynamic event-triggered (DET) control strategies are proposed based on the sampled information of neighboring agents. It has been theoretically demonstrated that, under the designed DET sampling strategies, the MAS can achieve bounded consensus and strictly positive minimum inter-event times are guaranteed. The effectiveness of the theoretical results is validated by numerical results.

14:15-14:30, Paper WeCT3.2	

Distributed Time-Varying Optimization Over a Strongly Connected and Weight-Balanced Digraph

Sheikhahmadi, Seyed Hemin	University of Texas at Arlington
Xie, Yijing	University of Texas at Arlington
Lin, Zongli	University of Virginia

Keywords: Multi-agent Systems
Abstract: This paper deals with the distributed time-varying optimization problem over a digragh (or directed graph). Motivated by the time-varying nature present in the cost functions, we model the time-varying features using an exosystem and formulate the problem of minimizing a global cost function, which is the sum of the local time-varying cost functions. We design a distributed algorithm for each agent that only utilizes the information of its own cost function and the information obtained through a network represented by a strongly connected and weight-balanced digraph. Convergence analysis is carried out to show that the decision variables of all agents converge to the time-varying optimal solution with time. Simulation results verify the theoretical conclusions.

14:30-14:45, Paper WeCT3.3	

Game-Based Strategy to Cooperative Localization with Input Constraints

Gao, Mengjing	Northwestern Polytechnical University
Chen, Kang	Northwestern Polytechnical University
Chang, Xiaofei	Northwestern Polytechnical University
Huang, Jingyao	Northwestern Polytechnical University
Wu, Zihao	Beihang University
Fu, Wenxing	Northwestern Polytechnical University

Keywords: Multi-agent Systems, Control Applications, Optimal Control
Abstract: The cooperative localization of multiple drones in space with a certain configuration to target enhances the acquisition of information and boosts situational awareness, presenting significant application prospects. Addressing the challenge of achieving high-precision cooperative localization for maneuver targets, this paper designs a Nash-based game cooperative localization strategy. Firstly, it establishes the cooperative localization scenario as a Stackelberg model and considers both localization accuracy and input constraints. Secondly, it theoretically derives the Nash equilibrium solution of the game model for multi-aircraft. Thirdly, an improved data-driven adaptive dynamic programming algorithm with independent actions is devised to solve the equilibrium solution. Finally, simulations verify that the proposed model and algorithm can achieve cooperative localization of maneuvering targets by multiple drones, meeting the requirements for localization accuracy. This provides a solution for the research of strategies in cooperative adversarial scenarios.

14:45-15:00, Paper WeCT3.4	

Resilient Leader-Follower Consensus of Discrete-Time High-Order Multi-Agent Systems with Time-Varying Graphs

Luo, Zihang	Central South University
Hu, Wenfeng	Central South University

Keywords: Multi-agent Systems, Networked Control
Abstract: This paper addresses the resilient leader-follower consensus problem for discrete-time high-order multi-agent systems with time-varying graphs. A resilient control law is proposed for each normally functioning follower to effectively mitigate the disruptive effects of malicious agents. Under the proposed control law, resilient leader-follower consensus is achieved exponentially, given that the graph is jointly strongly (2f+1)-robust, significantly reducing the communication burden at each time step. Finally, the effectiveness of the proposed approach is validated through a numerical simulation.

15:00-15:15, Paper WeCT3.5	

How Do Robot Swarms Behave Compliantly?

Zhang, Xiaozhen	Beijing Institute of Technology
Zhao, Zeming	Beijing Institute of Technology
Yang, Qingkai	Beijing Institute of Technology
Fang, Hao	Beijing Institute of Technology
Chen, Jie	Tongji University

Keywords: Multi-agent Systems, Networked Control, Robotics
Abstract: Conflicts often arise in swarm robotics between individual tasks related to environmental adaptation and the cooperative objective of maintaining a formation. For instance, obstacles may prevent robots from achieving a prescribed formation. Individual tasks, such as collision avoidance, are typically more urgent than the formation maintenance objective. As a result, it is necessary for the formation to compromise (i.e., be compliant) with these individual tasks, highlighting the need for swarm robots to behave compliantly. Inspired by the action principle of compliant control in physical robots, this paper proposes a distributed method that endows swarm robots with compliance. From the perspective of an individual robot, the method enables each robot to achieve its local tasks, allowing it to adapt to its environment. At the swarm level, the approach facilitates a compromise between formation maintenance and individual tasks, mitigating conflicts between individuality and collective objectives. Consequently, the swarm behaves compliantly, autonomously adjusting its formation shape. Finally, experimental results demonstrate the effectiveness of the proposed method, showing its ability to enhance the flexibility and adaptability of swarm formations.

15:15-15:30, Paper WeCT3.6	

A Lightweight and Secure Access Authentication Scheme for UAV Formation

Lu, Chaojie	Beihang University
Liu, Yishi	Beihang University
Jin, Kai	Institute of Data Communication Science and Technology
Zhang, Yanli	Institute of Data Communication Science and Technology
Dong, Xiwang	Beihang University

Keywords: Multi-agent Systems
Abstract: Unmanned Aerial Vehicle (UAV) swarm systems are playing an irreplaceable role in various fields. However, the security challenge of UAV network has become increasingly prominent. In this paper, a lightweight secure access scheme based on physical unclonable function (PUF) for UAV swarm systems is proposed. Firstly, the UAV formation network is modelled and the security requirement is analyzed. Then, a lightweight authentication and key agreement protocol based on PUF is designed for UAV formation network to ensure access security. To verify the effectiveness of our scheme, the communication and computing costs of it are compared to other protocols.

WeCT4	BOLERO 2
Optimal Control	Regular Session

14:00-14:15, Paper WeCT4.1	

Adaptive Distributed Observer-Based Model Predictive Control for Multi-Agent Formation with Resilience to Communication Link Faults

Xu, Binyan	University of Guelph
Dai, Yufan	University of Victoria
Suleman, Afzal	University of Victoria
Shi, Yang	Canada

Keywords: Optimal Control, Adaptive Control, Multi-agent Systems
Abstract: To address the nonlinear multi-agent formation tracking problem with input constraints and unknown communication faults, this paper develops a novel adaptive distributed observer-based model predictive control (MPC) method. The design integrates adaptive distributed observers into local control systems to estimate the leader's state, dynamics, and desired displacement. By utilizing these observed information to construct local references, the original distributed formation tracking problem is decomposed into fully localized tracking control tasks, efficiently handled by local MPC controllers. This design enhances resilience against communication faults while simplifying the distributed MPC formulation.

14:15-14:30, Paper WeCT4.2

Robust Model Predictive Control for Offshore Wind Turbine

Carreno Zagarra, Jose Jorge	Universidad Industrial De Santander
Reyes Ardila, Jorge Carlos	Universidad Industrial De Santander
Poveda, Diana Katheryn	Universidad Industrial De Santander
Villamizar, Rodolfo	Universidad Industrial De Santander

Keywords: Control Applications, Nonlinear Systems and Control, Optimal Control
Abstract: This paper presents a control scheme that combines the benefits of model predictive control (MPC) and active disturbance rejection by using generalized proportional integral (GPI) observers.The proposed control scheme was applied to a 5MW offshore wind turbine model. In order to validate the control approach a baseline controller is used, which combines an Indirect Speed Controller (ISC) and a collective blade pitch controller (CPC). Simulation results show that the Robust MPC is able to greatly reduce rotor speed and power variations in full load conditions and perfect wind preview.

14:30-14:45, Paper WeCT4.3

Design of Active Suspension LQGI Control of a Half Car Vehicle Model

Pacek, Daniel	Slovak University of Technology in Bratislava
Rosinová, Danica	Slovak University of Technology, Faculty of Electrical
Račkay, Juraj	Faculty of Electrical Engineering and Information Technology Of

Keywords: Optimal Control, Linear Systems, Motion Control
Abstract: This paper focuses on the design of a controller for vehicle with active suspension represented by a half car model, with aim to increase the crew comfort. The dynamics of the system is described by state-space equations, which are then used for the synthesis of the LQGI controller. Subsequently a PSO structure for fine tuning of the controller is created. The performance of the proposed controller is verified by MATLAB-Adams co-simulation. For the evaluation of the achieved results, the criteria for ride safety and comfort of car suspension according to ISO 8608 have been used. This work demonstrates a significant improvement in ride comfort and safety when using the proposed active suspension control.

14:45-15:00, Paper WeCT4.4

An Efficient Convex Optimization Pattern for Model Predictive Control of Hydraulic Servo Systems

Cui, Zhexin	Tongji University
Yue, Jiguang	Tongji University
Liu, Haichuan	Tongji University
Wu, Chenhao	Shanghai University

Keywords: Optimal Control, Control Applications
Abstract: The fast dynamic characteristic of hydraulic servo systems poses a great challenge to the physical implementation of model predictive control (MPC). To address the online iterative solving of the optimal control problem, this paper proposes an efficient convex optimization pattern to obtain the optimal control variables in the shortest possible control period, thus supporting the system tracking performance and safety. An optimal control problem of the hydraulic servo system MPC is established based on the considered mechanism model. The convexity of the optimization model is proved, which makes the global convergence valid to avoid complex solving. As a model transformation prerequisite, the positive definiteness of the Hessian matrix is elucidated. Then, a conversion method from the MPC quadratic programming form to the non-negative least squares form is presented, which enables simpler implementation programming and more efficient optimization solving. Finally, some numerical experiments verify the effectiveness and merits of the proposed pattern.

