

FINAL PROGRAM & BOOK OF ABSTRACTS



20TH IEEE INTERNATIONAL CONFERENCE ON CONTROL AND AUTOMATION (IEEE ICCA 2026)

Almaty, Kazakhstan
June 16-20, 2026



Organizers

IEEE Singapore Control Systems Chapter
Hong Kong Centre for Logistics Robotics
IEEE Kazakhstan Section



Technical Sponsors

IEEE Control Systems Society
Technical Committee on Control Theory (TCCT), Chinese Association of
Automation
IEEE Hong Kong Joint Chapter of RAS and CSS
Nazarbayev University, Kazakhstan
Institute of Smart Systems and Artificial Intelligence (ISSAI), Kazakhstan
Satbayev University, Kazakhstan



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–July 3, 2025, Tallinn, Estonia
- ❖ 20th IEEE International Conference on Control and Automation (IEEE ICCA 2026)
June 16–20, 2026, Almaty, Kazakhstan

COPYRIGHT INFORMATION

Copyright and Reprint Permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For reprint or republication permission, email to IEEE Copyrights Manager at pubs-permissions@ieee.org. All rights reserved. Copyright © 2026 by IEEE

IEEE Catalog Numbers:

Xplore Compliant Part Number: CFP26537-ART

ISBN: 979-8-3315-4853-7

Online ISSN: 1948-3457

Author Responsibilities

The IEEE distributes its technical publications throughout the world and wants to ensure that the material submitted to its publications is properly available to the readership of those publications. Authors must ensure that their Work meets the requirements as stated in section 8.2.1 of the IEEE PSPB Operations Manual, including provisions covering originality, authorship, author responsibilities and author misconduct. More information on IEEE's publishing policies may be found at

http://www.ieee.org/publications_standards/publications/rights/pub_tools_policies.html

Authors are advised especially of IEEE PSPB Operations Manual section 8.2.1.B12: "It is the responsibility of the authors, not the IEEE, to determine whether disclosure of their material requires the prior consent of other parties and, if so, to obtain it." Authors are also advised of IEEE PSPB Operations Manual section 8.1.1B: "Statements and opinions given in work published by the IEEE are the expression of the authors."

Author/Employer Rights

If you are employed and prepared the Work on a subject within the scope of your employment, the copyright in the Work belongs to your employer as a work-for-hire. In that case, the IEEE assumes that when you sign this Form, you are authorized to do so by your employer and that your employer has consented to the transfer of copyright, to the representation and warranty of publication rights, and to all other terms and conditions of this Form. If such authorization and consent have not been given to you, an authorized representative of your employer should sign this Form as the Author.

Contact Information

For technical inquiries about the content of these proceedings, please contact: PaperCept, Inc. contact@papercept.net

TABLE OF CONTENTS

Welcome Message	1
Organizing Committee	3
Conference Editorial Board and Reviewers	4
General Conference Information	10
Program at a Glance	12
Plenary Talk Addresses	17
Plenary Panel Session	20
Best Paper Award Finalists	23
Best Student Paper Award Finalists	24
Technical Program	25
Book of Abstracts	61
Keyword Index	143
Author Index	145
Local Information	159
Conference Venue Floorplan and Maps	161

Welcome Message

On behalf of the conference organizing committee, it is with great pleasure that we present the Final Program and Proceedings of the 20th IEEE International Conference on Control and Automation (IEEE ICCA 2026). Set against the captivating backdrop of Almaty, Kazakhstan, from June 16 to June 20, 2026, the conference is jointly organized by the IEEE Control Systems Society Singapore Chapter, IEEE Kazakhstan Section and Hong Kong Centre for Logistics Robotics (HKCLR), technically co-sponsored by IEEE Control Systems Society (CSS); the Technical Committee on Control Theory (TCCT), Chinese Association of Automation; IEEE Hong Kong Joint Chapter of RAS and CSS; Nazarbayev University, Kazakhstan; Institute of Smart Systems and Artificial Intelligence (ISSAI), Kazakhstan and Satbayev University, Kazakhstan. 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.

Almaty is the largest city in Kazakhstan, with a population exceeding two million residents. Situated in the foothills of the Trans-Ili Alatau mountains near the Kyrgyz border, Almaty serves not only as Kazakhstan's cultural and financial center, but also as an emerging hub for education and innovation. Set at an elevation of 700 to 900 meters, Almaty enjoys a scenic location surrounded by mountains and is traversed by the Big Almaty and Small Almaty rivers. Its natural beauty and mild climate make it one of the most attractive cities in Central Asia.

This year's conference boasts an enriching program featuring 58 sessions, including 3 plenary talks, and one 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 2026 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 497 submissions from academic researchers and engineers spanning 20 countries and regions worldwide. Following a rigorous review process by our esteemed program committee and reviewers, we are proud to include 352 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 2026. 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 Almaty!



Yunhui Liu, Yang Shi
General Chairs
IEEE ICCA 2026



Hao Fang, Xinyu Wu, Yamin Yan
Program Chairs
IEEE ICCA 2026

Organizing Committee

General Chairs

Yunhui Liu, Hong Kong, China Yang Shi, Canada

Program Chairs

Hao Fang, China Xinyu Wu, China Yamin Yan, Singapore

Organizing Chairs

Yili Fu, China Yanlong Zhao, China Ton Duc Do, Kazakhstan
Ziwei Wang, Singapore Matteo Rubagotti, Kazakhstan

Track Chairs

Haoyao Chen, China Weiwei Wan, Japan Haibin Duan, China

International Advisory Committee

Atakan Varol, Kazakhstan Pedro Albertos, Spain Jie Chen, China
Jie Huang, Hong Kong, China Karl H. Johansson, Sweden Daizhan Cheng, China
Clarence de Silva, Canada Jing Sun, USA J.V.R. Prasad, USA
Kimon P. Valavanis, USA Jifeng Zhang, China

Award Committee Chairs

Zongli Lin, USA Lihua Xie, Singapore

Panel Session Chairs

Ben M. Chen, Hong Kong, China. Oleg Yakimenko, USA

Invited Session Chairs

Jinwen Hu, China Wei Meng, China Jinqiang Cui, China
Qianwen Xu, Sweden Xiuxian Li, China Xunyuan Yin, Singapore
Zhi Gao, China Kenji Tahara, Japan Dikai Liu, Australia
Xiang Yin, China Haoang Li, China Maobin Lu, China

Regional Chairs

Yantao Shen, USA Wei Ren, USA Wenhua Chen, UK
Xiaoming Hu, Sweden Joerg Raisch, Germany Tongwen Chen, Canada
Youmin Zhang, Canada Cheng Xiang, Singapore Tao Yang, China
Aiguo Ming, Japan Siyuan Liu, Netherlands Kai Cai, Japan
Zhengtao Ding, UK

Publicity Chairs

Zhiqiang Miao, China Hai Lin, USA Bo Lu, China
Zhongkui Wang, Japan Yibei Li, China Chao Shen, Canada

Publication Chairs

Feng Lin, Singapore Xi Chen, Hong Kong, China

Finance Chairs

Rong Su, Singapore Lin Zhao, Singapore

Registration Chairs

Darwin Lau, Hong Kong, China Lu Liu, Hong Kong, China Elizabeth Ko, Hong Kong, China

Local Arrangement Chairs

Yerbol Absalyamov, Kazakhstan Almas Shitemirov, Kazakhstan Qingkai Yang, China

Social Activities Chairs

Fei Chen, Hong Kong, China. Yi Dong, China

Conference Editorial Board and Reviewers

Chairs

Hao Fang, China

Xinyu Wu, China

Yamin Yan, Singapore

Associate Editor

He Cai

Mingxue Cai

Weihua Cao

Wujing Cao

Fei Chen

Luefeng Chen

Wei Chen

Xiaojie Chen

Haoshu Cheng

Lan Cheng

Songsong Cheng

Jinqiang Cui

Yulong Ding

Mingjie Dong

Xiwang Dong

Yi Dong

Haibin Duan

Hao Fang

Xu Fang

Xue Feng

Yang Guidong

Meng Guo

Zixuan Guo

Jie Hou

Jinwen Hu

Wenfeng Hu

Xuhui Hu

Hailong Huang

Jie Huang

Ran Jiao

Cheng Jun

Weiyao Lan

Jinlong Lei

Yuquan Leng

Aming Li

Changsheng Li

Dachuan Li

Huiping Li

Jiahong Li

Xiuxian Li

Zhongkui Li

Feng Lin

Lu Liu

Shuai Liu

Tao Liu

Maobin Lu

Yue Ma

Zhiqiang Miao

Fuzhou Niu

Zhihong Peng

Zhaowu Ping

Yiwen Qi

Quan Quan

Qinyuan Ren

Jinjun Shan

Yixuan Sheng

Yangxi Shi

Qi Su

Youfeng Su

Zhiyong Sun

Yutao Tang

Bailing Tian

Biao Wang

Chen Wang

Dong Wang

Gang Wang

Jianan Wang

Lin Wang

Xiangyu Wang

Xinghu Wang

Yan-Wu Wang

Xuyang Wu

Yan Wu

Lele Xi

Zhengrong Xiang

Feng Xiao

Bin Xin

Dabo Xu

Jinming Xu

Juanjuan Xu

Sheng Xu

Lidong Yang

Qingkai Yang

Xingchen Yang

Jingwen Yi

Xiang Yin

Chengpu Yu

Wenwu Yu

Xianlin Zeng

Jihan Zhang

Ya Zhang

Yanjun Zhang

Dong Zhao

Lei Zhou

Bing Zhu

Zhiqiang Zuo

Zongyu Zuo

Reviewers

Almat Abdimalik

Sarvat Ahmad

Olzhas Akylbekov

Zaki Al-Farabi

Arystan Amangeldi

Junaid Anwar

Hamed Badihi

Jianjun Bai

Weiwei Bai

Guangliang Li

Guilu Li

Heng Li

Huiping Li

Jiahong Li

Jiatong Li

Jinna Li

Juyi Li

Le Li

Weize Wang

Wenjing Wang

Xiang Wang

Xiangyang Wang

Xiangyu Wang

Xianyi Wang

Xiaodong Wang

Xiaoxiao Wang

Xiaoyu Wang

Yuqi Bai	Lihua Li	Xinghu Wang
Zhang Baichuan	Ma Li	Xinyi Wang
Yuhao Bao	Ming Li	Xufei Wang
Mohammad Hossein Basiri	Muran Li	Yan-Wu Wang
Peter Bauer	Ruocheng Li	Yifan Wang
Dinora Berdikulova	Ruonan Li	Yuxiang Wang
Changyu Bi	Shanghao Li	Yuyang Wang
Yingcai Bi	Tianyang Li	Zehao Wang
Lingchao Bu	Tieshan Li	Zeyu Wang
He Cai	Wei Li	Zhishen Wang
Mingxue Cai	Wenling Li	Zhiyong Wang
Zai Cai	Xiang Li	Aniket Wattamwar
Fangfei Cao	Xiangxin Li	Haoran Wei
Haosen Cao	Xiaojie Li	Shaozhun Wei
Muqing Cao	Xingchen Li	Yue Wei
Weihua Cao	Xinyi li	Yuzhou Wei
Wujing Cao	Xiuxian Li	Junjie Wen
Yichao Cao	Yifei Li	Peijun Weng
Huixuan Chan	Yuanlong Li	Delong Wu
Shaoping Chang	Yuyan Li	Haiwen Wu
Yingxiu Chang	Zhaoyang Li	Jieshuai Wu
Subhajit Chatterjee	Zheng Li	Jinfeng Wu
Chen Chen	Zhongkui Li	Shaobo Wu
Chen Chen	Zhuo Li	Shizhen Wu
Chuheng Chen	Zichuang Li	Tao WU
Delong Chen	Dong Liang	Xiaobo Wu
Fei Chen	Ji Liang	Xipeng Wu
Guoqing Chen	Jingguo Liang	Xuyang Wu
HAN CHEN	Mengyao Liang	Yan Wu
Haohui Chen	Wenyuan Liang	Yanhong Wu
Haoyu Chen	Xiao Liang	Yezhen Wu
Ji Chen	Xinye Liang	Yiming Wu
Jia-Xuan CHEN	Yong Liang	Zongzhou Wu
Jiawen Chen	Juan Liao	Lele Xi
Jin Chen	Junlong Liao	Chaoyu Xia
Jun Chen	Bingxin Lin	Zhiwei Xia
Kaiwen Chen	Feng Lin	Zicong Xia
Lin Chen	Liquan Lin	Duojie Xiang
Luefeng Chen	Xianwu Lin	Yuzhu Xiang
Mou Chen	Zhonghao Lin	Zhengrong Xiang
Ru Chen	Bing Liu	Feng Xiao
Rujia Chen	Bowen Liu	Shi Xiasheng
Wei Chen	Chongyang Liu	Fawen Xie
Wei Chen	Dongdong Liu	Junjiang Xie
Weinan Chen	Fengjiao Liu	SHUKE XIE
Xi Chen	Hanyu Liu	Wenhao Xie
Xi Chen	Jingmei Liu	Bin Xin
Xiaojie Chen	Jinxin Liu	Yu Xing
Yizhou Chen	Keli Liu	Gao Xingyu
Yizong Chen	Lian Liu	Jingfeng Xiong
Yuhan Chen	Lu Liu	Yongyang Xiong

Cheng Cheng
Haoshu Cheng
Lan Cheng
Songsong Cheng
Teddy M. Cheng
Yi Cheng
Haozhen Chi
Ronghu Chi
Hu Chongyuan
Hongjun Chu
Shuang Cong
Di Cui
Jiatong Cui
Jinqiang Cui
Shichang Cui
Jiahao Dai
Xisheng Dai
Yufan Dai
Daofu Gong Daofu Gong
Di Deng
Shirong Deng
Yang Deng
Yuxiang Deng
Zhenhua Deng
Saddam Hocine DERROUAOUI
Jian Di
Erfan Dilfanian
Shuxin Ding
Wendi Ding
Yulong Ding
Anqi Dong
Haoze Dong
HongXin Dong
Mingjie Dong
Wei Dong
Xiwang Dong
Yi Dong
Zhang Dongmei
Junpeng Du
Kaixin Du
Ruiqi Du
Xixiang Du
Yongzhe Du
Zhao Du
Haibin Duan
Jiaxin Fan
Kangsheng Fan
Liyuan Fan
Xinyu Fan
Yunfeng FAN
Hao Fang

Lupeng Liu
Peng Liu
Qianyuan Liu
Shuai Liu
Shuai Liu
Songyuan Liu
Tao Liu
Tengfei Liu
Tianyu LIU
Wei Liu
Wenjie Liu
Xianzhe Liu
Xiao-Kang Liu
Xingxun Liu
Xuchen Liu
Yanbin Liu
Yang Liu
Yifan Liu
Yongbai Liu
Yueyue Liu
Yuhan Liu
Zhao-Qing Liu
Zhaocong Liu
Zhengqiang Liu
Zhong Liu
Kaihong Lu
Maobin Lu
Rongxiang Lu
Tian Lu
Chong Ghee Lua
Delin Luo
Hongbing Luo
Zihang Luo
Xiaoyong Lv
Jiahao Lyu
Mingzhe Lyu
Sida Lyu
Xufeng Lyu
Aoyun Ma
Fei Ma
Jiahai Ma
Runze Ma
Weijie Ma
Yue Ma
Yue Ma
Zhenhuan Ma
Zhonghai Ma
Bolin Mai
Ningning Mao
Zehui Mao
Jun Mei

Bochen Xu
Chengzhi Xu
Dabo Xu
Jingchen Xu
Jinming Xu
Jiwen XU
Juanjuan Xu
Liang Xu
Liang Xu
Sheng Xu
Tao Xu
Tong Xu
Xiang Xu
Xinyang Xu
XinYing Xu
Yansong Xu
Yuan Xu
Yuchun Xu
Yuechao Xu
Zhenyu Xu
Zhiyong Xu
Xiaomin Xue
Xin Yan
Xinhao Yan
Xinyu Yan
Biao Yang
Guidong Yang
Hongjun Yang
Jiahui Yang
Junyi Yang
Lidong Yang
Qingkai Yang
Shaofu Yang
Shiming Yang
Wenjing Yang
Xingchen Yang
Xinhua Yang
Yajie Yang
Yanhua Yang
Yulong Yang
Ken'ichi Yano
Jinke Yao
Maojiao Ye
Huiyang Yi
Jingwen Yi
Peng Yi
Yingmin Yi
Meng Yin
Shihong Yin
Xiang Yin
Li Ying

Xu Fang
Yiyuan Fang
Jian Feiyang
Mingyang Feng
Xue Feng
Yunji Feng
Yuxuan Feng
Zhi Feng
Zhi Feng
Zhiguang Feng
Zhiqiang Feng
RACHEL MERVEILLE FOMEKONG
FOMEKONG
Rui Fu
Yifang Fu
Zhang Fuyong
Jinming Gao
Rong Gao
Wanxin Gao
Yan Gao
Zhifeng Gao
Hector Garcia de Marina
Fan Geng
Nan Gu
Xinyu Guan
Yang Guidong
Jiayu Guo
Linwei Guo
Meichen Guo
Meng Guo
Xianggui Guo
Zixuan Guo
Bingxin HAN
Mingqiao Han
Wenhao Han
Fusheng Hao
Hui He
Junlin He
Qiyong He
Yuman He
Yupeng He
Lin Hong
Jie Hou
Chong Hu
Hao Hu
Jinchao Hu
Jinwen Hu
Jinwen Hu
Junmiao Hu
Mian Hu
Wenfeng Hu

Deyuan Meng
Min Meng
Wei Meng
Zhiqiang Miao
Xiao Min
Hyatt Moore
Bingxian Mu
Huaiyi Mu
Jiayue Ni
Yuan-Hua Ni
FUZHOU NIU
Rui Pan
Bo Pang
Yipeng Pang
Zhi Pang
Wang Peijun
Cheng Peng
Zhihong Peng
Zhouhua Peng
Swee King Phang
Zhaowu Ping
Yiwen Qi
Yuzhe Qian
Ping Qiao
Pengjie Qin
Meng Qiu
Xiaomei Qu
Quan Quan
Ying Shuai Quan
Perizat Rakhmetova
Fengrui Ran
Linyan Ren
Qinyuan Ren
Shipeng Ren
Jie Ruan
Zou Rui
Dominik Peter Schwindling
Jinjun Shan
Jingheng SHAO
Qi Shao
Yixuan Sheng
Mingming Shi
Tianbiao Shi
Yangxi Shi
Yongxia Shi
Jinyang Song
Yue Song
Jiangcheng Su
Qi Su
Youfeng Su

Ruobing Ying
Kenan Yong
Chengpu Yu
Hao Yu
Shicong Yu
Tingting Yu
Wei Yu
Wenwu Yu
Xiao Yu
Xin Yu
Ming Yuan
SHENGHAI YUAN
Shenghai Yuan
Yating Yuan
Wang Yuxiang
Xianlin Zeng
Chao Zhai
Junyong Zhai
Weiwei Zhan
Yang Zhan
Baoyong Zhang
Bi Zhang
Chunmei Zhang
Dingze Zhang
Fangfang Zhang
Gan Zhang
Hao Zhang
HUAIDONG ZHANG
Jiayu Zhang
Jihan Zhang
Kaifeng Zhang
Lele Zhang
Ning Zhang
Rui Zhang
Shisheng Zhang
Tao Zhang
Tianxue Zhang
Wangjin Zhang
Wei Zhang
Weiqiang Zhang
Xiangyu Zhang
Xiaozhen Zhang
Xin'ao Zhang
Ya Zhang
YanJun Zhang
Yanling Zhang
Yifan Zhang
Ying Zhang
Yuan Zhang
ZeJun Zhang

Xuhui Hu
Yunfeng Hu
Junyang Hua
Yongzhao Hua
Bomin Huang
Dongyue Huang
Hailong Huang
Jie Huang
Shuaiting Huang
Yan Huang
Yanting Huang
Yijun Huang
Zongsheng Huang
Mengzhen Huo
Shicheng Huo
Yidao Ji
Yuehui Ji
Zhu Jiaju
Buhui Jiang
Haoge Jiang
JIALIN JIANG
Tianya Jiang
Guohua Jiao
Lei Jiao
Ran Jiao
Chen Jiaqi
Huiyu Jin
Ronghe Jin
Xin Jin
Zhenghong Jin
Mengjie Jing
Zhang Jingya
Cheng Jun
Junjie Kang
Wei Kang
Yijie Ke
Chang Kong
Sanzhar Kusdavletov
Aiwen LAI
Weiyao Lan
Yilin Lang
Armin Lederer
Jinlong Lei
Yuquan Leng
Aming Li
Bin Li
Changsheng Li
Chenzui Li
Cong Li
Dachuan Li
Dewei Li

Donglin Sui
Bin Sun
Changqing Sun
Jinxin Sun
Jiu-Cheng Sun
Zhiyong Sun
Zhongbo Sun
Junkai Tan
Jingchuan Tang
Yutao Tang
Zixin Tao
Hao Teng
Tao Teng
Bailing Tian
Daiying Tian
Mingyue Tu
Biao Wang
Bingchang Wang
Chang Wang
Chen Wang
Chenchao Wang
Chunyan Wang
Dong Wang
Fang Wang
Fuyong wang
Gang Wang
Guangan Wang
Haochen Wang
Haoyu Wang
Hongkun Wang
Hongman WANG
Huanjie Wang
Huiting Wang
Ji Wang
Jiadong Wang
Jiahao Wang
Jialiang WANG
Jianan Wang
Jiapeng Wang
Junjie Wang
Lei Wang
Lin Wang
Linlin Wang
Linqi Wang
Maonan Wang
Mengzhi Wang
Miao Wang
PEI WANG
Peiyi Wang
Qiang Wang
Tianrui Wang

Zeqing Zhang
Zhenwen Zhang
Zhipeng Zhang
Benyun Zhao
Bin Zhao
Dong Zhao
Huarong Zhao
Jiachi Zhao
Jianing Zhao
Juan Zhao
Shenshen Zhao
Shiyu Zhao
Xiaoyu Zhao
Xinyi Zhao
Xinyue Zhao
Yongjia Zhao
Zhenhua Zhao
Zhixin Zhao
Zuoquan Zhao
Kefan Zheng
Xinyuan Zheng
Yifan Zheng
Yipin Zheng
Yiwei Zheng
Zewei Zheng
Zhi Zheng
Zhuoqing Zheng
Jie Zhou
Lei Zhou
Liutao Zhou
Ning Zhou
PANPAN ZHOU
Xuefeng Zhou
Xunkuai Zhou
YANMING ZHOU
Yue Zhou
Zhangli Zhou
Zhisong Zhou
Bing Zhu
Haichao Zhu
Jiacheng Zhu
Kui Zhu
Shanying Zhu
Shuyi Zhu
Yefen Zhu
Yiming Zhu
Yu Zhu
Zhao Zhu
Zhiqiang Zuo
Zongyu Zuo
Zhao Zuoquan

Feifei Li

Wanmin Wang

General Conference Information

The 20th IEEE International Conference on Control & Automation (IEEE ICCA 2026) will be held during June 16–20, 2026, in Almaty, Kazakhstan. The event is jointly organized by the IEEE Singapore Control Systems Chapter, IEEE Kazakhstan Section and Hong Kong Centre for Logistics Robotics (HKCLR), and technically co-sponsored by IEEE Control Systems Society (CSS); the Technical Committee on Control Theory (TCCT), Chinese Association of Automation; IEEE Hong Kong Joint Chapter of RAS and CSS; Nazarbayev University, Kazakhstan; Institute of Smart Systems and Artificial Intelligence (ISSAI), Kazakhstan and Satbayev University, Kazakhstan.

It is to create a forum for scientists and practicing engineers throughout the world to present the latest research findings and ideas in the areas of control and automation. The conference is featured with the Best Paper Award and the Best Student Paper Award.

IEEE ICCA Proceedings are to be included in EI Compendex and IEEE Xplore.

Language

The official language of the conference is English.

Registration Fees

Registration Categories	Early Registration (by April 30)	Late Registration (after April 30)	Paper Uploads with registration	Banquet	Lunches	Receptions
Full Registration, IEEE Member	SG\$1,200 (USD 936)	SG\$1,500	Two (2)	Included	Included	Included
Full Registration, Nonmember	SG\$1,300 (USD 1014)	SG\$1,600	Two (2)	Included	Included	Included
Reduced Registration, Student	SG\$600 (USD 468)	SG\$750	One (1)	Included	Included	Included
Reduced Registration, Retiree	SG\$600 (USD 468)	SG\$750	One (1)	Included	Included	Included
Reduced Registration, IEEE Life Member	SG\$60 (USD 468)	SG\$750	One (1)	Included	Included	Included

Additional Fees

Cost per paper for extra paper upload: SG\$300

Excess Page Charges: SG\$160 per page (maximum of two beyond the conference-imposed page limit).

Extra Banquet Ticket: SG\$200 per person

Onsite Registration Hours (in Almaty, Kazakhstan) and Location

Date: June 16, 2026 (Tuesday)

Time: 17:00–20:00

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Welcome Reception

Date: June 16, 2026 (Tuesday)

Time: 18:00-20:00

Venue: 7. UniHUB Creative space and coffee shop, Satbayev University, Almaty, Kazakhstan

Welcome Address

Date: June 17, 2026 (Wednesday)

Time: 08:30–08:45

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Plenary Talk

Date: June 17, 2026 (Wednesday)

Time: 08:45–12:15

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Best Paper Session

Date: June 17, 2026 (Wednesday)

Time: 13:30–15:10

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Best Student Paper Session

Date: June 17, 2026 (Wednesday)

Time: 15:30–17:10

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Program Slot

Date: June 17-19, 2026 (Wednesday to Friday)

Time: 13:30–17:15 (Wednesday), 08:30–15:30 (Thursday), 08:30–17:30 (Friday)

Venue: Assembly Hall, Room 256, Room 267, Room 269, Room 259, Room 264, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Plenary Session

Date: June 18, 2026 (Thursday)

Time: 16:00–17:30

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Conference Banquet

Date: June 18, 2026 (Thursday)

Time: 19:00–22:30

Venue: Svetlana Almaty, Kaisar Plaza, Zheltoksan St 115, Almaty 050000, Kazakhstan

Technical Tour

Date: June 20, 2026 (Saturday)

Time: 08:30–12:30

Venue: Campus Tour

Program at a Glance

ICCA 2026 Technical Program Tuesday June 16, 2026	
Track T1	Track T2
17:00-20:00	
TuTT1	18:00-20:00
Onsite Registration	TuTT2 Welcome Reception

ICCA 2026 Technical Program Wednesday June 17, 2026

Track T1	Track T2	Track T3	Track T4	Track T5	Track T6
08:30-08:45 Assembly Hall Keynote Session WeWT7 Welcome Address					
08:45-09:45 Assembly Hall Keynote Session WeP1T8 Plenary Talk 1: Toward Next-Generation Alarm Systems: Alarm Data Analytics and Early Fault Diagnosis					
10:15-11:15 Assembly Hall Keynote Session WeP2T9 Plenary Talk 2: Designing the Future Society with AI Robots by Backcasting from 2050					
11:15-12:15 Assembly Hall Keynote Session WeP3T10 Plenary Talk 3: Why LLM + Humanoid Robots Not Working as Expected?					
13:30-15:10 Assembly Hall Regular Session WeAT1 Best Paper Session	13:30-15:15 Room 256 Regular Session WeAT2 Robotics 1	13:30-15:15 Room 267 Regular Session WeAT3 Optimal Control 1	13:30-15:15 Room 269 Regular Session WeAT4 Multi-Agent Systems 1	13:30-15:15 Room 259 Regular Session WeAT5 Learning Systems	13:30-15:15 Room 264 Regular Session WeAT6 Adaptive Control
15:30-17:10 Assembly Hall Regular Session WeBT1 Best Student Paper Session	15:30-17:15 Room 256 Regular Session WeBT2 Robotics 2	15:30-17:15 Room 267 Regular Session WeBT3 Optimal Control 2	15:30-17:15 Room 269 Regular Session WeBT4 Multi-Agent Systems 2	15:30-17:15 Room 259 Regular Session WeBT5 Learning-Based Control	15:30-17:15 Room 264 Regular Session WeBT6 Control Applications

ICCA 2026 Technical Program Thursday June 18, 2026

Track T1	Track T2	Track T3	Track T4	Track T5	Track T6
08:30-10:15 Assembly Hall Regular Session ThAT1 Robotics 3	08:30-10:15 Room 256 Regular Session ThAT2 Advanced Control, Planning and Learning of Unmanned Systems	08:30-10:15 Room 267 Regular Session ThAT3 Advancements in Intelligent Perception and Autonomous Decision-Making	08:30-10:15 Room 269 Regular Session ThAT4 Collective Behavior Regulation Inspired by Swarm Intelligence and Its Applications	08:30-10:15 Room 259 Regular Session ThAT5 Distributed Optimization, Game and Learning Algorithms with Their Applications in Cyber-Physical Systems	08:30-10:15 Room 264 Regular Session ThAT6 Embodied Intelligent Robotics, Active Perception, and Human-Machine Interaction Technologies

10:30-12:15 Assembly Hall Regular Session ThBT1 Automated Guided Vehicles	10:30-12:15 Room 256 Regular Session ThBT2 Advanced Optimal Control, Path Planning, and Sensing for Autonomous Intelligent Vehicles	10:30-12:15 Room 267 Regular Session ThBT3 Agile Planning and Intelligent Control for Autonomous Robots	10:30-12:15 Room 269 Regular Session ThBT4 Cooperative Planning and Control for Unmanned Systems	10:30-12:15 Room 259 Regular Session ThBT5 DT-Driven Smart Inspection and Diagnosis	10:30-12:15 Room 264 Regular Session ThBT6 Embodied Multiagent Systems
--	--	--	---	--	---

13:45-15:30 Assembly Hall Regular Session ThCT1 Nonlinear Systems and Control	13:45-15:30 Room 256 Regular Session ThCT2 Advanced Technologies for Robot Learning, Control, and Manipulation	13:45-15:30 Room 267 Regular Session ThCT3 Autonomous Intelligence for Industry, Daily Services, and Rescue Operations	13:45-15:30 Room 269 Regular Session ThCT4 Distributed Control and Decision-Making for Multi-Agent Systems with Safety and Security Guarantees	13:45-15:30 Room 259 Regular Session ThCT5 Dynamic and Intelligent Decision-Making for Autonomous Systems	13:45-15:30 Room 264 Regular Session ThCT6 Embodied Perception, Decision, and Control for Autonomous Unmanned Systems
--	---	---	---	--	--

<p>16:00-17:30 Assembly Hall Plenary Session ThPT7</p> <p>Smart Systems: The Impact of Generative and Adaptive AI on Modern Automation</p>

ICCA 2026 Technical Program Friday June 19, 2026

Track T1	Track T2	Track T3	Track T4	Track T5	Track T6
08:30-10:15 Assembly Hall Regular Session FrAT1 Estimation and Identification	08:30-10:15 Room 256 Regular Session FrAT2 Integrating Embodied Intelligence: Perception and Advanced Control in Robotic Systems	08:30-10:15 Room 267 Regular Session FrAT3 Intelligent Perception and Secure Control of Unmanned Systems	08:30-10:15 Room 269 Regular Session FrAT4 Micro-Robotic Systems and Applications	08:30-10:15 Room 259 Regular Session FrAT5 Perception, Mapping, and Autonomous Control for Underwater Robotic Systems in Challenging Environments	08:30-10:15 Room 264 Regular Session FrAT6 Situational Awareness and Resilient Control in Cyber-Physical Systems
10:30-12:15 Assembly Hall Regular Session FrBT1 Exploring Task-Oriented Embodied Intelligence in Robots	10:30-12:15 Room 256 Regular Session FrBT2 Intelligent Collaborative Platform for Unmanned Autonomous Systems	10:30-12:15 Room 267 Regular Session FrBT3 Intelligent Sensing and Embodied Robotic Systems for Medical Diagnosis and Intervention	10:30-12:15 Room 269 Regular Session FrBT4 Modeling, Control and Estimation in Unmanned Aircraft Systems	10:30-12:15 Room 259 Regular Session FrBT5 Resilient Control and Intelligent Decision-Making for Intelligent Manufacturing and Unmanned Systems	10:30-12:15 Room 264 Regular Session FrBT6 Swarm Control with Virtual Tubes
13:45-15:30 Assembly Hall Regular Session FrCT1 High-Fidelity Perception, Modeling, and Safety-Critical Control for Autonomous Vehicles in Intelligent Transportation Systems	13:45-15:30 Room 256 Regular Session FrCT2 Intelligent Control, Communication Security, and Coordination for Multi-Agent Systems	13:45-15:30 Room 267 Regular Session FrCT3 Learning-Based Planning and Control of Robotic Systems	13:45-15:30 Room 269 Regular Session FrCT4 Multimodal Interaction and Robot-Assisted Rehabilitation	13:45-15:30 Room 259 Regular Session FrCT5 Sensing and Control in Exoskeletons	13:45-15:30 Room 264 Regular Session FrCT6 Touch Intelligence and Wireless Teleoperation
15:45-17:30 Assembly Hall Regular Session FrDT1 Human-Machine Interaction in Medical Robot	15:45-17:30 Room 256 Regular Session FrDT2 Intelligent Decision-Making and Applications	15:45-17:30 Room 267 Regular Session FrDT3 Machine Vision and Optical Sensing	15:45-17:30 Room 269 Regular Session FrDT4 Optimization and Control for Intelligent Autonomous Systems	15:45-17:30 Room 259 Regular Session FrDT5 Sensing, Perception, and Control for Autonomous Aerial Vehicles	15:45-17:30 Room 264 Regular Session FrDT6 Vulnerability Analysis, Secure State Estimation and Intrusion-/Fault-Tolerant Control for Cyber-Physical Systems

ICCA 2026 Technical Program Saturday June 20, 2026

Track T1

08:30-12:30

Campus Tour

Technical Tour

Plenary Talk Addresses

Toward Next-Generation Alarm Systems: Alarm Data Analytics and Early Fault Diagnosis

Professor Tongwen Chen

Fellow of IEEE

Department of Electrical and Computer Engineering, University of Alberta, Canada

Time: 08:45–09:45, June 17, 2026

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Chairs: Professor Yang Shi, University of Victoria, Canada

Abstract: In operating industrial facilities, alarm systems are configured to notify operators about any abnormal situation. The industrial standards (EEMUA and ISA) suggest that on average an operator should not receive more than six alarms per hour. This is, however, rarely the case in practice as the number of alarms each operator receives is far more than the standard. There exist strong industrial needs and economic benefits for better interpreting and managing alarms, and redesigning alarm systems to reduce false and nuisance alarms and increase the alarm accuracy. In this talk, we plan to summarize our recent work in this new area, targeting an intelligent and data-based approach, called “alarm data analytics,” and presenting a new set of advanced tools for alarm visualization, performance evaluation and analysis, alarm rationalization design, alarm flood classification, and root cause diagnosis, thereby to help industrial processes to comply with the new standards. The tools have been tested with real industrial data and used by process engineers in Canada and elsewhere.



Tongwen Chen is currently a Professor and Tier 1 Canada Research Chair in Intelligent Monitoring and Control at the University of Alberta, Canada. He received the BEng degree in Automation and Instrumentation from Tsinghua University, and the MSc and PhD degrees in Electrical Engineering from the University of Toronto. His research interests include computer- and network-based control systems, event-triggered control, advanced alarm management and design, and their applications to the process industry. He is a Fellow of IEEE, IFAC, the Royal Society of Canada, the Canadian Academy of Engineering, as well as the Chinese Association of Automation.

Designing the Future Society with AI Robots by Backcasting from 2050

Professor Yasuhisa Hirata

Graduate School of Engineering, Department of Robotics, Tohoku University, Japan

Time: 10:15–11:15, June 17, 2026

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Chairs: Professor Yunhui Liu, Chinese University of Hong Kong, China

Abstract: In recent years, Japan has increasingly emphasized the importance of envisioning the society we wish to realize by 2050 and then backcasting from that vision to identify the technologies we should develop today. Two prominent embodiments of this perspective are the Robot Industry Vision 2050 recently issued by the Japan Robot Association and the Moonshot R&D Program led by the Japanese Cabinet Office, both of which place humans, society, and the environment at the core of future robotics and automation. Building on this philosophy, I will first introduce our work in the Moonshot R&D Program (Goal 3), where we are developing a collective of adaptable AI-enabled robots that co-evolve with humans and nurture users' self-efficacy, illustrated by recent outcomes such as the Robotic Nimbus — a conceptual vision of future robots that flexibly change their form and function to support diverse users. I will then present our research on garment handling conducted under the InnoHK initiative in Hong Kong, focusing on dual-arm robotic manipulation for flexible clothing manufacturing. Finally, I will reflect on what unites these domains — the human at the center — and discuss how our community can co-design a vibrant, inclusive future society.



Yasuhisa Hirata is a Professor in the Graduate School of Engineering at Tohoku University, Sendai, Japan. He received his B.E., M.E., and Ph.D. degrees in mechanical engineering from Tohoku University in 1998, 2000, and 2004, respectively. His research interests include human–robot interaction, multi-robot coordination, and factory automation. He serves as a Project Manager of Japan's Moonshot R&D Program. He has also served as an Administrative Committee (AdCom) member of the IEEE Robotics and Automation Society (RAS) and currently serves as Chair of the IEEE RAS Technical Committee Cluster on Health and Medical Robotics.

Why LLM + Humanoid Robots Not Working as Expected?

Professor Max Q.-H MENG

Fellow of IEEE

Electrical and Electronic Engineering, Southern University of Science and Technology, China

Time: 11:15–12:15, June 17, 2026

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Chairs: Dr. Yamin Yan, Nanyang Technological University, Singapore

Abstract: At the cutting edge of artificial intelligence and biomimetic robotics, why does the combination of Large Language Model (LLM) plus humanoid robots still fall short of expectations and fail to be effectively deployed in practical applications? Drawing on the speaker's forty years of innovation experience and study in the field, this lecture reviews the past to gain new insights. It explores the current difficulties and obstacles facing AI and discusses how to maximize the enormous dividends brought by AI and biomimetic robots, before looking ahead to the future development trends of intelligent robots as well as the opportunities for innovation and the strategies and tactics to seize them.



Dr. Meng is Chair Professor and Head of EE Department at Southern University of Science and Technology, Fellow of Canadian Academy of Engineering and IEEE. Formerly a tenured professor at the University of Alberta in Canada and Head of EE Department at Chinese University of Hong Kong. He specializes in robotics perception and intelligence. Ranked in the global top 2% of scientists by Stanford, he has published over 1,000 papers, held 100+ patents, and won 30+ awards, including the IROS Harashima Award. He has led 60+ research projects (¥100M+) to completion, delivered 200+ plenary talks, and serves as editor for leading journals, including founding Editor-in-Chief of Biomimetic Intelligence and Robotics published by Elsevier. He was the General Chair of the flagship conferences in robotics and automation: IEEE/RSJ IROS 2005 and IEEE ICRA 2021.

Plenary Panel Session

Smart Systems: The Impact of Generative and Adaptive AI on Modern Automation

Time: 16:00–17:30pm, June 18, 2026

Venue: Assembly Hall, 6. Mining and Metallurgical Building, Satbayev University, Almaty, Kazakhstan

Panelists: Professor Zhong-Ping Jiang, New York University, USA
Professor Jinjun Shan, York University, Canada
Professor Tielong Shen, Sophia University, Japan, and Dalian University of Technology, China
Professor Ching-Ping Wong, Georgia Institute of Technology, USA and Chinese University of Hong Kong, China
Professor Tao Yang, Northeastern University, China

Chairs: Professor Ben M. Chen, Chinese University of Hong Kong, China
Professor Jifeng Zhang, The Chinese Academy of Sciences, China

The theme of IEEE ICCA 2026 plenary session revolves around Smart Systems: The Impact of Generative and Adaptive AI on Modern Automation. We are privileged to have five 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. Zhong-Ping Jiang received the M.Sc. in statistics from the University of Paris XI, France, in 1989, and Ph.D. in automatic control and mathematics from ParisTech-Mines, France, in 1993. He is currently an Institute Professor in the Department of Electrical and Computer Engineering at the Tandon School of Engineering, New York University. His main research interests include stability theory, robust/adaptive/distributed nonlinear control, robust adaptive dynamic programming, reinforcement learning and their applications to information, mechanical, transportation and biological systems.

Professor Jiang currently serves the IEEE Intelligent Transportation Systems Society's Board of Governors and leads the Distinguished Lecturer program. He has served as Deputy Editor-in-Chief, Senior Editor and Associate Editor for numerous journals. He is among the Clarivate Analytics Highly Cited Researchers and Stanford's Top 2% Most Highly Cited Scientists. In 2022, he received the Excellence in Research Award from the NYU Tandon School of Engineering. Prof. Jiang is a foreign member of the Academia Europaea (Academy of Europe) and an ordinary member of the European Academy of Sciences and Arts, and also is a Fellow of the IEEE, IFAC, CAA, AAIA and AAAS.



Dr. Jinjun Shan is a Full Professor of Space Engineering at the Department of Earth and Space Science and Engineering, York University. He is the founding director of Spacecraft Dynamics Control and Navigation Laboratory (SDCNLab) at York University. He received his Ph.D. degree from Harbin Institute of Technology, China, in 2002. His research progress is demonstrated through over 240 peer-reviewed journal and conference publications and 2 issued patents. Prof. Shan's accomplishments in research and engineering education have seen him recognized with prestigious recognitions such as the Fellow of Canadian Academy of Engineering (CAE), the Fellow of Engineering Institute of Canada (EIC), the Fellow of American Astronautical Society (AAS), and a member of European Academy of Sciences and Arts (EASA).



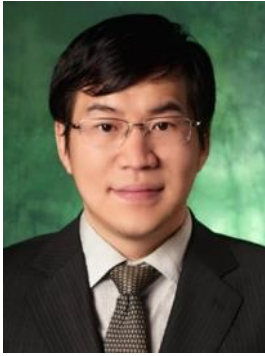
Dr. Tielong Shen received his Ph.D. from Sophia University in March 1992. In April of the same year, he joined the Department of Mechanical Engineering, at Sophia University, Tokyo, as an assistant professor. He was subsequently promoted to Associate Professor, Professor, and Specially Appointed Professor, and also served as Director of the Institute for Environment and Society. Since April 2024, he has been an Emeritus Professor of Sophia University, and Distinguished Professor at the School of Control Science and Engineering, Dalian University of Technology.

Professor Shen's research focuses on control theory of dynamical systems and its applications to mechatronic systems and automotive powertrain systems. He has been actively involved in academic service in the field of automatic control worldwide. He served as the General Chair of the 2015 and the 2021 Annual Conference of Society of Instrument and Control Engineers (SICE), Japan. He also served as General Chair of the 6th and 7th IFAC ECOMS. Over the past two decades, Professor Shen has continuously led multiple major research projects funded by the JSPS. He has also directed several international collaborative projects supported by the JST, including China–Japan and China–Japan–Korea cooperative programs. Furthermore, he has maintained long-term industry–academia collaborations with Toyota Motor Corp. and other Japanese automotive companies, focusing on the development of optimization-based control strategies and theoretical methods for automotive powertrain systems. In recognition of his contributions, Professor Shen received the 8th Outstanding Contribution Award at the Chinese Control Conference in 2021. He is a former Director of Society of Instrument and Control Engineers, Japan, and has been elected as a SICE Fellow.



Dr. Ching-Ping Wong is a Regents Professor and the Charles Smithgall Institute-Endowed Chair at Georgia Tech. He is also an Emeritus Professor of The Chinese University of Hong Kong and a foreign member of the Chinese National Academy of Engineering. After his doctoral study from the Pennsylvania State University, he was awarded a two-year postdoctoral fellowship with Nobel Laureate Professor Henry Taube at Stanford University. Prior to joining Georgia Tech, he was with AT&T Bell Laboratories for also 20 years and became an AT&T Bell Laboratories Fellow in 1992.

His research interests lie in the fields of materials for solar energy harvesting, energy storage and microelectronic packaging. Professor Wong has published widely with over 850 peer reviewed journal papers, 1,200 Conference Proceedings papers and 12 books. He is listed as one of the Highly Cited Researchers Award (Released by Clarivate) in 2018, 2019, 2020 and 2021. His H-index is 100. He has yielded fruitful research results and holds over 65 US patents. Professor Wong is considered an industry legend and has made significant contributions to the industry by pioneering new materials, which fundamentally changed the semiconductor packaging technology. Professor Wong has also successfully motivated and nurtured numerous inquisitive young minds over the years. As a distinguished scholar, Professor Wong was awarded numerous international honors, such as the AT&T Bell Labs Fellow Award in 1992, the IEEE Third Millennium Medal in 2000, Georgia Institute of Technology Class of 1934 Distinguished Professor Award in 2004, the IEEE Components, Packaging and Manufacturing Technology Field Award in 2005, IEEE EPS Society Outstanding Sustained Technical Contributions Award in 1995, the International Dresden Barkhausen Award (Germany) in 2012.



Dr. Tao Yang is a Professor at Northeastern University, China, a Changjiang Scholar Distinguished Professor, and a National High-level Youth Talent. He earned his Ph.D. from Washington State University in 2012. Before joining Northeastern University's State Key Laboratory of Synthetical Automation for Process Industries in 2019, he held research and faculty positions at the KTH Royal Institute of Technology (Sweden), the Pacific Northwest National Laboratory (USA), and the University of North Texas (USA).

Professor Yang is an IET Fellow. His research focuses on distributed cooperative control and optimization, industrial artificial intelligence, and the integration of intelligent optimization and control. He has led multiple Key and Major projects funded by the National Natural Science Foundation of China (NSFC) and the National Key R&D Program. Dr. Yang has authored over 100 journal papers, including more than 50 in IEEE Transactions and IFAC journals. His accolades include the National Teaching Achievement Award for Higher Education (Second Prize, 2022) and the Chinese Association of Automation (CAA) Natural Science Award (Second Prize, 2023). Dr. Yang actively serves the academic community as the Deputy Editor-in-Chief of *Acta Automatica Sinica* and as an Associate Editor for IEEE TCST, IEEE TCNS, and IEEE TNNLS. He also chairs the CAA Big Data Technical Committee and serves on multiple technical committees within IEEE CSS, IEEE IES, and IFAC.

Best Paper Award Finalists

1. Event-Triggered Incremental Fault-Tolerant Control: Recovery Performance and Convergence Time Guarantee

Li, Yu (The Hong Kong Polytechnic University)
Wen, Chih-Yung (The Hong Kong Polytechnic University)
Zhang, Youmin (Concordia University)

2. Multi-UAV Prescribed Time Lag Consensus Control Via Adaptive Weight Pigeon-Inspired Optimization

Chen, Rujia (Beihang University)
Duan, Haibin (Beihang University)
Xu, Gen (Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences)
Yu, Limin (STARMACH co.,Ltd)
Luo, Delin (Xiamen University)

3. Towards Efficient Robot Learning: Diffusion-Style Skill Learning and Transfer on Platform with Multi-Modal Perception and Force Feedback

Li, Dianxi (The Chinese University of Hong Kong)
Dong, Zhipeng (Hong Kong Center for Logistics Robotics)
Li, Zhuo (The Chinese University of Hong Kong)
Liu, Wenrui (The Chinese University of Hong Kong)
Chen, Fei (The Chinese University of Hong Kong)

4. Inverse Learning-Based Strategy for Linear Quadratic Differential Hypergame with Misperception

Xiong, Wei (Tongji University)
Dong, Yi (Tongji University)
Xin, Bin (Beijing Institute of Technology)
Wang, Tianqi (The Hong Kong Polytechnic University)
Hong, Yiguang (Chinese Academy of Sciences)

5. Online MPC-Augmented Reinforcement Learning for Path Tracking Control of Autonomous Vehicles

Xu, Qian (Southern University of Science and Technology)
Cao, Weipeng (Guangdong Laboratory of Artificial Intelligence and Digital Economy, Shenzhen)
Wang, Xueqian (Tsinghua University)
Li, Dachuan (Southern University of Science and Technology)

Best Student Paper Award Finalists

1. Nonsingular Impact Time Control Guidance with Field-Of-View Constraints: Theory and Experiment

Li, Heng (Beihang University)

Wang, Qing (Beihang University)

Yu, Jianglong (Beihang University)

Wang, Ming (Beihang University)

Dong, Xiwang (Beihang University)

2. Time-Advancing Multimodal Motion-State Estimation for Soft Lower-Limb Exoskeletons Using sEMG-IMU Fusion

Zhou, Zixiang (Harbin Institute of Technology, Shenzhen)

Zeng, Qiming (Harbin Institute of Technology, Shenzhen)

Liu, Zhao (Harbin Institute of Technology, Shenzhen)

Luo, Mingxiang (Harbin Institute of Technology, Shenzhen)

Hu, Kaiyu (Harbin Institute of Technology, Shenzhen)

Sheng, Yixuan (Harbin Institute of Technology, Shenzhen)

3. Khan-Suyla Cartographer: Mapping Communication-Suppression Zones for Multi-Level Drone Swarms

Aimashev, Eldar (Naval Postgraduate School)

Yakimenko, Oleg A. (Naval Postgraduate School)

4. Cooperative Safety-Critical Control of Mobile Agents by Real-Time Distributed Optimization

Sheng, Yuanxiu (Northeastern University)

Qin, Zhengyan (HKU)

Liu, Tengfei (Northeastern University)

Liu, Lu (City University of Hong Kong)

Jiang, Zhong-Ping (New York University)

5. Fast and Accurate Contact Wrench Estimation for Multirotors Via Decoupled Aerodynamics

Wu, Delong (Beijing Institute of Technology)

Shi, Yangxi (Beijing Institute of Technology)

Tao, Zichen (Beijing Institute of Technology)

Hao, Cui (Beijing Institute of Technology)

Yang, Qingkai (Beijing Institute of Technology)

Technical Program

Technical Program for Wednesday June 17, 2026

WeAT1	Assembly Hall
Best Paper Session (Regular Session)	
Chair: Xie, Lihua	Nanyang Technological University
13:30-13:50	WeAT1.1
Event-Triggered Incremental Fault-Tolerant Control: Recovery Performance and Convergence Time Guarantee	
Li, Yu	The Hong Kong Polytechnic University
Wen, Chih-Yung	The Hong Kong Polytechnic University
Zhang, Youmin	Concordia University
13:50-14:10	WeAT1.2
Multi-UAV Prescribed Time Lag Consensus Control Via Adaptive Weight Pigeon-Inspired Optimization	
Chen, Rujia	Beihang University
Duan, Haibin	Beihang University
Xu, Gen	Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences
Yu, Limin	STARMACH Co., Ltd
Luo, Delin	Xiamen University
14:10-14:30	WeAT1.3
Towards Efficient Robot Learning: Diffusion-Style Skill Learning and Transfer on Platform with Multi-Modal Perception and Force Feedback	
Li, Dianxi	The Chinese University of Hong Kong
Dong, Zhipeng	Hong Kong Center for Logistics Robotics
Li, Zhuo	The Chinese University of Hong Kong
Liu, Wenrui	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong
14:30-14:50	WeAT1.4
Inverse Learning-Based Strategy for Linear Quadratic Differential Hypergame with Misperception	
Xiong, Wei	Tongji University
Dong, Yi	Tongji University
Xin, Bin	Beijing Institute of Technology
Wang, Tianqi	The Hong Kong Polytechnic University
Hong, Yiguang	Chinese Academy of Sciences
14:50-15:10	WeAT1.5
Online MPC-Augmented Reinforcement Learning for Path Tracking Control of Autonomous Vehicles	
Xu, Qian	Southern University of Science and Technology
Cao, Weipeng	Guangdong Laboratory of Artificial Intelligence and Digital Economy (Shenzhen)
Wang, Xueqian	Tsinghua University

Li, Dachuan	Southern University of Science and Technology
WeAT2	Room 256
Robotics 1 (Regular Session)	
Chair: Miao, Zhiqiang	Hunan University
Co-Chair: Shi, Yangxi	Beijing Institute of Technology
13:30-13:45	WeAT2.1
Distributed Active Target Tracking for UAV Swarms in Cluttered Environments: A Perception and Planning Framework	
Shi, Yangxi	Beijing Institute of Technology
Wei, Shaozhun	Beijing Institute of Technology
Liu, Henghua	Beijing Institute of Technology
Fang, Hao	Beijing Institute of Technology
13:45-14:00	WeAT2.2
Nonlinear Mechanical Modeling and Experimental Validation of CFRP Energy Storage Elements for Jumping Robots	
Yang, Xuecong	Harbin Institute of Technology
Li, Zhaoxu	Harbin Institute of Technology
Tian, Baolin	Harbin Institute of Technology
Wang, Yuzheng	Aerospace System Engineering Shanghai
Hou, Baoshen	National Key Laboratory of Aerospace Mechanism, Aerospace System Engineering Shanghai
Yu, Haitao	Harbin Institute of Technology
Gao, Haibo	Harbin Institute of Technology
14:00-14:15	WeAT2.3
A Rapid Calculation Method and System for Modern Power Grid Performance Parameters	
Lu, Qiyang	South China University of Technology
Qin, Huabiao	South China University of Technology
Cui, Yuhao	Zhuhai Zhonghui Microelectronics CO., Ltd
14:15-14:30	WeAT2.4
A Structurally Constrained Rod-Driven Continuum Manipulator for Simplified Kinematic Modeling	
Yang, Wentuo	Shanghai Jiao Tong University
Zhou, Xionghui	Shanghai Jiao Tong University
Zhang, Teng	The University of Hong Kong
Xie, Le	Shanghai Jiao Tong University
14:30-14:45	WeAT2.5
VGGT-DynMap: Globally Consistent Static Dense Mapping Via Coarse-To-Fine Fusion in Dynamic Environments	
Liu, Jingting	Hunan University
Cao, Wenhan	Hunan University
Wu, ZhiHong	Hunan University
Chen, Hao	Hunan University
Li, Yujie	Hunan University
Huidong, Wang	Hunan University
Miao, Zhiqiang	Hunan University

14:45-15:00	WeAT2.6
Study on the Locomotion Performance of a Snake-Like Robot with Different Passive Joint Configurations	
Ji, Haoyi	Ritsumeikan University
Cao, Yiming	Ritsumeikan University Biwako-Kusatsu Campus
Wang, Zhongkui	Ritsumeikan University
15:00-15:15	WeAT2.7
Dynamic Parameter Identification of a Hybrid Bipedal Robotic Leg Via Current-Offset Compensation and Trajectory Optimization	
Xu, Kunhao	Harbin Institute of Technology
Tian, Baolin	Harbin Institute of Technology
Mu, Changxi	Harbin Institute of Technology
Wei, Dapeng	Chinese Academy of Sciences
Xiao, Jian	Chinese Academy of Sciences
Wang, Xiaojun	Chinese Academy of Sciences
Yu, Haitao	Harbin Institute of Technology

WeAT3	Room 267
Optimal Control 1 (Regular Session)	
Chair: Jiao, Xiaohong	Yanshan University
13:30-13:45	WeAT3.1
A Lazy Submodular Optimization Method for Efficient Dynamic Aggregation of Flexible Resources	
Mo, Qianlian	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Education, Southeast University
Jin, Yulong	NARI Technology Co., Ltd
Zheng, Tao	NARI Technology Co., Ltd
Zhang, Kaifeng	Southeast University
13:45-14:00	WeAT3.2
Energy-Saving Cruise Control for Connected HETs Enhanced by Physically Informed Neural Networks Based on HDP	
Tang, Wenbin	Yanshan University
Jiao, Xiaohong	Yanshan University
Zhang, Yahui	Yanshan University
14:00-14:15	WeAT3.3
Optimal Control of Nonlinear Discrete-Time Systems with Control Constraints	
Lv, Chuazhi	Shandong University of Science and Technology
Wang, Hongxia	Shandong University of Science and Technology
Zhang, Liping	Shandong University of Science and Technology
Zhang, Huanshui	Shandong University
14:15-14:30	WeAT3.4
Non-Euclidean Contraction Design of Firing-Rate Neural Networks by DC Programming	
Zhao, Chengyan	Kyushu Institute of Technology
Ueno, Satoshi	Ritsumeikan University
Mei, Wenjie	Nanjing University
Zheng, Yanqiu	Tokyo University of Science

Gao, Chong	Northwestern Polytechnical University
14:30-14:45	WeAT3.5
Real-Time Trajectory Planning for Heavy Trucks Via Safety-Aware Augmented Lagrangian ILQR	
Su, Youtao	Beijing Institute of Technology
Ju, Zhiyang	The University of Melbourne
Tu, Yuantao	Beijing Institute of Technology
Han, Xu	Beijing Institute of Technology
Gong, Jianwei	Beijing University of Technology
Xi, Junqiang	School of Mechanical Engineering, Beijing Institute of Technology
14:45-15:00	WeAT3.6
Robust Model Predictive Control for Hybrid Visual Servoing of Robotic Manipulators	
Pan, Rui	University of Victoria
Wang, Yunli	National Research Council Canada
Bellinger, Colin	University of Ottawa
Drummond, Chris	National Research Council Canada
Shi, Yang	Canada
15:00-15:15	WeAT3.7
Active Excitation through Motion: Raptor-Inspired Attack Separation Control of Airborne ISPs	
Yaokun, Lu	Beihang University
Teng, Hao	Beihang University
Zhao, Dong	Beihang University
Kexin, Liu	Beijing University
Qiao, Jianzhong	Beihang University
Guo, Lei	Beihang University

WeAT4	Room 269
Multi-Agent Systems 1 (Regular Session)	
Chair: Duan, Haibin	Beihang University
Co-Chair: KUSDAVLETOV, Sanzhar	Coventry University Kazakhstan
13:30-13:45	WeAT4.1
Greedy Algorithms for the Team Formation Problem with Time Windows	
Zhu, Weikun	National University of Defense Technology
Tang, Luohao	National University of Defense Technology
Lin, Fengyu	National University of Defense Technology
Lei, HongTao	National University of Defense Technology
Zhu, Xianqiang	National University of Defense Technology
Zhu, Cheng	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
13:45-14:00	WeAT4.2
Observer-Based Neuro-Adaptive Control for Consensus Tracking of Uncertain Multi-Agent Systems	

Zhao, Yinxiang	Beihang University
Luo, Zhibin	Beihang University
Wang, Qishao	Beihang University
Lv, Yuezhu	Beijing Institute of Technology
Yu, Yang	Beihang University
14:00-14:15	WeAT4.3
Adaptive Lyapunov-Based Distributed Safe Motion Planning and Formation Control for Multi-Agent Systems	
Abulkassov, Bakhtiyar	Astana IT University
Makhmudova, Valeriya	Astana IT University
Kaliyeva, Amina	Astana IT University
Amangeldi, Arystan	Astana IT University
Kusdavletov, Sanzhar	Coventry University Kazakhstan
14:15-14:30	WeAT4.4
Dual-Mode Heterogeneous Channel Access Method Based on Action Masking and Asynchronous Experience Replay	
Guo, Xianda	South China University of Technology
Qin, Huabiao	South China University of Technology
Cui, Yuhao	Zhuhai Zhonghui Microelectronics CO., Ltd
14:30-14:45	WeAT4.5
Velocity-Augmented Control Barrier Functions for Risk-Aware Distributed Formation under Disturbances	
Sun, Xiaoqian	Nankai University
Chen, Fei	Nankai University
Xiang, Linying	Xiamen University
14:45-15:00	WeAT4.6
Resilient UAV Swarm Control Via Starling-Inspired Attack Containment	
Gong, Shiqi	Beihang University
Duan, Haibin	Beihang University
Yongqiong, Yuan	China Electronics Technology Group Corporation (CETC), 20th Institute
Luo, Delin	Xiamen University
15:00-15:15	WeAT4.7
Distributed Control Framework of Multirobot System Using Automation and Control Applications*	
Zeinulla, Rassul	Kazakh British Technical University
Abdimalik, Almat	Kazakh-Brithish-Technical-University
Rakhmetkali, Ayan	Kazakh-Brithish Technical University
Masimba, Collins	Kazakh British Technical University
Samigulin, Timur	Kazakh British Technical University

WeAT5	Room 259
Learning Systems (Regular Session)	
Chair: Yu, Hao	Beijing Institute of Technology
13:30-13:45	WeAT5.1

Enhancing UAV Semantic Perception Via Controllable Latent Diffusion and Multi-Source Structural Priors	
Fu, Xinyi	Wuhan University
Zhang, Yibo	School of Remote Sensing and Information Engineering, Wuhan University
Xie, Mengjie	Wuhan University
Gao, Zhi	Wuhan University
Lin, Feng	National University of Singapore
13:45-14:00	WeAT5.2
Toward the Optimal Behavior Control Based on a System Model Including User Preferences	
Suzuki, Masakazu	Tokai University
14:00-14:15	WeAT5.3
Subject-Independent Motor Imagery EEG Classification for Portable BCI Using a Lightweight EEGNet-Lite Model	
Tuimebay, Yelnur	Satbayev University
Alimbayev, Chingiz	Satbayev University
Alimbayeva, Zhadyra	Satbayev University
Ozhikenov, Kassymbek	Satbayev University
14:15-14:30	WeAT5.4
From Potential to Implementation: Digital Transformation in Elderly Care Systems	
Mežnarec-Novosel, Suzanna	Alma Mater Europaea University
Lučan, Jelena	Alma Mater Europaea University
Bogataj, David	Alma Mater Europaea University
14:30-14:45	WeAT5.5
Optimization of Cross-Domain Detection Capabilities Based on RT-DETR	
Cao, Yue	Beijing Institute of Technology
Chen, Wenjie	Beijing Institute of Technology
14:45-15:00	WeAT5.6
Bandwidth-Efficient Exact Sampling for Distributed Speculative Decoding of LLMs Via Two-Stage Rejection Sampling	
Tang, Zhonghuan	Tongji University
Gong, Wei	Tongji University
Liwang, Minghui	Tongji University
Kang, Miao	Tongji University
Li, Li	Tongji University
15:00-15:15	WeAT5.7
Spacecraft Attitude Formation: An Event-Triggered Impulsive Control Approach	
Li, Zichuang	Beijing Institute of Technology
Yu, Hao	Beijing Institute of Technology
Hao, Renjian	Beijing Institute of Control Engineering
Song, Jiliang	Beijing Institute of Control Engineering
Shi, Dawei	Beijing Institute of Technology

WeAT6	Room 264
Adaptive Control (Regular Session)	
Chair: Peng, Zhouhua	Dalian Maritime University
Co-Chair: Guo, Zhao	Wuhan University

13:30-13:45	WeAT6.1
A State-Scheduled Regional Variable Impedance Control for Lower-Limb Exoskeletons	
Long, Qinyuan	Wuhan University
Liao, Yueru	Wuhan University
Yi, Shuowen	Wuhan University
Lu, Haolin	Wuhan University
Guo, Zhao	Wuhan University
13:45-14:00	WeAT6.2
Research on Adaptive Thermal Management Scheme for Hydrogen Fuel Cell Combined Heat and Power System*	
Li, Heran	Harbin Institute of Technology
Sun, Chuanyu	Harbin Institute of Technology
Korpebayev, Daryn	L.N. Gumilyov Eurasian National University, Satbayev University
KAi, Song	Harbin Institute of Technology
14:00-14:15	WeAT6.3
Fully Distributed Event-Triggered Cooperative Target Enclosing Control for Underactuated ASVs Via Adaptive Observers	
Wang, Anqing	Dalian Maritime University
Li, Xukun	Dalian Maritime University
Mou, Yanjie	Dalian Maritime University
Jiang, Yue	Dalian Maritime University
Wu, Wenjie	Dalian Maritime University
Peng, Zhouhua	Dalian Maritime University
14:15-14:30	WeAT6.4
Intelligent Real-Time Control of Electrostatic Precipitators Based on Neural Network Modeling	
Sagynuly, Sanzhar	Satbayev University
Omirbekova, Zhanar	Satbayev University
14:30-14:45	WeAT6.5
Adaptive Disturbance Rejection of Bearing-Based Formation for General Linear Multi-Agent Systems	
Peng, Cheng	The Chinese University of Hong Kong
Huang, Jie	Chinese Univ. of Hong Kong
14:45-15:00	WeAT6.6
Time-Varying Aerodynamic Parameter Estimation and Adaptive Dynamic Inversion Control of Aircrafts with Uncertain Actuator Faults	
Wang, Zhishen	Beijing Institute of Technology
Qu, Xiaolei	Northwestern Polytechnical University
Zhang, Yanjun	Beijing Institute of Technology

WeBT1	Assembly Hall
Best Student Paper Session (Regular Session)	
Chair: Xie, Lihua	Nanyang Technological University
15:30-15:50	WeBT1.1
Nonsingular Impact Time Control Guidance with Field-Of-View Constraints: Theory and Experiment	
Li, Heng	Beihang University
Wang, Qing	Beihang University
Yu, Jianglong	Beihang University

Wang, Ming	Beihang University
Dong, Xiwang	Beihang University
15:50-16:10	WeBT1.2
Time-Advancing Multimodal Motion-State Estimation for Soft Lower-Limb Exoskeletons Using sEMG-IMU Fusion	
Zhou, Zixiang	Harbin Institute of Technology, Shenzhen
Zeng, Qiming	Harbin Institute of Technology, Shenzhen
Liu, Zhao	Harbin Institute of Technology (Shenzhen)
Luo, Mingxiang	The State Key Laboratory of Robotics and Systems, Harbin Institute of Technology Shenzhen, Shenzhen
Hu, Kaiyu	Harbin Institute of Technology, Shenzhen
Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
16:10-16:30	WeBT1.3
Khan-Suyla Cartographer: Mapping Communication-Suppression Zones for Multi-Level Drone Swarms	
Aimashev, Eldar	Naval Postgraduate School
Yakimenko, Oleg A.	Naval Postgraduate School
16:30-16:50	WeBT1.4
Cooperative Safety-Critical Control of Mobile Agents by Real-Time Distributed Optimization	
Sheng, Yuanxiu	Northeastern University
Qin, Zhengyan	HKU
Liu, Tengfei	Northeastern University
Liu, Lu	City University of Hong Kong
Jiang, Zhong-Ping	New York University
16:50-17:10	WeBT1.5
Fast and Accurate Contact Wrench Estimation for Multirotors Via Decoupled Aerodynamics	
Wu, Delong	Beijing Institute of Technology
Shi, Yangxi	Beijing Institute of Technology
Tao, Zichen	Beijing Institute of Technology
Hao, Cui	Beijing Institute of Technology
Yang, Qingkai	Beijing Institute of Technology

WeBT2	Room 256
Robotics 2 (Regular Session)	
Chair: Li, Xiang	Tsinghua University
Co-Chair: Feng, Wenchao	The Chinese University of Hong Kong
15:30-15:45	WeBT2.1
Pre-Grasp Fiber Alignment in Robotic CFRP Layup: A Training-Free Spectral Framework with Wrist-Joint Compensation	
Feng, Wenchao	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong
Zhang, Weizhao	The Chinese University of Hong Kong
15:45-16:00	WeBT2.2

Integrating Vision-Language Planning and Closed-Loop Control for Robust Bimanual Robotic Manipulation	
Chen, Wei	The Chinese University of Hong Kong
Wu, Haiwen	The Chinese University of Hong Kong
Wang, Gang	The Chinese University of Hong Kong
Meng, Qiwei	CUHK
Wen, Youpeng	CUHK
Jiang, Taoran	The Chinese University of Hong Kong
Chen, Xieyuanli	Department of Mechanical and Automation Engineering, the Chinese University of Hong Kong, Hong Kong
Liu, Yunhui	Chinese University of Hong Kong
16:00-16:15	WeBT2.3
A Hybrid Modeling Method for Multi-Fingered Dexterous Robot Hands	
Zou, Qikai	Tsinghua University
Jiang, Yongpeng	Tsinghua University
Jia, Yongyi	Tsinghua University
Miao, Shu	Tsinghua University
Shen, Zhixi	Chongqing University
Li, Xiang	Tsinghua University
16:15-16:30	WeBT2.4
Underactuated Dynamic Legged-Rolling Enabled by a Simple Torso-Free Morphology	
Zheng, Yanqiu	Tokyo University of Science
Yan, Cong	Ritsumeikan University
Gao, Jing	Shanxi Agricultural University
Zhao, Chengyan	Kyushu Institute of Technology
16:30-16:45	WeBT2.5
Adaptive Extended Kalman Filter-Based Feedforward Disturbance Compensation for Robust Mobile Robot Trajectory Tracking	
Wani, Sameer	Indian Institute of Technology, Jammu
Singh, Padmini	IIT JAMMU
Sharma, Nalin Kumar	Indian Institute of Technology Jammu
16:45-17:00	WeBT2.6
Toward High-Precision Attitude Control of Underwater Vehicles Using Reaction Wheels	
He, Zhongyun	Hangzhou City University
Cui, Chenhuan	Hangzhou City University
Jiang, Yuning	Zhejiang University
He, Shiming	Hangzhou City University
17:00-17:15	WeBT2.7
Cross-Medium Model Predictive Control for a Compact Wheel-Propeller Amphibious Robot	
Liu, XinJiang	Hunan University
Miao, Zhiqiang	Hunan University
Chen, Yizong	Hunan University
Wang, Yaonan	Hunnan University

WeBT3	Room 267
Optimal Control 2 (Regular Session)	
Chair: Zhou, Jianshu	National University of Singapore
15:30-15:45	WeBT3.1
A Dynamic Fuzzy Evaluation Model for Online Risk Assessment of LNG Tanker Transportation	
Lin, Shifu	Wuhan University of Technology
Wang, Qiang	Wuhan University of Technology
15:45-16:00	WeBT3.2
Improved Quantum Two-Classification Network	
Cong, Shuang	University of Sci. & Tech. of China
Qiu, Jingru	University of Science and Technology of China
16:00-16:15	WeBT3.3
A Layered Residual Control and Safety Assessment Framework for Robot-Assisted Feeding Focused on Food Scooping and Near-Mouth Delivery	
Wu, Peixi	School of Biomedical Engineering, Shenzhen University Medical School, Shenzhen University, Shenzhen 518060, China
Jiang, Xiantai	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
You, Zijing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Liang, Xiaoxin	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
Shu, Yi	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
Li, Guanglin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Zhao, Guoru	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
Diao, Yanan	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
16:15-16:30	WeBT3.4
ASI: A Closed-Loop Robustness Proxy for Spatial Flight-Stability Mapping Using PX4 Flight Logs	
Bodagala, Jayawant	Independent Researcher
Bodagala, Balaji	Independent Researcher
16:30-16:45	WeBT3.5
Hamilton-Jacobi Reachability for Spacecraft Collision Avoidance	
Hui, Larry	University of California, Berkeley
Kam, Jordan	University of California, Berkeley
Su, William	University of California, Berkeley, Aerospace Engineering Program
Zhou, Jianshu	National University of Singapore

16:45-17:00	WeBT3.6
Robustness Quantification of MIMO-PI Controller from the Perspective of (γ) -Dissipativity	
Sheng, Zimao	Northwestern Polytechnical University
Yang, Shuxiang	Northwestern Polytechnical University
Yang, Hong'an	Northwestern Polytechnical University
Guo, Rongkun	Northwestern Polytechnical University
17:00-17:15	WeBT3.7
Active RF Signal Source Detection and Control for Efficient Quadcopter-Based Search and Rescue Missions	
Cao, Haosen	Chinese University of Hong Kong
Shao, Jingheng	The Chinese University of Hong Kong
Wang, Pei	The Chinese University of Hong Kong
Wu, Zongzhou	The Chinese University of Hong Kong
Zhao, Zuoquan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

WeBT4	Room 269
Multi-Agent Systems 2 (Regular Session)	
Chair: Xin, Bin	Beijing Institute of Technology
Co-Chair: Bian, Wenjing	Beijing Institute of Technology
15:30-15:45	WeBT4.1
D2CP: An Online Multi-Region Coverage Path Planning Method for Multiple UAVs Based on Divide-And-Conquer Strategy	
Zang, Yuechao	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Zhu, Xianqiang	National University of Defense Technology
Zhang, Qianzhen	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Liu, Qiting	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Zhang, Xiujie	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Zhu, Cheng	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
15:45-16:00	WeBT4.2
Generalized Distributed Average Tracking Over Diverse Detection Networks	

Ren, Yatao	Northwestern Polytechnical University
Liu, Yongfang	Peking University
Zhao, Yu	Peking University
16:00-16:15	WeBT4.3
Stability Analysis and Estimation of Domain of Attraction for Complex Network with Heterogeneous Individual Systems	
Tong, Mingjing	Beihang University
Liang, Quanyi	Beihang University
She, Zhikun	Beihang University
16:15-16:30	WeBT4.4
Multi-AAV Multi-Regional Coverage Path Planning with a Maximum Range Constraint	
Bian, Wenjing	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology
Jing, Mengjie	Beijing Institute of Technology
Chen, Chen	Beijing Institute of Technology
16:30-16:45	WeBT4.5
Hierarchical Clustered Distributed Localization for High-Dynamic UAVs Based on Fused AOA-TDOA	
Wang, Xibo	Tongji University
Deng, Di	Tongji University
Yi, Peng	Tongji University
Mu, Biqiang	AMSS
Hong, Yiguang	Chinese Academy of Sciences
16:45-17:00	WeBT4.6
Distributed Visibility Preservation for Hybrid Nonholonomic Leader-Follower Formation with General Network Structure	
Guan, Renhe	Harbin Institute of Technology Shenzhen
Yang, Jiahao	Harbin Institute of Technology, Shenzhen
Wang, Yan	School of Mechanical Electrical Engineering and Automation, Harbin Institute of Technology Shenzhen, Shenzhen 518000, China

WeBT5	Room 259
Learning-Based Control (Regular Session)	
Chair: Xu, Yunjian	Chinese University of Hong Kong
15:30-15:45	WeBT5.1
Real-Time Trajectory Tracking at Handling Limits: An Iterative Bandwidth-Regularized Sparse GP-MPC Approach	
Tu, Yuantao	Beijing Institute of Technology
Ju, Zhiyang	The University of Melbourne
Su, Youtao	Beijing Institute of Technology
Han, Xu	Beijing Institute of Technology
Tao, Gang	Beijing Institute of Technology
Gong, Jianwei	Beijing University of Technology
15:45-16:00	WeBT5.2
Hierarchical Reactive Power Optimization of Distribution Power Grid with Probabilistic Assessment of PV Reactive Power Support Capability	
Zang, Hao	Southeast University

Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Education, Southeast University
Luo, Songqi	State Grid Zhejiang Electric Power Co., Ltd
Zhang, Kaifeng	Southeast University
16:00-16:15	WeBT5.3
Offline Safe Reinforcement Learning: A Comparative Study	
Xu, Yunjian	Chinese University of Hong Kong
16:15-16:30	WeBT5.4
Robust MPC of Linear Time-Varying Systems: An Event-Triggered Learning Method	
Luo, Zhibin	Beihang University
Zhao, Yinxiang	Beihang University
Wang, Qishao	Beihang University
Wang, Qingyun	Beihang University
16:30-16:45	WeBT5.5
Improving Hutchinson Diagonal Estimation within the OCP-LS Algorithm	
Zhong, Jindi	Shandong University of Science and Technology
Zhang, Zhaorong	Shandong University
Wang, Hongxia	Shandong University of Science and Technology
16:45-17:00	WeBT5.6
AdaUMon: Adaptive UAV Monitoring with Trajectory-Temporal and Target-Relational Representation Via Reinforcement Learning	
Hu, Zeyun	The Chinese University of Hong Kong, Shenzhen
Xie, Yuejiao	The Chinese University of Hong Kong, Shenzhen
Li, Zhiheng	The Chinese University of Hong Kong, Shenzhen
Wang, Maonan	The Chinese University of Hong Kong, Shenzhen
Pun, Man ON	The Chinese University of Hong Kong, Shenzhen

WeBT6	Room 264
Control Applications (Regular Session)	
Chair: Shan, Jinjun	York University
15:30-15:45	WeBT6.1
Digital Twin-Enabled Adaptive Control for Hydroelectric Systems: Turbine Governor and Voltage Regulation	
Gui, Yonghao	Oak Ridge National Laboratory
Subedi, Sunil	Oak Ridge National Laboratory
Wang, Hong	Oak Ridge National Laboratory
Yin, Zhun	The Department of Electrical and Computer Engineering at New York University
Jia, Wenbo	Chelan County PUD
Jiang, Zhong-Ping	New York University
15:45-16:00	WeBT6.2
A Reinforcement Learning-Based Design of Energy-Efficient Cruising Control for Heavy-Duty Trucks	
Ta, La	Dalian University of Technology

Wu, Yuhu	Dalian University of Technology
Song, Yunfeng	Dalian University of Technology
Shen, Tielong	Dalian University of Technology
Xu, Fuguo	Chiba University
16:00-16:15	WeBT6.3
Real-Time Trajectory Planning and Correction Algorithm Based on Probe Feedback for CMM Blind Scanning Scenarios	
Feng, Zhiqiang	Tsinghua University
Wang, Ze	Tsinghua University
Li, Min	China University of Geosciences
Liang, Shuang	Genertec Machine Tool Engineering Research Institute Co., Ltd
Miao, Song	Genertec Machine Tool Engineering Research Institute Co., Ltd
16:15-16:30	WeBT6.4
Design and Implementation of a Single-Axis Seismic Simulator for Engineering Education	
Pumasupa, Alvaro	Peruvian University of Applied Sciences
Urrunaga, Yahir	Peruvian University of Applied Sciences
Yparraguirre, Mathias	Universidad Peruana De Ciencias Aplicadas
Perea, Carlos	Universidad Peruana De Ciencias Aplicadas
16:30-16:45	WeBT6.5
Robust End-To-End Planning for Resource-Constrained Autonomous Vehicles	
Singh, Larissa	York University
Schofield, Hunter	York University
Wang, Hao	York University
Zhang, Hao	York University
Shan, Jinjun	York University
16:45-17:00	WeBT6.6
Super-Twisting Sliding Mode Observer-Based Adaptive Distributed Attack-Resilient Control for DC Microgrids	
Ma, Kexin	Huazhong University of Science and Technology
Cai, Luzhao	Huazhong University of Science and Technology
Liu, Lian	Huazhong University of Science and Technology
Zhang, Yu	Huazhong University of Science and Technology
Liu, Xiao-Kang	Huazhong University of Science and Technology
Wang, Yan-Wu	Huazhong University of Science and Technology
17:00-17:15	WeBT6.7
An Aerial Robotic Manipulator for Offshore Wind Turbine Blade Inspection	
Yang, Yingying	Fuzhou University
Zhang, Zihao	Fuzhou University
Wang, Pei	Fuzhou University
Xie, Kaiyi	Fuzhou University

Lin, Yaohua	Fuzhou University
Li, Yifan	Fuzhou University
Li, Yuzheng	Fuzhou University
Liu, Qianyuan	Fuzhou University