15:00-15:15, Paper WeCT4.5

Tow-Layer Data-Driven Model Predictive Control for Coal Blending System of Coking Process

Hou, Xiangyu	Shanghai Jiao Tong University
Li, Dewei	Shanghai Jiao Tong University
He, Shaoying	Shanghai Jiao Tong University
Ma, Aoyun	Shanghai Jiao Tong University

Keywords: Control Applications, Process Automation, Optimal Control
Abstract: In the coal coking process, coal blending refers to the procedure of mixing different individual coal types from storage bins in specific proportions. The system controls the mass flow rate of each coal type to maintain the blending ratio, which is essential for enhancing production efficiency. Due to the uneven coal quality in storage bins, blockage at feeding ports and mechanism of coal flow monitoring, the coal blending system becomes a time-delayed and uncertain system. Existing control schemes fail to account for the impact of discharge port blockages on the maximum coal flow output. To address this, this paper proposes a two-layer data-driven model predictive control (MPC) framework. Model parameters are updated by using historical data and coal flow setpoints are recalibrated under constraints in the upper layer, while an MPC based on input-mapping method is solved in the lower layer to decrease the effects of the unknown but bounded uncertainties in system parameters. MATLAB simulations validate the effectiveness of the proposed method.

15:15-15:30, Paper WeCT4.6

An HTCPN-Based Self-Adaptive Optimal Control Method for Multi-Level Collaborative Manufacturing Networks

Guo, Zhengang	Northwestern Polytechnical University
Li, Xiaohua	Chengdu Aircraft Industrial (Group) Co., Ltd
Liang, Weicong	Chengdu Aircraft Industrial (Group) Co., Ltd
Zhang, Yingfeng	Https://controls.papercept.net/conferences/scripts/start.pl#WODE

Keywords: Adaptive Control, Optimal Control, Factory Modeling and Automation

Abstract: The increasing demand for highly customized complex products, such as aircraft and aero engines, in dynamic global production environments has brought great challenges to manufacturing enterprises and supply networks. To tackle the problem of dynamics and networked control among distributed heterogeneous manufacturing resources, a hierarchical timed colored Petri net (HTCPN)-based self-adaptive optimal control (SOC) method is proposed for multi-level collaborative manufacturing networks. In contrast to existing HTCPN models, an industrial dataspace is designed to interoperate large-scale, multi-source, and heterogeneous real-time data, which provides manufacturing processes with data subspaces dynamically. To achieve SOC, the corresponding optimization problem is solved by a tailored multi-objective ant colony optimization (ACO) algorithm. A case study based on a Chinese aircraft manufacturer demonstrates the effectiveness and efficiency of the proposed method in reducing cost, time, and energy consumption. This paper potentially enables discrete manufacturing enterprises to implement SOC in multi-level manufacturing networks.

WeDT5	GRANDE 1&2
Automation vs. Artificial Intelligence	Plenary Session
Chair: Chen, Ben M.	Chinese University of Hong Kong
Co-Chair: Ding, Zhengtao	The University of Manchester
16:00-17:30, Paper WeDT5.1	
Automation vs. Artificial Intelligence	
Chen, Tongwen	University of Alberta
Guay, Martin	Queen's University
Lin, Zongli	University of Virginia
Petlenkov, Eduard	Tallinn University of Technology

ThAT1	GRANDE 1&2
Automated Guided Vehicles	Regular Session
Chair: Zhang, Youmin	Concordia University

08:30-08:45, Paper ThAT1.1

Lateral Control of Holonomic Platoons Via Spatial Vehicle-To-Vehicle Learning

Wang, Wenxian	Beihang University
Meng, Deyuan	Beihang University (BUAA)
Yang, Tao	Northeastern University
Wang, Jing	North China University of Technology

Keywords: Automated Guided Vehicles, Learning-based Control, Control Applications

Abstract: This paper proposes a lateral controller for holonomic vehicle platoons that integrates both feedforward and feedback control strategies. A spatial axis is defined to assess the lateral tracking performance across the platoon characterized by a novel definition of lifted lateral string stability, and a holonomic vehicle model is developed. An unconstrained model predictive controller is then employed for trajectory tracking, and a novel feedforward vehicle-to-vehicle (V2V) learning-based controller is further incorporated to enhance transient tracking performance through V2V interaction. In this feedforward-feedback controller, a sufficient condition for lifted lateral string stability is derived through contraction mapping analysis, and its practical implementation is validated via simulations involving omni-directional wheeled vehicles.

08:45-09:00, Paper ThAT1.2

A Nonlinear Pursuit-Evasion Game Trajectory Planning Method for Spacecrafts with Low Sensitivity on the Initial Value

Yang, Zhiyuan	Beihang University
Wang, Honglun	Beihang University
Zhang, Menghua	Beijing Institute of Control Engineering
Wu, Jianfa	Beijing Institute of Control Engineering

Keywords: Automated Guided Vehicles, Optimal Control, Nonlinear Systems and Control

Abstract: Aiming at the nonlinear pursuit-evasion game problems of the spacecrafts, an improved Radau pseudo-spectral method whose initial values are pre-optimized by a hybrid optimization algorithm is proposed. This method transforms the nonlinear pursuit-evasion game problem considering J2 term perturbations, a bilateral optimal problem, into a unilateral optimal control problem based on the semi-direct method. Subsequently, hp-Radau pseudo-spectral method is used to further transform the unilateral optimal control problem into a nonlinear programming problem. Then, a hybrid optimization algorithm composed of the designed nonlinear adaptive particle swarm optimization (NAPSO) algorithm and the collocation method is to pre-optimize the initial guess value of the nonlinear programming problem, which is solved by the nonlinear programming solver. After that, the optimal control strategy and game trajectory of the spacecrafts can be obtained. Finally, the simulation results show that the proposed method can maintain high solution accuracy and efficiency with limited computational cost compared to the combined shooting and collocation method (CSCM), while reducing the initial value sensitivity of the method.

09:00-09:15, Paper ThAT1.3

An Intelligent Algorithm for Determining Optimal Wildfire Suppression Zone Using UAVs

Wu, Xiaobo	Concordia University
Fu, Yufei	Concordia University
Qiao, Linhan	Concordia University
Dong, Huajun	Concordia University
Qin, Qiaomeng	Concordia University
Dilfanian, Erfan	Concordia University
Taherzadeh, Amin	Concordia University
Zhang, Youmin	Concordia University
Benzerrouk, Hamza	Rotors&Wings Aerogroup
Guiddir, Hakim	Rotors&Wings Aerogroup

Keywords: Automated Guided Vehicles, Fault Detection and Diagnostics, Motion Control

Abstract: Wildfires inflict profound environmental and economic devastation. Aerial firefighting is a critical component in wildfire suppression efforts, offering the ability to access remote areas and take quick action. Traditional aerial firefighting operations totally depend on the experience and subjective judgment of pilots to determine the wildfire suppression zone and drop the fire retardant on it, resulting in inconsistent performance and a lack of scientific guidance. With the optimization objectives that cover as many wildfire points as possible within a limited zone, based on wildfire point location information observed by UAV and aircraft's motion state and related parameters, a Rectangle RANdom SAmple Consensus and Ground Pattern (R-RANSAC GP) algorithm combining R-RANSAC and the Ground Pattern method is proposed to determine the optimal wildfire suppression zone in real time. Both the simulated wildfire point and the real wildfire image are used to test the performance of the R-RANSAC GP. Results demonstrate that R-RANSAC can determine the optimal retardant dropping zone autonomously and intelligently.

09:15-09:30, Paper ThAT1.4

Towards Real-Time 3D Monocular-Based Reconstruction in Support of UAS Missions

Walczak, Ryan	The Naval Postgraduate School
Yakimenko, Oleg A.	Naval Postgraduate School

Keywords: Real-time Systems, Automated Guided Vehicles, Control Education

Abstract: This paper discusses the processes and resources needed to develop three-dimensional (3D) reconstructions of an object or indoor/outdoor environment using unmanned vehicles equipped with a single camera. A single camera captures a scene in two-dimensions (2D), inherently providing no information about the 3D space of the scene. Converting a stream of 2D images into a high-resolution 3D model requires a sequence of coordinated algorithmic processes. Literature review reveals the attempts to tackle the problem by configuring unmanned vehicles with a suite of sensors. This approach solves some problems with scene capturing but opens a large envelope of vulnerabilities when using

the system in critical missions requiring quick response, high confidence level and precision.

09:30-09:45, Paper ThAT1.5

Time Cooperative Guidance Law with the Maximum Consensus Algorithm of Time-To-Go

Lin, Zhi	Beihang University
Shi, Zhexin	Beihang University
Yu, Jianglong	Beihang University
Jiang, Hong	Beihang University
Dong, Xiwang	Beihang University
Ren, Zhang	Beihang University

Keywords: Automated Guided Vehicles, Control Applications

Abstract: This paper studies the problem of time cooperative guidance of multiple aircrafts against a stationary target. First, the maximum consensus algorithm of the time-to-go is introduced to calculate the impact time consensus error. Then, the consensus error is introduced into the navigation gain by feedback, and a cooperative guidance law with a time-varying navigation gain is designed to achieve cooperative guidance against the stationary target with impact time consensus. In addition, the convergence and stability of the guidance law is analyzed using the Lyapunov theories. Finally, the effectiveness of the algorithm is verified through the simulation and practical experiment.

09:45-10:00, Paper ThAT1.6

Enhancing Driver-Automation Interaction Using RL-Based Shared Control

Koritala, Naveen Kumar	Kyungpook National University
Defoort, Michael	Valenciennes Univ
Tsai, Chun-Wei	National Sun Yat Sen University
Veluvolu, Kalyana C	Kyungpook National University

Keywords: Automated Guided Vehicles, Intelligent and AI Based Control, Multi-agent Systems

Abstract: Shared control in autonomous driving requires optimal relative weight allocation between driver and automation to ensure safety and vehicle stability. This study proposes a Twin Delayed Deep Deterministic Policy Gradient (TD3) Reinforcement Learning (RL) based authority allocation approach incorporating driver behaviour to enhance adaptability and driver-automation collaboration. Simulations conducted in the MATLAB/SIMULINK-CarSim environment demonstrate that the proposed shared control framework significantly reduces lateral offset, heading error, and abrupt steering movements, leading to smoother control transitions and enhanced driving comfort. The results validate the effectiveness of the proposed method in improving the driver-automation interaction, ensuring a stable, intuitive, and safe shared driving experience

ThAT2	GRANDE 3
Modeling and Control of Complex Systems	Regular Session
Chair: Li, Zhi	Technical University of Munich

08:30-08:45, Paper ThAT2.1

Accelerating Control Design for Quasi-Resonant Mode Boost Converters through State Machine Modelling Approach

Li, Zhi	Technical University of Munich
Schwabe, Benjamin	Infineon Technologies AG
Servadei, Lorenzo	Technical University of Munich
Wille, Robert	Technical University of Munich

Keywords: Modeling and Control of Complex Systems, Nonlinear Systems and Control, Control Education

Abstract: The design of digital controllers for boost converters operating in quasi-resonant mode (QRM) is often hindered by the trade-off between accurately modeling dynamic behavior and efficiently analyzing frequency-domain characteristics. To address this challenge, this paper introduces a novel modeling approach that leverages a state machine to provide a highly accurate and computationally efficient model. By achieving a balance between precision and speed, this method enables faster simulation and design of digital controllers, while maintaining comparable simulation accuracy, thereby enhancing overall design efficiency and effectiveness.

08:45-09:00, Paper ThAT2.2

AI-Supported Dynamic System Identification: Recognizing a Differential Equation from Response Data

Kruzenshtern, Anna	LUT
Dodonov, Viktor	LUT University
Chechurin, Leonid	Lappeenranta University of Technology

Keywords: Modeling and Control of Complex Systems, Learning Systems, Estimation and Identification

Abstract: The paper proposes an approach to modeling dynamic systems by identifying the governing differential equations based on system responses. The work answers the question whether Artificial Neural Networks (ANNs) can be trained to recognize and infer symbolic representations of differential equations, just observing the response data. The proposed method consists of a two-stage pipeline. The first stage – Structural identification, when governing differential equation (DE) type recognition occurs. The stage is implemented as Transducer which transforms data from one representation to another while preserving the semantic content. The method takes advantage of the heuristic mechanism, bridging the gap between human cognition and machine learning. The second stage – Parametric identification, when the inferred equation coefficients are refined. Experiments were conducted using surrogate datasets generated from various classes of differential equations typical for oscillatory systems. The results demonstrate that trained ANN can effectively classify DEs, while the refinement process might provide an accurate parameter estimation.

09:00-09:15, Paper ThAT2.3

Establishing Models for Digital Twin of Hydropower Systems Using Probability Density Function Shaping

Yin, Zhun	The Department of Electrical and Computer Engineering at New Yor
Wang, Hong	Oak Ridge National Laboratory

Jiang, Zhong-Ping	New York University
Jia, Wenbo	Chelan County PUD

Keywords: Modeling and Control of Complex Systems, Estimation and Identification
Abstract: This paper introduces a digital twin modeling method for hydropower systems with Kaplan turbines using probability density function (PDF) shaping. We first use a multi-layer perceptron (MLP) model to build the discretized open-loop Kaplan unit, where the MLP is trained by historical data. Then we use a proportional integral double derivative (PIDD) controller and a lead-lag exciter to test the obtained digital twin model in a closed-loop fashion. Simulation results show that the proposed digital twin modeling method can accurately capture the dynamics of the Kaplan hydropower unit. Finally, we show that the obtained digital twin can help to optimize the PIDD parameters. Compared with the original PIDD controller, the optimized one can achieve an over 90% improvement on the mean square tracking error.

09:15-09:30, Paper ThAT2.4

Piecewise-Affine Jump State Estimator Design within Reachable Target Regions under Noisy Measurements

Ning, Zepeng	Nanyang Technological University
Geng, Junyi	Pennsylvania State University
Fang, Xu	Nanyang Technological University
Xie, Lihua	Nanyang Technological University

Keywords: Modeling and Control of Complex Systems, Estimation and Identification, Robust and H infinity Control
Abstract: This paper investigates state estimation of discrete-time jump systems via piecewise-affine (PWA) modeling. Since certain regions are unreachable within one time step, we present an algorithm to identify reachable target regions for system state and its estimation under noisy measurements. The mean-square stability and noise attenuation of the estimation error system are analyzed by excluding unreachable regions based on a mode-dependent piecewise Lyapunov function. A mode-dependent PWA estimator is then designed to ensure stability and fulfill the noise attenuation requirement with lower computational cost. In comparison, the approach based on reachable target regions reduces both computational complexity and conservativeness [1]. The proposed state estimation approach is validated and demonstrated to be advantageous through its application to the tunnel diode circuit.

09:30-09:45, Paper ThAT2.5

Modeling for a Hydrofoil Marine Vehicle in Gazebo

Zuoquan, Zhao	The Chinese University of Hong Kong
Yan, Ruixin	The Chinese University of Hong Kong
Wu, Zongzhou	The Chinese University of Hong Kong
Wang, Jialiang	The Chinese University of Hong Kong
Chen, Ben M.	The Chinese University of Hong Kong

Keywords: Modeling and Control of Complex Systems, Robotics
Abstract: While unmanned systems play an increasingly vital role in many marine applications, designing and testing a new unmanned marine system often involves substantial time, financial resources, and inherent risks. To mitigate these challenges, simulation is widely employed in the development of these systems. Among various modeling and simulation platforms, Gazebo stands out due to its user-friendly modeling capabilities, precise calculations, and low computational complexity. In this study, we present the development of a high-fidelity simulation platform in Gazebo for our unmanned marine system, Sea-U-Foil. We conduct a thorough analysis of the forces and moments acting on the Sea-U-Foil in a marine environment. To improve the fidelity of the simulation, we also incorporate the modeling of environmental factors such as waves and winds in Gazebo. Additionally, we ensure the accuracy of our simulation results by utilizing a combination of parameter identification methods, including direct measurement, computational fluid dynamics (CFD), and numerical analysis to identify the parameters of Sea-U-Foil. Our modeling process in Gazebo are expected to significantly advance the development of Sea-U-Foil and similar unmanned marine vehicles.

09:45-10:00, Paper ThAT2.6

Framework for a Data-Driven Digital Supply Chain Architecture in Smart Cities

Liao, Kai	China Industrial Control Systems Cyber Emergency Response Team,
Dou, Keqin	China Industrial Control Systems Cyber Emergency Response Team,
Liu, Shuai	China Industrial Control Systems Cyber Emergency Response Team,
Tan, Lu	China Industrial Control Systems Cyber Emergency Response Team,

Keywords: Modeling and Control of Complex Systems, Real-time Systems, Networked Control
Abstract: In smart cities, digital technologies are transforming urban operations and service models by seamlessly integrating with the real economy. Amid a global economic slowdown and increasing risks, traditional supply chains are no longer able to meet modern urban demands. Rapid advancements in cloud computing, big data, IoT, and AI have redefined supply chain processes—unlocking data's value as a new production factor that optimizes material, financial, and information flows while improving supply–demand relationships. Building on the ITU's standard Y.4910 Maturity Model of Digital Supply Chain for Smart Sustainable Cities (2023), this paper proposes a comprehensive, data-driven digital supply chain architecture for smart cities. The framework enhances real-time decision-making, optimizes resource allocation, and bolsters supply chain resilience through an innovative five-layer structure that integrates diverse data from various urban stakeholders. The five layers include: • Execution and Operation Layer: Automated devices and digital tools that perform supply chain tasks. • Interconnected Sensing Layer: Technologies that capture real-time status of assets, products, and activities across the chain. • Business Control Layer: Software and systems for scheduling, decision-making, and collaborative operations. • Model Interaction Layer: Tools for simulation, modeling, and optimization of business processes. • Security and Trust Layer: Mechanisms to safeguard data and ensure secure, reliable operations. Key contributions include: • A cloud-based, multi-level architecture unifying disparate supply chain processes.

• Data-driven AI decision-making that leverages cross-domain data for enhanced visibility and responsiveness. • A resilience evaluation mechanism that improves risk management and operational adaptability. Ultimately, this architecture empowers smart cities to achieve efficient, resilient, and adaptive supply chain operations in an ever-connected digital era.

ThAT3	BOLERO 1
Multi-Agent Systems II	Regular Session
Chair: Pietrasanta, Rodolfo	Université Paris-Saclay - Univ Evry

08:30-08:45, Paper ThAT3.1

Robust Integrated Adaptive Event-Triggered Protocols for Multi-Agent Systems

Zhao, Yinxiang	Beihang University
Luo, Zhibin	Beihang University
Wang, Qishao	Beihang University
Lv, Yuezu	Beijing Institute of Technology
Zhou, Jialing	Beijing Institute of Technology
Yu, Yang	Beihang University

Keywords: Multi-agent Systems, Adaptive Control
Abstract: This article studies the robust adaptive event-triggered consensus problem for multi-agent systems. A robust event-triggered adaptive protocol, incorporating an eventtriggered scheme, is proposed. The protocol enables adaptive tuning of the control gain matrix through intermittent update mechanisms, thereby ensuring control flexibility while also reducing the frequency of control updates. It is proved theoretically that the ultimate boundedness of the consensus error can be guaranteed based on the proposed protocol. The effectiveness of the proposed approach is demonstrated by a numerical example.