Technical Program for Thursday June 18, 2026

ThAT1	Assembly Hall
Robotics 3 (Regular Session)	
Chair: Huang, Hailong	Hong Kong Polytechnic University
Co-Chair: Gao, Zhi	Wuhan University
08:30-08:45	ThAT1.1
Development of Flapping Robots Using Piezoelectric Fiber Composites - Introduction of Click Mechanism -	
Suzuki, Keisuke	The University of Electro-Communications
Sato, Ryuki	The University of Electro-Communications
Ming, Aiguo	The University of Electro-Communications
08:45-09:00	ThAT1.2
Hybrid Control Architecture for Mobile Robot Fleets Integrating Centralized Coordination and Decentralized Navigation	
Abutalipov, Kaiser	Satbayev University
Tuleshov, Yerkebulan	Satbayev University
Issabekov, Zhanibek	Satbayev University
Rakhimzhanov, Rustem	Satbayev University
Rakhmetova, Perizat	Satbayev University
09:00-09:15	ThAT1.3
Convexity-Exploiting Successive Convexification for Safe Drone Racing	
Shen, Zhipeng	The Hong Kong Polytechnic University
Zhou, Shiyu	City University of Hong Kong
Huang, Hailong	Hong Kong Polytechnic University
09:15-09:30	ThAT1.4
S2Loc: A Temporal-Geometric Consistent Framework for Long-Term LiDAR Localization	
Wu, Yezhen	Wuhan University of Technology
Wang, Qiang	Wuhan University of Technology
09:30-09:45	ThAT1.5
HSURE: Hierarchical Safety-Aware Exploration Guided by Unknown Regions Using Dynamic Sparse Graphs	
Yang, Wenbin	Wuhan University
Xu, Jingzhong	Wuhan University
Gao, Zhi	Wuhan University
Zhou, Zhiyu	Wuhan University
Lin, Feng	National University of Singapore
09:45-10:00	ThAT1.6
Toggle-Assisted Electric Control Brake Knee Joint for Maintaining Step-Adaptive Swing Phase Angle	
Rei, Ito	Mie University
Masaki, Senzaki	Mie University
Yano, Ken'ichi	Mie University
Manabu, Goto	MASEN Engineering Corporation
Katsuhiko, Tori	IMASEN Engineering Corporation
10:00-10:15	ThAT1.7
HandCept: A Visual-Inertial Fusion Framework for Accurate Proprioception in Dexterous Hands	

Huang, Junda	Chinese University of Hong Kong
Guo, Honghao	The Chinese University of Hong Kong
Wu, Hao	National University of Singapore
Li, Yitong	National University of Singapore
Liu, Zhengyang	Meta
Ang Jr, Marcelo H.	NUS
Zhou, Jianshu	National University of Singapore

ThAT2	Room 256
Advanced Control, Planning and Learning of Unmanned Systems (Regular Session)	
Chair: Liang, Hongtao	Shaanxi Normal University
Co-Chair: Bai, Jianjun	Hangzhou Dianzi Univ
Organizer: Li, Huiping	Northwestern Polytechnical University
Organizer: Zong, Guangdeng	Qufu Normal University
Organizer: Liang, Hongtao	Shaanxi Normal University
Organizer: Liu, Xiaotao	Xidian University
08:30-08:45	ThAT2.1
Adaptive Trajectory Tracking Control for Underactuated AUVs with Prescribed Performance and RBFNN-Based Current Compensation	
Zhu, Shuyi	Hangzhou Dianzi University
Liu, Zhiyao	Hangzhou Dianzi University
Bai, Jianjun	Hangzhou Dianzi Univ
Chen, Yun	Hangzhou Dianzi University
08:45-09:00	ThAT2.2
Globally Asymptotic Formation Control of Networked USVs with Output and Input Constraints	
Liang, Hongtao	Shaanxi Normal University
Yu, Junzhi	College of Engineering, Peking University
Li, Huiping	Northwestern Polytechnical University
09:00-09:15	ThAT2.3
Risk-Averse Tracking Control for Autonomous Heavy-Duty Trucks in High-Speed Obstacle Avoidance Scenarios	
Wang, Yuanxin	Beijing Institute of Technology
Meng, Guoli	Beijing Institute of Technology
Li, Erhang	Beijing Institute of Technology
Wei, Hongqian	Beijing Institute of Technology
Yu, Huilong	Beijing Institute of Technology
Xi, Junqiang	School of Mechanical Engineering, Beijing Institute of Technology
09:15-09:30	ThAT2.4
Crossing the Sim-To-Real Barrier in RL for Quadrotor Control	
Zhao, Zeyuan	Shanghai Jiao Tong University
Zhou, Junyu	Shanghai Jiao Tong University
Li, Xianwei	Shanghai Jiao Tong University
09:30-09:45	ThAT2.5
Predefined-Time Disturbance-Rejection Control for UAVs without Flow Angle Measurements	
Li, Jinbai	Beihang University
Wang, Honglun	Beihang University

Wang, Yanxiang	Beihang University
Liu, Yiheng	Beihang University
09:45-10:00	ThAT2.6
Model-Based Accelerated Safe Reinforcement Learning for Constrained Trajectory Planning of Autonomous Vehicles	
Guo, Jiawei	School of Mathematics, Southeast University
Fu, Junjie	Southeast University

ThAT3	Room 267
Advancements in Intelligent Perception and Autonomous Decision-Making (Regular Session)	
Chair: Zhang, Chunmei	Taiyuan University of Science and Technology
Co-Chair: Zhao, Jiayi	Taiyuan University of Technology
Organizer: Cheng, Lan	Taiyuan University of Technology
Organizer: Zhang, Chunmei	Taiyuan University of Science and Technology
Organizer: Zhang, Jia	Beijing Institute of Technology
08:30-08:45	ThAT3.1
Confidence-Aware Point Cloud Optimization for Sparse-View 3D Gaussian Splatting	
Zhao, Jiayi	Taiyuan University of Technology
Cheng, Lan	Taiyuan University of Technology
Zhang, Jia	Beijing Institute of Technology
Xu, XinYing	Taiyuan University of Technology
08:45-09:00	ThAT3.2
Q-Learning Model Predictive Control with Adaptive Learning Period for Systems with Unknown Parameters	
Peng, He	North University of China
Xiaoli, Luan	Jiangnan University
Wen, Jiwei	Jiangnan University
Zhao, Zhiliang	North University of China
09:00-09:15	ThAT3.3
Adaptive Point Set Aggregation for Large Scale Maximal Covering Location Problems	
Zhu, Ruiyi	Beijing Institute of Technology
Liu, Yaxuan	Beijing Institute of Technology
Chen, Chen	Beijing Institute of Technology
09:15-09:30	ThAT3.4
Pulse Charging Strategy for Lithium Batteries Based on Deep Reinforcement Learning	
Chen, Boyang	Taiyuan University of Technology
Ren, Mifeng	Taiyuan University of Technology
Zhang, WenJie	Taiyuan University of Technology
09:30-09:45	ThAT3.5
An Automated Data Synthesis Framework for Visual-Language Navigation Training Based on 3D Gaussian Splatting	
Ma, Runze	Taiyuan University of Technology
Zhang, Weiqiang	Taiyuan University of Technology
Hao, Lingguang	Taiyuan University of Technology
Cheng, Lan	Taiyuan University of Technology
09:45-10:00	ThAT3.6

SD-MOMPA-Based Approach for Multi-UAV Cooperative Task Allocation	
Yang, Xiaokang	Taiyuan University of Science and Technology
Zhang, Chunmei	Taiyuan University of Science and Technology
Guo, Hong ge	Taiyuan University of Science and Technology

ThAT4	Room 269
Collective Behavior Regulation Inspired by Swarm Intelligence and Its Applications (Regular Session)	
Chair: Yang, Qingkai	Beijing Institute of Technology
Co-Chair: Zeng, Xianlin	Beijing Institute of Technology
Organizer: Yang, Qingkai	Beijing Institute of Technology
08:30-08:45	ThAT4.1
Consensus for Multi-Agent Systems with Stochastic Network and Noises by LLM	
Shang, Jinxin	Fuzhou University
Qi, Yiwen	Fuzhou University
08:45-09:00	ThAT4.2
NE Seeking for Linear Multi-Agent Systems with Time-Varying Costs	
Chongyuan, Hu	Bupt
Xu, Chengzhi	Beijing University of Posts and Telecommunications
Sun, Qiming	Beijing University of Posts and Telecommunications
Tang, Yutao	Beijing University of Posts and Telecommunications
09:00-09:15	ThAT4.3
Synergizing Geometric Fabrics with Population-Based Reinforcement Learning for Dexterous Manipulation of Articulated Objects	
Zhu, Yiming	Zhejiang University
Li, Zihao	Zhejiang University
Lang, Yilin	Zhejiang University
Ren, Qinyuan	Zhejiang University
09:15-09:30	ThAT4.4
Attention-Enhanced Artificial Potential Field with Deep Reinforcement Learning for Multi-UAV Cooperative Pursuit	
Wang, Yunan	Beihang University
Hua, Yongzhao	Beihang University
Li, Xiaoduo	Beihang University
Dong, Xiwang	Beihang University
09:30-09:45	ThAT4.5
Deep Koopman Operator-Based Linear Quadratic Regulator for Quadrotor Pursuit-Evasion Game	
Yang, Xin Mei	Beijing Institute of Technology
Dong, Wei	Beijing Institute of Technology
Cai, Yeyun	Beijing Institute of Technology
Shi, Xiang	Beijing Institute of Technology
Zhang, Lele	Beijing Institute of Technology
Wang, Chunyan	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
09:45-10:00	ThAT4.6

Solving Imperfect-Information Dynamic Defender-Attacker Blotto Games Based on Progressive-Expanding CFR	
He, Yuman	Beijing Institute of Technology
Zeng, Xianlin	Beijing Institute of Technology
Dou, Lihua	Beijing Institute of Technology

ThAT5	Room 259
Distributed Optimization, Game and Learning Algorithms with Their Applications in Cyber-Physical Systems (Regular Session)	
Chair: Hua, Haochen	Hohai University
Organizer: Xiao, Shunyu	Nanjing University of Posts and Telecommunications
Organizer: You, Keyou	Tsinghua University
Organizer: Ye, Maojiao	Nanjing University of Science and Technology
Organizer: Liu, Zhao-Qing	Nanjing University of Posts and Telecommunications
08:30-08:45	ThAT5.1
GFW-YOLO: A Small Traffic Sign Recognition Method Optimized for Detailed Features	
Huang, Chaohong	Chongqing University of Technology
Shen, Xiaoman	Chongqing University of Technology
Han, Shuchang	Chongqing University of Technology
Liu, Wei	Chongqing University of Technology
08:45-09:00	ThAT5.2
Privacy-Preserving Distributed Estimation of Global Storage Capacity Via Dynamic Differential Privacy	
Zhang, Yun	Jinan University
Cui, Zhongrui	Jinan University
Chang, Le	Shanghai University of Electric Power
09:00-09:15	ThAT5.3
Emergency Frequency Restoration in Weak Islanded Microgrids: A Noise-Suppressing Prescribed-Time Approach	
Ye, Ying	State Grid Company
Xu, Bingyan	State Grid Company
Chen, Yunfeng	State Grid Company
Cao, Chun	State Grid Company
Tang, Heng	State Grid Company
Tu, Niehua	Shanghai Electric Power Industry
Han, Yi	Shanghai Electric Power Industry
Tang, Xuyin	Shanghai Electric Power Industry
09:15-09:30	ThAT5.4
Demand Response Decision Optimization for EV Aggregators in V2G Systems Via Embedded-Crossed Graph Attention Reinforcement Learning	
Ruan, Mengxin	Hohai University
Hua, Haochen	Hohai University
Ma, Luyao	Hohai University
Zhou, Yang	Changsha University of Science and Technology
Jiang, Yingjin	China Quality Certification Centre

Sidorov, Denis	Energy Systems Institute, Siberian Branch of the Russian Academy of Sciences
Gertrudes, João Bosco	State University of Feira De Santana
09:30-09:45	ThAT5.5
Fully Distributed Optimal Coordination of Uncertain Euler-Lagrange Systems with Relative Output Measurement	
Liu, Tianyu	City University of Hongkong
Liu, Lu	City University of Hong Kong
09:45-10:00	ThAT5.6
Differentially Private Distributed Nash Equilibrium Seeking for Aggregative Games under an Event-Triggered Mechanism	
Teng, Yuxin	Nanjing University of Science and Technology
Liu, Chao	Nanjing University of Science and Technology
Ye, Maojiao	Nanjing University of Science and Technology
10:00-10:15	ThAT5.7
Quantized Asynchronous H _∞ Control for T-S Fuzzy Systems Based on Fuzzy State Observers	
Yang, Jing-yu	University of Science and Technology Beijing
Guo, Xianggui	University of Science and Technology Beijing
Ding, Dawei	chool of Automation and Electrical Engineer-Ing, University of Science and Technology Beijing, Beijing 100083, Ch
Hao, Liying	Dalian Maritime University

ThAT6	Room 264
Embodied Intelligent Robotics, Active Perception, and Human-Machine Interaction Technologies (Regular Session)	
Chair: Wang, Xiangyang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Jun, Cheng	Chinese Academy of Sciences
Organizer: Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Ziliang, Ren	Dongguan University of Technology
08:30-08:45	ThAT6.1
UGPT: Uncertainty-Guided Dynamic Prompt Tuning for Vision-Language Models	
Huang, Baoqin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Wu, Fuxiang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jun, Cheng	Chinese Academy of Sciences
Abduhalimzoda, Abdukarim	Tajik Technical University Named after Academician M.S. Osimi
Song, Chengqun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
08:45-09:00	ThAT6.2

CAMD-HER: Competence-Aware Multi-Dimensional Curriculum Hindsight Experience Replay for Sparse-Reward Dexterous Control	
Xu, Zhenyu	University of Macau
Ziliang, Ren	Dongguan University of Technology
Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Pun, Chi-Man	University of Macau
09:00-09:15	ThAT6.3
Hybrid Spiking Neural Network for Action Recognition	
Chen, Yan	Dongguan University of Technology
Ziliang, Ren	Dongguan University of Technology
Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Anvarzoda, Daler	Tajik Technical University Named after Academician M.S. Osimi
Bandishova, Risolat	Tajik Technical University Named after Academician M.S. Osimi
09:15-09:30	ThAT6.4
SpikeAttn-YOLO: An Attention-Enhanced Spiking Neural Network for Energy-Efficient Object Detection	
Zhou, Jun	Dongguan University of Technology
Ziliang, Ren	Dongguan University of Technology
Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Abdunabi, Qosimov	Tajik Technical University Named after Academician M.S. Osimi
Shavkat, Kholov	Tajik Technical University Named after Academician M.S. Osimi
09:30-09:45	ThAT6.5
MaskedStar: Orientation-Aware Star-Masked Depthwise Convolution for Lightweight Detection	
Liang, Zhihui	Dongguan University of Technology
Ziliang, Ren	Dongguan University of Technology
Gao, Hongchao	OPT Machine Vision Tech Co., Ltd, Dongguan
Chen, Hang	OPT Machine Vision Tech Co., Ltd, Dongguan
Liu, Ying	OPT Machine Vision Tech Co., Ltd, Dongguan
09:45-10:00	ThAT6.6
A VLM-Driven High-Fidelity Domain Randomization Framework for Imitation Learning	
Huo, Ziyun	Guilin University of Electronic Technology
Wu, Fuxiang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Hao, Fusheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Song, Chengqun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jun, Cheng	Chinese Academy of Sciences
Liu, Jianming	Guilin University of Electronic Technology
10:00-10:15	ThAT6.7
Combining Data Distribution and Adaptive Inference for Robotic Grasping in Vision-Language-Action	
Zhong, Lingye	Guilin University of Electronic Technology
Wu, Fuxiang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Hao, Fusheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Song, Chengqun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jun, Cheng	Chinese Academy of Sciences
Liu, Jianming	Guilin University of Electronic Technology

ThBT1	Assembly Hall
Automated Guided Vehicles (Regular Session)	
Chair: Ding, Yulong	Tongji University
10:30-10:45	ThBT1.1
Adaptive and Navigation under Global Guidance Degradation: A Candidate-Set Driven Approach	
Guan, Xinyu	Zhejiang University
Ren, Qinyuan	Zhejiang University
10:45-11:00	ThBT1.2
Straight-Line Tracking of Unicycle Mobile Robots Using Saturation Controller	
Yan, Hongjiao	South China University of Technology
Xu, Dabo	South China University of Technology
11:00-11:15	ThBT1.3
Energy-Efficient Yaw Stability Control for Four-Wheel-Independent-Drive Electric Vehicles	
Lu, Linying	Yanshan University
Fang, Jiayi	Beijing Institute of Technology
Zhang, Ting	Tsinghua University
Jia, Liheng	Yanshan University
Fang, Yiming	Yanshan University
11:15-11:30	ThBT1.4
Safe and Efficient Motion Coordination for Multi-AGV Systems with Dangerous Circle Detection	
Yang, Runbang	Nankai University
Liu, Jingxuan	Nankai University
Chen, Fei	Nankai University
11:30-11:45	ThBT1.5

Human-Like Trajectory Generation for Full-Process Curve Driving: An Explicit Parametric Approach	
Su, Shaoka	Tongji University
Chen, Hui	Tongji University
Yang, Jiabin	Tongji University
Lin, Huilong	School of Automotive Studies, Tongji University
11:45-12:00	ThBT1.6
Self-Supervised LiDAR-Camera Fusion with Joint Embedding Predictive Architecture for 3D Object Detection	
Chen, Tianjie	The University of Hong Kong
Xie, Le	Shanghai Jiao Tong University
Zhang, Teng	The University of Hong Kong

ThBT2	Room 256
Advanced Optimal Control, Path Planning, and Sensing for Autonomous Intelligent Vehicles (Regular Session)	
Chair: Zhang, Kunwu	China University of Geosciences
Organizer: Mu, Bingxian	University of Prince Edward Island
Organizer: Shen, Chao	Carleton University
Organizer: Xu, Binyan	University of Guelph
Organizer: Liu, Fuqiang	Chongqing University
Organizer: Zuo, Lei	Chang'an University
10:30-10:45	ThBT2.1
Distributed Coverage Control for Multi-Polar Unknown Environments Based on GNN-MLP	
Xu, Jiangwen	Chang'an University
Zuo, Lei	Chang'an University
Xiong, Li	Chang'an University
Zhang, Ziheng	Chang'an University
10:45-11:00	ThBT2.2
Improved Ant Colony Optimization for Revolving Path Planning	
Zhao, Bin	Chongqing University
Shang, Xiruo	Chongqing University
Deng, Zhichao	Chongqing University
Liu, Siyu	CRRG Qingdao Sifang Co., Ltd
Liu, Fuqiang	Chongqing University
11:00-11:15	ThBT2.3
Robust UWB-IMU Localization under NLOS Conditions Using Huber-IRLS Trilateration and EKF Fusion	
Ramadan, Omar A.	University of Guelph
Xu, Binyan	University of Guelph
Al Janaideh, Mohammad	University of Guelph
11:15-11:30	ThBT2.4
Optimal Kinodynamic Motion Planning through Anytime Bidirectional Heuristic Search with Tight Termination Condition	
Wang, Yi	University of New Hampshire
Mu, Bingxian	University of Prince Edward Island
Shokouhi, Shahab	University of New Hampshire
Thein, May-Win	University of New Hampshire
11:30-11:45	ThBT2.5
A Reinforcement Learning Framework for Real-Time Update of MPC Parameters with Ensured Stability	

Zhang, Xiangyu	University of New Hampshire
Li, Guowei	University of New Hampshire
Thein, May-Win	University of New Hampshire
Mu, Bingxian	University of Prince Edward Island
11:45-12:00	ThBT2.6
Distributed Learning-Based MPC with QP Formulation for Platooning Control of Heterogeneous Autonomous Surface Vehicles	
Lin, Yingtao	Carleton University
Shen, Chao	Carleton University
12:00-12:15	ThBT2.7
Data-Driven Robust MPC for the Path Following Control of Wheeled Mobile Robots	
Zahid, Sana	Carleton University
Shen, Chao	Carleton University

ThBT3	Room 267
Agile Planning and Intelligent Control for Autonomous Robots (Regular Session)	
Chair: Jin, Xin	Fudan University
Co-Chair: Miao, Zhiqiang	Hunan University
Organizer: Yong, Kenan	Nanjing University of Aeronautics and Astronautics
Organizer: Cai, Bo	Harbin Institute of Technology
Organizer: Ren, Lu	Anhui University
Organizer: Yin, Zeyang	Central South University
Organizer: Jin, Xin	Fudan University
Organizer: Pang, Bo	Northeastern University
10:30-10:45	ThBT3.1
Neural Network-Based Integral Sliding Mode Control for Modular Reconfigurable Flight Arrays under Midair Separation Disturbance	
Zhou, Weichen	Kunming University of Science and Technology
Yang, Chunxi	Kunming University of Science and Technology
Zhang, Xiufeng	Kunming University of Science and Technology
Sun, Hongwei	Huazhong University of Science and Technology
Shi, Yu	Kunming University of Science and Technology
10:45-11:00	ThBT3.2
Semiglobal Exponential Attitude Consensus under Switching Topologies: A Hybrid System Approach	
Zhang, Manting	Fudan University
Jin, Xin	Fudan University
Tang, Yang	East China University of Science and Technology
11:00-11:15	ThBT3.3
Risk-Aware Smooth Reinforcement Learning for Fixed-Wing UAV Aggressive Maneuvering	
Zhu, Haojie	Nanjing University of Aeronautics and Astronautics
Chen, Mou	Nanjing University of Aeronautics and Astronautics

Yan, Chao	Nanjing University of Aeronautics and Astronautics
Yong, Kenan	Nanjing University of Aeronautics and Astronautics
Han, Zengliang	College of Automation Engineering, Nanjing University of Aeronautics and Astronautics
11:15-11:30	ThBT3.4
Data-Driven H_{∞} Control for Satellite Orbit-Attitude System under Directional Jamming Via Off-Policy Reinforcement Learning	
Fu, Shuai	Fudan University
Jin, Xin	Fudan University
11:30-11:45	ThBT3.5
Occlusion-Aware Reinforcement Learning for Agile Quadrotor Target Tracking in Cluttered Environments	
Liu, Xingxun	Hunan University
Wang, Yaonan	Hunan University
Song, Shichen	Hunan University
Yang, Zeyu	Hunan University
Miao, Zhiqiang	Hunan University
11:45-12:00	ThBT3.6
LV-Fusion Planner: Dynamic Motion Primitive-Based Multimodal Fusion for Low-Latency UAV Path Planning	
He, Weiming	Sichuan University
Qi, Qihan	Sichuan University
Yang, Xinsong	Sichuan University

ThBT4	Room 269
Cooperative Planning and Control for Unmanned Systems (Regular Session)	
Chair: Xin, Bin	Beijing Institute of Technology
Co-Chair: Ding, Yulong	Tongji University
Organizer: Ding, Yulong	Tongji University
Organizer: Xin, Bin	Beijing Institute of Technology
Organizer: Wang, Miao	Beijing Institute of Technology
10:30-10:45	ThBT4.1
Smoothed Particle Hydrodynamics with Differential Interaction Potentials for Multi-Swarm Segregation and Coordination	
Li, Ruocheng	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology
Zhang, Shuai	Hong Kong Polytechnic University
Liu, Xuchen	Chinese University of Hong Kong
Cui, Jinqiang	Pengcheng Laboratory
Chen, Ben M.	Chinese University of Hong Kong
10:45-11:00	ThBT4.2
A Distributed Multi-Robot Herding Algorithm for Faster-Than-Herder Swarm Evaders	
Chen, Delong	Tongji University
Ding, Yulong	Tongji University
Chen, Jiayu	Tongji University
Yin, Zhen	Tongji University
11:00-11:15	ThBT4.3

Priority-Aware Multi-UAV Landing Scheduling with Yielding Strategy for Emergency Logistics	
Fan, Jiaxin	Tongji University
Ding, Yulong	Tongji University
Feng, Kairui	Tongji University
Tan, Yu Heng	National University of Singapore
11:15-11:30	ThBT4.4
Dense Semantic 3D Gaussian Splatting SLAM Via Consistent Feature Distillation and Gradient Decoupling	
Ying, Ruobing	Taiyuan University of Technology
Qi, Zixi	Taiyuan University of Technology
Zhang, Zhe	Taiyuan University of Technology
Cheng, Lan	Taiyuan University of Technology
11:30-11:45	ThBT4.5
Adaptive Exploration-Exploitation Balancing for Robotic Gas Source Seeking Via Time Progress and Spatial Dispersion	
Wang, Miao	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology
Yun, Qu	Beijing Aerospace Automatic Control Institute
11:45-12:00	ThBT4.6
Global Formation Stabilization of Higher-Order Integrators Using Bearing-Only Measurements	
Cheng, Haoshu	Nanyang Technological University
Yan, Yamin	Nanyang Technological University
Hu, Guoqiang	Nanyang Technological University
12:00-12:15	ThBT4.7
Enhanced OC-SORT for UAV Swarm Tracking Via Direction Consistency and Trajectory Memory	
Li, Tianyang	Beijing Institute of Technology
Peng, Zhihong	Beijing Institute of Technology
Li, Yukun	Beijing Institute of Technology
Zha, Wenzhong	Eastern Communications Group of China Electronics Technology Group Corporation

ThBT5	Room 259
DT-Driven Smart Inspection and Diagnosis (Regular Session)	
Chair: Chen, Xi	The Chinese University of Hong Kong
Organizer: Hong, Wenxing	Xiamen University
Organizer: Liu, Chuanbin	University of Science and Technology of China
Organizer: Huo, Mengzhen	School of Automation Science and Electrical Engineering, Beihang University
Organizer: Zhang, Jihan	The Chinese University of Hong Kong
Organizer: Li, Yu	The Chinese University of Hong Kong
Organizer: Huang, Yijun	The Chinese University of Hong Kong
Organizer: Hong, Duanqin	Xiamen University
Organizer: Zhu, Jiacheng	Donghai Lab
Organizer: Xu, Jiwen	The Chinese University of Hong Kong
10:30-10:45	ThBT5.1

An Unsupervised Underwater Image Restoration Framework with Adaptive Color Stretch and Compensation Strategy	
Zhu, Jiacheng	Donghai Lab
Ke, Cheng	Xiamen University
Tong, Yicheng	Zhejiang University
Mei, Lin	Donghai Lab
Zhang, Jihan	The Chinese University of Hong Kong
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
10:45-11:00	ThBT5.2
Environment-Aware Multi-UAV Search for Efficient Large-Scale Small Target Detection	
Xu, Jiwen	The Chinese University of Hong Kong
Hong, Duanqin	Xiamen University
Zhang, Jihan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
11:00-11:15	ThBT5.3
Campus Safety: UAV-Based Autonomous Defect Detection in Minnan-Style Architecture	
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
Zhang, Rui	Xiamen University
Wang, Xianyi	Xiamen University
Hong, Duanqin	Xiamen University
Zhang, Jihan	The Chinese University of Hong Kong
Luo, Kunhong	Xiamen University
11:15-11:30	ThBT5.4
A Multi-Agent Digital Twin Framework for LLM-Driven Building Energy and Indoor Air Quality Co-Simulation	
Huang, Yijun	The Chinese University of Hong Kong
Li, Yu	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
11:30-11:45	ThBT5.5
Frequency-Calibrated UNet with Optimized Compound Loss for Kelp Semantic Segmentation	
Hu, Xingzheng	Xiamen University
Chen, Binqiang	Xiamen University
Ke, Cheng	Xiamen University
Zhu, Jiacheng	Donghai Lab
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
11:45-12:00	ThBT5.6
Path Planning for Mobile Robots Based on Continuous Cost Guidance	
Jiang, Yuze	Xiamen University
Dong, Zicheng	Xiamen University
Ke, Cheng	Xiamen University

Hong, Wenxing	School of Aerospace Engineering, Xiamen University
ThBT6	Room 264
Embodied Multiagent Systems (Regular Session)	
Chair: Cui, Jinqiang	Pengcheng Laboratory
Organizer: Cui, Jinqiang	Pengcheng Laboratory
Organizer: Zhao, Shiyu	Westlake University
Organizer: Zhang, Hongwei	Harbin Institute of Technology
10:30-10:45	ThBT6.1
A Bearing-Strength Method for Motion Estimation of Unknown Energy Emitters	
Chen, Haoyu	Westlake University
Ning, Zian	Westlake University
Zhang, Yin	Westlake University
Zhao, Shiyu	Westlake University
10:45-11:00	ThBT6.2
Input-To-State Safety with High-Order Control Barrier Functions	
Wang, Xinyang	Harbin Institute of Technology
Zhang, Hongwei	Harbin Institute of Technology
11:00-11:15	ThBT6.3
Fixed-Time Distributed Robust Coverage Control for Heterogeneous UAVs-UGVs Systems with Human Interaction Via LLM	
Wu, Hao	Beihang University
Duan, Haibin	Beihang University
Chang, Yingxiu	Pengcheng Laboratory
Cui, Jinqiang	Pengcheng Laboratory
Yang, Jiankun	Peng Cheng Laboratory
11:15-11:30	ThBT6.4
A Hierarchical DRL-Based Planning and Navigation Framework for Complex Multi-Robot Missions Leveraging LLMs	
Liu, Lian	South China University of Technology; Peng Cheng Laboratory
Wang, Zhenmin	South China University of Technology
Liu, Xuchen	The Chinese University of Hong Kong
Cui, Jinqiang	Pengcheng Laboratory
11:30-11:45	ThBT6.5
PLAF: Pixel-Wise Language-Aligned Feature Extraction for Efficient 3D Scene Understanding	
Wen, Junjie	The Chinese University of Hong Kong
He, Junlin	Sun Yat-Sen University
Ma, Fei	University of Chinese Academy of Sciences
Cui, Jinqiang	Pengcheng Laboratory
11:45-12:00	ThBT6.6
HiveNav: Hierarchical Semantic Planning for UAV Swarm Exploration	
Liu, Xuchen	The Chinese University of Hong Kong

Zhang, Weichen	Tsinghua University
Li, Ruocheng	Beijing Institute of Technology
Wei, Hejun	Southern University of Science and Technology
Huang, Shunyu	Harbin Institute of Technology
Huang, JunSong	Harbin Institute of Technology, Shenzhen; Peng Cheng Laboratory
Cui, Jinqiang	Pengcheng Laboratory
12:00-12:15	ThBT6.7
Modeling and Control of a Swashplateless Rotor with a Teetering Hinge	
Wang, Biao	Nanjing University of Aeronautics and Astronautics
Wei, Xing	Nanjing University of Aeronautics and Astronautics
Tang, Chaoying	Nanjing University of Aeronautics and Astronautics

ThCT1	Assembly Hall
Nonlinear Systems and Control (Regular Session)	
Chair: Guay, Martin	Queen's University
13:45-14:00	ThCT1.1
Nonlinear Model Predictive Control with Time-Proportioning Vent and Ballast Actuation for an Autonomous Balloon Control System	
Azhdari, Maryam	Queen's University
Guay, Martin	Queen's University
14:00-14:15	ThCT1.2
A Mathematical Description of Intelligence in Dynamical System	
Liu, Shiqi	Tsinghua University
Zhang, Xiangteng	Tsinghua University
Yu, Zhouyang	Tsinghua University
Li, Shengbo Eben	Tsinghua University
14:15-14:30	ThCT1.3
Improving the Algorithms of Computing Control Inputs for a Class of Controllable Discrete-Time Bilinear Systems	
Zhao, Wenyu	Beihang University
Tie, Lin	Beihang University (Beijing University of Aeronautics and Astronautics)
14:30-14:45	ThCT1.4
Data-Driven Nonlinear Min-Max Model Predictive Control with Measurement Errors	
Wei, Yuzhou	Beijing Institute of Technology
Xiao, Wei	Beijing Institute of Technology
Wang, Linqi	Beijing Institute of Technology
Liu, Wenjie	Beijing Institute of Technology, Beijing, China
Wang, Gang	Beijing Institute of Technology
14:45-15:00	ThCT1.5
Multi-Factor Data Preparation and Scenario Assessment for Forecasting Freight Flows Along the Trans-Caspian International Transport Route	
Gafiatullin, Farkhad	"Online Shopping" LLP

Mukhanova, Gulmira	Satbayev University
Antoni, Alfonz	Budapest Metropolitan University
Imasheva, Gulnar	Satbayev University
Toregali, Nargiza	Satbayev University
15:00-15:15	ThCT1.6
Reduced-Order Flow Estimation and Predictive Station-Keeping in Flows Governed by the Navier-Stokes Equations	
Waterman, Adam	Queen's University
Guay, Martin	Queen's University

ThCT2	Room 256
Advanced Technologies for Robot Learning, Control, and Manipulation (Regular Session)	
Chair: Cai, Mingxue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Co-Chair: Xu, Sheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Cai, Mingxue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Xu, Sheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Yang, Lidong	The Hong Kong Polytechnic University
13:45-14:00	ThCT2.1
RRT*-Based Hybrid Path Planning Method and Automatic Navigation of Microswarms	
Jiang, Jialin	Shenyang Institute of Automation, Chinese Academy of Science
14:00-14:15	ThCT2.2
A Learning-Based Viscoplastic Filament Manufacture Method Using Robotic Arm Based on Flow Matching Policy	
Chen, Guoqing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Tang, Yifeng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jiang, Guolai	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Xu, Sheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
14:15-14:30	ThCT2.3
LogCosh Super-Twisting Control for Robust Path Planning and Following	
Cai, Mingxue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Gao, Daan	Southern University of Science and Technology
14:30-14:45	ThCT2.4
Physics-Informed Predictive Control for Isoline Tracking in Dynamic Scalar Fields	
Huang, Nanxi	Beijing Institute of Technology

Li, Zhuo	Tsinghua University
Zhang, Yanjun	Beijing Institute of Technology
Sun, Jian	Beijing Institute of Technology
Gao, Zhanyu	New York University
14:45-15:00	ThCT2.5
Real-Time Mask-Conditioned Surgical Grasping Via Action Chunking Transformers	
Duan, Wenxing	The Chinese University of Hong Kong
Li, Bin	The Chinese University of Hong Kong
Liu, Yunhui	Chinese University of Hong Kong
15:00-15:15	ThCT2.6
PID-Type Distributed Iterative Learning Control for Wheeled Mobile Robots: A Two-Dimensional System Approach	
Wang, Wenxian	Beihang University
Meng, Deyuan	Beihang University (BUAA)

ThCT3	Room 267
Autonomous Intelligence for Industry, Daily Services, and Rescue Operations (Regular Session)	
Chair: Hu, Songyu	Zhejiang University
Organizer: Chen, Haoyao	Harbin Institute of Technology, Shenzhen Graduate School
Organizer: Hu, Songyu	Zhejiang University
13:45-14:00	ThCT3.1
Lite 2S-AGCN towards Skeleton Action Recognition for Mobile and Edge Devices	
Zheng, Jianshu	Shenzhen Institutes of Advanced Technology
Zheng, Zhiyuan	Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences
Wang, Can	Chinese Academy of Sciences
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
14:00-14:15	ThCT3.2
DeepPVE: Deep Learning-Based Point Visibility Estimation against Density Variation and Noise	
He, Rui	Harbin Institute of Technology, Shenzhen
Cui, Hongkang	Harbin Institute of Technology (Shenzhen)
Chen, Haoyao	Harbin Institute of Technology, Shenzhen Graduate School
Li, Peng	Harbin Institute of Technology, Shenzhen
14:15-14:30	ThCT3.3
MSCN-LSTM: A Multi-Scale CNN and BiLSTM-Based Model for Multi-Modal Gesture Recognition Using EMG and IMU Signals	
He, Xiaoyao	Nanjing University of Aeronautics and Astronautics
Xie, Mingyang	Nanjing University of Aeronautics and Astronautics
Yao, Taike	Aero Engine Corporation of China Control System Research Institute
Zhou, Qi	Shanghai Jiaotong University
Bi, Youyi	Shanghai Jiao Tong University

14:30-14:45	ThCT3.4
High-Precision Vascular Network Mapping for Active Targeting Microrobots Navigation In-Vivo	
Huang, Renqiang	Soochow University
Zhang, WenKai	Soochow University
Pan, Hao	Soochow University
Zhang, Xinyue	Soochow University
Chen, Xuanhan	College of Electrical and Engineering, Soochow University
Sun, Lining	Soochow University
Li, Xiangpeng	Soochow University
14:45-15:00	ThCT3.5
Magnetically Controlled Patterning of Liquid Metals Via Superwetting of Fe Liquid Metal Composite Coatings for Flexible Electronics	
Sun, Xiaoqin	Northwestern Polytechnical University
Chen, Xuanhan	College of Electrical and Engineering, Soochow University
Deng, Yuguo	School of Mechatronics Engineering, Harbin Institute of Technology
Gan, Kun	Soochow University
Bao, Wanlin	Soochow University
Bing, Xiao	School of Automation, Northwestern Polytechnical University
Li, Xiangpeng	Soochow University
15:00-15:15	ThCT3.6
An RCM-Constrained Robot Path Planning Method Based on Two-Stage Sampling	
Xu, Jiahang	Zhejiang University
Hu, Jiaying	Zhejiang University
Li, Jiayi	Zhejiang University
Hu, Songyu	Zhejiang University
Fu, Jianzhong	Zhejiang University

ThCT4	Room 269
Distributed Control and Decision-Making for Multi-Agent Systems with Safety and Security Guarantees (Regular Session)	
Chair: Dong, Yi	Tongji University
Co-Chair: Liu, Tao	Southern University of Science and Technology
Organizer: Dong, Yi	Tongji University
Organizer: Liu, Tao	Southern University of Science and Technology
13:45-14:00	ThCT4.1
Data-Driven Cooperative Output Regulation of Singular Linear Multi-Agent Systems	
Cai, Jialei	University of Shanghai for Science and Technology
Zhou, Chi	University of Shanghai for Science and Technology
Liang, Dong	University of Shanghai for Science and Technology
Dong, Yi	Tongji University
Wang, Chaoli	Univ. of Shanghai for Sci. & Tech

Sun, Yuanyingyi	Shanghai Linksai Technology Co. Ltd
14:00-14:15	ThCT4.2
Control of a Reaction-Diffusion PDE-ODE System with an Actuator Delay	
Wu, Tao	Southern University of Science and Technology
Xu, Xiang	Southern University of Science and Technology
Wu, Xuyang	Southern University of Science and Technology
14:15-14:30	ThCT4.3
ADMM-Based Distributed Formation Control for Multi-Parafoil Systems	
Zhou, Tianyi	Shanghai Jiao Tong University
Zhou, Tianyi	Shanghai Jiao Tong University
Li, Yuanlong	Shanghai Jiao Tong University
Shi, Liangren	Shanghai Jiao Tong University
14:30-14:45	ThCT4.4
Position Synchronization of Multiple PMSM Systems: A Distributed Internal Model Approach	
Guo, Jiayu	Hefei University of Technology
Ping, Zhaowu	Hefei University of Technology
Zhang, Hongwei	Harbin Institute of Technology
14:45-15:00	ThCT4.5
A Scalable Distributed Algorithm for Solving Linear Equations Over Double-Layered Networks with Jointly Connected Clusters	
Chen, Chen	Southern University of Science and Technology
Wang, Lili	Southern University of Science and Technology
Liu, Tao	Southern University of Science and Technology
15:00-15:15	ThCT4.6
Active Vibration Control with Frequency-Switching Excitation: A Sparse Autoencoder and Reinforcement Learning Based Approach	
Wang, Hongman	Tongji University
Dong, Yi	Tongji University
Li, Rongyan	Tongji University
Xin, Bin	Beijing Institute of Technology
Wang, Qing	Beijing Institute of Technology
Chen, Xi	The Chinese University of Hong Kong

ThCT5	Room 259
Dynamic and Intelligent Decision-Making for Autonomous Systems (Regular Session)	
Chair: Zeng, Xianlin	Beijing Institute of Technology
Co-Chair: Dong, Xiwang	Beihang University
Organizer: Zeng, Xianlin	Beijing Institute of Technology
Organizer: Xu, Jinming	Zhejiang University
Organizer: Wang, Qing	BUAA
13:45-14:00	ThCT5.1

Momentum-Based Gradient-Free Algorithm for Nonsmooth Nonconvex Compositional Optimization without Large Outer Batches	
Hou, Jie	Beijing Institute of Technology
Zeng, Xianlin	Beijing Institute of Technology
Xu, Jinming	Zhejiang University
14:00-14:15	ThCT5.2
A Weighted Bundle Method of Multipliers with Improved Computational Efficiency	
Zheng, Zhuoqing	Southern University of Science and Technology
Li, Cong	Southern University of Science and Technology
Xu, Xiang	Southern University of Science and Technology
Wu, Xuyang	Southern University of Science and Technology
14:15-14:30	ThCT5.3
KL-Prior Regularized PPO: Integrating LLM Tactical Knowledge into Reinforcement Learning for Beyond-Visual-Range Air Combat	
Guo, Zheng	Beihang University
Yu, Jianglong	Beihang University
Chen, Yiming	Beihang University
Ren, Zhang	Beihang University
14:30-14:45	ThCT5.4
Koopman-Based Linear MPC with INDI for Quadrotor Trajectory Tracking Control	
Lv, Xiaokang	Beihang University
Wang, Qing	Beihang University
Wang, Shimin	Massachusetts Institute of Technology
Dong, Xiwang	Beihang University
14:45-15:00	ThCT5.5
Local Generalization Analysis for Decentralized Personalized Federated Learning	
Chen, Xing	Southeast University
Yu, Yuanyuan	Southeast University
Yang, Shaofu	Southeast University
Xu, Wenying	Southeast University
15:00-15:15	ThCT5.6
Spatial-Temporal Hierarchical Planning and Incremental NMPC Tracking for Fixed-Wing UAVs in Cluttered Environments	
Deng, Shijie	Beihang University
Yu, Jianglong	Beihang University
Feng, Zhi	Beihang University
Dong, Xiwang	Beihang University
15:15-15:30	ThCT5.7
DP-KF: A Dual-Stage Personalization Kalman Filter for Human Joint-Angle Prediction	
Wang, Nan	Nanjing University of Posts and Telecommunications
Shao, Xiaojuan	Nanjing University of Posts and Telecommunications

Lulu, Song	College of Automation, Nanjing University of Posts and Telecommunications, Nanjing, China
Ling, Ren	College of Automation, Nanjing University of Posts and Telecommunications, Nanjing China
Sha, Fan	College of Automation, Nanjing University of Posts and Telecommunications, Nanjing China
Chao, Deng	Nanjing University of Posts and Telecommunications

ThCT6	Room 264
Embodied Perception, Decision, and Control for Autonomous Unmanned Systems (Regular Session)	
Chair: Wu, Wentao	The Hong Kong Polytechnic University
Co-Chair: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Wu, Wentao	The Hong Kong Polytechnic University
Organizer: Wang, Huiting	The Hong Kong Polytechnic University
Organizer: Xu, Lei	KTH Royal Institute of Technology
Organizer: Chen, Wen-Hua	Loughborough University
Organizer: Zhang, Weidong	Shang Hai Jiaotong University
13:45-14:00	ThCT6.1
Safety-Critical Accelerated Fixed-Time Convergence Learning-Based Control Via Dual Objective Synthesis	
Tan, Junkai	The Hong Kong Polytechnic University
Wu, Wentao	The Hong Kong Polytechnic University
Chen, Wen-Hua	Loughborough University
Zuo, Zhiqiang	Tianjin University
Wang, Yijing	Tianjin University
14:00-14:15	ThCT6.2
Trajectory Tracking of Autonomous Ground Vehicles Based on Robust MPC with Gain Scheduling	
Zhang, Kunwu	China University of Geosciences
Wang, Huiting	The Hong Kong Polytechnic University
Cao, Weihua	China University of Geosciences, Wuhan, China
14:15-14:30	ThCT6.3
Closed-Chain Sim2Sim Gait Transfer for Linear-Actuator Driven Humanoid Robot on Complex Terrains	
Ding, Tao	Huazhong University of Science and Technology
Liu, Zexu	Huazhong University of Science and Technology
Zhang, Yuhao	Huazhong University of Science and Technology
Zhu, Qingmiao	Huazhong University of Science and Technology
Zhao, Xingwei	Huazhong University of Science and Technology

Bo, Tao	Huazhong University of Science and Technology
Shi, Yang	Canada
14:30-14:45	ThCT6.4
Tether-Connected Tilt-Rotor Quadrotor Robot for Building Maintenance	
Su, Jiangcheng	Hong Kong Polytechnic University
Zhou, Guanzhong	Hong Kong Polytechnic University
Haoyang, Yang	Hong Kong Polytechnic University
Cheng, Li	Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
Huang, Hailong	Hong Kong Polytechnic University
14:45-15:00	ThCT6.5
Graph-MAPPO for Self-Organized Airship Encirclement and Hotspot Surveillance	
Pei, Wenyuan	Beihang University
Liu, Simin	Beihang University
Zheng, Zewei	Beihang University
Zou, Yuxuan	Beihang University
15:00-15:15	ThCT6.6
GIGA: A Generative-Initialized Gated-Adaptation Framework for Multi-Agent Adversarial Games	
Wang, Xiaoxiao	Tongji University
Zhao, Yihang	Tongji University
Lei, Jinlong	Tongji University
Hong, Yiguang	Chinese Academy of Sciences

Technical Program for Friday June 19, 2026

FrAT1	Assembly Hall
Estimation and Identification (Regular Session)	
Chair: Li, Xianwei	Shanghai Jiao Tong University
Co-Chair: Yin, Xunyuan	Nanyang Technological University
08:30-08:45	FrAT1.1
Adaptive Image-Based Stationary Target Circumnavigation of Nonholonomic Mobile Robot	
Yu, Shicong	Fuzhou University
Su, Youfeng	Fuzhou University
Cai, He	South China University of Technology
Xu, Liang	Fuzhou University
08:45-09:00	FrAT1.2
LLM-Based Reliability Evaluation and Predictive Maintenance Over Complex Product Lifecycle	
Guo, Yi	Northwestern Polytechnical University
Guo, Zhengang	Northwestern Polytechnical University
Zhang, Yingfeng	Https://controls.papercept.net/conferences/scripts/start.pl#WODES16
09:00-09:15	FrAT1.3
Revisit Kalman Filter through the Lens of Dynamic Programming	
He, Zeyu	Tsinghua University
Cao, Wenhan	Tsinghua University
Liu, Shiqi	Tsinghua University
Liu, Chang	Cornell University
Li, Shengbo Eben	Tsinghua University
09:15-09:30	FrAT1.4
A Data-Driven and Model-Driven Fusion Methodology for Real-Time Radome Error Slope Estimation	
Liu, Bingxun	Northwestern Polytechnical University
Xu, Hongyang	Northwestern Polytechnical University
Fan, Pengfei	Northwestern Polytechnical University
Fan, Yonghua	Northwestern Polytechnical University
09:30-09:45	FrAT1.5
Dynamic Event-Triggered Observer for LTI Systems with Positive Minimum Inter-Event Times	
Liu, Yiyang	Shanghai Jiao Tong University
Li, Xianwei	Shanghai Jiao Tong University
Li, Shaoyuan	Shanghai Jiao Tong University
09:45-10:00	FrAT1.6
Optimization-Free Learning-Based Data-Enabled State Estimation with Application to Membrane Wastewater Treatment Processes	
Li, Xiaojie	Nanyang Technological University
Yin, Xunyuan	Nanyang Technological University
10:00-10:15	FrAT1.7

Stochastic Sensor Scheduling in Cyber-Physical Systems Subject to Energy Constraints	
Ning, Chuanyi	Beihang University
Hao, Fei	Beijing University of Aeronautics and Astronautics

FrAT2	Room 256
Integrating Embodied Intelligence: Perception and Advanced Control in Robotic Systems (Regular Session)	
Chair: Chan, Tobias	The Chinese University of Hong Kong
Organizer: Sun, Yichong	The Chinese University of Hong Kong
Organizer: Cai, Bo	Harbin Institute of Technology
08:30-08:45	FrAT2.1
Stochastic-Sampling-Based Event-Triggered Control for Markov Jump Systems: A Data-Based Scheme	
Zhang, Ning	East China University of Science and Technology
Niu, Yugang	East China University of Science and Technology
Cao, Zhiru	Shanghai University
08:45-09:00	FrAT2.2
Multi-UAVs Cooperative Path Planning Based on DQN under Communication Constraints	
Wu, Haoyu	Beijing Institute of Technology
Li, Chaofeng	Academy of Military Sciences
Guo, Huiyu	Beijing Institute of Technology
Wei, Yiran	National Key Laboratory of Near-Surface Detection
Pan, Zhenhua	Beijing Institute of Technology
09:00-09:15	FrAT2.3
Deep Reinforcement Learning for Dubins Traveling Salesman Problem	
Fang, Pengfei	Beihang University
Li, Wenling	Beihang University
Song, Jia	Beihang University
Li, Xiaoming	Shenzhen University
09:15-09:30	FrAT2.4
Deep-GeoGS: Efficient Deep Feature Matching with Geometric Awareness for Robust 3D Gaussian Splatting	
Han, Qihang	Guangdong Provincial Association for Science and Technology
Lai, Cunzhi	Guangdong University of Technology
Lin, Xubin	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Wu, Hongmin	Guangdong Institute of Intelligent Manufacturing
Zhou, Xuefeng	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
09:30-09:45	FrAT2.5
Few-Shot Pose Estimation for Robotic Sorting of Flexible Packages with Complex Overlapping and Ambiguous Boundaries	
Wang, JunYang	Wuyi University

Zhang, JiangMing	Guangdong Polytechnic Normal University
Jiang, Li	Wuyi University
Kong, ShaoHua	Wuyi University
Lin, Xubin	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Zhou, Xuefeng	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Yan, Wu	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Wu, Hongmin	Guangdong Institute of Intelligent Manufacturing
09:45-10:00	FrAT2.6
LeCal: Latency-Aware Curation and Alignment for LeRobot Teleoperation Datasets	
Chan, Tobias	The Chinese University of Hong Kong
10:00-10:15	FrAT2.7
A Two-Stage Vision-Guided Autonomous Docking Method for Underwater Unmanned Vehicles: Integrating Long-Range Optical Beacon Guidance with Close-Range AprilTag-Based Pose Estimation	
Wang, Jingyu	Harbin Institute of Technology(weihai)
Zhu, Yong	Harbin Institute of Technology(weihai)
Zhao, Yifan	Harbin Institute of Technology(weihai)
Ling, Qi	Harbin Institute of Technology
Pang, Zhiyuan	Harbin Institute of Technology
Huang, Bo	Harbin Institute of Technology

FrAT3	Room 267
Intelligent Perception and Secure Control of Unmanned Systems (Regular Session)	
Chair: Teng, Hao	Beihang University
Co-Chair: Guo, Kexin	Beihang University
Organizer: Teng, Hao	Beihang University
Organizer: Zhou, Liutao	University of Duisburg-Essen
Organizer: Zhao, Dong	Beihang University
Organizer: Yu, Xiang	Beihang University
08:30-08:45	FrAT3.1
Computationally Efficient Prescribed-Time Control for AUVs Via Single-Critic Network	
Zhang, Zhixuan	Beihang University
Xu, Qiang	Beihang University
Zhang, Liyao	Beihang University
Teng, Hao	Beihang University
Hu, Pengwei	Beihang University
Qiao, Jianzhong	Beihang University
08:45-09:00	FrAT3.2
Adaptive Disturbance Learning for Constrained Systems: A Hopf-Oscillator Driven Tube-MPC Approach	
Zhang, Liyao	Beihang University
Zhang, Zhixuan	Beihang University

Li, Shaohui	BeiHang University
Xu, Qiang	Beihang University
Shen, Xinjing	BeiHang University
Teng, Hao	Beihang University
09:00-09:15	FrAT3.3
Distributed Nonlinear Disturbance Observer-Based Refined Cooperative Control for Multi-Satellite with Mandatory Pointing Constraint	
Yixuan, Zhang	Beihang University
Shen, Xinjing	BeiHang University
Qinhe, Jin	Beihang University
Zhang, Zhixuan	Beihang University
Teng, Hao	Beihang University
Zaoxu, Zhu	Beihang University
09:15-09:30	FrAT3.4
Neural-Network-Augmented Sliding Mode Control for Precision Pointing of EO Pods under Composite Disturbances	
Wu, Jiaao	Beihang University
Yaokun, Lu	Beihang University
Yixuan, Zhang	Beihang University
Zhang, Liyao	Beihang University
Teng, Hao	Beihang University
Qiao, Jianzhong	Beihang University
09:30-09:45	FrAT3.5
Safety-Critical Composite Attitude Control for VLEO Satellites under Composite Disturbances	
Sun, Changqing	Beihang University
Li, Yifan	Beihang University
Yixuan, Zhang	Beihang University
Kun, Wang	Beihang University, Hangzhou Innovation Institute
Teng, Hao	Beihang University
Qiao, Jianzhong	Beihang University
09:45-10:00	FrAT3.6
Cross-Subject Recognition of Passenger Perceived Stress in Autonomous Driving Using LSTM-MHSA Networks	
Guo, Yirui	Beihang University
Zhang, Zhanpeng	Beihang University
Liu, Yuanyuan	Beihang University
Ren, Zhanyan	Beihang University
10:00-10:15	FrAT3.7
Efficient Positioning for Unmanned Systems: A Mamba-Based CSI Fingerprinting Framework	
Zhang, Zhanpeng	Beihang University
Guo, Yirui	Beihang University
Duan, Lanzhi	Beihang University
Xie, Xin	Jiangxi Research Institute of Beihang University
Yao, Jiaojiao	Beijing Tiantan Hospital, Capital Medical University
Wang, Changhai	Guangxi Transportation Design Group
Li, Daofei	Transport Information Management Center of Guangxi Zhuang Autonomous Region

Xia, Ming	Beihang University
FrAT4	Room 269
Micro-Robotic Systems and Applications (Regular Session)	
Chair: Niu, Fuzhou	Suzhou University of Science and Technology
Co-Chair: Mo, Hangjie	Hefei University of Technology
Organizer: Niu, Fuzhou	Suzhou University of Science and Technology
Organizer: Mo, Hangjie	Hefei University of Technology
08:30-08:45	FrAT4.1
A Semi-Analytical Model for Planar PCB Spiral Coils with Application to Magnetic Microrobot Actuation	
Chen, Yubing	Suzhou University of Science and Technology
Wang, Yu	Suzhou University of Science and Technology
Lian, Jibing	Suzhou University of Science and Technology
Bao, Danyang	Shenzhen Polytechnic University
Han, Dong	Zhejiang University
Mo, Hangjie	Hefei University of Technology
Li, Ying	Shenzhen Polytechnic University
Niu, Fuzhou	Suzhou University of Science and Technology
08:45-09:00	FrAT4.2
Development of a Sperm-Shaped Magnetic Algae Microrobot	
Zhang, Mengyu	Ocean University of China
Song, Liansheng	Ocean University of China
Yu, Wei	Ocean University of China
Zheng, Liushuai	City University of Hong Kong
Wen, Qi	Ocean University of China
Jin, Yujian	China Research Institute of Radiowave Propagation, Xinxiang 453003, China
Li, Junyang	Ocean University of China
09:00-09:15	FrAT4.3
Numerical Analysis and System Construction for an Automated Droplet Manipulation Technology Based on EWOD	
Lin, Jinhai	Xiamen University of Technology
Wang, Yihang	Xiamen University of Technology
Ma, Weicheng	Xiamen University of Technology
Tian, Ye	Xiamen University of Technology
Zhou, Yuantai	Xiamen University of Technology
Han, Qingxin	Xiamen University of Technology
Huan, Zhijie	Xiamen University of Technology
09:15-09:30	FrAT4.4
Load-Adaptive PID Control of Galvo Scanners Based on Online Moment of Inertia Identification	
Le, Jinyang	Xiamen University
Ma, Yao	Xiamen University
Wu, Guobin	Xiamen University
Wang, Yuqi	Xiamen University
Dai, Yingying	Xiamen University
Zhou, Wei	Xiamen University
Luo, Tao	Xiamen University

09:30-09:45	FrAT4.5
A Track Fusion Method for Scattered Vessel-Detection Data	
Jiang, Tian	Nanjing Research Institute of Electronics Technology
Geng, Chao	Nanjing Research Institute of Electronics Technology
09:45-10:00	FrAT4.6
Precision Disturbance Rejection Control of Fast Steering Mirror Based on Super-Twisting Sliding Mode	
Huang, Jin	China Academy of Engineering Physics
Ye, Haifu	China Academy of Engineering Physics
Liang, Xudong	Institute of Fluid Physics, China Academy of Engineering Physics
Wu, Linchao	China Academy of Engineering Physics
Tang, Wei	China Academy of Engineering Physics
Liu, Yueyue	Jiangnan University

FrAT5	Room 259
Perception, Mapping, and Autonomous Control for Underwater Robotic Systems in Challenging Environments (Regular Session)	
Chair: Lei, Lei	The Chinese University of Hong Kong
Co-Chair: Ding, Wendi	The Chinese University of Hong Kong
Organizer: Lei, Lei	The Chinese University of Hong Kong
Organizer: Yang, Guidong	The Chinese University of Hong Kong
Organizer: Huang, Dongyue	Nanyang Technological University
Organizer: Ding, Wendi	The Chinese University of Hong Kong
Organizer: Zhang, Jianxing	Huazhong University of Science and Technology
Organizer: Wen, Junjie	The Chinese University of Hong Kong
Organizer: Han, Mingqiao	The Chinese University of Hong Kong
Organizer: Zhao, Benyun	The Chinese University of Hong Kong
08:30-08:45	FrAT5.1
A Review of Intelligent Trajectory Planning for Unmanned Underwater Vehicles	
Li, Shangqing	Huazhong University of Science and Technology
Wang, Yuhan	Huazhong University of Science and Technology
Gao, Longlong	Huazhong University of Science and Technology
Yuan, Chang	Huazhong University of Science and Technology
Yin, Peiyi	Huazhong University of Science and Technology
Zhang, Jianxing	Huazhong University of Science and Technology
Li, Baoren	Huazhong University of Science and Technology

08:45-09:00	FrAT5.2
Dynamics Modeling and Trim Control for Underwater Gliders	
Lei, Lei	The Chinese University of Hong Kong
Yang, Guidong	The Chinese University of Hong Kong
Han, Mingqiao	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
09:00-09:15	FrAT5.3
SLAM for Underwater Autonomous Unmanned Systems: Sensors, Framework and Limitations	
Han, Mingqiao	The Chinese University of Hong Kong
Wang, Chenxiao	Tongji University
Lei, Lei	The Chinese University of Hong Kong
Yang, Guidong	The Chinese University of Hong Kong
Ding, Yulong	Tongji University
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
09:15-09:30	FrAT5.4
PSB-NANO: A Forward-Looking Imaging Sonar Benchmark for Underwater Pile Diagnosis	
Li, Kun	Nanjing University of Posts and Telecommunications
Zhang, Zhen	Nanjing University of Posts and Telecommunications
Zhao, Benyun	The Chinese University of Hong Kong
Wang, Enliang	Nanjing University of Posts and Communications
Lei, Lei	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
09:30-09:45	FrAT5.5
A Novel Spatiotemporal Environment Perception Framework for Ocean Current Field	
Wang, Yichen	Beijing Institute of Technology
Lei, Lei	The Chinese University of Hong Kong
Li, Ying	Beijing Institute of Technology
09:45-10:00	FrAT5.6
Efficient Real-Time Modeling of Longitudinal Dynamics for Semi-Submerged Hydrofoil Unmanned Surface Vehicles	
Ding, Wendi	The Chinese University of Hong Kong
Yan, Ruixin	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

FrAT6	Room 264
Situational Awareness and Resilient Control in Cyber-Physical Systems (Regular Session)	
Chair: Badihi, Hamed	Tampere University, Tampere 33720, Finland
Co-Chair: Zhang, Youmin	Concordia University
Organizer: Badihi, Hamed	Tampere University, Tampere 33720, Finland
Organizer: Zhang, Youmin	Concordia University
08:30-08:45	FrAT6.1
Event-Triggered Fixed-Time Resilient Secondary Control of Smart Grid under FDI Attacks	
Li, Jin	Concordia University
Zhang, Youmin	Concordia University
08:45-09:00	FrAT6.2
Distributed Fault-Tolerant Control for Multi-Agent Systems with Flexible Manipulators Using Riemannian Motion Policy Composition	
Pan, JiaHao	HangZhou DianZi University
Wang, SiWei	HangZhou DianZi University
Guan, YaCun	HangZhou DianZi University
Yang, Hao	Nanjing University of Aeronautics and Astronautics
Jiang, Bin	NUAA
Zhang, Youmin	Concordia University
09:00-09:15	FrAT6.3
Specified-Time Distributed Nash Equilibrium Seeking for Multicoalition Cyber-Physical Systems	
Tao, Qianle	Northwestern Polytechnical University
Chengxin, Xian	Northwestern Polytechnical University
Zhao, Yu	Peking University
09:15-09:30	FrAT6.4
Cascaded Cooperative Disturbance Rejection Control for Air-Ground Heterogeneous Systems Via Fixed-Time Extended State Observers	
Li, Yongze	Northwestern Polytechnical University
Wang, Ban	Northwestern Polytechnical University
Chang, Bufan	Northwestern Polytechnical University
Fu, Yifang	Northwestern Polytechnical University
Mu, Lingxia	Xi'an University of Technology
09:30-09:45	FrAT6.5
Time-Localized Wavelet Packet Feature Extraction for Wind Turbine Gearbox Fault Detection	
Ramezanzadeh, Nasrin	Universitat Politècnica De València (UPV)
Chatterjee, Subhajit	Faculty of Engineering and Natural Sciences, Tampere University, Tampere 33720, Finland
Badihi, Hamed	Tampere University, Tampere 33720, Finland
09:45-10:00	FrAT6.6

Reliable Multi-Target SCADA-Based Condition Monitoring for Wind Turbine Pitch Fault Detection	
Chatterjee, Subhajt	Faculty of Engineering and Natural Sciences, Tampere University, Tampere 33720, Finland
Badihi, Hamed	Tampere University, Tampere 33720, Finland

FrBT1	Assembly Hall
Exploring Task-Oriented Embodied Intelligence in Robots (Regular Session)	
Chair: Yang, Qingkai	Beijing Institute of Technology
Co-Chair: Cui, Jinqiang	Pengcheng Laboratory
Organizer: Yang, Qingkai	Beijing Institute of Technology
10:30-10:45	FrBT1.1
Cooperative Bearing-Angle Target Encirclement Via Multi-Agent Reinforcement Learning with Collaborative Adaptive Kalman Filtering	
Gao, Jingran	Hebei University of Science and Technology
Xi, Lele	Hebei University of Science and Technology
Wang, Hongkun	Hebei University of Science and Technology
Wei, Yue	Guangdong Laboratory of Artificial Intelligence and Digital Economy (SZ)
10:45-11:00	FrBT1.2
Safe Distributed Formation of Heterogeneous Discrete-Time Multi-Agent Systems	
Lu, Rongxiang	Tongji University
Wang, Zhipeng	Tongji University
Cheng, Bin	Tongji University
He, Bin	Tongji University
11:00-11:15	FrBT1.3
Meta-Gradient Based Reward Shaping for Resilient Heterogeneous Platooning against Cyber Attacks	
Xia, Zhiwei	Shanghai University
Liu, Chun	Shanghai University
Ren, Xiaoqiang	Shanghai University
Wang, Xiaofan	Shanghai Jiao Tong University
11:15-11:30	FrBT1.4
VINS-LIFT: Leveraging Visual-Language Models for Robust VI-SLAM in Environments with Elevators	
Lyu, Mingzhe	Southern University of Science and Technology
Feng, Yuxuan	Tongji University
Wang, Yongcai	Tsinghua University
Zhang, Hong	Southern University of Science and Technology
Cui, Jinqiang	Pengcheng Laboratory
11:30-11:45	FrBT1.5
A Physics-Informed Optimization Control Allocation Strategy for Coaxial Multirotor	
Wang, Meng	Beihang University
Chen, Zeshuai	Beihang University
Guo, Yuxin	Beihang University

Guo, Kexin	Beihang University
Yu, Xiang	Beihang University
11:45-12:00	FrBT1.6
Disturbance-Observer-Based Model Predictive Control for Nonlinear Discrete-Time Systems	
Zhang, Limin	Beijing Research Institute of Telemetry
Li, Peng	Beijing Research Institute of Telemetry
Shi, Jiangbo	Beijing Research Institute of Telemetry
Li, Xiaoliang	Beijing Research Institute of Telemetry
Liu, Bin	Beijing Research Institute of Telemetry
12:00-12:15	FrBT1.7
Pursuit-Evasion Game for High-Speed Flight Vehicles under Measurement Delays	
Qiu, Mengqi	Beihang University
Zhang, Zejun	Beihang University
Guo, Kexin	Beihang University
Zhang, Kaifeng	Beihang
Yu, Xiang	Beihang University

FrBT2	Room 256
Intelligent Collaborative Platform for Unmanned Autonomous Systems (Regular Session)	
Chair: Wang, Xuehe	Sun Yat-Sen University
Co-Chair: Peng, Zhouhua	Dalian Maritime University
Organizer: Meng, Wei	Guangdong University of Technology
Organizer: Chen, Ci	Guangdong University of Technology
Organizer: Wang, Xuehe	Sun Yat-Sen University
10:30-10:45	FrBT2.1
Distributed Online Minimax Optimization with Compressed Communication	
Li, Fan	Northeastern University
Xu, Lei	KTH Royal Institute of Technology
Zhang, Kunpeng	Northeastern University
Yi, Xinlei	Tongji University
Yuan, Ye	Huazhong University of Science and Technology
Li, Yuzhe	Northeastern University, China
Shi, Yang	Canada
Yang, Tao	Northeastern University
10:45-11:00	FrBT2.2
Observer-Based Distributed Nash Equilibrium Seeking for High-Order Nonlinear Players with Input Delay	
Sheng, Zhaoming	Qufu Normal University
11:00-11:15	FrBT2.3
FEDBUD: Joint Incentive and Privacy Optimization for Resource-Constrained Federated Learning	
Liu, Tao	Sun Yat-Sen University
Wang, Xuehe	Sun Yat-Sen University
11:15-11:30	FrBT2.4

Lattice-Based Data Generation for Neural Model Predictive Control	
Li, Xingchen	Tsinghua University
Li, Tianxun	Tsinghua University
You, Keyou	Tsinghua University
11:30-11:45	FrBT2.5
Energy-Constrained Navigation for Planetary Rovers with Singular Internal Power Source	
Hu, Tianxin	Nanyang Technological University
Guo, Weixiang	Nanyang Technological University
Qian, Rui	Nanyang Technological University
Jin, Jiaye	Nanyang Technological University
Zhao, Haoran	Nanyang Technological University
Yuan, Shenghai	Nanyang Tech. Univ
Xie, Lihua	Nanyang Technological University
11:45-12:00	FrBT2.6
A Comparative Study of Differentiable Physics Learning and MPC for Bidirectional-Thrust Quadrotor Maneuvers	
Zhang, Yechen	Shanghai Jiao Tong University
Li, Fanxing	Shanghai Jiao Tong University
Sun, Fangyu	Shanghai Jiaotong University
De, Qixin	Shanghai Jiao Tong University
Zhang, Linzuo	Shanghai Jiao Tong University
Zou, Danping	Shanghai Jiao Tong University
12:00-12:15	FrBT2.7
Safety-Critical Perimeter-Defense Guidance of Autonomous Surface Vehicles Based on Nonlinear Model Predictive Control	
Li, Ronghui	Dalian Maritime University
Gu, Nan	Dalian Maritime University
Peng, Zhouhua	Dalian Maritime University
Liu, Lu	Dalian Maritime University
Wang, Anqing	Dalian Maritime University
Wang, Haoliang	Dalian Maritime University

FrBT3	Room 267
Intelligent Sensing and Embodied Robotic Systems for Medical Diagnosis and Intervention (Regular Session)	
Chair: Zhang, Dongxu	Xiamen University
Organizer: Lu, Bo	Soochow University
Organizer: Zhou, Mingchuan	Zhejiang University
Organizer: Zhang, He	Harbin Institute of Technology
10:30-10:45	FrBT3.1
TBCA-SlowFast: A Spatiotemporal Network for Endoscopic Image-Based round Window Membrane Puncture Recognition	
Yang, Jiahui	Harbin Institute of Technology
Zhu, Haifeng	Harbin Institute of Technology
Zhang, Zhuowen	Harbin Institute of Technology
Yuan, Haozhong	Zhuzhou CRRC Times Electric Co. Ltd
Li, Yuanyuan	The Second Affiliated Hospital of Harbin Medical University
Zhao, Jie	Harbin Institute of Technology
Zhang, He	Harbin Institute of Technology
10:45-11:00	FrBT3.2

An Ultra-Fast and Broadly Compatible Temperature-Control Device for Rapid Nucleic Acid Amplification	
Yang, Yuhong	Xiamen University
Qian, Yuan	Xiamen University
Yang, Jiayu	Xiamen University
Wang, Junnan	Xiamen University
Zhang, Dongxu	Xiamen University
11:00-11:15	FrBT3.3
Diffusion Policy-Based Framework for Autonomous Laparoscope View Control with Optimal RCM Selection	
Li, Xudong	Soochow University
Zhang, Xueli	Soochow University
Zhang, Jiangang	School of Mechanical and Electric Engineering, Soochow University
Hou, Wenjie	Gynecology and Obstetrics Department, the Fourth Affiliated Hospital of Soochow University
Lining, Sun	Soochow University
Lu, Bo	Soochow University
11:15-11:30	FrBT3.4
From 3D Gaussian to Contact Force Estimation: An Image-Guided and Biomechanics-Cohorted Force Predictor	
Guo, Shuyan	Columbia University Irving Medical Center
He, Chao	Soochow University
Lu, Bo	Soochow University
11:30-11:45	FrBT3.5
Pattern-Aware Adaptive Dual-View Contrastive Learning for Temporal Knowledge Graph Reasoning	
Zou, Longyin	National University of Defense Technology
Ding, Zhaoyun	National University of Defense Technology
Chen, Wen	National University of Defense Technology
11:45-12:00	FrBT3.6
CM-Bench: A Comprehensive Cross-Modal Feature Matching Benchmark Bridging Visible and Infrared Images	
Liangzheng, Sun	Beijing Information Science & Technology University
He, Mengfan	Tsinghua University
Shao, Xingyu	Tsinghua University
Li, Binbin	Beijing Information Science and Technology University
Yan, ZhiQiang	Beijing Information Science and Technology University
Li, Chunyu	Beijing Institute of Technology
Meng, Ziyang	Tsinghua University
Xing, Fei	Tsinghua University

FrBT4	Room 269
Modeling, Control and Estimation in Unmanned Aircraft Systems (Regular Session)	
Chair: Hu, Jinwen	Northwestern Polytechnical University
Co-Chair: Yang, Lidong	The Hong Kong Polytechnic University

Organizer: Zhang, Jiandong	Northwestern Polytechnical University
Organizer: Xu, Zhao	Northwestern Polytechnical University
Organizer: Hu, Jinwen	Northwestern Polytechnical University
10:30-10:45	FrBT4.1
An Improved Active Rendezvous Path Planning Method for UAV-Based Autonomous Aerial Refueling under Wind-Field Constraints	
Sun, Xiang	Northwestern Polytechnical University
Li, Weihong	AVIC the First Aircraft Institute
Niu, Yifeng	National University of Defense Technology
Chen, Jun	Northwestern Polytechnical University
10:45-11:00	FrBT4.2
Installation Error Calibration for USV-Mounted USBL Positioning Systems Via Enhanced WOA	
Xu, Ruoyu	Northwestern Polytechnical University
Zhao, Chunhui	Northwestern Polytechnical University
Hu, Jinwen	Northwestern Polytechnical University
Lyu, Yang	Northwestern Polytechnical University
Song, Yanyan	Given Name(s)*
Sun, Yinghao	Northwestern Polytechnical University
11:00-11:15	FrBT4.3
Landing Guidance Based on Multi-Sensor Variational Bayesian Adaptive Fusion	
Lv, Mingwei	China Aviation Industry Shenyang Aircraft Design Institute
Li, Bingyan	Northwestern Polytechnical University
Wang, Yuxiang	Northwestern Polytechnical University
Xu, Zhao	Northwestern Polytechnical University
Hu, Jinwen	Northwestern Polytechnical University
11:15-11:30	FrBT4.4
An Intelligent Hierarchical Method for Spacecraft Maneuver Detection under Short-Arc Observation	
Yang, Zhiyuan	Beihang University
Wang, Honglun	Beihang University
Wu, Tiancai	Beihang University
Zhang, Menghua	Beijing Institute of Control Engineering
Wu, Jianfa	Beijing Institute of Control Engineering
11:30-11:45	FrBT4.5
Control Barrier Function-Based Reinforcement Learning for Safe Microrobot Autonomous Navigation	
Zhao, Jiachi	The HONG KONG Polytechnic University

Xu, Qianyin	The HONG KONG Polytechnic University
Yang, Lidong	The Hong Kong Polytechnic University
11:45-12:00	FrBT4.6
Target Search in Complex Environments Using UAV with Panoramic LiDAR and Restricted FOV Camera Fusion	
Huidong, Wang	Hunan University
Han, Xiangqian	Hunan University
Li, Shaojie	Hunan University
Miao, Zhiqiang	Hunan University
12:00-12:15	FrBT4.7
A Block-Affine Registration and Cloud-Controlled Stitching Method for UAV-Borne Hyperspectral Cameras	
Yang, Zihan	Wuhan University
Liu, Xinyi	Wuhan University
Li, Qian	Wuhan Zhongyuan Electronics Group
Duan, Yansong	Wuhan University

FrBT5	Room 259
Resilient Control and Intelligent Decision-Making for Intelligent Manufacturing and Unmanned Systems (Regular Session)	
Chair: Huang, Jie	Fuzhou University
Co-Chair: Li, Jiahong	Beijing Union University
Organizer: Huang, Jie	Fuzhou University
Organizer: Xue, Dong	East China University of Science and Technology
Organizer: Shi, Mingming	Sichuan University
Organizer: Li, Jiahong	Beijing Union University
Organizer: Liu, Shangkun	Fuzhou University
10:30-10:45	FrBT5.1
Decentralized Target Assignment and Motion Control for Multi-Agent Swarms in Communication-Denied Environments	
Shi, Mingming	Sichuan University
Gao, Yuhan	Xi'an Jiaotong-Liverpool University
Ji, Chengtao	Xi'an Jiaotong-Liverpool University
10:45-11:00	FrBT5.2
LLM-DTS: Resilience Formation Control Via Semantic Reasoning and Adaptive Topology Switching	
Zhou, Xuanjie	East China University of Science and Technology
Zhang, Yafen	East China University of Science and Technology
Zhou, Zhao	East China University of Science and Technology
Xue, Dong	East China University of Science and Technology
11:00-11:15	FrBT5.3
Hyperbolic Sine Function-Based Intermittent Control on Fixed-Time Output Synchronization of Multi-Layer Networks	
Zhao, Tingting	Fuzhou University
Huang, Jingli	FUZHOU UNIVERSITY
Liu, Shangkun	Fuzhou University
Huang, Jie	Fuzhou University
11:15-11:30	FrBT5.4

Enhancing Convergence in Multi-Agent Consensus under Hybrid Byzantine-DoS Attacks: A Comparative Study	
Ouyang, Yuhan	Fuzhou University
Liu, Shangkun	Fuzhou University
Huang, Jingli	FUZHOU UNIVERSITY
Huang, Jie	Fuzhou University
11:30-11:45	FrBT5.5
Energy and Safety-Aware Multi-UAV Inspection Over DEM Terrain with Offline Planning and Online Deconfliction	
Tang, Jingqi	Fuzhou University
Ning, Yingying	Fujian Institute of Education
Liu, Shangkun	Fuzhou University
Huang, Jie	Fuzhou University
11:45-12:00	FrBT5.6
Robust Battery RUL Prediction Via Matern Gaussian Processes with Student-T Likelihood	
Li, Jiahong	Beijing Union University
Liu, Shangkun	Fuzhou University
Huang, Jie	Fuzhou University

FrBT6	Room 264
Swarm Control with Virtual Tubes (Regular Session)	
Chair: Quan, Quan	Beihang University
Co-Chair: Gu, Shuang	The School of Automation Science and Electrical Engineering, Beihang University, Beijing, 100191, China
Organizer: Quan, Quan	Beihang University
Organizer: Liu, Yan-Jun	Liaoning University of Technology
Organizer: Zhu, Bo	Nanjing University
Organizer: Gao, Yan	Tiangong University
10:30-10:45	FrBT6.1
Event-Triggered NMPC with DCBFs for Safe Formation Navigation of 4WIS-4WID Robots	
Wang, Bin	Liaoning University of Technology
Zeng, Qiang	Liaoning University of Technology
Liu, Yan-Jun	Liaoning University of Technology
10:45-11:00	FrBT6.2
Distributed Passing-Through Control within a Virtual Tube for a Robotic Swarm Based on Null-Space-Based Method	
Gao, Yan	Tiangong University
Tang, Xiaozhen	Tiangong University
Qi, Guoyuan	Tiangong University
11:00-11:15	FrBT6.3
A Distributed Semi-Autonomous Strategy for One-To-Many UAV Cooperative Transport within Virtual Tubes	
Gu, Shuang	The School of Automation Science and Electrical Engineering, Beihang University, Beijing, 100191, China
Liu, Runxiao	Beihang University
Gao, Yan	Tiangong University
Quan, Quan	Beihang University
11:15-11:30	FrBT6.4

Skeletal Virtual Tube Generation for Urban UAV Swarm Navigation	
Dai, Xunhua	Central South University
Liao, Yuting	Central South University
11:30-11:45	FrBT6.5
Distributed Control Strategy for Cooperative UAVs at a Y-Shaped Intersection	
Wang, Mingzhao	Beijing Jiaotong University
Fu, Rao	School of Traffic and Transportation, Beijing Jiaotong University
Liu, Zhishuo	School of Traffic and Transportation, Beijing Jiaotong University
11:45-12:00	FrBT6.6
Dual-Layer Safety Tubes with Explicit Reference Governor for Distributed UAV Swarm Navigation	
Jin, Yu	Sun Yat-Sen University
Chen, Qile	Nanjing University
Tang, Jiacheng	Sun Yat-Sen University
Yang, Xia	Sun Yat-Sen University
Zhu, Bo	Nanjing University
12:00-12:15	FrBT6.7
A Real-Time Dynamic 3D Virtual Tube for Multi-UAV Swarm Control	
Tang, Zeyu	Guilin University of Aerospace Technology
Liu, Zihui	Guangxi University
Long, Shike	Guilin University of Aerospace Technology
Wang, Yongjun	Guilin University of Aerospace Technology
Sun, Shanlin	Guilin University of Aerospace Technology

FrCT1	Assembly Hall
High-Fidelity Perception, Modeling, and Safety-Critical Control for Autonomous Vehicles in Intelligent Transportation Systems (Regular Session)	
Chair: Yang, Guidong	The Chinese University of Hong Kong
Co-Chair: Fang, Yiyuan	Waseda University
Organizer: Yang, Guidong	The Chinese University of Hong Kong
Organizer: Zhou, Zhisong	The Chinese University of Hong Kong
Organizer: Chen, Jin	Shanghai Jiao Tong University
Organizer: Li, Qingxiang	Jilin University
Organizer: Fang, Yiyuan	Waseda University
Organizer: Li, Ming	KTH Royal Institute of Technology
Organizer: Wang, Jieyu	Tsinghua University
Organizer: Wang, Maonan	The Chinese University of Hong Kong, Shenzhen
Organizer: Guo, Zixuan	The Chinese University of Hong Kong
Organizer: Xie, Shuke	Tongji University
13:45-14:00	FrCT1.1

A Closed-Loop Deadlock Prediction, Prevention, and Resolution Framework for Heterogeneous Robot Fleet Scheduling in Smart Factories	
Hu, Yunqing	Zhuzhou Crrc Times Electric Co., Ltd
Long, Teng	Zhuzhou CRRC Times Electric Co., Ltd
Hu, Enze	CRRC
Huang, Zhikun	Crrc Zhuzhou Electric Locomotive Research Institute Co., Ltd
Luo, Jiayang	CRRC
14:00-14:15	FrCT1.2
A Physics-Guided Data-Driven Compensation Modeling of Energy Consumption for Low-Sampling-Rate Data	
Fang, Yiyuan	Waseda University
Bao, Yida	Waseda university. Faculty of Science and Engineering
Yang, Wei-hsiang	Waseda University
Kamiya, Yushi	Waseda University
14:15-14:30	FrCT1.3
Risk Analysis of Dangerous Driving Behaviors on Highways: A Prediction-Based Driving Risk Assessment Framework	
Guo, Zixuan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
14:30-14:45	FrCT1.4
From Post-Hoc Filtering to Geometric Learning: Learning Cross-View Geometric Consistency for Multi-View Stereo	
Yang, Guidong	The Chinese University of Hong Kong
Huang, Yijun	The Chinese University of Hong Kong
Shao, Jingheng	The Chinese University of Hong Kong
Wang, Pei	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
14:45-15:00	FrCT1.5
Artificial-Reference MPC: Discontinuous-Curvature Path Tracking for Autonomous Vehicles	
Li, Zihan	Jilin University
Wang, Ping	Jilin University
Li, Pengfei	Jilin University
Fu, Xiuwei	Jilin University
Ma, Bin	Jilin University
15:00-15:15	FrCT1.6
UW3D: A Unified Multi-View Benchmark for Robust Underwater 3D Reconstruction	
Yang, Guidong	The Chinese University of Hong Kong
Wang, Chenxiao	Tongji University
Han, Mingqiao	The Chinese University of Hong Kong

Lei, Lei	The Chinese University of Hong Kong
Ding, Yulong	Tongji University
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

FrCT2	Room 256
Intelligent Control, Communication Security, and Coordination for Multi-Agent Systems (Regular Session)	
Chair: Huang, Zongsheng	University of Electronic Science and Technology of China
Organizer: Yang, Yue	Wuhan University of Technology
Organizer: Bai, Weiwei	Dalian Maritime University
Organizer: Jia, Zehua	Hainan University
Organizer: Zhang, Yichi	China Academy of Launch Vehicle Technology
13:45-14:00	FrCT2.1
Super-Twisting Sliding Mode Control for Affine Formation Maneuver of Multi-ASV Systems	
Zhang, Dingze	Wuhan University of Technology
Liu, Kezhong	Wuhan University of Technology
Yang, Yue	Wuhan University of Technology
Li, Tieshan	University of Electronic Science and Technology of China
14:00-14:15	FrCT2.2
Enterprise Fire Safety System Risk Assessment Based on Multi-Agent Modeling within a Complex Adaptive Systems Framework	
Song, Zhenjun	China Academy of Launch Vehicle Technology & China University of Mining and Technology-Beijing
Shan, Wei	China Academy of Launch Vehicle Technology
Huang, Xintao	China Academy of Launch Vehicle Technology
Zhang, Yichi	China Academy of Launch Vehicle Technology
14:15-14:30	FrCT2.3
Resilient Multi-Agent Perception for Near-Space Vehicle Swarms with Intra-Swarm Attentive Enhancement	
He, Qibin	National Key Laboratory of Nearspace Physics
Xue, Hanqing	National Key Laboratory of Nearspace Physics
Guo, Lingxi	Science and Technology on Space Physics Laboratory
Gu, Tianqi	Science and Technology on Space Physics Laboratory
Yang, Zhe	Science and Technology on Space Physics Laboratory
Chen, Chao	Science and Technology on Space Physics Laboratory
14:30-14:45	FrCT2.4
Real-Time Intelligent Identification of UAV RF Fingerprints Based on YOLO26 and Embedded System Validation	
Xue, Hanqing	National Key Laboratory of Nearspace Physics

Qie, Rongkai	National Key Laboratory of Nearspace Physics
Chen, Chao	Science and Technology on Space Physics Laboratory
He, Qibin	National Key Laboratory of Nearspace Physics
Wang, Peng	National Key Laboratory of Nearspace Physics
Dou, Xiaoming	Science and Technology on Space Physics Laboratory
Guo, Lingxi	Science and Technology on Space Physics Laboratory
Sun, Haiwen	Research Institute
14:45-15:00	FrCT2.5
Multi-Agent Coordination for Derivative-Free Optimization: A Two-Stage Hybrid Speeding-Up Slowing-Down Algorithm	
Zhao, Yuxuan	Hong Kong University of Science and Technology
Wang, Yijian	Hong Kong University of Science and Technology
Wang, Junkai	Georgia Institute of Technology
Zhang, Fumin	Hong Kong University of Science and Technology
15:00-15:15	FrCT2.6
Multi-UAV Task Assignment: An Enhanced WTA Model with Linearized Voyage Constraints in MILP	
Wang, Zekun	North Automatic Control Technology Institute
Xing, Cheng	Aerospace Information Research Institute, Chinese Academy of Sciences
Zhao, Jianxin	North Automatic Control Technology Institute
Zhang, Hongying	North Automatic Control Technology Institute
Yan, Tao	North Automatic Control Technology Institute
He, Zheng	North Automatic Control Technology Institute
15:15-15:30	FrCT2.7
Prescribed-Time Observer-Based Human-In-The-Loop Optimal Output Tracking Control for Multiagent Systems	
Huang, Zongsheng	University of Electronic Science and Technology of China
Yan, Yamin	Nanyang Technological University
Li, Tieshan	University of Electronic Science and Technology of China

FrCT3	Room 267
Learning-Based Planning and Control of Robotic Systems (Regular Session)	
Chair: Li, Xiang	Tsinghua University
Co-Chair: Gao, Ding	Zhejiang University of Technology
Organizer: Kan, Zhen	University of Science and Technology of China
Organizer: Yin, Xiang	Shanghai Jiao Tong University
Organizer: Huang, Xiucui	Chongqing University
Organizer: Chen, Wenrui	Hunan University
13:45-14:00	FrCT3.1

Reactive Planning for Air-Ground Collaboration Based on Linear Temporal Logic	
Zhou, Zhangli	University of Science and Technology of China
Li, Hao	University of Science and Technology of China
Kan, Zhen	University of Science and Technology of China
14:00-14:15	FrCT3.2
Asymptotic Optimal Search for Scalable Multi-Agent Linear Temporal Logic Task Planning	
Zhou, Zhangli	University of Science and Technology of China
Chen, Ziyang	University of Science and Technology of China
Li, Lin	University of Science and Technology of China
Li, Hao	University of Science and Technology of China
Kan, Zhen	University of Science and Technology of China
14:15-14:30	FrCT3.3
FA-MARL: Frontier Assignment with Multi-Agent Reinforcement Learning for Efficient Decentralized Multi-Robot Exploration	
Song, Peng	Northwestern Polytechnical University
Yang, Hong'an	Northwestern Polytechnical University
14:30-14:45	FrCT3.4
Learning to Interact: Socially Adaptable and Risk-Aware Trajectory Planning Via Inverse Reinforcement Learning	
Li, Shanghao	Beijing Institute of Technology
Ke, Weiling	Tongji University
Wang, Danjing	Beijing Institute of Technology
Fang, Hao	Beijing Institute of Technology
14:45-15:00	FrCT3.5
Kinematic-Aware Motion Planning and Reinforcement-Learning-Based Adaptive Control of Autonomous Underwater Vehicles	
Ma, Yue	Tsinghua University
Li, Xiang	Tsinghua University
Song, Shiji	Tsinghua University
15:00-15:15	FrCT3.6
Exploring the Correlation between Level Walking and Stair Ambulation for Fine-Grained Gait Phase Prediction	
Sun, Youping	Shandong University
Li, Xingeng	Shandong University
Ma, Chuncan	Qilu Hospital of Shandong University
Ma, Xunju	China North Artificial Intelligence & Innovation Research Institute
Zhang, Huanghe	Shandong University
15:15-15:30	FrCT3.7
Modeling and Hierarchical Control of a Flexible Assistive Hip Exoskeleton	
Gao, Ding	Zhejiang University of Technology

Du, Mingyu	Zhejiang University of Technology
Zhang, Luobin	Zhejiang University of Technology
Weng, Yongjie	Zhejiang University of Technology
Wei, Wei	China Jiliang University
Cai, Shibo	China Jiliang University

FrCT4	Room 269
Multimodal Interaction and Robot-Assisted Rehabilitation (Regular Session)	
Chair: Wang, Hui	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Wang, Zhiyong	Harbin Institute of Technology, Shenzhen
Organizer: Zhang, Bi	Shenyang Institute of Automation, Chinese Academy of Sciences,
Organizer: Yang, Xingchen	Southeast University
13:45-14:00	FrCT4.1
A Window-Level Structured Representation and Temporal Modeling Framework for Early EEG-Based Cognitive State Prediction in ICU	
Zhihui, Yang	Shenyang Institute of Automation, Chinese Academy of Sciences
Zhao-Han, Wang	Shenyang Institute of Automation, Chinese Academy of Sciences
En-Ming, Shi	Shenyang Institute of Automation, Chinese Academy of Sciences
Cheng-Hang, Li	Shenyang Institute of Automation, Chinese Academy of Sciences
Xu, Zhuang	Shenyang Institute of Automation, Chinese Academy of Sciences
Zhang, Bi	Shenyang Institute of Automation, Chinese Academy of Sciences,
14:00-14:15	FrCT4.2
Neuromechanics-Based Reinforcement Learning for FES Control of Lower-Limb Movements	
Zeng, Qiming	Harbin Institute of Technology, Shenzhen
Cao, Ruikai	Harbin Institute of Technology, Shenzhen
Zhou, Zixiang	Harbin Institute of Technology, Shenzhen
Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
Wang, Zhiyong	Harbin Institute of Technology, Shenzhen
14:15-14:30	FrCT4.3
Hybrid Intelligent Control of Electrostatic Precipitators Based on MIMO Modeling and Fuzzy Logic	
Omirbekova, Zhanar	Satbayev University
Shiryayeva, Olga	Satbayev University
Iskakova, Aigul	Satbayev University
14:30-14:45	FrCT4.4
Design of a Digital Twin System Enhanced by Augmented Reality for Reconfigurable Soft Robots	
Arymbekov, Beken	Satbayev University
Alipbayev, Daniyar	Satbayev University
14:45-15:00	FrCT4.5

System Model and Analysis of Dynamic Radio Resource Management in 5G Mobile Networks	
Kengesbayeva, Sara	The Pennsylvania State University
Smailov, Nurzhigit	Satbayev University
Targynova, Zhanerkem	Satbayev University
15:00-15:15	FrCT4.6
Muscle Coactivation in Athletes: A Comparative Study of Rock Climbing and Taekwondo Teams	
Liu, Shengjie	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Zheng, Yufeng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Pingao, Huang	School of Electronic Engineering and Automation, Guilin University of Electronic Technology
Liu, Wenquan	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Fang, Peng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Wang, Hui	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
15:15-15:30	FrCT4.7
A Multi-Point Wearable Fluidic Haptic Interface for Rendering Remotely Grasped Surfaces During Teleoperation Tasks	
Padilla, Mark Lester Francisco	The Chinese University of Hong Kong
Trinitatova, Daria	The Chinese University of Hong Kong (CUHK)
Tokmurziyev, Issatay	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong

FrCT5	Room 259
Sensing and Control in Exoskeletons (Regular Session)	
Chair: Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
Organizer: Dong, Mingjie	Beijing University of Technology
13:45-14:00	FrCT5.1
Lateral Stair Ascending Gait Recognition Based on IMU and Deep Learning Methods	
Yang, Junyi	Shenzhen Institutes of Advanced Technology
Pang, Zhi	College of Intelligent Robotics and Advanced Manufacturing, Fudan University, Shanghai, China
Wang, Shuai	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen

Luo, Mingxiang	The State Key Laboratory of Robotics and Systems, Harbin Institute of Technology Shenzhen, Shenzhen
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
14:00-14:15	FrCT5.2
Real-Time Prosthetic Hand Control Based on Muscle Synergy Decomposition of Forearm EMG Signals	
Gao, Naixing	Harbin Institute of Technology, Shenzhen
Cao, Ruikai	Harbin Institute of Technology, Shenzhen
Yang, Chen	Harbin Institute of Technology Shenzhen
Sun, Bin	Harbin Institute of Technology
Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
14:15-14:30	FrCT5.3
Stable Online Hand Gesture Decoding with Hybrid sEMG-Ultrasound Sensing and Multimodal Transformers	
Du, Zhao	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen, China
Yang, Junyi	Shenzhen Institutes of Advanced Technology
Li, Xiangxin	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen, China
Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Yin, Meng	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen, China
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
14:30-14:45	FrCT5.4
Modeling and Trajectory Optimization of a High-Mobility Tensegrity Robot with a Simplified Actuation Scheme	
Wang, Binyan	Shanghai Jiao Tong University
Yi, Yinfan	Shanghai Jiaotong University
Dai, Shenghao	Shanghai Jiao Tong University
Zhang, Shuai	Shanghai Jiao Tong University
Li, Wei	Chongqing University
14:45-15:00	FrCT5.5
Development of an Underwater Compact Exoskeleton to Assist Leg Motion During Scuba Diving	
Wang, Xiangyang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Ma, Yue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Wang, Xufei	Tsinghua University

Luan, Mengbo	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jianquan, Sun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Chen, Chunjie	Shenzhen Institutes of Advanced Technology (SIAT), CAS
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
15:00-15:15	FrCT5.6
Multi-Mode Coordinated Control for Bilateral Upper Limb Rehabilitation Exoskeleton	
Guo, Shishang	University of Science and Technology Beijing
Lu, Hanxinyang	University of Science and Technology Beijing
Tang, Jiabao	University of Science and Technology Beijing
Hao, Xiaoyue	Hebei University of Technology
Jiao, Ran	University of Science and Technology Beijing
Zhang, Jianhua	University of Science and Technology Beijing
15:15-15:30	FrCT5.7
Preliminary Evaluation of Passive Upper Limb Exoskeleton Assistance Based on Electromyography and Time-Frequency Analysis	
Yang, Lan	Nanjing University of Science and Technology
Li, Yudi	Nanjing University of Science and Technology
Li, Xin	Nanjing University of Science and Technology
Zou, Jiani	Nanjing University of Science and Technology
Zhou, Hui	Nanjing University of Science and Technology

FrCT6	Room 264
Touch Intelligence and Wireless Teleoperation (Regular Session)	
Chair: Li, Qiang	Shenzhen Technology University
Co-Chair: Li, Yinggang	Shenzhen Technology University
Organizer: Li, Qiang	Shenzhen Technology University
Organizer: Kappasov, Zhanat	Nazarbayev University
Organizer: Li, Yinggang	Shenzhen Technology University
Organizer: Li, Peng	Nankai University
Organizer: Chen, Fei	The Chinese University of Hong Kong
13:45-14:00	FrCT6.1
A Two-Stage Optimization Framework for Designing Direct-Drive Dexterous Robotic Hands	
Wang, Yanyi	Shenzhen Technology University
Zhang, Zhenyuan	Shenzhen Technology University
Chen, Mingqi	Shenzhen Technology University
Long, Junjie	ShenZhen Technology University

Lyu, Jingke	Shenzhen Technology University
Kappassov, Zhanat	Nazarbayev University
Li, Yinggang	Shenzhen Technology University
Li, Qiang	Shenzhen Technology University
14:00-14:15	FrCT6.2
Design and Experimental Evaluation of a Robotic Gripper for Object Stiffness Estimation Via Motor Torque Analysis	
Muratkanov, Miras	Nazarbayev University
Kairolla, Airis	Nazarbayev University
Galimzhanov, Temirlan	Nazarbayev University
Mukashev, Dinmukammed	Nazarbayev University
Chen, Mingqi	Shenzhen Technology University
Li, Qiang	Shenzhen Technology University
Kappassov, Zhanat	Nazarbayev University
14:15-14:30	FrCT6.3
Comparative Evaluation of Depth Camera and Dual-LiDAR Systems for Automated Feed Bunk Monitoring	
Kairolla, Airis	Nazarbayev University
Muratkanov, Miras	Nazarbayev University
Galimzhanov, Temirlan	Nazarbayev University
Sandykbayeva, Danissa	Nazarbayev University
Zhanibekov, Askhat	COWMAS
Kappassov, Zhanat	Nazarbayev University
14:30-14:45	FrCT6.4
Antiphase Stereo-Light Modulation for Time-Based Highlighted Region of Interest in Robotic Vision	
Al-Farabi, Zaki	Nazarbayev University
Kairolla, Airis	Nazarbayev University
Yelenov, Amir	Nazarbayev University
Kappassov, Zhanat	Nazarbayev University
Mukashev, Dinmukammed	Nazarbayev University
14:45-15:00	FrCT6.5
Optimizer Bias in Facial Expression Recognition and Transfer Learning	
Gongyue, Zhang	Harbin Institute of Technology Shenzhen, China
Liu, Shuyan	Shenzhen Children's Hospital
Li, Xiuhong	Shenzhen Children's Hospital
Li, Xueqing	Shenzhen Children's Hospital
Wang, Jinghua	Shenzhen Children's Hospital
15:00-15:15	FrCT6.6
From Perception to Interpretation: A BNN-BN Fusion Approach for Explainable Human Factor Assessment	
Liu, Yingjuan	National University of Defense Technology
Zhou, Yun	National University of Defense Technology

FrDT1	Assembly Hall
Human-Machine Interaction in Medical Robot (Regular Session)	
Chair: Wang, Lin	Chinese Academy of Sciences
Co-Chair: Li, Changsheng	Beijing Institute of Technology
Organizer: Wang, Lin	Chinese Academy of Sciences
Organizer: Li, Changsheng	Beijing Institute of Technology

15:45-16:00	FrDT1.1
A Perspective Review of Coupling Regulation Depth in Human-Exoskeleton Control	
Zou, Hongfei	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences, Guangdong, China
Wang, Lin	Chinese Academy of Sciences
16:00-16:15	FrDT1.2
Fatigue-Induced Knee Joint Cartilage Mechanical Responses During Squat as Risk Indicators in a Musculoskeletal Digital Twin Framework	
Wang, Lin	Chinese Academy of Sciences
Jiaju, Zhu	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
16:15-16:30	FrDT1.3
A Diffusion-Driven Local Planner for Robotic Manipulators in Constrained Environments	
Lian, Zihan	Soochow University
Sun, Chengfeng	Soochow University
Chi, Wenzheng	Soochow University
Yang, Hao	Soochow University
16:30-16:45	FrDT1.4
A Unified and Differentiable Handling of Multilevel Constraint Method for Time-Varying Quadratic Optimal Problem and Its Application to Robot Control	
Wang, Zeyu	Beijing Institute of Technology
Wang, Jiahao	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
16:45-17:00	FrDT1.5
Flexible Interactive Control for Robot-Assisted Orthopedic Procedures	
Liang, Xinye	Beijing Institute of Technology
Wang, Jiapeng	Beijing University of Technology
Zhang, Weijun	Beijing Institute of Technology
Li, Peng	Harbin Institute of Technology, Shenzhen
Tian, Ye	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
17:00-17:15	FrDT1.6
TimesNet-Based Human-Robot Interaction Intent Recognition for the Orthopedic Surgical Robot	
Wang, Jiapeng	Beijing University of Technology
Zhang, Weijun	Beijing Institute of Technology
Lyu, Sida	Beijing Institute of Technology
Liang, Xinye	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
17:15-17:30	FrDT1.7
A Continuum Manipulator with Variable Curvature for Electrocautery Hemostasis in Spinal Endoscopic Surgery: Design, Modeling and in Vivo Validation	
Wu, Xipeng	Beijing Institute of Technology

Qian, Chao	Beijing Institute of Technology
Wang, Weize	Beijing Institute of Technology
Lyu, Xufeng	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology

FrDT2	Room 256
Intelligent Decision-Making and Applications (Regular Session)	
Chair: Dong, Xiwang	Beihang University
Organizer: Meng, Min	Tongji University
Organizer: Li, Xiuxian	Tongji University
Organizer: Xu, Liang	Shanghai University
Organizer: You, Keyou	Tsinghua University
Organizer: Lu, Peng	The University of Hong Kong
15:45-16:00	FrDT2.1
Global Convergence Analysis of Gauss-Newton Policy Gradient for LQR with Random Packet Loss	
Zhang, Zhenning	Shanghai University
Tianyang, Tian	Shanghai University
Yi, Xinlei	Tongji University
Xu, Liang	Shanghai University
16:00-16:15	FrDT2.2
Reach-Avoid Games with a NonCooperative Target Along a Line Segment	
Cai, Jiajun	Beihang University
Yan, Rui	Beihang University
Liang, Ruining	Beihang University
Mi, Shuai	Tsinghua University
Dong, Xiwang	Beihang University
16:15-16:30	FrDT2.3
Disturbance Observer-Based Nonlinear MPC for Quadrotor against Impacts and Load Uncertainties	
Chen, Xinqi	Tongji University
Li, Xiuxian	Tongji University
Meng, Min	Tongji University
Lu, Peng	The University of Hong Kong
16:30-16:45	FrDT2.4
HGLAD: A Hierarchical Global-Local Decoupling Adversarial Decision-Making Framework Via Agentic Design	
Chen, Ji	Tongji University
Lei, Jinlong	Tongji University
Yi, Peng	Tongji University
16:45-17:00	FrDT2.5
A LLM Temporal Reasoning Framework Via Fine-Grained Role Extraction and Action Pruning	
Wang, Jiale	National University of Defense Technology
Ding, Zhaoyun	National University of Defense Technology
Sun, Siyang	National University of Defense Technology
17:00-17:15	FrDT2.6
Nash Equilibrium Seeking for Multicoalition Games with Varying Number of Heterogeneous General Linear Players	

Chen, Yiyang	Beihang University
Hua, Yongzhao	Beihang University
Li, Xiaoduo	Beihang University
Dong, Xiwang	Beihang University
17:15-17:30	FrDT2.7
Analysis of the Post-Stroke Motor Function Specificity by Integrating EEG and Cerebral Oxygenation Information: A Pilot Study towards Neurorehabilitation Application	
Meng, Haotian	Southern University of Science and Technology
Xu, Xuan	Kunming Medical University
Meng, Fanyuan	Kunming Medical University
Tan, Qiyun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Mao, He	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Hui, Wang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Ao, Lijuan	Kunming Medical University
Li, Guanglin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Chen, Moxian	Kunming Medical University
Fang, Peng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

FrDT3	Room 267
Machine Vision and Optical Sensing (Regular Session)	
Chair: Chen, Wei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Co-Chair: Gu, Feifei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Jiao, Guohua	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences, Guangdong, China
Organizer: Chen, Wei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Zhao, Juan	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
15:45-16:00	FrDT3.1
Diffusion-Based Data Augmentation for Long-Tailed Wind-Turbine Surface Defect Detection	
Qin, Dawei	Guangdong Feida Transportation Engineering Co., Ltd
Zhou, Boming	Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences
Jiao, Guohua	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences, Guangdong, China
Yuan, Tianshuo	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

16:00-16:15	FrDT3.2
Deep Learning-Based 3D Reconstruction from Underwater Gated Images	
Zhou, Ruixiang	Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences
Yan, Wenxi	South China University of Technology
Chen, Wei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
16:15-16:30	FrDT3.3
Narrow-Baseline Binocular Endoscopic System and Three-Dimensional Reconstruction Method	
Liu, Qiyu	Shenzhen Institutes of Advanced Technology, University of Chinese Academy of Sciences
Zhang, Zhen	Shenzhen Institutes of Advanced Technology, University of Chinese Academy of Sciences
Zheng, Bowen	Nanjing Institute of Technology
Song, Zhan	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Gu, Feifei	Shenzhen Institutes of Advanced Technology, Chinese University of Hong Kong
16:30-16:45	FrDT3.4
A Fast-Tracking Method for Aerial High-Maneuvering Targets Based on Multi-Stage Fusion Strategy	
Liu, Hu	Xi'an Institute of Applied Optics
Zhu, Lei	Xi'an Institute of Applied Optics
Li, Jiajia	Xi'an Institute of Applied Optics
Wu, Yan	Xi'an Institute of Applied Optics
Zhao, Xuechen	Xi'an Institute of Applied Optics
Hou, Rui	Xi'an Institute of Applied Optics
16:45-17:00	FrDT3.5
Optimization Methods for Autonomous Target Locking Strategies Based on Small Unmanned Aerial Vehicles	
Wu, Yan	Xi'an Institute of Applied Optics
Zhu, Lei	Xi'an Institute of Applied Optics
Zhao, Xuechen	Xi'an Institute of Applied Optics
Liu, Hu	Xi'an Institute of Applied Optics
Li, Jiajia	Xi'an Institute of Applied Optics
Sun, Hao	Xi'an Institute of Applied Optics
Hou, Rui	Xi'an Institute of Applied Optics
17:00-17:15	FrDT3.6
Efficient 3D Face Reconstruction in Spherical Coordinates with a High-Throughput Structured-Light System	
Ren, Bin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Ye, Yuping	Fujian University of Technology
Song, Zhan	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
17:15-17:30	FrDT3.7

Occlusion-Resilient UAV Victim Detection in Dense Forest Search and Rescue Via Light Field Rendering and Lightweight YOLO	
Wang, Pei	The Chinese University of Hong Kong
Wang, Jialiang	The Chinese University of Hong Kong
Shao, Jingheng	The Chinese University of Hong Kong
Cao, Haosen	Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

FrDT4	Room 269
Optimization and Control for Intelligent Autonomous Systems (Regular Session)	
Chair: Lu, Maobin	Beijing Institute of Technology
Organizer: Yu, Xiao	Xiamen University
Organizer: Chen, Chen	Beijing Institute of Technology
Organizer: Lu, Maobin	Beijing Institute of Technology
15:45-16:00	FrDT4.1
Robust Data-Driven Safety Control for Perturbed Polynomial Systems Via Control Barrier Certificates	
Sun, Yutong	Xiamen University
Guan, Jinting	Xiamen University
Yu, Xiao	Xiamen University
Lan, Weiyao	Xiamen University
16:00-16:15	FrDT4.2
Safety-Critical Control for Tethered Human--Robot Guidance Systems Via Control Barrier Functions	
Xie, Tao	Xiamen University
Yu, Xiao	Xiamen University
Lan, Weiyao	Xiamen University
16:15-16:30	FrDT4.3
Robust Distributed Nash Equilibrium Seeking for Discrete-Time Agents	
Liu, Lupeng	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
Chen, Jie	Tongji University
Lu, Maobin	Beijing Institute of Technology
16:30-16:45	FrDT4.4
Haptic Teleoperation System Based on Parallel Mechanism: Design and Implementation	
Yan, Qilin	Beijing Institute of Technology
Liu, Geyuan	Beijing Institute of Technology
Xie, Bowei	Beijing Institute of Technology
Xie, Kedi	Xiamen University
Lu, Maobin	Beijing Institute of Technology
16:45-17:00	FrDT4.5
A Hierarchical Reinforcement Learning Framework for Reach-Avoid Games with Obstacles	
Yang, Kun	Beijing Institute of Technology
Chen, Yanqiu	Beijing Institute of Technology
Chen, Chen	Beijing Institute of Technology

17:00-17:15	FrDT4.6
Resilient Formation Control for Vehicle Platoons against Cyberattacks and Uncertainties	
Chen, Xiaolong	The Hong Kong University of Science and Technology (Guangzhou)
Zhong, Ruiguo	The Hong Kong University of Science and Technology (Guangzhou)
Liu, Pei	The Hong Kong University of Science and Technology
Shi, Jianxin	Beihang University
Ma, Jun	The Hong Kong University of Science and Technology
17:15-17:30	FrDT4.7
An Interactive System for Assessing Visual-Cognitive Abilities in Children with Autism Spectrum Disorder	
Tang, Ziyang	Harbin Institute of Technology, Shenzhen
Ji, Haoyu	Harbin Institute of Technology, Shenzhen
Guo, Jinbin	Harbin Institute of Technology, Shenzhen
Yang, Zhihao	Harbin Institute of Technology, Shenzhen
Huang, Wenze	Harbin Institute of Technology, Shenzhen
Gao, Yu	Harbin Institute of Technology, Shenzhen
Liu, Xueting	Southern University of Science and Technology
Liu, Jiao	Lishui Maternal and Child Health Hospital, Zhejiang
Hu, Hui	Lishui Maternal and Child Health Hospital, Zhejiang
Zhang, Peile	Lishui Maternal and Child Health Hospital, Zhejiang
Ren, Weihong	Harbin Institute of Technology, Shenzhen
Wang, Zhiyong	Harbin Institute of Technology, Shenzhen
Liu, Honghai	Harbin Institute of Technology, Shenzhen

FrDT5	Room 259
Sensing, Perception, and Control for Autonomous Aerial Vehicles (Regular Session)	
Chair: Jiang, Jiaqi	Beijing Institute of Technology
Co-Chair: Liu, Junhui	Beijing Institute of Technology
Organizer: Jiang, Jiaqi	Beijing Institute of Technology
Organizer: Liu, Junhui	Beijing Institute of Technology
Organizer: Wang, Jianan	Beijing Institute of Technology
Organizer: Shan, Jiayuan	Beijing Institute of Technology
15:45-16:00	FrDT5.1
Improved CST Method for Shape Perception of Flexible Variable-Camber Wings	
Yang, Pengqian	Beijing Institute of Technology
Chai, Shuqiang	Beijing Institute of Technology
Liu, Junhui	Beijing Institute of Technology

Zhou, Feng	Beijing Institute of Technology
Shan, Jiayuan	Beijing Institute of Technology
Ding, Yan	Beijing Institute of Technology
Li, Chunyu	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology
16:00-16:15	FrDT5.2
Communication-Constrained Cooperative Motion Planning for Dubins Formation Turning	
Bi, Changyu	Beijing Institute of Technology
Hu, Xuchi	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology
Jiang, Jiaqi	Beijing Institute of Technology
Li, Chunyu	Beijing Institute of Technology
Liu, Junhui	Beijing Institute of Technology
Wang, Yankai	Beijing Institute of Technology
Ding, Yan	Beijing Institute of Technology
Shan, Jiayuan	Beijing Institute of Technology
16:15-16:30	FrDT5.3
An Implementation of the Universal Birkhoff Pseudospectral Theory Using a Generic Nonlinear Programming Solver	
Liu, Chenyang	Beijing Institute of Technology
Liu, Junhui	Beijing Institute of Technology
Shan, Jiayuan	Beijing Institute of Technology
Li, Chunyu	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology
Wang, Yankai	Beijing Institute of Technology
16:30-16:45	FrDT5.4
Design of an Iris-Inspired Tactile Gripper for Aerial Grasping	
Cao, Zhuang	Beijing Institute of Technology
Jiang, Jiaqi	Beijing Institute of Technology
Zhou, Zhengyang	Beijing Institute of Technology
Li, Guilu	Zhejiang Wanli University
Wang, Jianan	Beijing Institute of Technology
16:45-17:00	FrDT5.5
System Identification of Multi-Rotor UAV Attitude Dynamics with Direct Model-Based Excitation	
Ke, Yijie	Fuyao University of Science and Technology
17:00-17:15	FrDT5.6
A Foldable Aerial-Ground Multimodal Robot: Design and Control	
Zeng, Kai	Hunan University
Miao, Zhiqiang	Hunan University
Wang, Haoyu	Hunan University
Wang, Yaonan	Hunan University

FrDT6	Room 264
Vulnerability Analysis, Secure State Estimation and Intrusion-/Fault-Tolerant Control for Cyber-Physical Systems (Regular Session)	
Chair: Huang, Xin	Northeast Electric Power University
Co-Chair: Xiao, Shuyi	Taiyuan University of Technology
Organizer: Huang, Xin	Northeast Electric Power University

Organizer: Xu, Jiapeng	Tianjin University
15:45-16:00	FrDT6.1
Fault Observer Using PI-Type Error Feedback	
Liu, Jing	Northeast Electric Power University
Huang, Xin	Northeast Electric Power University
16:00-16:15	FrDT6.2
Cooperative Fault-Tolerant Consensus of Heterogeneous Multi Agent Systems with Actuator Failures and Unknown Parameters	
Xiao, Shuyi	Taiyuan University of Technology
Yan, Gaowei	Taiyuan University of Technology
16:15-16:30	FrDT6.3
Vulnerability of Remote State Estimation Subject to Physical False Data Injection Attacks	
Huang, Jiahao	Zhejiang University of Science and Technology
Tan, Qi	Zhejiang University of Science and Technology
Xie, Shuzong	Zhejiang University of Science and Technology
Xu, Xiaozhou	Zhejiang University of Science and Technology
Dai, Jiahao	Zhejiang University of Science and Technology
Xu, Jiapeng	Tianjin University
16:30-16:45	FrDT6.4
Linear Residual Generators for Fault Estimation in Discrete-Time Nonlinear Systems	
Ranjan, Ritu	Texas A&M University
Kravaris, Costas	Texas A&M University

16:45-17:00	FrDT6.5
AI-Driven Pipeline Leak Detection Using Thermal UAV Imagery & Hybrid CNN-Transformer Networks for Real-Time Infrastructure Monitoring	
Akyzbekov, Olzhas	Satbayev University
17:00-17:15	FrDT6.6
Causality-Enhanced Normalizing Flows with Piecewise Time-Varying DAGs for Anomaly Detection	
Zhang, Ming-Qing	Beijing University of Chemical Technology
Zhou, Liang-Yu	Beijing University of Chemical Technology
Hao, Da-Ben	Beijing University of Chemical Technology
Zhu, Qunxiong	Beijing University of Chemical Technology
He, Yan-Lin	Beijing University of Chemical Technology
Zhang, Yang	Beijing University of Chemical Technology
Lu, Tongwei	The College of Computer Science and Engineering, Wuhan Institute of Technology
Xu, Yuan	Beijing University of Chemical Technology
17:15-17:30	FrDT6.7
Stabilization Control for a Class of Fractional-Order Memristor-Based Neural Network System, pp. 2119-2124.	
Zhang, Zhe	Guangxi University
Miao, Zhiqiang	Hunan University

Book of Abstracts

Technical Program for Wednesday June 17, 2026

WeAT1	Assembly Hall
Best Paper Session (Regular Session)	
Chair: Xie, Lihua	Nanyang Technological University
13:30-13:50	WeAT1.1
<i>Event-Triggered Incremental Fault-Tolerant Control: Recovery Performance and Convergence Time Guarantee</i>	
Li, Yu	The Hong Kong Polytechnic University
Wen, Chih-Yung	The Hong Kong Polytechnic University
Zhang, Youmin	Concordia University
<p>To ensure both recovery performance and convergence time, this paper proposes a novel incremental Fault-Tolerant Control (FTC) integrated with an event-triggered mechanism. A function with prescribed performance is designed to constrain the tracking errors, guaranteeing that they always remain within the prescribed safety boundary. By incorporating the prescribed-time control theory into incremental control, the tracking errors recover to a stable state within a user-defined time. To reduce computational burden, an event-triggered mechanism is further integrated to the proposed prescribed-performance and prescribed-time incremental FTC to avoid unnecessary control updates. Finally, based on the proposed incremental FTC, the angular rate controller for fixed-wing aircraft is developed to improve flight safety. Simulation results demonstrate that the developed FTC effectively overcomes the asymmetric wing damage, achieving the desired recovery performance and convergence time while significantly reducing computational cost.</p>	
13:50-14:10	WeAT1.2
<i>Multi-UAV Prescribed Time Lag Consensus Control Via Adaptive Weight Pigeon-Inspired Optimization</i>	
Chen, Rujia	Beihang University
Duan, Haibin	Beihang University
Xu, Gen	Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences
Yu, Limin	STARMACH Co., Ltd
Luo, Delin	Xiamen University
<p>This paper investigates the lag consensus problem arising from leader state information transmission in multi-manned aerial vehicle (multi-UAV) leader-follower communication network and develops a prescribed time (PT) lag consensus protocol. The stability of the control law is rigorously established through construction of an appropriate Lyapunov function, accompanied by derivation of the corresponding stability criteria. To enhance system's performance, an adaptive weight pigeon-inspired optimization (AWPIO) is developed, incorporating an adaptive weight adjustment mechanism for controller parameter tuning and energy consumption minimization. The efficiency of the proposed control protocol and optimization algorithm is comprehensively demonstrated through numerical simulation and comparative experiment.</p>	
14:10-14:30	WeAT1.3
<i>Towards Efficient Robot Learning: Diffusion-Style Skill Learning and Transfer on Platform with Multi-Modal Perception and Force Feedback</i>	
Li, Dianxi	The Chinese University of Hong Kong
Dong, Zhipeng	Hong Kong Center for Logistics Robotics

Li, Zhuo	The Chinese University of Hong Kong
Liu, Wenrui	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong
<p>This work proposes a bimanual force-feedback teleoperation platform designed for collecting and learning complex manipulation tasks. The system integrates two Franka robotic arms as the leader and another two as the follower, supporting real-time force feedback and high-precision multimodal data collection. To enhance the performance of diffusion-style policies, several algorithmic improvements are introduced, including an efficient 3D point cloud encoder, a stochastic interpolation framework to reduce distribution discrepancies, and an inpainting-based method to improve action continuity. Additionally, large language models (LLMs) are incorporated to enable natural language interaction, task instruction parsing, and semantic execution. We validate the system in a "congee shop" scenario, where it autonomously performs tasks such as adding ingredient, water pouring, cooking, serving, and so on. Experimental results demonstrate the system's effectiveness in handling multimodal, contact-rich tasks and interacting naturally with users.</p>	
14:30-14:50	WeAT1.4
<i>Inverse Learning-Based Strategy for Linear Quadratic Differential Hypergame with Misperception</i>	
Xiong, Wei	Tongji University
Dong, Yi	Tongji University
Xin, Bin	Beijing Institute of Technology
Wang, Tianqi	The Hong Kong Polytechnic University
Hong, Yiguang	Chinese Academy of Sciences
<p>This paper considers a two-player linear quadratic differential hypergame where Player 2 holds misperception about the objective of Player 1. Such a problem arises in practical situations such as mixed human-autonomous driving, where the autonomous vehicle may misinterpret human driving intentions. Such misperception typically precludes exact hyper-Nash equilibria and brings technical challenge in the design of the optimal strategy for Player 2 due to obscured Nash-relevant parameters under state-only observations. To address the difficulty, we develop an inverse learning-based method that reconstructs the Nash-relevant closed-loop dynamics induced by the opponent's strategy from finite state trajectories. Based on the recovered game structure, a Riccati flow-based strategy update law is then designed, which drives the proposed strategy toward the exact Nash equilibrium of the underlying game. The effectiveness of the proposed strategy is validated by a car-following case with misperception between an autonomous vehicle and a human driver.</p>	
14:50-15:10	WeAT1.5
<i>Online MPC-Augmented Reinforcement Learning for Path Tracking Control of Autonomous Vehicles</i>	
Xu, Qian	Southern University of Science and Technology
Cao, Weipeng	Guangdong Laboratory of Artificial Intelligence and Digital Economy (Shenzhen)
Wang, Xueqian	Tsinghua University
Li, Dachuan	Southern University of Science and Technology
<p>The Reinforcement Learning (RL) provides an effective paradigm for control strategy design of autonomous vehicles (AV). However, the actual application of RL is hindered by challenges of training inefficiency and runtime instability. This paper proposes a novel RL framework with online MPC augmentation for path tracking. To enhance the online control performance of the RL, the proposed</p>	

framework introduces an MPC controller to provide real-time constrained augmentation to the control signal of the RL controller. In addition, the augmented control and the magnitude of MPC compensations are fed back to guide the update of state and rewards during the retraining of RL. In this manner, the AV agent explicitly learns the interaction between learning-based control and optimization-based augmentation, enabling faster convergence of the training stage. Simulation results demonstrate that the proposed framework achieves competitive tracking control accuracy, while drastically reducing the RL training overhead with a large magnitude of reduction in convergence time.

WeAT2	Room 256
Robotics 1 (Regular Session)	
Chair: Miao, Zhiqiang	Hunan University
Co-Chair: Shi, Yangxi	Beijing Institute of Technology
13:30-13:45	WeAT2.1
<i>Distributed Active Target Tracking for UAV Swarms in Cluttered Environments: A Perception and Planning Framework</i>	
Shi, Yangxi	Beijing Institute of Technology
Wei, Shaozhun	Beijing Institute of Technology
Liu, Henghua	Beijing Institute of Technology
Fang, Hao	Beijing Institute of Technology
<p>UAV swarms tracking moving targets in cluttered environments face coupled challenges: bearing-only observability limits, dynamic uncertainty diffusion, and environmental occlusions. To address these, we propose a completely distributed, unified active perception and planning framework. First, a Distributed Recursive Least Squares (DRLS)-based estimator circumvents traditional linearization errors to guarantee state convergence under bearing-only constraints. Second, to proactively suppress uncertainty, an entropy-driven formation strategy leverages the kinematic evolution of the error covariance, steering the swarm to maximize information gain against the principal uncertainty axes. Third, bridging active guidance with safe execution, a kinodynamic planner generates collision-free trajectories that explicitly resolve Field-of-View (FoV) limits and teammate occlusions. Extensive high-fidelity simulations demonstrate that the proposed system ensures persistent tracking in dense clutter, significantly reducing theoretical uncertainty and estimation errors while maintaining exceptional formation survivability and flexibility.</p>	
13:45-14:00	WeAT2.2
<i>Nonlinear Mechanical Modeling and Experimental Validation of CFRP Energy Storage Elements for Jumping Robots</i>	
Yang, Xuecong	Harbin Institute of Technology
Li, Zhaoxu	Harbin Institute of Technology
Tian, Baolin	Harbin Institute of Technology
Wang, Yuzheng	Aerospace System Engineering Shanghai
Hou, Baoshen	National Key Laboratory of Aerospace Mechanism, Aerospace System Engineering Shanghai
Yu, Haitao	Harbin Institute of Technology
Gao, Haibo	Harbin Institute of Technology
<p>Jumping robots, which offer high energy density and tunable properties, exhibit superior obstacle-crossing capability for exploration missions. However, most existing studies rely on simplified linear spring assumptions for modeling, which fail to accurately capture the nonlinear mechanical behavior of large-deformation composite leaf springs. To address this issue, this paper presents an equivalent mechanical model of a carbon fiber-reinforced polymer (CFRP)-based jumping mechanism derived from geometrically nonlinear theory. First, for a rec-tangular CFRP leaf spring compressed at both ends, a</p>	

circular arc assumption is introduced to describe large-deflection deformation. Using the variational principle, an analytical relationship between compression displacement and elastic force is derived in the form of elliptic integrals. Second, an experimental platform consisting of a servo motor, reduction gears, a winding roller, and sensors is developed to enable high-precision compression loading via closed-loop position proportional-integral-derivative (PID) control. Mechanical tests are conducted on CFRP leaf springs of various specifications. Finally, an empirical correction coefficient is introduced to calibrate the parameters of the theoretical model. Experimental results show that the calibrated model achieves a coefficient of determination R^2 above 0.99 and a root mean square error below 5% of the peak force, validating its predictive accuracy within a compression range of less than $L/2$. The proposed mechanical model provides a reliable theoretical basis for the optimal design and performance prediction of elastic elements in jumping robots.

14:00-14:15	WeAT2.3
<i>A Rapid Calculation Method and System for Modern Power Grid Performance Parameters</i>	
Lu, Qiyang	South China University of Technology
Qin, Huabiao	South China University of Technology
Cui, Yuhao	Zhuhai Zhonghui Microelectronics CO., Ltd
<p>To address the critical challenges in the rapid calculation of key performance parameters within the complex environment of modern power grids, this paper proposes a rapid calculation method and system for modern power grid performance parameters. The system leverages a sparse frequency-domain energy mapping architecture as its core, combined with a reconfigurable dynamic observation window mechanism. It fundamentally optimizes the computational model by transforming traditional time-domain point-wise dense operations into efficient frequency-domain scalar projections. Experimental results and hardware deployment demonstrate that the system significantly reduces resource consumption and processing latency while maintaining high precision, and the monitoring performance complies with international standards such as IEC 61000-4-30, providing an efficient and reconfigurable system-level solution for refined real-time power grid monitoring.</p>	
14:15-14:30	WeAT2.4
<i>A Structurally Constrained Rod-Driven Continuum Manipulator for Simplified Kinematic Modeling</i>	
Yang, Wentuo	Shanghai Jiao Tong University
Zhou, Xionghui	Shanghai Jiao Tong University
Zhang, Teng	The University of Hong Kong
Xie, Le	Shanghai Jiao Tong University
<p>Continuum and serpentine manipulators have attracted sustained interest due to their ability to navigate confined environments and safely interact with unstructured surroundings. Among existing modeling paradigms, constant-curvature representations offer an appealing trade-off between model fidelity and computational efficiency, enabling real-time control and planning. However, achieving reliable constant-curvature deformation in continuum manipulators remains challenging, particularly under external loading and practical actuation constraints. To address these challenges, this work introduces a novel continuum manipulator design that enforces constant-curvature deformation through mechanical synchronization. The core mechanism forces all discrete segments within a bending section to undergo equal rotation angles via a rigid coupling system.</p>	
14:30-14:45	WeAT2.5
<i>VGGT-DynMap: Globally Consistent Static Dense Mapping Via Coarse-To-Fine Fusion in Dynamic Environments</i>	
Liu, Jingting	Hunan University
Cao, Wenhan	Hunan University

Wu, ZhiHong	Hunan University
Chen, Hao	Hunan University
Li, Yujie	Hunan University
Huidong, Wang	Hunan University
Miao, Zhiqiang	Hunan University

Abstract— Dense 3D mapping is fundamental to spatial perception and navigation in mobile robotics. Recently, the Visual Geometry Grounded Transformer (VGGT) has emerged as a powerful approach, offering rich dense geometric priors and fast inference speeds, with the ability to jointly process multiple images in a single forward pass in under one second. However, its limited input frame capacity constrains practical deployment in real-world scenarios. While RGB-D Visual Odometry (VO) provides reliable long-trajectory pose estimation, directly accumulating VGGT point clouds often leads to geometric distortions and global inconsistencies due to sensor noise and accumulated drift. To address these challenges, we propose a two-stage mapping framework that systematically couples dynamic RGB-D VO with VGGT point cloud processing to achieve high-fidelity 3D mapping. In the first stage, pose fusion is performed, wherein VO trajectories are leveraged to robustly initialize and refine the global poses of independent mapping sessions, ensuring local geometric stability. In the second stage, point cloud fusion is executed by aligning and merging VGGT point clouds under global optimization constraints to eliminate structural divergence. Experimental results demonstrate that our framework effectively enables long-trajectory dense mapping while significantly enhancing the global consistency of the reconstructed maps. By explicitly integrating reliable dynamic VO priors with VGGT-based point cloud refinement, our system delivers robust, high-quality static dense mapping in dynamic environments, achieving superior performance over existing RGB-D SLAM baselines. I. INTRODUC

14:45-15:00	WeAT2.6
<i>Study on the Locomotion Performance of a Snake-Like Robot with Different Passive Joint Configurations</i>	
Ji, Haoyi	Ritsumeikan University
Cao, Yiming	Ritsumeikan University Biwako-Kusatsu Campus
Wang, Zhongkui	Ritsumeikan University

This paper experimentally investigates the influence of passive joint configuration on the locomotion performance of a snake-like robot. The four-joint planar robot is used to evaluate multiple joint configurations, including fully actuated, three actuated joints with one passive joint (3A+1P), two actuated joints with two passive joints (2A+2P), and one actuated joint with three passive joints (1A+3P), under identical control inputs and physical conditions. Locomotion performance is quantitatively assessed using average forward velocity and cost of transport (COT). Experimental results show that incorporating passive joints can improve locomotion efficiency compared with the fully actuated configuration. Furthermore, different passive joint configurations exhibit distinct characteristics: the 3A+1P configuration achieves the highest forward speed under appropriate spring conditions, while the 2A+2P configuration demonstrates lower COT and better energy efficiency. These results indicate that locomotion performance strongly depends on passive joint placement, offering insights for the design of energy-efficient snake robots.

15:00-15:15	WeAT2.7
<i>Dynamic Parameter Identification of a Hybrid Bipedal Robotic Leg Via Current-Offset Compensation and Trajectory Optimization</i>	
Xu, Kunhao	Harbin Institute of Technology
Tian, Baolin	Harbin Institute of Technology
Mu, Changxi	Harbin Institute of Technology
Wei, Dapeng	Chinese Academy of Sciences
Xiao, Jian	Chinese Academy of Sciences

Wang, Xiaojun	Chinese Academy of Sciences
Yu, Haitao	Harbin Institute of Technology

Parameter identification for hybrid bipedal robotic legs remains challenging because parallel mechanisms introduce strong dynamic coupling and nonlinear friction is difficult to model accurately. This paper presents an enhanced identification method for a six-degree-of-freedom hybrid robotic leg with a 3-DOF serial hip, a serial knee, and a 2-DOF parallel ankle. The closed-loop kinematics of the parallel ankle are formulated, and a motor-to-joint torque mapping is derived using the principle of virtual work. The hybrid mechanism is then transformed into an equivalent serial multibody system for Lagrangian dynamic modeling. To improve model accuracy, motor current offsets are incorporated into the identification process to compensate for zero drift in low-torque regions. In addition, a trajectory optimization criterion formulated as a mass-weighted sum of the condition numbers of link-wise sub-regressor matrices is introduced to improve the balance of parameter excitation, subject to nonsingularity and excitation constraints. Experiments on the physical robotic leg show that current-offset compensation provides modest improvements under the baseline objective, while the final configuration combining the unified objective with current-offset compensation achieves the best overall performance. Compared with the baseline configuration, the final configuration reduces the NRMSE of Joint 1 and Joint 6 by 53.3% and 40.1%, respectively.

WeAT3	Room 267
Optimal Control 1 (Regular Session)	
Chair: Jiao, Xiaohong	Yanshan University
13:30-13:45	WeAT3.1
<i>A Lazy Submodular Optimization Method for Efficient Dynamic Aggregation of Flexible Resources</i>	
Mo, Qianlian	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Education, Southeast University
Jin, Yulong	NARI Technology Co., Ltd
Zheng, Tao	NARI Technology Co., Ltd
Zhang, Kaifeng	Southeast University

To accommodate the diversity and time-varying characteristics of grid regulation demands and flexible resource, efficient aggregation mechanisms are required to support grid regulation services. Dynamic aggregation adaptively adjusts resource composition according to grid demands, overcoming the limitations of the traditional fixed resource composition in virtual power plants (VPPs). However, the computational complexity of the large-scale resource composition is a new bottleneck. This paper introduces a dynamic aggregation optimization framework based on submodularity, which includes resource selection and coordination. A lazy submodular optimization method is proposed in the resource selection process to enhance the efficiency of flexible resource aggregation. Using the diminishing-return property of submodular functions, the proposed method caches previous aggregation gains as upper bounds, significantly reducing redundant evaluations. The method greatly improves computational efficiency while maintaining optimal aggregation quality. Simulations highlight the efficacy of the proposed method in dynamic aggregation.

13:45-14:00	WeAT3.2
<i>Energy-Saving Cruise Control for Connected HETs Enhanced by Physically Informed Neural Networks Based on HDP</i>	
Tang, Wenbin	Yanshan University
Jiao, Xiaohong	Yanshan University
Zhang, Yahui	Yanshan University

<p>To maintain efficient, economical driving for hybrid electric trucks (HETs), energy-saving cruise control must be used in complex dynamic traffic scenarios to optimize vehicle speed profiles and avoid unnecessary acceleration or deceleration. This paper proposes a Heuristic Dynamic Programming (HDP)- based energy-saving cruise control strategy enhanced with PINN. By incorporating power balance, SOC dynamics, and energy conservation as regularization terms into the loss function, PINN improves the model's predictive accuracy for complex nonlinear systems under physical constraints. The energy consumption model's output is incorporated into cruise control as an economic indicator for cruise-speed planning. Concurrently, an Informer neural network predicts the preceding vehicle's speed from historical data, mitigating the impact of the vehicle's uncertain driving behavior on energy-saving cruise control. HDP achieves optimal speed-cruise control in dynamic traffic scenarios by integrating the predicted speed of the preceding vehicle, the vehicle's predicted energy consumption, and its own state.</p>	
14:00-14:15	WeAT3.3
<i>Optimal Control of Nonlinear Discrete-Time Systems with Control Constraints</i>	
Lv, Chuanzhi	Shandong University of Science and Technology
Wang, Hongxia	Shandong University of Science and Technology
Zhang, Liping	Shandong University of Science and Technology
Zhang, Huanshui	Shandong University
<p>This paper develops an efficient numerical algorithm to solve a class of discrete-time nonlinear optimal control problems with control constraints. Firstly, by introducing a virtual control variable, the original constrained optimal control problem is transformed into an unconstrained form. Subsequently, an Optimal Control Principle (OCP)-based algorithm with superlinear convergence is presented to solve the transformed problem. The computation of the gradient and Hessian matrix is further reformulated as optimal control problems of different types, and explicit forward-backward recursive formulas are derived using variational methods. Finally, numerical simulations are conducted to demonstrate the effectiveness of the proposed algorithm and its superior computational efficiency.</p>	
14:15-14:30	WeAT3.4
<i>Non-Euclidean Contraction Design of Firing-Rate Neural Networks by DC Programming</i>	
Zhao, Chengyan	Kyushu Institute of Technology
Ueno, Satoshi	Ritsumeikan University
Mei, Wenjie	Nanjing University
Zheng, Yanqiu	Tokyo University of Science
Gao, Chong	Northwestern Polytechnical University
<p>This paper proposes a DC (Difference-of-Convex) programming approach for designing contracting firing-rate neural networks. Based on non-Euclidean log-norm contraction conditions, we formulate a tunable optimization framework that jointly optimizes network parameters and metric weights. The resulting nonconvex design problem is reformulated as a standard DC program via a posynomial representation and logarithmic transformation. Numerical simulations show that the proposed method improves contraction margins and robustness-performance trade-offs compared with baseline designs.</p>	
14:30-14:45	WeAT3.5
<i>Real-Time Trajectory Planning for Heavy Trucks Via Safety-Aware Augmented Lagrangian ILQR</i>	
Su, Youtao	Beijing Institute of Technology
Ju, Zhiyang	The University of Melbourne
Tu, Yuantao	Beijing Institute of Technology

Han, Xu	Beijing Institute of Technology
Gong, Jianwei	Beijing University of Technology
Xi, Junqiang	School of Mechanical Engineering, Beijing Institute of Technology
<p>Trajectory planning for heavy-duty trucks involves a critical trade-off between computational efficiency and dynamic fidelity, especially during high-speed emergency maneuvers. Standard kinematic planners cannot ensure safety under limit handling conditions, while high-fidelity nonlinear optimization methods struggle to meet the requirements of real-time feasibility. We propose Safety-Aware Augmented Lagrangian iLQR (SA-AL-iLQR) to bridge this gap. Our method combines a differentiable nonlinear tire model and actuator dynamics to accurately predict vehicle behavior. In addition, the hard safety constraints, including collision avoidance and rollover prevention, are reformulated as continuously differentiable functions. This enables SA-AL-iLQR to rigorously enforce safety boundaries, ensuring the Load Transfer Ratio (LTR) remains within limits. TruckSim simulations have verified that the planner can prevent instability when the kinematic baseline fails, demonstrating significant improvements in stability while meeting the 10 Hz real-time requirements on standard hardware, with negligible efficiency loss.</p>	
14:45-15:00	WeAT3.6
<i>Robust Model Predictive Control for Hybrid Visual Servoing of Robotic Manipulators</i>	
Pan, Rui	University of Victoria
Wang, Yunli	National Research Council Canada
Bellinger, Colin	University of Ottawa
Drummond, Chris	National Research Council Canada
Shi, Yang	Canada
<p>Visual servoing (VS) can enhance the control precision of robotic manipulators by incorporating visual feedback into the closed-loop control process. However, in practical VS systems, it is challenging to ensure that the target object stays within the camera's field of view while maintaining robustness against external disturbances. This work develops a robust model predictive control (RMPC) framework for hybrid VS (HVS) of robotic manipulators. In the proposed HVS scheme, image moments are selected as visual features to regulate the translational motion of the camera, whereas Euler angles are chosen to characterize the camera attitude for rotational regulation. A virtual camera model is further incorporated to decouple the image-moment kinematics from the camera rotation. Based on this decoupled model, we formulate an RMPC scheme with tightened state constraints that enforce state and input constraints under bounded disturbances. Moreover, sufficient conditions that ensure recursive feasibility and guarantee closed-loop stability are rigorously established. Finally, simulation results demonstrate the robustness and constraint-handling capability of the proposed RMPC scheme.</p>	
15:00-15:15	WeAT3.7
<i>Active Excitation through Motion: Raptor-Inspired Attack Separation Control of Airborne ISPs</i>	
Yaokun, Lu	Beihang University
Teng, Hao	Beihang University
Zhao, Dong	Beihang University
Kexin, Liu	Beijing University
Qiao, Jianzhong	Beihang University
Guo, Lei	Beihang University
<p>Airborne inertial stabilized platforms in staring mode are vulnerable to false data injection attacks. In this mode, attack biases and physical disturbances can appear as similar slow drifts in the actuation channel; strong nonlinear dynamics and observability singularities further obscure their source. To overcome this attack-disturbance</p>	

separation difficulty, we construct an observability-based attack-disturbance separability metric and propose an information-regularized model predictive control (IR-MPC) method. The method mimics raptor peering, where small deliberate head motions acquire additional visual information without breaking sustained gaze, to generate safe active excitation trajectories. The induced excitation enhances the separability between composite physical disturbances and attack signals, thereby supporting online attack identification, separation, and compensation. Simulations calibrated by prototype identification experiments show attack/friction convergence within 0.29 s/0.48 s after excitation starts, while keeping the excitation trajectory inside the FOV safety corridor

WeAT4	Room 269
Multi-Agent Systems 1 (Regular Session)	
Chair: Duan, Haibin	Beihang University
Co-Chair: Kuvadletov, Sanzhar	Coventry University Kazakhstan
13:30-13:45	WeAT4.1
<i>Greedy Algorithms for the Team Formation Problem with Time Windows</i>	
Zhu, Weikun	National University of Defense Technology
Tang, Luohao	National University of Defense Technology
Lin, Fengyu	National University of Defense Technology
Lei, HongTao	National University of Defense Technology
Zhu, Xianqiang	National University of Defense Technology
Zhu, Cheng	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
<p>This paper presents a multiple team formation problem with time window constraints, which aims to select agents from a candidate set to form multiple teams for the completion of multiple tasks with distinct time windows. A selected agent can only participate in disjoint tasks. Furthermore, agents may fail in task execution. This problem has a wide range of applications. A mathematical model is formulated for this problem, and a series of greedy algorithms based on different heuristic rules are proposed. Computational experiments demonstrate that three of these algorithms exhibit excellent performance in terms of both solution quality and computational time. Index Terms—Multi-agent team formation, Time window constraints, Greedy algorithms.</p>	
13:45-14:00	WeAT4.2
<i>Observer-Based Neuro-Adaptive Control for Consensus Tracking of Uncertain Multi-Agent Systems</i>	
Zhao, Yinxiang	Beihang University
Luo, Zhibin	Beihang University
Wang, Qishao	Beihang University
Lv, Yuezu	Beijing Institute of Technology
Yu, Yang	Beihang University
<p>This extended abstract proposes a distributed consensus tracking protocol for heterogeneous multi-agent systems with unmodeled nonlinear dynamics. To estimate unmeasurable leader states without dimensional constraints, a generalized distributed adaptive observer relying on leader observability is developed. Furthermore, fully adaptive matrix-form update laws are designed for both observation and feedback gains. This eliminates predetermined matrix reliance and resolves structural coupling via dynamic error-driven</p>	

<p>adjustments. Finally, a continuous robust control term with a dynamically decaying parameter smoothly compensates for uncertainties, ensuring chattering-free asymptotic stability. Simulations verify the proposed protocol.</p>	
14:00-14:15	WeAT4.3
<i>Adaptive Lyapunov-Based Distributed Safe Motion Planning and Formation Control for Multi-Agent Systems</i>	
Abulkassov, Bakhtiyar	Astana IT University
Makhmudova, Valeriya	Astana IT University
Kaliyeva, Amina	Astana IT University
Amangeldi, Arystan	Astana IT University
Kuvadletov, Sanzhar	Coventry University Kazakhstan
<p>This paper investigates an adaptive Lyapunov-based distributed control for safe motion planning and leader-follower formation in multi-agent systems. The objective is to maintain a stable formation, allow additional agents to safely join the group, and guide all agents to designated goal positions. A distributed control law is derived, where each follower relies only on local information from the leader. Safety during motion and agent insertion is ensured through repulsive potential terms that enforce collision avoidance, and speed constraints. The proposed method guarantees formation stability and asymptotic convergence to the target positions. Simulation results with multiple robots demonstrate safe agent insertion, formation maintenance, and coordinated parking at goal locations.</p>	
14:15-14:30	WeAT4.4
<i>Dual-Mode Heterogeneous Channel Access Method Based on Action Masking and Asynchronous Experience Replay</i>	
Guo, Xianda	South China University of Technology
Qin, Huabiao	South China University of Technology
Cui, Yuhao	Zhuhai Zhonghui Microelectronics CO., Ltd
<p>Dual-mode heterogeneous systems integrating Power Line Communication (PLC) and Wireless Communication (WLC) are vital for ensuring reliability in the Power Internet of Things (PIoT). However, rule-based schemes lack adaptive collaboration among multiple Stations (STAs). Applying Multi-Agent Reinforcement Learning (MARL) to such systems faces two challenges: invalid action spaces from asynchronous channel states and reward misalignment due to heterogeneous transmission rates. To address these, this paper proposes Action Masking and Asynchronous Experience Replay for Dual-Mode Channel Access (AMA-DCA). Simulation results show that AMA-DCA significantly outperforms the Multiplexing algorithm in throughput, collision probability, and mean delay.</p>	
14:30-14:45	WeAT4.5
<i>Velocity-Augmented Control Barrier Functions for Risk-Aware Distributed Formation under Disturbances</i>	
Sun, Xiaojian	Nankai University
Chen, Fei	Nankai University
Xiang, Linying	Xiamen University
<p>This paper addresses leader-follower formation tracking for double-integrator agents while enforcing collision avoidance with other agents and static circular obstacles in the presence of stochastic acceleration disturbances. We design a distributed nominal formation controller and augment it with a risk-aware safety filter that embeds conditional value-at-risk (CVaR) into a control barrier function (CBF) condition. We use velocity-augmented distance barrier functions to reduce the relative degree to one and derive an affine-in-control form of the resulting CVaR-CBF constraints. This derivation yields a convex online quadratic program that minimally modifies the nominal input. Under a leader-rooted uniform joint connectivity condition, we</p>	

prove asymptotic convergence of the disturbance-free formation error and provide a simple bound on the augmentation parameter that implies standard position-clearance constraints. Simulations illustrate safe obstacle avoidance and formation recovery under the proposed controller.	
14:45-15:00	WeAT4.6
<i>Resilient UAV Swarm Control Via Starling-Inspired Attack Containment</i>	
Gong, Shiqi	Beihang University
Duan, Haibin	Beihang University
Yongqiong, Yuan	China Electronics Technology Group Corporation (CETC), 20th Institute
Luo, Delin	Xiamen University
Resilient control of uncrewed aerial vehicle (UAV)swarm with attack containment strategy under denial-of-service (DoS) attacks is investigated in this paper. Inspired bystarling flocks that achieve emergent global resilience through dynamic local topology adjustments, an attack containment strategy is proposed to identify and actively isolate disconnected nodes in finite time, preventing erroneous information propagation. Based on the connectivity identification, a fixed-time distributed observer is designed to ensure accurate leader state estimation. On this basis, a distributed resilient control framework is constructed, ensuring resilient swarm coordination under DoS attacks. The effectiveness of the proposed method is validated through theoretical analysis and numerical simulations	
15:00-15:15	WeAT4.7
<i>Distributed Control Framework of Multirobot System Using Automation and Control Applications*</i>	
Zeinulla, Rassul	Kazakh British Technical University
Abdimalik, Almat	Kazakh-British-Technical-University
Rakhmetkali, Ayan	Kazakh-British Technical University
Masimba, Collins	Kazakh British Technical University
Samigulin, Timur	Kazakh British Technical University
In this paper, a distributed control framework of multirobot system will be described in which a SIMATIC S7-1500 PLC (programmable logic controller) is employed to provide a stable source of sequence control, interlocks and safety logic, and MATLAB is employed to provide a higher level of coordination, monitoring and processing of motion feedback. The process of data exchange in both directions between the PLC and MATLAB is done through OPC UA and operator control is done using WinCC HMI/SCADA with clear modes, alarms and diagnostics. Stable communication, proper work of the process sequence, and online reception of the results of movement of the robot during operation were experimentally tested and confirmed. The proposed solution helps to transform a set of manipulators into an operator-friendly industrial automation system with a focus on any high-tech system.	

WeAT5	Room 259
Learning Systems (Regular Session)	
Chair: Yu, Hao	Beijing Institute of Technology
13:30-13:45	WeAT5.1
<i>Enhancing UAV Semantic Perception Via Controllable Latent Diffusion and Multi-Source Structural Priors</i>	
Fu, Xinyi	Wuhan University

Zhang, Yibo	School of Remote Sensing and Information Engineering, Wuhan University
Xie, Mengjie	Wuhan University
Gao, Zhi	Wuhan University
Lin, Feng	National University of Singapore
UAV imagery semantic segmentation underpins the expansion of the low-altitude economy, with immense practical application value and broad development prospects, yet its advancement is constrained by scarce pixel-level annotated datasets. Data augmentation is a core solution to this bottleneck. Despite the certain effectiveness of existing methods in improving model robustness, they suffer from notable limitations. Traditional methods merely realize superficial data variation and fail to introduce novel semantic structures, while generative methods rely on single priors, leading to poor structural fidelity and semantic misalignment in generated UAV scenes. To address this, we propose a method based on controllable diffusion models, fusing pixel-level semantic masks, HED edge maps as visual priors and category-enriched text prompts as semantic guidance via a custom control adapter. Specifically, it excels in preserving UAV scene structural and semantic consistency; simultaneously, it enriches dataset texture and color diversity without re-annotation. Extensive experiments on UAV benchmarks verify its superiority, significantly boosting segmentation model mIoU and advancing generative UAV data augmentation.	
13:45-14:00	WeAT5.2
<i>Toward the Optimal Behavior Control Based on a System Model Including User Preferences</i>	
Suzuki, Masakazu	Tokai University
As a basic example for realizing personal AGI, the author has formulated a simple problem of dealing with highway congestion and examined the problem-solving (decision-making) process. In this paper, for the example of determining the optimal sequence of simple actions, such as where to consider routes, whether to make detours, and which exit interchange to choose, shown is the results of optimal behavior control that encompasses recognition and planning based on a system model that includes personal preferences as part of situation and environment. The preferences that should be incorporated for personalizing AGI are considered and their relationship with the behavioral evaluation function is investigated. It is also shown that the evaluation function changes as the preferences of the actor (pAGI user) change, and as a result, the optimal behavior also changes in a complex manner.	
14:00-14:15	WeAT5.3
<i>Subject-Independent Motor Imagery EEG Classification for Portable BCI Using a Lightweight EEGNet-Lite Model</i>	
Tuimebay, Yelnur	Satbayev University
Alimbayev, Chingiz	Satbayev University
Alimbayeva, Zhadyra	Satbayev University
Ozhikenov, Kassymbek	Satbayev University
Brain-computer interface systems based on motor imagery have attracted considerable attention because they allow users to control external devices without actual muscle movement. At the same time, reliable classification of motor imagery EEG signals remains difficult because these signals are highly variable across individuals and often contain noise and artifacts. In this study, we examined the possibility of subject-independent motor imagery classification using a compact deep learning model suitable for portable BCI applications. EEG data from the PhysioNet Motor Movement/Imagery database were used, and the analysis focused on left-hand and right-hand imagery tasks. To make the system more practical for wearable use, only six electrodes located over the sensorimotor cortex were selected. The EEG signals were preprocessed through filtering, artifact reduction, epoch segmentation, and normalization. The proposed EEGNet-Lite model was then compared with conventional CSP-based approaches	

combined with LDA and SVM classifiers. Performance was evaluated using a leave-one-subject-out cross-validation scheme with accuracy and F1-score as the main metrics. The results showed that EEGNet-Lite achieved the best overall performance, reaching 84.6% accuracy and an F1-score of 0.83. These findings suggest that a lightweight neural network can provide reliable subject-independent motor imagery classification even with a reduced number of EEG channels, which is important for the development of portable and wearable BCI systems	
14:15-14:30	WeAT5.4
<i>From Potential to Implementation: Digital Transformation in Elderly Care Systems</i>	
Mežnarec-Novosel, Suzanna	Alma Mater Europaea University
Lučan, Jelena	Alma Mater Europaea University
Bogataj, David	Alma Mater Europaea University
<p>This paper examines digital readiness in elderly care systems through a comparative study of social service providers in Slovenia and Croatia within the framework of smart age-friendly communities, integrated care, and social innovation. A structured survey conducted between January and February 2025 among 458 providers assessed structural challenges, availability of digital solutions, and feasibility of technological integration. The survey was carried out within the CENTINOSS project and is positioned in relation to broader research on social innovations for integrated care of community-dwelling older adults and on socio-cultural and organizational aspects of knowledge and technology transfer. Descriptive analysis identified patterns of acceptance, implementation gaps, and cross-national differences. The findings show that both countries operate under similar structural constraints, particularly workforce shortages and limited financial resources, which influence the pace of digital transformation. Low-complexity communication and safety technologies, such as emergency alarms, video communication, and medication reminders, are widely perceived as feasible, whereas advanced solutions such as robotics and virtual reality remain marginal and cautiously evaluated. The study contributes to a socio-technical understanding of digital transformation in elderly care and advances a multilevel implementation perspective linking European governance, national policies, organizational capacity, and professional competencies.</p>	
14:30-14:45	WeAT5.5
<i>Optimization of Cross-Domain Detection Capabilities Based on RT-DETR</i>	
Cao, Yue	Beijing Institute of Technology
Chen, Wenjie	Beijing Institute of Technology
<p>Object detectors often suffer a significant performance decline when faced with domain shifts between the source domain (collected data) and the target domain (actual application data). This is due to significant visual differences between images across domains, such as variations in object scale, texture, and content style. To improve cross-domain detection performance, this paper proposes integrating two modules: AssemFormer (an assembly-based convolutional vision transformer) and SEAM (Separated and Enhanced Attention Module) into the RT-DETR detector. AssemFormer combines the local feature extraction capabilities of convolutional neural networks with the global context modeling power of Transformers, addressing the limitations of traditional convolutional neural networks in capturing long-range dependencies and local details. SEAM improves feature responses in unobstructed regions while compensating for information loss in occluded areas, thereby enhancing detection capabilities for obscured objects. It also addresses the lack of inductive bias and weak local detail capture in pure Transformers. Together, these modules mitigate the adverse effects of domain differences between synthetic and real images, optimizing performance for cross-domain object detection. In the Sim10k-Cityscapes crossdomain detection task, the mAP improved by 5.8%, and in the Cityscapes-FoggyCityscapes task, it increased by 5.7%.</p>	
14:45-15:00	WeAT5.6

<i>Bandwidth-Efficient Exact Sampling for Distributed Speculative Decoding of LLMs Via Two-Stage Rejection Sampling</i>	
Tang, Zhonghuan	Tongji University
Gong, Wei	Tongji University
Liwang, Minghui	Tongji University
Kang, Miao	Tongji University
Li, Li	Tongji University
<p>Distributed Speculative Decoding (DSD) has emerged as a promising paradigm to reduce the serving costs of Large Language Models (LLMs) by offloading the drafting process to edge devices. However, the communication overhead required to synchronize probability distributions between the cloud server and the edge client creates a significant bottleneck, particularly in bandwidth-limited environments. Existing solutions often resort to lossy compression methods, which degrade the probabilistic integrity required for complex reasoning tasks. In this paper, we propose a novel Two-Stage Rejection Sampling framework. Our approach exploits the heavy-tailed nature of residual probability distributions by partitioning the vocabulary into a dominant "Head" and a sparse "Tail." By prioritizing the transmission of the Head and employing a hierarchical rejection sampling scheme, we drastically reduce data transmission while mathematically guaranteeing exact sampling from the target distribution. Experimental results show that our method effectively alleviates bandwidth pressure and accelerates inference without compromising the model's reasoning fidelity.</p>	
15:00-15:15	WeAT5.7
<i>Spacecraft Attitude Formation: An Event-Triggered Impulsive Control Approach</i>	
Li, Zichuang	Beijing Institute of Technology
Yu, Hao	Beijing Institute of Technology
Hao, Renjian	Beijing Institute of Control Engineering
Song, Jiliang	Beijing Institute of Control Engineering
Shi, Dawei	Beijing Institute of Technology
<p>Addressing the problem of spacecraft attitude formation control, this paper proposes an innovative approach: unlike traditional methods, short-duration jet-driven signals are approximated as impulsive control signals to characterize the "instantaneous" changes in the spacecraft's angular velocity. Furthermore, instead of pursuing equivalence with continuous control signals, the evaluation of impulsive control effectiveness is directly based on closed-loop control performance, aiming to design an impulsive controller that ensures the closed-loop system performance approximates that of a given nominal continuous reference system. This method provides a new theoretical framework for significantly reducing spacecraft fuel consumption and actuator wear while maintaining control accuracy. Finally, numerical examples are presented to demonstrate the effectiveness of the proposed control algorithm.</p>	

WeAT6	Room 264
Adaptive Control (Regular Session)	
Chair: Peng, Zhouhua	Dalian Maritime University
Co-Chair: Guo, Zhao	Wuhan University
13:30-13:45	WeAT6.1
<i>A State-Scheduled Regional Variable Impedance Control for Lower-Limb Exoskeletons</i>	
Long, Qinyuan	Wuhan University
Liao, Yueru	Wuhan University
Yi, Shuowen	Wuhan University
Lu, Haolin	Wuhan University

Guo, Zhao	Wuhan University
<p>Safe and adaptive assistance remains a key challenge for lower-limb rehabilitation exoskeletons, because the required human--exoskeleton interaction stiffness should vary continuously with both the instantaneous tracking deviation and the user's recovery state. Conventional fixed-impedance or discretely switched controllers either over-constrain natural gait or provide insufficient corrective guidance when deviations grow. To address this problem, this paper proposes a state-scheduled regional variable impedance control (RVIC) scheme. RVIC introduces a sigmoid-based virtual safety corridor in the error space to regulate the joint stiffness smoothly: low stiffness is maintained inside the corridor to preserve transparency, while stiffness increases continuously outside the corridor to provide corrective assistance. In addition, a recovery score $\sin [0,1]$ is incorporated as a scheduling variable to continuously tune both the overall assistance intensity and the corridor width, enabling principled assistance--autonomy trade-off across rehabilitation stages. Simulations and treadmill experiments on a wearable lower-limb exoskeleton with five healthy subjects validate that RVIC achieves stable human--exoskeleton interaction and smooth stiffness transitions.</p>	
13:45-14:00	WeAT6.2
<p><i>Research on Adaptive Thermal Management Scheme for Hydrogen Fuel Cell Combined Heat and Power System*</i></p>	
Li, Heran	Harbin Institute of Technology
Sun, Chuanyu	Harbin Institute of Technology
Korpebayev, Daryn	L.N. Gumilyov Eurasian National University, Satbayev University
KAi, Song	Harbin Institute of Technology
<p>Abstract—The application of Proton Exchange Membrane Fuel Cell (PEMFC) Combined Heat and Power (CHP) systems in cold regions presents significant energy-saving potential, yet their dynamic thermal management remains a critical challenge. The cooling loop of the CHP system is characterized by strong nonlinearity, large thermal inertia, and high susceptibility to severe disturbances from internal electrical loads and external extreme-cold heat grids. Traditional controllers often suffer from integral windup and sluggish responses under such conditions, leading to severe temperature overshoots, &quot;cold shock&quot; risks, and excessive parasitic power consumption. To address these issues, this paper proposes a novel Adaptive Smith Predictor-based Active Disturbance Rejection Control (Adaptive SP-ADRC) strategy. And Forgetting Factor Recursive Least Squares (FFRLS) algorithm is integrated to online identify the time-varying high-frequency gain, ensuring the controller adapts to physical parameter drifts. Concurrently, a Smith Predictor is employed to compensate for the large thermal lag, enabling the linear extended state observer (LESO) to effectively estimate and reject multi-source disturbances. A high-fidelity thermodynamic model is established and tested under extreme dynamic scenarios. Simulation results demonstrate that, compared to a baseline Fuzzy-PID controller, the proposed Adaptive SP-ADRC reduces the maximum temperature overshoot by 81.5% during electrical load steps and effectively prevents "cold shock" during sudden external cold impacts. Index Terms— Proton exchange membrane fuel cell (PEMFC), Combined heat and power (CHP), Thermal management, Active disturbance rejection control (ADRC), Online parameter identification, Large thermal inertia.</p>	
14:00-14:15	WeAT6.3
<p><i>Fully Distributed Event-Triggered Cooperative Target Enclosing Control for Underactuated ASVs Via Adaptive Observers</i></p>	
Wang, Anqing	Dalian Maritime University
Li, Xukun	Dalian Maritime University
Mou, Yanjie	Dalian Maritime University
Jiang, Yue	Dalian Maritime University
Wu, Wenjie	Dalian Maritime University

Peng, Zhouhua	Dalian Maritime University
<p>This paper addresses the cooperative target enclosing problem for underactuated autonomous surface vehicles (ASVs) under jointly connected directed graphs. To tackle the challenges of limited communication and time-varying, intermittently disconnected topologies in practical maritime environments, a fully distributed event-triggered control framework is proposed, which consists of a coordination layer and a control layer. In the coordination layer, an event-triggered adaptive fully distributed observer is designed, enabling each ASV to achieve asymptotic estimation of both the system matrix and the state of the moving target under intermittent communication while strictly excluding Zeno behavior. Based on this, the control layer generates distributed guidance commands in the Earth-fixed frame according to the desired enclosing distance and relative angle. It then employs fuzzy logic systems to approximate the unknown vessel dynamics and designs a robust tracking controller to ensure the accurate execution of the guidance commands. Simulation results demonstrate that the proposed method ensures the enclosing errors are uniformly ultimately bounded under communication constraints and topology switching, while significantly reducing the communication frequency.</p>	
14:15-14:30	WeAT6.4
<p><i>Intelligent Real-Time Control of Electrostatic Precipitators Based on Neural Network Modeling</i></p>	
Sagynuly, Sanzhar	Satbayev University
Omirebekova, Zhanar	Satbayev University
<p>This paper describes the development and testing of an intelligent control system designed to optimise the operation of electrostatic precipitators in real time. The main objective of the research is to improve the efficiency of flue gas treatment through the use of intelligent algorithms based on artificial neural networks. As part of the research, an analysis of existing electrostatic precipitators was carried out and key parameters affecting their performance were identified, including input parameters (voltage, pressure, gas temperature) and output parameters (concentration of pollutants and gas humidity). The Levenberg–Marquardt training algorithm (trainlm) was used to build the model, ensuring high convergence rates when working with small and medium-sized data samples. The developed mathematical model based on a neural network demonstrated the ability to approximate the relationships between the input and output parameters of the gas cleaning process.</p>	
14:30-14:45	WeAT6.5
<p><i>Adaptive Disturbance Rejection of Bearing-Based Formation for General Linear Multi-Agent Systems</i></p>	
Peng, Cheng	The Chinese University of Hong Kong
Huang, Jie	Chinese Univ. of Hong Kong
<p>The existing bearing-based formation control has mainly focused on multiple integrator systems. The main reason is that the existing methods use Routh's criterion to determine various control gains, which is only effective for low order integrator systems. In this paper, we further study the bearing-based formation control for a large class of linear multi-agent systems. By leveraging the solution of a particular Riccati equation, we manage to find a distributed bearing-based control law to achieve the bearing-based formation. Moreover, we introduce an adaptive bearing-based control technique to deal with the disturbance rejection problem for bounded disturbances with unknown bounds. Instead of resorting to Routh's criterion, we apply rigorous Lyapunov analysis to guarantee the closed-loop stability. Finally, the effectiveness of the proposed approach is verified through the formation control of a group of quadrotors.</p>	
14:45-15:00	WeAT6.6
<p><i>Time-Varying Aerodynamic Parameter Estimation and Adaptive Dynamic Inversion Control of Aircrafts with Uncertain Actuator Faults</i></p>	
Wang, Zhishen	Beijing Institute of Technology