08:45-09:00, Paper ThAT3.2

Heterogeneous Alignment-Based Spatio-Temporal Graph Reinforcement Learning for Dynamic Multi-UAVs Task Assignment

Zhu, Haojie	Nanjing University of Aeronautics and Astronautics
Chen, Mou	Nanjing University of Aeronautics and Astronautics
Zhou, Tongle	Nanjing University of Aeronautics and Astronautics
Han, Zengliang	College of Automation Engineering, Nanjing University of Aeronau

Keywords: Multi-agent Systems, Learning Systems
Abstract: The dynamic task assignment for heterogeneous Unmanned Aerial Vehicles (UAVs) has emerged as a pivotal challenge in mission-critical applications such as disaster response and urban logistics. A novel Heterogeneous Alignment-based Spatio-Temporal Graph Reinforcement Learning (HASTG-RL) framework is proposed to address this issue. First, a Dynamic Spatio-Temporal Graph (DSTG) is constructed to update environment states continuously. Second, a Transformer-based heterogeneous alignment mechanism is developed to resolve the UAV heterogeneity. Moreover, independent critic networks incorporating multi-objective optimization are designed to simultaneously evaluate task completion, energy consumption, and flight distance. The simulation results show that the proposed method demonstrates superior performance in task completion rate and better flight distance compared to state-of-the-art baselines in dynamic scenarios.

09:00-09:15, Paper ThAT3.3

Finite Time Robust Flocking of Second-Order Linear Agents

Pietrasanta, Rodolfo	Université Paris-Saclay - Univ Evry
Chadli, M.	University Paris-Saclay Evry
Nouveliere, Lydie	IBISC, Université Paris Saclay, Univ Evry

Keywords: Multi-agent Systems, Linear Systems, Modeling and Control of Complex Systems
Abstract: In this paper, we propose a novel control strategy inspired by sliding mode principles, designed to drive a set of second-order linear agents into a lattice configuration in finite time, thereby satisfying Reynolds' flocking rules. Moreover, we demonstrate that the control law is robust against a class of external disturbances, ensuring stable flocking behavior even in the presence of uncertainties. To validate our theoretical results, we present several simulation scenarios that confirm both the effectiveness and robustness of the proposed approach.

09:15-09:30, Paper ThAT3.4

Cooperative Persistent Surveillance with a Multi-UGV System Based on Reinforcement Learning

Li, GuangZheng	Beijing Institute of Technology
Li, Zhuo	Tsinghua University
Wang, Gang	Beijing Institute of Technology
Chu-ge, Wu	Beijing Institute of Technology
Wang, Jingjing	Beijing University of Technology
Sun, Jian	Beijing Institute of Technology

Keywords: Multi-agent Systems, Learning Systems, Control Applications
Abstract: This paper investigates a persistent surveillance problem using a group of unmanned ground vehicles (UGVs) in a cooperative manner. The primary objective is to achieve continuous and frequent coverage of the entire target area through cooperation of the multi-UGV system. To this end, we model the persistent surveillance problem as a decentralized partially observable Markov decision process, where a knowability map is introduced for the target area and employed in the design of reward functions. Due to the limited sensing range of each UGV, the knowability map cannot be directly available. Thus, a consensus-based estimation method is designed for each UGV for estimation, and the issue of partial observability is resolved by fully exploiting observations from neighboring UGVs. Furthermore, we propose a deep reinforcement learning-based algorithm with the architecture of centralized training and distributed execution, which derives efficient cooperative surveillance policies for the UGVs. Extensive simulations demonstrate the effectiveness and robustness of the proposed algorithm for the persistent surveillance.

09:30-09:45, Paper ThAT3.5	
Affine Formation Control from Data	
Fang, Xu	Nanyang Technological University
Ning, Zepeng	Nanyang Technological University
Li, Yifei	Beijing Institute of Technology
Wenjian, Cai	Qingdao University of Science and Technology
Xie, Lihua	Nanyang Technological University

Keywords: Multi-agent Systems, Networked Control, Linear Systems
Abstract: Different from existing works that require information of dynamic models, this paper investigates how to achieve distributed affine formation control without such information. First, a leader-follower framework is introduced, which forms the basis for a data-driven distributed protocol that enables followers to form a time-varying target formation. This method removes the necessity for followers to employ estimators to obtain information about the target formation. Second, by addressing both noise-free and noisy data scenarios, data-based stability criteria for multi-agent systems are developed, with the control gain matrices derived.

09:45-10:00, Paper ThAT3.6	
Engineering Application Progress of Multi-Agent Deep Reinforcement Learning	
Bao, Kanghua	Southwest Computer Co., Ltd
Shi, Tao	Southwest Computer Co., Ltd
Wang, Shuxu	Southwest Computer Co., Ltd

Keywords: Multi-agent Systems, Learning Systems, Learning-based Control
Abstract: Multi-agent reinforcement learning (MARL) is an important theoretical branch in the field of machine learning. It integrates methodologies from disciplines such as deep neural networks, reinforcement learning, cybernetics, game theory, and cognitive science, making it suitable for solving various complex multi-agent sequential decision-making problems. The multi-agent deep reinforcement learning (MADRL) method, which combines MARL with deep neural networks, has been widely applied to solve various real-world problems such as traffic signal control, autonomous driving, strategic games, and large model construction, demonstrating broad application prospects. This paper provides an overview of the progress of MADRL in engineering applications, which is divided into three main sections. Firstly, it reviews the research history and application algorithms of deep reinforcement learning (DRL), and outlines the concepts, methods, and problem representations of MADRL. Secondly, from the perspectives of three engineering fields: intelligent game theory, wisdom transport, and unmanned swarm system, it explores the latest engineering application examples of MADRL. Finally, it summarizes the challenges and prospects of MADRL in future engineering applications.

ThAT4	BOLERO 2
Estimation and Identification I	Regular Session
Chair: Jevuczo, Gabor	HUN-REN Institute for Computer Science and Control

08:30-08:45, Paper ThAT4.1	
Design of Bayesian Transfer Filter for Systems with Inequality Constraints	
Huang, Yongjin	Jiangnan University
Zhang, Tianyu	Jiangnan University
Zhao, Shunyi	Jiangnan University
Liu, Fei	Jiangnan University

Keywords: Estimation and Identification, Linear Systems
Abstract: This paper introduces a novel filtering algorithm that integrates inequality state constraints into a Bayesian transfer learning (TL) framework. The proposed method interprets inequality constraints as pseudo-measurements and combines them with transferred knowledge from the source domain to condition the posterior distribution of the target state. This design mitigates the adverse effects of noisy and low-quality target data on estimation performance. To optimize the transfer of source information, the Kullback-Leibler (KL) divergence between the target and source domains is minimized. Additionally, a transfer weight matrix is introduced to balance information utilization between the domains, reducing the risk of negative transfer caused by biased source data. Simulation experiments demonstrate that the proposed weighted Bayesian transfer filter (WBTF) significantly enhances estimation accuracy, particularly under high-noise conditions in the source domain.

08:45-09:00, Paper ThAT4.2	
Design and Experimental Test of Datatic Approximate Optimal Filter in Nonlinear Dynamic Systems	
He, Weixian	Tsinghua University
He, Zeyu	Tsinghua University
Cao, Wenhan	Tsinghua University
Gao, Haoyu	Tsinghua University
Liu, Tong	Tsinghua University
Shuai, Bin	Tsinghua University
Liu, Chang	Cornell University
Li, Shengbo Eben	Tsinghua University

Keywords: Estimation and Identification, Learning Systems
Abstract: Filtering is crucial in engineering fields, providing vital state estimation for control systems. However, the nonlinear nature of complex systems and the presence of non-Gaussian noises pose significant challenges to the performance of conventional filtering methods in terms of estimation accuracy and computational efficiency. In this work, we present a data-driven closed-loop filter, termed datatic approximate optimal filter (DAOF), specifically designed for nonlinear systems under non-Gaussian conditions. We first formulate a Markovian filtering problem (MFP), which inherently shares a connection with reinforcement learning (RL) as it aims to compute the optimal state estimate by minimizing the accumulated error. To solve MFP, we propose DAOF, which primarily incorporates a trained RL policy and features two distinct structural designs: DAOF-v1 and DAOF-v2. Designed for systems with explicit models, DAOF-v1 combines prediction and update phases, with the RL policy generating the update value. Meanwhile, DAOF-v2 bypasses system modeling by directly outputting the state estimate. Then, we utilize an actor-critic algorithm to learn the parameterized policy for DAOF. Experimental results on a 2-degree-of-freedom

(2-DOF) vehicle system, equipped with explicit system models, demonstrate the superior accuracy and computational efficiency of DAOF-v1 compared to existing nonlinear filters. Moreover, DAOF-v2 showcases its unique ability to perform filtering without requiring explicit system modeling, as validated by a 14-DOF vehicle system.

09:00-09:15, Paper ThAT4.3

mathscr{l}-Step-Ahead Active Learning-Based Dual Control for Exploration and Exploitation in Auto-Optimization

Yu, Yalei	Loughborough University
Jiang, Jingjing	Loughborough University
Chen, Wen-Hua	Loughborough University
Li, Zhongguo	University of Manchester
Lohse, Niels	University of Birmingham

Keywords: Learning-based Control, Linear Systems, Estimation and Identification

Abstract: In this paper, a mathscr{l}-step-ahead active learning-based dual control for exploration and exploitation (LAL-DCEE) is proposed to address the challenges of auto-optimization amidst unknown references and environments. The algorithm of LAL-DCEE features a dual-loop structure, employing future gradients by looking ahead mathscr{l}-step to guide the next control command. This approach comprises an inner loop for fast gradient updates and an outer loop for slow gradient updates. Specifically, gradients for future mathscr{l}-step are iteratively refined within the inner loop using ensemble-based active learning, enabling rapid calculation of cost function gradients (emph{i.e.} estimated reference trajectory). These refined gradients then inform the outer loop, where a dual controller tailored for a system characterized by a general linear form steers the controlled system. The stability analysis of LAL-DCEE has been rigorously established. Additionally, numerical examples are employed to illustrate the effectiveness of the proposed method.

09:15-09:30, Paper ThAT4.4

Sampled-Data Fractional Sliding Mode Observer Design for Nonlinear Perturbed Fractional Reaction Diffusion Neural Networks with Delay

Chen, Juan	Changzhou University
Zhang, Chenlong	Changzhou University
Ge, Fudong	Tianjin University
Garone, Emanuele	Université Libre De Bruxelles

Keywords: Estimation and Identification, Nonlinear Systems and Control, Robust and H infinity Control

Abstract: This paper explores an extension of sampled-data sliding mode observer design for two cases of coupled nonlinear fractional reaction diffusion neural networks (FRDNNs) under time-varying delays and disturbances by sliding mode strategy. The first issue is with boundary input disturbances (BIDs). Another issue is with external distributed disturbances (EDDs).It is assumed that sensors provide spatial point measurements (SPMs), and a limited number of sensors are allocated in a spatial interval. Under SPMs, the design of sampled-data fractional sliding mode observer (SDFSMO) with robustness against BIDs or uncertain EDDs is explored, which guarantees the asymptotic stability of the error dynamics. Then, by using the fractional Lyapunov method, the sufficient conditions for desired performance are obtained. Conservatism is reduced via utilizing features of sliding mode algorithm and nonlinear generalized Lipschitz continuity. Fractional numerical examples are stated to test the theoretical result.

09:30-09:45, Paper ThAT4.5

FO-ORCA: An Optimization-Enhanced Interaction Model with Filtering for Pedestrian Trajectory Prediction in Dense Crowds

Zhang, Chao	Tongji University
Niu, Dunbiao	Tongji University
Lei, Jinlong	Tongji University
Yi, Peng	Tongji University

Keywords: Estimation and Identification, Man-machine Interactions, Robotics

Abstract: The coexistence of humans and robots in dynamic environments relies on the ability of intelligent agents to understand each other's behaviors and predict their movements. This paper proposes an optimization-enhanced interaction model for pedestrian trajectory prediction in crowded environments, which is crucial for robot navigation in densely populated settings. The model, based on Optimal Reciprocal Collision Avoidance (ORCA) , simulates interactions among pedestrians. It enables an agent to recognize the responsibility for making minor changes in both the velocity direction and magnitude when interacting with other agents, reflecting the characteristic of pedestrians seeking the most efficient path to their destination. Furthermore, we introduce an intention-driven online learning framework that incorporates probabilistic decision-making, model parameter learning, and noise variance adaptation. This framework continuously refines both the internal and external interaction states of the model, addressing the uncertainties in pedestrian path planning. The simulation results validate the optimality and energy efficiency of the generated paths. Experiments on real-world datasets demonstrate the generalizability of our approach to realistic environments, with improvement in trajectory prediction accuracy compared to existing models.

09:45-10:00, Paper ThAT4.6

Comparison of Optical Flow-Based Linear Angular Rate Estimation Methods Considering Real Flight Data

Jevuczo, Gabor	HUN-REN Institute for Computer Science and Control
Bauer, Peter	Institute for Computer Science and Control

Keywords: Estimation and Identification, Signal Processing, Robotics

Abstract: The angular velocities of an observer moving through an arbitrary scene can be obtained solely from mono camera image sequences, utilizing the optical flow. A major obstacle in this approach is that, the optical flow is non linearly related to the 3-D motion parameters. In this work three possible linear methods are presented to solve this nonlinear equation and then these methods are evaluated and compared using real mono camera images and real sensor measurements collected during two test flights.

ThBT1	GRANDE 1&2
Sensor/Data Fusion	Regular Session
Chair: Zhang, Youmin	Concordia University

10:30-10:45, Paper ThBT1.1

A Novel Distributed Fusion Algorithm for Maneuvering Target Tracking with Angle-Only Sensors

Zhang, Yuge	Northwestern Polytechnical University
Yang, Guangyu	Northwestern Polytechnical University
Zhu, Supeng	Northwestern Polytechnical University
Fu, Wenxing	Northwestern Polytechnical University

Keywords: Sensor/Data Fusion, Sensor Networks, Estimation and Identification

Abstract: A novel distributed fusion algorithm is proposed to address the challenge of maneuvering target tracking using angle-only sensors. Firstly, the square root cubature Kalman filter (SRCKF) is employed to estimate the target's position. Secondly, a distributed fusion architecture for multi-sensor systems is developed to form a distributed SRCKF (DSRCKF) method. Subsequently, a novel covariance intersection (NCI) algorithm is introduced, which formulates the fusion weight selection as a semidefinite programming problem. Additionally, the interacting multiple model (IMM) approach is integrated to achieve maneuvering target tracking, effectively mitigating filter divergence caused by mismatched target motion models. Finally, simulation experiments are performed to evaluate the tracking accuracy of the proposed IMM-DSRCKF-NCI algorithm, showcasing its superior performance and confirming its effectiveness.

10:45-11:00, Paper ThBT1.2

Dual-Modality Wildfire Detection with Visible and Infrared Images from UAVs

Dong, Huajun	Concordia University
Fu, Yufei	Concordia University
Zhang, Youmin	Concordia University
Qiao, Linhan	Concordia University
Dilfanian, Erfan	Concordia University
Wu, Xiaobo	Concordia University
Qin, Qiaomeng	Concordia University

Keywords: Sensor/Data Fusion, Fault Detection and Diagnostics, Signal Processing

Abstract: Wildfires pose significant risks to the environment and human safety. To address the limitations of single-modality detection, this paper proposes a dual-modality wildfire detection framework that integrates visible and infrared images captured by UAV-mounted cameras. Multimodal images are first registered and then processed through an enhanced YOLOv8-based object detection model with a dual-stream architecture. Experimental results demonstrate improved performance over single-modality baselines in terms of precision, recall, and mean Average Precision (mAP). The proposed method highlights the effectiveness of dual-modality method for accurate and robust wildfire detection.

11:00-11:15, Paper ThBT1.3

Cooperative Localization in Vehicular Networks Based on Multimodal Information Fusion

Wu, Liangkun	Southwest Minzu University
Qu, Xiaomei	Southwest Minzu University
Cao, Ting	Southwest Minzu University
HuaLin, Yao	Southwest Minzu University
Meng, Wei	NTU

Keywords: Sensor/Data Fusion

Abstract: Abstract—To enhance vehicle localization accuracy in vehicular networks, this paper proposes a cooperative localization method based on multimodal information fusion. A hierarchical fusion localization framework is established by deeply integrating LiDAR point cloud data, camera visual information, and Global Navigation Satellite System (GNSS) signals. The method employs a dual fusion mechanism: (1) at the sensor fusion level, the three-dimensional spatial information from LiDAR is combined with the two-dimensional visual features from cameras to achieve robust vehicle detection and precise inter-vehicle distance measurement, effectively overcoming the perceptual limitations of a single sensor in adverse weather conditions (such as LiDAR attenuation in rain or fog) and the depth estimation errors of cameras; (2) at the localization fusion level, the inter-vehicle distance information is integrated with GNSS data to enhance vehicle localization accuracy further The mathematical model based on the maximum likelihood strategy can be transformed into a quadratic non-convex programming problem, and an iterative optimization algorithm is utilized to solve an approximate quadratic programming problem with linear constraints at each iteration, thereby obtaining the global optimal solution for the original problem. Experimental results demonstrate that the multimodal fusion approach significantly improves localization accuracy compared with traditional single-modal methods.

11:15-11:30, Paper ThBT1.4

On Visual-Inertial SLAM Based on Deep Feature Extraction and Matching

Du, Xinran	Beihang Univercity
Zuo, Zongyu	Beihang Univercity
Zhu, Bing	Beihang Univercity

Keywords: Signal Processing, Sensor/Data Fusion, Estimation and Identification

Abstract: This paper investigates the enhancement of visual-inertial SLAM performance in challenging environments using deep learning technologies. A novel hybrid SLAM system is proposed, integrating deep feature extraction ALIKED and matching techniques LightGlue. Compared to traditional SLAM methods, we achieve high localization accuracy and improve robustness in low-texture and dynamic environments, leading to more stable trajectory estimation and mapping. Extensive experiments in various scenarios demonstrate the effectiveness, versatility, and superiority of the proposed method.

11:30-11:45, Paper ThBT1.5

Machine Learning-Based Modeling of Rainfall Impact on FMCW Radar Performance

Rahbar Ranji, Matina	University of Windsor
Salih, Media	University of Windsor
Lei, Zike	University of Windsor

Chen, Xiang	University of Windsor

Keywords: Sensor/Data Fusion, Sensor Networks
Abstract: This paper presents a machine learning-based modeling framework, designed to quantify the impact of rainfall on Frequency Modulated Continuous Wave (FMCW) radar performance by developing a criterion. the proposed framework encompasses several critical steps, including data collection, data processing, feature selection, performance estimation, and model fitting. Initially, the captured area of radar is divided into multiple units, with each unit sampled on a plane. Six point cloud features are defined to analyze the characteristics of the captured data within each unit. The measured performance is proposed based on the calculated features, which facilitates subsequent machine learning training. The collected data are split into training sets for developing a rainfall criterion and validation sets for testing its performance, with experiment results confirming the effectiveness and precision of the proposed modeling framework.