Qu, Xiaolei	Northwestern Polytechnical University
Zhang, Yanjun	Beijing Institute of Technology
<p>This paper addresses the flight control problem of high-performance aircraft subject to aerodynamic parameter uncertainties and unknown control surface failures. First, the influence of control surface failures on flight performance is analyzed, and a nonlinear aircraft model incorporating actuator faults is established. Then, a parameterized model suitable for online identification is constructed, and an adaptive aerodynamic parameter estimation algorithm based on variable-rate forgetting recursive least-squares is proposed to achieve real-time parameter estimation. On this basis, a hierarchical fault-tolerant control scheme based on adaptive dynamic inversion is developed, which integrates outer loop position and trajectory control with inner loop attitude and angular rate control, enabling real-time dynamic compensation under unknown actuator faults and command tracking of flight altitude, lateral displacement and sideslip angle. Finally, numerical simulations based on an F-16 aircraft model validate the effectiveness of the proposed method. The results show that the designed parameter estimation algorithm can effectively estimate the time-varying aerodynamic parameters, and the fault-tolerant control scheme is able to maintain satisfactory tracking performance and system stability in the presence of uncertain elevator failure.</p>	

WeBT1	Assembly Hall
Best Student Paper Session (Regular Session)	
Chair: Xie, Lihua	Nanyang Technological University
15:30-15:50	WeBT1.1
<i>Nonsingular Impact Time Control Guidance with Field-Of-View Constraints: Theory and Experiment</i>	
Li, Heng	Beihang University
Wang, Qing	Beihang University
Yu, Jiangleong	Beihang University
Wang, Ming	Beihang University
Dong, Xiwang	Beihang University
<p>This paper investigates the impact time control guidance problem under field-of-view (FOV) constraints. Unlike existing results, the proposed method avoids control singularity, which enhances the reliability of the guidance system. First, a guidance model is formulated, and the corresponding guidance objectives are explicitly defined. Then, a nominal guidance law is developed using an inverse-dynamics-based design method to enable accurate time-to-go prediction. Subsequently, by incorporating impact-time error feedback, a nonsingular impact-time guidance law with FOV constraints is proposed, and the stability of the impact-time error is rigorously proven. Finally, numerical simulations and equivalent physical experiments are conducted to comprehensively validate the effectiveness of the proposed method.</p>	
15:50-16:10	WeBT1.2
<i>Time-Advancing Multimodal Motion-State Estimation for Soft Lower-Limb Exoskeletons Using sEMG-IMU Fusion</i>	
Zhou, Zixiang	Harbin Institute of Technology, Shenzhen
Zeng, Qiming	Harbin Institute of Technology, Shenzhen
Liu, Zhao	Harbin Institute of Technology (Shenzhen)
Luo, Mingxiang	The State Key Laboratory of Robotics and Systems, Harbin Institute of Technology Shenzhen, Shenzhen
Hu, Kaiyu	Harbin Institute of Technology, Shenzhen

Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
<p>Latency in the sensing-estimation pipeline can make exoskeleton assistance arrive late. We study an offline time-advancing estimator that fuses sEMG and IMU signals to predict future gait phase, bilateral hip angles, and walking speed at $t+\delta$. The model uses a lightweight dual-stream architecture with a CNN sEMG encoder, a GRU IMU encoder, and a channel-wise gating module. Evaluation on a synchronized sEMG-IMU-MoCap dataset from eight participants under six treadmill conditions (48 trials) showed that, at $\delta = 100$ ms, the fusion model achieved NRMSE 0.082 ± 0.017 for phase, 0.060 ± 0.013 for hip angle, and 0.183 ± 0.027 for speed, with correlations of 0.970 ± 0.014, 0.984 ± 0.010, and 0.867 ± 0.037. Fusion also degraded more gracefully than unimodal baselines as the horizon increased to 250 ms, supporting its use for offline future-state estimation</p>	
16:10-16:30	WeBT1.3
<i>Khan-Suyla Cartographer: Mapping Communication-Suppression Zones for Multi-Level Drone Swarms</i>	
Aimashev, Eldar	Naval Postgraduate School
Yakimenko, Oleg A.	Naval Postgraduate School
<p>This paper presents algorithms and preliminary results for a specialized Cartographer role within the heterogeneous Khan-Suyla drone swarm currently under development at the Naval Postgraduate School. The envisioned swarm comprises diverse unmanned aerial vehicles equipped with different sensors, capabilities, and mission roles, collaborating to execute complex, multi-objective disaster-response or defense operations. Swarm-level efficiency is enhanced by assigning tasks such as reconnaissance, jamming, and strike to dedicated drone subsets. The Cartographer's function is to reconstruct the geometry of the operational communication-service region using limited flight trajectories and sparse packet-delivery measurements. Unlike dense signal-quality mapping, the Cartographer focuses on estimating the service-area boundary, where trajectory-planning and relay-placement decisions are most sensitive. To accelerate boundary convergence, an active sampling strategy is introduced that selects measurement points along the evolving iso-band, concentrating new observations near the current estimate. To validate the complete closed-loop system, a hardware-in-the-loop test bench was constructed, integrating a motion-capture system with a position-dependent virtual jammer. This jammer replicates communication losses and delays without radio-frequency transmission, enabling controlled and repeatable comparisons among different reconstruction algorithms. Gaussian Process (GP) and Neural Field (NF)-based reconstructions are evaluated using held-out flight runs and a dense emulator reference. Results indicate that NF yields a more stable estimate of the service-area geometry and reduces false-infeasible expansions near the boundary compared to GP. These improvements support the use of communication-zone maps as feasibility constraints for planning under degraded communication conditions.</p>	
16:30-16:50	WeBT1.4
<i>Cooperative Safety-Critical Control of Mobile Agents by Real-Time Distributed Optimization</i>	
Sheng, Yuanxiu	Northeastern University
Qin, Zhengyan	HKU
Liu, Tengfei	Northeastern University
Liu, Lu	City University of Hong Kong
Jiang, Zhong-Ping	New York University
<p>This paper studies the problem of cooperative safety for multiple mobile agents moving and performing distinct tasks in a shared environment. Under information-exchange constraints, three key technical challenges must be addressed simultaneously: the distributed implementation of safety-critical controllers, guaranteed convergence rates of the optimization algorithm under communication constraints, and the preservation of safety in the presence of</p>	

<p>algorithm-induced errors. We propose a novel design of cooperative safety-critical controllers based on a distributed implementation of a dual gradient algorithm. Convergence analysis of the optimization algorithm and safety analysis of the resulting closed-loop system are developed using tools from robust nonlinear control. Sufficient conditions on the controller parameters that guarantee safety of the multi-agent system are derived, revealing a trade-off between the convergence rate of the optimization algorithm and the satisfaction of safety constraints. The effectiveness of the proposed approach is demonstrated through numerical simulation and experimental results.</p>	
16:50-17:10	WeBT1.5
<p><i>Fast and Accurate Contact Wrench Estimation for Multirotors Via Decoupled Aerodynamics</i></p>	
Wu, Delong	Beijing Institute of Technology
Shi, Yangxi	Beijing Institute of Technology
Tao, Zichen	Beijing Institute of Technology
Hao, Cui	Beijing Institute of Technology
Yang, Qingkai	Beijing Institute of Technology
<p>Real-time and precise contact wrench estimation is essential for autonomous multirotors to enhance performance in tasks such as aerial manipulation and payload transportation. Most existing research neglects the aerodynamic interference during flights, resulting in intrinsic discrepancies between the estimated external wrench and the actual contact wrench. To address this issue, we introduce a contact wrench estimation method based on an optimal filter framework. Our approach explicitly models linear aerodynamic effects, thereby ensuring the decoupling of airflow disturbances from contact wrenches. We rigorously verify the observability of the system through Lie derivatives and present a system identification algorithm for aerodynamic parameters. Comprehensive simulations and real-world experiments demonstrate that the proposed method effectively mitigates aerodynamic interference, providing fast and accurate contact wrench estimation for multirotors.</p>	

WeBT2	Room 256
Robotics 2 (Regular Session)	
Chair: Li, Xiang	Tsinghua University
Co-Chair: Feng, Wenchao	The Chinese University of Hong Kong
15:30-15:45	WeBT2.1
<p><i>Pre-Grasp Fiber Alignment in Robotic CFRP Layup: A Training-Free Spectral Framework with Wrist-Joint Compensation</i></p>	
Feng, Wenchao	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong
Zhang, Weizhao	The Chinese University of Hong Kong
<p>Robotic pick-and-place of CFRP prepregs deposits fiber angular error into the cured laminate whenever the gripper heading at pick-up deviates from the ply design axis—yet no existing automated layup system measures or corrects this deviation before contact occurs. A closed-loop, training-free architecture is presented in which wrist joint J6 is rotated to the measured fiber direction before the gripper touches the material. Fiber orientation is recovered from overhead RGB imagery via 2-D Fast Fourier Transform (FFT) analysis of tow spatial periodicity; a Peak-to-Sidelobe Ratio (PSR) gate withholds commands when spectral contrast is insufficient; and a C²-continuous quintic J6 trajectory drives the Bernoulli gripper to the target angle without perturbing the Cartesian pick point. The same pipeline accommodates unidirectional (UD) plies through single-peak spectral analysis, with peak count serving as an automatic ply-type discriminator requiring no separate classification. Closed-loop</p>	

<p>evaluation in a ROS2–Gazebo digital twin over 70°–112° at 3° increments yields MAE = 0.40° and RMSE = 0.82°; all orientations fall within the ±2° aerospace structural tolerance at 30 Hz throughput on a commodity CPU.</p>	
15:45-16:00	WeBT2.2
<p><i>Integrating Vision-Language Planning and Closed-Loop Control for Robust Bimanual Robotic Manipulation</i></p>	
Chen, Wei	The Chinese University of Hong Kong
Wu, Haiwen	The Chinese University of Hong Kong
Wang, Gang	The Chinese University of Hong Kong
Meng, Qiwei	CUHK
Wen, Youpeng	CUHK
Jiang, Taoran	The Chinese University of Hong Kong
Chen, Xieyuanli	Department of Mechanical and Automation Engineering, the Chinese University of Hong Kong, Hong Kong
Liu, Yunhui	Chinese University of Hong Kong
<p>Reliable robotic manipulation in unstructured and dynamic environments remains challenging due to perception uncertainty, modelling errors, and interaction-induced disturbances. While recent vision-language models (VLMs) enable flexible instruction understanding and task decomposition, high-level semantic reasoning alone does not guarantee stable physical execution under dynamic conditions. This paper proposes a hybrid manipulation framework that integrates VLM-based task decomposition with closed-loop position-based visual servoing (PBVS) for robust task execution. High-level instructions are translated into structured manipulation primitives, which are executed through two unified control interfaces: single_arm_pbvs and dual_arm_pbvs. These interfaces regulate Cartesian pose errors using real-time visual feedback, enabling continuous error correction and stable convergence during manipulation. The proposed framework is validated on a dual-arm robotic platform in representative manipulation tasks involving dynamic disturbances and interaction variability. Experimental results demonstrate stable and consistent task execution under perception uncertainty and environmental changes.</p>	
16:00-16:15	WeBT2.3
<p><i>A Hybrid Modeling Method for Multi-Fingered Dexterous Robot Hands</i></p>	
Zou, Qikai	Tsinghua University
Jiang, Yongpeng	Tsinghua University
Jia, Yongyi	Tsinghua University
Miao, Shu	Tsinghua University
Shen, Zhixi	Chongqing University
Li, Xiang	Tsinghua University
<p>The multi-fingered robot hand is a generalizable device that acts as the end effector of robot manipulators or humanoid robots to perform various dexterous tasks, e.g., grasping in clutter and in-hand manipulation. The multi-fingered robot hand is commonly equipped with multiple degrees of freedom (DoFs). While such high DoFs lay the foundation for highly skillful tasks, they also open up challenges for the modeling of multi-fingered hands, which is very important as it describes the mapping from the motion of finger joints to the task where the robot performs. This paper proposes a new modeling method for multi-fingered robot hands, where analytical techniques are employed to establish the kinematic and dynamic models first, and then data-driven networks are constructed to compensate for the residual errors to further improve the precision. A series of simulation studies and experiments are carried out to illustrate the effectiveness of the proposed method. The results show that the hybrid approach</p>	

effectively combines the interpretability of analytical modeling with the adaptability of data-driven learning, significantly improving pose estimation accuracy and enhancing performance in dexterous manipulation tasks while maintaining physical plausibility.	
16:15-16:30	WeBT2.4
<i>Underactuated Dynamic Legged-Rolling Enabled by a Simple Torso-Free Morphology</i>	
Zheng, Yanqiu	Tokyo University of Science
Yan, Cong	Ritsumeikan University
Gao, Jing	Shanxi Agricultural University
Zhao, Chengyan	Kyushu Institute of Technology
Torso-free legged systems are lightweight and mechanically simple. In single support, however, stance-driven motion induces reaction torques on the other leg, so the shape dynamics are strongly coupled and cannot be arbitrarily shaped by direct actuation. This study revisits a planar two-rod minimal robot as a testbed for underactuated legged-rolling and develops an acceleration-level orbit-tracking framework. By writing the constrained dynamics in a projection form and deriving an explicit input–output acceleration map for a three-dimensional shape output, we design a computed-acceleration tracking law that commands the desired output accelerations and incorporates PD feedback. Since touchdown induces impacts and leg relabeling, step-to-step variability is inherent to the hybrid dynamics. Accordingly, we examine how orbit design, i.e., the time scale and terminal geometry, together with feedback gains, shape the emergent gait and its asymptotic periodicity. The proposed formulation provides a compact and interpretable platform for studying gait formation in a torso-free, highly underactuated morphology.	
16:30-16:45	WeBT2.5
<i>Adaptive Extended Kalman Filter–Based Feedforward Disturbance Compensation for Robust Mobile Robot Trajectory Tracking</i>	
Wani, Sameer	Indian Institute of Technology, Jammu
Singh, Padmini	IIT JAMMU
Sharma, Nalin Kumar	Indian Institute of Technology Jammu
Trajectory tracking of mobile robots under unknown time-varying disturbances and nonstationary noise is challenging. This paper presents a disturbance-aware control framework combining a nonlinear PID controller with feed forward disturbance compensation. Linear and angular disturbances are modeled as augmented states and estimated online using EKF and Adaptive EKF (AEKF). While EKF assumes fixed noise covariances, the AEKF updates them adaptively using innovation statistics to maintain estimator consistency under abrupt noise changes. A circular reference trajectory ensures persistent excitation, and sudden noise variations are introduced to assess robustness. Simulation results show that EKF improves tracking under stationary noise but degrades under nonstationary conditions. In contrast, the AEKF maintains bounded estimation error, accurate disturbance reconstruction, and superior tracking performance, highlighting the importance of adaptive covariance tuning for robust nonlinear mobile robot control.	
16:45-17:00	WeBT2.6
<i>Toward High-Precision Attitude Control of Underwater Vehicles Using Reaction Wheels</i>	
He, Zhongyun	Hangzhou City University
Cui, Chenhuan	Hangzhou City University
Jiang, Yuning	Zhejiang University
He, Shiming	Hangzhou City University
This paper presents the design, modeling, and experimental validation of an underwater vehicle equipped with a reaction wheel system for high-precision attitude control. Unlike underwater platforms that rely on hydrodynamic forces generated by rudders or	

differential thrust, the proposed system achieves attitude control through internal momentum exchange, thereby eliminating the need for external flow interaction. A complete dynamic model of the vehicle is developed, incorporating both the rigid-body dynamics and the coupled dynamics of the reaction wheel assembly. Experimental evaluations are conducted in a water tank environment, where the proposed reaction wheel-based system is compared against a thruster-based yaw control scheme. The results demonstrate that the proposed approach achieves significantly improved tracking accuracy and smoother transient behavior, highlighting its potential for precise and low-disturbance maneuvering in underwater applications.	
17:00-17:15	WeBT2.7
<i>Cross-Medium Model Predictive Control for a Compact Wheel-Propeller Amphibious Robot</i>	
Liu, XinJiang	Hunan University
Miao, Zhiqiang	Hunan University
Chen, Yizong	Hunan University
Wang, Yaonan	Hunnan University
Amphibious robots have overcome the operational limitations of single-medium environments, demonstrating significant application value in tasks such as marine monitoring and cross-domain intervention. Addressing challenges like high system complexity and limited reliability caused by drive redundancy in small amphibious platforms, this paper proposes an amphibious robot design based on “variable propeller-leg” technology and its control architecture. This configuration achieves morphological reuse of actuators, significantly reducing drive components while balancing multi-degree-of-freedom underwater maneuverability with complex terrain traversal capability on land. To enable efficient cross-medium motion control, an integrated dynamics model covering both aquatic and terrestrial environments is established, alongside a multi-mode model predictive control (MPC) framework. This framework effectively handles the highly coupled nonlinear dynamics of the robot across different media, enabling real-time optimization and coordination of control inputs for underwater and terrestrial motion while strictly adhering to physical constraints. Finally, comprehensive testing in the ROS2-Gazebo high-fidelity simulation environment validated the proposed robot’s amphibious cross-domain capabilities and demonstrated the effectiveness and superior performance of the MPC control scheme.	

WeBT3	Room 267
Optimal Control 2 (Regular Session)	
Chair: Zhou, Jianshu	National University of Singapore
15:30-15:45	WeBT3.1
<i>A Dynamic Fuzzy Evaluation Model for Online Risk Assessment of LNG Tanker Transportation</i>	
Lin, Shifu	Wuhan University of Technology
Wang, Qiang	Wuhan University of Technology
The risk state of liquefied natural gas (LNG) tanker road transportation exhibits significant dynamic variability. Under continuous monitoring conditions, achieving stable and consistent risk assessment remains a critical challenge. To address this issue, this paper establishes a comprehensive risk indicator system and proposes a dynamic fuzzy evaluation model driven by a sliding-window-enabled adaptive fusion mechanism. Specifically, this mechanism dynamically reconciles expert prior knowledge with streaming data characteristics to enable adaptive weight adjustment. By updating indicator membership degrees based on monitoring data, multi-source risk indicators are mapped to the probability distribution of the vehicle’s overall risk level, thereby realizing continuous dynamic risk assessment. Experimental results show that, under an optimal 60-second sliding window, the proposed model effectively reflects the dynamic evolution of the risk estimation process. Under 20 dB noise interference, the posterior probability vector yields an	

average root mean square error (RMSE) of 0.0269 and a maximum RMSE of 0.1998, demonstrating strong robustness against sensor disturbances and the ability to stably and adaptively track changes in estimated risk states.	
15:45-16:00	WeBT3.2
<i>Improved Quantum Two-Classification Network</i>	
Cong, Shuang	University of Sci. & Tech. of China
Qiu, Jingru	University of Science and Technology of China
An improved quantum neural network based on a parameterized quantum circuit for 0 or 1 classification of images is designed in this paper. A classical handwritten digital image of size 28×28 pixels is compressed into a 4×4-pixel image, whose 16 classical images represent the probability amplitudes of a 4-qubit state input in the quantum state preparation circuit. The output and corresponding 0 or 1 labels are used as training data for supervised learning of a parameterized quantum recognition circuit composed of 4 qubits. The complete design process is studied in detail, including the input of classical data, quantum state preparation, the output recognition of images by the parameterized quantum circuit, and the projection measurement of the designated readout qubit. In the training of the network parameters, the goal of minimizing the loss function is to achieve optimal quantum circuit parameters. In the performance comparison experiments, handwritten digital images from the MNIST dataset are used to conduct recognition tests on two specific digits, and the test accuracy is 98.88%. The recognition accuracy rate increases by 8.13% compared with the recognition performance before the improvement. The quantum image recognition network designed in this paper can be extended to multiclass classification applications.	
16:00-16:15	WeBT3.3
<i>A Layered Residual Control and Safety Assessment Framework for Robot-Assisted Feeding Focused on Food Scooping and Near-Mouth Delivery</i>	
Wu, Peixi	School of Biomedical Engineering, Shenzhen University Medical School, Shenzhen University, Shenzhen 518060, China
Jiang, Xiantai	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
You, Zijing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Liang, Xiaoxin	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
Shu, Yi	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
Li, Guanglin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Zhao, Guoru	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China
Diao, Yanan	The Neural Engineering Center Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences Shenzhen, China

Robot-assisted feeding systems are pivotal for enhancing the dietary independence of individuals with upper-limb impairments. However, current feeding robots suffer from poor scooping stability and low safety during near-mouth interaction, hindering widespread practical application. To address these challenges, we propose a robust hierarchical control and unified evaluation framework for the "food scooping-to-delivery" process by constructing a layered architecture that combines Finite State Machine (FSM) reference generation with PPO residual control, and establishing a Train-Eval Split protocol utilizing simulation privileged information. Simulation results demonstrate that the proposed method achieves task success rates of 0.380 and 0.420 under two granular loads (300 and 800 particles, respectively). This represents an approximate threefold improvement over the traditional finite state machine strategy, Park-FSM (0.120/0.140), and significantly outperforms Traj-Improve (0.180/0.220). Significant differences were observed compared to Park-FSM under both loads ($p(300)=0.005, p(800)=0.003$). Furthermore, ablation studies reveal that removing the semantic trajectory leads to a surge in near-mouth contact risks (maximum contact force > 7.5 N), while the absence of the auto-calibration mechanism causes a significant drop in task success rate under high loads (falling to 0.270). These findings prove that the proposed method effectively bridges the gap between scooping efficacy and delivery safety in assisted feeding tasks. It holds promise for resolving clinical issues such as near-mouth injury risks and food acquisition difficulties faced by patients with upper-limb impairments.	
16:15-16:30	WeBT3.4
<i>ASI: A Closed-Loop Robustness Proxy for Spatial Flight-Stability Mapping Using PX4 Flight Logs</i>	
Bodagala, Jayawant	Independent Researcher
Bodagala, Balaji	Independent Researcher
Small unmanned aerial vehicles (UAVs) flying close to the ground and structures face spatially heterogeneous disturbances, such as shear layers, wake recirculation, and varying ground effects. These disturbances can amplify closed-loop position errors and control effort. Although wind and turbulence can be measured using specialized sensors or estimated through modeling techniques, there is currently no method to quantify closed-loop control robustness in space using standard flight logs alone. This paper proposes the Airspace Safety Index (ASI), a bounded scalar field derived from PX4 flight logs that maps three-dimensional space to values between 0 and 1. In this work, safety is defined operationally as a low likelihood of large destabilizing motion within a given airspace for a specific UAV and controller configuration. ASI combines disturbance-sensitive dispersion features from flight logs, including attitude jitter, angular-rate jitter, horizontal acceleration, and motor-command variability. These features are combined using robust percentile normalization and convex weighting to produce a spatial representation of reduced closed-loop control robustness. The method is validated using proxies for drift radius and closed-loop motion, and a reproducible artifact bundle and pipeline are provided for generating tables and spatial maps from standard flight logs. ASI is further evaluated through stress tests, including dose-response gust injection in simulation, controller intervention, and spatial repeatability tests, to address concerns related to estimator coupling and overfitting.	
16:30-16:45	WeBT3.5
<i>Hamilton–Jacobi Reachability for Spacecraft Collision Avoidance</i>	
Hui, Larry	University of California, Berkeley
Kam, Jordan	University of California, Berkeley
Su, William	University of California, Berkeley, Aerospace Engineering Program
Zhou, Jianshu	National University of Singapore
This article presents a Hamilton–Jacobi (HJ) reachability framework for a two–satellite collision avoidance problem operating in the same circular orbit, where relative motion is modeled in the radial–tangential–normal (RTN) frame using planar Hill–Clohessy–Wiltshire	

(HCW) dynamics. We define the target state space as unsafe relative configurations in the orbit plane corresponding to minimum separation requirements consistent with Federal Communications Commission (FCC) orbital standards. The interaction between spacecraft is formulated as a zero-sum differential game, where Player 1 is the controlled satellite and Player 2 is modeled as a bounded adversarial disturbance with unknown intent. We present the HJ formulation and compute backward reachable sets that characterize relative states from which collision cannot be avoided under worst-case disturbances, while states outside this set admit provably collision-free trajectories. These reachable sets are integrated with supervisory hybrid control logic to determine when evasive maneuvers must be initiated, enabling mathematically grounded safety guarantees for scalability.

16:45-17:00 WeBT3.6

Robustness Quantification of MIMO-PI Controller from the Perspective of (γ) -Dissipativity

Sheng, Zimao	Northwestern Polytechnical University
Yang, Shuxiang	Northwestern Polytechnical University
Yang, Hong'an	Northwestern Polytechnical University
Guo, Rongkun	Northwestern Polytechnical University

The proportional-integral-derivative (PID) controller and its variants are widely used in control engineering, but they often rely on linearization around equilibrium points and empirical parameter tuning, making them ineffective for multi-input-multi-output (MIMO) systems with strong coupling, intense external disturbances, and high nonlinearity. Moreover, existing methods rarely explore the intrinsic stabilization mechanism of PID controllers for disturbed nonlinear systems from the perspective of modern robust control theories such as dissipativity and \mathcal{L}_2 -gain. To address this gap, this study focuses on γ -dissipativity (partially equivalent to \mathcal{L}_2 -gain) and investigates the optimal parameter tuning of MIMO-PI controllers for general disturbed nonlinear MIMO systems. First, by integrating dissipativity theory with the Hamilton-Jacobi-Isaacs (HJI) inequality, sufficient conditions for the MIMO-PI-controlled system to achieve γ -dissipativity are established, and the degree of γ -dissipativity in a local region containing the origin is quantified. Second, an optimal parameter tuning strategy is proposed, which reformulates the γ -dissipativity optimization problem into a class of standard eigenvalue problems (EVPs) and further converts it into linear matrix inequality (LMI) formulations for efficient online computation. Comprehensive simulation experiments validate the effectiveness and optimality of the proposed approach. This work provides a theoretical basis for the robust stabilization of general disturbed nonlinear MIMO systems and enriches the parameter tuning methods of PID controllers from the perspective of dissipativity.

17:00-17:15 WeBT3.7

Active RF Signal Source Detection and Control for Efficient Quadcopter-Based Search and Rescue Missions

Cao, Haosen	Chinese University of Hong Kong
Shao, Jingheng	The Chinese University of Hong Kong
Wang, Pei	The Chinese University of Hong Kong
Wu, Zongzhou	The Chinese University of Hong Kong
Zhao, Zuoquan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Existing quadcopter-based search and rescue (SAR) operations have not yet sufficiently integrated onboard active perception with real-time motion control, which significantly limits overall search efficiency. This paper introduces an active radio frequency (RF) source-seeking framework utilizing a quadcopter quadcopter as a temporary long-term evolution (LTE) base station. The quadcopter follows a controlled helical trajectory around a moving orbit center, collecting Power Headroom (PHR), Signal-to-Noise Ratio (SNR), and Modulation and Coding Scheme (MCS) measurements. These are reconstructed into local scalar signal strength fields using angular-domain zero-order hold and closed-path integrals to estimate 3D gradients. Fidelity-weighted fusion of the gradients generates a steering vector for the orbit center, enabling gradient-ascent navigation toward the source. A geometric controller defined on the special Euclidean group SE(3) directly computes thrust and moment inputs to achieve stable helical motion, ensuring agile and robust tracking suitable for time-critical SAR operations. Theoretical analysis proves exponential convergence to the desired helical path segments under piecewise-constant steering. Simulations based on real-world RF field data validate the approach, demonstrating rapid error convergence, stable orbiting, and effective search to the signal source without predefined trajectories. The proposed system addresses limitations of existing SAR methods by exploiting RF signals for occlusion-resistant localization, offering an autonomous, and efficient solution that increases survival probabilities in complex terrains.

WeBT4 Room 269

Multi-Agent Systems 2 (Regular Session)

Chair: Xin, Bin	Beijing Institute of Technology
Co-Chair: Bian, Wenjing	Beijing Institute of Technology

15:30-15:45 WeBT4.1

D2CP: An Online Multi-Region Coverage Path Planning Method for Multiple UAVs Based on Divide-And-Conquer Strategy

Zang, Yuechao	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Zhu, Xianqiang	National University of Defense Technology
Zhang, Qianzhen	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Liu, Qiting	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Zhang, Xiujie	National University of Defense Technology, National Key Laboratory of Information Systems Engineering
Zhu, Cheng	National University of Defense Technology, National Key Laboratory of Information Systems Engineering

In dynamic environments, multi-UAV systems encounter significant challenges in executing coverage missions due to uncertainties such as unknown obstacles, sudden task requirement changes, and equipment failures. Traditional offline planning methods struggle to adapt to dynamically changing environments. Therefore, to address the multi-region coverage problem in multi-UAV systems under scenarios with dynamically changing task regions, we propose a novel D2CP (Discretization, Conversion, Partitioning, Conflict Resolution, Path Planning) algorithm. This algorithm incorporates multiple dynamic factors and is capable of effectively adapting to real-

time changes in UAV status and task requirements, demonstrating strong adaptability and practicality. The D2CP algorithm employs a divide-and-conquer strategy, dividing the process into five stages to efficiently handle task replanning. Experimental results using DJI Phantom 4 Pro and Matrice 300 RTK drones demonstrate significant reductions in solving time and task completion time, while achieving balanced workload distribution among UAVs. Our approach shows robust performance across various dynamic scenarios, confirming its effectiveness in complex environments.	
15:45-16:00	WeBT4.2
<i>Generalized Distributed Average Tracking Over Diverse Detection Networks</i>	
Ren, Yatao	Northwestern Polytechnical University
Liu, Yongfang	Peking University
Zhao, Yu	Peking University
In this article, the generalized distributed average tracking (DAT) problem for multi-agent systems is investigated over diverse detection networks. Traditional DAT algorithms assume that each agent can detect a reference signal, which is restrictive in practical scenarios where agents possess diverse detection capabilities. First, an embedded generalized DAT algorithm is proposed to estimate the average of the detectable reference signals. By distributively estimating network characteristic information and embedding it into the average reference signal estimator, the generalized DAT problem can be effectively addressed even when some agents are unable to detect the reference signal. Furthermore, to handle more diverse detection tasks, a class of generalized DAT algorithms over diverse detection networks is developed, which allows each agent to detect an arbitrary number of reference signals. Compared with existing DAT algorithms, this article is the first to consider the generalized DAT problem applicable to diverse detection scenarios, including one-to-one, one-to-many, many-to-one, and many-to-no cases, thereby relaxing the detection capability limitations imposed by traditional DAT algorithms. Finally, simulation examples are provided to verify the effectiveness of the proposed algorithms.	
16:00-16:15	WeBT4.3
<i>Stability Analysis and Estimation of Domain of Attraction for Complex Network with Heterogeneous Individual Systems</i>	
Tong, Mingjing	Beihang University
Liang, Quanyi	Beihang University
She, Zhikun	Beihang University
This paper addresses the asymptotic stability and the estimation of the domain of attraction (DOA) for the directed heterogeneous complex network. Assuming that the network is strongly connected, we find that if there exists an individual system whose linearized system is asymptotically stable with respect to its equilibrium point, then there must exist appropriate coupling strengths such that the entire network is asymptotically stable with respect to its equilibrium point. Due to excessively high computational complexity, many algorithms for estimating the DOA by iteratively computing Lyapunov functions fail to perform effectively on complex networks. To avoid this, we choose the Lyapunov function of the linearized system of the network for estimating the DOA and then use a binary search-based approach to enlarge this estimation. Moreover, for network with polynomial vector field, we convert the computation of the estimation of the DOA into a typical problem of solving sum of squares (SOS) programming. Especially, by decreasing the number of parameter variables and the degree of the polynomials in the SOS programming, the computational complexity is significantly reduced such that the estimation of large-scale network also can be solved by the existing semi-definite programming software. Finally, three examples are used to illustrate the validity and effectiveness of our approach.	
16:15-16:30	WeBT4.4
<i>Multi-AAV Multi-Regional Coverage Path Planning with a Maximum Range Constraint</i>	

Bian, Wenjing	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology
Jing, Mengjie	Beijing Institute of Technology
Chen, Chen	Beijing Institute of Technology
With the increasing importance of autonomous aerial vehicles (AAVs), the AAV coverage path planning problem has attracted increasing attention. This paper focuses on multi-AAV multi-regional coverage path planning with a maximum range constraint. To address this problem, this paper proposes a new modeling approach by dividing task regions into strips and reformulating the problem as a clustered multi-depot multiple traveling salesman problem with a maximum range constraint. A two-stage hybrid algorithm based on adaptive large neighborhood search is developed to solve the problem. In the first stage, an initial solution is generated using a marginal insertion cost-based constructive heuristic. In the second stage, an ALNS framework combined with local search iteratively destroys and repairs solutions to escape local optima. Considering the cluster constraint, cluster (strip)-specific operators are designed by extending vertex operations to clusters and adjusting the starting and ending vertices of each cluster through random changes or swaps. Experimental results show that the proposed algorithm produces better solutions than the comparison algorithms for most test instances.	
16:30-16:45	WeBT4.5
<i>Hierarchical Clustered Distributed Localization for High-Dynamic UAVs Based on Fused AOA-TDOA</i>	
Wang, Xibo	Tongji University
Deng, Di	Tongji University
Yi, Peng	Tongji University
Mu, Biqiang	AMSS
Hong, Yiguang	Chinese Academy of Sciences
High-dynamic unmanned aerial vehicle (UAV) clusters often face challenges such as limited communication bandwidth and intense maneuvering during cooperative sensing. To address these issues, this paper proposes a hierarchical clustered distributed cooperative localization framework. The localization process is decoupled into two levels based on relative measurements. At the intra-cluster level, member nodes utilize high-frequency angle-of-arrival (AOA) data to obtain local estimates via distributed weighted consensus. At the inter-cluster level, cluster heads periodically introduce time-difference-of-arrival (TDOA) constraints to perform global geometric refinements. Furthermore, an extended kalman filter (EKF) is integrated to fuse these spatial estimates with the target's motion model for stable tracking. Simulation results demonstrate that the proposed algorithm significantly reduces communication overhead while achieving localization accuracy comparable to centralized methods.	
16:45-17:00	WeBT4.6
<i>Distributed Visibility Preservation for Hybrid Nonholonomic Leader-Follower Formation with General Network Structure</i>	
Guan, Renhe	Harbin Institute of Technology Shenzhen
Yang, Jiahao	Harbin Institute of Technology, Shenzhen
Wang, Yan	School of Mechanical Electrical Engineering and Automation, Harbin Institute of Technology Shenzhen, Shenzhen 518000, China
This paper studies leader-follower formation tracking problem for hybrid multiple nonholonomic robots with visibility constraints. With onboard vision sensors on follower robots and inter-robot communication, a new distributed controller for leader-follower formation is proposed based on dynamic surface control method. Our	

presented controller can make tracking errors of relative distances and bearing angles between each leader-follower pair in the robot team arbitrarily small by adjusting parameters. In addition, the visibility sensor constraints and connectivity of communication graph are preserved all the time. Unlike most of papers which can merely cope with the condition where one leader tracks only one leader, our methods can be suitable to more general network structure with multiple leaders as well. Furthermore, the proposed method is adaptive to different kinds of robots including first-order and second-order multi-robot systems. Also, it can be robust to actuator faults and abrupt disturbance in second-order robots. Lyapunov stability analysis and several numerical simulation are presented to verify the correctness and effectiveness of our proposed controller.

WeBT5	Room 259
Learning-Based Control (Regular Session)	
Chair: Xu, Yunjian	Chinese University of Hong Kong
15:30-15:45	WeBT5.1
<i>Real-Time Trajectory Tracking at Handling Limits: An Iterative Bandwidth-Regularized Sparse GP-MPC Approach</i>	
Tu, Yuantao	Beijing Institute of Technology
Ju, Zhiyang	The University of Melbourne
Su, Youtao	Beijing Institute of Technology
Han, Xu	Beijing Institute of Technology
Tao, Gang	Beijing Institute of Technology
Gong, Jianwei	Beijing University of Technology
<p>Trajectory tracking at handling limits poses a critical challenge for autonomous driving systems, where parameter uncertainties and highly nonlinear tire dynamics necessitate adaptive control. However, standard adaptive implementations often exhibit instability. For instance, while Gaussian Process Model Predictive Control (GP-MPC) can theoretically correct model mismatches, standard implementations suffer from overfitting-induced control chattering driven by unconstrained likelihood maximization on noisy data. In this paper, we present a Bandwidth-regularized Sparse GP-MPC scheme to address this issue by combining a Subset of Data (SoD) Sparse GP approximation with a physically consistent hyperparameter clamping strategy. Specifically, bounding the kernel length-scale imposes a strict spectral bandwidth limit. This essentially prevents the model from fitting high-frequency noise beyond the physical limits of the actuators. Co-simulation tests confirm that our regularized approach resolves the severe control chattering seen in baseline GP-MPC. The vehicle recovers a smooth transient behavior that closely matches the nominal reference, yielding reduced overshoot, faster settling times, and better overall tracking precision.</p>	
15:45-16:00	WeBT5.2
<i>Hierarchical Reactive Power Optimization of Distribution Power Grid with Probabilistic Assessment of PV Reactive Power Support Capability</i>	
Zang, Hao	Southeast University
Wang, Ying	Key Laboratory of Measurement and Control of CSE, Ministry of Education, Southeast University
Luo, Songqi	State Grid Zhejiang Electric Power Co., Ltd
Zhang, Kaifeng	Southeast University
<p>The integration of high proportions of distributed photovoltaic (PV) systems has led to voltage violations in distribution power grid. Using the remaining capacity of PV inverters for reactive power regulation is an efficient voltage control method. Existing studies typically address PV reactive power capabilities statically, failing to fully account for dynamic variations caused by solar radiation fluctuations. This paper proposes a data-driven probabilistic assessment and hierarchical</p>	

<p>reactive power optimization method. A spatiotemporal probabilistic prediction model is constructed to perform multi-quantile predictions of PV active power and node loads and dynamically constructs reactive power support boundaries to assess PV reactive voltage support. A hierarchical optimization strategy is developed to coordinate the adjustment of various reactive power resources in the distribution power grid. Case study results using an improved IEEE 33-bus system show that the proposed method effectively mitigates voltage fluctuations and improves the efficiency of reactive power regulation.</p>	
16:00-16:15	WeBT5.3
<i>Offline Safe Reinforcement Learning: A Comparative Study</i>	
Xu, Yunjian	Chinese University of Hong Kong
<p>The deployment of reinforcement learning in safety-critical domains such as robotics and autonomous driving requires agents not only to maximize task rewards but also to adhere to strict safety constraints. Safe reinforcement learning addresses this challenge by formulating constrained optimization problems, typically involving auxiliary cost functions that must remain below specified limits throughout interaction. While online safe RL algorithms have demonstrated effectiveness in controlled environments, their reliance on hazardous trial-and-error exploration poses fundamental barriers to real-world deployment. Offline safe RL emerges as a compelling alternative, aiming to learn constrained policies entirely from static, pre-collected datasets without any online interaction. This report summarizes the initial phase of an MSc research project dedicated to establishing empirical foundations in offline safe RL through systematic reproduction of key baselines and proposes a focused future direction that leverages sequence modeling to address core challenges in the field.</p> <p>We first investigate online constrained policy optimization to build intuition about constraint satisfaction mechanisms. Experiments on the SafetyPointCircle1-v0 task comparing Constrained Policy Optimization (CPO) [1] against unconstrained Trust Region Policy Optimization (TRPO) [2] yield instructive results: TRPO pursued reward maximization aggressively, achieving higher cumulative rewards at the cost of severe safety violations, while CPO maintained costs near the specified limit through second-order optimization and projection onto the feasible region. This comparison solidified understanding of how explicit constraint satisfaction can be achieved through constrained optimization rather than reward shaping.</p> <p>We also explore offline safe RL through reproduction of the Constrained Actor-Critic with Policy Search algorithm on the OfflineCarCircle-v0 task.</p>	
16:15-16:30	WeBT5.4
<i>Robust MPC of Linear Time-Varying Systems: An Event-Triggered Learning Method</i>	
Luo, Zhibin	Beihang University
Zhao, Yinxiang	Beihang University
Wang, Qishao	Beihang University
Wang, Qingyun	Beihang University
<p>This extended abstract addresses the robust model predictive control (MPC) problem for unknown linear systems by proposing an event-triggered model learning mechanism. First, historical system state trajectories and input sequences are utilized to estimate the unknown system matrices. An event-triggered identification mechanism is formulated to balance the computational load of online identification with the closed-loop gain. Subsequently, the min-max MPC method is implemented to achieve robust control of the unknown plant based on the identified model. Through the integration of the triggering mechanism with robust MPC, the closed-loop system is mathematically guaranteed to be robustly stable. Numerical simulation validates the effectiveness of the proposed method.</p>	
16:30-16:45	WeBT5.5

<i>Improving Hutchinson Diagonal Estimation within the OCP-LS Algorithm</i>	
Zhong, Jindi	Shandong University of Science and Technology
Zhang, Zhaorong	Shandong University
Wang, Hongxia	Shandong University of Science and Technology
<p>Based on the Optimal Control Principle for Large-Scale Problems (OCP-LS), this paper systematically investigates multiple improvement strategies for Hutchinson trace estimation. These include combining single sampling with exponential smoothing, reducing estimation frequency, varying the distribution of random vectors, and employing block-wise Hutchinson estimation. Using ResNet-18 as the benchmark model on the CIFAR-10 image classification task, we conduct a comparative analysis of the convergence behavior of different improvement strategies under a limited training budget. Experimental results show that, with only one Hutchinson sample per step, introducing appropriate smoothing and structured estimation strategies can significantly reduce estimation variance and achieve faster and more stable convergence in the early training stage compared to the original Hutchinson method. Further experiments indicate that some improved methods can attain convergence speeds comparable to or even exceeding that of Stochastic Gradient Descent (SGD) under constrained computational resources. Our findings demonstrate that targeted improvements to the Hutchinson method can enhance the practicality of second-order approximations in deep learning without significantly increasing computational or storage overhead.</p>	
16:45-17:00	WeBT5.6
<i>AdaUMon: Adaptive UAV Monitoring with Trajectory-Temporal and Target-Relational Representation Via Reinforcement Learning</i>	
Hu, Zeyun	The Chinese University of Hong Kong, Shenzhen
Xie, Yuejiao	The Chinese University of Hong Kong, Shenzhen
Li, Zhiheng	The Chinese University of Hong Kong, Shenzhen
Wang, Maonan	The Chinese University of Hong Kong, Shenzhen
Pun, Man ON	The Chinese University of Hong Kong, Shenzhen
<p>Unmanned aerial vehicle (UAV)-based dynamic traffic monitoring requires real-time adaptive trajectory planning to track spatially distributed and temporally evolving demands in urban environments. However, existing reinforcement learning (RL)-based approaches encode heterogeneous state information through shared networks, neglecting the temporal patterns in trajectory histories and the inter-target interactions among dynamic demands, resulting in policies prone to detours and ineffective prioritization. In this paper, we identify that the monitoring state naturally decomposes into two structurally distinct components: ordered trajectory sequences that reflect motion dynamics, and unordered target sets that capture demand interactions. To this end, we propose AdaUMon, which incorporates a dual-branch trajectory module with spatial and motion encoders to capture complementary movement patterns, and a self-attention target module to model inter-demand interactions and dynamic priority. The learned representations are fused into a unified state embedding for PPO-based policy optimization. Extensive experiments across two urban scenarios show that AdaUMon reduces travel distance by up to 43% compared to conventional re-planning baselines while achieving full compliance with communication-restricted zones.</p>	

WeBT6	Room 264
Control Applications (Regular Session)	

Chair: Shan, Jinjun	York University
15:30-15:45	WeBT6.1
<i>Digital Twin-Enabled Adaptive Control for Hydroelectric Systems: Turbine Governor and Voltage Regulation</i>	
Gui, Yonghao	Oak Ridge National Laboratory
Subedi, Sunil	Oak Ridge National Laboratory
Wang, Hong	Oak Ridge National Laboratory
Yin, Zhun	The Department of Electrical and Computer Engineering at New York University
Jia, Wenbo	Chelan County PUD
Jiang, Zhong-Ping	New York University

This paper presents a comprehensive Digital Twin (DT) framework for hydroelectric systems that enables adaptive control of both turbine governors and excitation systems without requiring detailed manufacturer specifications. The proposed framework integrates neural network-based system identification with stabilizing adaptive control laws for the installed turbine controller and middle-branch adaptive tuning for installed voltage regulator. Using real operational data from Unit C-8 at Rocky Reach Dam (1,349 MW capacity), high-fidelity neural network models are developed to capture turbine and generator dynamics without requiring detailed manufacturer specifications. The DT enables safe controller synthesis and validation in simulation before deployment. For turbine control, the proposed method achieves 79.9% Mean Square Error (MSE) reduction compared to the optimal controller. For voltage regulation, the adaptive excitation controller achieves approximately 42.6% MSE reduction while preserving installed protection logic. The results demonstrate that digital twin technology provides a practical pathway for modernizing hydropower control systems with minimal operational disruption.

15:45-16:00	WeBT6.2
<i>A Reinforcement Learning-Based Design of Energy-Efficient Cruising Control for Heavy-Duty Trucks</i>	
Ta, La	Dalian University of Technology
Wu, Yuhu	Dalian University of Technology
Song, Yunfeng	Dalian University of Technology
Shen, Tielong	Dalian University of Technology
Xu, Fuguo	Chiba University

To address the difficulty of balancing vehicle speed tracking and fuel economy for heavy-duty trucks under cruise control on undulating roads, this paper proposes an energy-saving cruise control method based on offline reinforcement learning, aiming to jointly minimize speed deviation and fuel consumption. To mitigate the overestimation of Q-values for out-of-distribution actions caused by distributional shift in offline data, Conservative Q-Learning (CQL) is introduced to enhance the reliability of value estimation, thereby improving the stability and deployability of the learned policy. Simulation results show that, compared with conventional control methods, the proposed approach can suppress speed fluctuations more rapidly under real road-grade disturbances and effectively reduce cumulative fuel consumption. In addition, hardware-in-the-loop experiments verify that the method meets high-frequency real-time control requirements and demonstrates strong potential for practical engineering applications.

16:00-16:15	WeBT6.3
<i>Real-Time Trajectory Planning and Correction Algorithm Based on Probe Feedback for CMM Blind Scanning Scenarios</i>	
Feng, Zhiqiang	Tsinghua University
Wang, Ze	Tsinghua University
Li, Min	China University of Geosciences

Liang, Shuang	Genertec Machine Tool Engineering Research Institute Co., Ltd
Miao, Song	Genertec Machine Tool Engineering Research Institute Co., Ltd
<p>Coordinate measuring machines (CMMs) are critical equipment in the field of high-end industrial geometric metrology. They are widely used in precision manufacturing and aerospace due to their high accuracy, robustness, and versatility. Most existing offline trajectory planning methods rely heavily on prior knowledge of the workpiece and accurate CAD models. This dependency makes them unsuitable for blind scanning tasks, where the geometric features of the measured object are unknown. To address this issue, this study proposes a 3D real-time trajectory planning and correction algorithm based on probe feedback, which breaks the traditional dependency on CAD models and prior information. It enables real-time planning and dynamic correction of the probe path, even in the absence of sufficient prior information. The theoretical derivation and design process of the algorithm are detailed. Experimental results show that the proposed algorithm demonstrates good feasibility, stability, and robustness when dealing with complex surfaces with unknown shape features. The generated trajectory effectively covers the target area, and the speed, acceleration, and probe deformation of each axis remain within the set limits, indicating engineering feasibility and potential for broader applications.</p>	
16:15-16:30	WeBT6.4
<i>Design and Implementation of a Single-Axis Seismic Simulator for Engineering Education</i>	
Pumasupa, Alvaro	Peruvian University of Applied Sciences
Urrunaga, Yahir	Peruvian University of Applied Sciences
Yparraquarre, Mathias	Universidad Peruana De Ciencias Aplicadas
Perea, Carlos	Universidad Peruana De Ciencias Aplicadas
<p>Experimental validation in structural dynamics is essential for engineering education, particularly in earthquake-prone regions like Peru. However, the high cost of commercial shake tables limits their availability in many university laboratories. This paper presents the design, modeling, and control of a low-cost (approx. \$450 USD) single-axis seismic simulator. The system utilizes an ESP32 microcontroller, a DC motor, and a MATLAB-based interface to reproduce customizable vibration profiles. To ensure accurate trajectory tracking of reference seismic signals, a Linear Quadratic Regulator (LQR) combined with a full-order state observer was implemented. Experimental results demonstrate that the controller effectively manages the system's mechanical inertia, making this low-cost prototype a highly viable and accessible pedagogical tool for structural engineering laboratories in developing regions.</p>	
16:30-16:45	WeBT6.5
<i>Robust End-To-End Planning for Resource-Constrained Autonomous Vehicles</i>	
Singh, Larissa	York University
Schofield, Hunter	York University
Wang, Hao	York University
Zhang, Hao	York University
Shan, Jinjun	York University
<p>Autonomous vehicles rely on integrated perception, planning, and control systems to operate safely and efficiently. Traditional systems often depend on powerful computing hardware, but do not perform as well on smaller embedded platforms. To address this, we developed an end-to-end solution which can achieve accurate real-time</p>	

<p>decision-making using lightweight algorithms. The objective was to design a system that operates efficiently and delivers the fastest possible response on resource-constrained platforms. This paper presents a real-time, vision-based autonomous driving system developed for the 2025 American Control Conference (ACC) Self-Driving Car Student Competition using QCar 2, a small-scale autonomous vehicle platform developed by Quanser. The perception module was designed using a YOLOv8 deep learning model trained to detect stop signs, traffic lights, and cones from RGB-D and CSI camera feeds. The final model achieved an overall mAP@0.5 of 0.979, with class-specific results of 0.985 for stop signs, 0.975 for red lights, and 0.977 for cones, ensuring high detection precision and reliability. For navigation, the system employed the A* algorithm to generate optimal paths and a PID-based Pure Pursuit controller for accurate and smooth trajectory tracking. The system was validated in a competitive setting at the ACC 2025 Self-Driving Car Student Competition in Denver, USA, where it secured first place.</p>	
16:45-17:00	WeBT6.6
<i>Super-Twisting Sliding Mode Observer-Based Adaptive Distributed Attack-Resilient Control for DC Microgrids</i>	
Ma, Kexin	Huazhong University of Science and Technology
Cai, Luzhao	Huazhong University of Science and Technology
Liu, Lian	Huazhong University of Science and Technology
Zhang, Yu	Huazhong University of Science and Technology
Liu, Xiao-Kang	Huazhong University of Science and Technology
Wang, Yan-Wu	Huazhong University of Science and Technology
<p>Distributed control of DC Microgrids is gaining widespread application in modern power grids. However, the sparse communication network is vulnerable to cyber-attacks. In this paper, a super-twisting sliding mode observer-based adaptive distributed attack-resilient control strategy is proposed for DC Microgrid in the presence of unbounded attacks injected into the control input channel. The super-twisting algorithm eliminates estimation errors and guarantees fast convergence of the system. Moreover, to automatically adjust the compensation strength, an adaptive feedback law is further designed. The effectiveness of the proposed strategy is verified by simulations via MATLAB/Simulink.</p>	
17:00-17:15	WeBT6.7
<i>An Aerial Robotic Manipulator for Offshore Wind Turbine Blade Inspection</i>	
Yang, Yingying	Fuzhou University
Zhang, Zihao	Fuzhou University
Wang, Pei	Fuzhou University
Xie, Kaiyi	Fuzhou University
Lin, Yaohua	Fuzhou University
Li, Yifan	Fuzhou University
Li, Yuzheng	Fuzhou University
Liu, Qianyuan	Fuzhou University
<p>Offshore wind power is a key contributor to the global transition toward renewable energy. However, offshore wind turbine operation and blade inspection—particularly in harsh marine environments—remain challenging due to high costs and safety risks. This study presents an aerial manipulator specifically designed for wind turbine blade inspection. The proposed system integrates three components: a bio-inspired adaptive end-effector, a force-feedback telescopic manipulator, and an anti-disturbance control framework. The end-effector, inspired by the lotus seedpod, improves surface conformability and contact stability, reducing slippage and transient</p>	

contact loss under vibration. The telescopic manipulator absorbs impact loads and vibrational energy, enhancing operational safety and mechanical reliability. A hierarchical control architecture incorporating a nonlinear disturbance observer (NDOB) is implemented to ensure platform stability during physical interaction. The framework enables accurate attitude regulation and trajectory tracking of the UAV under dynamic environmental disturbances. The system is validated through simulations and physical scenario experiments.

Technical Program for Thursday June 18, 2026

ThAT1	Assembly Hall
Robotics 3 (Regular Session)	
Chair: Huang, Hailong	Hong Kong Polytechnic University
Co-Chair: Gao, Zhi	Wuhan University
08:30-08:45	ThAT1.1
<i>Development of Flapping Robots Using Piezoelectric Fiber Composites - Introduction of Click Mechanism -</i>	
Suzuki, Keisuke	The University of Electro-Communications
Sato, Ryuki	The University of Electro-Communications
Ming, Aiguo	The University of Electro-Communications
<p>Developing agile flapping robots like insects is still an important task to achieve successful potential applications of the flapping robots. Authors have been working on developing flapping robots using a new type of piezoelectric material, that is, piezoelectric fiber composites, while mimicking the structure and the control of insects. To enhance the performance of the flapping robots, this paper describes an introduction of click mechanism to a flapping robot using piezoelectric fiber composites inspired from insects. The simulation-based design is performed to achieve flapping motions with large flapping amplitude and high speed by utilizing the click mechanism. A prototype of flapping robot using the designed click mechanism has been fabricated and large flapping amplitude and high speed due to the click mechanism have been confirmed by experimental results.</p>	
08:45-09:00	ThAT1.2
<i>Hybrid Control Architecture for Mobile Robot Fleets Integrating Centralized Coordination and Decentralized Navigation</i>	
Abutalipov, Kaisar	Satbayev University
Tuleshov, Yerkebulan	Satbayev University
Issabekov, Zhanibek	Satbayev University
Rakhimzhanov, Rustem	Satbayev University
Rakhmetova, Perizat	Satbayev University
<p>Mobile systems with multiple robots are widely used in warehouse and production logistics, where work efficiency is determined not only by the quality of local navigation of an individual robot, but also by the consistency of movement of the entire fleet. With the increasing number of robots in a limited environment, characteristic problems arise conflicts at intersections, mutual delays, queues in narrow corridors and mutual blockages. Fully decentralized approaches provide good local adaptation, but do not guarantee a global order of movement. Fully centralized approaches allow you to create conflict-free plans, but they are sensitive to computational complexity and the mismatch between a discrete model and continuous execution. The paper proposes a hybrid fleet management framework for mobile robots that combines a centralized level of coordination based on multi-agent pathfinding and decentralized execution using the Nav2 navigation stack in the ROS2/Gazebo environment. Conflict-based search is used as a centralized planning method that forms a globally consistent discrete plan. For practical implementation, the Fleet Manager intermediate coordination module has been developed, which converts a discrete plan into a sequence of goals and waypoint commands for Nav2, tracks the progress of robots and initiates replanning in case of deviations. Experimental validation was conducted at two levels: a discrete Python model and continuous simulation in Gazebo. Three modes are compared: centralized coordination in a discrete model as a reference, decentralized execution using Nav2 alone, and hybrid management of MAPF + Nav2. The results show that in simple scenarios, Nav2-only mode can provide acceptable behavior, but in conditions of corridors and conflicts, the likelihood of blockages increases and waiting times</p>	

worsen. The hybrid approach enhances stability and predictability of fleet motion by integrating global coordination with local adaptability.	
09:00-09:15	ThAT1.3
<i>Convexity-Exploiting Successive Convexification for Safe Drone Racing</i>	
Shen, Zhipeng	The Hong Kong Polytechnic University
Zhou, Shiyu	City University of Hong Kong
Huang, Hailong	Hong Kong Polytechnic University
<p>Autonomous drone racing requires time-optimal trajectories that are both dynamically feasible under the full nonlinear quadrotor model and safe with respect to reliable gate traversal. This paper presents a tractable trajectory-optimization framework based on successive convexification augmented with systematic convexity exploitation. We incorporate geometric gate decomposition by representing gate-passage requirements as convex constraints (intersections of half-spaces and second-order cones), thereby certifying complete traversal without intricate variables or intricate nonconvex constraint mechanisms. Beyond accelerating the main optimization, we show that the exploited convex structure also enables strong initialization: a single convex program can provide a high-quality initial guess and, in many cases, a competitive solution. Extensive comparative evaluations demonstrate significant computational improvements from successive convexification and convexity exploitation, while real-world flight experiments validate the physical feasibility and repeatability of the resulting trajectories.</p>	
09:15-09:30	ThAT1.4
<i>S2Loc: A Temporal-Geometric Consistent Framework for Long-Term LiDAR Localization</i>	
Wu, Yezhen	Wuhan University of Technology
Wang, Qiang	Wuhan University of Technology
<p>Reliable long-term localization is essential for autonomous navigation, yet significant drift often arises when transient environmental changes are incorrectly matched to the pre-built static map. We propose S2Loc, a hierarchical framework that replaces passive error tolerance with active constraint verification. By explicitly decoupling feature reliability from feature existence, the system ensures that only spatiotemporally consistent geometric features are utilized for localization. Specifically, the Stable Structure Perception (SSP) module functions as a strict validation layer to extract dominant structural planes while actively intercepting structural inconsistencies. This allows the Structure-Guided Matching (SGM) registration strategy to leverage exclusively these validated constraints to optimize the pose estimation. Extensive experiments on the NCLT dataset and in industrial environments subject to frequent layout changes demonstrate that S2Loc reduces translational errors by an average of 46.6%, maintaining robustness even under environmental variations (with a Global Change Rate reaching up to 41.8%).</p>	
09:30-09:45	ThAT1.5
<i>HSURE: Hierarchical Safety-Aware Exploration Guided by Unknown Regions Using Dynamic Sparse Graphs</i>	
Yang, Wenbin	Wuhan University
Xu, Jingzhong	Wuhan University
Gao, Zhi	Wuhan University
Zhou, Zhiyu	Wuhan University
Lin, Feng	National University of Singapore
<p>Autonomous exploration with Unmanned Ground Vehicles (UGVs) demands a balance between exploration efficiency and navigation safety. However, existing methods typically focus on known regions or frontiers, neglecting the informative potential of unknown regions, resulting in redundant backtracking or suboptimal efficiency. To address this issue, we introduce HSURE, a hierarchical safety-aware autonomous exploration framework guided by unknown regions. We</p>	

explicitly decompose unknown regions by topological connectivity and construct an observability-driven safety assessment using dynamic sparse graphs in known space. Leveraging these hybrid representations, we devise a coarse-to-fine safety-aware exploration planner. The global planner computes an optimal coverage path, and the local planner refines this into a safe and executable trajectory. Extensive simulation and real-world experiments demonstrate the proposed method outperforms state-of-the-art baselines, significantly reducing exploration time and trajectory redundancy while maintaining navigational safety.

09:45-10:00 ThAT1.6

Toggle-Assisted Electric Control Brake Knee Joint for Maintaining Step-Adaptive Swing Phase Angle

Rei, Ito	Mie University
Masaki, Senzaki	Mie University
Yano, Ken'ichi	Mie University
Manabu, Goto	MASEN Engineering Corporation
Katsuhiko, Tori	IMASEN Engineering Corporation

Compact passive single-axis prosthetic knees are widely prescribed because of their low mass and short build height, yet their swing motion is largely unregulated. At low cadences, this can cause insufficient minimum toe clearance (MTC) due to premature knee extension after peak flexion, and (ii) knee-flexed initial contact caused by terminal impact and prolonged late swing, both of which increase fall risk. This paper presents a compact uniaxial prosthetic knee that electronically actuates a conventional load-break through a toggle mechanism, enabling swing-phase knee-angle holding at arbitrary timings with reduced actuator torque. The knee applies braking at two key instants: it holds the knee at peak flexion until the predicted MTC instant and locks the knee at full extension in late swing until initial contact. A prototype (build length 205 mm, mass 918 g) was tested in level walking with one unilateral transfemoral amputee at cadences of 60–90 rpm, compared with two conventional passive knees. At 75 rpm, the proposed knee increased MTC from 0.5 mm to 23.7 mm and eliminated toe scuffing, while at 60 rpm, fall prevention was achieved by maintaining the fully extended position.

10:00-10:15 ThAT1.7

HandCept: A Visual-Inertial Fusion Framework for Accurate Proprioception in Dexterous Hands

Huang, Junda	Chinese University of Hong Kong
Guo, Honghao	The Chinese University of Hong Kong
Wu, Hao	National University of Singapore
Li, Yitong	National University of Singapore
Liu, Zhengyang	Meta
Ang Jr, Marcelo H.	NUS
Zhou, Jianshu	National University of Singapore

In the pursuit of general robotic manipulation, dexterous hands require reliable and scalable proprioception, which remains a key bottleneck due to limitations in sensing integration and generality. This paper presents HandCept, a visual-inertial proprioception framework for accurate joint angle estimation without relying on embedded joint sensors. HandCept integrates a wrist-mounted RGB-D camera and distributed 9-axis IMUs to estimate link poses through complementary sensing modalities. A zero-shot visual pipeline trained on synthetic data provides global 6D pose observations, while inertial measurements deliver high-frequency orientation updates. These asynchronous signals are fused via a latency-compensated Extended Kalman Filter, enabling real-time, drift-free estimation under dynamic conditions. Experimental results show that HandCept achieves joint angle errors within $\pm 2^\circ$ to $\pm 4^\circ$ without observable drift, outperforming visual-only and inertial-only baselines. The proposed framework further demonstrates strong IMU stability and cross-device uniformity, allowing a shared reference frame and simplified

calibration. HandCept provides a generalizable and hardware-efficient solution for dexterous hand proprioception, supporting robust closed-loop manipulation in real-world environments.

ThAT2 Room 256

Advanced Control, Planning and Learning of Unmanned Systems (Regular Session)

Chair: Liang, Hongtao	Shaanxi Normal University
Co-Chair: Bai, Jianjun	Hangzhou Dianzi Univ
Organizer: Li, Huiping	Northwestern Polytechnical University
Organizer: Zong, Guangdeng	Qufu Normal University
Organizer: Liang, Hongtao	Shaanxi Normal University
Organizer: Liu, Xiaotao	Xidian University

08:30-08:45 ThAT2.1

Adaptive Trajectory Tracking Control for Underactuated AUVs with Prescribed Performance and RBFNN-Based Current Compensation

Zhu, Shuyi	Hangzhou Dianzi University
Liu, Zhiyao	Hangzhou Dianzi University
Bai, Jianjun	Hangzhou Dianzi Univ
Chen, Yun	Hangzhou Dianzi University

This paper proposes an adaptive trajectory tracking scheme for underactuated AUVs subject to time-varying ocean currents and uncertainties. A fast-convergent RBFNN observer with fractional-order terms is designed to accurately estimate disturbances at the kinematic level. By integrating Prescribed Performance Control (PPC) into the backstepping framework, tracking errors are strictly confined within a predefined performance funnel. Simulation results verify that the proposed method ensures superior transient stability and robust disturbance rejection compared to standard backstepping controllers.

08:45-09:00 ThAT2.2

Globally Asymptotic Formation Control of Networked USVs with Output and Input Constraints

Liang, Hongtao	Shaanxi Normal University
Yu, Junzhi	College of Engineering, Peking University
Li, Huiping	Northwestern Polytechnical University

This article addresses the asymptotic formation control issue for networked unmanned surface vehicles (USVs) with output and input constraints. Specifically, a leader-follower scheme is developed to make each USV follow its reference trajectory without collisions among vehicles. Moreover, a global prescribed performance control is proposed to ensure tracking errors converge to optimal constrained boundaries regardless of initial conditions. Additionally, an adaptive formation controller is designed with the auxiliary variable to guarantee asymptotic convergence of the tracking system towards the origin with a small residual set, where the first-order filtering is introduced to avoid repeated differentiation and the fuzzy logic system is employed to attenuate effects of uncertainties and disturbances. Based on Lyapunov stability theorem, the rigorous closed-loop stability is achieved in terms of convergence and boundedness. Finally, numerical simulations show the effectiveness of the proposed method.

09:00-09:15 ThAT2.3

Risk-Averse Tracking Control for Autonomous Heavy-Duty Trucks in High-Speed Obstacle Avoidance Scenarios

Wang, Yuanxin	Beijing Institute of Technology
Meng, Guoli	Beijing Institute of Technology
Li, Erhang	Beijing Institute of Technology

Wei, Hongqian	Beijing Institute of Technology
Yu, Huilong	Beijing Institute of Technology
Xi, Junqiang	School of Mechanical Engineering, Beijing Institute of Technology
<p>High-speed maneuvers for autonomous heavy-duty trucks pose significant control challenges due to nonlinear dynamics, while the high center of gravity makes them prone to catastrophic rollover. To address this, we propose a Risk-Averse Nonlinear Model Predictive Control (NMPC) framework. First, a structured residual Physics-Informed Neural Network (rPINN) is constructed to compensate for the mismatch between the model and the actual nonlinear vehicle dynamics, thereby enhancing multi-step prediction accuracy while ensuring physical consistency. Second, a Safe Operating Envelope (SOE) is constructed offline via grid-based reachability analysis. The resulting stability boundaries are identified across varying speeds and approximated by a convex polytope for real-time optimization. Furthermore, the stability envelope is mapped to a differentiable risk potential field and integrated into the NMPC as a soft constraint. This mechanism proactively mitigates risk by preventing the vehicle from approaching the stability boundaries. Simulations demonstrate that the proposed framework enhances trajectory tracking performance and lateral stability.</p>	
09:15-09:30	ThAT2.4
<i>Crossing the Sim-To-Real Barrier in RL for Quadrotor Control</i>	
Zhao, Zeyuan	Shanghai Jiao Tong University
Zhou, Junyu	Shanghai Jiao Tong University
Li, Xianwei	Shanghai Jiao Tong University
<p>Reinforcement learning (RL) has shown promise for quadrotor control, but sim-to-real transfer remains highly challenging: policies that work well in simulation often fail or even crash in reality. The core difficulty lies in unmodeled dynamics and disturbances, including actuator-level thrust dynamics affected by nonlinear aerodynamic drag, body-relative airflow, and multimodal environmental noise, that are usually omitted or over-simplified in simulation. To address these issues, we propose an RL-based controller with three key design choices: careful selection of temporal parameters such as motor inertia and control delay to stabilize reward-action mapping, (ii) an input space design that uses body-rates history and rotation-matrix attitude representation to balance efficiency, robustness, and accuracy, and (iii) diffusion-based noise modeling that captures complex real-world disturbances beyond simple parametric approximations. We validate our approach on Crazyfly quadrotors across diverse and challenging trajectories unseen during training, where our policy significantly outperforms classical controllers in tracking accuracy. These results show that principled design in modeling and training can enable reliable zero-shot sim-to-real transfer of RL policies for quadrotor flight.</p>	
09:30-09:45	ThAT2.5
<i>Predefined-Time Disturbance-Rejection Control for UAVs without Flow Angle Measurements</i>	
Li, Jinbai	Beihang University
Wang, Honglun	Beihang University
Wang, Yanxiang	Beihang University
Liu, Yiheng	Beihang University
<p>Aiming at the challenge of achieving precise control performance when the flow angle of unmanned aerial vehicles (UAVs) cannot be measured directly, a predefined-time disturbance-rejection control (PTDRC) method without flow angle measurements is proposed. Based on the six-degree-of-freedom (6-DOF) nonlinear model of the UAV, an affine nonlinear form containing position, path angle, flow angle, angular rate, and velocity loop is derived; an flow angle estimation network (FAEN) is developed using a deep learning-based approach, in which the network structure contains three stacked gated recurrent unit (GRU) layers followed by a fully-connected layer; and a PTDRC method for the UAV without flow</p>	

<p>angle measurements is designed based on the estimated flow angle. Simulation results demonstrate that the FAEN exhibits stronger robustness against coefficient perturbations compared with the extended Kalman filter (EKF). Under different aerodynamic coefficient perturbations and turbulence intensities, the proposed PTDRC method achieves higher control accuracy and stronger disturbance rejection performance than the linear active disturbance rejection control (LADRC).</p>	
09:45-10:00	ThAT2.6
<i>Model-Based Accelerated Safe Reinforcement Learning for Constrained Trajectory Planning of Autonomous Vehicles</i>	
Guo, Jiawei	School of Mathematics, Southeast University
Fu, Junjie	Southeast University
<p>Deep Reinforcement Learning (DRL) shows great potential in achieving high-performance autonomous navigation but suffers from high sample complexity and exploration risks. This paper proposes a safety-aware Model-Based Reinforcement Learning (MBRL) framework to address these issues. First, we integrate a High-Order Control Barrier Functions (HOCBFs) module to ensure safety. This module strictly constrains policy actions within safe regions, significantly minimizing training violations. Second, we apply a modular Stochastic Value Gradient (SVG) scheme that aligns policy updates with safety-filtered execution. Finally, to enhance sample efficiency, we employ a Dyna-style architecture augmented by a Sparse Gaussian Process (SGP) dynamics model. We initialize the model via offline pre-training and fine-tune it online. This design reduces model mismatch and keeps the computational cost manageable. Experimental results show improved learning efficiency and safety performance compared to the baselines.</p>	

ThAT3	Room 267
Advancements in Intelligent Perception and Autonomous Decision-Making (Regular Session)	
Chair: Zhang, Chunmei	Taiyuan University of Science and Technology
Co-Chair: Zhao, Jiayi	Taiyuan University of Technology
Organizer: Cheng, Lan	Taiyuan University of Technology
Organizer: Zhang, Chunmei	Taiyuan University of Science and Technology
Organizer: Zhang, Jia	Beijing Institute of Technology
08:30-08:45	ThAT3.1
<i>Confidence-Aware Point Cloud Optimization for Sparse-View 3D Gaussian Splatting</i>	
Zhao, Jiayi	Taiyuan University of Technology
Cheng, Lan	Taiyuan University of Technology
Zhang, Jia	Beijing Institute of Technology
Xu, XinYing	Taiyuan University of Technology
<p>To address the artifacts arising from low-quality geometric initialization in 3D Gaussian Splatting under sparse views, this paper proposes a general, plug-and-play self-supervised point cloud optimization framework. Seamlessly integrated into the InstantSplat pipeline, our method leverages monocular depth estimation as a geometric constraint. Specifically, it constructs a gradient-based spatial confidence mask to suppress edge noise in the depth prior, dynamically calibrates depth scales via confidence-weighted statistical moment matching, and optimizes the point cloud using a combination of Charbonnier loss and an adaptive anchor regularization mechanism. Experimental results demonstrate that our approach effectively eliminates geometric artifacts, significantly enhancing the visual quality and robustness of novel view synthesis compared to the baseline.</p>	

08:45-09:00	ThAT3.2
<i>Q-Learning Model Predictive Control with Adaptive Learning Period for Systems with Unknown Parameters</i>	
Peng, He	North University of China
Xiaoli, Luan	Jiangnan University
Wen, Jiwei	Jiangnan University
Zhao, Zhiliang	North University of China
<p>In the present study, a Q-learning model predictive control with adaptive adjustment of learning period is proposed for unknown linear discrete-time systems to optimize the mixed H_2/H_∞ performance index. To improve the learning efficiency of the control gain, the influence function is used to construct the quantitative relationship between the measured data and learning performance. Meanwhile, to achieve better control performance in the case of system disturbance mutation, the receding horizon optimization of model predictive control combined with Q-learning is presented. Finally, effectiveness of the proposed algorithm is numerically evaluated.</p>	
09:00-09:15	ThAT3.3
<i>Adaptive Point Set Aggregation for Large Scale Maximal Covering Location Problems</i>	
Zhu, Ruiyi	Beijing Institute of Technology
Liu, Yaxuan	Beijing Institute of Technology
Chen, Chen	Beijing Institute of Technology
<p>Maximal covering location problems (MCLP) are fundamental in spatial optimization with widespread applications in sensor networks, smart cities, and robotics. The growing need for fine-grained decision-making in modern systems results in both large-scale candidate facility location and demand point sets, rendering this NP-hard combinatorial optimization beyond the practical computational limits of existing solvers. Simple aggregation methods improve scalability, but often incur a significant loss in solution quality, motivating the need for intelligent aggregation mechanisms. To address this, the paper proposes an adaptive aggregation framework that effectively reduces problem dimensionality while maintaining high-quality coverage. The proposed method establishes an iterative framework of aggregation-optimization-refinement, driven by novel criteria: a coverage inconsistency evaluation that detects discrepancies between approximate and actual coverage, and a local gain potential analysis that identifies regions with high potential for solution improvement. Using these indicators to selectively refine spatial granularity, the framework adaptively preserves high-quality coverage while maintaining computational efficiency. Simulations with up to 100,000 points demonstrate that the proposed algorithm achieves high-quality coverage comparable to leading solvers with substantial runtime reductions, confirming its scalability for solving large-scale MCLP.</p>	
09:15-09:30	ThAT3.4
<i>Pulse Charging Strategy for Lithium Batteries Based on Deep Reinforcement Learning</i>	
Chen, Boyang	Taiyuan University of Technology
Ren, Mifeng	Taiyuan University of Technology
Zhang, WenJie	Taiyuan University of Technology
<p>If lithium batteries aim to achieve fast and safe charging while reducing polarization and extending battery lifespan, precise control is essential. This paper combines deep reinforcement learning with pulse charging to propose a novel charging control method. Addressing the poor generalization capability of traditional approaches, this method dynamically adjusts initial conditions during training, enabling the model to adapt to diverse charging environments and swiftly respond to new operational scenarios. It effectively enhances the model's generalization ability while significantly suppressing polarization effects during charging. Simulation results show that with this method, polarization voltage</p>	

remains around 0.2V, and temperature stays below 50°C during the charging process.	
09:30-09:45	ThAT3.5
<i>An Automated Data Synthesis Framework for Visual-Language Navigation Training Based on 3D Gaussian Splatting</i>	
Ma, Runze	Taiyuan University of Technology
Zhang, Weiqiang	Taiyuan University of Technology
Hao, Lingguang	Taiyuan University of Technology
Cheng, Lan	Taiyuan University of Technology
<p>Language Navigation (VLN) models is severely constrained by the scarcity of high-quality, diverse training data. Traditional data collection methods rely on costly robotic platforms and labor-intensive manual annotation, resulting in limited data scale and significant scene bias. To overcome this bottleneck, this paper proposes a novel, end-to-end automated VLN training data synthesis framework. Its core innovation lies in efficiently generating large-scale training data—featuring precise geometry, rich semantics, and natural language instructions—using only multi-view RGB image sequences of target scenes as input. Specifically, we first employ 3D Gaussian splatting techniques to reconstruct high-fidelity, renderable neural scene representations from images. Subsequently, we design a data-driven method for automatically constructing navigation graphs and innovatively introduce an open-vocabulary 2D segmentation model to inject dense, consistent instance-level semantic information into scenes, thereby eliminating reliance on costly manual annotation. Finally, based on this semantic navigation structure, we automatically generate diverse navigation instructions through a context-aware command generator. Experiments demonstrate that data synthesized using this framework significantly improves navigation success rates for mainstream VLN baseline models in unseen environments. Moreover, our method exhibits significant advantages over traditional approaches in terms of data generation efficiency and scene editability. This work provides a practical new pathway for achieving low-cost, large-scale, high-quality VLN data production.</p>	
09:45-10:00	ThAT3.6
<i>SD-MOMPA-Based Approach for Multi-UAV Cooperative Task Allocation</i>	
Yang, Xiaokang	Taiyuan University of Science and Technology
Zhang, Chunmei	Taiyuan University of Science and Technology
Guo, Hong ge	Taiyuan University of Science and Technology
<p>Multi-UAV cooperative task allocation is a typical multi-objective constrained optimization problem with discrete combinatorial structure, strong constraint coupling, and conflicting objectives. To address these issues, this paper proposes a State-aware(S) Decomposition-guided(D) Multi-Objective Marine Predators Algorithm (MOMPA), abbreviated as SD-MOMPA. A multi-objective model is first established by considering total system energy consumption, maximum completion time, and load variance under task uniqueness, energy, capacity, and time-window constraints. Then, the decomposition idea from MOEA/D is introduced into MOMPA to enhance search directionality along different Pareto preferences; state-aware phase scheduling is designed to adaptively coordinate exploration and exploitation using population diversity, improvement rate, and feasibility ratio; and local replanning is applied to infeasible solutions to preserve favorable task-allocation structures. Comparative experiments show that SD-MOMPA achieves competitive convergence performance and obtains a well-distributed Pareto solution set, demonstrating its effectiveness for constrained multi-UAV task allocation.</p>	

ThAT4	Room 269
-------	----------

Collective Behavior Regulation Inspired by Swarm Intelligence and Its Applications (Regular Session)	
Chair: Yang, Qingkai	Beijing Institute of Technology
Co-Chair: Zeng, Xianlin	Beijing Institute of Technology
Organizer: Yang, Qingkai	Beijing Institute of Technology
08:30-08:45	ThAT4.1
<i>Consensus for Multi-Agent Systems with Stochastic Network and Noises by LLM</i>	
Shang, Jinxin	Fuzhou University
Qi, Yiwen	Fuzhou University
<p>This paper studies the consensus problem for stochastic multiagent systems (SMASs) under compound noises (additive and multiplicative noises) over stochastic networks via a Large Language Model (LLM). Existing challenges primarily stem from the difficulty in obtaining appropriate control gains to rapidly mitigate noises under stochastic network conditions. Furthermore, the simultaneous presence of these networks and compound noises complicates the transformation into unified error dynamics. To address these issues, this paper applies LLM inference to the adaptive selection of control gains $\alpha(k)$. By utilizing the LLM's powerful reasoning capabilities and ability to process complex contextual information, this approach dynamically selects appropriate control gains to cope within complex environments. Specifically, a stochastic approximation (SA) protocol is employed where the LLM's designed gains, subject to specific convergence constraints, effectively reduce the influence of noises for SMASs. In addition to ensuring state boundedness through Lyapunov theory, a semi-decomposition technique to establish consensus among agents is employed. The effectiveness of our LLM-based control scheme is ultimately demonstrated by a representative numerical example.</p>	
08:45-09:00	ThAT4.2
<i>NE Seeking for Linear Multi-Agent Systems with Time-Varying Costs</i>	
Chongyuan, Hu	Bupt
Xu, Chengzhi	Beijing University of Posts and Telecommunications
Sun, Qiming	Beijing University of Posts and Telecommunications
Tang, Yutao	Beijing University of Posts and Telecommunications
<p>This paper addresses the problem of distributed Nash equilibrium seeking for multi-agent systems composed of heterogeneous linear agents. Unlike most existing works that assume static cost functions or single-integrator dynamics, we consider a dynamic noncooperative game where the cost functions evolve over time and the agents are subject to high-order physical constraints. We conduct a hierarchical design consisting of a distributed algorithm for the Nash equilibrium seeking at the upper level and a reference-tracking controller at the lower level. Rigorous theoretical analysis of the system performance reveals that the algorithm performance is fundamentally limited by the variation rate of the realtime NE. Numerical simulations are presented to validate the effectiveness of the proposed algorithm.</p>	
09:00-09:15	ThAT4.3
<i>Synergizing Geometric Fabrics with Population-Based Reinforcement Learning for Dexterous Manipulation of Articulated Objects</i>	
Zhu, Yiming	Zhejiang University
Li, Zihao	Zhejiang University
Lang, Yilin	Zhejiang University
Ren, Qinyuan	Zhejiang University
<p>Dexterous manipulation of articulated objects necessitates navigating a high-dimensional configuration space riddled with discontinuous contact dynamics. Standard end-to-end Reinforcement Learning often struggles in this regime, frequently converging to jittery, unstable</p>	

<p>policies. To bridge this gap, we propose a hierarchical control framework that synergizes the extensive exploration capabilities of Population-Based Training with the structural priors of Geometric Fabrics embedded directly into the learning loop. We construct a decoupled attractor landscape that guides the arm and fingertips toward task-relevant poses, strictly confined by anisotropic repulsive metrics for self-collision avoidance and singular barrier potentials for joint limits. This formulation not only leverages the diverse experience collection of a population of agents but also effectively projects the RL problem into a physically consistent manifold, transforming the policy's role from raw motor command generation to high-level energy shaping. Extensive validation in the massively parallelized IsaacLab simulation environment demonstrates that our GF-Delta strategy achieves a 97.47% success rate in drawer-opening tasks. Compared to standard joint-space baselines, our method exhibits superior convergence efficiency and generates smooth, feasible trajectories without requiring complex reward engineering.</p>	
09:15-09:30	ThAT4.4
<i>Attention-Enhanced Artificial Potential Field with Deep Reinforcement Learning for Multi-UAV Cooperative Pursuit</i>	
Wang, Yunan	Beihang University
Hua, Yongzhao	Beihang University
Li, Xiaoduo	Beihang University
Dong, Xiwang	Beihang University
<p>To address the problem of multi-UAV cooperative pursuit of a high-speed evader in obstacle-rich environments, this paper proposes a hybrid cooperative pursuit algorithm trained under the centralized training with decentralized execution paradigm. The proposed algorithm employs an attention encoder to produce compact representations of dynamic neighbor observations and adopts the Twin Delayed Deep Deterministic Policy Gradient framework to output continuous potential field parameters, achieving cooperative pursuit and obstacle avoidance control through attention-weighted potential fields. The Dual-Channel Gradient Decoupling architecture is designed to segregate the multi-network optimization pathways, thereby resolving the Actor-Critic gradient conflict arising from the shared attention encoder. In addition, the Critic-Anchored KL Regularization is introduced to suppress the target-value non-stationarity caused by fluctuations in the attention distribution. Simulation experiments demonstrate that the algorithm attains an average capture success rate of 88% with a peak of 92%, outperforms the baseline in both convergence speed and final performance.</p>	
09:30-09:45	ThAT4.5
<i>Deep Koopman Operator-Based Linear Quadratic Regulator for Quadrotor Pursuit-Evasion Game</i>	
Yang, Xin Mei	Beijing Institute of Technology
Dong, Wei	Beijing Institute of Technology
Cai, Yeyun	Beijing Institute of Technology
Shi, Xiang	Beijing Institute of Technology
Zhang, Lele	Beijing Institute of Technology
Wang, Chunyan	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
<p>This paper proposes a deep Koopman operator-based output regulation framework to address the pursuit-evasion (PE) game problem of quadrotors with strongly nonlinear dynamics. First, for the nonlinear quadrotor dynamics, a deep neural network is trained to lift the physical states into a high-dimensional latent linear space. Then, an output matrix is introduced to map the lifted states to task-relevant outputs. Next, a discrete-time linear quadratic regulator (LQR) with an output-weighted quadratic cost is formulated to yield a Riccati-based controller for efficient regulation. In contrast to existing Koopman-based control schemes, the proposed approach improves the modeling fidelity for nonlinear flight dynamics. Finally, simulation demonstrates that the proposed controller outperforms the baseline</p>	

controller and also provides a principled and computationally efficient alternative to purely reinforcement learning (RL)-based policies.	
09:45-10:00	ThAT4.6
<i>Solving Imperfect-Information Dynamic Defender-Attacker Blotto Games Based on Progressive-Expanding CFR</i>	
He, Yuman	Beijing Institute of Technology
Zeng, Xianlin	Beijing Institute of Technology
Dou, Lihua	Beijing Institute of Technology
<p>This work studies imperfect-information dynamic Defender-Attacker Blotto games under graph constraints. In this game, two players make multi-stage decisions on how to allocate and move limited resources to control critical nodes, with each player observing only part of the opponent's resources at each stage, highlighting the challenges of imperfect information. Existing reinforcement learning methods suffer from low sample efficiency and lack theoretical guarantees, while classic counterfactual regret minimization (CFR) algorithms struggle with low computational efficiency in large action spaces. To address this, we propose a Progressive-Expanding Counterfactual Regret Minimization (PE-CFR) algorithm. This method uses hybrid strategy pruning to construct a high-quality initial action subset and applies progressive expansion mechanism to explore the full action space. Experiments on networks with 3 to 6 nodes show that PE-CFR significantly outperforms the baseline in both convergence speed and computational efficiency. The equilibrium generated reveals that resource allocation strategy should consider network topology and the opponent's mobility, rather than solely consider values of nodes.</p>	

ThAT5	Room 259
Distributed Optimization, Game and Learning Algorithms with Their Applications in Cyber-Physical Systems (Regular Session)	
Chair: Hua, Haochen	Hohai University
Organizer: Xiao, Shunyuan	Nanjing University of Posts and Telecommunications
Organizer: You, Keyou	Tsinghua University
Organizer: Ye, Maojiao	Nanjing University of Science and Technology
Organizer: Liu, Zhao-Qing	Nanjing University of Posts and Telecommunications
08:30-08:45	ThAT5.1
<i>GFW-YOLO: A Small Traffic Sign Recognition Method Optimized for Detailed Features</i>	
Huang, Chaohong	Chongqing University of Technology
Shen, Xiaoman	Chongqing University of Technology
Han, Shuchang	Chongqing University of Technology
Liu, Wei	Chongqing University of Technology
<p>This Traffic sign detection plays a pivotal role in Intelligent Transportation Systems (ITS) and Advanced Driver Assistance Systems (ADAS) by providing critical support for driving safety and accident prevention. To address the challenges of small-target omission, occlusion, and low detection precision in complex environments, this paper proposes a novel traffic sign detection algorithm optimized for small objects based on the YOLOv8n framework. First, a C2f-CGLU module is developed by integrating Channel Gated Linear Units (CGLU) into the bottleneck structure of the C2f module within the backbone, thereby strengthening the model's perception of local details and channel-updating capabilities for partially occluded signs. Furthermore, design lightweight Feature Refinement Fusion (FRF) module is introduced to reconstruct the</p>	

cross-convolutional neck structure of YOLOv8n; this module, termed C2f-FRF, facilitates superior feature detail fusion while simultaneously reducing the total parameter count. Additionally, the original loss function is replaced with Wise-IoU to optimize bounding box regression performance and mitigate the adverse impact of low-quality training samples. Finally, an additional dedicated detection layer is incorporated to specifically enhance the precision of small-target localization. Experimental evaluations on the GTSD2021 and TT100K datasets demonstrate that the proposed GFW-YOLO model significantly outperforms the baseline YOLOv8n, achieving a 2.6% and 6.7% increase in mAP50 on the respective datasets, alongside a 10.9% reduction in parameters.	
08:45-09:00	ThAT5.2
<i>Privacy-Preserving Distributed Estimation of Global Storage Capacity Via Dynamic Differential Privacy</i>	
Zhang, Yun	Jinan University
Cui, Zhongrui	Jinan University
Chang, Le	Shanghai University of Electric Power
<p>Distributed Energy Storage Systems (DESSs) are critical for grid stability, yet their effective scheduling relies on accurate knowledge of the global total capacity. However, the capacity data of individual storage units is commercially sensitive. Traditional distributed consensus algorithms allow for decentralized estimation but often expose the initial states of nodes to neighbors, leading to privacy leakage. To address this challenge, this paper proposes a privacy-preserving distributed estimation strategy based on text it{Dynamic Differential Privacy}. We design a time-varying noise injection mechanism where Laplace noise is added to the consensus process. The noise scale is initialized at a high level to mask raw data and follows a decay function, reducing to zero at a pre-set time step $\\$T\\$. Theoretical analysis proves that this method ensures the privacy of individual units during the transient phase and achieves exact convergence to the true global capacity at step $\\$T\\$, effectively balancing the trade-off between privacy protection and estimation accuracy.</p>	
09:00-09:15	ThAT5.3
<i>Emergency Frequency Restoration in Weak Islanded Microgrids: A Noise-Suppressing Prescribed-Time Approach</i>	
Ye, Ying	State Grid Company
Xu, Bingyan	State Grid Company
Chen, Yunfeng	State Grid Company
Cao, Chun	State Grid Company
Tang, Heng	State Grid Company
Tu, Niehua	Shanghai Electric Power Industry
Han, Yi	Shanghai Electric Power Industry
Tang, Xuyin	Shanghai Electric Power Industry
<p>Frequency stability in islanded microgrids is often compromised by the low inertia of inverter-based interfaces and the prevalence of measurement noise in weak communication links. Traditional secondary control strategies, such as asymptotic or finite-time methods, typically suffer from slow convergence rates and are sensitive to noise, leading to steady-state fluctuations or prolonged recovery times. To address these challenges, this paper proposes a noise-resilient distributed secondary control strategy tailored for the emergency frequency recovery of weak microgrids. By employing a prescribed-time control framework with time-varying gains, the proposed method ensures that frequency synchronization is achieved exactly within a user-defined time window, regardless of initial system states. Theoretical analysis reveals that the inherent growing gain of the controller effectively suppresses bounded measurement noise as the deadline approaches, ensuring deterministic recovery precision. Numerical simulations on a modified IEEE 33-bus system validate that the proposed strategy can restore frequency to the nominal value</p>	

within 5 seconds, exhibiting superior robustness compared to conventional fixed-gain approaches.	
09:15-09:30	ThAT5.4
<i>Demand Response Decision Optimization for EV Aggregators in V2G Systems Via Embedded-Crossed Graph Attention Reinforcement Learning</i>	
Ruan, Mengxin	Hohai University
Hua, Haochen	Hohai University
Ma, Luyao	Hohai University
Zhou, Yang	Changsha University of Science and Technology
Jiang, Yingjin	China Quality Certification Centre
Sidorov, Denis	Energy Systems Institute, Siberian Branch of the Russian Academy of Sciences
Gertrudes, João Bosco	State University of Feira De Santana
<p>With the increasing penetration of electric vehicles (EVs), vehicle-to-grid (V2G) technology enables them to act as flexible resources within the power grid. Electric vehicle aggregators (EVAs) play a crucial role in coordinating large-scale EV charging and discharging, yet they face the dual challenge of maximizing economic benefits of EVAs while maintaining user satisfaction. To address this issue, this paper develops a solution method based on Stackelberg game theory. As leaders, EVAs determine charging prices and V2G compensation to optimize profits and achieve peak shaving and valley filling, while users, as followers, respond to regulatory signals and adjust their charging behaviors accordingly. An embedded cross multi-agent actor-critic (EC-MAAC) algorithm is further proposed to address the scalability issues arising from large-scale EV participation in V2G systems, while alleviating the reliance of conventional game-theoretic solvers on convexity and differentiability assumptions for tractable equilibrium computation. Simulation results demonstrate that the proposed EC-MAAC approach achieves a 15.1% reduction in EVA operating costs, a 44.6% increase in user rewards, and an improvement in SoC satisfaction from 91.2% to 96.8%, effectively balancing economic efficiency and user satisfaction.</p>	
09:30-09:45	ThAT5.5
<i>Fully Distributed Optimal Coordination of Uncertain Euler-Lagrange Systems with Relative Output Measurement</i>	
Liu, Tianyu	City University of Hongkong
Liu, Lu	City University of Hong Kong
<p>This paper investigates the distributed optimal coordination problem for multiple uncertain Euler-Lagrange systems. We first propose a novel measurement-based distributed optimal coordinator to generate the local reference trajectory without relying on communication networks. Notably, the coordinator gains are designed as two time-varying decreasing functions with distinct decay rates, which avoids the dependence on global information and, meanwhile, mitigates the error terms stemming from the replacement of communicated variables with physical outputs. Then, a norm-estimation-based adaptive controller is designed to achieve accurate reference tracking, where only one updated parameter needs to be introduced, regardless of the dimensions of disturbances and uncertainties. By constructing an appropriate composite Lyapunov function and utilizing the property of a perturbed time-varying differential inequality, it is proved that agents' outputs can asymptotically converge to the global optimum. The proposed scheme is fully distributed and inherently immune to cyber-attacks.</p>	
09:45-10:00	ThAT5.6
<i>Differentially Private Distributed Nash Equilibrium Seeking for Aggregative Games under an Event-Triggered Mechanism</i>	
Teng, Yuxin	Nanjing University of Science and Technology

Liu, Chao	Nanjing University of Science and Technology
Ye, Maojiao	Nanjing University of Science and Technology
<p>This paper considers differentially private distributed Nash equilibrium seeking for aggregative games under an event-triggered mechanism. By incorporating an event-triggered scheme with a privacy protected aggregate estimation mechanism, a distributed Nash equilibrium seeking strategy is proposed. In the proposed strategy, the privacy protection is achieved by using Laplace noises to mask the information exchanged among the players, in which the transmission instants are determined by an event-triggered mechanism. By gradually weakening inter-player interactions, the proposed strategy ensures that players' actions can be driven exactly to the Nash equilibrium while ensuring rigorous ϵ-differential privacy with reduced communication costs. The effectiveness of the proposed strategy is verified using a numerical example.</p>	
10:00-10:15	ThAT5.7
<i>Quantized Asynchronous H^∞ Control for T-S Fuzzy Systems Based on Fuzzy State Observers</i>	
Yang, Jing-yu	University of Science and Technology Beijing
Guo, Xianggui	University of Science and Technology Beijing
Ding, Dawei	School of Automation and Electrical Engineering, University of Science and Technology Beijing, Beijing 100083, Ch
Hao, Liying	Dalian Maritime University
<p>This work explores the observer-based controller problem for nonlinear networked dynamics where quantization non-idealities, exogenous disturbances, and asynchronous premise constraints are explicitly accounted for. A novel switching mechanism, leveraging the bounds of the MFs within an interval Type-2 Takagi-Sugeno (T-S) fuzzy framework, is proposed to control the approximated nonlinear model effectively. The proposed strategy obviates the need for precise MF information, accommodates premise asynchrony, and maintains low conservatism. The errors induced by quantization are formulated as bounded disturbances, which are suppressed under a prescribed H^∞ performance index. Within the Lyapunov stability framework, conditions are derived to ensure asymptotic stability for the integrated system. The efficacy of the proposed approach, along with its advantages over existing methods, is subsequently confirmed via illustrative simulations.</p>	

ThAT6	Room 264
Embodied Intelligent Robotics, Active Perception, and Human-Machine Interaction Technologies (Regular Session)	
Chair: Wang, Xiangyang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Jun, Cheng	Chinese Academy of Sciences
Organizer: Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Ziliang, Ren	Dongguan University of Technology
08:30-08:45	ThAT6.1
<i>UGPT: Uncertainty-Guided Dynamic Prompt Tuning for Vision-Language Models</i>	
Huang, Baoqin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Wu, Fuxiang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jun, Cheng	Chinese Academy of Sciences
Abduhalimzoda, Abdukarim	Tajik Technical University Named after Academician M.S. Osimi
Song, Chengqun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
<p>Adapting frozen vision-language models (VLMs) to downstream tasks via prompt tuning has emerged as a parameter-efficient alternative to full fine-tuning. However, existing prompt tuning methods still lack explicit control over how strongly prompts should adapt to different samples, despite the significant variation in sample difficulty and prediction reliability—a critical limitation for trustworthy deployment in complex real-world scenarios such as autonomous perception and intelligent control systems. We propose UGPT (Uncertainty-Guided Dynamic Prompt Tuning), a framework that explicitly leverages visual prediction uncertainty as a sample-level control signal for prompt modulation. UGPT computes normalized entropy from a frozen zero-shot CLIP branch, maps it through a lightweight Uncertainty Injection Network (UIN) into prompt-space perturbation vectors, and applies broadcast injection to generate sample-adaptive dynamic prompts. Under the 16-shot few-shot setting, UGPT uses only 41K trainable parameters in total, achieves 81.58% Top 1 accuracy on ImageNet-1K, and obtains consistent improvements across four out-of-distribution benchmarks (Avg. OOD: 62.0%). Ablation studies and interpretability analyses confirm that the perturbation magnitude increases monotonically with uncertainty, validating the principled "harder samples receive stronger modulation" mechanism.</p>	
08:45-09:00	ThAT6.2
<p><i>CAMD-HER: Competence-Aware Multi-Dimensional Curriculum Hindsight Experience Replay for Sparse-Reward Dexterous Control</i></p>	
Xu, Zhenyu	University of Macau
Ziliang, Ren	Dongguan University of Technology
Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Pun, Chi-Man	University of Macau
<p>Sparse-reward goal-conditioned reinforcement learning remains difficult in dexterous robotic control, where informative successful interactions are rare during early exploration. Although Hindsight Experience Replay (HER) improves sample efficiency by relabeling failed trajectories with achieved goals, standard HER usually adopts fixed hindsight-goal sampling heuristics and does not explicitly account for the agent's current competence. Meanwhile, existing curriculum strategies often rely on a single difficulty dimension, which may be insufficient for high-dimensional dexterous tasks. In this paper, we propose Competence-Aware Multi-Dimensional Curriculum HER (CAMD-HER), an extension of HER for sparse-reward goal-conditioned learning. CAMD-HER introduces a competence-aware hindsight relabeling mechanism that prioritizes candidate goals according to competence matching, novelty, and learning progress, and a multi-dimensional curriculum strategy that progressively adjusts task difficulty through success threshold, goal sampling range, reset perturbation, and observation noise. The proposed method is integrated into an off-policy HER-based training framework and implemented in a Stable-Baselines3-compatible manner. Experiments on the HandReach benchmark show that CAMD-HER improves training effectiveness over standard DDPG+HER by accelerating learning and achieving better performance under sparse rewards. The results indicate that jointly adapting replay selection and environment difficulty is an effective way to improve sample efficiency in goal-conditioned dexterous reinforcement learning.</p>	
09:00-09:15	ThAT6.3

<p><i>Hybrid Spiking Neural Network for Action Recognition</i></p>	
Chen, Yan	Dongguan University of Technology
Ziliang, Ren	Dongguan University of Technology
Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Anvarzoda, Daler	Tajik Technical University Named after Academician M.S. Osimi
Bandishova, Risolat	Tajik Technical University Named after Academician M.S. Osimi
<p>Human action recognition based on spiking neural networks (SNNs) has attracted increasing interest due to their low-power advantage. However, existing SNN-based methods are limited by training difficulties caused by the non-differentiability of spikes, which prevents their accuracy from surpassing that of artificial neural networks (ANNs). To address this bottleneck, this work proposes a Hybrid ANN-SNN Network (Hybrid-AS) that integrates both network paradigms within a two-stream architecture. The ANN branch ensures high recognition accuracy, while the SNN branch maintains energy efficiency. To achieve effective cross-branch complementarity, we introduce significance score computation and multi-granularity sampling mechanisms for deep feature integration. Extensive experiments on HMDB-51, UCF-101, and Kinetics-400 demonstrate that Hybrid-AS achieves state-of-the-art accuracy while preserving the low-power characteristics of SNNs, advancing efficient action recognition.</p>	
09:15-09:30	ThAT6.4
<p><i>SpikeAttn-YOLO: An Attention-Enhanced Spiking Neural Network for Energy-Efficient Object Detection</i></p>	
Zhou, Jun	Dongguan University of Technology
Ziliang, Ren	Dongguan University of Technology
Qieshi, Zhang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Abdunabi, Qosimov	Tajik Technical University Named after Academician M.S. Osimi
Shavkat, Kholov	Tajik Technical University Named after Academician M.S. Osimi
<p>Spiking Neural Networks (SNNs) represent a class of biologically inspired neural models that employ discrete spike-based communication, contrasting with the continuous-valued activations of traditional Artificial Neural Networks (ANNs). This event-driven paradigm offers significant advantages in power efficiency and temporal processing capabilities, positioning SNNs as promising alternatives for energy-constrained applications. However, two critical challenges impede their widespread adoption: the persistent performance gap compared to ANNs, and the substantial computational overhead associated with training. The non-differentiable nature of spike generation prevents direct application of standard backpropagation, while existing training methodologies present fundamental limitations. ANN- to-SNN conversion techniques typically require extended temporal sequences and sacrifice inherent spatiotemporal dynamics, whereas surrogate gradient methods demand complete temporal unrolling, resulting in computational burdens comparable to conventional ANNs. To address these challenges, this work introduces the Integer Leaky Integrate-and-Fire (I-LIF) neuron model, which substantially reduces training complexity while maintaining adaptive capability. Additionally, we develop two specialized SNN architectural components: a convolution-based processing block and a Transformer-based attention block, specifically designed to overcome performance degradation in object detection applications. Extensive experimental validation on Coco,</p>	

Gen1 and PASCAL VOC benchmarks demonstrates substantial performance improvements, confirming the potential of SNNs for complex visual perception tasks and advancing their practical deployment in real-world systems.	
09:30-09:45	ThAT6.5
<i>MaskedStar: Orientation-Aware Star-Masked Depthwise Convolution for Lightweight Detection</i>	
Liang, Zhihui	Dongguan University of Technology
Ziliang, Ren	Dongguan University of Technology
Gao, Hongchao	OPT Machine Vision Tech Co., Ltd, Dongguan
Chen, Hang	OPT Machine Vision Tech Co., Ltd, Dongguan
Liu, Ying	OPT Machine Vision Tech Co., Ltd, Dongguan
Real-time defect detection in industrial and infrastructural environments often faces a dilemma: dense convolutions are computationally expensive, while lightweight operators provide limited inductive bias for high-frequency, anisotropic patterns such as cracks. This paper proposes MaskedStar, a masked depthwise convolution that restricts learnable kernel locations to two complementary star supports: a horizontal-vertical cross and a diagonal "X". Building on MaskedStar, two plug-and-play backbone blocks: MaskedStar-S, which fuses dual MaskedStar branches with different dilations via lightweight ChannelSE attention, and MaskedStar-D, which additionally blends an optional full-context branch for mid-level pyramid features, are designed. Replacing the P3/P4 C3k2 blocks in a YOLO11n baseline yields consistent improvements on three benchmarks: NEU-DET (75.8/44.1 → 76.9/44.4), RDD-MotorBike (92.8/59.6 → 93.4/59.8), and RDD-Drone (59.7/33.6 → 62.0/35.8) for mAP50/mAP50:95. Overall, the observed improvements suggest that explicit orientation priors are a practical option for lightweight detectors targeting elongated patterns. Index Terms— Object detection, orientation-aware convolution, surface defect detection, road damage detection.	
09:45-10:00	ThAT6.6
<i>A VLM-Driven High-Fidelity Domain Randomization Framework for Imitation Learning</i>	
Huo, Ziyun	Guilin University of Electronic Technology
Wu, Fuxiang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Hao, Fusheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Song, Chengqun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jun, Cheng	Chinese Academy of Sciences
Liu, Jianming	Guilin University of Electronic Technology
Training robust vision-based robotic manipulation policies requires large-scale data, yet real-world collection is costly and unsafe. We present a high-fidelity simulation framework for data generation and policy learning, built on Isaac Lab with a closed-loop teleoperation pipeline for a UR5 manipulator and Robotiq 2F-85 gripper. The framework unifies demonstration collection, domain randomization, and policy training in a single pipeline. A central component is a semantic-aware parameter identifier that helps overcome a limitation of conventional DR by preventing unconstrained sampling from decoupling physical parameters from visual appearance, which otherwise yields semantically inconsistent scenarios that introduce	

spurious visual-physical correlations. To resolve this, we leverage a Vision-Language Model to infer material categories from RGB observations and assign physically plausible nominal values with confidence-aware bounds for friction and density. We validate the framework by training a Vision-Language-Action policy on the generated data. The results show that the parameter identifier attains high hit rates on material property prediction, and that the proposed DR meaningfully improves average task success over a position-only baseline.	
10:00-10:15	ThAT6.7
<i>Combining Data Distribution and Adaptive Inference for Robotic Grasping in Vision-Language-Action</i>	
Zhong, Lingye	Guilin University of Electronic Technology
Wu, Fuxiang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Hao, Fusheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Song, Chengqun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jun, Cheng	Chinese Academy of Sciences
Liu, Jianming	Guilin University of Electronic Technology
Recent advances in vision-language-action (VLA) models enable end-to-end robotic manipulation by learning from demonstrations. However, existing approaches have predominantly focused on scaling model architectures or expanding dataset size, often overlooking the interaction between training data distribution and inference strategies. To address this gap, we jointly study data distribution and inference strategy for robotic grasping, emphasizing coordinated distribution design and adaptive inference. Our approach integrates a compositional data collection strategy that decomposes the task state space into orientation and spatial factors, efficiently expanding coverage with a limited number of demonstrations. Additionally, we propose an adaptive inference mechanism that dynamically adjusts the execution horizon during critical task phases, thereby enhancing task performance. Embedding-space analysis suggests that performance saturates once the relevant state-space dimensions are sufficiently covered. Real-robot experiments validate our approach, demonstrating a 98% grasp success rate with only 81 demonstrations. Furthermore, applying adaptive inference to a moderately covered dataset improves the success rate from 90% to 97%, suggesting that inference-level refinement can complement data coverage, though it cannot fully compensate for insufficient distribution design.	

ThBT1	Assembly Hall
Automated Guided Vehicles (Regular Session)	
Chair: Ding, Yulong	Tongji University
10:30-10:45	ThBT1.1
<i>Adaptive and Navigation under Global Guidance Degradation: A Candidate-Set Driven Approach</i>	
Guan, Xinyu	Zhejiang University
Ren, Qinyuan	Zhejiang University
In complex environments such as industrial logistics, mobile robots relying on global planning are susceptible to communication latency, computational fluctuations, and non-convex environmental constraints. These factors often render reference paths stale or cause global guidance failures, resulting in stagnation or collisions at the control level. To address these navigation challenges, this paper proposes a candidate-set driven local resilient decision framework. By	

<p>constructing a hybrid candidate set (model-based and policy-based) and incorporating receding horizon online evaluation, the proposed method reduces dependency on global paths while achieving an adaptive trade-off between local navigation efficiency and safety margins. Furthermore, an embedded fail-safe mechanism employs a conservative baseline strategy to guarantee robust operation within tightly constrained environments. Experimental results demonstrate that the proposed approach effectively avoids local deadlocks, reduces collision risks, and enhances navigation efficiency under conditions where global reference paths are significantly delayed or unreliable, while ensuring real-time performance.</p>	
10:45-11:00	ThBT1.2
<p><i>Straight-Line Tracking of Unicycle Mobile Robots Using Saturation Controller</i></p>	
Yan, Hongjiao	South China University of Technology
Xu, Dabo	South China University of Technology
<p>This paper considers the problem of straight-line tracking for unicycle mobile robots when the reference angular velocity is trivial, and the persistence of excitation condition is a lack. To overcome this limitation, we present a controller to ensure global exponential tracking with input constraints. Simulation results confirm that the method achieves fast convergence.</p>	
11:00-11:15	ThBT1.3
<p><i>Energy-Efficient Yaw Stability Control for Four-Wheel-Independent-Drive Electric Vehicles</i></p>	
Lu, Linying	Yanshan University
Fang, Jiayi	Beijing Institute of Technology
Zhang, Ting	Tsinghua University
Jia, Liheng	Yanshan University
Fang, Yiming	Yanshan University
<p>Four-wheel-independent-drive electric vehicles (FWID-EVs) provide high control flexibility and actuator redundancy, making them promise for improving both yaw stability and energy efficiency. However, existing studies mainly focus on stability enhancement, while the energy cost associated with direct yaw moment control is often neglected. In addition, the control emphasis between stability and efficiency should vary with the instantaneous vehicle stability state. To this end, this paper proposes a stability-aware yaw control framework for FWID-EVs. At the upper layer, a yaw stability controller is designed using prescribed performance control (PPC) and SMC to regulate the vehicle's yaw response and ensure lateral stability. At the lower layer, a phase-plane-based stability index is constructed, and a driving torque allocation strategy that considers tire utilization and motor efficiency is proposed. Simulation results demonstrate that the proposed approach can effectively maintain yaw stability while reducing energy consumption, thereby achieving a better balance between safety and energy efficiency for FWID-EVs.</p>	
11:15-11:30	ThBT1.4
<p><i>Safe and Efficient Motion Coordination for Multi-AGV Systems with Dangerous Circle Detection</i></p>	
Yang, Runbang	Nankai University
Liu, Jingxuan	Nankai University
Chen, Fei	Nankai University
<p>In this paper, we propose a motion coordination strategy for multi-AGV systems operating on predefined closed paths, in which path preprocessing and dangerous circle detection serve as the two key mechanisms. Through path preprocessing, we explicitly analyze the network topology to identify conflict-prone segments and encode potential interaction relationships among AGVs, thereby transforming implicit collision and deadlock risks into a structured representation available for online decision-making. Building upon this</p>	

<p>representation, we employ a dangerous circle detection method to identify cyclic blocking configurations that are the fundamental cause of deadlocks under bidirectional motion. This enables us to shift deadlock avoidance from reactive resolution to proactive prevention by evaluating one-step-ahead motion states and suppressing the formation of dangerous circles via selective stopping and resuming actions, without resorting to global path replanning.</p>	
11:30-11:45	ThBT1.5
<p><i>Human-Like Trajectory Generation for Full-Process Curve Driving: An Explicit Parametric Approach</i></p>	
Su, Shaoka	Tongji University
Chen, Hui	Tongji University
Yang, Jiaxin	Tongji University
Lin, Huilong	School of Automotive Studies, Tongji University
<p>Conventional Lane Centering Control (LCC) algorithms typically rely on the passive geometric tracking of the lane centerline during curve navigation. Consequently, they fail to replicate the active pose-adjustment mechanisms exhibited by human drivers throughout the entry, mid-curve, and exit phases, thereby degrading the human-like quality and safety margins of the system. To address these limitations, this study proposes a human-like trajectory generation approach tailored for full-process curve driving. First, an explicit parameter-driven trajectory generation model is established. By introducing five critical physical parameters, including a pre-positioning lateral offset and a time factor, this model quantitatively translates implicit human driving expertise into a controllable "pre-positioning mechanism." Furthermore, a hierarchical trajectory generation method is developed. The initial stage constructs a baseline trajectory incorporating pre-positioning features using the explicit parameters. Subsequently, a Quadratic Programming (QP) model integrating a jerk penalty is formulated to eliminate curvature discontinuities while faithfully preserving the pre-positioning geometric anchors, ensuring high-order dynamic smoothness. Finally, comprehensive closed-loop validation is conducted utilizing a Carla-Speedgoat Hardware-in-the-Loop (HIL) platform integrated with a curvature-feedforward Stanley controller. Experimental results demonstrate that the proposed approach, while fully compatible with the Conventional Centerline Tracking (CCT) approach, consistently generates dynamically executable trajectories with prominent human-like characteristics.</p>	
11:45-12:00	ThBT1.6
<p><i>Self-Supervised LiDAR-Camera Fusion with Joint Embedding Predictive Architecture for 3D Object Detection</i></p>	
Chen, Tianjie	The University of Hong Kong
Xie, Le	Shanghai Jiao Tong University
Zhang, Teng	The University of Hong Kong
<p>Autonomous driving systems require reliable 3D perception for tasks such as detection and segmentation. In recent years, multimodal integration of LiDAR's spatial information with camera's contextual insights has achieved significant progress in this domain using supervised learning techniques. However, supervised models depend on extensive labeled data, which limits their widespread deployment. Self-supervised learning (SSL) addresses this challenge by pretraining on unlabeled data to develop transferable features, yet prior SSL fusion techniques struggle with bridging modality differences, achieving precise alignment, and extracting meaningful abstractions. Inspired by the Joint Embedding Predictive Architecture, we propose a two-stage SSL pretraining method that fuses LiDAR and camera signals, improving semantic coherence and facilitating efficient adaptation to downstream tasks such as 3D object detection. The evaluations demonstrate significant performance gains in data-scarce scenarios, outperforming traditional SSL methods and competing supervised methods.</p>	

ThBT2	Room 256
Advanced Optimal Control, Path Planning, and Sensing for Autonomous Intelligent Vehicles (Regular Session)	
Chair: Zhang, Kunwu	China University of Geosciences
Organizer: Mu, Bingxian	University of Prince Edward Island
Organizer: Shen, Chao	Carleton University
Organizer: Xu, Binyan	University of Guelph
Organizer: Liu, Fuqiang	Chongqing University
Organizer: Zuo, Lei	Chang'an University
10:30-10:45	ThBT.2.1
<i>Distributed Coverage Control for Multi-Polar Unknown Environments Based on GNN-MLP</i>	
Xu, Jiangwen	Chang'an University
Zuo, Lei	Chang'an University
Xiong, Li	Chang'an University
Zhang, Ziheng	Chang'an University
<p>This paper investigates the distributed coverage control problem for multi-agent systems operating in complex environments characterized by unknown sensory density functions. To address this challenge, we propose a novel cooperative control framework that synergizes Graph Neural Networks (GNN) and Multi-Layer Perceptrons (MLP). Specifically, GNNs are employed to aggregate dynamic neighbor information, while MLPs approximate the local sensory density. This architecture enables agents to adaptively optimize their deployment based on estimated fields without requiring global prior knowledge. Lyapunov stability theory is employed to guarantee the convergence of the agents' positions, regarding the estimation errors of the density function. Numerical simulation shows that the proposed method outperforms the traditional Lloyd's algorithm by achieving performance comparable to benchmarks with access to the ground-truth density function. Furthermore, ablation studies validate the efficacy of the GNN component in enhancing both coverage performance and estimation accuracy.</p>	
10:45-11:00	ThBT.2.2
<i>Improved Ant Colony Optimization for Revolving Path Planning</i>	
Zhao, Bin	Chongqing University
Shang, Xiruo	Chongqing University
Deng, Zhichao	Chongqing University
Liu, Siyu	CRRC Qingdao Sifang Co., Ltd
Liu, Fuqiang	Chongqing University
<p>To overcome the limitations of existing moxibustion robots, such as reliance on predefined paths, poor adaptability to body surface, and lack of temperature regulation, this paper proposes a revolving moxibustion path planning method based on improved Ant Colony Optimization (ACO). First, a revolving moxibustion path planning model is established by integrating the body surface normals and heat transfer model, which enhances surface adaptability and enables temperature prediction during treatment. Second, the ACO algorithm is improved by designing a path transition probability function that incorporates directional guidance and turning angle constraints, along with an adaptive pheromone enhancement strategy based on the Sigmoid function. These enhancements accelerate the convergence of the algorithm while balancing global exploration and local exploitation. Experimental results illustrate that the proposed method performs well in surface adaptability, moxibustion efficacy, and operational efficiency, providing a valuable reference for further research and applications of moxibustion robots.</p>	
11:00-11:15	ThBT.2.3
<i>Robust UWB-IMU Localization under NLOS Conditions Using Huber-IRLS Trilateration and EKF Fusion</i>	
Ramadan, Omar A.	Univeristy of Guelph

Xu, Binyan	University of Guelph
Al Janaideh, Mohammad	University of Guleph
<p>Ultra-wideband (UWB) ranging is a widely used solution for indoor positioning, but its accuracy degrades under non-line-of-sight (NLOS) conditions where range errors become biased, non-Gaussian, and heavy-tailed. In loosely coupled UWB-IMU fusion, these corrupted ranges first affect the nonlinear least-squares (LS) trilateration step, and the resulting erroneous position pseudo-measurements can destabilize a downstream extended Kalman filter (EKF). This paper proposes a robust trilateration front-end based on the Huber loss, solved via iteratively reweighted least squares (IRLS), and integrates it into a 15-state error-state inertial navigation EKF. The Huber-IRLS formulation bounds the influence of large residuals, improving robustness to NLOS-contaminated anchors without explicit NLOS detection or anchor rejection. Experiments in a controlled 3D indoor simulation with geometry-based NLOS modeling demonstrate that the robust method preserves nominal LOS accuracy while significantly improving NLOS performance. In the baseline NLOS scenario, the EKF position RMSE is reduced from 0.205 m (LS) to 0.131 m (Huber-IRLS), with the 95th-percentile error reduced from 0.376 m to 0.250 m. Moreover, the proposed Huber-IRLS solver achieves substantially lower runtime than lsqnonlin-based LS, reducing the total per-update computation from approximately 2.23 ms to 0.20 ms, supporting real-time deployment.</p>	
11:15-11:30	ThBT.2.4
<i>Optimal Kinodynamic Motion Planning through Anytime Bidirectional Heuristic Search with Tight Termination Condition</i>	
Wang, Yi	University of New Hampshire
Mu, Bingxian	University of Prince Edward Island
Shokouhi, Shahab	University of New Hampshire
Thein, May-Win	University of New Hampshire
<p>This paper introduces Bidirectional Tight Informed Trees (BTIT*), an asymptotically optimal kinodynamic sampling-based motion planning algorithm that integrates an anytime bidirectional heuristic search (Bi-HS) and ensures the meet-in-the-middle property (MMP) and optimality (MM-optimality). BTIT* is the first anytime MEET-style algorithm to utilize termination conditions that are efficient to evaluate and enable early termination on-the-fly in batch-wise sampling-based motion planning. Experiments show that BTIT* achieves strongly faster time-to-first solution and improved convergence than representative non-lazy informed batch planners on two kinodynamic benchmarks: a 4D double-integrator model and a 10D linearized Quadrotor. The source code is available https://github.com/yi213-robotic/Bidirectional-Tight-Informed-Trees.</p>	
11:30-11:45	ThBT.2.5
<i>A Reinforcement Learning Framework for Real-Time Update of MPC Parameters with Ensured Stability</i>	
Zhang, Xiangyu	University of New Hampshire
Li, Guowei	University of New Hampshire
Thein, May-Win	University of New Hampshire
Mu, Bingxian	University of Prince Edward Island
<p>Model Predictive Control (MPC) is an established technique for controlling constrained dynamical systems, but its performance is highly sensitive to the tuning of its cost function weighting matrices and prediction horizon. Manual tuning is often time-consuming and yields sub-optimal performance for systems operating under varying conditions. This paper presents a novel framework that utilizes Reinforcement Learning (RL) for the online, simultaneous adaptation of these key parameters. By interacting with the closed-loop system, the RL agent learns a dynamic tuning policy aimed at maximizing a cumulative reward associated with tracking performance and control efficiency. To establish baseline safety, the framework first constructs a pre-certified stability-guaranteed set of MPC parameters offline. However, a critical challenge remains during online operation:</p>	

dynamic parameter updates render the closed-loop system a switched system, where arbitrary switching can induce instability. To address this, we introduce a supervisory stability filter based on a Common Lyapunov Function (CLF). This mechanism rigorously enforces a monotonic decay in a fixed energy metric, functioning as a real-time safety gate that permits only stability-preserving updates from the RL agent. Finally, the framework's effectiveness is demonstrated through a comprehensive numerical evaluation comparing Deep Q-Network (DQN), Proximal Policy Optimization (PPO), and Trust Region Policy Optimization (TRPO), highlighting the superior tracking accuracy and stability of the proposed approach.

11:45-12:00 ThBT2.6

Distributed Learning-Based MPC with QP Formulation for Platooning Control of Heterogeneous Autonomous Surface Vehicles

Lin, Yingtao Carleton University

Shen, Chao Carleton University

This paper develops a distributed learning-based model predictive control (DMPC) framework with an explicit quadratic programming (QP) formulation for platooning control of heterogeneous autonomous surface vehicles (ASVs) under disturbances and modeling uncertainties. A composite control structure is adopted, in which the control signal consists of a nominal control term, a neuro-adaptive term, and a feedforward term. The nominal control term is obtained by solving a tube-based robust MPC problem, while a neuro-adaptive term estimates matched uncertainties online. The feedforward term is included to form a linear prediction model which facilitates the QP formulation. By integrating neural network (NN) based disturbance estimation into the tube-based MPC design, the proposed method preserves recursive feasibility, constraint satisfaction, and closed-loop stability. Simulation results demonstrate excellent control performance and improved disturbance rejection capability.

12:00-12:15 ThBT2.7

Data-Driven Robust MPC for the Path Following Control of Wheeled Mobile Robots

Zahid, Sana Carleton University

Shen, Chao Carleton University

The data-driven model predictive control (MPC) approach is investigated for path following control applications of wheeled mobile robots (WMRs). By updating Hankel matrices continuously using input-output data, the robot motion dynamics can be encoded into an implicit linearized model, which facilitates the MPC controller design. A novel two-step path following control algorithm is proposed so that part of the control problem can be formulated into a standard form quadratic program (QP), which can be solved efficiently by off-the-shelf optimization software. The detailed path following control algorithm design is discussed for a linear equivalent model and the nonlinear unicycle model of WMRs. The linearization errors are estimated throughout the control sequence and explicitly included in a robust MPC problem formulation. Simulation results demonstrate excellent path following performance with the proposed data-driven method.

ThBT3 Room 267

Agile Planning and Intelligent Control for Autonomous Robots (Regular Session)

Chair: Jin, Xin Fudan University

Co-Chair: Miao, Zhiqiang Hunan University

Organizer: Yong, Kenan Nanjing University of Aeronautics and Astronautics

Organizer: Cai, Bo Harbin Institute of Technology

Organizer: Ren, Lu Anhui University

Organizer: Yin, Zeyang Central South University

Organizer: Jin, Xin Fudan University

Organizer: Pang, Bo Northeastern University

10:30-10:45 ThBT3.1

Neural Network-Based Integral Sliding Mode Control for Modular Reconfigurable Flight Arrays under Midair Separation Disturbance

Zhou, Weichen Kunming University of Science and Technology

Yang, Chunxi Kunming University of Science and Technology

Zhang, Xiufeng Kunming University of Science and Technology

Sun, Hongwei Huazhong University of Science and Technology

Shi, Yu Kunming University of Science and Technology

This paper proposes a neural-network-based integral sliding mode control (NN-ISMC) method to address abrupt variations during the midair reconfiguration of modular reconfigurable flight arrays (MRFAs). First, an integral sliding function is constructed to eliminate the reaching phase and enhance robustness at the moment of separation. Then, an online neural network is employed to estimate the equivalent disturbance from the sliding variable and system states for feedforward compensation. A Lyapunov-based adaptive law is derived to guarantee convergence of all closed-loop signals. Finally, comparative simulations are provided for several representative scenarios to demonstrate effectiveness of the proposed method.

10:45-11:00 ThBT3.2

Semiglobal Exponential Attitude Consensus under Switching Topologies: A Hybrid System Approach

Zhang, Manting Fudan University

Jin, Xin Fudan University

Tang, Yang East China University of Science and Technology

In this paper, we study attitude synchronization on SO(3) under switching communication topologies within a hybrid framework. A hybrid model is constructed to capture continuous attitude dynamics and discrete topology switching, and a distributed controller based on relative attitude information is adopted. Due to switching, the Lyapunov function may be discontinuous at switching instants. To address this issue, a trajectory-based bounding technique is developed. Under a minimum dwell-time condition, semiglobal exponential synchronization is established. Numerical simulations validate the theoretical results.

11:00-11:15 ThBT3.3

Risk-Aware Smooth Reinforcement Learning for Fixed-Wing UAV Aggressive Maneuvering

Zhu, Haojie Nanjing University of Aeronautics and Astronautics

Chen, Mou Nanjing University of Aeronautics and Astronautics

Yan, Chao Nanjing University of Aeronautics and Astronautics

Yong, Kenan Nanjing University of Aeronautics and Astronautics

Han, Zengliang College of Automation Engineering, Nanjing University of Aeronautics and Astronautics

Fixed-wing Unmanned Aerial Vehicles (UAVs) are essential for high-dynamic aerial missions, yet fully exploiting their mechanical capabilities remains a challenge. Unlocking their potential for aggressive maneuvers via Deep Reinforcement Learning (DRL) is hindered by control jitter and safety concerns. In this paper, a Risk-Aware Smooth Reinforcement Learning framework (RAS-RL) is

proposed to achieve aggressive flight without compromising safety or stability. Specifically, a learnable spectral filter is designed to denoise the observation stream, and Jacobian regularization is incorporated to suppress actuator jitter in closed-loop execution. Furthermore, a model-predictive risk-aware reward shaping term is constructed by combining a nominal dynamics model with a supervised residual dynamics approximator. Lastly, a curriculum learning schedule is employed that progressively increases command aggressiveness, observation noise, and the risk weight to stabilize training under the shaped objective. In high-fidelity JSBSim simulations, RAS-RL achieves a 96% success rate on randomized command tests with 0.8% safety violations, while maintaining low action fluctuation comparable to smoothness-oriented baselines.

11:15-11:30 ThBT3.4

Data-Driven H_∞ Control for Satellite Orbit-Attitude System under Directional Jamming Via Off-Policy Reinforcement Learning

Fu, Shuai Fudan University

Jin, Xin Fudan University

This paper addresses the robust orbit-attitude control problem for satellites subject to directional jamming. Unlike conventional approaches that model interference as additive Gaussian noise, we formulate the anti-jamming problem as a zero-sum differential game based on the coupled nonlinear orbit-attitude dynamics, thereby transforming the problem from passive disturbance rejection to active geometry-aware anti-jamming control. A novel interference metric is introduced to characterize the intensity of directional jamming, which is explicitly determined by the beam-to-beam geometry between the target and the adversary. To solve the resulting Hamilton-Jacobi-Isaacs equation without requiring precise knowledge of the system dynamics, an off-policy integral reinforcement learning algorithm is developed. The proposed data-driven scheme iteratively approximates the Nash equilibrium solution using neural networks. Rigorous theoretical analysis guarantees the Uniformly Ultimate Boundedness of the weight approximation errors and the finite L_2 -gain stability of the closed-loop system, thereby ensuring H_∞ robustness. Numerical simulations validate the efficacy of the proposed method.

11:30-11:45 ThBT3.5

Occlusion-Aware Reinforcement Learning for Agile Quadrotor Target Tracking in Cluttered Environments

Liu, Xingxun Hunan University

Wang, Yaonan Hunnan University

Song, Shichen Hunan University

Yang, Zeyu Hunan University

Miao, Zhiqiang Hunan University

Autonomous quadrotor target tracking in cluttered environments remains a critical challenge, requiring persistent tracking of dynamic targets using exclusively onboard perception. Existing approaches frequently struggle with agile maneuvers, sim-to-real gaps, and prolonged target occlusions. To address these limitations, we propose a robust reinforcement learning framework. For high-bandwidth maneuverability and a minimized sim-to-real gap, our policy directly outputs collective thrust and body rates, bypassing the delays inherent in standard position controllers. Furthermore, we design a specialized observation space encoding target kinematics and introduce a novel geometry-agnostic visibility reward to proactively anticipate occlusions and maintain line-of-sight (LOS). To facilitate stable convergence and overcome early local optima, we implement a progressive curriculum learning strategy that incrementally scales obstacle density. Comprehensive simulations demonstrate that our framework maintains robust tracking capabilities and achieves exceptionally high success rates, even under severe occlusion conditions.

11:45-12:00 ThBT3.6

LV-Fusion Planner: Dynamic Motion Primitive-Based Multimodal Fusion for Low-Latency UAV Path Planning

He, Weiming Sichuan University

Qi, Qihan Sichuan University

Yang, Xinsong Sichuan University

LiDAR-based and vision-based end-to-end path planning algorithms suffer from lighting variations and texture deficiency, leading to sudden trajectory planning failure and subsequent collision accidents. To address this problem, this paper proposes LV-Fusion Planner, a LiDAR-vision fusion end-to-end path planning algorithm based on the YOPO algorithm. The planner fuses LiDAR, vision and UAV self-state multimodal data. It combines dynamic motion primitive-based trajectory parameterization with end-to-end mapping from multimodal data to trajectory. It enables low-latency and fully autonomous navigation and overcomes single-modal perception limitations in path planning.

ThBT4 Room 269

Cooperative Planning and Control for Unmanned Systems (Regular Session)

Chair: Xin, Bin Beijing Institute of Technology

Co-Chair: Ding, Yulong Tongji University

Organizer: Ding, Yulong Tongji University

Organizer: Xin, Bin Beijing Institute of Technology

Organizer: Wang, Miao Beijing Institute of Technology

10:30-10:45 ThBT4.1

Smoothed Particle Hydrodynamics with Differential Interaction Potentials for Multi-Swarm Segregation and Coordination

Li, Ruocheng Beijing Institute of Technology

Xin, Bin Beijing Institute of Technology

Zhang, Shuai Hong Kong Polytechnic University

Liu, Xuchen Chinese University of Hong Kong

Cui, Jinqiang Pengcheng Laboratory

Chen, Ben M. Chinese University of Hong Kong

In this paper, we present a distributed framework for coordinated motion among multiple robotic swarms. The proposed approach is built upon the Smoothed Particle Hydrodynamics (SPH) paradigm, in which each robot is modeled as a particle and computes its control input based on the relative positions of neighboring robots within a finite communication range. Inspired by the immiscibility phenomenon observed in water-oil mixtures, we incorporate a differential interaction mechanism into the SPH framework to encode heterogeneous inter-group behaviors. As a result, in scenarios involving multiple robot groups with distinct affiliations, the swarm can spontaneously evolve from random initial configurations into multiple well-segregated and uniformly organized formations. Simulation results validate the effectiveness of the proposed method.

10:45-11:00 ThBT4.2

A Distributed Multi-Robot Herding Algorithm for Faster-Than-Herder Swarm Evaders

Chen, Delong Tongji University

Ding, Yulong Tongji University

Chen, Jiayu Tongji University

Yin, Zhen Tongji University

Multi-robot herding is of great importance for autonomous agricultural and livestock management systems. However, traditional methods often struggle to converge when dealing with evader swarms that are faster and have a strong tendency to disperse. This paper proposes a decentralized cooperative herding algorithm that combines a greedy strategy with dynamic convex hull envelopment. The algorithm uses a

real-time dynamic convex hull to regulate the robot formation, while employing a greedy strategy that allows each robot to autonomously select the nearest target within its field of view, complemented by a rotational search mechanism to ensure target visibility. Based on a second-order dynamics model, a coverage angle constraint considering the speed ratio and a force-balancing control law are designed to ensure the dynamic stability of the encirclement. In a scenario with 6 herders managing 30 high-speed evaders, the proposed algorithm significantly reduces the average completion time and improves stability compared to a non-cooperative greedy strategy. The algorithm demonstrates strong robustness against obstacles, scalability to larger groups, and varying initial conditions, providing a feasible solution for practical ranch applications.	
11:00-11:15	ThBT4.3
<i>Priority-Aware Multi-UAV Landing Scheduling with Yielding Strategy for Emergency Logistics</i>	
Fan, Jiaxin	Tongji University
Ding, Yulong	Tongji University
Feng, Kairui	Tongji University
Tan, Yu Herng	National University of Singapore
Multi-UAV systems have demonstrated significant potential in urban low-altitude transportation, particularly in disaster response and emergency supply delivery, owing to their high maneuverability and contactless delivery capabilities. However, under high-density arrival traffic and limited vertiport resources, conventional landing scheduling methods struggle to balance delivery timeliness for supplies with varying urgency against UAV battery safety. To address these challenges, this paper formulates a multi-UAV landing scheduling optimization problem for emergency logistics that jointly considers delivery efficiency with priority differentiation and low-battery risk, where the decision variables exhibit strong coupling. To solve this problem, we propose a priority-aware multi-UAV landing scheduling framework. The landing sequence is first determined by a genetic algorithm, followed by a Sequence-Based Approach with Yield strategy (SBAY) for approach control. The SBAY model introduces outer yield holding points to create expedited descent corridors for earlier-ranked UAVs in the landing sequence, thereby mitigating the conflict between strongly coupled decision variables and reducing low-battery risks. Simulation results demonstrate that the proposed method improves delivery efficiency for high-priority emergency supplies while ensuring battery safety and effectively enhances overall landing scheduling performance.	
11:15-11:30	ThBT4.4
<i>Dense Semantic 3D Gaussian Splatting SLAM Via Consistent Feature Distillation and Gradient Decoupling</i>	
Ying, Ruobing	Taiyuan University of Technology
Qi, Zixi	Taiyuan University of Technology
Zhang, Zhe	Taiyuan University of Technology
Cheng, Lan	Taiyuan University of Technology
This paper addresses semantic boundary blurring and the conflict between geometric and semantic optimization in existing semantic visual SLAM systems based on Gaussian Splatting. Current semantic 3DGS methods typically employ simple feature regression strategies, which lead to averaged semantic features at object boundaries and often destabilize geometric tracking due to forced semantic constraints. To this end, we propose a novel 3DGS-SLAM system. First, we introduce Semantic Center Loss and Entropy Minimization Loss to replace conventional regression losses. Drawing upon metric learning principles, these losses consolidate intra-class features in the latent space and sharpen semantic boundaries. Second, we design a gradient decoupling mechanism that separates geometric updates from semantic optimization, preventing semantic gradients from interfering with camera pose estimation. Experiments on the Replica dataset demonstrate that our method achieves significantly improved semantic segmentation accuracy (mIoU) while maintaining	

high-precision trajectory estimation and superior rendering quality, outperforming current state-of-the-art approaches.	
11:30-11:45	ThBT4.5
<i>Adaptive Exploration-Exploitation Balancing for Robotic Gas Source Seeking Via Time Progress and Spatial Dispersion</i>	
Wang, Miao	Beijing Institute of Technology
Xin, Bin	Beijing Institute of Technology
Yun, Qu	Beijing Aerospace Automatic Control Institute
Gas source localization is critical for industrial safety monitoring, disaster rescue, and environmental protection. This paper presents an adaptive source-seeking planner that explicitly balances exploration and exploitation under uncertainty. At each step, the robot samples candidate goal points and scores them by combining an exploitation term derived from a Gaussian-like dispersion model and (ii) an exploration term computed as frontier-based information gain. To avoid search stagnation, a time-dependent penalization is introduced to reduce the attractiveness of early sampled goals, discouraging long-distance revisits. Moreover, the exploration-exploitation weight is adapted online using the spatial variance of a high-probability candidate set: dispersed candidates trigger stronger exploration, while concentrated candidates promote rapid exploitation toward the source. Simulation and real-robot experiments demonstrate that the proposed algorithm improves search efficiency in complex environments.	
11:45-12:00	ThBT4.6
<i>Global Formation Stabilization of Higher-Order Integrators Using Bearing-Only Measurements</i>	
Cheng, Haoshu	Nanyang Technological University
Yan, Yamin	Nanyang Technological University
Hu, Guoqiang	Nanyang Technological University
This paper investigates leaderless bearing-constrained formation control for higher-order integrator systems utilizing bearing-only measurements. Unlike existing results, which are typically limited to first- or second-order dynamics, this work addresses systems of arbitrary order. We first establish a baseline for bearing-constrained formation control using state feedback and bearing measurements. By designing bearing-feedback sliding surface and employing the backstepping technique, a distributed control law is synthesized to guarantee global convergence of the bearing constraint errors to zero. Subsequently, by leveraging the separation principle and the certainty equivalence principle, a distributed output-feedback control law is synthesized to achieve the target formation. Finally, the performance of the developed control schemes is demonstrated through numerical simulations.	
12:00-12:15	ThBT4.7
<i>Enhanced OC-SORT for UAV Swarm Tracking Via Direction Consistency and Trajectory Memory</i>	
Li, Tianyang	Beijing Institute of Technology
Peng, Zhihong	Beijing Institute of Technology
Li, Yukun	Beijing Institute of Technology
Zha, Wenzhong	Eastern Communications Group of China Electronics Technology Group Corporation
Multi-object tracking (MOT) in Unmanned Aerial Vehicle (UAV) swarm scenarios presents unique challenges due to dense formations, appearance similarity, frequent occlusion, and limited resolution. We propose a lightweight tracking framework based on Observation-Centric SORT (OC-SORT), specifically designed for appearance-free aerial tracking. We further introduce a Velocity Direction Consistency (VDC) module, which leverages temporally distant motion cues to construct a stable and discriminative descriptor. This helps suppress angular inconsistencies, improves association in dense formations,	

and significantly reduces ID switches when UAV trajectories overlap or targets undergo occlusion. Additionally, a trajectory memory module is employed to store recent observations and recover identities lost due to short-term occlusion without relying on visual features. Experimental results on the UAVSwarm Dataset demonstrate that our approach improves ID consistency and overall tracking accuracy compared to existing methods, while maintaining real-time performance.

ThBT5	Room 259
DT-Driven Smart Inspection and Diagnosis (Regular Session)	
Chair: Chen, Xi	The Chinese University of Hong Kong
Organizer: Hong, Wenxing	Xiamen University
Organizer: Liu, Chuanbin	University of Science and Technology of China
Organizer: Huo, Mengzhen	School of Automation Science and Electrical Engineering, Beihang University
Organizer: Zhang, Jihan	The Chinese University of Hong Kong
Organizer: Li, Yu	The Chinese University of Hong Kong
Organizer: Huang, Yijun	The Chinese University of Hong Kong
Organizer: Hong, Duanqin	Xiamen University
Organizer: Zhu, Jiacheng	Donghai Lab
Organizer: Xu, Jiwen	The Chinese University of Hong Kong
10:30-10:45	ThBT5.1
<i>An Unsupervised Underwater Image Restoration Framework with Adaptive Color Stretch and Compensation Strategy</i>	
Zhu, Jiacheng	Donghai Lab
Ke, Cheng	Xiamen University
Tong, Yicheng	Zhejiang University
Mei, Lin	Donghai Lab
Zhang, Jihan	The Chinese University of Hong Kong
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
Digital Twin (DT)-driven smart inspection and diagnosis in marine environments rely on reliable underwater visual perception for state estimation, anomaly analysis, and virtual-physical consistency. However, underwater images are severely degraded by wavelength-dependent absorption and scattering, which hinders accurate inspection of underwater assets, ecological targets, and robotic operations. To address this issue, this paper proposes ACSC-UJR, an unsupervised underwater image restoration framework with adaptive color stretch and compensation (ACSC). The ACSC module supplements missing red-channel information while suppressing overcompensation in severely degraded scenes, and a multi-branch fully convolutional network is further designed to learn multi-scale restoration features without paired supervision. Experiments on UIEB and LSU1 show that ACSC-UJR achieves state-of-the-art unsupervised performance in peak signal-to-noise ratio and structural similarity, while maintaining a favorable trade-off between restoration quality and model complexity. These results indicate that the proposed method can serve as an effective visual front-end for DT-driven smart inspection in underwater scenarios.	
10:45-11:00	ThBT5.2
<i>Environment-Aware Multi-UAV Search for Efficient Large-Scale Small Target Detection</i>	

Xu, Jiwen	The Chinese University of Hong Kong
Hong, Duanqin	Xiamen University
Zhang, Jihan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
Searching for small targets in large-scale natural environments is challenging due to limited flight resources and the sparse spatial distribution of targets. Traditional coverage strategies often rely on uniform sweeping patterns, which can lead to redundant observations and inefficient exploration. In this paper, we propose an environment-aware multi-UAV search framework for efficient large-scale small target detection. The proposed approach leverages environmental sensing and prior information to construct a probabilistic spatial belief map that estimates the likelihood of target presence. Instead of exhaustively covering the entire search area, high-probability regions are extracted and clustered into representative anchor points, significantly reducing planning complexity. A cooperative multi-UAV searching strategy is then developed by solving a reward-driven team orienteering problem under flight distance and safety constraints. Extensive simulations demonstrate that the proposed method improves search efficiency and information collection compared with conventional coverage strategies. Field experiments with multiple UAVs further validate the feasibility and effectiveness of the framework in real-world environments.	
11:00-11:15	ThBT5.3
<i>Campus Safety: UAV-Based Autonomous Defect Detection in Minnan-Style Architecture</i>	
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
Zhang, Rui	Xiamen University
Wang, Xianyi	Xiamen University
Hong, Duanqin	Xiamen University
Zhang, Jihan	The Chinese University of Hong Kong
Luo, Kunhong	Xiamen University
The preservation of traditional Minnan-style architecture, characterized by complex topologies such as upturned eaves and elaborate facades, poses significant challenges for manual structural inspections. To overcome the labor-intensive and subjective nature of traditional methods, this paper proposes an autonomous Unmanned Aerial Vehicle (UAV) inspection framework tailored for safe and highly efficient defect detection in high-traffic campus environments. The proposed system integrates a hybrid path planning strategy, combining Boustrophedon and A-star algorithms, to ensure collision-free navigation and high-fidelity image acquisition across both expansive exteriors and spatially constrained interiors. Field deployments at Xiamen University validate the superiority of this framework, which cuts flight duration by more than half while increasing surface coverage to over 96 percent compared to manual piloting. Furthermore, we developed XMU AI-DETECT, a closed-loop visual decision-support platform coupled with a comprehensive deep learning-based object detection framework for robust anomaly identification against intricate brickwork backgrounds. This framework effectively transforms raw aerial data into actionable maintenance strategies, establishing a highly scalable paradigm for the preventative conservation of complex cultural heritage sites.	
11:15-11:30	ThBT5.4
<i>A Multi-Agent Digital Twin Framework for LLM-Driven Building Energy and Indoor Air Quality Co-Simulation</i>	
Huang, Yijun	The Chinese University of Hong Kong

Li, Yu	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
Simulation-based building thermal and indoor air quality analysis requires coupling building energy simulation (BES) with computational fluid dynamics (CFD), yet the associated multi-software configuration workflow remains fragmented, expertise-demanding, and error-prone. This paper presents a multi-agent co-simulation framework that transforms natural-language building-analysis requests into controlled BES-CFD workflows within a digital twin environment. The framework organizes an analysis chain comprising objective-profile extraction, case-bundle planning, shared research memory, domain-specific artifact generation with context-isolated sub-agents, guarded runtime execution with policy-constrained overrides, and evidence reporting. Retrieval-augmented generation supports each sub-agent, while a human-in-the-loop approval gate and a two-layer artifact management scheme separate candidate outputs from the validated runtime baseline to improve traceability, reproducibility, and execution safety. A sports hall occupancy-driven thermal and air quality analysis task is used to evaluate the framework, with a cross-backbone assessment across six frontier LLMs. All backbones complete the workflow and produce identical physical outputs under the guarded execution policy, while exhibiting substantial planning-level diversity in artifact expressiveness and scenario design.	
11:30-11:45	ThBT5.5
<i>Frequency-Calibrated UNet with Optimized Compound Loss for Kelp Semantic Segmentation</i>	
Hu, Xingzheng	Xiamen University
Chen, Binqiang	Xiamen University
Ke, Cheng	Xiamen University
Zhu, Jiacheng	Donghai Lab
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
Semantic segmentation of kelp holds critical significance for intelligent aquaculture and automated phenotypic analysis. However, conventional models suffer from representation collapse due to the extreme pixel-level long-tailed distribution between the dominant kelp body and sparse holdfast structures. To address this, we propose a Frequency-Calibrated UNet (FCUNet) featuring an Adaptive Frequency-Calibrated Classifier (AFCC). By integrating Adaptive Feature Norm (AFN) and Channel Group Scaling (CGS), the AFCC recalibrates logit distributions to prevent the marginalization of kelp holdfast category. Furthermore, we introduce an optimized compound loss that synergistically couple's pixel-wise hard-sample mining with global structural consistency. Evaluated on our self-collected land-based Macroalgae Phenotyping Image Dataset (MPID), the framework demonstrates superior robustness across five mainstream backbones. Notably, the proposed method achieves significant performance gains for the holdfast category, improving the IoU and F1 Score by 0.1897 and 0.1933 respectively in the UNet architecture, effectively ensuring structural integrity for macroalgae phenotyping.	
11:45-12:00	ThBT5.6
<i>Path Planning for Mobile Robots Based on Continuous Cost Guidance</i>	
Jiang, Yuze	Xiamen University
Dong, Zicheng	Xiamen University
Ke, Cheng	Xiamen University
Hong, Wenxing	School of Aerospace Engineering, Xiamen University
To address the challenge of balancing initial solution efficiency and asymptotic convergence in complex environments, this paper	

proposes CG-RRT*, a real-time path planning method guided by a continuous cost field. A lightweight neural network is employed to construct a global continuous cost field offline, effectively eliminating the high computational overhead of online inference. By adaptively adjusting the sampling radius based on the cost field and employing a two-stage strategy---integrating frontier guidance with ellipsoidal constraints---the algorithm achieves rapid exploration and stable convergence. Experimental results demonstrate that CG-RRT* achieves a 100% success rate under a 2% optimality threshold across various complex environments. With an average planning time of only 84~ms, the proposed method is approximately 7 times faster than the state-of-the-art NIRRT* while maintaining comparable path quality. Its robust generalization capability is further validated in unseen complex scenarios and real-world ancient architecture inspection tasks.

ThBT6	Room 264
Embodied Multiagent Systems (Regular Session)	
Chair: Cui, Jinqiang	Pengcheng Laboratory
Organizer: Cui, Jinqiang	Pengcheng Laboratory
Organizer: Zhao, Shiyu	Westlake University
Organizer: Zhang, Hongwei	Harbin Institute of Technology
10:30-10:45	ThBT6.1
<i>A Bearing-Strength Method for Motion Estimation of Unknown Energy Emitters</i>	
Chen, Haoyu	Westlake University
Ning, Zian	Westlake University
Zhang, Yin	Westlake University
Zhao, Shiyu	Westlake University
This paper studies motion estimation of moving energy emitters using passive sensors. The emitters may be light, acoustic, or radio sources. While the bearing vector pointing from the sensor to the emitter can be easily obtained, existing approaches mainly rely on the bearing-only motion estimation method. However, this method suffers from a fundamental limitation that the sensor must have lateral motion to ensure observability. Unfortunately, this lateral motion requirement often conflicts with the sensor's desired motion in many tasks. In this paper, we point out that the received signal strength, which can also be obtained easily in many ways, can greatly enhance motion estimation. Surprisingly, this strength information has not been well explored so far. Here, we propose a new bearing-strength method to fully exploit both the bearing and strength measurements. Our theoretical analysis shows that the system observability is significantly enhanced in the sense that the lateral motion condition is not required anymore. Real-world experimental results verify the proposed method and the theoretical analysis. It is notable that the benefit of the proposed method comes with no additional cost since it simply utilizes the received strength information that has not been fully exploited in the past.	
10:45-11:00	ThBT6.2
<i>Input-To-State Safety with High-Order Control Barrier Functions</i>	
Wang, Xinyang	Harbin Institute of Technology
Zhang, Hongwei	Harbin Institute of Technology
Input-to-state safety is a crucial property for evaluating the robustness of a safe set against unknown disturbances. To guarantee the input-to-state safety of the safe set, input-to-state safe control barrier functions (ISSf-CBFs) have been proposed and further extended to a high-order version, termed as input-to-state safe high-order control barrier functions (ISSf-HOCBFs) to handle safety constraints with arbitrary relative degree. However, existing results on ISSfHOCBFs are limited to matched disturbances, which cannot affect the high-order control barrier function design until the control input is applied. In this paper, we extend the input-tostate safety guarantee from CBFs	

to HOCBFs under unmatched disturbances and propose a new type of ISSf-HOCBFs to handle safety constraints with arbitrary relative degree. A case study of an adaptive cruise control system is provided to demonstrate the effectiveness of the proposed methods	
11:00-11:15	ThBT6.3
<i>Fixed-Time Distributed Robust Coverage Control for Heterogeneous UAVs-UGVs Systems with Human Interaction Via LLM</i>	
Wu, Hao	Beihang University
Duan, Haibin	Beihang University
Chang, Yingxiu	Pengcheng Laboratory
Cui, Jinqiang	Pengcheng Laboratory
Yang, Jiankun	Peng Cheng Laboratory
<p>To address the area coverage challenge in heterogeneous UAVs-UGVs systems, this article proposes a fixed-time distributed robust coverage control method based on human-machine interaction via large language model (LLM). This approach is applicable to scenarios involving system uncertainties and external disturbances. First, the multi-dimensional dynamic models of UAVs and UGVs are unified and the Voronoi diagram partitioning method is used to obtain the area and centroid for each region. A fixed-time observer is developed to estimate system uncertainties and external disturbances. A distributed fixed-time controller based on dynamic fast terminal sliding mode (FTSMC) is developed to achieve rapid error convergence within the fixed time. For scenarios such as issuing commands during emergencies, a method is developed where LLM parses human input dialogues and subsequently issues coverage tasks to the system. The Lyapunov function is employed to prove system stability under the designed control framework. Simulation results show that the coverage control error converges to near-zero within the fixed time. The proposed coverage control method enables the heterogeneous UAVs-UGVs systems to achieve area coverage within the specified timeframe.</p>	
11:15-11:30	ThBT6.4
<i>A Hierarchical DRL-Based Planning and Navigation Framework for Complex Multi-Robot Missions Leveraging LLMs</i>	
Liu, Lian	South China University of Technology; Peng Cheng Laboratory
Wang, Zhenmin	South China University of Technology
Liu, Xuchen	The Chinese University of Hong Kong
Cui, Jinqiang	Pengcheng Laboratory
<p>With increasingly complex mission requirements, current multi-robot systems often struggle to achieve stable and effective cooperative task planning in open-ended, partially observable, and communication-constrained real-world scenarios while ensuring the executability of joint plan. To address these challenges, this paper proposes a learning-based general hierarchical planning framework. At the top layer, a large language model is introduced for task understanding and decomposition of complex missions. The middle layer constructs a modular cooperative capability library, in which policies are uniformly encapsulated as waypoint generation modules, thereby constraining high-level reasoning and enhancing cross-task transferability. The bottom layer develops a waypoint-guided deep reinforcement learning motion planner that performs online collision avoidance and stable navigation using only local sensing. Experimental results demonstrate that, under diverse open-ended instructions, the top-layer planner can reliably generate executable task decomposition and assignment schemes; across different environment structures, the proposed motion planner consistently completes waypoint navigation, validating the generality and deployability of the proposed framework in open-task and communication-constrained scenarios.</p>	
11:30-11:45	ThBT6.5

<i>PLAF: Pixel-Wise Language-Aligned Feature Extraction for Efficient 3D Scene Understanding</i>	
Wen, Junjie	The Chinese University of Hong Kong
He, Junlin	Sun Yat-Sen University
Ma, Fei	University of Chinese Academy of Sciences
Cui, Jinqiang	Pengcheng Laboratory
<p>Accurate open-vocabulary 3D scene understanding requires semantic representations that are both language-aligned and spatially precise at the pixel level, while remaining scalable when lifted to 3D space. However, existing representations struggle to jointly satisfy these requirements, and densely propagating pixel-wise semantics to 3D often results in substantial redundancy, leading to inefficient storage and querying in large-scale scenes. To address these challenges, we present empty{PLAF}, a Pixel-wise Language-Aligned Feature extraction framework that enables dense and accurate semantic alignment in 2D without sacrificing open-vocabulary expressiveness. Building upon this representation, we further design an efficient semantic storage and querying scheme that significantly reduces redundancy across both 2D and 3D domains. Experimental results show that emph{PLAF} provides a strong semantic foundation for accurate and efficient open-vocabulary 3D scene understanding. The codes are publicly available at https://github.com/RockWenJJ/PLAF.</p>	
11:45-12:00	ThBT6.6
<i>HiveNav: Hierarchical Semantic Planning for UAV Swarm Exploration</i>	
Liu, Xuchen	The Chinese University of Hong Kong
Zhang, Weichen	Tsinghua University
Li, Ruocheng	Beijing Institute of Technology
Wei, Hejun	Southern University of Science and Technology
Huang, Shunyuan	Harbin Institute of Technology
Huang, JunSong	Harbin Institute of Technology, Shenzhen; Peng Cheng Laboratory
Cui, Jinqiang	Pengcheng Laboratory
<p>This paper presents HiveNav, a distributed semantic exploration framework for multi-UAV target search in structured environments. Inspired by the hierarchical decomposition and memory-driven reasoning style of CityNavAgent~cite{zhang2025citynavagent}, the full stack is redesigned for swarm robotics with three core upgrades. First, simulated RGB-D sensing is replaced with a real RGB-LiDAR reconstruction pipeline based on FAST-LIVO2~cite{zheng2025fastlivo2}, and a colorized semantic point cloud map is constructed for planning. Second, centralized planning is replaced with distributed hierarchical semantic planning (HSP) agents that run asynchronously on each UAV, enabling parallel decision making under heterogeneous observations. Third, a swarm-memory mechanism is introduced to share real-time state, future intent, and reservation information, reducing duplicated exploration and inter-agent conflicts. On top of this semantic layer, an SPH-based swarm navigation planner~cite{li2025sphswarm} is integrated as the motion-level planner for decentralized collision-free trajectory generation. Simulated experiments in multiple indoor scenes show consistent gains over geometric and centralized baselines, including higher task success, faster first-target discovery, and lower exploration overlap, while maintaining practical planner latency in the LLM-driven decision loop. These results demonstrate that colorized semantic mapping, distributed agents, and swarm memory are complementary and jointly critical for robust multi-UAV exploration.</p>	
12:00-12:15	ThBT6.7
<i>Modeling and Control of a Washplateless Rotor with a Teetering Hinge</i>	

Wang, Biao	Nanjing University of Aeronautics and Astronautics
Wei, Xing	Nanjing University of Aeronautics and Astronautics
Tang, Chaoying	Nanjing University of Aeronautics and Astronautics
<p>To reduce the structural complexity and maintenance cost associated with conventional swashplate mechanisms, a swashplateless rotor with a teetering hinge is studied. The rotor achieves cyclic pitch control through periodic acceleration and deceleration of the motor combined with a tilted lag-pitch hinge. However, the blade motion and cyclic pitch generation mechanism of the rotor are complex, and its dynamic characteristics still lack systematic modeling and analysis. Therefore, the dynamic model of the blade is established based on Lagrangian mechanics and the blade element method. In addition, a closed-loop motor speed control scheme based on quasi-proportional resonant (QPR) control and active disturbance rejection control (ADRC) is designed. Simulation and bench experimental results demonstrate that the rotor can achieve effective cyclic pitch variation and adjustable thrust vector control, and that the theoretical analysis agrees well with the experimental results, providing a feasible solution for the simplification and lightweight design of rotor systems for micro aerial vehicles (MAVs).</p>	

ThCT1	Assembly Hall
Nonlinear Systems and Control (Regular Session)	
Chair: Guay, Martin	Queen's University
13:45-14:00	ThCT1.1
<i>Nonlinear Model Predictive Control with Time-Proportioning Vent and Ballast Actuation for an Autonomous Balloon Control System</i>	
Azhdari, Maryam	Queen's University
Guay, Martin	Queen's University
<p>This paper presents a nonlinear model predictive control (NMPC) strategy for altitude regulation of a high-altitude balloon equipped with a vent valve and a ballast release mechanism. The control objective is to track commanded altitude references under time-varying atmospheric conditions while respecting actuator limits and the discrete nature of valve operation. To better reflect practical hardware, a duty-cycle actuation model is adopted: within each control interval, the controller allocates fractions of time for venting and ballast release, and the plant implements these commands through first-order valve dynamics. The proposed NMPC is implemented and evaluated in simulation with interpolated atmospheric data. Results on step changes in altitude reference demonstrate stable tracking and physically plausible on/off valve operation while avoiding the computational burden of mixed-integer predictive control.</p>	
14:00-14:15	ThCT1.2
<i>A Mathematical Description of Intelligence in Dynamical System</i>	
Liu, Shiqi	Tsinghua University
Zhang, Xiangteng	Tsinghua University
Yu, Zhouyang	Tsinghua University
Li, Shengbo Eben	Tsinghua University
<p>From the origin of life to the formulation of thermodynamic laws, understanding whether physical systems can manifest intelligence has remained a central scientific challenge. The ability to quantify intelligence is essential for determining whether a system exhibits intelligent behavior, and prior theoretical work has highlighted deep connections between intelligence and the fundamental principles of living systems. Dynamical systems offer a foundational framework for modeling the evolution of physical processes; however, their potential to exhibit intelligence has not been systematically characterized. In this paper, we introduce a mathematical modeling framework that</p>	

<p>defines dynamical systems composed of two interacting subsystems as Meta-Coupled Systems (MCS) to analyze the emergence of intelligence. Leveraging the concept of state entropy, we establish the Intelligence Emerging Principle (IEP) and derive its necessary and sufficient conditions. We claim that an isolated system that satisfies the energy conservation and an increment of positive total entropy, along with an entropy-declining subsystem, is able to generate intelligent behaviors. Furthermore, we specialize IEP under linear dynamical systems with different energy forms and find that linear systems can also exhibit intelligence in some extent. Through both linear and nonlinear illustrative simulations, we verify the effectiveness of this mathematical framework as a principled method of investigating intelligence in dynamical systems.</p>	
14:15-14:30	ThCT1.3
<i>Improving the Algorithms of Computing Control Inputs for a Class of Controllable Discrete-Time Bilinear Systems</i>	
Zhao, Wenyu	Beihang University
Tie, Lin	Beihang University (Beijing University of Aeronautics and Astronautics)
<p>For nonlinear systems, controllability is in general difficult to prove, let alone to compute the control inputs that achieve state transitions. In this paper, we consider a class of discrete-time bilinear systems which own not only algebraically verifiable controllability criteria but also algorithms of computing the required control inputs to achieve state transitions based on the root locus approach. However, since such control inputs are approximated rather than exact, there exist computation errors between the real terminal state and the given terminal state. How to minimize the errors becomes an important issue for the bilinear systems. We first analyze the errors and find through simulations that the selection of the root locus gain significantly influences the errors. As a result, under the constraint that all the control inputs have to be real numbers, the larger the root locus gains are, the smaller the errors will be. We then provide an efficient method to minimize the errors by adding one more control input, so that the locations of the open-loop transfer function's zeros can be adjusted and a larger gain can be obtained. Simulations demonstrate our provided method and the previous algorithms to achieve transitions between arbitrarily given pairs of states can thus be improved.</p>	
14:30-14:45	ThCT1.4
<i>Data-Driven Nonlinear Min-Max Model Predictive Control with Measurement Errors</i>	
Wei, Yuzhou	Beijing Institute of Technology
Xiao, Wei	Beijing Institute of Technology
Wang, Linqi	Beijing Institute of Technology
Liu, Wenjie	Beijing Institute of Technology, Beijing, China
Wang, Gang	Beijing Institute of Technology
<p>This paper addresses a data-driven predictive control problem for discrete-time nonlinear systems subject to process disturbances and measurement errors. In the absence of an accurate system model, a lifting-based representation is employed to transform the nonlinear dynamics into a linearly parameterized form, enabling tractable controller design from data. To account for bounded uncertainties, a worst-case performance criterion is incorporated, leading to an optimization problem that can be reformulated as a semidefinite program (SDP). The resulting control strategy enforces constraint satisfaction while maintaining closed-loop stability. Numerical studies demonstrate that the proposed approach achieves reliable regulation under noisy measurements and outperforms existing data-driven control schemes in terms of performance.</p>	
14:45-15:00	ThCT1.5

<i>Multi-Factor Data Preparation and Scenario Assessment for Forecasting Freight Flows Along the Trans-Caspian International Transport Route</i>	
Gafiatullin, Farkhad	"Online Shopping" LLP
Mukhanova, Gulmira	Satbayev University
Antoni, Alfonz	Budapest Metropolitan University
Imasheva, Gulnar	Satbayev University
Toregali, Nargiza	Satbayev University
<p>Accurate forecasting of freight flows along international transport corridors has become increasingly vital amid global supply chain reconfiguration. This study focuses on the Trans-Caspian International Transport Route (TITR), a key Eurasian corridor linking China, Kazakhstan, the Caspian region, and Europe. The research aims to enhance the precision of freight forecasting by applying a multi-factor data preparation and scenario assessment framework grounded in artificial intelligence and data-driven analytics. The methodology integrates heterogeneous datasets from 2010–2024, sourced from national and international institutions such as Kazakh Invest, Kazakhstan Temir Zholy, the World Bank, and OECD. Five principal factor groups were identified—infrastructure investment, technological advancement and digitalization, market liberalization, environmental policy, and cargo structure transformation—each represented by quantitative indicators and derived variables. Data preprocessing included normalization, outlier treatment, interpolation of missing values, dimensionality reduction, and feature engineering to ensure consistency and analytical validity. The proposed multi-factor approach enables scenario-based evaluation of freight flow dynamics under varying development conditions. By combining theoretical principles of transport economics with systematic data preparation and factor integration, the study establishes a robust methodological basis for forecasting freight volumes and supporting strategic decisions within the TITR corridor.</p>	
15:00-15:15	ThCT1.6
<i>Reduced-Order Flow Estimation and Predictive Station-Keeping in Flows Governed by the Navier-Stokes Equations</i>	
Waterman, Adam	Queen's University
Guay, Martin	Queen's University
<p>This paper investigates predictive station-keeping of a passive vehicle navigating in environmental flow fields governed by the Navier–Stokes equations. A computational framework combining Proper Orthogonal Decomposition (POD) reduced-order models, moving-sensor flow estimation, and nonlinear model predictive control (MPC) is developed. The vehicle is assumed to possess limited actuation capability and can only modify its vertical velocity while horizontal motion is determined by the surrounding flow. The goal is to exploit altitude-dependent flow structures in order to regulate the vehicle toward a desired spatial region. The work should therefore be interpreted as a computational investigation of the integration of reduced-order flow estimation and predictive control rather than the development of a new MPC theory. Simulation studies illustrate how predictive control can exploit environmental flow structures for station-keeping tasks.</p>	

ThCT2	Room 256
Advanced Technologies for Robot Learning, Control, and Manipulation (Regular Session)	
Chair: Cai, Mingxue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Co-Chair: Xu, Sheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Organizer: Cai, Mingxue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Xu, Sheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Yang, Lidong	The Hong Kong Polytechnic University
13:45-14:00	ThCT2.1
<i>RRT*-Based Hybrid Path Planning Method and Automatic Navigation of Microswarms</i>	
Jiang, Jialin	Shenyang Institute of Automation, Chinese Academy of Science
<p>Remotely controllable untethered microrobots with multiple functions and performances have attracted increasing research interests in recent years. Benefiting from the small sizes, these miniaturized agents have exhibited promising application potential in biomedicine, especially for therapy tasks in confined, tortuous, and vulnerable physiological environments. Targeted navigation is crucial for practical applications, where effective path planning methods and motion control algorithms are necessary for obstacle avoidance. Moreover, at in vivo scenarios, the peristalsis of biological tissue will lead to deviations between real-time environments and pre-registered environments. Thus, a planning method with online adjustment mechanism would be worthy exploring. In this work, we proposed a rapidly exploring random tree*(RRT*)-based hybrid planning scheme. In comparison to conventional RRT* methods, a potential field-based module is employed to modify the planned paths when possible, collision may occur. Then, we designed a super twisting sliding mode controller (STSMC) to govern the motion control. A disturbance observer (DOB) was presented to estimate system states and lumped disturbances. Simulations and experiments were performed to validate our proposed schemes via a vortex microswarm. The results indicate that the hybrid scheme could effectively update the motion directions for the microswarm when new obstacles are added, and the motion controller is adequate to achieve precise trajectory tracking.</p>	
14:00-14:15	ThCT2.2
<i>A Learning-Based Viscoplastic Filament Manufacture Method Using Robotic Arm Based on Flow Matching Policy</i>	
Chen, Guoqing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Tang, Yifeng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jiang, Guolai	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Xu, Sheng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
<p>In traditional material laboratory operations, a special filament with double-helical structures is often manufactured via manual work. This manual manufacturing process uses two needles to pull viscous melt materials along curved paths and at the same time rotate the needles. Therefore, the quality of produced filaments is always affected by human operation factors. Such factors as motion consistency, rotation coordination, and process stability all impact the quality of the filament. Hence, in order to improve repeatability and reduce differences caused by different operators, this paper researches a demonstration-guided robot viscoplastic filament drawing system. In this system, a robot manipulator first learns drawing skills from human experts, then independently completes the drawing process under specific endpoint constraint conditions. Firstly, this filament drawing task is formulated as a goal-directed sequential</p>	

control problem. It requires the end-effector to carry out translational and rotational movements in a coordinated way. Secondly, for understanding the multi-mode characteristic of possible expert movement paths, a strategy based on flow-matching is proposed. This strategy is applied to learn a conditional continuous-time action generation mechanism. Thirdly, the expert demonstration data is collected through simulation methods. Subsequently, the strategy undergoes offline training to approximate the velocity field of action paths in the task space. Finally, the effectiveness of the proposed method is verified by both simulation and real-world examples.	
14:15-14:30	ThCT2.3
<i>LogCosh Super-Twisting Control for Robust Path Planning and Following</i>	
Cai, Mingxue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Gao, Daan	Southern University of Science and Technology
Output singularities and slow error convergence are two critical factors that cause sliding mode control failure. This paper proposes LogCosh Super-Twisting Control (LCSTC), a super-twisting sliding mode controller constructed with a nonsingular terminal sliding manifold that incorporates the LogCosh function. We also apply LCSTC to the path following task. LCSTC avoids singular behavior, achieves faster, finite-time convergence, and improves path-following accuracy. Based on this controller, we develop two planners. One is based on the upgraded RRT*(URRT*) algorithm for static scenes, and the other is based on the bi-robot APF(BiRAPF) algorithm for dynamic scenes. Both planners generate short paths while maintaining a safe distance, and they couple with LCSTC to form integrated plan-and-follow schemes. Simulations with LCSTC in representative two-dimensional scenarios show generally faster convergence and lower following RMSE than classical sliding mode control (SMC) and super-twisting control (STC). Experiments conducted on a magnetic microrobot further strengthen the dependable effects of the LCSTC controller in practical scenarios. The efficacy of two plan-and-follow schemes is also demonstrated by simulations.	
14:30-14:45	ThCT2.4
<i>Physics-Informed Predictive Control for Isoline Tracking in Dynamic Scalar Fields</i>	
Huang, Nanxi	Beijing Institute of Technology
Li, Zhuo	Tsinghua University
Zhang, Yanjun	Beijing Institute of Technology
Sun, Jian	Beijing Institute of Technology
Gao, Zhanyu	New York University
This paper addresses the problem of isoline tracking in dynamic spatiotemporal scalar fields. This task is challenging because the field is unknown, time-varying, and can only be sensed through local pointwise measurements. Most existing methods are designed for static scalar fields. We present a physics-informed (PI) predictive control scheme for a nonholonomic vehicle. A local predictor is proposed to estimate the local field strength near a potential arrival point from short trajectory history and query-point information. The predictor employs physical residual regularization and multi-step recursive error to better capture the dynamics of spatiotemporal field evolution. A PI Predictive controller is designed with incorporation of the predictor to generate a set of feasible finite-horizon tracking trajectories and to select the optimal one. Only the first step of the optimal trajectory is implemented. The effectiveness and advantages of our scheme are validated via isoline tracking simulation experiments conducted on dynamic scalar fields.	
14:45-15:00	ThCT2.5
<i>Real-Time Mask-Conditioned Surgical Grasping Via Action Chunking Transformers</i>	

Duan, Wenxing	The Chinese University of Hong Kong
Li, Bin	The Chinese University of Hong Kong
Liu, Yunhui	Chinese University of Hong Kong
Learning-based surgical manipulation often relies on accurate pose estimation and large annotated datasets, both of which are hard to obtain in dynamic surgical environments. We propose an end-to-end framework for learning mask-conditioned surgical grasping policies from teleoperated demonstrations. An online SAM+XMem pipeline generates target masks with minimal user input, while synchronized RGB images, masks, robot states, and actions are collected to train an Action Chunking Transformer (ACT) policy. Using RGB images and masks as dual visual streams helps the policy separate appearance from task-relevant spatial cues, improving robustness to occlusion. We evaluate the effectiveness of our method in grasp-centric surgical scenarios, specifically focusing on the Needle Pick task in both the SurRoL simulator and real-world settings. Results show that mask-conditioned input consistently improves task success, highlighting the value of explicit spatial guidance for reliable policy learning in visually challenging surgical scenes.	
15:00-15:15	ThCT2.6
<i>PID-Type Distributed Iterative Learning Control for Wheeled Mobile Robots: A Two-Dimensional System Approach</i>	
Wang, Wenxian	Beihang University
Meng, Deyuan	Beihang University (BUAA)
This paper aims to address the distributed control problem within cooperative learning systems and achieve high-precision performance from the beginning to the end via an iterative learning process. Specifically, a PID-type distributed iterative learning control (DILC) approach is proposed for multi-agent networks to achieve learning-based output consensus. By formulating an augmented vector to incorporate all terms in the PID-type DILC, a rigorous necessary and sufficient condition is derived for consensus error convergence via two-dimensional system analysis. Notably, the presented theoretical results can be naturally generalized to conventional D-type or PD-type DILC approaches. Furthermore, simulations are conducted on wheeled mobile robots to demonstrate the effectiveness and superior performance of the proposed PID-type DILC.	