ThBT2	GRANDE 3
Energy Efficiency	Regular Session
Chair: Nourollahi Hokmabad, Hossein	Tallinn University of Technology

10:30-10:45, Paper ThBT2.1	

A Study on Comparison of Energy Management Strategies for a Series Hybrid Tracked Vehicle

Gocer, Ismail	FNSS Savunma Sistemleri A.S
Baslamisli, S. Caglar	Hacettepe üniversitesi

Keywords: Energy Efficiency, Control Applications, Optimal Control
Abstract: After the advancements in the automotive sector, energy management systems for hybrid powertrains are now also being widely investigated for tracked vehicles. This paper presents an overview of several strategies including Dynamic Programming (DP), Equivalent Consumption Minimization Strategy (ECMS), Thermostat Strategy and Model Predictive Control (MPC). These methods are applied to a fictitious tracked vehicle over a predefined driving cycle to demonstrate their main pros and cons; the results show that the offline DP algorithm provides globally optimal solutions, whereas the online ECMS algorithm achieves close results to those of DP. The rule-based Thermostat strategy offers a simple application method; however, it doesn't conduct any optimal control procedure like the others. MPC is quite successful in tracking a State of Charge (SoC) profile however, this approach requires calculation of a referen ce signal. In another application of the MPC, charge sustaining around a desired SoC can be successively achieved, once a proper cost function is applied.

10:45-11:00, Paper ThBT2.2	

Power Control of Switched Wireless Cellular Networks by Probability Transition Rates Optimization

Zhao, Chengyan	Ritsumeikan University
Ueno, Satoshi	Ritsumeikan University
Zhu, Bohao	The University of Hong Kong
Mei, Wenjie	Southeast University
Zhou, Yan	Shenyang Jianzhu University

Keywords: Linear Systems, Optimal Control, Energy Efficiency
Abstract: Wireless cellular networks require efficient distributed power control to ensure that all users achieve the desired signal-to-interference ratio while minimizing transmission power. Existing algorithms demonstrate exponentially fast convergence under fixed network conditions. In this work, we extend this framework to networks with randomly switching topologies. We consider two scenarios: one where network parameters follow a random process, allowing parameter optimization for faster convergence; and another where parameters are fixed, and convergence is optimized by adjusting the switching rate. To address the NP-hardness of general control optimization, we propose a novel framework based on difference-of-convex (DC) programming, which efficiently yields globally optimal power allocations under random switching. Simulation results show that the proposed method satisfies SIR requirements and significantly accelerates convergence in various dynamic network settings.

11:00-11:15, Paper ThBT2.3	

Customer Baseline Load (CBL) Estimation Method Based on Privacy Protection Scheme Using Blockchain

Liu, Renkai	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Ed
Li, Yaping	China Electric Power Research Institute CO., Ltd
Zhang, Kaifeng	Southeast University

Keywords: Energy Efficiency, Estimation and Identification
Abstract: In demand response (DR), customer baseline load plays an important role in determining economic compensation. Traditionally, it is believed that private data cannot be used when estimating baseline loads. This paper proposes a privacy protection scheme based on blockchain to make the use of private data possible. Based on this scheme, the baseline load can be estimated by combining customers private data and non-private data, in which the convolutional neural network (CNN) is employed to capture the relationships of these data and estimate baseline load. This method can be applied to accurately determine the authenticity of customers demand response and solve the problem of baseline load estimation for continuously participating in demand response. Finally, a comparison between our method and other estimation method demonstrates that our study can improve the rationality and reliability of baseline load estimation.

11:15-11:30, Paper ThBT2.4	

Co-Optimization of Motion and Energy Domain for Hydrogen-Powered Hybrid UAVs: A Bi-Directional Coupling Architecture

Song, Xiaowei	Beihang University
Guo, Xiaoyu	City University of Hong Kong
Liu, Guowei	Beihang University
Yang, Zihan	Beihang University
Liu, Lu	City University of Hong Kong

Keywords: Energy Efficiency, Robotics, Automated Guided Vehicles
Abstract: Hydrogen-powered hybrid unmanned aerial vehicles

(UAVs) are gaining increasing popularity in long-endurance aerial missions, owing to their superior energy density. Motion planning and energy management (power allocation) are two key algorithms supporting energy-efficient autonomous flight of hybrid UAVs. Most existing research concentrates on a sequential 'planning-then-management' architecture, in which motion and energy optimization are decoupled. In this paper, we propose a bidirectional coupling architecture to achieve co-optimization between motion domain and energy domain. In the motion domain, by incorporating real-time fuel cell efficiency from the energy domain, motion re-optimization is carried out to rescale the pre-generated polynomial trajectory into an energy-efficient motion trajectory, which is then followed by a Differential-Flatness-Based Controller (DFBC). In the energy domain, based on a motion-guided state-of-charge (SOC) reference, an adaptive equivalent consumption minimization strategy (A-ECMS) is carried out to offer optimized power allocation for the hydrogen-powered hybrid system. Finally, the proposed bi-directional coupling architecture is validated in a simulated case study on industrial plant inspection, demonstrating that the energy efficiency can be improved by over 13% as a result of the cross-domain co-optimization.

11:30-11:45, Paper ThBT2.5	

Forecast-Driven and Scenario-Based Building Energy Management Using a Stochastic Optimization Approach

Nourollahi Hokmabad, Hossein	Tallinn University of Technology
Tala, Hemmati Shahsavar	University of Tabriz
Vergara Barrios, Pedro	Delft University of Technology
Husev, Oleksandr	Gdansk University of Technology
Belikov, Juri	Tallinn University of Technology

Keywords: Energy Efficiency, Smart Buildings, Optimal Control
Abstract: Buildings are essential components of power grids, and their energy performance directly affects overall power system operation. This paper presents a novel stochastic optimization framework for building energy management systems, aiming to enhance buildings' energy performance and facilitate their effective integration into emerging intelligent power grids. In this method, solar power generation and building electricity demand forecasts are combined with historical data, leveraging statistical characteristics to generate probability matrices and corresponding scenarios with associated probabilities. These scenarios are then used to solve the stochastic optimization problem, optimizing building energy flow while accounting for existing uncertainties. The results demonstrate that the proposed methodology effectively manages inherent uncertainties while maintaining performance and outperforming rule-based and custom-built reinforcement learning-based solutions.

ThBT3	BOLERO 1
Multi-Agent Systems III	Regular Session
Chair: Walczak, Ryan	The Naval Postgraduate School

10:30-10:45, Paper ThBT3.1	

Fixed-Relative-Switched Threshold Strategies for Consensus Tracking Control of Nonlinear Multiagent Systems

Wang, Ziming	The Hong Kong University of Science and Technology (Guangzhou)
Gao, Yun	The Hong Kong University of Science and Technology (Guangzhou)
Rikos, Apostolos I.	The Hong Kong University of Science and Technology (Gz)
Pang, Ning	Shanghai Jiao Tong University
Ji, Yiding	Hong Kong University of Science and Technology (Guangzhou)

Keywords: Multi-agent Systems, Nonlinear Systems and Control, Adaptive Control
Abstract: This paper investigates event-triggered consensus tracking in nonlinear semi-strict-feedback multi-agent systems involving one leader and multiple followers. We first employ radial basis function neural networks and backstepping techniques to approximate the unknown nonlinear dynamics, facilitating the design of dual observers to measure the unknown states and disturbances. Then three adaptive event-triggered control schemes are proposed: fixed-threshold, relative-threshold, and switched-threshold configurations, each featuring specialized controller architectures and triggering mechanisms. Through Lyapunov stability analysis, we establish that the follower agents can asymptotically track the reference trajectory of the leader, meanwhile all error signals remain uniform bounded. Our proposed control strategies effectively prevent Zeno behaviors through stringent exclusion criteria. Finally, an illustrative example is presented, demonstrating the competitive performance of our control framework in achieving consensus tracking and optimizing triggering efficiency.

10:45-11:00, Paper ThBT3.2	

Enhancing Autonomous Multi-Agent Coordination for Unmanned Ground Vehicle Operations in Denied Urban Environments Using Proximal Policy Optimization

Moore, Hyatt	U.S. Naval Postgraduate School
Yakimenko, Oleg A.	Naval Postgraduate School

Keywords: Multi-agent Systems, Intelligent and AI Based Control, Learning-based Control
Abstract: This paper explores the use of multi-agent reinforcement learning (MARL), specifically Proximal Policy Optimization (PPO), to improve the coordination and exploration efficiency of autonomous unmanned ground vehicles (UGVs) operating in contested urban environments. Motivated by the challenges of modern urban conflicts—highlighted by recent experiences such as the ongoing conflict in Ukraine—this study seeks to enhance autonomous decision-making and adaptability where communication networks may be compromised or unreliable, and hostile agents may be present. Building upon previous work comparing heuristic and RL-based exploration methods, this manuscript details the iterative refinement of PPO through reward shaping, revisit decay penalties, and training parameter adjustments. Results demonstrate that PPO significantly improves exploration coverage, stability, and efficiency, though some challenges in policy generalization and convergence stability remain. The study concludes by identifying future research directions, including real-world hardware integration and enhanced scalability methods for multi-agent deployments. Although adversarial entities and communication constraints are not explicitly modeled in the current simulations,

the reinforcement learning framework developed here is extensible to contested and denied operational environments.