ThCT3	Room 267
Autonomous Intelligence for Industry, Daily Services, and Rescue Operations (Regular Session)	
Chair: Hu, Songyu	Zhejiang University
Organizer: Chen, Haoyao	Harbin Institute of Technology, Shenzhen Graduate School
Organizer: Hu, Songyu	Zhejiang University
13:45-14:00	ThCT3.1
<i>Lite 2S-AGCN towards Skeleton Action Recognition for Mobile and Edge Devices</i>	
Zheng, Jianshu	Shenzhen Institutes of Advanced Technology
Zheng, Zhiyuan	Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences
Wang, Can	Chinese Academy of Sciences
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
Skeleton-based action recognition shows great potential in human-computer interaction and healthcare. However, mainstream high-precision models (e.g., 2S-AGCN) have a large parameter count	

(≈3.0M) and high computational complexity. This paper proposes a lightweight two-stream adaptive graph convolutional network (Lite 2S-AGCN), which simplifies the graph convolution structure and optimizes network depth, reducing parameters from 3.0M to 40K and model size from 11.7MB to 156KB. Experimental results show that compared with 2S-AGCN, Lite 2S-AGCN achieves 91.29% accuracy (vs. 58.37%) and 1.74ms average inference time (vs. 9.97ms) on CZU-MHAD (cross-person test), and 94.42% accuracy (vs. 35.58%) and 1.81ms average inference time (vs. 7.43ms) on UTD-MHAD. It outperforms the baseline significantly in inference speed with excellent recognition performance, making it suitable for resource-constrained edge and mobile devices.

14:00-14:15 ThCT3.2

DeepPVE: Deep Learning-Based Point Visibility Estimation against Density Variation and Noise

He, Rui	Harbin Institute of Technology, Shenzhen
Cui, Hongkang	Harbin Institute of Technology (Shenzhen)
Chen, Haoyao	Harbin Institute of Technology, Shenzhen Graduate School
Li, Peng	Harbin Institute of Technology, Shenzhen

For a long time, many point visibility estimation methods based on traditional geometric analysis or surface reconstruction have been studied. However, they struggle to handle scenes with varying density and noise. In this work, a real-time voxel-based point visibility estimation network, namely DeepPVE, is proposed to address the above problems. The scene points are voxelized into a grid and input into the encoder-decoder structure with sparse 3D convolution to extract local structural information and spatial relationships from the point cloud in an efficient manner. Compared to point-based approaches, the proposed DeepPVE can extract features that are easier to distinguish, leading to higher accuracy in visibility estimation. Moreover, it is robust against variations in point cloud density and noise. To overcome the lack of datasets, we propose an automatic point visibility data generator based on ray tracing which enables the self-supervised training of the proposed network, and a universal benchmark to evaluate the proposed estimation methods, enabling a comprehensive comparison. The visibility estimation tests, involving 600 objects and 300 pre-sampled viewpoints, confirm the generalization ability, adaptation to density variations, and robustness against noise of the DeepPVE in comparison with recent well-known methods. Furthermore, the relevant code will be released to promote the development of point visibility estimation.

14:15-14:30 ThCT3.3

MSCN-LSTM: A Multi-Scale CNN and BiLSTM-Based Model for Multi-Modal Gesture Recognition Using EMG and IMU Signals

He, Xiaoyao	Nanjing University of Aeronautics and Astronautics
Xie, Mingyang	Nanjing University of Aeronautics and Astronautics
Yao, Taike	Aero Engine Corporation of China Control System Research Institute
Zhou, Qi	Shanghai Jiaotong University
Bi, Youyi	Shanghai Jiao Tong University

Gesture recognition plays a crucial role in human-computer interaction, robotics, and assistive technologies. In this study, we propose a novel framework, MSCN-LSTM, for gesture recognition using EMG and IMU signals. The model combines Multi-Scale Convolutional Neural Networks (Multi-Scale CNN) with Bidirectional Long Short-Term Memory (BiLSTM) networks to integrate spatial features from EMG signals with temporal dependencies from IMU signals. Extensive experiments demonstrate that MSCN-LSTM outperforms traditional models like GRU, LSTM, and other multi-modal models such as DSC-GRU and Multimodal CNN across

accuracy, precision, recall, and F1 score. Achieving a recognition accuracy of 97.41%, MSCN-LSTM excels in both robustness and precision. Additionally, the model demonstrates real-time applicability, with an inference time of 52.97 ms per sample, making it suitable for dynamic, real-time applications.

14:30-14:45 ThCT3.4

High-Precision Vascular Network Mapping for Active Targeting Microrobots Navigation In-Vivo

Huang, Renqiang	Soochow University
Zhang, WenKai	Soochow University
Pan, Hao	Soochow University
Zhang, Xinyue	Soochow University
Chen, Xuanhan	College of Electrical and Engineering, Soochow University
Sun, Lining	Soochow University
Li, Xiangpeng	Soochow University

Microrobots hold significant promise for targeted drug delivery, yet their precise navigation through vascular networks remains challenging due to the lack of accurate, high-resolution in vivo vascular maps. Existing imaging modalities are largely limited to ex vivo or phantom-based mapping, lacking the spatial resolution and penetration depth required for in situ guidance. Here, we present a methodology for constructing high-resolution 3D vascular network models in vivo using a reflection-mode photoacoustic microscopy system. Our approach achieves imaging of microvascular structures down to capillary levels in mouse ears and subcutaneous tumors. Through a dedicated image processing pipeline, raw volumetric data are transformed into quantifiable, navigable vascular maps that preserve topological fidelity. This work addresses the critical bottleneck of in situ map construction, providing essential support for microrobot navigation and targeted therapeutic delivery.

14:45-15:00 ThCT3.5

Magnetically Controlled Patterning of Liquid Metals Via Superwetting of Fe Liquid Metal Composite Coatings for Flexible Electronics

Sun, Xiaoqin	Northwestern Polytechnical University
Chen, Xuanhan	College of Electrical and Engineering, Soochow University
Deng, Yuguo	School of Mechatronics Engineering, Harbin Institute of Technology
Gan, Kun	Soochow University
Bao, Wanlin	Soochow University
Bing, Xiao	School of Automation, Northwestern Polytechnical University
Li, Xiangpeng	Soochow University

Gallium-based liquid metals (LMs) that remain fluid at room temperature combine fluidic mobility with high metallic electrical conductivity, emerging as highly attractive transformative materials in flexible electronics. However, constrained by their extremely high surface tension, liquid metals struggle to achieve reliable wetting and adhesion on flexible substrates, which severely hinders their widespread application in flexible electronics. Here, we report a magnetically controlled superwetting strategy that enables the construction of patterned liquid metal circuits on flexible substrates. Our approach is based on an iron-liquid metal composite (FeLMC), which effectively overcomes the high surface tension limits of liquid metals, enabling the LM to undergo ultrafast spreading on flexible substrates such as Ecoflex, thereby exhibiting remarkable superwetting performance. Even if prolonged exposure leads to a degradation in wetting performance, the coating's superwetting properties can be regenerated through simple mechanical stirring. We designed and fabricated a liquid metal based flexible strain sensor by

using FeLMC as the wetting layer to monitor bending angle of a human finger. It exhibits a highly linear response in its relative resistance change with respect to the finger bending angle. The proposed method offers a highly promising way for advancing the low-cost and scalable manufacturing of liquid metal based flexible electronic devices and wearable systems.	
15:00-15:15	ThCT3.6
<i>An RCM-Constrained Robot Path Planning Method Based on Two-Stage Sampling</i>	
Xu, Jiahang	Zhejiang University
Hu, Jiaying	Zhejiang University
Li, Jiayi	ZheJiang University
Hu, Songyu	Zhejiang University
Fu, Jianzhong	Zhejiang University
<p>The Remote Center of Motion (RCM) constraint plays a critical role in robot-assisted minimally invasive surgery, ensuring that surgical instruments move around a fixed point and thereby reducing tissue damage near the surgical incision. RCM constraint methods can be categorized into mechanical and algorithmic approaches. Mechanical methods provide high accuracy but lack flexibility, while algorithmic methods offer greater adaptability; however, existing algorithmic approaches typically maintain RCM constraints in real time at the velocity level, which can fail under task conflicts or in complex environments. To address this issue, this paper proposes a novel robot path planning method based on two-stage sampling, which enforces RCM constraints through geometric construction rather than real-time correction, explicitly considering the global feasibility of the path. First, the robot performs a collision-free first-stage sampling in the task space to generate an initial path of the working points. Then, based on geometric relationships, all initial path points are mapped through the RCM point to compute the corresponding robot joint-end poses. Finally, a second-stage sampling is performed on the obtained joint-end poses to generate the final path in the robot's joint or Cartesian space. To address sudden pose changes and increased RCM errors caused by initial path points being close to the RCM point, a distance-checking mechanism is introduced, and helical interpolation is applied to poses exceeding the threshold, ensuring path continuity and satisfaction of the RCM constraint. Experimental results demonstrate that the proposed method produces feasible paths that meet the precision requirements of medical robots under RCM constraints.</p>	

ThCT4	Room 269
Distributed Control and Decision-Making for Multi-Agent Systems with Safety and Security Guarantees (Regular Session)	
Chair: Dong, Yi	Tongji University
Co-Chair: Liu, Tao	Southern University of Science and Technology
Organizer: Dong, Yi	Tongji University
Organizer: Liu, Tao	Southern University of Science and Technology
13:45-14:00	ThCT4.1
<i>Data-Driven Cooperative Output Regulation of Singular Linear Multi-Agent Systems</i>	
Cai, Jialei	University of Shanghai for Science and Technology
Zhou, Chi	University of Shanghai for Science and Technology
Liang, Dong	University of Shanghai for Science and Technology
Dong, Yi	Tongji University
Wang, Chaoli	Univ. of Shanghai for Sci. & Tech

Sun, Yuanyingyi	Shanghai Linksa Technology Co. Ltd
<p>Cooperative output regulation of singular multi-agent systems has wide applications in unmanned systems, smart grids, and other fields. Prior study provided the pioneering work on the cooperative output regulation with deterministic models by introducing the novel distributed observers. However, when the mathematical models of follower agents are unknown, traditional model-based design methods will no longer be applicable. This study extends the existing results to more general linear singular discrete-time multi-agent systems with unknown system matrices. To deal with the external disturbances, a coordinate transformation is employed to transfer the original tracking problem to a simplified stabilization problem. By using input and state data satisfying the full rank requirement, the feedback gain for each agent can be designed by solving data-based linear matrix inequalities. Then, a data-driven distributed control scheme is proposed to solve the problem under some mild conditions. Finally, an illustrative example is provided to verify the correctness of the proposed scheme.</p>	
14:00-14:15	ThCT4.2
<i>Control of a Reaction-Diffusion PDE–ODE System with an Actuator Delay</i>	
Wu, Tao	Southern University of Science and Technology
Xu, Xiang	Southern University of Science and Technology
Wu, Xuyang	Southern University of Science and Technology
<p>Controlling a reaction-diffusion PDE–ODE system presents a formidable challenge due to the inherent instability of both the open-loop PDE and open-loop ODE components. Consequently, a single controller must compensate for the instability of both the PDE and ODE states simultaneously. In this study, we address this challenging control problem inherent in reaction-diffusion PDE–ODE systems. Moreover, we extend our investigation to encompass a scenario where the connection between the PDE and ODE is subject to distributed delays, further complicating the control task. To tackle this formidable challenge, we employ a combination of predictor feedback and infinite-dimensional backstepping techniques to design an effective controller. We rigorously analyze the stability properties of the resulting closed-loop system, considering both L2 and L∞ norms, and establish proofs based on Lyapunov construction. Finally, we illustrate the effectiveness of our proposed controller through a simulation example.</p>	
14:15-14:30	ThCT4.3
<i>ADMM-Based Distributed Formation Control for Multi-Parafoil Systems</i>	
Zhou, Tianyi	Shanghai Jiao Tong University
Zhou, Tianyi	Shanghai Jiao Tong University
Li, Yuanlong	Shanghai Jiao Tong University
Shi, Liangren	Shanghai Jiao Tong University
<p>This paper investigates the cooperative formation control problem for multi-parafoil systems, which involves highly nonlinear flight dynamics of parafoils and nonconvex coupling constraints including collision avoidance and formation maintenance. To tackle these difficulties, a distributed controller based on alternating direction method of multipliers (ADMM) is proposed, where subproblems are efficiently solved by employing differential dynamic programming (DDP), closed-form projections and semidefinite relaxation (SDR). Benefiting from the parallel structure of ADMM and the effective handling of constraints, the proposed approach is applicable for real-time control and features good scalability with respect to the number of parafoils. Simulation results of multiple parafoils with formation switching verify the effectiveness of the proposed approach.</p>	
14:30-14:45	ThCT4.4

<i>Position Synchronization of Multiple PMSM Systems: A Distributed Internal Model Approach</i>	
Guo, Jiayu	Hefei University of Technology
Ping, Zhaowu	Hefei University of Technology
Zhang, Hongwei	Harbin Institute of Technology
<p>This paper investigates a position synchronization problem of multiple permanent magnet synchronous motor (PMSM) systems under parametric uncertainties and directed communication network. Based on the distributed internal model approach, a distributed position synchronization controller is proposed, which can simultaneously achieve position tracking, disturbance rejection, and robustness. Moreover, it can lead to superior transient performance. The simulation results demonstrate the effectiveness of our design.</p>	
14:45-15:00	ThCT4.5
<i>A Scalable Distributed Algorithm for Solving Linear Equations Over Double-Layered Networks with Jointly Connected Clusters</i>	
Chen, Chen	Southern University of Science and Technology
Wang, Lili	Southern University of Science and Technology
Liu, Tao	Southern University of Science and Technology
<p>This paper studies a scalable distributed algorithm for solving linear equations over double-layered multi-agent networks. The network is divided into clusters, each consisting of an aggregator and a group of agents. Agents exchange local information within clusters, while aggregators coordinate information across clusters. Unlike existing results that require the inter-cluster communication graph to remain connected at all times, this paper considers a switching inter-cluster communication graph that may be disconnected at any time instant, as long as it satisfies a jointly connected condition. By modeling the resulting error dynamics as a linear switched system and exploiting its uniform complete observability (UCO) property, we establish exponential convergence of the distributed algorithm to the unique solution of a linear equation.</p>	
15:00-15:15	ThCT4.6
<i>Active Vibration Control with Frequency-Switching Excitation: A Sparse Autoencoder and Reinforcement Learning Based Approach</i>	
Wang, Hongman	Tongji University
Dong, Yi	Tongji University
Li, Rongyan	Tongji University
Xin, Bin	Beijing Institute of Technology
Wang, Qing	Beijing Institute of Technology
Chen, Xi	The Chinese University of Hong Kong
<p>This paper proposes an integrated frequency identification and reinforcement learning based approach for active vibration control system to especially address the challenge from the frequency-switching excitation. Technically, we first propose a sparse autoencoder based method to identify frequencies, capable of directly extracting feature and achieving fast inference speeds and then design an optimal frequency-specific control policy with the aid of reinforcement learning technique. In particular, the Beta distribution is adopted in the construction of FxLMS-based reinforcement learning environment and used to model the action in Markov decision process due to its bounded property, which not only results in a stable training process, but also accelerates the convergence of policy optimization. Our integrated method requires no manual parameter tuning when the frequency of the excitation dramatically changes and effectively minimizes the total error energy under different frequencies of the exciter, demonstrated in the experiment of 8-channel AVC system.</p>	

ThCT5	Room 259
Dynamic and Intelligent Decision-Making for Autonomous Systems (Regular Session)	
Chair: Zeng, Xianlin	Beijing Institute of Technology
Co-Chair: Dong, Xiwang	Beihang University
Organizer: Zeng, Xianlin	Beijing Institute of Technology
Organizer: Xu, Jinming	Zhejiang University
Organizer: Wang, Qing	BUAA
13:45-14:00	ThCT5.1
<i>Momentum-Based Gradient-Free Algorithm for Nonsmooth Nonconvex Compositional Optimization without Large Outer Batches</i>	
Hou, Jie	Beijing Institute of Technology
Zeng, Xianlin	Beijing Institute of Technology
Xu, Jinming	Zhejiang University
<p>Stochastic compositional optimization (SCO) arises in a wide range of applications, including risk management and reinforcement learning. However, most existing methods for SCO rely on the smoothness assumption and require large batch sizes. To overcome these limitations, we propose a novel stochastic gradient-free algorithm, called SRMGF, designed for general nonsmooth nonconvex SCO. Unlike prior large-batch methods, SRMGF uses an increasing batch size for inner function evaluations, while employing only a single outer sample per iteration for gradient estimations. We further incorporate a momentum-based variance-reduction scheme to stabilize estimations. Theoretically, we prove that SRMGF converges to a (δ, ϵ)-Goldstein stationary point with a rate of $\mathcal{O}(\delta^{-1/2} T^{-1/4})$, achieving a total function query complexity of $\mathcal{O}(\delta^{-4} \epsilon^{-6})$. Notably, SRMGF is the first algorithm to guarantee convergence without the need for large outer batches in nonsmooth SCO. Finally, numerical experiments on real-world tasks demonstrate the efficiency of SRMGF.</p>	
14:00-14:15	ThCT5.2
<i>A Weighted Bundle Method of Multipliers with Improved Computational Efficiency</i>	
Zheng, Zhuoqing	Southern University of Science and Technology
Li, Cong	Southern University of Science and Technology
Xu, Xiang	Southern University of Science and Technology
Wu, Xuyang	Southern University of Science and Technology
<p>The method of multipliers (MM) is a standard approach for equality-constrained convex optimization, but it often suffers from high computational cost in the primal update, and its dual update amounts to a gradient ascent step that can result in slow convergence. The bundle method of multipliers (BMM) mitigates these issues by incorporating a proximal bundle model into both the primal and dual updates, leading to a cheaper primal update and a more effective dual update. Nevertheless, the primal subproblem in BMM may still be expensive to solve. To improve computational efficiency, we propose a weighted BMM, which introduces a weighted proximal term to diagonalize the quadratic component of the primal subproblem. With this modification, the subproblem becomes significantly more tractable when solved using gradient-based dual approaches. We establish convergence of the proposed method under standard assumptions and demonstrate its superior time efficiency through numerical experiments.</p>	
14:15-14:30	ThCT5.3
<i>KL-Prior Regularized PPO: Integrating LLM Tactical Knowledge into Reinforcement Learning for Beyond-Visual-Range Air Combat</i>	
Guo, Zheng	Beihang University

Yu, Jianglong	Beihang University
Chen, Yiming	Beihang University
Ren, Zhang	Beihang University
<p>Beyond-visual-range (BVR) air combat is a complex sequential decision-making problem. Reinforcement learning (RL) agents often struggle to discover multi-phase tactics in such high-dimensional spaces. While large language models (LLMs) offer strong strategic reasoning, integrating them directly into RL training remains an open challenge. To address this, a novel framework named KL-Prior Regularized PPO is proposed in this paper. This training-time-only framework incorporates a data-driven LLM tactical prior into the Proximal Policy Optimization (PPO) objective via a decaying KL-divergence penalty. This prior is constructed by analyzing 299 winning engagements from a baseline RL agent, successfully encoding the "fire-and-extend" BVR doctrine into soft action distributions. Unlike inference-time fusion methods, actions in this approach are sampled exclusively from the PPO policy. This design preserves the stationary Markov Decision Process (MDP) assumption, which is critical for stable value function learning. The proposed method is evaluated in a high-fidelity 3D BVR simulator featuring F-16 aircraft, realistic sensors, and AIM-120C missile dynamics. Over 50,000 training episodes, KL-Prior PPO achieves a 28.8% accumulated win rate, outperforming the pure PPO baseline (25.0%). Furthermore, three failed inference-time fusion variants are analyzed. Entropy collapse and value function poisoning are identified as their fundamental failure mechanisms. These insights provide practical design guidance for robust LLM-RL integration in complex control domains.</p>	
14:30-14:45	ThCT5.4
<p><i>Koopman-Based Linear MPC with INDI for Quadrotor Trajectory Tracking Control</i></p>	
Lv, Xiaokang	Beihang University
Wang, Qing	Beihang University
Wang, Shimin	Massachusetts Institute of Technology
Dong, Xiwang	Beihang University
<p>This paper proposes an analytical Koopman-based linear model predictive control (MPC) method for real-time quadrotor trajectory tracking. While linear MPC offers computational efficiency, it sacrifices modeling fidelity; nonlinear MPC solved via sequential quadratic programming achieves high accuracy but requires multiple iterations at each control step. We develop a systematic procedure to derive Koopman observables that lift the dynamics into a quasi-linear model with state-dependent control matrix. An assumed state trajectory converts this to a linear time-varying system at each control period, enabling quadratic program formulation with guaranteed real-time solvability. An incremental nonlinear dynamic inversion (INDI)-based robust control allocation scheme is proposed, which requires no precise control effectiveness model. Simulation results demonstrate tracking performance comparable to nonlinear MPC with deterministic computation times. The proposed method requires no training data collection, making it straightforward to implement.</p>	
14:45-15:00	ThCT5.5
<p><i>Local Generalization Analysis for Decentralized Personalized Federated Learning</i></p>	
Chen, Xing	Southeast University
Yu, Yuanyuan	Southeast University
Yang, Shaofu	Southeast University
Xu, Wenying	Southeast University
<p>Generalization analysis in personalized federated learning (PFL) is crucial for the design of learning algorithms. Existing theoretical studies primarily focus on characterizing the generalization performance of the global averaged model, while the performance of individual agents' local models remains largely unexplored. To</p>	

<p>address this gap, we first establish agent-specific generalization error bounds for decentralized personalized federated learning (D-PFL) based on the notion of algorithmic stability. By reformulating the iteration process of D-PFL as a linear dynamical system and leveraging matrix decomposition techniques, we explicitly characterize how data perturbations propagate across the shared and personalized layers. Our analysis reveals the connection between network topology and agent-level generalization: agents with higher topological centrality benefit from more effective diffusion of perturbations through the communication network and consequently achieve improved generalization performance. In contrast, peripheral agents experience weaker perturbation dissipation and are therefore more susceptible to overfitting. Numerical experiments are provided to validate the theoretical findings.</p>	
15:00-15:15	ThCT5.6
<p><i>Spatial-Temporal Hierarchical Planning and Incremental NMPC Tracking for Fixed-Wing UAVs in Cluttered Environments</i></p>	
Deng, Shijie	Beihang University
Yu, Jianglong	Beihang University
Feng, Zhi	Beihang University
Dong, Xiwang	Beihang University
<p>Fixed-wing UAV navigation in cluttered environments requires robust spatial-temporal planning and high-fidelity tracking under non-holonomic constraints. To address these challenges, this paper presents a hierarchical framework tightly coupling a kinematic-aware front-end, a MINCO-based trajectory optimizer, and an incremental Nonlinear Model Predictive Control (NMPC) scheme. To strike an optimal balance between computational tractability and geometric tightness, an adaptive Safe Flight Corridor (SFC) generation strategy is developed based on a 3D Dubins search. Furthermore, a novel Kinematics-Aware Terminal Regularization (KATR) mechanism is introduced. It effectively resolves kinematic boundary conflicts caused by naive zero-acceleration assumptions, preventing forced zero-curvature terminal states while unlocking tangential acceleration degrees of freedom. For robust execution, the incremental NMPC utilizes a physics-informed Zero-Control Invariant Set Extrapolation to eradicate terminal predictive conflicts, ensuring exact terminal convergence. ROS and PX4 SITL simulations demonstrate that the framework achieves millisecond-level online planning and high-fidelity 3D maneuver tracking with sub-meter root-mean-square error (RMSE).</p>	
15:15-15:30	ThCT5.7
<p><i>DP-KF: A Dual-Stage Personalization Kalman Filter for Human Joint-Angle Prediction</i></p>	
Wang, Nan	Nanjing University of Posts and Telecommunications
Shao, Xiaojuan	Nanjing University of Posts and Telecommunications
Lulu, Song	College of Automation, Nanjing University of Posts and Telecommunications, Nanjing, China
Ling, Ren	College of Automation, Nanjing University of Posts and Telecommunications, Nanjing, China
Sha, Fan	College of Automation, Nanjing University of Posts and Telecommunications, Nanjing, China
Chao, Deng	Nanjing University of Posts and Telecommunications
<p>Real-time and accurate joint angle prediction is essential for human-machine interaction systems, yet it remains difficult due to substantial inter-subject variability and diverse locomotion tasks. While advances</p>	

in neural networks have boosted prediction accuracy, data-driven approaches often struggle to achieve low-latency estimation in real-world online settings. To address this gap, we propose a dual-stage personalization Kalman filter (DP-KF) framework that couples long-term personalization with short-term dynamic correction. In the first stage, human physiological characteristics are incorporated as individualized prior conditions, and a conditional variational autoencoder (CVAE) is employed to generate a long-timescale baseline trajectory of joint angles. Meanwhile, a plantar-pressure matrix is fused to enrich gait, which improves the identifiability and stability of the learned latent variables. In the second stage, a Kalman filter (KF) operates under a system dynamics model and applies recursive estimation. It performs online short-timescale prediction of the residual between the long-timescale baseline trajectory generated in the first stage and the real-time observed joint angles. Finally, comparative experiments and ablation studies demonstrate that the proposed method achieves superior accuracy, while maintaining real-time performance.

ThCT6	Room 264
Embodied Perception, Decision, and Control for Autonomous Unmanned Systems (Regular Session)	
Chair: Wu, Wentao	The Hong Kong Polytechnic University
Co-Chair: Huang, Hailong	Hong Kong Polytechnic University
Organizer: Wu, Wentao	The Hong Kong Polytechnic University
Organizer: Wang, Huiting	The Hong Kong Polytechnic University
Organizer: Xu, Lei	KTH Royal Institute of Technology
Organizer: Chen, Wen-Hua	Loughborough University
Organizer: Zhang, Weidong	Shang Hai Jiaotong University
13:45-14:00	ThCT6.1
<i>Safety-Critical Accelerated Fixed-Time Convergence Learning-Based Control Via Dual Objective Synthesis</i>	
Tan, Junkai	The Hong Kong Polytechnic University
Wu, Wentao	The Hong Kong Polytechnic University
Chen, Wen-Hua	Loughborough University
Zuo, Zhiqiang	Tianjin University
Wang, Yijing	Tianjin University
<p>This paper proposes a safety-critical approximate optimal control framework, which synthesizes dual control for safety and optimality using Nesterov accelerated gradients with fixed-time stability (DCSO-NAG-FxT). For both safety and optimality objectives, a dual-objective function is constructed, and the Nesterov acceleration-based fixed-time learning law is applied to update the learning weights. Rigorous theoretical analysis establishes practical fixed-time stability for the closed-loop system, ensuring that the settling time of weights is uniformly bounded. By deriving explicit conditions for the bi-homogeneous weight updates, this work bridges the gap between accelerated gradient methods and fixed-time stability in adaptive dynamic programming. Furthermore, a safety-aware synthesis mechanism is integrated to guarantee the forward invariance of safe sets during the learning transient. Simulations on a nonlinear benchmark demonstrate faster convergence, lower cost, and zero safety violations.</p>	
14:00-14:15	ThCT6.2
<i>Trajectory Tracking of Autonomous Ground Vehicles Based on Robust MPC with Gain Scheduling</i>	
Zhang, Kunwu	China University of Geosciences

Wang, Huiting	The Hong Kong Polytechnic University
Cao, Weihua	China University of Geosciences, Wuhan, China
<p>With the rapid advancement of information and automation technologies, autonomous ground vehicles (AGVs) have been widely deployed across various industrial and domestic applications. Trajectory tracking of AGVs remains a challenging task in practice due to the presence of external disturbances and physical constraint. To address this challenge, this extended abstract presents a tube-based model predictive control (MPC) framework. The key idea is to reformulate the original tracking problem as a regulation problem by analyzing the dynamics of the tracking error. A robust positively invariant set is then computed to capture the influence of external disturbances on the evolution of the tracking error. Furthermore, a gain-scheduling mechanism is developed to reduce the conservatism arising from the invariant set. The resulting tube-based MPC scheme ensures constraint satisfaction and tracking accuracy while effectively handling external disturbances.</p>	
14:15-14:30	ThCT6.3
<i>Closed-Chain Sim2Sim Gait Transfer for Linear-Actuator Driven Humanoid Robot on Complex Terrains</i>	
Ding, Tao	Huazhong University of Science and Technology
Liu, Zexu	Huazhong University of Science and Technology
Zhang, Yuhao	Huazhong University of Science and Technology
Zhu, Qingmiao	Huazhong University of Science and Technology
Zhao, Xingwei	Huazhong University of Science and Technology
Bo, Tao	Huazhong University of Science and Technology
Shi, Yang	Canada
<p>Linear-actuator driven full-size humanoid robots (LF-HRs) provide high payload capacity and low energy consumption during static standing. Nevertheless, the coupled closed-chain kinematics and linear actuator dynamics introduce a deployment gap, making reinforcement learning (RL) locomotion policies trained on a 12-DoF opened-chain model difficult to transfer and deploy. To address this gap, we propose a robust two-stage closed-chain Sim2Sim gait transfer controller, which geometrically correlates rotational joint angles with linear actuator displacements through a high-fidelity virtual-physical joint space mapping. Specifically, sagittal-plane projection is employed to model the hip and knee linkages, and a Jacobian-based iterative solver is developed to accurately handle the parallel ankle mechanism, thereby guaranteeing coordinated and kinematically feasible motion under closed-chain constraints. Building on this mapping, we combine potential-based reward shaping and domain randomization to transfer the learned policy from the opened-chain training environment to a high-fidelity closed-chain model, followed by two-stage validation on unstructured terrains, including height field and rough ground. The proposed controller provides an effective pathway for the high-performance deployment of LF-HRs.</p>	
14:30-14:45	ThCT6.4
<i>Tether-Connected Tilt-Rotor Quadrotor Robot for Building Maintenance</i>	
Su, Jiangcheng	Hong Kong Polytechnic University
Zhou, Guanzhong	Hong Kong Polytechnic University
Haoyang, Yang	Hong Kong Polytechnic University
Cheng, Li	Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
Huang, Hailong	Hong Kong Polytechnic University

<p>This paper explores a robotic system that synergizes the adhesion capability of wall-climbing robots with the agility of aerial vehicles for building maintenance applications. While wall-climbing robots can adhere to vertical surfaces, they suffer from limited obstacle-crossing abilities; conversely, unmanned aerial vehicles offer flexible maneuverability around walls but face challenges including limited proximity to surfaces, short endurance, and operational risks. To address these limitations, we propose a tether-connected tilt-rotor quadrotor robot that leverages the tensile force from the tether to enhance endurance and flexibility. The integration of a tilt-rotor mechanism with the tether enables decoupled position and attitude control, allowing the robot to approach walls at arbitrary orientations and substantially improving adaptability to complex environments. The dynamic model of this tethered tilt-rotor quadrotor is analyzed, with system identification employed to determine key parameters. Controller design and parameter tuning are subsequently performed based on the established model and identified parameters. Experimental results validate the effectiveness of the controller in angle command tracking and demonstrate the system's potential for wall inspection applications.</p>	
14:45-15:00	ThCT6.5
<i>Graph-MAPPO for Self-Organized Airship Encirclement and Hotspot Surveillance</i>	
Pei, Wenyuan	Beihang University
Liu, Simin	Beihang University
Zheng, Zewei	Beihang University
Zou, Yuxuan	Beihang University
<p>This paper studies a coordination-layer problem for self-organized airship encirclement and hotspot surveillance. A team of airships moves on a prescribed standoff ring around a protected location, while its angular distribution is adjusted according to a hotspot-induced directional surveillance demand. To characterize this task, a density-based equal-mass criterion is introduced on the angular domain, where the hotspot increases the task value of the facing sector without removing the coverage demand on the remaining ring. Based on this formulation, Graph-MAPPO is developed by embedding a lightweight ring message-passing encoder into the MAPPO actor-critic architecture. The proposed method preserves the standard PPO optimization backbone but injects a graph inductive bias matched to the fixed neighbor-only communication topology, so that each agent can aggregate multi-hop neighborhood information for local mass equalization. The model is intended for the tangential redistribution layer, with radial regulation and low-level stabilization assumed to be handled by an inner-loop controller. Comparative simulations, including multi-seed training, message-passing-depth ablation, random-initial-formation tests, and spacing-dynamics evaluation, demonstrate the advantages of Graph-MAPPO over an MLP-based MAPPO baseline and a handcrafted local controller in convergence and hotspot-oriented redistribution.</p>	
15:00-15:15	ThCT6.6
<i>GIGA: A Generative-Initialized Gated-Adaptation Framework for Multi-Agent Adversarial Games</i>	
Wang, Xiaoxiao	Tongji University
Zhao, Yihang	Tongji University
Lei, Jinlong	Tongji University
Hong, Yiguang	Chinese Academy of Sciences
<p>Multi-agent adversarial games with pre-protection points are challenging due to partial observability, sparse rewards, delayed feedback, and dynamically evolving opponent strategies. In such settings, pure centralized training with decentralized execution (CTDE) reinforcement learning often suffers from low sample efficiency and fragile coordination, while standard behavior cloning struggles to represent multimodal expert policies and may lead to an unstable transition from imitation to autonomous exploration. To address these issues, we propose Generative-Initialized Gated-</p>	

Adaptation (GIGA), a two-stage framework that bootstraps multi-agent reinforcement learning with generative expert priors. In Stage I, a conditional variational autoencoder is trained to model the multimodal distribution of expert behaviors, yielding a structured latent prior for policy initialization. In Stage II, a bias-initialized gating mechanism adaptively combines the frozen expert prior with a learnable residual policy under the CTDE paradigm, enabling a smooth transition from expert-guided behavior to maximum-entropy reinforcement learning. Together with twin centralized critics, GIGA improves convergence speed, final performance, and robustness across multiple training regimes, outperforming strong multi-agent reinforcement learning baselines and the expert policy used for initialization.

Technical Program for Friday June 19, 2026

FrAT1	Assembly Hall
Estimation and Identification (Regular Session)	
Chair: Li, Xianwei	Shanghai Jiao Tong University
Co-Chair: Yin, Xunyu	Nanyang Technological University
08:30-08:45	FrAT1.1
<i>Adaptive Image-Based Stationary Target Circumnavigation of Nonholonomic Mobile Robot</i>	
Yu, Shicong	Fuzhou University
Su, Youfeng	Fuzhou University
Cai, He	South China University of Technology
Xu, Liang	Fuzhou University
<p>This paper investigates the stationary target circumnavigation control problem for nonholonomic mobile robot. To this end, an image-based visual servoing framework is proposed, which relies solely on image measurements for feedback control, without any target depth or global position information. Meanwhile, the camera field-of-view (FOV) constraints and collision avoidance constraints are taken into account in the control design. Building on this framework, an adaptive control algorithm is developed to estimate the unknown parameters online, thereby guaranteeing that the robot asymptotically converges to the desired circumnavigation radius. Simulation results validate the effectiveness of the proposed method.</p>	
08:45-09:00	FrAT1.2
<i>LLM-Based Reliability Evaluation and Predictive Maintenance Over Complex Product Lifecycle</i>	
Guo, Yi	Northwestern Polytechnical University
Guo, Zhengang	Northwestern Polytechnical University
Zhang, Yingfeng	https://controls.papercept.net/conferences/scripts/start.pl#WODES16
<p>Complex products such as aero-engines are characterized by long manufacturing chains, strong cross-stage coupling, and multi-source heterogeneous data, which often lead to inconsistent product quality, degraded reliability, and high operation and maintenance costs. To address these challenges, this paper proposes a full lifecycle reliability evaluation and predictive maintenance method for complex products using large language models (LLMs). In contrast to existing methods that rely on isolated stage-wise analysis or single-source data, the proposed method integrates multi-source information from the design, production, assembly, and operation stages into a unified dataspace by exploiting the semantic understanding and text-processing capabilities of LLMs. Based on stage-specific failure characteristics, adaptive statistical models are employed to construct component-level reliability models, enabling dynamic reliability evaluation throughout the entire lifecycle. Furthermore, a safety-economic multi-objective optimization model is established, considering reliability and maintenance costs. The optimal predictive maintenance strategy is obtained using multi-objective particle swarm optimization. A case study based on a Chinese aero-engine manufacturer demonstrates that the proposed method effectively improves system reliability while reducing maintenance costs and failure frequency. This work enables lifecycle reliability management and maintenance decision-making for high-precision complex products.</p>	
09:00-09:15	FrAT1.3
<i>Revisit Kalman Filter through the Lens of Dynamic Programming</i>	
He, Zeyu	Tsinghua University
Cao, Wenhan	Tsinghua University

Liu, Shiqi	Tsinghua University
Liu, Chang	Cornell University
Li, Shengbo Eben	Tsinghua University
<p>The Kalman filter is the optimal filter for accurate state estimation in linear Gaussian state-space models. Since the emergence of the Kalman filter, it has found extensive application in fields such as robotics, aerospace, and autonomous driving. Traditional derivations rely on orthogonal projection and Bayesian filtering theory. However, in this paper, we introduce a novel perspective by reinterpreting the Kalman filter through dynamic programming—a mathematical optimization technique that decomposes complex problems into overlapping subproblems solved recursively for optimal solutions. First, we construct a dynamic model of the estimation error for a linear system. By leveraging the model's iterative characteristics and assuming independence in the noise distribution, we have demonstrated that the dynamic model exhibits Markovian properties. Using mathematical induction and the established Markov model, we then prove that the Kalman filter possesses both optimal substructure and overlapping subproblem properties, laying the foundation for proving the Kalman filter from a dynamic programming viewpoint. Furthermore, we formulate the Bellman equation for the Kalman filter and apply policy iteration to alternately perform policy evaluation (solving for the optimal error covariance) and policy improvement (determining the optimal Kalman gain). Through this approach, we successfully reconstruct the Kalman filter from the perspective of dynamic programming. Our method not only provides a novel perspective for the proof of the Kalman filter but also bridges the gap in understanding the Kalman filter from the perspective of reinforcement learning.</p>	
09:15-09:30	FrAT1.4
<i>A Data-Driven and Model-Driven Fusion Methodology for Real-Time Radome Error Slope Estimation</i>	
Liu, Bingxun	Northwestern Polytechnical University
Xu, Hongyang	Northwestern Polytechnical University
Fan, Pengfei	Northwestern Polytechnical University
Fan, Yonghua	Northwestern Polytechnical University
<p>This paper proposes a hybrid BiLSTM-EKF framework for real-time radome error slope estimation in precision-guided aircraft. By combining data-driven learning with model-based filtering, the method dynamically adapts noise parameters through temporal analysis of seeker measurements. This enables simultaneous achievement of real-time accuracy in low-noise conditions and robust performance in high-noise environments. Simulations demonstrate the approach maintains low mean square error across varying noise conditions with inference latency below 0.4 ms, while effectively suppressing parasitic feedback loops to enhance guidance stability. The proposed solution overcomes conventional EKF limitations and provides reliable performance under complex electromagnetic interference and noise uncertainty.</p>	
09:30-09:45	FrAT1.5
<i>Dynamic Event-Triggered Observer for LTI Systems with Positive Minimum Inter-Event Times</i>	
Liu, Yiyang	Shanghai Jiao Tong University
Li, Xianwei	Shanghai Jiao Tong University
Li, Shaoyuan	Shanghai Jiao Tong University
<p>This paper investigates distributed observer design under dynamic event-triggered communication. For event-triggering mechanisms, ensuring a strictly positive minimum inter-event time (MIET) is crucial for practical implementation. For dynamic event-triggered distributed observers, existing works typically rely on time-regularization to guarantee such a positive MIET. In contrast to existing works, this</p>	

paper demonstrates that, for the distributed observer problem, a dynamic event-triggering mechanism can inherently ensure a strictly positive MIET. Additionally, exponential convergence of the estimation error is guaranteed. Finally, the effectiveness of the proposed method is verified through numerical simulations.	
09:45-10:00	FrAT1.6
<i>Optimization-Free Learning-Based Data-Enabled State Estimation with Application to Membrane Wastewater Treatment Processes</i>	
Li, Xiaojie	Nanyang Technological University
Yin, Xunyuan	Nanyang Technological University
Data-enabled moving horizon estimation (MHE) reconstructs system states by solving an online optimization problem based on a non-parametric model constructed from system data. However, its applicability to modern industrial processes, which typically have high nonlinearity and large scales, is limited. Specifically, the non-parametric representation is only applicable to linear time-invariant systems, and solving optimization problems is computationally intensive, especially for large-scale systems. To address these challenges, this paper proposes a computationally efficient data-enabled state estimation approach for nonlinear systems. By integrating Koopman operator theory with Willems' fundamental lemma, the proposed framework enables nonlinear systems to be represented directly from data without explicit model identification. Moreover, a neural network is employed to generate an operator, based on which full-state information can be reconstructed without solving an optimization problem online. The effectiveness of the proposed method is demonstrated via an application to a membrane-based wastewater treatment process.	
10:00-10:15	FrAT1.7
<i>Stochastic Sensor Scheduling in Cyber-Physical Systems Subject to Energy Constraints</i>	
Ning, Chuanyi	Beihang University
Hao, Fei	Beijing University of Aeronautics and Astronautics
In this paper, the problem of stochastic sensor scheduling has been studied. The dynamic of the estimation error is modeled as a Markovian jump system. Then the sufficient and necessary condition for the mean-square boundedness of the estimation error has been provided. Moreover, a unified optimization framework is proposed to jointly design the sensor selection probability and the transmission power. Since the optimization problem is non-convex, the successive convex approximation algorithm has been designed to obtain the suboptimal solution. Simulation results are provided based on the three-tank system to demonstrate the feasibility and the efficiency of the theoretical results.	

FrAT2	Room 256
Integrating Embodied Intelligence: Perception and Advanced Control in Robotic Systems (Regular Session)	
Chair: Chan, Tobias	The Chinese University of Hong Kong
Organizer: Sun, Yichong	The Chinese University of Hong Kong
Organizer: Cai, Bo	Harbin Institute of Technology
08:30-08:45	FrAT2.1
<i>Stochastic-Sampling-Based Event-Triggered Control for Markov Jump Systems: A Data-Based Scheme</i>	
Zhang, Ning	East China University of Science and Technology
Niu, Yugang	East China University of Science and Technology
Cao, Zhiru	Shanghai University

This paper proposes a data-based event-triggered control scheme for Markov jump systems (MJSs) with stochastic sampling. An event-triggered controller is constructed via transmitted sampled states, under which the stability criteria depending on system parameters are derived. Considering that the actual system parameters may not be fully known or available to the controller, this work further focuses on the control strategy under completely unknown system parameters. First, by fully considering the stochastic nature of the MJSs, input/state data corresponding to each mode are collected offline. Subsequently, by introducing a mode-specific data-based representation, the original model-dependent sufficient conditions are transformed into the fully data-based forms. Based on this, the designed controller can be implemented using only the offline collected input/state data. Finally, the simulation results verify the effectiveness of the proposed data-based control strategy.	
08:45-09:00	FrAT2.2
<i>Multi-UAVs Cooperative Path Planning Based on DQN under Communication Constraints</i>	
Wu, Haoyu	Beijing Institute of Technology
Li, Chaofeng	Academy of Military Sciences
Guo, Huiyu	Beijing Institute of Technology
Wei, Yiran	National Key Laboratory of Near-Surface Detection
Pan, Zhenhua	Beijing Institute of Technology
Multi-UAVs cooperative path planning in complex environments necessitates simultaneous optimization of trajectory efficiency and satisfaction of kinematic, safety, and communication constraints, significantly elevating problem complexity. To address this challenge, a multi-UAVs cooperative path planning method based on deep Q-learning is proposed. A multi-constraint environmental model is established, integrating a two-dimensional grid representation with explicit communication connectivity metrics. A multi-objective reward function is designed to jointly optimize path length, communication interruption rate, and maximum communication interruption time, guiding agents toward policies that balance navigational efficiency with network maintenance. Simulation experiments demonstrate that the proposed method enables 3-UAVs coverage of 3-4 targets and synchronized arrival of 2-UAVs, maintaining communication interruption rate below 15%. The results validate the feasibility and effectiveness of the method under multi-constraint conditions, highlighting its potential for real-world multi-UAVs cooperative missions.	
09:00-09:15	FrAT2.3
<i>Deep Reinforcement Learning for Dubins Traveling Salesman Problem</i>	
Fang, Pengfei	Beihang University
Li, Wenling	Beihang University
Song, Jia	Beihang University
Li, Xiaoming	Shenzhen University
Existing deep reinforcement learning (DRL) methods for the traveling salesman problem (TSP) are primarily developed under the Euclidean cost model. However, many practical routing tasks involve curvature-constrained vehicles, leading to the Dubins TSP (DTSP), where travel costs are curvature-dependent and the visiting order is tightly coupled with per-visit headings. This coupled structure poses a challenge to existing DRL approaches. This paper formulates DTSP as a Markov decision process and proposes DRL-DTSP, a DRL approach with encoder-decoder framework that autoregressively generates a coupled action pair to jointly select the next node and its heading. To better capture curvature-dependent costs, we develop a curvature-constraint-aware decoder with physics-informed node-selection biases and a dedicated heading-selection module driven by tailored geometric features. Instance augmentation and a lightweight heading refinement are further applied to improve solution quality. Numerical results demonstrate that DRL-DTSP achieves competitive or superior	

solution quality against representative baselines while remaining computationally efficient, with increasing advantages under tighter curvature constraints.	
09:15-09:30	FrAT2.4
<i>Deep-GeoGS: Efficient Deep Feature Matching with Geometric Awareness for Robust 3D Gaussian Splatting</i>	
Han, Qihang	Guangdong Provincial Association for Science and Technology
Lai, Cunzhi	Guangdong University of Technology
Lin, Xubin	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Wu, Hongmin	Guangdong Institute of Intelligent Manufacturing
Zhou, Xuefeng	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
3D Gaussian Splatting (3DGS) has recently revolutionised the field of real-time new-view synthesis; however, its optimisation performance remains closely dependent on the quality of the initial sparse representation, which is typically derived from traditional Structure from Motion (SfM) algorithms like COLMAP. In complex environments featuring texture-free regions, repetitive patterns, or significant changes in lighting, traditional SfM often produces fragmented or overly noisy initialisations. These unreliable initialisations confine the 3D Gaussian distribution to erroneous spatial priors, leading to catastrophic ghosting artefacts and structural blurring. To address this, we propose Deep-GeoGS, a robust and efficient deep geometric initialisation framework designed to provide high-quality spatial priors for 3DGS. By explicitly modelling the geometric consistency between high-dimensional depth descriptors and epipolar constraints, we effectively eliminate spatial outliers that would otherwise degrade the quality of the radiance field. Our method demonstrates excellent performance across multiple datasets.	
09:30-09:45	FrAT2.5
<i>Few-Shot Pose Estimation for Robotic Sorting of Flexible Packages with Complex Overlapping and Ambiguous Boundaries</i>	
Wang, JunYang	Wuyi University
Zhang, JiangMing	Guangdong Polytechnic Normal University
Jiang, Li	Wuyi University
Kong, ShaoHua	Wuyi University
Lin, Xubin	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Zhou, Xuefeng	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Yan, Wu	Institute of Intelligent Manufacturing, Guangdong Academy of Sciences
Wu, Hongmin	Guangdong Institute of Intelligent Manufacturing
In industrial logistics environments, chaotically stacked flexible packages present substantial challenges for robotic sorting due to severe overlap, ambiguous object boundaries, and large morphological variations. These issues are further amplified in few-shot scenarios, where limited training data often leads to overfitting and poor generalization in conventional vision models. To address these challenges, this paper proposes a few-shot pose estimation framework for robotic sorting of flexible packages with complex overlapping and boundary ambiguity. First, to alleviate data scarcity, a generative data augmentation strategy is developed by combining	

explicit physical spatial transformations with implicit feature disentanglement using a β -VAE. This hybrid augmentation mechanism significantly improves the diversity and robustness of the training dataset under severe occlusion conditions. Second, a multi-task perception network based on Directional Mask R-CNN is introduced to simultaneously perform instance segmentation and orientation estimation, enabling accurate perception of overlapping flexible packages. The 3D spatial centroid (X, Y, Z) of each target is then efficiently recovered by aligning the predicted masks with depth data, enabling reliable pose estimation for robotic manipulation. Finally, a system level validation platform is implemented using a FRANKA robotic arm equipped with a vacuum suction gripper to execute autonomous sorting tasks. Experiments in real chaotic stacking scenarios demonstrate that the proposed method achieves a visual recognition accuracy of 99.7% and a physical grasping success rate of 86.5%, validating its effectiveness for few-shot robotic sorting of flexible packages.	
09:45-10:00	FrAT2.6
<i>LeCal: Latency-Aware Curation and Alignment for LeRobot Teleoperation Datasets</i>	
Chan, Tobias	The Chinese University of Hong Kong
Teleoperated robot-learning datasets of ten log actions, proprioception, and video under a shared sample index, but that indexing does not guarantee physical synchrony. In low-cost leader-follower systems, actuator delay, middleware scheduling, and camera buffering can create persistent temporal offsets that degrade dataset quality. We present LeCal, a LeRobot-native post hoc calibration workflow and released CLI for estimating command-to-state delay, reporting confidence diagnostics, estimating camera-to- proprioception offset when local video is available, and exporting alignment artifacts. The method remains usable without observation. Leader state by treating the recorded action stream as the control-side surrogate. On a released SO-101 calibration dataset with 72 analyzed episodes, LeCal finds a concentrated action-to-state delay distribution with mean 4.194 frames (139.815 ms at about 30 Hz). Applying the estimated lag reduces mean action-state residual from 4.007 to 1.070, a 64.559% improvement. LeCal clearly outperforms synchronous indexing, a fixed 1-step shift, and GCC-PHAT, while remaining nearly tied with plain normalized cross-correlation on this joint-isolation dataset. A full benchmark over 388 episodes from eight public LeRobot corpora shows only a small overall edge over plain NCC, supporting LeCal primarily as a practical calibration workflow rather than a dramatic new correlator.	
10:00-10:15	FrAT2.7
<i>A Two-Stage Vision-Guided Autonomous Docking Method for Underwater Unmanned Vehicles: Integrating Long-Range Optical Beacon Guidance with Close-Range AprilTag-Based Pose Estimation</i>	
Wang, Jingyu	Harbin Institute of Technology(weihai)
Zhu, Yong	Harbin Institute of Technology(weihai)
Zhao, Yifan	Harbin Institute of Technology(weihai)
Ling, Qi	Harbin Institute of Technology
Pang, Zhiyuan	Harbin Institute of Technology
Huang, Bo	Harbin Institute of Technology
This paper presents a two-stage vision-guided autonomous docking method for UUV docking in underwater environments. A green optical beacon is used for long-range guidance, while an AprilTag marker is adopted for close-range relative pose estimation and fine attitude adjustment. Combined with a self-attention mechanism and finite-state machine-based control, the proposed method improves docking robustness and precision under varying water-clarity conditions. The method provides a practical solution for reliable underwater autonomous docking.	

FrAT3	Room 267
Intelligent Perception and Secure Control of Unmanned Systems (Regular Session)	
Chair: Teng, Hao	Beihang University
Co-Chair: Guo, Kexin	Beihang University
Organizer: Teng, Hao	Beihang University
Organizer: Zhou, Liutao	University of Duisburg-Essen
Organizer: Zhao, Dong	Beihang University
Organizer: Yu, Xiang	Beihang University
08:30-08:45	FrAT3.1
<i>Computationally Efficient Prescribed-Time Control for AUVs Via Single-Critic Network</i>	
Zhang, Zhixuan	Beihang University
Xu, Qiang	Beihang University
Zhang, Liyao	Beihang University
Teng, Hao	Beihang University
Hu, Pengwei	Beihang University
Qiao, Jianzhong	Beihang University
<p>This paper investigates the trajectory tracking control problem for Autonomous Underwater Vehicles (AUVs) subject to unknown external disturbances. A prescribed-time adaptive dynamic programming (PTADP) scheme is proposed to achieve optimal tracking performance within a user-defined time. Within this scheme, a single critic neural network (NN) with time-varying activation functions is constructed to approximate the solution to the Hamilton-Jacobi-Bellman (HJB) equation. Rigorous theoretical analysis based on the Lyapunov method confirms the Uniform Ultimate Boundedness (UUB) of both the approximation errors and tracking errors. Simulation results validate the significant convergence speed of the proposed PTADP scheme.</p>	
08:45-09:00	FrAT3.2
<i>Adaptive Disturbance Learning for Constrained Systems: A Hopf-Oscillator Driven Tube-MPC Approach</i>	
Zhang, Liyao	Beihang University
Zhang, Zhixuan	Beihang University
Li, Shaohui	BeiHang University
Xu, Qiang	Beihang University
Shen, Xinjing	BeiHang University
Teng, Hao	Beihang University
<p>This paper investigates the robust control problem for constrained systems subject to unknown multi-harmonic disturbances. We propose a composite control approach that integrates a Hopf-oscillator-based learning module with Tube-based Model Predictive Control (Tube-MPC). The core innovation lies in addressing the inherent conflict between learning-induced transients and system safety: while the adaptive oscillators learning disturbance features online, the Tube-MPC provides a robust positively invariant (RPI) safety buffer that effectively absorbs oscillatory and non-monotonic learning residuals. By incorporating the learned disturbance into a feedforward compensation term, the proposed method reduces the effective disturbance impact acting on the plant, thereby enhancing steady-state accuracy and reducing control effort. Theoretical analysis and simulation results confirm that the approach guarantees recursive feasibility and hard-constraint satisfaction throughout the adaptive learning process.</p>	
09:00-09:15	FrAT3.3
<i>Distributed Nonlinear Disturbance Observer-Based Refined Cooperative Control for Multi-Satellite with Mandatory Pointing Constraint</i>	
Yixuan, Zhang	Beihang University

Shen, Xinjing	BeiHang University
Qinhe, Jin	Beihang University
Zhang, Zhixuan	Beihang University
Teng, Hao	Beihang University
Zaoux, Zhu	Beihang University
<p>Achieving consensus control is essential for high-precision satellite formation and the rapid deployment of laser communications within very low earth orbit (VLEO), constellations. However, formation flying missions pose strict pointing constraints on VLEO satellites. Furthermore, the satellite bodies are subjected to multi-source disturbances, such as flexible vibrations and environmental disturbances, degrading the attitude control accuracy, which in turn affects the relative attitude acquisition. To address the anti-disturbance high-precision consensus problem, this paper proposes a cooperative prescribed performance control scheme by integrating a distributed nonlinear disturbance observer (DNDO) and a distributed relative attitude observer (DRAO). Firstly, considering the actual satellite communication topology, a DRAO is designed to enable each satellite to acquire its desired pointing direction. Secondly, a DNDO is developed based on the disturbance dynamics of each satellite to achieve precise estimation of disturbances. Finally, by combining the DNDO and DRAO, a prescribed performance control scheme is designed based on barrier Lyapunov function under pointing angle error constraints. Simulation results based on a multi-satellite system consisting of five satellites demonstrate the effectiveness and superior performance of the proposed method.</p>	
09:15-09:30	FrAT3.4
<i>Neural-Network-Augmented Sliding Mode Control for Precision Pointing of EO Pods under Composite Disturbances</i>	
Wu, Jiaao	Beihang University
Yaokun, Lu	Beihang University
Yixuan, Zhang	Beihang University
Zhang, Liyao	Beihang University
Teng, Hao	Beihang University
Qiao, Jianzhong	Beihang University
<p>To address the high-precision control problem of the coarse loop pitch axis of an Electro-Optical (EO) pod under the combined effects of carrier maneuvering, vibration, mechanical friction, mass imbalance torque, and parameter uncertainties, a control scheme based on a Radial Basis Function (RBF) neural network is proposed. First, the dynamic model of the coarse loop pitch axis is established to clarify the characteristics of composite multi-source disturbances. Second, an adaptive law and a sliding mode controller based on a Radial Basis Function neural network were designed to accurately estimate the dynamic characteristics of the electro-optical pod and achieve precise control of the system. The effectiveness of the proposed method is verified through simulations.</p>	
09:30-09:45	FrAT3.5
<i>Safety-Critical Composite Attitude Control for VLEO Satellites under Composite Disturbances</i>	
Sun, Changqing	Beihang University
Li, Yifan	Beihang University
Yixuan, Zhang	Beihang University
Kun, Wang	Beihang University, Hangzhou Innovation Institute
Teng, Hao	Beihang University
Qiao, Jianzhong	Beihang University
<p>Secure attitude maneuvers of spacecraft in Very Low Earth Orbit (VLEO) are affected by composite disturbances, including center of mass variations and atmospheric drag. For systems subject to mandatory constraints, such disturbances can compromise attitude tracking precision and potentially lead to safety violations. To address</p>	

this challenge, a maneuvering control scheme based on disturbance observation and barrier function is proposed. First, a coupled spacecraft attitude dynamics model is developed to reveal the influence of composite disturbances. Second, a composite controller incorporating a nonlinear disturbance observer and a state-dependent barrier function is designed to perform real-time compensation of these disturbances while ensuring constraints compliance. The effectiveness and robustness of the proposed approach are validated through numerical simulations.

09:45-10:00 FrAT3.6

Cross-Subject Recognition of Passenger Perceived Stress in Autonomous Driving Using LSTM-MHSA Networks

Guo, Yirui	Beihang University
Zhang, Zhanpeng	Beihang University
Liu, Yuanyuan	Beihang University
Ren, Zhanyan	Beihang University

In highly automated autonomous driving systems, passenger state perception is essential for safe operation, reliable decision-making, and effective human-machine collaboration. However, existing studies mainly focus on coarse-grained binary stress classification and lack the ability to distinguish stress induced by different sensory disturbances. To address this limitation, this paper proposes an EEG (Electroencephalogram)-based stress type recognition method using deep learning. A realistic autonomous driving environment with visual and auditory stressors is constructed, and EEG data are collected from multiple subjects. Sequential features are extracted using sliding windows and frequency-domain analysis. An LSTM-MHSA (LSTM with Multi-Head Self-Attention) network is designed to capture temporal dependencies and focus on critical information. Cross-subject experiments achieve an accuracy of 82.66%, outperforming traditional machine learning methods and the standard LSTM model. The results demonstrate the effectiveness of the proposed method and support intelligent perception and safety-oriented human-machine collaboration in autonomous driving systems.

10:00-10:15 FrAT3.7

Efficient Positioning for Unmanned Systems: A Mamba-Based CSI Fingerprinting Framework

Zhang, Zhanpeng	Beihang University
Guo, Yirui	Beihang University
Duan, Lanzhi	Beihang University
Xie, Xin	Jiangxi Research Institute of Beihang University
Yao, Jiaojiao	Beijing Tiantan Hospital, Capital Medical University
Wang, Changhai	Guangxi Transportation Design Group
Li, Daofei	Transport Information Management Center of Guangxi Zhuang Autonomous Region
Xia, Ming	Beihang University

Reliable localization is essential for autonomous operation in unmanned industrial environments, where vision-based methods often degrade due to poor illumination, occlusion, and privacy constraints. WiFi Channel State Information (CSI) enables fingerprinting based localization by capturing fine-grained signal characteristics. However, existing approaches either rely on limited handcrafted features or employ deep models such as CNNs, LSTMs, and Transformers, which suffer from restricted global modeling capability or high computational complexity. To address these challenges, this paper proposes a novel Mamba-based CSI fingerprinting framework built upon a selective state space model. The proposed method efficiently captures long-range dependencies in high-dimensional CSI sequences with linear computational complexity, inherently bypassing the sequential and computational

bottlenecks of traditional architectures. Experimental results in a real-world indoor environment demonstrate that the proposed approach achieves high localization accuracy with a root mean square error (RMSE) of 1.04 m and a mean absolute error (MAE) of 1.08 m. Furthermore, complexity analysis on a standard CPU platform reveals that the proposed framework achieves an exceptionally low inference latency of 1.51 ms, outperforming conventional and deep learning baselines in efficiency. This optimal trade-off between localization accuracy and real-time execution speed confirms the immense potential of the proposed method for resource-constrained devices in dynamic unmanned systems.

FrAT4 Room 269

Micro-Robotic Systems and Applications (Regular Session)

Chair: Niu, Fuzhou	Suzhou University of Science and Technology
Co-Chair: Mo, Hangjie	Hefei University of Technology
Organizer: Niu, Fuzhou	Suzhou University of Science and Technology
Organizer: Mo, Hangjie	Hefei University of Technology

08:30-08:45 FrAT4.1

A Semi-Analytical Model for Planar PCB Spiral Coils with Application to Magnetic Microrobot Actuation

Chen, Yubing	Suzhou University of Science and Technology
Wang, Yu	Suzhou University of Science and Technology
Lian, Jibing	Suzhou University of Science and Technology
Bao, Danyang	Shenzhen Polytechnic University
Han, Dong	Zhejiang University
Mo, Hangjie	Hefei University of Technology
Li, Ying	Shenzhen Polytechnic University
Niu, Fuzhou	Suzhou University of Science and Technology

Planar printed circuit board (PCB) spiral coils are widely used in programmable magnetic actuation systems due to their compact structure and ease of array integration. For magnetic microrobot control, accurate and computationally efficient modeling of magnetic fields and their spatial gradients is essential, as they directly determine magnetic force generation and motion controllability. This paper presents a control-oriented semi-analytical magnetic field model for planar PCB spiral coils based on a parametric line-integral formulation of the Biot-Savart law along the Archimedean spiral conductor path. The proposed model enables efficient computation of three-dimensional magnetic flux density and magnetic field gradients, making it suitable for iterative evaluation and future real-time control applications. The modeling accuracy is validated through comparison with three-dimensional finite-element simulations in Ansys Maxwell. Based on the computed field gradients, magnetic forces acting on a spherical microrobot are derived, establishing a direct mapping from coil current inputs to mechanical actuation forces. Furthermore, a programmable planar PCB spiral coil array and a magnetic microrobot actuation platform are implemented, and experiments including multi-microrobot motion and microfluidic manipulation demonstrate the application potential of this system in microfluidic transportation and micro-operation.

08:45-09:00 FrAT4.2

Development of a Sperm-Shaped Magnetic Algae Microrobot

Zhang, Mengyu	Ocean University of China
Song, Liansheng	Ocean University of China
Yu, Wei	Ocean University of China

Zheng, Liushuai	City University of Hong Kong
Wen, Qi	Ocean University of China
Jin, Yujian	China Research Institute of Radiowave Propagation, Xinxiang 453003, China
Li, Junyang	Ocean University of China
<p>Magnetic microrobots are promising platforms for targeted drug delivery, with sperm-inspired types attracting particular attention due to their flexible, wave-like motion. Despite significant progress in this field, the simple fabrication of sperm-like flexible robots remains a major challenge. This paper proposes a novel, universal strategy based on a magnetic head made of iron oxide and a flexible tail from filamentous algae for the fabrication of a bio-hybrid flexible sperm-like microrobot, which demonstrates potential for targeted drug delivery within microenvironments in the future. Based on its ingenious head-tail connection structure, the microrobot can effectively move under a precessing magnetic field and achieve reciprocating motion without turning back. Furthermore, vascular channel simulation experiments validate its excellent motion performance in microenvironments. This fabrication method is simple, versatile, and exhibits autofluorescence, providing a new pathway for the large-scale fabrication of high-performance medical microrobots.</p>	
09:00-09:15	FrAT4.3
<p><i>Numerical Analysis and System Construction for an Automated Droplet Manipulation Technology Based on EWOD</i></p>	
Lin, Jinhai	Xiamen University of Technology
Wang, Yihang	Xiamen University of Technology
Ma, Weicheng	Xiamen University of Technology
Tian, Ye	Xiamen University of Technology
Zhou, Yuantai	Xiamen University of Technology
Han, Qingxin	Xiamen University of Technology
Huan, Zhijie	Xiamen University of Technology
<p>Liquid transport via electrowetting-on-dielectric (EWOD) represents an effective microfluidic manipulation method. However, owing to the complexity of droplet motion at the microscale, in-depth research on the characteristic analysis of the droplet motion process remains lacking. In this study, an electromechanical model of parallel plate electrodes was introduced to conduct a force analysis of the droplet motion process. Furthermore, simulations based on COMSOL were performed to investigate the effects of dielectric layer thickness and dielectric constant on electric potential distribution. The droplet deformation characteristics induced by contact angle variation were analyzed, and the dynamic response characteristics of the droplet manipulation were evaluated. Meanwhile, to achieve closed-loop control of droplets, a deep learning based visual feedback system was adopted for real-time recognition and localization of droplets. Finally, an integrated droplet manipulation system was constructed, achieving automated transport and fusion of droplets.</p>	
09:15-09:30	FrAT4.4
<p><i>Load-Adaptive PID Control of Galvo Scanners Based on Online Moment of Inertia Identification</i></p>	
Le, Jinyang	Xiamen University
Ma, Yao	Xiamen University
Wu, Guobin	Xiamen University
Wang, Yuqi	Xiamen University
Dai, Yingying	Xiamen University
Zhou, Wei	Xiamen University
Luo, Tao	Xiamen University
<p>To address the deterioration in control performance caused by changes in load moment of inertia during mirror replacement in galvo scanners of laser processing systems, this work proposes a three-loop adaptive PID control method based on online moment of inertia</p>	

<p>identification. First, a dynamic model of the galvo motor and a three-stage closed-loop cascade control architecture are established to analyze how variations in load moment of inertia affect key performance metrics, including the system's natural frequency and damping ratio. Subsequently, an online identification scheme directly derived from the mechanical motion equations is developed. By combining low-frequency logarithmic sweep excitation with a recursive least-squares algorithm, the proposed method enables accurate identification of the galvo scanner's moment of inertia. Finally, based on the identified inertia values, the velocity-loop PI gains and position-loop P proportional gain of the controller are adaptively updated. Simulation results demonstrate that the proposed approach rapidly adjusts control parameters after mirror replacement while preserving the standard PID architecture. The load-adaptive controller enables the galvo scanner to achieve a settling time to 1% of full-scale less than 1 ms across mirrors with different moment of inertia. This method effectively resolves the trade-off between the requirement for mirror replacement and high precision control in galvo scanning systems. Moreover, the identification algorithm is computationally efficient, facilitating hardware implementation.</p>	
09:30-09:45	FrAT4.5
<p><i>A Track Fusion Method for Scattered Vessel-Detection Data</i></p>	
Jiang, Tian	Nanjing Research Institute of Electronics Technology
Geng, Chao	Nanjing Research Institute of Electronics Technology
<p>With the rapid development of maritime surveillance technology, the volume of data generated by sea-surface target detection systems has grown exponentially. The effective governance of massive heterogeneous detection data has become a critical bottleneck for maritime situational awareness. To address the issues of inconsistent attribute descriptions, difficult multi-source data fusion, and severe track fragmentation in current maritime detection data, this paper proposes an automated data governance method for massive maritime detection data. This method constructs a unified maritime target knowledge base to achieve attribute standardization for multi-source heterogeneous data from satellites, radar, electro-optical sensors, ADS-B, and AIS. A multi-source attribute alignment algorithm based on time-decay weighting is proposed to resolve attribute discrimination conflicts for the same target. A track merging mechanism based on attribute-spatiotemporal-batch three-dimensional association is designed to effectively handle track fragmentation caused by detection interruptions. Finally, a quadratic least-squares fitting method is employed to achieve track splicing and smoothing, realizing fully automated processing from raw detection data to high-quality track data. Experimental results demonstrate that the proposed method achieves 97.6% attribute normalization accuracy, 95.39% track merging correctness, providing a reliable data foundation for maritime target tracking and situational analysis.</p>	
09:45-10:00	FrAT4.6
<p><i>Precision Disturbance Rejection Control of Fast Steering Mirror Based on Super-Twisting Sliding Mode</i></p>	
Huang, Jin	China Academy of Engineering Physics
Ye, Haifu	China Academy of Engineering Physics
Liang, Xudong	Institute of Fluid Physics, China Academy of Engineering Physics
Wu, Linchao	China Academy of Engineering Physics
Tang, Wei	China Academy of Engineering Physics
Liu, Yueyue	Jiangnan University
<p>In order to solve the problem of precision tracking of fast steering mirror system (FSM), an anti-disturbance control method based on super-twisting sliding mode was proposed. Based on the super-</p>	

twisting algorithm (STA), the perturbation observer and controller are constructed respectively. In this approach, the disturbance observer estimates both external disturbances and internal parameter uncertainties in real-time and provides feedforward compensation accordingly. The position closed-loop control of the fast-steering mirror adopts a second-order super-twisting sliding mode controller to achieve effective tracking. Numerical simulation results demonstrate that the proposed method can successfully estimate disturbances, effectively mitigate the chattering phenomenon inherent in traditional sliding mode control (SMC), and reduce the impact of external disturbances, thereby enhancing the precision and robustness of the FSM control system.

FrAT5	Room 259
Perception, Mapping, and Autonomous Control for Underwater Robotic Systems in Challenging Environments (Regular Session)	
Chair: Lei, Lei	The Chinese University of Hong Kong
Co-Chair: Ding, Wendi	The Chinese University of Hong Kong
Organizer: Lei, Lei	The Chinese University of Hong Kong
Organizer: Yang, Guidong	The Chinese University of Hong Kong
Organizer: Huang, Dongyue	Nanyang Technological University
Organizer: Ding, Wendi	The Chinese University of Hong Kong
Organizer: Zhang, Jianxing	Huazhong University of Science and Technology
Organizer: Wen, Junjie	The Chinese University of Hong Kong
Organizer: Han, Mingqiao	The Chinese University of Hong Kong
Organizer: Zhao, Benyun	The Chinese University of Hong Kong
08:30-08:45	FrAT5.1
<i>A Review of Intelligent Trajectory Planning for Unmanned Underwater Vehicles</i>	
Li, Shangqing	Huazhong University of Science and Technology
Wang, Yuhan	Huazhong University of Science and Technology
Gao, Longlong	Huazhong University of Science and Technology
Yuan, Chang	Huazhong University of Science and Technology
Yin, Peiyi	Huazhong University of Science and Technology
Zhang, Jianxing	Huazhong University of Science and Technology
Li, Baoren	Huazhong University of Science and Technology
Unmanned Underwater Vehicles (UUVs) are essential for executing critical marine missions; however, traditional navigation systems face severe bottlenecks in complex underwater environments owing to limited sensing ranges, communication constraints, and the absence of autonomous decision-making. Consequently, intelligent trajectory planning has emerged as the foundational technology for realizing UUV autonomous navigation. This paper systematically reviews the state-of-the-art in UUV intelligent trajectory planning, focusing primarily on autonomous obstacle avoidance and energy consumption optimization. We first describe our literature search methodology and present a structured algorithmic taxonomy. We then	

categorize mainstream algorithms ranging from heuristic searches to deep reinforcement learning frameworks and summarize their key innovations and performance metrics. While contemporary methods demonstrate significant breakthroughs in simulated scenarios, transitioning these theoretical models to robust engineering systems remains a substantial challenge. This review identifies critical technical bottlenecks, including environmental uncertainty, the trade-off between real-time computational performance and algorithmic complexity, and multi-objective optimization conflicts—and discusses the simulation-to-reality (sim-to-real) gap with concrete engineering guidance. Finally, we outline future research priorities spanning hardware advancement, software algorithm optimization, and reliability enhancement, including standardized benchmarking frameworks and hardware-in-the-loop (HIL) validation approaches, aiming to promote the engineering practicality of highly adaptable, autonomous underwater embodied agents.