11:00-11:15, Paper ThBT3.3

DISCO: Diffusion-Based Inter-Agent Swarm Collision-Free Optimization for UAVs

Bitla, Bhanu Teja	International Institute of Information Technology Hyderabad
Idoko, Simon	University of Tartu
Thokala, Shilpitha Chowdary	Amrita Vishwa Vidyapeetham, Coimbatore
Singh, Arun	University of Tartu
Krishna, Madhava	IIIT-Hyderabad

Keywords: Multi-agent Systems, Robotics, Learning-based Control
Abstract: We present a diffusion-based generative model for coordinated trajectory planning in multi-UAV swarms. The proposed method represents each UAV's trajectory in a Bernstein polynomial coefficient space and employs a de-noising diffusion process with self-attention layers to generate diverse, feasible motion plans. A safety filter is integrated into the generation pipeline to refine candidate trajectories, enforcing inter-drone collision avoidance and other feasibility constraints. The model is trained offline on a large set of expert demonstration trajectories, eliminating the need for reinforcement learning and manual reward function design. In experiments with a 16-UAV swarm using a dataset of collision-free trajectories, the approach achieved a high success rate in producing safe and smooth flight paths. These results demonstrate that the learned planner can rapidly generate a diverse set of smooth, collision-free trajectories for the swarm.

11:15-11:30, Paper ThBT3.4

A Neural Network Model Based on Differential Evolution Algorithm for Traveling Salesman Problem

Yu, Rui	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology

Keywords: Fuzzy and Neural Systems, Learning Systems, Multi-agent Systems
Abstract: This paper presents a novel neural network-based optimization framework, NNDE, to solve the traveling salesman problem (TSP). The core idea is to use a radial basis function network (RBFN) to evaluate each edge by its three features, thereby guiding a modified nearest neighbor algorithm (MNNA) in constructing satisfactory solutions. Then, the differential evolution (DE) algorithm is employed to iteratively optimize the network parameters to enhance the performance of RBFN. Finally, the proposed NNDE is evaluated on several benchmark instances of TSP. The experimental results demonstrate its performance and feasibility.

11:30-11:45, Paper ThBT3.5

A Dynamic Inversion Approach to Time-Varying Optimization

Keshani, Ali	Queen's University
Guay, Martin	Queen's University

Keywords: Nonlinear Systems and Control, Real-time Systems, Multi-agent Systems
Abstract: In this paper, we solve a class of time-varying optimization problems. A dynamic inversion approach is used to provide a continuous-time optimization algorithm. The dynamic inversion yield a Newton-based time varying continuous-time dynamics that guarantees asymptotic convergence of the algorithm to the optimal time-varying solution. The Newton-based implementation of the algorithm avoids the explicitly computation of the inverse of the time-varying Hessian matrix which significantly reduces the computational complexity while preserving the accuracy of the optimization process. The study provides a detailed stability analysis of the approach. An application of the dynamic inversion approach to time-varying distributed optimization problems is considered. A simulation study is conducted to assess the performance of the proposed technique.

ThBT4	BOLERO 2
Estimation and Identification II	Regular Session
Chair: Faedo, Nicolas	Politecnico Di Torino

10:30-10:45, Paper ThBT4.1

Cognitive Hierarchy Game-Based Method for Multi-Agent Lane Change Intention Recognition

Xiao, Suyang	Tongji University
Deng, Di	Tongji University
Lei, Jinlong	Tongji University
Yi, Peng	Tongji University

Keywords: Estimation and Identification, Learning Systems, Multi-agent Systems
Abstract: In intelligent driving systems, the accurate prediction for lane-changing intentions of traffic participants is crucial for enhancing driving safety and traffic efficiency, especially in complex traffic environments. In this paper, we propose a novel cognitive hierarchy game-based lane-changing intention recognition (CHG-LCIR) method to dynamically predict the vehicle intentions, which innovatively integrates game theory with probabilistic inference. A hierarchical game model is first developed to describe the dynamic coupling interactions among vehicles. Then, the probabilistic inference approach is incorporated to estimate potential cognitive states, significantly improving the adaptability of the model to dynamic scenarios. Experimental validation based on the NGSIM dataset demonstrates that the proposed CHG-LCIR effectively achieves a good balance between model interpretability and intention performance.

10:45-11:00, Paper ThBT4.2

Parametric Interpolants for Frequency-Domain Models of Marine Structures in the Loewner Framework

Faedo, Nicolas	Politecnico Di Torino
Paduano, Bruno	Politecnico Di Torino

Keywords: Estimation and Identification, Linear Systems, Control Applications
Abstract: Traditionally, the dynamic analysis of marine structures is based on linear potential flow theory assumptions, in which a

frequency-domain-based characterisation is seemingly computed using hydrodynamic codes. To circumvent the non-parametric nature of such models, this paper proposes the construction of parametric interpolants for marine structures, based on the Loewner framework. The Loewner approach to interpolation utilises pure frequency-based responses only, producing interpolants (dynamical models) in terms of descriptor systems employing simple projections, avoiding altogether the use of optimisation routines. Furthermore, since Loewner interpolants are, in general, not guaranteed to be input-output stable, we employ an algorithm to achieve optimal stability enforcement in mathcal{RH}_{infty}, by solving an associated Nehari problem. The overall performance of the proposed interpolants is assessed in detail, considering a numerical case study featuring a benchmark offshore structure.

11:00-11:15, Paper ThBT4.3	

A Hierarchical Adaptive Observer Approach for Synchronization in Heterogeneous Multi-Agent Systems

Abdl Ghani, Hasan	IRSEEM
Thabet, Rihab El Houda	NORMANDY UNIVERSITY Univ, UNIROUEN
Khemmar, Redouane	ESIGELEC
Ahmed Ali, Sofiane	University of Evry, IBISC Lab

Keywords: Multi-agent Systems, Estimation and Identification
Abstract: This paper presents a novel observer-based synchronization framework designed for heterogeneous multi-agent systems operating under realistic conditions, such as discrete and noisy measurements, intermittent communication, and agent heterogeneity. The framework incorporates a hierarchical structure: a Filtered High-Gain Observer to reconstruct the leader's state in the presence of noisy and discrete measurements, a Distributed Observer which enables each follower to independently estimate the state of the leader for synchronization purposes, and a Adaptive Local Observer for each follower that simultaneously estimates its own states and unknown parameters. The local observer incorporates a closed-loop output predictor to address challenges arising from discrete measurements and ensure continuous estimation. Stability and robustness are shown using a Lyapunov-based approach, and simulation results validate the effectiveness of the proposed method to maintain precise coordination between vehicles. This approach improves performance, making it suitable for real time vehicle platooning applications.

11:15-11:30, Paper ThBT4.4	

Data-Based Estimation of Excitation Force in Wave Energy Converters

Saavedra, Marcos David	Instituto LEICI (UNLP-CONICET), Facultad De Ingeniería, Universi
Faedo, Nicolas	Politecnico Di Torino
Inthamoussou, Fernando Ariel	Universidad Nacional De La Plata, Instituto LEICI (CONICET-UNLP)
Mosquera, Facundo D.	Universidad Nacional De La Plata
Garelli, Fabricio	National University of La Plata

Keywords: Estimation and Identification, Learning Systems
Abstract: Wave energy conversion technology inherently requires tailored control system technology to improve energy capture performance, leading to a reduced cost of energy and allowing commercialisation in the short term. It is well-known that optimal energy absorption requires instantaneous knowledge of the resource, i.e. the so-called wave excitation force. To date, most of the techniques available for estimating the wave excitation are model-based, often requiring a precise system and resource description, which is significantly difficult to achieve due to the inherent uncertainty introduced by standard practices in hydrodynamic modelling. Motivated by this issue, this paper presents a data-based approach to wave excitation force estimation for wave energy converters. Based on experimental data obtained from a comprehensive wave tank campaign designed to simulate diverse maritime conditions, this paper evaluates the performance of various neural network architectures, including static models and those incorporating temporal considerations. The analysis focuses on two input groups: kinematic variables alone and kinematic variables augmented with surrounding wave height measurements. The findings reveal that architectures incorporating temporal considerations and supplementary input features achieve superior performance, particularly in wide-banded sea states. These results highlight the capability of data-based models to achieve accurate estimation performance, reducing the need for precise analytical modelling while leveraging the ability of neural networks to extract information from auxiliary input signals.

11:30-11:45, Paper ThBT4.5	

Data-Driven Unknown-Input Observers for Continuous-Time Linear Time-Invariant Systems

Wei, Yuzhou	Beijing Institute of Technology
Liu, Wenjie	Beijing Institute of Technology, Beijing, China
Wang, Lingi	Beijing Institute of Technology
Wang, Gang	Beijing Institute of Technology
Sun, Jian	Beijing Institute of Technology
Cai, Tao	Beijing Institute of Technology

Keywords: Estimation and Identification, Linear Systems
Abstract: State estimation in the presence of unknown inputs is a fundamental challenge in control and monitoring applications. While classical unknown-input observers (UIOs) rely on explicit system models, their applicability is often limited due to system complexity and modeling uncertainties. Recent advances in data-driven approaches have enabled state estimation using only pre-collected input-output data, bypassing the need for explicit system identification. However, existing data-driven UIO designs have been predominantly developed for discrete-time systems, leaving a critical gap in continuous-time formulations. This paper addresses this gap by introducing a novel data-driven unknown-input observer (D-UIO) for continuous-time linear time-invariant (LTI) systems. The proposed method constructs the observer directly from offline input-output-state data, without requiring knowledge of system matrices. By leveraging historical data, we derive necessary and sufficient conditions for the existence of a continuous-time D-UIO and establish theoretical guarantees on its stability and convergence. Specifically, we prove that under mild assumptions, the state estimation error asymptotically converges to zero. Furthermore, we demonstrate the equivalence between the conditions derived in the data-driven framework and those obtained using the classical model-based approach. Numerical simulations validate the effectiveness of the proposed method, showing that it achieves performance comparable to model-based UIOs while requiring no prior knowledge of system dynamics.