08:45-09:00	FrAT5.2
<i>Dynamics Modeling and Trim Control for Underwater Gliders</i>	
Lei, Lei	The Chinese University of Hong Kong
Yang, Guidong	The Chinese University of Hong Kong
Han, Mingqiao	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
Autonomous underwater gliders rely on net buoyancy modulation and internal mass redistribution to achieve energy-efficient, long-endurance locomotion. Unlike conventional propeller-driven vehicles, their flight mechanics are fundamentally governed by natural trim equilibria rather than direct continuous thrust. This paper formulates a comprehensive multi-body dynamic framework that explicitly couples rigid-body kinematics, anisotropic added-mass effects, and nonlinear hydrodynamics with internal moving-mass actuation. We propose a novel trim-oriented control methodology that leverages a buoyancy adjustment system (BAS) to govern macroscopic dive-to-climb tendencies, while utilizing an attitude adjustment system (AAS) for bounded, localized pitch-trim regulation. Furthermore, a depth-dependent scheduling mechanism is integrated to systematically throttle volumetric transitions. Comprehensive numerical simulations demonstrate that the proposed framework yields highly stable, repeatable glide cycles. By mitigating severe transient oscillations and avoiding actuator saturation near apogee and perigee inflections, this approach provides a robust, physically intuitive, and hardware-aware control paradigm for underactuated marine robots.	
09:00-09:15	FrAT5.3
<i>SLAM for Underwater Autonomous Unmanned Systems: Sensors, Framework and Limitations</i>	
Han, Mingqiao	The Chinese University of Hong Kong
Wang, Chenxiao	Tongji University
Lei, Lei	The Chinese University of Hong Kong
Yang, Guidong	The Chinese University of Hong Kong
Ding, Yulong	Tongji University
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong
Underwater Autonomous Unmanned Systems (UAUS) increasingly rely on Simultaneous Localization and Mapping (SLAM) to enable closed loop autonomy in missions such as infrastructure inspection, ocean mapping, and environmental monitoring. Compared with	

terrestrial and aerial platforms, underwater operation presents distinctive sensing constraints. Global positioning is generally unavailable, optical perception can degrade severely in turbid water, and acoustic sensing, despite its reliability under low visibility, often exhibits structured artifacts, heavy tailed noise, low update rates, and non-negligible latency. These characteristics shape both the operating envelopes of practical sensors and the reliability of the measurement constraints provided to the estimator. This review connects sensor operating envelopes with deployable SLAM design for UAUS. We first summarize common underwater sensing modalities and their dominant constraints and failure mechanisms. We then review representative SLAM framework through a modular pipeline, focusing on data synchronization and association, local pose estimation, and loop closure with global optimization. Within local estimation, we organize methods into optimization based, filtering based, and learning enhanced categories, and discuss how they are combined in practice. Finally, motivated by failures observed in turbid vision and noisy acoustic mapping, we outline key limitations and future directions toward uncertainty aware front ends, robust global estimation, adaptive multi-sensor fusion, and evaluation protocols that better reflect field deployment requirements.

09:15-09:30 FrAT5.4

PSB-NANO: A Forward-Looking Imaging Sonar Benchmark for Underwater Pile Diagnosis

Li, Kun	Nanjing University of Posts and Telecommunications
Zhang, Zhen	Nanjing University of Posts and Telecommunications
Zhao, Benyun	The Chinese University of Hong Kong
Wang, Enliang	Nanjing University of Posts and Communications
Lei, Lei	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Underwater piles require routine inspection, but optical sensing is often unreliable in turbid water, making forward-looking imaging sonar an attractive alternative. Public datasets and reproducible evaluation protocols for pile inspection in sonar imagery, however, remain scarce. We present dataset {}, a forward-looking sonar benchmark for joint pile detection and state classification. The current release contains 8,120 raw sonar clips and a human-labeled core set of 1,981 three-frame temporal composites (T3) with 2,019 annotated pile instances. The released state labels represent sonar-observed appearance states inferred from acoustic evidence rather than externally validated physical ground truth. T3 encodes short-term dynamics in a three-channel form that remains compatible with standard 2D detectors. To support reproducible benchmarking, we release annotations, manifests, fixed split files, evaluation scripts, and a traceable model-in-the-loop expansion pipeline. We further report baselines for Faster R-CNN and several YOLO variants under COCO-style metrics. Benchmark results indicate that pile-state detection in noisy sonar imagery remains challenging, especially for minority fractured cases.

09:30-09:45 FrAT5.5

A Novel Spatiotemporal Environment Perception Framework for Ocean Current Field

Wang, Yichen	Beijing Institute of Technology
Lei, Lei	The Chinese University of Hong Kong
Li, Ying	Beijing Institute of Technology

Ocean current fields contain complex spatial patterns and temporal evolution, which pose significant challenges for efficient environment

perception. This paper proposes a novel spatiotemporal environment perception framework for ocean current fields based on reduced-order modeling. After preprocessing and valid-ocean masking, singular value decomposition is applied to historical current snapshots to extract dominant spatial modes and form a compact low-rank representation. On this basis, two downstream tasks are considered. For spatial perception, sparse observations are used to reconstruct the full current field through least-squares estimation of modal coefficients. For temporal prediction, dynamic mode decomposition is introduced in the reduced-order coefficient space to perform one-step forecasting. Experimental results demonstrate that the proposed framework achieves accurate reconstruction from partial observations and effective short-term prediction, indicating that it can provide a compact and interpretable representation for unified spatiotemporal perception of ocean current fields.

09:45-10:00 FrAT5.6

Efficient Real-Time Modeling of Longitudinal Dynamics for Semi-Submerged Hydrofoil Unmanned Surface Vehicles

Ding, Wendi	The Chinese University of Hong Kong
Yan, Ruixin	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Semi-submerged hydrofoil systems provide an effective solution for reducing hydrodynamic drag in high-speed unmanned surface vehicles (USVs) by partially lifting the hull out of the water. However, the hydrodynamic characteristics of such systems vary significantly with changes in immersion state and vehicle motion, making accurate real-time modeling challenging.

In this paper, a real-time modeling framework for a multi-strut semi-submerged hydrofoil system is proposed. The hydrodynamic forces are reconstructed using a vector decomposition approach based on the approximately linear relationship between hydrodynamic characteristics and the submerged length of slender hydrofoil struts, while hydrostatic forces are evaluated using a volumetric discretization method.

The model is validated through both computational fluid dynamics (CFD) simulations and towing tank experiments. Results demonstrate that the proposed approach achieves accurate prediction of lift, drag, and pitching moment while maintaining real-time computational performance, making it suitable for dynamic simulation and control of hydrofoil-based USVs.

FrAT6 Room 264

Situational Awareness and Resilient Control in Cyber-Physical Systems (Regular Session)

Chair: Badihi, Hamed	Tampere University, Tampere 33720, Finland
Co-Chair: Zhang, Youmin	Concordia University
Organizer: Badihi, Hamed	Tampere University, Tampere 33720, Finland
Organizer: Zhang, Youmin	Concordia University

08:30-08:45 FrAT6.1

Event-Triggered Fixed-Time Resilient Secondary Control of Smart Grid under FDI Attacks

Li, Jin	Concordia University
Zhang, Youmin	Concordia University

This paper investigates the problem of resilient secondary control for smart grid systems subject to false data injection (FDI) attacks. An event-triggered fixed-time secondary control strategy is proposed to

<p>simultaneously guarantee fast frequency regulation and proportional active power sharing while significantly reducing communication burden. The proposed control framework integrates fixed-time convergence properties with an event-triggered communication mechanism, ensuring that system states converge to desired equilibria within a predefined time bound independent of initial conditions, even in the presence of bounded FDI attacks. Rigorous theoretical analysis is provided to establish fixed-time stability and to exclude Zeno behavior. Simulation results demonstrate the effectiveness of the proposed approach in enhancing resilience against cyber-attacks while achieving substantial communication savings compared with conventional time-triggered schemes.</p>	
08:45-09:00	FrAT6.2
<p><i>Distributed Fault-Tolerant Control for Multi-Agent Systems with Flexible Manipulators Using Riemannian Motion Policy Composition</i></p>	
Pan, JiaHao	HangZhou DianZi University
Wang, SiWei	HangZhou DianZi University
Guan, YaCun	HangZhou DianZi University
Yang, Hao	Nanjing University of Aeronautics and Astronautics
Jiang, Bin	NUAA
Zhang, Youmin	Concordia University
<p>This paper addresses the fault-tolerant control problem for multi-agent systems with flexible manipulators governed by coupled ordinary differential equation-partial differential equation (ODE-PDE) dynamics. A distributed control framework is proposed to handle actuator faults, flow-induced disturbances and obstacle avoidance constraints through three integrated mechanisms. First, each agent employs a model-based baseline controller that compensates for unknown faults while suppressing elastic vibrations. Second, a neural disturbance perception encoder is designed to extract low-dimensional latent features from dynamics residuals, providing all agents with a consistent representation of the flow environment. Third, residual reinforcement learning policies trained with disturbance-aware rewards augment the baseline control through Riemannian motion policy (RMP) flow composition, ensuring asymptotic convergence to consensus under disturbance-free conditions and bounded tracking errors under persistent disturbances. Numerical simulations demonstrate the effectiveness of the proposed methods.</p>	
09:00-09:15	FrAT6.3
<p><i>Specified-Time Distributed Nash Equilibrium Seeking for Multicoalition Cyber-Physical Systems</i></p>	
Tao, Qianle	Northwestern Polytechnical University
Chengxin, Xian	Northwestern Polytechnical University
Zhao, Yu	Peking University
<p>This paper studies distributed Nash equilibrium seeking (DNES) for multicoalition cyber-physical systems overweight-unbalanced directed communication networks. Within each coalition, all nodes cooperate to optimize the coalition's objective under a consensus constraint, while different coalitions compete with one another. First, by integrating multi-step planning with optimal control techniques, a specified-time DNES framework is developed for such multicoalition cyber-physical systems, guaranteeing convergence to the Nash equilibrium (NE) within a specified settling time. Furthermore, to eliminate biases in both the average gradient estimation and the system state that arise from the unbalanced directed communication topology inside each coalition, a specified-time balance compensator is designed for each coalition based on in-neighbor sampling information. Then, by utilizing properties of iteration matrices and constructing discrete Lyapunov functions, the specified-time convergence of the compensator and the overall system is rigorously established. Finally, a simulation result involving the power</p>	

<p>generation game is presented to demonstrate the effectiveness of the proposed algorithm.</p>	
09:15-09:30	FrAT6.4
<p><i>Cascaded Cooperative Disturbance Rejection Control for Air-Ground Heterogeneous Systems Via Fixed-Time Extended State Observers</i></p>	
Li, Yongze	Northwestern Polytechnical University
Wang, Ban	Northwestern Polytechnical University
Chang, Bufan	Northwestern Polytechnical University
Fu, Yifang	Northwestern Polytechnical University
Mu, Lingxia	Xi'an University of Technology
<p>This paper proposes a cascaded cooperative control strategy using a fixed-time extended state observer (FTESO) for air-ground heterogeneous systems under complex disturbances. Firstly, an air-ground dynamic model incorporating a bidirectional signal connection is established. Then, a FTESO is designed to estimate modeling errors and wind disturbances in real time, ensuring observation error convergence within a fixed time. A cooperative integral sliding mode controller manages outer-loop coordination to reduce deviations, while an inner-loop controller tracks attitude commands. Lyapunov analysis confirms global system stability. Finally, simulations demonstrate superior robustness and accuracy compared to traditional nonlinear observers.</p>	
09:30-09:45	FrAT6.5
<p><i>Time-Localized Wavelet Packet Feature Extraction for Wind Turbine Gearbox Fault Detection</i></p>	
Ramezanzadeh, Nasrin	Universitat Politècnica De València (UPV)
Chatterjee, Subhajit	Faculty of Engineering and Natural Sciences, Tampere University, Tampere 33720, Finland
Badihi, Hamed	Tampere University, Tampere 33720, Finland
<p>Wind turbine gearboxes operate under variable loading and harsh environmental conditions, making early fault detection essential for reducing turbine downtime and operation and maintenance (O&M) costs. This study proposes an interpretable fault indicator based on wavelet packet decomposition (WPD) combined with a normalized rolling-energy ratio. The analysis focuses on the 10 Hz to 40 Hz frequency band, which is physically motivated by the frequency region surrounding the rotational frequency of the high-speed shaft (i.e., 1800 rpm \approx 30 Hz). Using vibration measurements from the NREL gearbox condition-monitoring dataset, one-minute vibration segments sampled at 40 kHz are processed through a decimated WPD framework to reconstruct narrow subbands within the target frequency region. A peak-response time window is then identified using an energy ratio between a detector subband and a low-frequency reference band, enabling the extraction of compact windowed features. Experimental analysis across multiple accelerometer locations shows that the selected subband centered near 34 Hz provides the strongest separation between healthy and damaged gearbox conditions. The proposed time-localized wavelet packet feature extraction framework provides an interpretable and computationally efficient approach for wind turbine gearbox fault detection.</p>	
09:45-10:00	FrAT6.6
<p><i>Reliable Multi-Target SCADA-Based Condition Monitoring for Wind Turbine Pitch Fault Detection</i></p>	
Chatterjee, Subhajit	Faculty of Engineering and Natural Sciences, Tampere University, Tampere 33720, Finland

Badihi, Hamed	Tampere University, Tampere 33720, Finland
<p>Wind energy plays a key role in modern power systems, but the rapid expansion of the sector creates challenges for the long-term reliability and operational safety of wind turbines. Normal behavior models (NBMs) are widely used for turbine-performance monitoring, yet most existing approaches rely on single-target formulations that increase deployment complexity and often produce ambiguous fault indications. To address these limitations, we propose a multi-target NBM that jointly monitors multiple supervisory control and data acquisition (SCADA) signals through a unified health indicator. The framework integrates autoregressive (AR) lag features within a stacking ensemble to capture temporal dependencies and nonlinear operating patterns and couples the resulting residuals with a LOESS-smoothed mean-squared-deviation (MSD) decision statistic. The proposed framework is then validated on pitch-fault anomaly data using active power and gearbox-oil temperature signals. Compared with conventional single-target NBMs, the proposed approach suppresses spurious alerts, increases confidence in detected anomalies, reduces monitoring effort, preserves predictive accuracy, and improves the reliability of fault diagnosis.</p>	

FrBT1	Assembly Hall
Exploring Task-Oriented Embodied Intelligence in Robots (Regular Session)	
Chair: Yang, Qingkai	Beijing Institute of Technology
Co-Chair: Cui, Jinqiang	Pengcheng Laboratory
Organizer: Yang, Qingkai	Beijing Institute of Technology
10:30-10:45	FrBT1.1
<i>Cooperative Bearing-Angle Target Encirclement Via Multi-Agent Reinforcement Learning with Collaborative Adaptive Kalman Filtering</i>	
Gao, Jingran	Hebei University of Science and Technology
Xi, Lele	Hebei University of Science and Technology
Wang, Hongkun	Hebei University of Science and Technology
Wei, Yue	Guangdong Laboratory of Artificial Intelligence and Digital Economy (SZ)
<p>This paper proposes a multi-agent cooperative pursuit framework that integrates target state estimation and cooperative pursuit control. For state estimation, a Collaborative Adaptive Kalman Filter (CAKF) is developed, which integrates bearing-angle measurements from multiple pursuers to improve accuracy and robustness under noisy conditions and (ii) performs online adaptive updates of the noise covariance based on an innovation-driven mechanism. For the pursuit task, a Distributed Multi-Agent Deep Deterministic Policy Gradient (DMADDPG) framework is proposed to alleviate the problem of poor generalization ability of single-strategy controllers. A large number of experiments verify the effectiveness, robustness, and scalability of the proposed system.</p>	
10:45-11:00	FrBT1.2
<i>Safe Distributed Formation of Heterogeneous Discrete-Time Multi-Agent Systems</i>	
Lu, Rongxiang	Tongji University
Wang, Zhipeng	Tongji University
Cheng, Bin	Tongji University
He, Bin	Tongji University
<p>This paper investigates the distributed formation control problem for heterogeneous nonlinear discrete-time multi-agent systems under safety and stability constraints. The core challenge lies in ensuring</p>	

<p>safety within heterogeneous multi-agent systems operating in discrete-time environments, while addressing nonlinear uncertainties that further complicate control design. To address these issues, a control framework based on the backstepping method is proposed, integrating a control Lyapunov function for stability and a higher-order control barrier function for safety. To accommodate varying agent orders while guaranteeing bounded formation error and collision-free operation, a discrete-time formulation of the control barrier function is further developed. Moreover, neural networks are employed to approximate unknown nonlinearities and uncertainties, thereby enhancing the overall robustness and adaptability of the control strategy. Finally, a numerical simulation validated the effectiveness of the proposed formation control.</p>	
11:00-11:15	FrBT1.3
<i>Meta-Gradient Based Reward Shaping for Resilient Heterogeneous Platooning against Cyber Attacks</i>	
Xia, Zhiwei	Shanghai University
Liu, Chun	Shanghai University
Ren, Xiaoqiang	Shanghai University
Wang, Xiaofan	Shanghai Jiao Tong University
<p>Heterogeneous vehicle platooning relies on Vehicle-to-Everything (V2X) communication, exposing the system to False Data Injection (FDI) attacks. In such adversarial environments, standard Deep Reinforcement Learning (DRL) methods calculate rewards directly from compromised observations. This dependency creates a reward trap where agents optimize corrupted objectives and execute unsafe behaviors. To address this issue, a Meta-Gradient based Reward Shaping (MGRS) framework is proposed for resilient platoon control. Formulated as a heterogeneous optimization problem, the framework introduces a parameterized reward teacher updated via meta-gradients derived from ground-truth physical states. This mechanism dynamically rectifies biased reward signals, enabling heterogeneous agents to learn safe policies despite sensor falsification. Simulation results demonstrate that the MGRS framework significantly enhances system resilience, maintaining string stability and avoiding collisions under FDI attacks where traditional static-reward baselines fail.</p>	
11:15-11:30	FrBT1.4
<i>VINS-LIFT: Leveraging Visual-Language Models for Robust VI-SLAM in Environments with Elevators</i>	
Lyu, Mingzhe	Southern University of Science and Technology
Feng, Yuxuan	Tongji University
Wang, Yongcai	Tsinghua University
Zhang, Hong	Southern University of Science and Technology
Cui, Jinqiang	Pengcheng Laboratory
<p>Pose tracking failure in elevator environments is currently a most challenging issue for Visual-Inertial SLAM systems, mainly due to the contradict measurements between the nearly static visual features and the dramatical acceleration changes captured by IMU measurements. To address this challenge, this paper investigates the key features of the inconsistent measurements, and proposes VINS-LIFT, a novel framework that leverages Visual-Language Models (VLMs) to enhance the robustness of VI-SLAM in environments with elevators. Specifically, our system fuses lightweight visual scene understanding (distilled from Qwen2.5-VL) with IMU motion tracking through a novel fusion mechanism, triggering motion priors and adaptive covariance modulation once an elevator scenario is detected. This synergistic framework enables reliable state estimation despite sudden lighting changes, motion disturbances, or visual degradation common in elevator environments. We validate our method on real-world datasets, demonstrating significant performance gains in trajectory estimation and robustness compared to conventional VI-SLAM baselines. This work highlights the potential of VLM-driven adaptations for enhancing SLAM robustness in challenging motion scenarios.</p>	

11:30-11:45	FrBT1.5
<i>A Physics-Informed Optimization Control Allocation Strategy for Coaxial Multirotor</i>	
Wang, Meng	Beihang University
Chen, Zeshuai	Beihang University
Guo, Yuxin	Beihang University
Guo, Kexin	Beihang University
Yu, Xiang	Beihang University
<p>Coaxial multirotors offer enhanced thrust density without increasing the platform size, making them attractive for aerial manipulations and aggressive flight. However, the intrinsic aerodynamic interaction between upper and lower rotors introduces thrust loss and torque coupling, significantly increases the complexity of control allocation. This paper proposes a physics-informed optimization control allocation solution for coaxial multirotors. Firstly, a three-dimensional nonlinear polynomial mapping model between motor DShot commands and the generated thrust and torque is experimentally identified. The identified aerodynamic knowledge is then incorporated into a constrained quadratic-programming-based optimization formulation. The resulting framework enables real-time optimal distribution of motor commands while satisfying actuator limits. Comparative experiments demonstrate that the proposed method significantly improves thrust estimation accuracy and mitigates aerodynamic coupling effects.</p>	
11:45-12:00	FrBT1.6
<i>Disturbance-Observer-Based Model Predictive Control for Nonlinear Discrete-Time Systems</i>	
Zhang, Limin	Beijing Research Institute of Telemetry
Li, Peng	Beijing Research Institute of Telemetry
Shi, Jiangbo	Beijing Research Institute of Telemetry
Li, Xiaoliang	Beijing Research Institute of Telemetry
Liu, Bin	Beijing Research Institute of Telemetry
<p>This paper investigates disturbance-observer based model predictive control for nonlinear discrete-time systems. It develops a novel disturbance observer tailored to discrete-time nonlinear dynamics. To mitigate the effect of disturbances, the control law incorporates an explicit disturbance rejection term constructed from the observer estimate. A robust positively invariant set for the state-error dynamics is derived via linear matrix inequalities. Based on this set, tightened state and input constraints are formulated to guarantee constraint satisfaction for the actual system. Closed-loop stability and recursive feasibility are established analytically. Numerical simulations on a cart-spring system substantiate the effectiveness of the proposed disturbance-observer-based nonlinear MPC scheme.</p>	
12:00-12:15	FrBT1.7
<i>Pursuit-Evasion Game for High-Speed Flight Vehicles under Measurement Delays</i>	
Qiu, Mengqi	Beihang University
Zhang, Zejun	Beihang University
Guo, Kexin	Beihang University
Zhang, Kaifeng	Beihang University
Yu, Xiang	Beihang University
<p>This study investigates high-speed pursuit-evasion under measurement delays by integrating the unscented Kalman filter (UKF) with Stackelberg differential game theory. The engagement is modeled as a nonlinear differential game, where the UKF compensates for temporal lags and estimates the relative states of</p>	

non-cooperative players. Building on these estimates, a Stackelberg equilibrium framework enables real-time adaptive maneuvering. Numerical simulations validate the robustness and efficacy of the proposed approach in ensuring successful penetration within complex adversarial environments.

FrBT2	Room 256
Intelligent Collaborative Platform for Unmanned Autonomous Systems (Regular Session)	
Chair: Wang, Xuehe	Sun Yat-Sen University
Co-Chair: Peng, Zhouhua	Dalian Maritime University
Organizer: Meng, Wei	Guangdong University of Technology
Organizer: Chen, Ci	Guangdong University of Technology
Organizer: Wang, Xuehe	Sun Yat-Sen University
10:30-10:45	FrBT2.1
<i>Distributed Online Minimax Optimization with Compressed Communication</i>	
Li, Fan	Northeastern University
Xu, Lei	KTH Royal Institute of Technology
Zhang, Kunpeng	Northeastern University
Yi, Xinlei	Tongji University
Yuan, Ye	Huazhong University of Science and Technology
Li, Yuzhe	Northeastern University, China
Shi, Yang	Canada
Yang, Tao	Northeastern University
<p>This paper investigates distributed online minimax optimization over multi-agent networks. A distributed online mirror descent algorithm integrated with compressed communication is proposed to address the limitations of Euclidean-based methods and communication bottlenecks. To the best of our knowledge, this is among the first attempts to design a communication-efficient distributed online minimax algorithm. The algorithm utilizes Bregman divergence to adapt to the geometric structure of decision variables and employs an absolute error compressor to reduce communication overhead. Theoretical analysis establishes a sublinear dynamic regret bound dependent on path variation.</p>	
10:45-11:00	FrBT2.2
<i>Observer-Based Distributed Nash Equilibrium Seeking for High-Order Nonlinear Players with Input Delay</i>	
Sheng, Zhaoming	Qufu Normal University
<p>This paper investigates the distributed Nash equilibrium seeking problem for high-order players subject to input delay, unmeasurable states, and unmatched nonlinearities. The distributed estimator is designed to estimate the decisions of non-neighboring players, and the state observer is designed to estimate the unmeasurable states. After skillfully introducing the tuning gain and nonlinearities into the design process, the distributed Nash equilibrium seeking strategy is constructed by using a non-recursive design method. Based on the Lyapunov stability theory, it is shown that the decisions of all players can globally asymptotically converge to the Nash equilibrium when the input delay satisfies certain conditions. Finally, the validity of the proposed results is demonstrated by using simulation examples.</p>	
11:00-11:15	FrBT2.3
<i>FEDBUD: Joint Incentive and Privacy Optimization for Resource-Constrained Federated Learning</i>	
Liu, Tao	Sun Yat-Sen University
Wang, Xuehe	Sun Yat-Sen University

<p>Federated learning has become a popular paradigm for privacy protection and edge-based machine learning. However, defending against differential attacks and devising incentive strategies remain significant bottlenecks in this field. Despite recent works on privacy-aware incentive mechanism design for federated learning, few of them consider both data volume and noise level. In this paper, we propose a novel federated learning system called FEDBUD, which combines privacy and economic concerns together by considering the joint influence of data volume and noise level on incentive strategy determination. In this system, the cloud server controls monetary payments to edge nodes, while edge nodes control data volume and noise level that potentially impact the model performance of the cloud server. To determine the mutually optimal strategies for both sides, we model FEDBUD as a two-stage Stackelberg Game and derive the Nash Equilibrium using the mean-field estimator and virtual queue. Experimental results on real-world datasets demonstrate the outstanding performance of FEDBUD.</p>	
11:15-11:30	FrBT2.4
<i>Lattice-Based Data Generation for Neural Model Predictive Control</i>	
Li, Xingchen	Tsinghua University
Li, Tianxun	Tsinghua University
You, Keyou	Tsinghua University
<p>Approximating Model Predictive Control (MPC) with neural networks is a promising approach for real-time control on resource-constrained embedded systems. An important consideration in this process is the generation of high-quality training data that effectively covers the feasible state space. In this paper, we propose a data generation framework based on the S_n lattice, a well-known covering lattice that is proven optimal for dimensions up to 5 and remains the best-known covering for most dimensions up to 21. We develop an efficient algorithm combining Chebyshev centering, random rotation, BFS flooding, and binary search to enumerate lattice points within arbitrary polytopes. We prove a deterministic upper bound on the pointwise approximation error that links the lattice covering radius to the Lipschitz constants of both the MPC policy and the neural network and further analyze the closed-loop stability. Experiments demonstrate that our lattice-based approach achieves improved approximation accuracy compared to random uniform sampling, while maintaining comparable computational efficiency.</p>	
11:30-11:45	FrBT2.5
<i>Energy-Constrained Navigation for Planetary Rovers with Singular Internal Power Source</i>	
Hu, Tianxin	Nanyang Technological University
Guo, Weixiang	Nanyang Technological University
Qian, Rui	Nanyang Technological University
Jin, Jiaye	Nanyang Technological University
Zhao, Haoran	Nanyang Technological University
Yuan, Shenghai	Nanyang Tech. Univ
Xie, Lihua	Nanyang Technological University
<p>Planetary exploration rovers often must operate for extended durations under the low and nearly constant electrical power provided by radioisotope thermoelectric generators (RTGs). While energy-aware planning has been studied for aerial and underwater robots under battery limits, few works for ground rovers explicitly model power flow or enforce instantaneous power constraints imposed by RTG power conditioning and onboard subsystems. Classical terrain-aware planners emphasize slope or traversability, and trajectory optimization methods typically focus on geometric smoothness and dynamic feasibility, neglecting energy feasibility. We present an energy-constrained trajectory planning framework for RTG-powered rovers that explicitly integrates physics-based models of translational, rotational, and resistive power with baseline subsystem loads. By incorporating both cumulative RTG energy supply and instantaneous bus power constraints into SE (2)-based polynomial trajectory optimization, the method ensures trajectories that are simultaneously</p>	

<p>smooth, dynamically feasible, and power-compliant. Simulation results on lunar-like terrain show that our planner generates trajectories with peak power within 0.55% of the prescribed limit, while existing methods exceed limits by over 17%. This demonstrates a principled and practical approach to energy-aware autonomy for long-duration planetary missions.</p>	
11:45-12:00	FrBT2.6
<i>A Comparative Study of Differentiable Physics Learning and MPC for Bidirectional-Thrust Quadrotor Maneuvers</i>	
Zhang, Yechen	Shanghai Jiao Tong University
Li, Fanxing	Shanghai Jiao Tong University
Sun, Fangyu	Shanghai Jiaotong University
De, Qixin	Shanghai Jiao Tong University
Zhang, Linzuo	Shanghai Jiao Tong University
Zou, Danping	Shanghai Jiao Tong University
<p>Traditional quadrotors can only generate thrust in one direction. These limits sustained inverted flight and aggressive maneuvers such as fast 180-degree half-flips. Bidirectional thrust can remove this limit, but it also makes control harder because the motors must pass through a thrust-reversal deadzone. This paper proposes a Differentiable Physics Learning (DPL) pipeline for autonomous half-flips with a bidirectional-thrust quadrotor. The policy is trained with differentiable rigid-body and propulsion dynamics, including the thrust-reversal process. We compare DPL with Model Predictive Control (MPC) in a modified VisFly simulator and in real flight tests. Results show that DPL achieves faster flips and smaller altitude error than MPC. The learned policy is also more robust to thrust-reversal deadzones and requires less online computation. These results show that differentiable physics can be an effective way to train agile controllers for quadrotors with discontinuous actuation.</p>	
12:00-12:15	FrBT2.7
<i>Safety-Critical Perimeter-Defense Guidance of Autonomous Surface Vehicles Based on Nonlinear Model Predictive Control</i>	
Li, Ronghui	Dalian Maritime University
Gu, Nan	Dalian Maritime University
Peng, Zhouhua	Dalian Maritime University
Liu, Lu	Dalian Maritime University
Wang, Anqing	Dalian Maritime University
Wang, Haoliang	Dalian Maritime University
<p>This paper investigates the design of perimeter-defense guidance laws for a defending autonomous surface vehicle (ASV) under input and collision avoidance constraints. A safety-critical perimeter-defense guidance method based on nonlinear model predictive control is proposed. Using the concept of dual optimization design, the optimal attack strategy of the attacker is first estimated by the defending ASV, utilizing information on the dynamics and intent of the attacking ASV. Subsequently, the predicted strategy is embedded into the cost function of the defending ASV, and constraints related to collision avoidance with static obstacles, as well as upper bounds on surge and angular velocities, are incorporated into the optimization framework. By solving this optimization problem, real-time guidance commands are generated that satisfy all constraints, ensuring effective interception of the attacker while guaranteeing safe navigation and avoiding collisions. Finally, the effectiveness of the proposed safety-critical perimeter-defense guidance method is illustrated by the simulation results.</p>	

FrBT3	Room 267
Intelligent Sensing and Embodied Robotic Systems for Medical Diagnosis and Intervention (Regular Session)	
Chair: Zhang, Dongxu	Xiamen University
Organizer: Lu, Bo	Soochow University

Organizer: Zhou, Mingchuan	Zhejiang University
Organizer: Zhang, He	Harbin Institute of Technology
10:30-10:45	FrBT3.1
<i>TBCA-SlowFast: A Spatiotemporal Network for Endoscopic Image-Based round Window Membrane Puncture Recognition</i>	
Yang, Jiahui	Harbin Institute of Technology
Zhu, Haifeng	Harbin Institute of Technology
Zhang, Zhuowen	Harbin Institute of Technology
Yuan, Haozhong	Zhuzhou CRRC Times Electric Co. Ltd
Li, Yuanyuan	The Second Affiliated Hospital of Harbin Medical University
Zhao, Jie	Harbin Institute of Technology
Zhang, He	Harbin Institute of Technology
<p>Compared with traditional otologic surgery, transcanal endoscopic minimally invasive ear surgery offers prominent advantages of less surgical trauma, shorter operation time, and lower risk of postoperative complications. However, the narrow space of the ear canal makes it extremely challenging to integrate conventional force sensors into surgical instruments, leading to the lack of effective real-time state perception during the round window membrane (RWM) puncture procedure. To address this critical issue, this paper proposes an endoscopic image-based deep learning network for accurate recognition of RWM puncture states, named TBCA-SlowFast. The network takes the SlowFast network as the baseline and innovatively introduces a Temporal Branch Coordinate Attention (TBCA) module to enhance the model's ability to capture fine-grained spatiotemporal features and suppress complex background interference in surgical scenes. We further construct a self-built simulated RWM puncture dataset for model training and validation and conduct comprehensive comparative experiments to evaluate the performance of the proposed method. Experimental results show that the TBCA-SlowFast network achieves a recognition accuracy of 88.23% on the test set, which is 1.96% higher than the original SlowFast network. Meanwhile, the TBCA module only introduces a small increase in parameters (0.7M) and computational complexity (14.1M FLOPs), realizing a good trade-off between recognition accuracy and real-time performance. The proposed method can provide reliable intraoperative state feedback for transcanal minimally invasive ear surgery, effectively reducing the risk of over-insertion during RWM puncture and improving the safety and reliability of the surgical procedure.</p>	
10:45-11:00	FrBT3.2
<i>An Ultra-Fast and Broadly Compatible Temperature-Control Device for Rapid Nucleic Acid Amplification</i>	
Yang, Yuhong	Xiamen University
Qian, Yuan	Xiamen University
Yang, Jiayu	Xiamen University
Wang, Junnan	Xiamen University
Zhang, Dongxu	Xiamen University
<p>Conventional PCR instruments are often constrained by low heating and cooling efficiency, insufficient protocol compatibility, and poor suitability for rapid on-site testing. To address these issues, this study develops an ultra-fast temperature-control system for nucleic acid amplification with high efficiency and broad protocol compatibility. The system integrates time-domain and space-domain temperature control schemes and consists of a dynamic temperature cycling module, a thermostatic module, and a microfluidic chip switching module. In the dynamic temperature cycling module, a Peltier thermoelectric cooler serves as the core component, and a sandwich-stacked structure is adopted to enhance heat transfer efficiency and achieve rapid temperature ramping. The thermostatic module employs a combined design of a ceramic heater and an insulating bakelite structure to provide a stable thermal environment for</p>	

annealing and fluorescence detection. Efficient chip transfer among functional modules is realized through a precision ball screw linear stage and a force-controlled push rod mechanism. A hierarchical closed-loop control architecture is adopted, integrating Bang–Bang control, incremental PID, integral-separation PID, and position–force dual closed-loop control to enable coordinated multi-module operation. In addition, fatigue life was evaluated using the finite element method to ensure the mechanical reliability of the module under frequent reciprocating opening and closing during PCR amplification. Among structural steel, aluminum alloy, and PA66-GF30, aluminum alloy was selected as the module bracket material due to its superior fatigue performance. The proposed system improves amplification speed, temperature-control accuracy, and detection stability while maintaining compatibility with different amplification protocols, providing a compact solution for point-of-care testing and rapid pathogen screening.	
11:00-11:15	FrBT3.3
<i>Diffusion Policy-Based Framework for Autonomous Laparoscope View Control with Optimal RCM Selection</i>	
Li, Xudong	Soochow University
Zhang, Xueli	Soochow University
Zhang, Jiangang	School of Mechanical and Electric Engineering, Soochow University
Hou, Wenjie	Gynecology and Obstetrics Department, the Fourth Affiliated Hospital of Soochow University
Lining, Sun	Soochow University
Lu, Bo	Soochow University
<p>Autonomous laparoscope control plays a critical role in maintaining a stable surgical field of view (FOV), improving surgeons' operational efficiency, and enhancing intraoperative safety. To address the requirement for reliable real-time surgical instrument tracking in minimally invasive surgery (MIS), this paper proposes a visual tracking framework for surgical robots based on Diffusion Policy and optimal remote center of motion (RCM) constraints. A two-stage RCM selection strategy is first developed, where candidate RCMs are predefined through robot kinematics and surgical constraints, and the optimal RCM is determined through multi-criteria evaluation. An RCM-constrained control method based on spherical linear interpolation is then introduced, which ensures zero lateral velocity at the RCM point. By incorporating an intuitive virtual plane (IVP) constraint, our method reduces view misalignment and improves the eye–hand coordination. EfficientSAM is employed for fast and accurate segmentation of surgical targets from laparoscopic images. Finally, a Diffusion Policy–based trajectory tracking method is trained on a dedicated laparoscopic dataset to achieve robust instrument tracking. The experiment obtained relatively good data results through methods such as visualization and error comparison, effectively demonstrating the effectiveness and feasibility of the proposed framework.</p>	
11:15-11:30	FrBT3.4
<i>From 3D Gaussian to Contact Force Estimation: An Image-Guided and Biomechanics-Cohorted Force Predictor</i>	
Guo, Shuyan	Columbia University Irving Medical Center
He, Chao	Soochow University
Lu, Bo	Soochow University
<p>Estimating tool–tissue interaction force from visual observations is important for surgical simulation and robot-assisted intervention, yet direct force sensing is often unavailable in minimally invasive settings. Existing vision-based approaches typically rely on 2D appearance cues or end-to-end mappings that lack explicit geometric and biomechanical interpretability.</p> <p>In this work, we propose a multi-stage framework that classifies contact force state from surgical image sequences through explicit geometric</p>	

and physical representations. Our approach has three key components. First, we reconstruct dynamic tissue geometry from temporal surgical images using 3D Gaussian-based scene modeling to capture deformable structure and motion. Second, we bridge vision and biomechanics by converting the Gaussian representation into mesh structures that enable localized deformation analysis. Third, we learn a deformation-to-force classifier by introducing an efficient MLP structure, in which localized geometric states around the tool tip are mapped to discrete contact/non-contact labels that exhibit stepwise transitions over time.

Validation on a SOFA-based liver simulation ($\approx 48k$ samples, 162 runs) demonstrates high prediction accuracy and geometric plausibility on public endoscopic data, providing a physically interpretable framework for vision-based surgical force state estimation.

11:30-11:45 FrBT3.5

Pattern-Aware Adaptive Dual-View Contrastive Learning for Temporal Knowledge Graph Reasoning

Zou, Longyin	National University of Defense Technology
Ding, Zhaoyun	National University of Defense Technology
Chen, Wen	National University of Defense Technology

Temporal Knowledge Graph (TKG) extrapolation predicts future facts by modeling historical evolutionary patterns. However, current methods are hindered by feature noise from irrelevant snapshots and prediction bias toward high-frequency interactions, obscuring emergent events. We propose PACL (Pattern-Aware Contrastive Learning) to adaptively balance historical regularities and local evolution. PACL integrates statistical priors with dual-view semantic features to quantify the historical dependency of each query, generating a pattern-aware coefficient that modulates an adaptive gated contrastive loss. By reinforcing consistency for pattern conforming instances while relaxing constraints for emergent facts, PACL prevents local signals from being smoothed over by historical inertia. Evaluations on four benchmark datasets demonstrate that PACL consistently outperforms state-of-the-art models, particularly in complex, dynamic scenarios.

11:45-12:00 FrBT3.6

CM-Bench: A Comprehensive Cross-Modal Feature Matching Benchmark Bridging Visible and Infrared Images

Liangzheng, Sun	Beijing Information Science & Technology University
He, Mengfan	Tsinghua University
Shao, Xingyu	Tsinghua University
Li, Binbin	Beijing Information Science and Technology University
Yan, ZhiQiang	Beijing Information Science and Technology University
Li, Chunyu	Beijing Institute of Technology
Meng, Ziyang	Tsinghua University
Xing, Fei	Tsinghua University

Infrared-visible (IR-VIS) feature matching plays an essential role in cross-modality visual localization, navigation and perception. Along with the rapid development of deep learning techniques, a number of representative image matching methods have been proposed. However, cross-modal feature matching is still a challenging task due to the significant appearance difference. A significant gap for cross-modal feature matching research lies in the absence of standardized benchmarks and metrics for evaluations. In this paper, we introduce a comprehensive cross-modal feature matching benchmark, CM-Bench, which encompasses 30 feature matching algorithms across diverse cross-modal datasets. Specifically, state-of-the-art traditional and deep learning-based methods are first summarized and

categorized into sparse, semidense, and dense methods. These methods are evaluated by different tasks including homography estimation, relative pose estimation, and feature-matching-based geo-localization. In addition, we introduce a classification-network-based adaptive preprocessing front-end that automatically selects suitable enhancement strategies before matching. We also present a novel infrared-satellite cross-modal dataset with manually annotated ground-truth correspondences for practical geo-localization evaluation. The dataset and resource will be available at: <https://github.com/SLZ98/CM-Bench>.

FrBT4 Room 269

Modeling, Control and Estimation in Unmanned Aircraft Systems (Regular Session)

Chair: Hu, Jinwen	Northwestern Polytechnical University
Co-Chair: Yang, Lidong	The Hong Kong Polytechnic University
Organizer: Zhang, Jiandong	Northwestern Polytechnical University
Organizer: Xu, Zhao	Northwestern Polytechnical University
Organizer: Hu, Jinwen	Northwestern Polytechnical University

10:30-10:45 FrBT4.1

An Improved Active Rendezvous Path Planning Method for UAV-Based Autonomous Aerial Refueling under Wind-Field Constraints

Sun, Xiang	Northwestern Polytechnical University
Li, Weihong	AVIC the First Aircraft Institute
Niu, Yifeng	National University of Defense Technology
Chen, Jun	Northwestern Polytechnical University

Unmanned aerial vehicle-based autonomous aerial refueling (UAV-based AAR) is essential for extending mission endurance for long-duration operations, yet rendezvous operations under stochastic wind fields remain a key technical bottleneck. Current methods adopt passive tanker strategies or precomputed trajectories, lacking adaptive online correction for wind-induced deviations. This study proposes a tanker-initiated hierarchical rendezvous planning and replanning framework for four-dimensional (4-D) synchronization (time, position, airspeed, heading) with a receiver UAV on a fixed cruise route. A recursive wind field model fusing steady wind, improved Dryden turbulence, and discrete gusts is embedded into a 3-DOF numerical simulation platform. Offline, a constrained 3-D Dubins planner generates spatiotemporally synchronized reference trajectories satisfying kinematic and fuel constraints; online, the hierarchical replanner switches between full Dubins recomputation and receding-horizon pure-pursuit (RH-PP) refinement to detect wind-induced deviations and suppress error divergence. Numerical experiments verify the proposed framework achieves robust 4-D rendezvous under realistic wind disturbances, providing a practical technical solution for UAV-based AAR.

10:45-11:00 FrBT4.2

Installation Error Calibration for USV-Mounted USBL Positioning Systems Via Enhanced WOA

Xu, Ruoyu	Northwestern Polytechnical University
Zhao, Chunhui	Northwestern Polytechnical University
Hu, Jinwen	Northwestern Polytechnical University

Lyu, Yang	Northwestern Polytechnical University
Song, Yanyan	Given Name(s)*
Sun, Yinghao	Northwestern Polytechnical University
<p>USBL integrated positioning systems are affected by position errors induced by the lever arm and misalignment angles between the acoustic array and attitude sensors, making installation-parameter calibration essential for accurate underwater target positioning. This paper proposes an improved adaptive triple sub-population whale optimization algorithm (ATWOA) to estimate installation parameters by minimizing positioning residuals from the installation-error model. Experiments show that, compared with GA-BP, PSO-VMD, conventional WOA, and improved UKF, ATWOA achieves lower positioning errors and smaller dispersion of estimated installation angles, demonstrating its effectiveness and reliability for USV-mounted USBL integrated positioning systems.</p>	
11:00-11:15	FrBT4.3
<p><i>Landing Guidance Based on Multi-Sensor Variational Bayesian Adaptive Fusion</i></p>	
Lv, Mingwei	China Aviation Industry Shenyang Aircraft Design Institute
Li, Bingyan	Northwestern Polytechnical University
Wang, Yuxiang	Northwestern Polytechnical University
Xu, Zhao	Northwestern Polytechnical University
Hu, Jinwen	Northwestern Polytechnical University
<p>Terminal carrier landing requires reliable redundant guidance information fusion under asynchronous multi-rate measurements, communication delays, packet loss, and non-stationary noise with occasional outliers. This paper proposes an integrated framework that combines time alignment, integrated scheduling, and a robust variational Bayesian adaptive filter with anomaly score driven strong tracking. Three-point Lagrange interpolation with time backtracking is used for time registration, while the scheduling module unifies coordinate frames and manages repeated updates. Simulation comparisons with an IMM baseline demonstrate improved fusion reliability in terminal landing conditions.</p>	
11:15-11:30	FrBT4.4
<p><i>An Intelligent Hierarchical Method for Spacecraft Maneuver Detection under Short-Arc Observation</i></p>	
Yang, Zhiyuan	Beihang University
Wang, Honglun	Beihang University
Wu, Tiancai	Beihang University
Zhang, Menghua	Beijing Institute of Control Engineering
Wu, Jianfa	Beijing Institute of Control Engineering
<p>Aiming at the spacecraft maneuver detection problem under short-arc observation, an intelligent hierarchical method based on bidirectional long short-term memory network with integrated self-attention (BiLSTM-SA) is proposed. This method decomposes the spacecraft maneuver detection problem into two layers: maneuver identification and impulse velocity estimation. During the offline training phase, under short-arc observation condition, the classification and regression networks based on BiLSTM-SA are trained hierarchically with first order and second-order difference inputs. At the online application phase, based on the output of the classification network for maneuver identification, the regression network for impulse velocity estimation is further applied to output the spacecraft's maneuver time and estimated impulse velocity. Simulation results</p>	

<p>show that the proposed method achieves higher maneuver identification accuracy and more precise estimates of maneuver time and impulse velocity vector, with reduced decision time compared with the baselines.</p>	
11:30-11:45	FrBT4.5
<p><i>Control Barrier Function-Based Reinforcement Learning for Safe Microrobot Autonomous Navigation</i></p>	
Zhao, Jiachi	The HONG KONG Polytechnic University
Xu, Qianyin	The HONG KONG Polytechnic University
Yang, Lidong	The Hong Kong Polytechnic University
<p>Magnetic microrobots hold immense potential for biomedical applications such as targeted drug delivery. However, achieving precise and safe navigation remains a challenge due to the complex working environments. In this paper, a safety-critical autonomous navigation framework that integrates Reinforcement Learning (RL) with Control Barrier Functions (CBFs) is proposed to enable robust obstacle avoidance for magnetic microrobots. The CBF constraint is derived to define the safe admissible control space for microrobots navigation. The constraint is embedded as a safety filter layer within a RL policy network. This architecture allows microrobots to learn efficient navigation strategies in complex environments while strictly enforcing collision-free behaviors, effectively addressing the black-box safety concerns of RL. Simulations in cluttered environments demonstrate that the proposed method achieves successful navigation with zero collisions. Furthermore, real-world experiments using a helical microrobot achieve safe autonomous navigation with zero collisions, verifying the framework's feasibility and robustness against physical uncertainties.</p>	
11:45-12:00	FrBT4.6
<p><i>Target Search in Complex Environments Using UAV with Panoramic LiDAR and Restricted FOV Camera Fusion</i></p>	
Huidong, Wang	Hunan University
Han, Xiangqian	Hunan University
Li, Shaojie	Hunan University
Miao, Zhiqiang	Hunan University
<p>For target search tasks in unknown large-scale environments, existing pure vision-based methods are constrained by the narrow field of view of sensors, making it difficult to strike a balance between rapid spatial coverage and avoiding redundant searches. To address this, this paper proposes an efficient autonomous target search system for unmanned aerial vehicles based on the collaboration of an omnidirectional LiDAR and a restricted FOV camera. The system establishes a novel geometric-guided semantic dual-modal framework, fundamentally decoupling the spatial exploration and potential target search processes. First, an incremental dual-modal viewpoint extractor is designed to efficiently separate high-quality geometric exploration viewpoints and potential semantic preview viewpoints from the environmental point cloud. Based on this, a global search planner based on the Asymmetric Traveling Salesperson Problem is proposed, which innovatively introduces a unified cost matrix incorporating a fused yaw penalty and a hysteresis state machine to achieve optimal scheduling for the two types of heterogeneous viewpoints. Comparative experiments across multiple complex simulation environments demonstrate that the proposed framework not only secures an extremely high true target discovery rate with minimal computational overhead but also enhances macroscopic search flight efficiency, providing a novel paradigm that balances high discovery rates with high efficiency in practical search and rescue missions.</p>	
12:00-12:15	FrBT4.7
<p><i>A Block-Affine Registration and Cloud-Controlled Stitching Method for UAV-Borne Hyperspectral Cameras</i></p>	

Yang, Zihan	Wuhan University
Liu, Xinyi	Wuhan University
Li, Qian	Wuhan Zhongyuan Electronics Group
Duan, Yansong	Wuhan University
<p>Unmanned Aerial Vehicle (UAV) remote sensing technology, owing to its operational flexibility, low cost, and rapid deployment capability, has become an important tool for remote sensing monitoring. Among existing UAV payloads, visible-light cameras are widely used, whereas the application of hyperspectral imaging systems on UAV platforms remains relatively limited. To address this gap, a UAV-borne hyperspectral camera has been developed, and a method integrating block affine model-based registration with cloud-control-based stitching is proposed. For heterospectral registration, a block-based affine transformation strategy is adopted. Specifically, grid partitioning combined with local feature matching is used to estimate spatially varying affine transformations, effectively compensating for local geometric distortions and enabling high-precision registration of heterospectral images. For flight strip stitching, the concept of "cloud control" is introduced, in which existing geospatial datasets are utilized to perform feature matching with individual flight strips. Control points derived from this process are then used to refine the position and orientation system (POS) parameters of the strips, thereby enabling high-accuracy inter-strip stitching. To validate the effectiveness of the proposed method, experiments were conducted in the Yushu area of Jilin Province, China. The results demonstrate that the positioning accuracy achieved by the proposed approach is better than two ground sample distances (GSDs). These findings confirm that the developed hyperspectral camera and processing method effectively enhance UAV-based remote sensing capabilities and provide an important technical foundation for intelligent perception applications such as precision agriculture and environmental monitoring.</p>	

FrBT5	Room 259
Resilient Control and Intelligent Decision-Making for Intelligent Manufacturing and Unmanned Systems (Regular Session)	
Chair: Huang, Jie	Fuzhou University
Co-Chair: Li, Jiahong	Beijing Union University
Organizer: Huang, Jie	Fuzhou University
Organizer: Xue, Dong	East China University of Science and Technology
Organizer: Shi, Mingming	Sichuan University
Organizer: Li, Jiahong	Beijing Union University
Organizer: Liu, Shangkun	Fuzhou University
10:30-10:45	FrBT5.1
<i>Decentralized Target Assignment and Motion Control for Multi-Agent Swarms in Communication-Denied Environments</i>	
Shi, Mingming	Sichuan University
Gao, Yuhan	Xi'an Jiaotong-Liverpool University
Ji, Chengtao	Xi'an Jiaotong-Liverpool University
<p>Coordinating multi-agent swarms for simultaneous target assignment and motion control typically relies on explicit inter-agent communication. However, in communication-denied scenarios, such as electromagnetic jamming or enforced radio silence, this reliance undermines system reliability. To address this, we propose a fully communication-free, decentralized framework that jointly performs target assignment and motion control for missions with strict target quotas. The approach relies solely on onboard sensing and operates in two stages: a flocking-based controller ensures cohesion and collision avoidance, followed by a local "counting region" mechanism that enables agents to infer task completion and autonomously select targets. Simulation results demonstrate that the proposed framework</p>	

satisfies target quotas and achieves efficient, conflict-free convergence without negotiation or information exchange.	
10:45-11:00	FrBT5.2
<i>LLM-DTS: Resilience Formation Control Via Semantic Reasoning and Adaptive Topology Switching</i>	
Zhou, Xuanjie	East China University of Science and Technology
Zhang, Yafen	East China University of Science and Technology
Zhou, Zhao	East China University of Science and Technology
Xue, Dong	East China University of Science and Technology
<p>Achieving robust formation navigation for Multi-Robot Systems (MRS) in complex and non-convex environments remains a fundamental challenge in modern robotics. Traditional Model Predictive Control (MPC) methods, which rely on fixed parameters and rigid topologies, are highly susceptible to local minima and navigation deadlocks when encountering dense obstacle traps or narrow apertures. To address these limitations, this paper proposes LLM-DTS, a hierarchical method that utilizes a Large Language Model (LLM) as a cognitive reasoner to perform environmental semantic analysis and dynamically reconfigure the underlying MPC topology and control parameters. The simulation results demonstrate that the proposed method increases navigation success rates across diverse scenarios and enables autonomous formation reshaping to traverse extreme spatial bottlenecks, enhancing the stability and environmental adaptability of the system.</p>	
11:00-11:15	FrBT5.3
<i>Hyperbolic Sine Function-Based Intermittent Control on Fixed-Time Output Synchronization of Multi-Layer Networks</i>	
Zhao, Tingting	Fuzhou University
Huang, Jingli	FUZHOU UNIVERSITY
Liu, Shangkun	Fuzhou University
Huang, Jie	Fuzhou University
<p>The conventional assumption that all node states are fully measurable and exchangeable is generally unrealistic in practical systems. To overcome the issues of inaccurate convergence time in large-scale switched system stability theorems, unmeasurable node states, and potential chattering in system states, a hyperbolic sine function-based fixed-time aperiodic intermittent control (FTAIC) approach is developed to achieve output synchronization in multi-layer networks (MLNs). Firstly, a novel output-coupled MLN model is proposed, explicitly depicting the heterogeneity of intra-layer and inter-layer dynamical structures allowed by different layers and nodes. Secondly, the novel hyperbolic sine function-based FTAIC is proposed, aiming to mitigate the chattering effects associated with conventional FTAIC controllers that rely on sign functions. By applying the fixed-time (FT) switching stability theorem, a compact criterion for achieving fixed-time output synchronization (FOS) is derived, eliminating the restriction on the output matrix being positive-definite and diagonal. Finally, numerical examples are provided to validate the effectiveness of the proposed control design and the derived criterion.</p>	
11:15-11:30	FrBT5.4
<i>Enhancing Convergence in Multi-Agent Consensus under Hybrid Byzantine-DoS Attacks: A Comparative Study</i>	
Ouyang, Yuhan	Fuzhou University
Liu, Shangkun	Fuzhou University
Huang, Jingli	FUZHOU UNIVERSITY
Huang, Jie	Fuzhou University

<p>With the widespread adoption of multi-agent systems in open communication environments, security threats have become increasingly severe. In mixed threat scenarios where Byzantine attacks and Denial of Service (DoS) attacks coexist, existing methods struggle to simultaneously address identification efficiency and control convergence speed while often relying on predefined reference points. This study proposes the Hybrid-Resilient Adaptive Consensus (HRAC) algorithm to secure multi-agent systems against mixed Byzantine and DoS attacks. The algorithm employs a dynamic reputation mechanism to identify malicious nodes in real-time, combined with event-triggered control to maintain communication efficiency during DoS attacks. Simulation results demonstrate that without requiring predefined reference points, the algorithm significantly improves convergence speed, outperforming traditional norm-based methods in both recovery efficiency and topology adaptability. This work provides an adaptive security framework for multi-agent coordination in complex attack environments.</p>	
11:30-11:45	FrBT5.5
<p><i>Energy and Safety-Aware Multi-UAV Inspection Over DEM Terrain with Offline Planning and Online Deconfliction</i></p>	
Tang, Jingqi	Fuzhou University
Ning, Yingying	Fujian Institute of Education
Liu, Shangkun	Fuzhou University
Huang, Jie	Fuzhou University
<p>In reservoir hydropower inspection, mission feasibility is often jointly constrained by endurance-limited energy budgets and stringent safety requirements imposed by rugged terrain and restricted airspace. This paper considers multi-UAV inspection over terrain reconstructed from a digital elevation model (DEM), where onboard energy is limited and safety must be maintained both near no-fly zones (NFZs) and during close-proximity multi-UAV execution. A two-layer framework is presented. In the offline layer, a DEM-derived terrain graph is constructed, and an additive edge cost is formulated by combining edgewise traversal energy with a clearance-based safety floor to discourage boundary-hugging solutions. Building on an energy-elevation-aware A* (EEA*) search framework, an energy-safety-aware EEA* (ES-EEA*) planner is developed, which retains elevation-aware node ordering to discourage costly climbs while balancing energy-safety trade-offs through the proposed scalarized edge cost. In the online layer, hard inter-UAV horizontal separation is enforced by a deconfliction mechanism in which impending conflicts are resolved through stepwise yield/hold actions with bounded local recovery replanning when required. Over $N = 30$ planning instances, ES-EEA* achieves a mean energy reduction of 3.16% relative to geometric A*, with zero safety-floor violations in the tested set. In a two-UAV execution case, zero violation duration ($T_{vio} = 0$) is achieved with only a 0.75% energy overhead.</p>	
11:45-12:00	FrBT5.6
<p><i>Robust Battery RUL Prediction Via Matern Gaussian Processes with Student-T Likelihood</i></p>	
Li, Jiahong	Beijing Union University
Liu, Shangkun	Fuzhou University
Huang, Jie	Fuzhou University
<p>Accurate remaining useful life (RUL) prediction is critical for the safety and reliability of lithium-ion batteries. However, industrial battery data often exhibit complex non-stationary degradation patterns and are contaminated by sensor anomalies and structural outliers, rendering conventional data-driven models unreliable. To address these challenges, this paper proposes a unified robust probabilistic framework: Matern-Kernel Deep Gaussian Processes with Student-t Likelihood (MK-DGP-t). First, we construct a multi-layer Deep Gaussian Process (DGP) employing the Matern kernel to effectively capture non-smooth temporal correlations and high-dimensional degradation features, overcoming the over-smoothing limitations of standard Radial Basis Function (RBF) kernels. Second, to mitigate the impact of outliers, we replace the Gaussian observation noise</p>	

assumption with a heavy-tailed Student-t likelihood. This formulation naturally down-weights anomalous observations during the variational inference process, ensuring robust posterior estimation. Finally, we design a risk-aware decision mechanism that decomposes predictive uncertainty into epistemic and aleatoric components, enabling the identification of hazardous operating conditions. Validations on the NASA PCoE lithium-ion battery dataset (cell B0005) demonstrate that the proposed MK-DGP-t achieves superior RUL prediction accuracy and robustness compared to state-of-the-art shallow GPs and deterministic deep learning baselines, particularly in the presence of heavy-tailed noise.

FrBT6	Room 264
<p>Swarm Control with Virtual Tubes (Regular Session)</p>	
Chair: Quan, Quan	Beihang University
Co-Chair: Gu, Shuang	The School of Automation Science and Electrical Engineering, Beihang University, Beijing, 100191, China
Organizer: Quan, Quan	Beihang University
Organizer: Liu, Yan-Jun	Liaoning University of Technology
Organizer: Zhu, Bo	Nanjing University
Organizer: Gao, Yan	Tiangong University
10:30-10:45	FrBT6.1
<p><i>Event-Triggered NMPC with DCBFs for Safe Formation Navigation of 4WIS-4WID Robots</i></p>	
Wang, Bin	Liaoning University of Technology
Zeng, Qiang	Liaoning University of Technology
Liu, Yan-Jun	Liaoning University of Technology
<p>This paper proposes an event-triggered nonlinear model predictive control (NMPC) framework integrated with a discrete-time control barrier function (DCBF) for the trajectory tracking and safety-critical control of four-wheel independent steering and independent driving (4WIS-4WID) formation systems. To achieve the optimal performance while ensuring that the critical system variables never violate predefined constraint boundaries, the DCBF constraints are enforced over the prediction horizon to guarantee set forward invariance and safety properties including obstacle avoidance. An event-triggered mechanism is incorporated into the NMPC optimization problem to determine the next triggering instant, thereby significantly reducing the computational burden and conserving network resources without compromising closed-loop safety or performance. Under the proposed scheme, the optimization problem is recursively feasible and closed-loop stability is established. Finally, simulations confirm the effectiveness of the proposed strategy.</p>	
10:45-11:00	FrBT6.2
<p><i>Distributed Passing-Through Control within a Virtual Tube for a Robotic Swarm Based on Null-Space-Based Method</i></p>	
Gao, Yan	Tiangong University
Tang, Xiaozhen	Tiangong University
Qi, Guoyuan	Tiangong University
<p>In our previous work, a virtual tube is proposed to guide a robotic swarm to pass through a cluttered environment. In this work, we use the null-space-based (NSB) method to design a passing-through controller for the robots. Firstly, the virtual tube is modeled in a Frenet-Serret frame using appropriate mathematical descriptions. Then, a distributed swarm controller is proposed based on the NSB method. We make the subtask of avoiding collision between robots have a higher priority, and the subtask of passing through the virtual tube has a lower priority. As the subtask of keeping within the virtual tube is considered a hard constraint, it has the same priority as the task of avoiding collision between robots. Finally, the effectiveness of the proposed method is validated through a numerical simulation.</p>	

11:00-11:15	FrBT6.3
<i>A Distributed Semi-Autonomous Strategy for One-To-Many UAV Cooperative Transport within Virtual Tubes</i>	
Gu, Shuang	The School of Automation Science and Electrical Engineering, Beihang University, Beijing, 100191, China
Liu, Runxiao	Beihang University
Gao, Yan	Tiangong University
Quan, Quan	Beihang University
<p>This paper proposes a distributed strategy for one-to-many unmanned aerial vehicle (UAV) transport, in which a single human operator can manage multiple UAVs in a semi-autonomous mode. Cooperative transport control and virtual tube passage control are integrated within the virtual system, allowing UAVs to safely get through pre-planned virtual tubes. A single human controller enters commands through the keyboard, and the router broadcasts the velocity scaling factor and desired rotation angle to all UAVs. The swarm executes keyboard commands for velocity adjustment along the tube, collective rotation, and collective return, which realize more diverse collective motion modes. Simulation with ten UAVs and outdoor experiments with three UAVs are conducted in two types of tubes: with a straight generator curve and with an irregular generator curve. The results indicate that the proposed strategy improves the consistency and adaptability of UAV swarms when unexpected situations arise.</p>	
11:15-11:30	FrBT6.4
<i>Skeletal Virtual Tube Generation for Urban UAV Swarm Navigation</i>	
Dai, Xunhua	Central South University
Liao, Yuting	Central South University
<p>The rapid deployment of Unmanned Aerial Vehicle (UAV) swarms in dense urban environments necessitates a navigation infrastructure that ensures both computational efficiency and operational safety. This paper proposes an automated framework for the generation of a virtual tube network based on 3D topological reconstruction. Firstly, a Grid-Based Generalized Voronoi Diagram (GVD) is employed to extract skeletal backbones from discrete height slices, maximizing the clearance from building obstacles. Secondly, we introduce a hierarchical planning logic for heterogeneous spaces, bridging 2D planar topologies into a unified 3D manifold through minimized horizontal displacement associations. Finally, parametric virtual tubes are synthesized by calculating boundary-fitted envelopes along the 3D backbone, providing a topologically guaranteed safe volume for swarm navigation. Simulation results in environments with varying obstacle densities demonstrate that while the proposed method maintains a strategic trade-off in path length, it achieves sub-millisecond computational efficiency and superior safety clearance compared to A* and Probabilistic Roadmap (PRM) algorithms. The framework effectively decouples global navigation from local collision avoidance, fostering a structured and organized traffic flow for high-density swarm operations.</p>	
11:30-11:45	FrBT6.5
<i>Distributed Control Strategy for Cooperative UAVs at a Y-Shaped Intersection</i>	
Wang, Mingzhuo	Beijing Jiaotong University
Fu, Rao	School of Traffic and Transportation, Beijing Jiaotong University
Liu, Zhishuo	School of Traffic and Transportation, Beijing Jiaotong University
<p>Intersections are inevitable bottlenecks in emerging low-altitude air traffic networks that adopt a "sky highway" paradigm, where traffic is organized within structured virtual tubes to enable scalable, high-</p>	

11:45-12:00	FrBT6.6
<i>Dual-Layer Safety Tubes with Explicit Reference Governor for Distributed UAV Swarm Navigation</i>	
Jin, Yu	Sun Yat-Sen University
Chen, Qile	Nanjing University
Tang, Jiacheng	Sun Yat-Sen University
Yang, Xia	Sun Yat-Sen University
Zhu, Bo	Nanjing University
<p>Inspired by hierarchical planning in intelligent vehicles—where offline route selection precedes online lane selection—this paper presents a dual-layer safety tube framework for distributed UAV swarms. It comprises: (i) an offline-constructed global virtual tube providing collision-free corridors in voxel maps, and (ii) online-updated individual prediction tubes that envelope closed-loop trajectories under frozen references. Environment and inter-UAV collision avoidance are respectively enforced via tube containment and separation conditions. To ensure explicit realizability, we introduce a pre-stabilized controller with an Explicit Reference Governor (ERG) that regulates an auxiliary reference to enforce safety constraints. The ERG integrates a navigation field for tube progression while avoiding boundaries and neighbors, along with a dynamic safety margin that scales reference derivatives based on minimum distances to tube walls and neighboring tubes. Requiring no large-scale optimization and communicating only low-dimensional tube parameters, the framework achieves low computational and communication overhead. Simulations in realistic underground garage environments demonstrate safe, efficient swarm navigation through narrow ramps and consecutive sharp corners while maintaining prescribed safety distances.</p>	
12:00-12:15	FrBT6.7
<i>A Real-Time Dynamic 3D Virtual Tube for Multi-UAV Swarm Control</i>	
Tang, Zeyu	Guilin University of Aerospace Technology
Liu, Zihui	Guangxi University
Long, Shike	Guilin University of Aerospace Technology
Wang, Yongjun	Guilin University of Aerospace Technology
Sun, Shanlin	Guilin University of Aerospace Technology
<p>Unmanned aerial vehicle (UAV) swarms have attracted increasing attention because of their superior efficiency and robustness. However, safe and agile formation flight in cluttered environments remains a critical challenge. Existing methods offer partial solutions, yet still suffer from limited adaptability, high computational or communication costs, and a predominant focus on two-dimensional scenarios with pre-defined virtual tube information. To address these limitations, this paper proposes a dynamic virtual tube-oriented control method for UAV swarms in three-dimensional environments. The proposed approach first guides the leader UAV along a predefined route using the carrot-chasing algorithm. Then, a reference generating line is established from the leader's traveled trajectory, based on which a 3D virtual tube is dynamically</p>	

constructed using preset tube parameters. Finally, by integrating the dynamic virtual tube with leader-follower consensus control, a controller law is designed for follower UAVs, enabling them to maintain formation while remaining strictly inside the generated tube. Compared with existing methods, the proposed strategy extends virtual tube control from 2D to 3D space and reduces dependence on pre-defined tube information. Simulation results demonstrate that the proposed method successfully achieves stable UAV formation flight within dynamically generated virtual tubes.

FrCT1	Assembly Hall
High-Fidelity Perception, Modeling, and Safety-Critical Control for Autonomous Vehicles in Intelligent Transportation Systems (Regular Session)	
Chair: Yang, Guidong	The Chinese University of Hong Kong
Co-Chair: Fang, Yiyuan	Waseda University
Organizer: Yang, Guidong	The Chinese University of Hong Kong
Organizer: Zhou, Zhisong	The Chinese University of Hong Kong
Organizer: Chen, Jin	Shanghai Jiao Tong University
Organizer: Li, Qingxiang	Jilin University
Organizer: Fang, Yiyuan	Waseda University
Organizer: Li, Ming	KTH Royal Institute of Technology
Organizer: Wang, Jieyu	Tsinghua University
Organizer: Wang, Maonan	The Chinese University of Hong Kong, Shenzhen
Organizer: Guo, Zixuan	The Chinese University of Hong Kong
Organizer: Xie, Shuke	Tongji University
13:45-14:00	FrCT1.1
<i>A Closed-Loop Deadlock Prediction, Prevention, and Resolution Framework for Heterogeneous Robot Fleet Scheduling in Smart Factories</i>	
Hu, Yunqing	Zhuzhou Crcc Times Electric Co., Ltd
Long, Teng	Zhuzhou CRRC Times Electric Co., Ltd
Hu, Enze	CRRC
Huang, Zhikun	Crcc Zhuzhou Electric Locomotive Research Institute Co., Ltd
Luo, Jiexiang	CRRC
<p>Deadlock is a major bottleneck in heterogeneous robot fleet scheduling for smart-factory intralogistics, where kinematic asymmetry, battery-induced timing drift, and class-dependent resource holding exacerbate circular waits. This paper proposes a closed-loop prediction–prevention–resolution framework within a receding-horizon architecture. The core is a Heterogeneity-Aware Deadlock-Resilient Model Predictive Control (HA DRMPC) scheme that embeds calibrated multi-horizon deadlock-risk forecasts into constrained optimization, enabling adaptive rerouting, reservation adjustment, and task resequencing under explicit risk budgets. A conjunctive deadlock confirmation logic—combining risk exceedance, resource-allocation graph (RAG) cycle detection, and temporal persistence—triggers an event-driven recovery MPC that guarantees monotonic deadlock dissolution with minimal schedule disruption. Experiments on a high-fidelity digital twin (750-node factory map, four commercial robot types) show that under high-density (50 robots) and high-disturbance (≤ 130 ms latency) conditions, the proposed framework reduces mean time to recovery by 40.0% and blocking rate by 53.7% relative to the industrial baseline RCS 2000, while maintaining a normalized recovery rate above 94%. These results</p>	

demonstrate a scalable and disturbance robust solution that shifts deadlock handling from passive mitigation to proactive, risk regulated control for heterogeneous robot fleets.

14:00-14:15	FrCT1.2
<i>A Physics-Guided Data-Driven Compensation Modeling of Energy Consumption for Low-Sampling-Rate Data</i>	
Fang, Yiyuan	Waseda University
Bao, Yida	Waseda university, Faculty of Science and Engineering
Yang, Wei-hsiang	Waseda University
Kamiya, Yushi	Waseda University

To address the degradation in prediction accuracy of electric vehicle energy consumption under low sampling rates, this paper proposes an energy consumption modeling approach that integrates vehicle dynamics mechanisms with machine learning. First, multi-source time-series data were collected through real-world on-road vehicle experiments, followed by a resampling analysis across different sampling rates. Subsequently, a physically interpretable feature framework was developed to provide a unified representation of propulsion energy consumption, regenerative braking energy recovery, and auxiliary system energy use. Based on this framework, linear regression, neural network, support vector machine, and Gaussian Process models were trained and validated. The results demonstrate that, over a sampling interval range of 1 s to 60 s, the proposed method maintains stable and high-accuracy predictive performance, achieving a MAPE of approximately 3%–4%, which significantly outperforms conventional statistical feature-based models. This study provides an effective pathway for energy consumption evaluation and energy-efficient control of electric buses under low-frequency data conditions.

14:15-14:30	FrCT1.3
<i>Risk Analysis of Dangerous Driving Behaviors on Highways: A Prediction-Based Driving Risk Assessment Framework</i>	
Guo, Zixuan	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Dangerous driving behaviors pose significant threats to traffic safety, especially on highways. Timely identification and risk assessment of such behaviors enable authorities to issue early warnings, implement targeted interventions, and ultimately enhance overall road safety. However, existing approaches tend to emphasize the identification of dangerous driving behaviors yet fall short in assessing the degree of risk these behaviors entail. This gap limits their applicability in proactive traffic safety management and targeted risk mitigation. To address this issue, we propose a prediction-based driving risk assessment framework assisted by UAVs. Specifically, aerial imagery is utilized to capture vehicle trajectories rapidly. A hierarchical Transformer model is then employed to perform uncertainty-aware trajectory prediction. Based on the predicted trajectories, we introduce two risk assessment metrics—potential collision probability and potential collision severity—to estimate the potential driving risk associated with different driving behaviors. Our method is evaluated on the AD4CHE naturalistic highway driving dataset through the extraction and analysis of characteristic driving behaviors. The system has the potential to realize vehicle behavior monitoring and risk identification for specific areas in highway scenarios.

14:30-14:45	FrCT1.4
<i>From Post-Hoc Filtering to Geometric Learning: Learning Cross-View Geometric Consistency for Multi-View Stereo</i>	
Yang, Guidong	The Chinese University of Hong Kong

Huang, Yijun	The Chinese University of Hong Kong
Shao, Jingheng	The Chinese University of Hong Kong
Wang, Pei	The Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Multi-view stereo (MVS) has achieved significant advances in dense depth estimation and reconstruction by constructing differentiable cost volumes and learning to regularize them. However, cross-view geometric consistency is still predominantly enforced through post-hoc depth filtering, where geometrically inconsistent estimates are removed after inference, often resulting in incomplete point cloud reconstruction. This paper proposes a geometric consistency learning approach that explicitly incorporates cross-view geometric constraints into the training objective, thereby reducing reliance on post-hoc filtering. Specifically, the proposed method formulates cross-view geometric consistency directly in 3D point space by back-projecting image pixel coordinates of the reference and adjacent source views using predicted and ground-truth depths, followed by point alignment under known camera poses, enabling explicit evaluation of geometric discrepancies across views. Based on the resulting point-wise geometric residuals, a differentiable geometry-aware weighting mechanism is introduced to suppress geometrically unreliable depth hypotheses during training, rather than discarding them after inference. Extensive experiments demonstrate that the proposed approach yields consistent improvements in both reconstruction accuracy and completeness, achieves state-of-the-art performance on standard MVS benchmarks when integrated with complementary components, and further demonstrates its effectiveness in real-world outdoor scenarios.

14:45-15:00 FrCT1.5

Artificial-Reference MPC: Discontinuous-Curvature Path Tracking for Autonomous Vehicles

Li, Zihan	Jilin University
Wang, Ping	Jilin University
Li, Pengfei	Jilin University
Fu, Xiuwei	Jilin University
Ma, Bin	Jilin University

Path tracking for autonomous vehicles remains challenging when reference trajectories exhibit curvature discontinuities, such as sharp corners or interrupted segments. Directly following these non-smooth inputs often results in tracking instability or aggressive steering maneuvers. To address this, we propose an Artificial-Reference MPC (AR-MPC) framework. The core of this approach is the introduction of an artificial reference state and its corresponding input as additional decision variables within the optimization problem. In this way, the artificial reference is governed by the vehicle's kinematic constraints and is optimized online to serve as a smooth, reachable intermediate target. To further refine tracking performance, a path segmentation strategy is incorporated to categorize road geometries into typical scenarios based on their geometric features. This allows the controller to employ scenario-specific weighting matrices, ensuring appropriate control efforts for different maneuvers. Co-simulations conducted in MATLAB/Simulink and CarSim environment demonstrate that the proposed AR-MPC significantly reduces tracking errors and enhances motion smoothness. Real-world experiments on the QCar platform further validate the effectiveness of the proposed approach.

15:00-15:15 FrCT1.6

UW3D: A Unified Multi-View Benchmark for Robust Underwater 3D Reconstruction

Yang, Guidong	The Chinese University of Hong Kong
Wang, Chenxiao	Tongji University
Han, Mingqiao	The Chinese University of Hong Kong
Lei, Lei	The Chinese University of Hong Kong
Ding, Yulong	Tongji University
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Underwater 3D reconstruction is critical for marine exploration and remains severely constrained by visual degradation caused by wavelength-dependent attenuation and volumetric scattering. Although geometry-based and neural rendering reconstruction paradigms have advanced substantially in terrestrial settings, their performance degrades considerably underwater due to the lack of unified multi-view datasets with physically consistent degradation modeling and reliable multi-view geometric supervision. In this paper, we introduce UW3D, a unified multi-view dataset and benchmark for underwater 3D reconstruction that integrates physics-consistent synthetic degradations with real-world underwater multi-view sequences within a standardized evaluation framework. The synthetic component is constructed using a revised underwater image formation model that explicitly characterizes attenuation and backscatter while preserving strict multi-view geometric consistency inherited from high-fidelity in-air multi-view data, providing metric depth maps, ground-truth point clouds, and surface normal maps derived via local plane fitting with edge-preserving smoothing for supervised geometric learning and controlled degradation-aware evaluation. The real-world component comprises multi-view sequences captured under varying turbidity and illumination conditions. To address initialization instability under severe optical degradation, we adopt a globally optimized pose-structure estimation strategy that jointly refines camera poses and sparse geometry using dense geometry-aware correspondences and globally consistent optimization, establishing reliable camera-scene configurations for downstream reconstruction. UW3D enables consistent evaluation across geometry-based and neural rendering-based reconstruction paradigms on both synthetic and real-world datasets. Extensive benchmarking results and ROV-based reconstruction experiments demonstrate practical applicability in industrial scenarios.

FrCT2 Room 256

Intelligent Control, Communication Security, and Coordination for Multi-Agent Systems (Regular Session)

Chair: Huang, Zongsheng	University of Electronic Science and Technology of China
Organizer: Yang, Yue	Wuhan University of Technology
Organizer: Bai, Weiwei	Dalian Maritime University
Organizer: Jia, Zehua	Hainan University
Organizer: Zhang, Yichi	China Academy of Launch Vehicle Technology

13:45-14:00 FrCT2.1

Super-Twisting Sliding Mode Control for Affine Formation Maneuver of Multi-ASV Systems

Zhang, Dingze	Wuhan University of Technology
Liu, Kezhong	Wuhan University of Technology
Yang, Yue	Wuhan University of Technology
Li, Tieshan	University of Electronic Science and Technology of China

This paper explores the affine formation maneuver control problem for multi-autonomous surface vehicle systems under complex

practical environment. A stress matrix-based approach is employed to define the formation geometry, enabling flexible affine maneuvers. To effectively suppress the influence of disturbances in dynamic maritime environments, a supertwisting sliding mode control strategy is proposed. Firstly, the control strategy ensures that the followers can track the affine transformations determined by the leaders, while mitigating the chattering phenomenon in traditional sliding mode control. Secondly, a Lyapunov function is constructed to analyze the stability of the system, guaranteeing that the formation tracking errors are uniformly ultimately bounded. Finally, the effectiveness of the proposed strategy is verified through simulation studies. The simulation results demonstrate that under the proposed super-twisting sliding mode control strategy, the ASV formation maintains high tracking precision and successfully executes affine maneuvers for obstacle avoidance.

14:00-14:15 FrCT2.2

Enterprise Fire Safety System Risk Assessment Based on Multi-Agent Modeling within a Complex Adaptive Systems Framework

Song, Zhenjun	China Academy of Launch Vehicle Technology & China University of Mining and Technology-Beijing
Shan, Wei	China Academy of Launch Vehicle Technology
Huang, Xintao	China Academy of Launch Vehicle Technology
Zhang, Yichi	China Academy of Launch Vehicle Technology

Enterprise fire safety is shaped by nonlinear interactions among leadership, management, workers, facilities, and the environment, which cannot be adequately captured by traditional static assessment methods. Existing practices mainly rely on qualitative inspections and static scoring models, providing only snapshot evaluations and overlooking the micro-level mechanisms through which multiple factors accumulate into systemic fire risk. This paper develops a fire complex adaptive system agent-based model (FCAS-ABM), in which the five subsystems are represented as heterogeneous agents characterized by stochastic evolution, nonlinear feedback, and veto thresholds. Based on the model, a composite system safety index incorporating dynamic smoothing, grading, and trend-oriented early warning is constructed. The model is calibrated using expert knowledge and engineering data and implemented in a five-year discrete-time simulation to examine baseline dynamics and alternative governance strategies. Baseline simulations and scenario analyses reveal that the FCAS-ABM provides a quantitative and interpretable tool for dynamic enterprise fire-risk assessment, proactive early warning, and governance strategy optimization.