11:45-12:00, Paper ThBT4.6	
Analysis and Design of LTI Full-State Observers: A New Approach to an Old Problem	
Papageorgiou, Panos	University of Patras
Alexandridis, Antonio	University of Patras

Keywords: Estimation and Identification, Linear Systems, Control of Distributed Generation Systems

Abstract: Eigenvalue-assignment methods for observer designs of linear time invariant (LTI) systems are crucial for both the decaying and the performance characteristics of the observer response. Contrary to the conventional, cumbersome techniques, mainly concentrating on placing individually the observer poles sufficiently far to the left of the plant ones, a novel approach is established that: i) assigns all real parts of the observer eigenvalues at any arbitrary, common for all, predetermined position, ii) provides the region limits and the managing capabilities of modulating the corresponding imaginary parts, iii) results in a very simple procedure by solving a Lyapunov-type equation, for which it is guaranteed that a solution always exists. As is shown by conducting a complete theoretical analysis, the implementation of the proposed method is simple and straightforward, obtaining a stable observer-gain matrix. The latter makes it ideal for designing full-state estimators for LTI systems especially of large or very large dimensions, such the ones met in power applications, etc. This is further demonstrated by applying the technique to a 10th-order linearized model of a thyristor-controlled series capacitor (TCSC)-power unit. The proposed approach is thus highlighted and evaluated through the system responses.

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Zhao, Wanbing	WeBT1.2
Zhao, Yibo	WeAT1.6
	WeCT1.2
Zhao, Yinxiang	ThAT3.1
Zhao, Zeming	WeCT3.5
Zhao, Zuoquan	WeBT2.6
Zheng, Canlun	WeCT2.6
Zheng, Zhiyuan	WeBT1.2
Zhong, Zhe	WeAT3.2
Zhou, Guanzhong	WeAT1.2
Zhou, Jialing	ThAT3.1
Zhou, Mengqi	TuBT2.1
Zhou, Mingkang	WeCT2.5
Zhou, Tongle	ThAT3.2
Zhou, Xuan	TuBT1.1
Zhou, Yan	ThBT2.2
Zhu, Bing	ThBT1.5
Zhu, Bohao	ThBT2.2
Zhu, Chenrui	WeAT4.4
Zhu, Haojie	ThAT3.2
Zhu, Huaishi	WeBT3.2
Zhu, Junfan	TuAT2.4
Zhu, Mingyan	WeBT3.2
Zhu, Shanying	WeAT4
	WeBT4
Zhu, Supeng	ThBT1.1
Zhu, Xiaoyuan	WeCT1.3
	WeCT1.5
Zhu, Yang	WeBT1.2
	WeBT1.4
Zhu, Yiming	WeAT3.2
Zug, Sebastian	WeAT3.3
Zuo, Zongyu	ThBT1.5
Zuoquan, Zhao	ThAT2.5

Local Information

Conference Venue

The 19th IEEE International Conference on Control and Automation (IEEE ICCA 2025) will be held on June 30–July 3, 2025, Original Sokos Hotel Viru, Tallinn, Estonia.
Address: Viru väljak 4, 10111 Tallinn, Estonia
Tel: +372 680 9300
URL: https://www.sokoshotels.fi/en/hotels/tallinn/original-sokos-hotel-viru

Currency

The local currency in is the euro (EUR). Credit and debit cards are widely accepted throughout Estonia, including in taxis, restaurants, and shops. While cash is accepted, contactless and mobile payments are commonly used, and ATMs are readily available. There is usually no need to exchange large amounts of cash in advance.

Emergency Call

Emergency Number: **112**. You can dial 112 from anywhere in Estonia or across Europe to reach emergency services. In Tallinn, this number connects you to the police, ambulance, or fire department. Operators can assist you in Estonian and often in English or Russian as well.

Airport Transfer – Car Rental

The distance from **Tallinn Airport (Lennart Meri Tallinn Airport)** to the city center is approximately **4 km**, or about a **10-minute drive**. Public transport options such as buses and trams are available and run frequently. Taxi services and ride-hailing apps (like Bolt) are also widely used and reasonably priced. For further information: https:// transport.tallinn.ee/

Language

The official language of Estonia is Estonian, a Finno-Ugric language that is closely related to Finnish but quite different from most other European languages. Its vocabulary and pronunciation can be unfamiliar and challenging for visitors. However, English is widely spoken, especially in Tallinn, particularly in tourist areas, hotels, and restaurants.

Electricity

Estonia uses Northern European electrical standards: 230 volts at 50 Hz. The standard plug type is the Europlug with two round prongs (Type C and F sockets). Travelers from countries using different voltage or plug types may need a power adapter or voltage converter for their electronic devices.

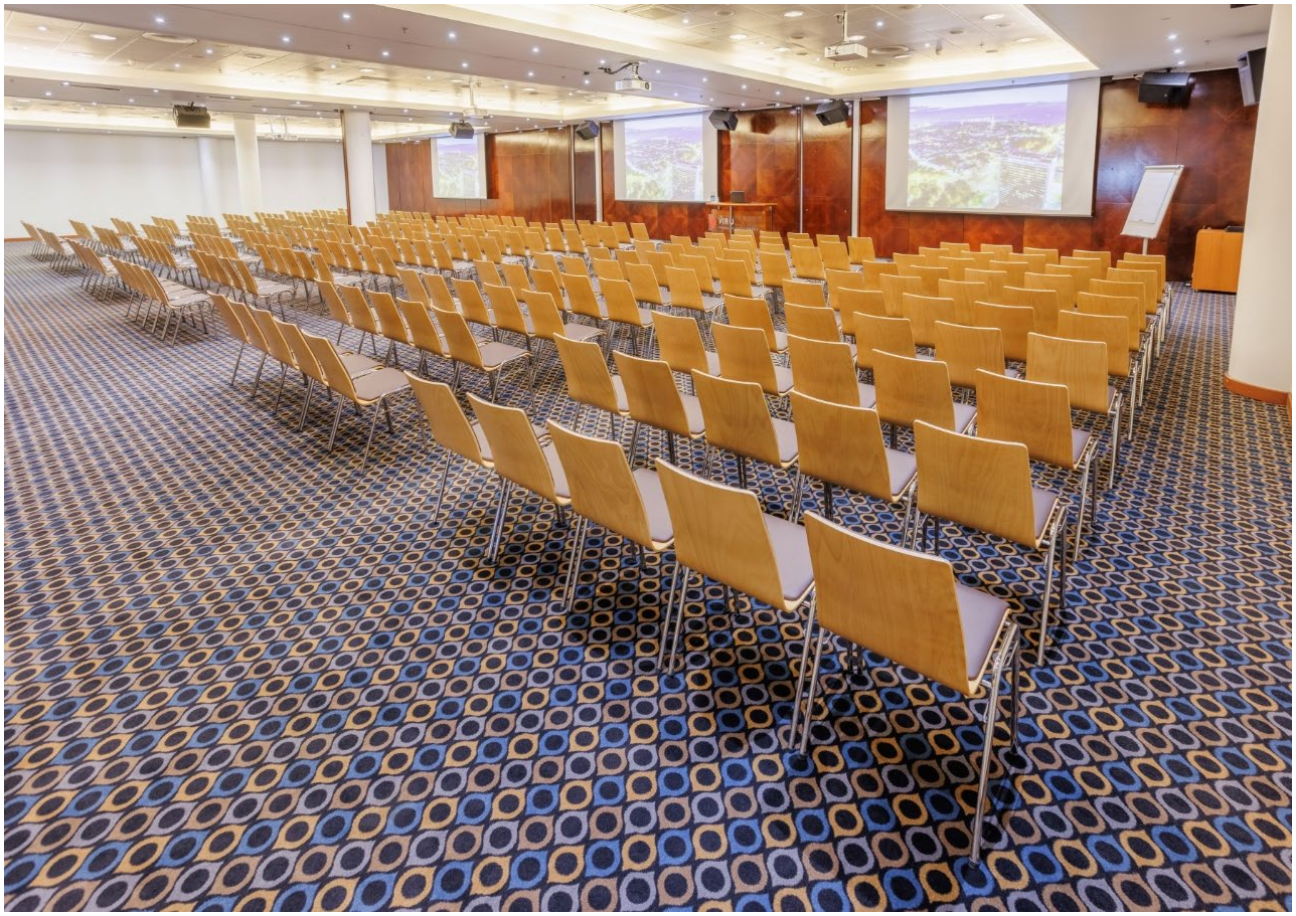
Time

Estonia operates on Eastern European Time (EET), UTC+02:00, and observes Daylight Saving Time. During the summer months, the country switches to Eastern European Summer Time (EEST), UTC+03:00.

Weather

Tallinn has a temperate climate with warm summers and cold, snowy winters. Summer temperatures typically range from 15°C to 25°C, while winters can drop well below freezing. The weather can be unpredictable, especially in spring and autumn, so visitors should come prepared for sudden changes. For up-to-date forecasts, visit the Estonian Weather Service: https://www.ilmateenistus.ee/?lang=en.

Conference Venue Floorplan and Maps



Main Conference Hall: Grande Theatre

Floorplan of the Main Conference Hall, Breakout Session Areas and Additional Facilities

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