14:15-14:30 FrCT2.3

Resilient Multi-Agent Perception for Near-Space Vehicle Swarms with Intra-Swarm Attentive Enhancement

He, Qibin	National Key Laboratory of Near-space Physics
Xue, Hanqing	National Key Laboratory of Near-space Physics
Guo, Lingxi	Science and Technology on Space Physics Laboratory
Gu, Tianqi	Science and Technology on Space Physics Laboratory
Yang, Zhe	Science and Technology on Space Physics Laboratory
Chen, Chao	Science and Technology on Space Physics Laboratory

Resilient collaborative perception is pivotal for near-space vehicle (NSV) swarms executing missions such as wide-area earth observation. However, the system-wide perception resilience is threatened by non-uniform vulnerabilities stemming from

platform/sensor heterogeneity and vast variations in observed targets (e.g., in scale and morphology). Systematic assessment and lightweight enhancement of such resilience remain under-explored. To this end, we propose a holistic resilience evaluation and enhancement framework for NSV swarm perception. Our framework quantifies collaborative perception fragility by instantiating heterogeneous virtual perception nodes with an advanced object detector and diagnosing their performance disparities on the DOTA-v1.0 benchmark, which features diverse aerial scenes and targets from vehicles to ships. Based on the profiling, we devise a lightweight intraswarm attentive enhancement mechanism. Without modifying the base detection architecture, this mechanism adaptively reinforces the perception of vulnerable target categories by simulating principles of attentional coordination and feature fusion within a cluster. Experiments on DOTA-v1.0 demonstrate that our mechanism effectively boosts the overall detection accuracy and, more importantly, homogenizes performance across target categories, thereby enhancing systemic resilience. This work provides a quantifiable assessment tool and a plug-and-play enhancement solution for designing collaborative perception systems in NSV swarms, with potential implications for broader multi-agent systems.

14:30-14:45 FrCT2.4

Real-Time Intelligent Identification of UAV RF Fingerprints Based on YOLO26 and Embedded System Validation

Xue, Hanqing	National Key Laboratory of Near-space Physics
Qie, Rongkai	National Key Laboratory of Near-space Physics
Chen, Chao	Science and Technology on Space Physics Laboratory
He, Qibin	National Key Laboratory of Near-space Physics
Wang, Peng	National Key Laboratory of Near-space Physics
Dou, Xiaoming	Science and Technology on Space Physics Laboratory
Guo, Lingxi	Science and Technology on Space Physics Laboratory
Sun, Haiwen	Research Institute

With the proliferation of unmanned aerial vehicles (UAVs), non-cooperative target detection has become a critical security concern. Traditional radar and optical methods often fail to detect small-scale UAVs in complex environments. This paper proposes a novel RF fingerprint identification technique leveraging the YOLO26 architecture. By transforming raw I/Q signals into high-resolution time-frequency spectrograms, we treat signal identification as a specialized object detection task. The YOLO26 model is optimized with the loss function to improve sensitivity to narrow-band frequency hopping signals. Experimental results demonstrate that the proposed method achieves a Mean Average Precision (mAP50) of 98.1% on public datasets. Furthermore, the system delivers a real-time inference speed of 21.73 FPS on the Huawei Ascend 310B AI chip, which verifies its effectiveness for edge deployment in low-altitude security scenarios.

14:45-15:00 FrCT2.5

Multi-Agent Coordination for Derivative-Free Optimization: A Two-Stage Hybrid Speeding-Up Slowing-Down Algorithm

Zhao, Yuxuan	Hong Kong University of Science and Technology
Wang, Yijian	Hong Kong University of Science and Technology
Wang, Junkai	Georgia Institute of Technology
Zhang, Fumin	Hong Kong University of Science and Technology

Coordination in multi-agent systems offers a powerful paradigm for distributed optimization in unknown environments, yet extending these principles to high-dimensional parameter space optimization remains challenging. This paper proposes a two-stage hybrid variant of the Speeding-Up or Slowing-Down (SUSD) algorithm for derivative-free optimization where gradients are ill-defined. The proposed method first employs a weighted centroid direction (WCD) for efficient exploration and fast initial descent, then switches to the original PCA-based direction for refined local convergence. A convergence analysis establishes that the WCD direction locally aligns with the negative gradient under mild conditions, while the PCA stage inherits the convergence properties of the original SUSD. Numerical experiments on data-driven LQR problems and high-dimensional Rosenbrock functions demonstrate that the hybrid method achieves faster initial progress and lower per-iteration compared to the original SUSD. The result is a theoretically grounded derivative-free optimizer bridging multi-agent coordination with high-dimensional optimization.

15:00-15:15 FrCT2.6

Multi-UAV Task Assignment: An Enhanced WTA Model with Linearized Voyage Constraints in MILP

Wang, Zekun	North Automatic Control Technology Institute
Xing, Cheng	Aerospace Information Research Institute, Chinese Academy of Sciences
Zhao, Jianxin	North Automatic Control Technology Institute
Zhang, Hongying	North Automatic Control Technology Institute
Yan, Tao	North Automatic Control Technology Institute
He, Zheng	North Automatic Control Technology Institute

Unmanned aerial vehicles (UAVs) have become indispensable assets for close-ground surveillance and strike operations, playing a vital role in modern military applications. This paper addresses the problem of multi-UAV task assignment within command and control (C2) systems. While existing research has explored various assignment models, limited attention has been given to dynamic task allocation for multi-UAVs. Conventional approaches often fail to account for voyage constraints when assigning multiple tasks to a single UAV. To overcome these limitations, we enhance the classical weapon target assignment (WTA) model by incorporating linearized voyage constraints within a mixed-integer linear programming (MILP) framework. Specifically, we establish a fuel-time relationship and develop a linear route estimation method to compute the voyage requirements for UAVs. The fuel-time relationship is validated through flight experiments, and numerical simulations demonstrate that the proposed MILP formulation outperforms existing methods, confirming its effectiveness in dynamic mission scenarios.

15:15-15:30 FrCT2.7

Prescribed-Time Observer-Based Human-In-The-Loop Optimal Output Tracking Control for Multiagent Systems

Huang, Zongsheng	University of Electronic Science and Technology of China
Yan, Yamin	Nanyang Technological University
Li, Tieshan	University of Electronic Science and Technology of China

This work investigates a prescribed-time observer-based human-in-the-loop (HiTL) optimal output tracking control problem for multiagent systems. The HiTL method facilitates the intervention and guidance provided by the human operator, thereby avoiding imminent dangers. To address the problem that the leader's information is unavailable to each follower, a distributed observer with prescribed-time convergence is designed to enable accurate estimation within a user-

defined time. Subsequently, by combining the follower dynamics with this observer, the HiTL output tracking problem is reformulated into an optimal linear quadratic tracking problem. Meanwhile, the nonhomogeneous algebraic Riccati equations (AREs) are established to solve this problem. Finally, numerical simulations verify the effectiveness of the proposed control scheme.

FrCT3 Room 267

Learning-Based Planning and Control of Robotic Systems (Regular Session)

Chair: Li, Xiang	Tsinghua University
Co-Chair: Gao, Ding	Zhejiang University of Technology
Organizer: Kan, Zhen	University of Science and Technology of China
Organizer: Yin, Xiang	Shanghai Jiao Tong University
Organizer: Huang, Xiucai	Chongqing University
Organizer: Chen, Wenrui	Hunan University

13:45-14:00 FrCT3.1

Reactive Planning for Air-Ground Collaboration Based on Linear Temporal Logic

Zhou, Zhangli	University of Science and Technology of China
Li, Hao	University of Science and Technology of China
Kan, Zhen	University of Science and Technology of China

In unknown and complex environments, relying on a single or homogeneous robotic system often leads to inefficiency or even task failure, particularly when dealing with tasks governed by multiple objectives and constraints in temporal logic. These challenges become more pronounced for task assigners as robots enhance their capabilities during task execution. To address these issues, this paper presents a double reactive planning framework tailored for heterogeneous robotic systems. The framework consists of two main modules: offline task pre-allocation and online reactive allocation and planning. Offline task pre-allocation assigns tasks to drones and quadruped robots based on robot capability and task decomposition specifications. Meanwhile, online reactive allocation and planning updates the knowledge base by sharing perceptual information, incorporates internal logical relationships among task atomic propositions, and adjusts task assignments in response to changes in the robots' capabilities. This ensures task completion while adhering to temporal logic constraints. To validate the framework's effectiveness, we conducted theoretical analyses and simulation experiments. The results show that our approach successfully coordinates the reassignment of both local and global tasks, replanning movements to overcome the challenges posed by unknown environments while maximizing the efficiency and flexibility of heterogeneous robotic teams.

14:00-14:15 FrCT3.2

Asymptotic Optimal Search for Scalable Multi-Agent Linear Temporal Logic Task Planning

Zhou, Zhangli	University of Science and Technology of China
Chen, Ziyang	University of Science and Technology of China
Li, Lin	University of Science and Technology of China
Li, Hao	University of Science and Technology of China
Kan, Zhen	University of Science and Technology of China

Existing search-based task planning methods for multi-agent systems face computational intractability when simultaneously exploring sub-tasks and workspaces. This paper presents an asymptotic optimal search (AOS) method for multi-agent systems with Linear Temporal Logic (LTL) task specifications. AOS constructs a planning tree by searching over sub-tasks while deriving system states through iterative computation of sub-task completion positions and times. This approach decouples planning from workspace exploration, significantly reducing computational complexity. The method first generates a locally optimal plan rapidly, then systematically expands unexplored nodes to ensure global optimality. Sub-trees generated from unexplored nodes are pruned based on current minimum cost, restricting search space without eliminating optimal solutions. The minimum cost is updated asymptotically during sub-tree expansion, further constraining tree depth. Theoretical analysis proves AOS maintains completeness and optimality while achieving per-node linear complexity with respect to agent count, enabling practical scalability for large multi-agent systems. Simulation and experimental results demonstrate that AOS achieves superior computational efficiency for large-scale multi-agent systems with LTL-based tasks, solving problems with thousands of agents within seconds.	
14:15-14:30	FrCT3.3
<i>FA-MARL: Frontier Assignment with Multi-Agent Reinforcement Learning for Efficient Decentralized Multi-Robot Exploration</i>	
Song, Peng	Northwestern Polytechnical University
Yang, Hong'an	Northwestern Polytechnical University
Autonomous multi-robot exploration in unknown environments requires both rapid coverage and reliable coordination. Traditional frontier-based methods are computationally efficient, but they often suffer from redundant exploration and limited adaptability in complex multi-robot settings. To address these limitations, we propose FA-MARL, a decentralized framework that integrates frontier assignment with multi-agent reinforcement learning (MARL) under the centralized training and decentralized execution (CTDE) paradigm. In the proposed method, each robot learns an adaptive frontier evaluation strategy to balance travel distance and information gain, while a multi-level reward guides the team toward efficient coverage and suppresses redundancy. To support practical deployment, FA-MARL is implemented in a modular pipeline that combines Gmapping for mapping, A* for global planning, and DWA for local control. Simulation and real-world experiments with TurtleBot2 robots demonstrate that FA-MARL outperforms heuristic baselines in both exploration efficiency and stability, while remaining effective under asynchronous execution and varying team sizes.	
14:30-14:45	FrCT3.4
<i>Learning to Interact: Socially Adaptable and Risk-Aware Trajectory Planning Via Inverse Reinforcement Learning</i>	
Li, Shanghao	Beijing Institute of Technology
Ke, Weiling	Tongji University
Wang, Danjing	Beijing Institute of Technology
Fang, Hao	Beijing Institute of Technology
Navigating complex interactive scenarios on highways requires autonomous vehicles to simultaneously ensure strict collision avoidance and seamless integration into natural traffic flows. Since traditional planning models struggle to capture the implicit cooperative dynamics inherent in human driving, this paper proposes a data-driven trajectory planning framework based on Maximum Entropy Inverse Reinforcement Learning. The framework adopts a practical generate-evaluate-select paradigm that explicitly decouples hard safety constraints from soft behavioral preference evaluation. To accurately characterize multi-vehicle interactions, we formulate a comprehensive spatial-temporal feature representation, notably introducing interaction risk and social adaptability features to explicitly quantify spatial safety margins and temporal velocity coordination.	

Evaluated on the real-world NGSIM dataset, the proposed approach significantly outperforms representative rule-based and expert-tuned baselines by achieving the lowest trajectory deviation and the highest interactive safety margins. These results indicate that the explicit integration of social adaptability and risk perception enables the planner to effectively handle complex multi-vehicle interactions, successfully reproducing naturalistic, safe, and comfortable driving behaviors.	
14:45-15:00	FrCT3.5
<i>Kinematic-Aware Motion Planning and Reinforcement-Learning-Based Adaptive Control of Autonomous Underwater Vehicles</i>	
Ma, Yue	Tsinghua University
Li, Xiang	Tsinghua University
Song, Shiji	Tsinghua University
Autonomous Underwater Vehicles (AUVs) can autonomously complete environmental perception, positioning, analysis, and decision-making in complex environments, and play an important role in marine scientific research and resource exploration. This paper considers an underactuated AUV, which reduces mechanical complexity, weight, and energy consumption. However, the underactuated structure introduces strong nonlinear coupling in motion, complicating path planning and trajectory tracking. To address this issue, this paper introduces a kinematic-aware motion planning method together with a reinforcement-learning-based adaptive control scheme. The planning module employs an improved Rapidly exploring Random Tree (RRT) algorithm that explicitly incorporates the kinematic constraints of the AUV, thereby generating smooth and dynamically feasible trajectories with reduced path length and energy consumption. On the control side, an adaptive tracking controller is developed, where reinforcement learning dynamically tunes the parameters of a PID structure. This design leverages the interpretability and robustness of classical PID control while enhancing adaptability and stability under environmental uncertainties. Finally, extensive simulations and comparative studies are conducted to validate the effectiveness of the proposed framework in deep-sea environments.	
15:00-15:15	FrCT3.6
<i>Exploring the Correlation between Level Walking and Stair Ambulation for Fine-Grained Gait Phase Prediction</i>	
Sun, Youping	Shandong University
Li, Xingeng	Shandong University
Ma, Chuncan	Qilu Hospital of Shandong University
Ma, Xunju	China North Artificial Intelligence & Innovation Research Institute
Zhang, Huanghe	Shandong University
Fine-grained gait phase prediction from surface electromyography can provide richer timing cues than a coarse stance/swing split, yet its reliability across locomotion modes remains insufficiently characterized at the sub-phase level. This paper studies cross mode generalization under an interval-based five-segment formulation using SIAT-LLMD. Level walking is annotated into five consecutive gait-cycle intervals, while stair ascent and stair descent are treated as mode-specific subsets within a compatible interval template. Multi-channel sEMG is segmented by sliding windows, encoded by compact time-domain features, and classified using a feed-forward artificial neural network. We report within-mode performance and direct transfer, where we train on a source mode and test on a target mode without calibration. Results show strong separability within each mode, whereas cross mode deployment degrades substantially, particularly between level walking and stair ambulation, with errors concentrated near swing-related intervals. In contrast, transfer between stair ambulation is comparatively stable, suggesting closer neuromuscular signatures within stair ambulation. Overall, the findings indicate that fine-grained phase boundaries are highly mode-	

dependent, motivating context-aware modeling and domain adaptation for multi-environment deployment.	
15:15-15:30	FrCT3.7
<i>Modeling and Hierarchical Control of a Flexible Assistive Hip Exoskeleton</i>	
Gao, Ding	Zhejiang University of Technology
Du, Mingyu	Zhejiang University of Technology
Zhang, Luobin	Zhejiang University of Technology
Weng, Yongjie	Zhejiang University of Technology
Wei, Wei	China Jiliang University
Cai, Shibo	China Jiliang University
<p>To address the issues of lower limb motor function decline and increased metabolic burden in patients with sarcopenia and myasthenia gravis, traditional rigid exoskeletons often cause significant physical conflict or misalignment at the human-robot interface due to their large mass and joint axis misalignment. In this study, a lightweight flexible assistive hip exoskeleton was developed, and a hierarchical control strategy based on human-robot interaction was proposed. The hierarchical strategy employed a dual-layer architecture: the perception layer utilized an adaptive Hopfield oscillator to achieve accurate gait phase estimation, while the control layer implemented a variable parameter admittance algorithm based on a variant of the Sigmoid function combined with a feedforward compensation mechanism. This approach addressed the inherent hysteresis and nonlinearity of flexible transmissions, enabling adaptive adjustment of stiffness and damping parameters. Experimental results demonstrated that the system exhibited excellent force-tracking performance, with a mean root mean square error (RMSE) of 9.79~N and an average peak delay of 0.058~s. Metabolic cost evaluations indicated that the proposed dynamic parameter adjustment strategy provided more significant assistance than fixed-parameter strategies, reducing the subjects' metabolic cost by up to 11.2%. The system showed high potential for clinical promotion and application in pathological gait rehabilitation.</p>	

FrCT4	Room 269
Multimodal Interaction and Robot-Assisted Rehabilitation (Regular Session)	
Chair: Wang, Hui	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Wang, Zhiyong	Harbin Institute of Technology, Shenzhen
Organizer: Zhang, Bi	Shenyang Institute of Automation, Chinese Academy of Sciences,
Organizer: Yang, Xingchen	Southeast University
13:45-14:00	FrCT4.1
<i>A Window-Level Structured Representation and Temporal Modeling Framework for Early EEG-Based Cognitive State Prediction in ICU</i>	
Zhihui, Yang	Shenyang Institute of Automation, Chinese Academy of Sciences
Zhao-Han, Wang	Shenyang Institute of Automation, Chinese Academy of Sciences
En-Ming, Shi	Shenyang Institute of Automation, Chinese Academy of Sciences
Cheng-Hang, Li	Shenyang Institute of Automation, Chinese Academy of Sciences
Xu, Zhuang	Shenyang Institute of Automation, Chinese Academy of Sciences
Zhang, Bi	Shenyang Institute of Automation, Chinese Academy of Sciences,

Cognitive state assessment in functionally impaired populations relies heavily on subjective clinical rating scales, which limits continuous monitoring and early warning. To address this limitation, this study proposes an	
<p>electroencephalography (EEG)-based framework for early prediction of cognitive states. Using the intensive care unit (ICU) as a representative application scenario, continuous multichannel EEG signals are modelled through a sliding window strategy, and multi-scale structured time–frequency–modality features are constructed by combining local mean decomposition and short-time Fourier transform. On this basis, a cooperative prediction architecture is developed by integrating window-level feature encoding with cross-window temporal modelling, enabling prospective inference of future cognitive states. Experiments conducted on real ICU patient data demonstrate that, in short-term prediction scenarios, the proposed method significantly outperforms multiple temporal</p> <p>baseline models in terms of accuracy, class balance, and crossfold stability. Furthermore, confusion matrix analysis indicates that prediction errors are predominantly confined to adjacent cognitive levels, which is consistent with the continuous evolution of cognitive states. These results confirm the feasibility of short-term cognitive state prediction using limited historical EEG signals and provide an effective technical pathway for prospective monitoring and early warning in ICU settings.</p>	
14:00-14:15	FrCT4.2
<i>Neuromechanics-Based Reinforcement Learning for FES Control of Lower-Limb Movements</i>	
Zeng, Qiming	Harbin Institute of Technology, Shenzhen
Cao, Ruikai	Harbin Institute of Technology, Shenzhen
Zhou, Zixiang	Harbin Institute of Technology, Shenzhen
Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
Wang, Zhiyong	Harbin Institute of Technology, Shenzhen
<p>Stroke often leads to motor dysfunction and gait impairment, significantly affecting patients' mobility and quality of life. Functional electrical stimulation (FES) has been widely used in neurorehabilitation to activate paralyzed muscles and promote motor recovery. However, achieving coordinated control of multiple lower-limb joints remains challenging due to complex musculoskeletal dynamics. This study proposes a control framework that integrates a musculoskeletal model with reinforcement learning to generate muscle stimulation signals for coordinated lower-limb movements. The musculoskeletal model simulates the dynamics of the hip, knee, and ankle joints, while reinforcement learning is used to learn optimal stimulation strategies for joint control. Simulation results show that the proposed method can achieve coordinated control of the three joints under FES actuation. The root mean square errors (RMSE) of the hip, knee, and ankle joints were 3.52°, 4.60°, and 1.72°, respectively. Compared with a conventional controller, the reinforcement learning-based method improved trajectory tracking accuracy and produced smoother joint movements, demonstrating its potential for FES-based lowerlimb rehabilitation.</p>	
14:15-14:30	FrCT4.3
<i>Hybrid Intelligent Control of Electrostatic Precipitators Based on MIMO Modeling and Fuzzy Logic</i>	
Omirebekova, Zhanar	Satbayev University
Shiryayeva, Olga	Satbayev University
Iskakova, Aigul	Satbayev University
This paper proposes a hybrid intelligent control strategy for electrostatic precipitators (ESPs) used in industrial gas cleaning	

<p>systems. The approach integrates a Multiple-Input Multiple-Output (MIMO) dynamic model, decoupling techniques, PID controllers, and fuzzy logic control to enhance gas distribution efficiency and regulate electrical operating conditions. The ESP system exhibits strong cross-coupling among gas flow channels and nonlinear dependencies in electrical parameters, complicating conventional control design. To address this, a MIMO model with cross-transfer functions is developed to capture system dynamics accurately. Initially, PID controllers are designed for decoupled subsystems. The interaction effects are then compensated to mitigate cross-channel coupling. To improve robustness under uncertain and time-varying operating conditions, a fuzzy logic controller is incorporated to regulate electrical operating conditions adaptively. Simulation results demonstrate significant performance improvements, including the elimination of overshoot, a reduction in steady-state error, and an enhanced transient response. The proposed method achieves an 8.5% relative efficiency improvement over the baseline control strategy. Overall, the proposed hybrid strategy enhances the energy efficiency, robustness, and adaptability of ESP operation, making it suitable for real-time industrial implementation.</p>	
14:30-14:45	FrCT4.4
<p><i>Design of a Digital Twin System Enhanced by Augmented Reality for Reconfigurable Soft Robots</i></p>	
Arymbekov, Beken	Satbayev University
Alipbayev, Daniyar	Satbayev University
<p>In the rapidly advancing domain of soft robotics, continuous progress in material science, structural design, and theoretical approaches has accelerated the development of soft robotic systems, which are increasingly evolving toward flexible and modular architectures with broad industrial applications. Nevertheless, a key challenge in this field remains the accurate representation of shape-morphing behavior, as existing visualization and simulation tools are limited in their ability to capture the complex, continuous deformations inherent to soft robots. In addition, there is a shortage of intuitive and user-friendly platforms that support effective visualization and interactive control of these adaptive systems. To address these limitations, this study proposes a novel digital twin (DT) framework for reconfigurable soft robots within an augmented reality (AR) environment. The proposed system enables more precise and natural visualization of three-dimensional soft deformations while offering an intuitive simulation interface. A parameterized curve-based approach is employed to dynamically update the digital twin in AR, ensuring smooth transitions across different shape-morphing states. Three primary deformation modes—stretching, bending, and twisting—are identified and supported by advanced visualization techniques for accurate representation. Furthermore, sensor fusion is integrated to capture real-time structural changes of the soft robot and translate them into parameterized curves. The system operates entirely within an AR environment, allowing users to perform immersive analysis and simulate the reconfiguration of real-world soft robotic systems.</p>	
14:45-15:00	FrCT4.5
<p><i>System Model and Analysis of Dynamic Radio Resource Management in 5G Mobile Networks</i></p>	
Kengesbayeva, Sara	The Pennsylvania State University
Smailov, Nurzhigit	Satbayev University
Targynova, Zhanerkem	Satbayev University
<p>This paper addresses the problem of dynamic radio resource management in heterogeneous 5G networks (HetNets). Radio Resource Management (RRM) involves a complex multidimensional optimization problem in the context of high-density small-cell infrastructure, interference, and backhaul constraints. The study proposes a joint model that integrates the processes of resource allocation (RA), user association (UA), and power allocation (PA). The proposed model is described based on queue dynamics, the SINR metric, and Shannon's capacity formula, while network stability is ensured using the Lyapunov method. Numerical simulation results showed that the proposed dynamic control method reduces the</p>	

<p>average queue length by 30–40% and increases network throughput compared to static scheduling algorithms. Furthermore, accounting for backhaul constraints allows for a more accurate assessment of network performance. The results confirm the importance of joint optimization approaches for effective radio resource management in 5G networks.</p>	
15:00-15:15	FrCT4.6
<p><i>Muscle Coactivation in Athletes: A Comparative Study of Rock Climbing and Taekwondo Teams</i></p>	
Liu, Shengjie	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Zheng, Yufeng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Pingao, Huang	School of Electronic Engineering and Automation, Guilin University of Electronic Technology
Liu, Wenquan	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences
Fang, Peng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Wang, Hui	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
<p>Muscle coactivation, quantified by the coactivation index (CI), is a fundamental mechanism in human motor control and also provides important bioinspiration for robot motion control. Understanding the muscle coactivation characteristics of professional athletes' limb joint movements is critical for advanced robot motion control strategies. However, most studies have focused on the general population, with limited attention to elite athletes and insufficient consideration of multiple joints and sports, leaving cross-joint and cross-sport differences poorly understood. This study investigated muscle coactivation in rock climbing and taekwondo athletes. Seven elite rock climbers and nine elite taekwondo athletes performed elbow and knee extension and flexion tasks under isokinetic and isotonic conditions while surface electromyography was recorded to calculate CI. Multivariate analysis of variance revealed that elbow coactivation in taekwondo athletes was significantly influenced by exercise mode and movement type, with higher CI observed during flexion and under isotonic conditions. Knee coactivation was primarily affected by movement type within individual sports, whereas team differences emerged in pooled analyses, with opposite flexor–extensor CI patterns between sports. Pooled analysis of dominant-side joint revealed higher CI in the elbow than the knee and significant interactions between team, movement type, and joint. These findings highlight the complexity and sport-specificity of muscle coactivation and provide a theoretical basis for applications in robot motion control and motion skill training.</p>	
15:15-15:30	FrCT4.7
<p><i>A Multi-Point Wearable Fluidic Haptic Interface for Rendering Remotely Grasped Surfaces During Teleoperation Tasks</i></p>	
Padilla, Mark Lester Francisco	The Chinese University of Hong Kong
Trinitatova, Daria	The Chinese University of Hong Kong (CUHK)
Tokmurziyev, Issatay	The Chinese University of Hong Kong
Chen, Fei	The Chinese University of Hong Kong
<p>This work introduces a multipoint fluidic haptic device designed to improve performance in teleoperation tasks. The system features 16</p>	

taxels actuated by electroosmotic pumps, providing precise and localized haptic feedback while maintaining compatibility with commercially available hand-tracking interfaces. The proposed teleoperation system integrates a closed-loop feedback system, where a tactile sensor mounted on the robotic arm captures remote object surfaces and conveys them to the operator through the haptic display. This work highlights the potential of fluid-based haptic systems for advancing teleoperation and remote manipulation applications, offering a foundation for further exploration of tactile feedback in human-robot interaction.

FrCT5	Room 259
Sensing and Control in Exoskeletons (Regular Session)	
Chair: Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Sheng, Yixuan	Harbin Institute of Technology, Shenzhen
Organizer: Dong, Mingjie	Beijing University of Technology
13:45-14:00	FrCT5.1
Lateral Stair Ascending Gait Recognition Based on IMU and Deep Learning Methods	
Yang, Junyi	Shenzhen Institutes of Advanced Technology
Pang, Zhi	College of Intelligent Robotics and Advanced Manufacturing, Fudan University, Shanghai, China
Wang, Shuai	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen
Luo, Mingxiang	The State Key Laboratory of Robotics and Systems, Harbin Institute of Technology Shenzhen, Shenzhen
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Lateral movement training is essential for strengthening hip abductor muscles and improving pelvic stability. While lateral walking on level ground has been extensively studied, lateral stair ascending—a critical activity of daily living—presents substantially more complex dynamic challenges due to gravity, joint loading, and postural instability. In this paper, we investigate gait phase recognition for lateral stair ascending using wearable inertial sensors and propose a hybrid deep learning framework, termed TCNSE- LSTM. We construct a high-density dataset using 14 Inertial Measurement Units (IMUs) mounted on key lowerlimb muscle groups of 12 healthy subjects. Each gait window is represented by a compact 672-dimensional engineered feature sequence extracted from 84 raw IMU channels. The proposed network integrates: (i) a TCN-style dilated convolutional backbone for multi-scale feature interaction along the engineered feature sequence; (ii) a 1-D Squeeze-and-Excitation (SE) channel attention module for adaptive reweighting across learned channels; and (iii) a Long Short-Term Memory (LSTM) layer for modeling long-range dependencies in the refined feature sequence prior to classification. Experimental results show that the proposed method achieves an overall accuracy of 97.50%, significantly outperforming standard CNN, LSTM, and dilated-convolution baselines under the same data processing and training protocol. In particular, our model exhibits superior robustness in identifying the

highly unstable Split-step Double Support (SPDS) phase, where the body's center of mass spans two stair steps. These findings indicate that the proposed framework provides a reliable sensing front-end for precise control of lower-limb exoskeletons operating on unstructured stair terrains.

14:00-14:15	FrCT5.2
Real-Time Prosthetic Hand Control Based on Muscle Synergy Decomposition of Forearm EMG Signals	
Gao, Naixing	Harbin Institute of Technology, Shenzhen
Cao, Ruikai	Harbin Institute of Technology, Shenzhen
Yang, Chen	Harbin Institute of Technology Shenzhen
Sun, Bin	Harbin Institute of Technology
Sheng, Yixuan	Harbin Institute of Technology, Shenzhen

Surface electromyography (sEMG) offers a non-invasive interface for prosthetic hand control, yet clinical adoption remains hindered by poor robustness to electrode shift, inter-subject variability, and muscle fatigue. This study proposes a real-time prosthetic control framework based on muscle synergy decomposition of forearm sEMG signals to address these limitations. Muscle activation levels were extracted from 16-channel sEMG recordings, and a fixed synergy matrix was obtained via non-negative matrix factorization (NMF) during an offline calibration phase. Real-time synergy activation coefficients were computed via pseudo-inverse and mapped to continuous control commands. A support vector machine (SVM) classifier was trained on time-domain features extracted from these coefficients. Experiments with six able-bodied subjects demonstrated that three muscle synergies consistently explained over 90% of data variance, with inter-subject cosine similarity exceeding 0.8. Offline classification achieved 93.03% mean accuracy across five gestures. In real-time object manipulation tasks, the system enabled successful power grasp, lateral pinch, and three-finger grasp with low latency and no critical control failures. These results validate that synergy-based decomposition provides a physiologically interpretable, computationally efficient, and robust solution for intuitive multi-functional prosthetic hand control.

14:15-14:30	FrCT5.3
Stable Online Hand Gesture Decoding with Hybrid sEMG-Ultrasound Sensing and Multimodal Transformers	
Du, Zhao	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen, China
Yang, Junyi	Shenzhen Institutes of Advanced Technology
Li, Xiangxin	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen, China
Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Yin, Meng	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences Shenzhen, China
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS

Abstract—The seamless control of dexterous prosthetic hands requires human-machine interfaces (HMIs) that are not only highly accurate but also robust against online decoding instabilities. In this paper, we propose SU-CT, a unified framework that leverages the temporal responsiveness of sEMG and the morphological stability of A-mode ultrasound. In our architecture, a shallow 1D-CNN tokenizer extracts local spatiotemporal features, which are then fused and

modeled by a Multimodal Transformer to capture global sequence context. Evaluated on 8 subjects across 9 hand gestures, SU-CT achieves a state-of-the-art offline accuracy of 98.85%. In an online Target Matching Task (TMT), the system demonstrates a high Task Success Rate of 96.5% with a motion completion time of low delay. Our work provides a stable forward-mapping solution for human-in-the-loop prosthetic control.	
14:30-14:45	FrCT5.4
<i>Modeling and Trajectory Optimization of a High-Mobility Tensegrity Robot with a Simplified Actuation Scheme</i>	
Wang, Binyan	Shanghai Jiao Tong University
Yi, Yinfan	Shanghai Jiaotong University
Dai, Shenghao	Shanghai Jiao Tong University
Zhang, Shuai	Shanghai Jiao Tong University
Li, Wei	Chongqing University
<p>Mobile tensegrity robots have attracted significant attention due to their lightweight, resilient structures and potential for deployment in challenging environments. However, the majority of existing designs suffer from drawbacks such as inefficient zigzag locomotion mode, excessive motor requirements, and complex actuation schemes. Recently, a novel mobile tensegrity robot featuring a regular prismatic envelope and a simple dual-pendulum actuation scheme was proposed, which achieved smooth and efficient straight-line rolling with minimal actuation by eliminating the zigzag motion. However, its turning capabilities require further optimization, particularly in terms of actuation strategies. In this paper, we focus on the improvement of the turning process of this robot by optimizing its actuation trajectories of the two pendulums. A simplified dynamic model describing the turning dynamics is first developed. Based on the model, the actuation trajectory is parameterized using Fourier series and optimized within a finite-dimensional parameter space. An optimal trajectory is obtained, which is compared with a constant-velocity baseline trajectory in MuJoCo simulation. The results show that the optimized trajectory improves the turning performance by 102.8% in the simplified model and by 190.7% in simulation, compared with the baseline, which demonstrate the feasibility of the proposed model-based actuation trajectory optimization framework.</p>	
14:45-15:00	FrCT5.5
<i>Development of an Underwater Compact Exoskeleton to Assist Leg Motion During Scuba Diving</i>	
Wang, Xiangyang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Ma, Yue	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Wang, Xufei	Tsinghua University
Luan, Mengbo	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Jianquan, Sun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Cao, Wujing	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Chen, Chunjie	Shenzhen Institutes of Advanced Technology (SIAT), CAS
Wu, Xinyu	Shenzhen Institutes of Advanced Technology (SIAT), CAS
<p>Enhancing underwater locomotion can improve divers' operational efficiency while lowering the physiological risks associated with prolonged physical exertion. Although wearable robotic systems have been widely explored for terrestrial applications, their deployment in</p>	

underwater environments remains largely unexplored. This study presents a rigid underwater hip exoskeleton designed to assist flutter kick during scuba diving. The mechanical structure enables bidirectional assistance throughout the kicking cycle while maintaining natural leg mobility. To achieve synchronization between the human motion and robotic assistance, a gait-based adaptive oscillator (GBO) is used to estimate the kicking phase in real time, enabling phase-based torque assistance. A proof-of-concept experiment was conducted with one participant performing flutter kick in a swimming pool. The results show that the proposed exoskeleton can operate reliably underwater and deliver assistance synchronized with the user's kicking motion, providing experimental evidence for the practical feasibility of rigid underwater exoskeleton assistance in a real underwater setting.	
15:00-15:15	FrCT5.6
<i>Multi-Mode Coordinated Control for Bilateral Upper Limb Rehabilitation Exoskeleton</i>	
Guo, Shishang	University of Science and Technology Beijing
Lu, Hanxinyang	University of Science and Technology Beijing
Tang, Jiabao	University of Science and Technology Beijing
Hao, Xiaoyue	Hebei University of Technology
Jiao, Ran	University of Science and Technology Beijing
Zhang, Jianhua	University of Science and Technology Beijing
<p>This paper presents a multi-mode coordinated control method for a bilateral upper-limb exoskeleton rehabilitation robot. A kinematic model is established using an improved D–H convention, and gravity compensation is derived based on the principle of virtual work. A hierarchical control framework is developed with three operating modes. The transparent mode incorporates feedforward compensation to enable near zero-force teaching. The passive training mode uses PID control for trajectory tracking during early rehabilitation. The active training mode applies admittance control, allowing the system to respond to interaction forces between the user and the robot. In addition, a mirror bilateral strategy is introduced, in which the motion of the healthy limb is mapped to the affected side. An active participation mechanism is included, with fault-tolerant trajectory adjustment based on force feedback from the affected limb. Experimental results on shoulder joint movements demonstrate high tracking accuracy in passive mode, effective force-based interaction control in active mode with adjustable admittance gain, and reliable trajectory generation in mirror training. These results confirm the system's ability to adapt to different patient conditions and rehabilitation stages.</p>	
15:15-15:30	FrCT5.7
<i>Preliminary Evaluation of Passive Upper Limb Exoskeleton Assistance Based on Electromyography and Time-Frequency Analysis</i>	
Yang, Lan	Nanjing University of Science and Technology
Li, Yudi	Nanjing University of Science and Technology
Li, Xin	Nanjing University of Science and Technology
Zou, Jiani	Nanjing University of Science and Technology
Zhou, Hui	Nanjing University of Science and Technology
<p>This study conducted comparative experiments under two conditions: with and without exoskeleton wear. Two healthy subjects performed standardized movements across four right-arm holding tasks while</p>	

simultaneously recording surface electromyography (sEMG) signals from six muscles. The exoskeleton's assistive effect was evaluated based on muscle activation levels, Superlet time-frequency characteristics, and co-contraction of BB-TB muscle pair. The results indicated that overall activation levels in major upper limb muscle groups decreased after exoskeleton wear. Besides, this study demonstrates that passive upper-limb exoskeletons have the potential to reduce the load on upper muscle groups in specific type of task. The findings of this study could provide guidance for the structural optimization and performance improvement of passive upper-limb exoskeletons. Future work will be conducted with more subjects and long-term wear experiments.

FrCT6	Room 264
Touch Intelligence and Wireless Teleoperation (Regular Session)	
Chair: Li, Qiang	Shenzhen Technology University
Co-Chair: Li, Yinggang	Shenzhen Technology University
Organizer: Li, Qiang	Shenzhen Technology University
Organizer: Kappassov, Zhanat	Nazarbayev University
Organizer: Li, Yinggang	Shenzhen Technology University
Organizer: Li, Peng	Nankai University
Organizer: Chen, Fei	The Chinese University of Hong Kong
13:45-14:00	FrCT6.1
<i>A Two-Stage Optimization Framework for Designing Direct-Drive Dexterous Robotic Hands</i>	
Wang, Yanyi	Shenzhen Technology University
Zhang, Zhenyuan	Shenzhen Technology University
Chen, Mingqi	Shenzhen Technology University
Long, Junjie	Shenzhen Technology University
Lyu, Jingke	Shenzhen Technology University
Kappassov, Zhanat	Nazarbayev University
Li, Yinggang	Shenzhen Technology University
Li, Qiang	Shenzhen Technology University
The emergence of micro-motors has made it possible to design direct-drive dexterous hands with flexible in-hand manipulation capabilities and without complex mechanical transmission errors. However, existing design methods in this context still rely on heuristic trial-and-error, lacking systematic methodologies. We propose a two-stage optimization framework that formalizes the design of direct-drive dexterous hands as an automated, gradient-free optimization problem. Using the Covariance Matrix Adaptation Evolution Strategy (CMA-ES), the framework autonomously resolves highly coupled design parameters under the physical constraints of selected micro-motors. The first stage identifies an optimal hand configuration by maximizing the opposability envelope volume. After that, the second stage refines phalanx proportions by reproducing natural human hand motions within a physics simulator. By optimizing a composite loss function that strictly penalizes physical unfeasibility, the optimized design reduces self-collision depth by 50.49% and joint limit violations by 32.01% compared with the empirical baseline. This methodology connects theoretical kinematics with physical hardware constraints, rapidly generating optimal dexterous hand design from micro-motors.	
14:00-14:15	FrCT6.2
<i>Design and Experimental Evaluation of a Robotic Gripper for Object Stiffness Estimation Via Motor Torque Analysis</i>	
Muratkanov, Miras	Nazarbayev University
Kairolla, Airis	Nazarbayev University
Galimzhanov, Temirlan	Nazarbayev University
Mukashev, Dinmukhammed	Nazarbayev University
Chen, Mingqi	Shenzhen Technology University

Li, Qiang	Shenzhen Technology University
Kappassov, Zhanat	Nazarbayev University
This paper presents a sensorless method for estimating object stiffness using only the built-in feedback of smart servo actuators. A custom parallel-jaw gripper driven by two Dynamixel XM540-W150-R motors is mounted on a Staubli TX40 manipulator and performs controlled current-ramp squeezing while motor current and encoder position are recorded. Applied torque is derived from current readings through actuator conversion constants and experimentally identified friction compensation, while object compression is computed from a calibrated encoder-to-distance kinematic model. A compliance correction is introduced to reduce bias caused by structural deflection of the 3D-printed PLA fingers under load. The method is validated on six household objects spanning soft-to-rigid behavior, each tested in five repeated trials. Estimated linear stiffness ranges from 0.079 Nm/mm for a kitchen sponge to approximately 2.97 Nm/mm for an apple, with rigid objects showing near-zero compression at the measurement floor. Results confirm that the proposed torque-compression profiling approach can discriminate objects of different stiffness categories without external force/torque or tactile sensors, supporting low-cost integration into robotic manipulation workflows.	
14:15-14:30	FrCT6.3
<i>Comparative Evaluation of Depth Camera and Dual-LiDAR Systems for Automated Feed Bunk Monitoring</i>	
Kairolla, Airis	Nazarbayev University
Muratkanov, Miras	Nazarbayev University
Galimzhanov, Temirlan	Nazarbayev University
Sandykbayeva, Danissa	Nazarbayev University
Zhanibekov, Askhat	COWMAS
Kappassov, Zhanat	Nazarbayev University
In intensive cattle finishing systems, residual feed assessment is still predominantly performed by human bunk callers who visually estimate leftover volume in feed bunks. This subjective process leads to inconsistent feeding decisions, feed waste, and potential health risks for livestock. This paper presents a controlled, side-by-side evaluation of two perception modalities for automated volumetric feed estimation: a static overhead Intel RealSense D455 RGB-D depth camera and (ii) a traversal-based dual Hokuyo 2D LiDAR system that reconstructs 3D geometry by stitching sequential scans. Both systems were tested on the same physical feed bunk using identical crushed barley samples ranging from 5 to 14 L. A shared grid-based height integration pipeline was used for volume computation. The depth camera achieved a mean absolute error (MAE) of 0.57 L with near-zero systematic bias, while the dual-LiDAR system produced an MAE of 1.78 L in raw mode and 1.37 L after applying an empirical calibration factor ($k = 1.1631$). The results indicate that single-frame RGB-D acquisition provides higher accuracy and better consistency under controlled bunk conditions, primarily due to reduced sensitivity to motion artifacts and higher spatial point density. The findings offer practical guidance for sensor selection in perception-estimation loops for precision livestock feeding automation.	
14:30-14:45	FrCT6.4
<i>Antiphase Stereo-Light Modulation for Time-Based Highlighted Region of Interest in Robotic Vision</i>	
Al-Farabi, Zaki	Nazarbayev University
Kairolla, Airis	Nazarbayev University
Yelenov, Amir	Nazarbayev University
Kappassov, Zhanat	Nazarbayev University
Mukashev, Dinmukhammed	Nazarbayev University
This paper describes an antiphase dual-source illumination approach that creates a hardware-defined Region of Interest (ROI) through temporal superposition: two laterally modulated light fields overlap to form a central zone with substantially reduced flicker. Electrical verification confirmed near-ideal antiphase modulation, and high-	

<p>speed camera analysis showed that intensity peaks in one lateral zone align with troughs in the other, producing a markedly flatter temporal profile in the overlap region. Photometric measurements confirmed that stabilization does not come at the cost of dimming: ROI reached nearly double the mean illuminance of the lateral areas of the ROI. Together, these results validate the additive superposition model and show that antiphase lighting can produce a brighter, more temporally stable illumination region in a controlled static setup. These findings establish the photometric basis of the proposed method and motivate future applications in various robotic systems.</p>	
14:45-15:00	FrCT6.5
<i>Optimizer Bias in Facial Expression Recognition and Transfer Learning</i>	
Gongyue, Zhang	Harbin Institute of Technology Shenzhen, China
Liu, Shuyan	Shenzhen Children's Hospital
Li, Xiuhong	Shenzhen Children's Hospital
Li, Xueqing	Shenzhen Children's Hospital
Wang, Jinghua	Shenzhen Children's Hospital
<p>Adaptive optimizers in the AdamW family usually use a fixed default preconditioning strength. However, this setting may not be suitable for facial expression recognition and transfer tasks with different dataset structures. In this paper, we extend p-norm preconditioning experiments to facial expression recognition and transfer to a child pain expression dataset, and study optimizer bias from the perspective of dataset structure. We use p as a unified control variable to adjust the balance between macro low-frequency expression patterns and local detail features. Experiments with both basic and newer backbones on conventional facial expression datasets and a self-collected child pain dataset show that the base setting of AdamW may still overemphasize detail information in facial expression recognition. Increasing p appropriately can improve the focus on macro expression patterns and achieve better performance. For example, on RAF-DB, p=0.6 improves performance by 1.91% over the base setting. We further find that the child pain expression task, with only three classes, has a relatively more dispersed feature space and therefore prefers a different optimizer bias from the seven-class RAF-DB task. These results suggest that AdamW is not optimal for all facial expression datasets and transfer tasks, and that the preferred optimizer bias is closely related to dataset structure.</p>	
15:00-15:15	FrCT6.6
<i>From Perception to Interpretation: A BNN-BN Fusion Approach for Explainable Human Factor Assessment</i>	
Liu, Yingjuan	National University of Defense Technology
Zhou, Yun	National University of Defense Technology
<p>In complex human-machine collaboration systems, the psychophysiological states of operators directly affect system performance and safety, yet traditional control architectures cannot effectively quantify these impacts. This paper proposes a human factors risk assessment and intervention decision support framework integrating Bayesian Neural Networks (BNN) and Bayesian Networks (BN). To validate the framework under highstakes, high-uncertainty conditions, we adopt psychological crisis as a proxy for extreme human-factor states, for which robust physiological markers are well documented. For early warning of psychological crises, the BNN extracts risk probabilities and quantifies predictive uncertainty from multimodal physiological signals (e.g., heart rate variability, EEG alpha power). The BNN outputs serve as evidence variables in a BN that explicitly models interactions among biological, psychological, and social factors, facilitating the transition from black-box prediction to interpretable causal reasoning. Validated on synthetic data driven by the literature, the BNN achieves an AUC of 0.9625 with well-calibrated uncertainty. Meanwhile, the BN identifies alpha power as the key biological driver and social support as the strongest</p>	

protective factor through sensitivity analysis and counterfactual simulation. This framework provides an interpretable tool for the accurate and timely identification of human factors and supports personalized interventions, offering a new paradigm for integrated human-adaptive control systems.

FrDT1	Assembly Hall
Human-Machine Interaction in Medical Robot (Regular Session)	
Chair: Wang, Lin	Chinese Academy of Sciences
Co-Chair: Li, Changsheng	Beijing Institute of Technology
Organizer: Wang, Lin	Chinese Academy of Sciences
Organizer: Li, Changsheng	Beijing Institute of Technology
15:45-16:00	FrDT1.1
<i>A Perspective Review of Coupling Regulation Depth in Human-Exoskeleton Control</i>	
Zou, Hongfei	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences, Guangdong, China
Wang, Lin	Chinese Academy of Sciences
<p>Lower-limb exoskeletons are representative wearable human-robot systems whose control performance critically depends on compliant interaction under strong physical coupling with the user. While a wide range of compliant control strategies has been proposed, existing review studies predominantly classify these methods based on algorithmic structures, which limits a systematic understanding of their underlying human-exoskeleton coupling regulation mechanisms. This paper introduces the concept of Coupling Regulation Depth (CRD) from a system-level perspective to characterize the hierarchical extent to which human-related information is incorporated into control regulation and decision-making. Based on this perspective, compliant control strategies for lower-limb exoskeletons are conceptually categorized into three levels: low CRD, dominated by kinematic reference tracking; medium CRD, characterized by explicit regulation of interaction dynamics; and high CRD, featuring cooperation based on human states and movement intentions. Representative methods at each level are comparatively analyzed in terms of regulation targets, human roles, and applicable scenarios. The proposed CRD framework provides a unified perspective for understanding and analyzing compliant control strategies and offers insights for the design of human-exoskeleton cooperative control architectures.</p>	
16:00-16:15	FrDT1.2
<i>Fatigue-Induced Knee Joint Cartilage Mechanical Responses During Squat as Risk Indicators in a Musculoskeletal Digital Twin Framework</i>	
Wang, Lin	Chinese Academy of Sciences
Jiaju, Zhu	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
<p>With the rapid development of intelligent human-computer interaction systems, such as wearable assistive devices, rehabilitation robots, and virtual training platforms, accurate assessment of the human biomechanical state is essential for ensuring interaction safety and optimizing control strategies. Muscle fatigue is one of the most critical physiological factors affecting human performance in human-machine collaborative tasks, as it can alter neuromuscular coordination, reduce joint stability, and change load transfer patterns, thereby increasing injury risk and impairing interaction performance. Therefore, understanding fatigue-induced biomechanical changes is a key prerequisite for improving interaction safety and developing fatigue-aware control strategies. In this study, 20 healthy male participants performed repeated deep squats under different loads until exhaustion, while motion capture, force platform, and surface electromyography data were synchronously collected. Based on these data, a subject-specific musculoskeletal modeling and finite</p>	

<p>element analysis framework was established to investigate the effects of muscle fatigue on the mechanical response and potential injury risk of tibial cartilage. Tibiofemoral contact forces were calculated in OpenSim and then applied as external loading conditions in ANSYS to evaluate the maximum principal stress and equivalent strain of tibial cartilage. The results showed that with increasing muscle fatigue, tibiofemoral axial compressive force gradually decreased and its peak occurrence was delayed. Despite the overall reduction in axial loading, significant spatial redistribution of cartilage stress and strain was observed, with high-stress regions progressively shifting toward the posterior medial side, while the medial tibial cartilage consistently exhibited higher stress and strain than the lateral side. These findings suggest that fatigue may reduce joint contact stability and promote shear stress accumulation, thereby increasing the risk of cartilage surface collagen damage, interfacial friction, superficial degeneration, and early structural deterioration. The proposed musculoskeletal digital twin framework enables non-invasive evaluation of internal joint mechanical responses under fatigue and provides a new technical pathway for movement safety assessment, personalized training load management, and injury prevention in human-computer interaction systems.</p>	
16:15-16:30	FrDT1.3
<p><i>A Diffusion-Driven Local Planner for Robotic Manipulators in Constrained Environments</i></p>	
Lian, Zihan	Soochow University
Sun, Chengfeng	Soochow University
Chi, Wenzheng	Soochow University
Yang, Hao	Soochow University
<p>Abstract—Precise real-time obstacle avoidance remains a critical bottleneck for robotic manipulation in highly constrained environments. While Diffusion Policy offers a robust framework for complex behavior generation, standard Transformer backbones often suffer from representation attenuation in deep layers and stochastic instability during the denoising process. We address these limitations by proposing an enhanced Diffusion Policy framework featuring a specialized Transformer architecture. Specifically, we integrate custom Diffusion Transformer (DiT) blocks with Adaptive Layer Normalization (AdaLN-Zero) to stabilize conditional denoising and introduce symmetrical long skip connections inspired by U-ViT to preserve fine-grained spatial geometric features. Experimental results on the PushT benchmark demonstrate that our method achieves a 94.5% success rate, significantly outperforming the baseline in both precision and training convergence. Furthermore, our model achieves a 15.4 ms inference latency on an NVIDIA RTX 4090 GPU, satisfying the 50 Hz requirement for high frequency closed-loop control. These architectural refinements provide a scalable solution for deploying agile robotic agents in cluttered, real-world scenarios.</p>	
16:30-16:45	FrDT1.4
<p><i>A Unified and Differentiable Handling of Multilevel Constraint Method for Time-Varying Quadratic Optimal Problem and Its Application to Robot Control</i></p>	
Wang, Zeyu	Beijing Institute of Technology
Wang, Jiahao	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
<p>Practical robotic control tasks are frequently formulated as time-varying quadratic programming (TVQP) problems. Recurrent Neural Network (RNN) exhibit superior efficacy in addressing TVQP, attributed to their inherent parallel processing and dynamic tracking capabilities. However, conventional techniques encounter significant challenges when handling multilevel inequality constraints, such as concurrent joint position and velocity limits, as their reliance on non-smooth piecewise functions inevitably induces control chattering. This study proposes a unified and differentiable multilevel constraint handling framework. By ensuring global differentiability, the proposed method satisfies the rigorous demand for continuous derivative</p>	

<p>information in gradient-based neurodynamics, while maintaining compatibility with traditional numerical solvers. Simulation experiments on a Franka robot arm executing complex trajectories demonstrate that the proposed approach achieves high-precision tracking while ensuring strict adherence to multilevel constraints.</p>	
16:45-17:00	FrDT1.5
<p><i>Flexible Interactive Control for Robot-Assisted Orthopedic Procedures</i></p>	
Liang, Xinye	Beijing Institute of Technology
Wang, Jiapeng	Beijing University of Technology
Zhang, Weijun	Beijing Institute of Technology
Li, Peng	Harbin Institute of Technology, Shenzhen
Tian, Ye	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
<p>Balancing operational transparency with dynamic stability remains a critical challenge in robotic-assisted surgery. This paper proposes a flexible adaptive admittance control strategy based on interaction force feedback to meet the multi-scale task requirements of surgical procedures. By employing interaction force as a comprehensive index of the surgeon's intent, a nonlinear mapping law based on the Sigmoid function is established to achieve continuous and stable transitions of damping coefficients. The integration of an adaptive Butterworth filter and nonlinear saturation constraints further ensure force signal fidelity and system safety. Experimental results on the orthopedic robot demonstrate that the strategy accurately adjusts dynamic responses according to real-time energy characteristics. Compared with the conventional fixed high-damping mode, the proposed method can suppress the tremor phenomenon during precise operation effectively, and can significantly reduce the operation resistance when conducting large-workspace movement.</p>	
17:00-17:15	FrDT1.6
<p><i>TimesNet-Based Human-Robot Interaction Intent Recognition for the Orthopedic Surgical Robot</i></p>	
Wang, Jiapeng	Beijing University of Technology
Zhang, Weijun	Beijing Institute of Technology
Lyu, Sida	Beijing Institute of Technology
Liang, Xinye	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
<p>The osteotomy procedure in robot-assisted Total Knee Arthroplasty imposes stringent requirements on the compliance and safety of physical human-robot interaction. Owing to disturbances from heavy surgical instruments and high-frequency non-stationary mechanical vibrations, conventional time-series models struggle to robustly extract the surgeon's genuine operational intent from six-dimensional force signals. This paper proposes a framework for orthopedic robot interaction intent recognition and control based on TimesNet. The framework first performs real-time data preprocessing via gravity/eccentric moment compensation and adaptive Butterworth filtering. Subsequently, TimesNet is introduced to transform one-dimensional temporal force signals into two-dimensional tensors, effectively decoupling local high-frequency vibrations from long-term intentional trends across multiple period scales. The recognized intents are then fed into an admittance controller to achieve compliant trajectory tracking. Offline evaluations demonstrate that TimesNet outperforms baseline models such as LSTM and Transformer in key metrics, including classification accuracy and F1-Score. In simulated osteotomy experiments, the system exhibits end-to-end responsiveness that meets high-frequency control requirements, effectively ensuring the safety of osteotomy operations and significantly enhancing the compliance of human-robot interaction.</p>	
17:15-17:30	FrDT1.7

<i>A Continuum Manipulator with Variable Curvature for Electrocautery Hemostasis in Spinal Endoscopic Surgery: Design, Modeling and in Vivo Validation</i>	
Wu, Xipeng	Beijing Institute of Technology
Qian, Chao	Beijing Institute of Technology
Wang, Weize	Beijing Institute of Technology
Lyu, Xufeng	Beijing Institute of Technology
Duan, Xingguang	Beijing Institute of Technology
Li, Changsheng	Beijing Institute of Technology
<p>Spinal endoscopic surgery is a representative minimally invasive technique for the treatment of spinal disorders, but the narrow operative corridor and constrained workspace impose high requirements on the dexterity and accessibility of surgical instruments, especially for electrocautery hemostasis. To address the limitations of conventional electrocautery instruments in complex surgical regions, this paper proposes a variable-curvature continuum electrocautery surgical manipulator for spinal endoscopic surgery. The proposed manipulator adopts a modular design integrating an electrocautery tool, a flexible distal segment, and a proximal actuation mechanism, and achieves distal bending, curvature adjustment, axial translation, and overall rotation through tendon-driven actuation. A constant-curvature kinematic model is established to describe the tip pose, and a workspace analysis is conducted to evaluate the reachable region of the manipulator. In addition, an intuitive master-slave mapping method based on a master device is developed to improve teleoperation performance. A prototype of the proposed manipulator is fabricated, and in vivo animal experiments are conducted to validate its operational feasibility and hemostatic effectiveness. The experimental results demonstrate that the proposed manipulator can achieve precise targeting and safe electrocautery hemostasis in complex tissue environments, indicating its potential application in minimally invasive spinal endoscopic surgery.</p>	

FrDT2	Room 256
Intelligent Decision-Making and Applications (Regular Session)	
Chair: Dong, Xiwang	Beihang University
Organizer: Meng, Min	Tongji University
Organizer: Li, Xiuxian	Tongji University
Organizer: Xu, Liang	Shanghai University
Organizer: You, Keyou	Tsinghua University
Organizer: Lu, Peng	The University of Hong Kong
15:45-16:00	FrDT2.1
<i>Global Convergence Analysis of Gauss-Newton Policy Gradient for LQR with Random Packet Loss</i>	
Zhang, Zhenning	Shanghai University
Tianyang, Tian	Shanghai University
Yi, Xinlei	Tongji University
Xu, Liang	Shanghai University
<p>This paper investigates policy gradient methods for the linear quadratic regulator (LQR) problem with Bernoulli packet loss. Since packet losses alter the system dynamics and the expected cost function, existing results on policy gradients for deterministic LQR cannot be directly extended. Therefore, we first prove that, although the LQR with packet losses is a non-convex optimization problem, policy gradient methods can converge to the globally optimal policy, as gradient dominance still holds. We then characterize the "almost" smoothness property of the packet-loss LQR cost function, which provides a foundation for step size selection and convergence-rate guarantees. Furthermore, we heuristically tailor a Gauss-Newton method to the packet-loss LQR and rigorously prove its exponentially fast convergence to the global optimum. By appropriately scaling the</p>	

step size according to the loss rate, the convergence rate of the Gauss-Newton method under losses shares the same expression as in the loss-free case. Finally, numerical simulations validate the theoretical results.	
16:00-16:15	FrDT2.2
<i>Reach-Avoid Games with a NonCooperative Target Along a Line Segment</i>	
Cai, Jiajun	Beihang University
Yan, Rui	Beihang University
Liang, Ruining	Beihang University
Mi, Shuai	Tsinghua University
Dong, Xiwang	Beihang University
<p>This paper studies a multiplayer reach-avoid differential game where a noncooperative target moves along a line segment. The pursuers cooperate to escort the target moving from the start point to the goal point of the line segment against the evaders, whose objective is to attack the target before the target reaches the goal point and avoid being captured by the pursuers. Due to the complexity of direct analysis, the entire game is decomposed to multiple subgames, each involving one pursuer and one evader. First, the properties of the players' trajectories and control inputs are analyzed under optimal play for various payoff functions. Then, an evasion region is introduced for the pursuer-evader pair, from which a safe distance is defined to evaluate the safety of the target. Three pursuit winning conditions and strategies are presented to guarantee the safety arrival of the target, regardless of the evasion strategy. Finally, a maximum matching is obtained by combining all subgame outcomes, which guarantees a lower bound on the number of defeated evaders. Numerical simulations are presented to illustrate the theoretical results.</p>	
16:15-16:30	FrDT2.3
<i>Disturbance Observer-Based Nonlinear MPC for Quadrotor against Impacts and Load Uncertainties</i>	
Chen, Xinqi	Tongji University
Li, Xiuxian	Tongji University
Meng, Min	Tongji University
Lu, Peng	The University of Hong Kong
<p>During capture tasks, the quadrotor inevitably suffers from impact disturbances and payload uncertainties. These composite disturbances pose a significant challenge to controllers. This paper proposes a dual-loop disturbance observer-based nonlinear model predictive control framework. The position loop estimates body-axis disturbance forces to decouple the payload disturbances from the attitude, while the inner loop employs a predefined-time sliding mode disturbance observer to ensure reliability. The Nonlinear Model Predictive Control (NMPC) integrates disturbance estimation to generate anti-disturbance actions. High-fidelity simulations validate the robustness of the proposed controller against both impact and payload disturbances.</p>	
16:30-16:45	FrDT2.4
<i>HGLAD: A Hierarchical Global-Local Decoupling Adversarial Decision-Making Framework Via Agentic Design</i>	
Chen, Ji	Tongji University
Lei, Jinlong	Tongji University
Yi, Peng	Tongji University
<p>Heterogeneous multi-agent adversarial tasks require balancing global collaboration with local constraints under partial observability. Centralized LLM-based frameworks suffer from tight coupling between global awareness and local execution, causing context overload, action failures and short-sighted policies. We propose HGLAD, a hierarchical agentic framework decoupling global situation assessment from local execution. It comprises: a low-frequency</p>	

Strategic Cognition Layer for global assessment and long-term planning via zero-shot chain-of-thought (CoT); and a high-frequency Tactical Execution Layer that generates executable actions by integrating strategic guidance with local constraints using SayCan and ReAct. Experiments show HGLAD outperforms strong centralized baselines, ensuring policy robustness and action feasibility while improving adversarial performance.	
16:45-17:00	FrDT2.5
<i>A LLM Temporal Reasoning Framework Via Fine-Grained Role Extraction and Action Pruning</i>	
Wang, Jiale	National University of Defense Technology
Ding, Zhaoyun	National University of Defense Technology
Sun, Siyang	National University of Defense Technology
In recent years, Large Language Models (LLMs) have been increasingly applied to Temporal Knowledge Graph Question Answering (TKGQA). However, when dealing with complex temporal reasoning, LLMs often struggle and generate inaccurate or misleading responses. A major cause of this issue is that existing methods typically expose LLMs to massive, unpruned candidate action spaces retrieved from knowledge graphs. Without a clear understanding of fine-grained entity semantic roles (e.g., distinguishing subjects from objects or temporal anchors), LLMs are highly susceptible to tool-calling hallucinations and reasoning loops. To address this challenge, we propose a novel Role-Aware reasoning framework for TKGQA. Our approach introduces an entity role extraction module to dynamically identify the semantic roles of entities within the natural language query. By leveraging these structured roles to deterministically prune the candidate action space, we provide the LLM with a highly purified and logically constrained set of reasoning paths. Experimental results demonstrate that our framework effectively mitigates LLM hallucinations during multi-step inference, achieving a significant overall accuracy improvement from 41% to 49% on the complex MultiTQ dataset.	
17:00-17:15	FrDT2.6
<i>Nash Equilibrium Seeking for Multicoalition Games with Varying Number of Heterogeneous General Linear Players</i>	
Chen, Yiyang	Beihang University
Hua, Yongzhao	Beihang University
Li, Xiaoduo	Beihang University
Dong, Xiwang	Beihang University
This paper studies the Nash equilibrium (NE) seeking problem for multicoalition games with varying number of heterogeneous general linear players. In such games, the players cooperate within their own coalitions while competing against other coalitions. Each player can only access its own cost function but is required to optimize the cost function of the entire coalition. To address this issue, an average gradient estimate is designed overweight-balanced digraphs utilizing strategy information and the estimation results are then integrated into the control input to guide players to the NE. In response to players joining or leaving due to task completion and new task initiation, the prescribed-time protocol is introduced to drive players to the NE solution before such changes occur. Then the convergence properties of the proposed algorithm are analyzed based on the Lyapunov method. Finally, a numerical simulation of the multicoalition mobile sensor connectivity game is conducted to demonstrate the effectiveness of the algorithm.	
17:15-17:30	FrDT2.7
<i>Analysis of the Post-Stroke Motor Function Specificity by Integrating EEG and Cerebral Oxygenation Information: A Pilot Study towards Neurorehabilitation Application</i>	
Meng, Haotian	Southern University of Science and Technology

Xu, Xuan	Kunming Medical University
Meng, Fanyuan	Kunming Medical University
Tan, Qiyun	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Mao, He	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Hui, Wang	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Ao, Lijuan	Kunming Medical University
Li, Guanglin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Chen, Moxian	Kunming Medical University
Fang, Peng	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Specificity analysis of motor function after stroke is of great significance for guiding rehabilitation and developing intelligent rehabilitation systems. This study focused on an integrated EEG/Cerebral Oxygenation crossmodal analysis for poststroke motor function assessment towards clinical neurorehabilitation applications. We recruited eight healthy volunteers and four post-stroke hemiplegic patients and designed a standardized elbow flexion-extension paradigm. For analysis, the PLI and Pearson correlation coefficient were used for functional connectivity analysis between EEG and cerebral oxygen (fNIRS), while transfer entropy (TE) was adopted for cross-modal coupling strength quantification. The results showed that the hemiplegic patients had specific EEG features, with elevated β/γ band connectivity during affected limb movement, δ band hyper-connectivity, and stronger connectivity in unaffected brain regions. For fNIRS signals, the connectivity in resting exceeded that in motor state, the prefrontal cortex had the strongest connectivity, and the unaffected brain regions also showed higher connectivity. There is a bidirectional information transmission between EEG and cerebral oxygen signals, with significantly higher $TE\Delta HbO \rightarrow EEG$ in motor state, on patients, and during affected limb movement, respectively. This study preliminarily revealed the neurophysiological mechanisms of post-stroke motor dysfunction and compensation and verified the EEG-fNIRS coupling as an objective biomarker for function assessment, which may provide a support for developing intelligent rehabilitation robots and precision rehabilitation.	

FrDT3	Room 267
Machine Vision and Optical Sensing (Regular Session)	
Chair: Chen, Wei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Co-Chair: Gu, Feifei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Jiao, Guohua	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences, Guangdong, China
Organizer: Chen, Wei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Organizer: Zhao, Juan	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
15:45-16:00	FrDT3.1

<i>Diffusion-Based Data Augmentation for Long-Tailed Wind-Turbine Surface Defect Detection</i>	
Qin, Dawei	Guangdong Feida Transportation Engineering Co., Ltd
Zhou, Boming	Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences
Jiao, Guohua	Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences, Guangdong, China
Yuan, Tianshuo	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
<p>Long-tailed data distribution and limited annotated samples present major challenges for wind-turbine surface defect detection, particularly for rare contamination-related defects. To address this issue, this paper proposes a diffusion-based data augmentation method tailored for long-tailed wind-turbine defect detection. The method generates additional minority-class defect samples while preserving the surface context and visual realism of the original images. To validate its effectiveness, the augmented dataset is evaluated using multiple mainstream object detectors under different training settings. Experimental results show that the proposed augmentation strategy consistently improves minority-class detection performance, increasing mAP@0.5 from 0.346–0.377 to 0.694–0.775. These results demonstrate that diffusion-based augmentation is an effective way to alleviate class imbalance and enhance long-tailed defect detection in wind-turbine inspection.</p>	
16:00-16:15	FrDT3.2
<i>Deep Learning-Based 3D Reconstruction from Underwater Gated Images</i>	
Zhou, Ruixiang	Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences
Yan, Wenxi	South China University of Technology
Chen, Wei	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
<p>Accurate long-range 3D reconstruction in underwater environments remains challenging due to severe light absorption, scattering, and the high acquisition cost of dense delay scanning in conventional range-gated imaging systems. To improve reconstruction efficiency while reducing hardware and data collection costs, this paper proposes a deep learning framework that integrates coded gating strategy design with data-driven depth estimation. Instead of dense temporal scanning, three carefully designed coded range-gated images are employed to encode complementary depth information, significantly reducing acquisition complexity. A multi-encoder–decoder architecture with DINOv2 backbones is adopted to extract multi-scale features from the coded observations, followed by cross-level feature fusion and a DPT-based prediction head for dense depth reconstruction in a single forward pass. To address the scarcity and high cost of real underwater paired datasets, a depth-prior-guided low-cost data synthesis pipeline is developed to construct a large-scale training dataset without expensive field measurements. This strategy enables effective supervision while maintaining physical consistency with underwater imaging characteristics. Extensive experiments on both simulated and real-world data demonstrate that the proposed method achieves superior performance compared to traditional analytic reconstruction methods and baseline learning models in terms of Absolute Relative Error (AbsRel) and threshold accuracy $\delta < 1.25$. The proposed approach provides an efficient, scalable, and cost-effective solution for underwater 3D perception, with strong potential for applications such as seabed mapping and underwater inspection.</p>	

16:15-16:30	FrDT3.3
<i>Narrow-Baseline Binocular Endoscopic System and Three-Dimensional Reconstruction Method</i>	
Liu, Qiyu	Shenzhen Institutes of Advanced Technology, University of Chinese Academy of Sciences
Zhang, Zhen	Shenzhen Institutes of Advanced Technology, University of Chinese Academy of Sciences
Zheng, Bowen	Nanjing Institute of Technology
Song, Zhan	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Gu, Feifei	Shenzhen Institutes of Advanced Technology, Chinese University of Hong Kong
<p>Three-dimensional imaging technology has significant application value in endoscopic medicine. Accurate 3D depth information can assist both surgical procedures and routine diagnosis. This paper proposes a narrow-baseline binocular endoscopic system and a corresponding 3D reconstruction method. After completing binocular calibration and epipolar rectification, Foundation Stereo is introduced to achieve dense disparity estimation. Combined with chessboard calibration information for scale correction, 3D reconstruction results with real-world metric scale are obtained. The proposed method is validated on both real endoscopic images and the Middlebury 2014 benchmark dataset and is compared with the traditional Semi-Global Block Matching (SGBM) method. Experimental results show that in real endoscopic scenarios, the proposed approach can generate structurally continuous 3D reconstructions with reasonable geometric shapes under complex imaging conditions. The results provide a feasible technical route and experimental basis for narrow-baseline binocular endoscopic 3D imaging.</p>	
16:30-16:45	FrDT3.4
<i>A Fast-Tracking Method for Aerial High-Maneuvering Targets Based on Multi-Stage Fusion Strategy</i>	
Liu, Hu	Xi'an Institute of Applied Optics
Zhu, Lei	Xi'an Institute of Applied Optics
Li, Jiajia	Xi'an Institute of Applied Optics
Wu, Yan	Xi'an Institute of Applied Optics
Zhao, Xuechen	Xi'an Institute of Applied Optics
Hou, Rui	Xi'an Institute of Applied Optics
<p>Aiming at the aerial security threats posed by highly maneuverable unmanned aerial vehicles (UAVs), existing electro-optical tracking systems often struggle to achieve both rapid response and reliable performance. To address this issue, this paper proposes a multi-stage fast tracking method based on a fusion strategy for highly maneuverable aerial targets. First, the characteristics of the kernelized correlation filter (KCF) tracking algorithm are analyzed, along with the core problems encountered in conventional tracking centering processes, including target escape, motion-induced image blur, and tracking loss caused by limited servo rotation speed. Subsequently, a multi-stage tracking framework is constructed, comprising four sequential stages: initial target acquisition, deviation conversion and template pre-storage, fast servo rotation centering, and stable tracking guided by the pre-stored target feature template. Finally, experimental evaluations and analyses are conducted to verify the effectiveness of the proposed method. The results demonstrate that the multi-stage method improves tracking centering efficiency by a factor of 3.44, effectively enhancing both tracking speed and stability. Moreover, it substantially improves the rapidity, accuracy, and robustness of electro-optical systems in tracking highly maneuverable aerial targets. This work provides a novel solution for advancing electro-optical tracking technologies against highly maneuverable aerial targets.</p>	

16:45-17:00	FrDT3.5
<i>Optimization Methods for Autonomous Target Locking Strategies Based on Small Unmanned Aerial Vehicles</i>	
Wu, Yan	Xi'an Institute of Applied Optics
Zhu, Lei	Xi'an Institute of Applied Optics
Zhao, Xuechen	Xi'an Institute of Applied Optics
Liu, Hu	Xi'an Institute of Applied Optics
Li, Jiajia	Xi'an Institute of Applied Optics
Sun, Hao	Xi'an Institute of Applied Optics
Hou, Rui	Xi'an Institute of Applied Optics

Swarm operations of unmanned aerial vehicles (UAVs) have emerged as a disruptive technology reshaping future operational paradigm, where reconnaissance perception and autonomous target locking serve as core capabilities. To tackle the engineering challenges including scarce effective features of dim and small targets, easy loss caused by target maneuvering, significant system link latency, and the difficulty in balancing locking accuracy and real-time performance, this paper proposes an optimized autonomous locking strategy for dim and small targets in small UAV platforms. By optimizing the system management architecture, an efficient closed-loop kill chain of detection-localization-tracking-aiming-engagement is constructed. Based on the YOLOv8 detector, weak target features are preserved via image block-based inference. A frame-number encoding and cache traceability mechanism is designed to achieve precise information-image synchronization and reduce link latency. An intelligent autonomous switching logic between detection and tracking is established to support target reacquisition after loss and human-in-the-loop intervention. Field experiments demonstrate that the proposed method provides a reliable technical solution for autonomous reconnaissance and engagement of small UAVs.

17:00-17:15	FrDT3.6
<i>Efficient 3D Face Reconstruction in Spherical Coordinates with a High-Throughput Structured-Light System</i>	
Ren, Bin	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences
Ye, Yuping	Fujian University of Technology
Song, Zhan	Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences

Acquiring complete and high-fidelity 3D facial geometry is essential for applications such as digital avatar generation and biometric analysis. However, existing methods struggle to balance high-resolution data acquisition with efficient processing, often suffering from heavy computational costs and cumulative drift during rapid head movements. To address these challenges, we present a complete high-speed 3D facial reconstruction system that tightly integrates a custom monocular structured light scanner with an efficient, globally consistent registration pipeline. First, our hardware system acquires 1.77-megapixel facial geometry at 35Hz. To handle this massive data stream, we implement a spatiotemporal keyframe selection strategy based on spherical grid sampling to effectively filter redundant frames. For global registration, we introduce an angular-guided pipeline. By utilizing a spherical projection mechanism, we bypass exhaustive pairwise feature matching, thereby significantly reducing the graph construction complexity. Furthermore, by replacing the heavy non-linear Pose Graph Optimization (PGO) backend with cascaded matrix multiplications along a Minimum Spanning Tree (MST) structure, we completely bypass the time-consuming optimization phase. Experimental results demonstrate that our entire system achieves a 14.8× overall speedup compared to standard PGO baselines, while maintaining robust sub-millimeter geometric precision (Inlier RMSE of 0.339 mm) under large pose variations.

17:15-17:30	FrDT3.7
-------------	---------

<i>Occlusion-Resilient UAV Victim Detection in Dense Forest Search and Rescue Via Light Field Rendering and Lightweight YOLO</i>	
Wang, Pei	The Chinese University of Hong Kong
Wang, Jialiang	The Chinese University of Hong Kong
Shao, Jingheng	The Chinese University of Hong Kong
Cao, Haosen	Chinese University of Hong Kong
Chen, Xi	The Chinese University of Hong Kong
Chen, Ben M.	Chinese University of Hong Kong

Search and rescue (SAR) in dense forest poses significant challenges due to heavy canopy occlusion and poor visibility. Traditional methods like thermal imaging and LiDAR often fail to penetrate dense vegetation effectively. This paper proposes a novel system that combines Light Field Rendering (LFR)—a synthetic aperture imaging technique using drones to capture unstructured light fields for occlusion removal—with a super-lightweight You-Only-Look-Once (YOLO) model generated via YOLO-Light, a NeuroEvolution-based architecture optimization method. By integrating multi-perspective thermal images into occlusion-free integral images and applying the lightweight YOLO for real-time detection, our approach achieves high precision and recall in victim localization under heavy occlusion. Experimental results on datasets from forested terrains demonstrate a reduction in model parameters by more than 10 times while maintaining detection accuracy above 90%, enabling deployment on resource-constrained drones.

FrDT4	Room 269
Optimization and Control for Intelligent Autonomous Systems (Regular Session)	
Chair: Lu, Maobin	Beijing Institute of Technology
Organizer: Yu, Xiao	Xiamen University
Organizer: Chen, Chen	Beijing Institute of Technology
Organizer: Lu, Maobin	Beijing Institute of Technology

15:45-16:00	FrDT4.1
<i>Robust Data-Driven Safety Control for Perturbed Polynomial Systems Via Control Barrier Certificates</i>	
Sun, Yutong	Xiamen University
Guan, Jinting	Xiamen University
Yu, Xiao	Xiamen University
Lan, Weiyao	Xiamen University

This paper investigates the safety-critical control problem for continuous-time nonlinear polynomial systems subject to perturbations, where the system matrices A and B are entirely unknown. To ensure safety without prior knowledge of the model, we propose a robust, data-driven framework based on control barrier certificates (CBCs). Unlike existing deterministic approaches, the proposed method explicitly incorporates unmodeled dynamics and perturbations into the safety constraints by leveraging sum-of-squares (SOS) programming. Using the collected input and state data, a quadratic CBC and a corresponding safe controller are synthesized simultaneously. The framework guarantees that system trajectories remain within the safe set even in the presence of bounded perturbations. Simulation results on a nonlinear polynomial system demonstrate the robustness and effectiveness of the proposed data-driven synthesis approach.

16:00-16:15	FrDT4.2
<i>Safety-Critical Control for Tethered Human-Robot Guidance Systems Via Control Barrier Functions</i>	
Xie, Tao	Xiamen University

Yu, Xiao	Xiamen University
Lan, Weiyao	Xiamen University
<p>This paper focuses on ensuring the safety of tethered human-robot guidance systems in obstacle-cluttered environments. In such systems, the robot and the human are physically coupled by a tether, which imposes unique geometric constraints and requires coordinated safety guarantees for both participants. To address this, we first establish a unified human-robot coupled kinematic model. Then, a safety-critical control framework is proposed by integrating Signal Temporal Logic (STL) with Control Barrier Functions (CBF). Specifically, the high-level task goals are described by STL to generate nominal motions, while the low-level CBF-based optimization ensures real-time obstacle avoidance and maintains the required tethered guiding mode. The performance of the proposed method is validated through Gazebo simulations and hardware experiments with a quadruped robot. Results show that our approach effectively guides the human while strictly satisfying all safety and tether-related constraints.</p>	
16:15-16:30	FrDT4.3
<p><i>Robust Distributed Nash Equilibrium Seeking for Discrete-Time Agents</i></p>	
Liu, Lupeng	Beijing Institute of Technology
Deng, Fang	Beijing Institute of Technology
Chen, Jie	Tongji University
Lu, Maobin	Beijing Institute of Technology
<p>This paper investigates the distributed Nash equilibrium seeking problem of N players with discrete-time dynamics under jointly strongly connected switching networks. First, by integrating gradient play technique with a novel discrete-time distributed observer design, we develop a discrete-time distributed Nash equilibrium seeking controller to solve the problem. Next, we establish two technical lemmas to analyze the uniform exponential stability of discrete-time linear switched systems. Then, we obtain the exponential stability of the interconnected closed-loop systems by constructing a Lyapunov function and providing a controller gain design method with the small gain arguments. Finally, the discrete-time distributed Nash equilibrium seeking is achieved over jointly strongly connected switching communication networks. The effectiveness of the developed approach is demonstrated by a numerical simulation example.</p>	
16:30-16:45	FrDT4.4
<p><i>Haptic Teleoperation System Based on Parallel Mechanism: Design and Implementation</i></p>	
Yan, Qilin	Beijing Institute of Technology
Liu, Geyuan	Beijing Institute of Technology
Xie, Bowei	Beijing Institute of Technology
Xie, Kedi	Xiamen University
Lu, Maobin	Beijing Institute of Technology
<p>Teleoperation systems are essential in high-risk domains such as minimally invasive surgery, nuclear maintenance, and space exploration. However, effective haptic feedback usually requires expensive force sensors and specialized hardware, resulting in high cost and system complexity. To address this issue, this paper presents a cost-effective sensorless teleoperation system based on a unified impedance control framework. The system adopts a master-slave architecture, where a custom high-stiffness Delta parallel manipulator serves as the master device and a 6-DOF serial manipulator serves as the slave device. The forward channel maps master-side motion to slave-side poses commands, while the feedback channel synthesizes virtual spring-damper interaction forces from master-slave pose discrepancies without distal force/torque sensors. Experiments demonstrate stable tracking performance and contact-related haptic cues during constrained interaction. The proposed system reduces hardware overhead and</p>	

<p>integration complexity, providing a practical solution for educational and general industrial teleoperation applications.</p>	
16:45-17:00	FrDT4.5
<p><i>A Hierarchical Reinforcement Learning Framework for Reach-Avoid Games with Obstacles</i></p>	
Yang, Kun	Beijing Institute of Technology
Chen, Yanqiu	Beijing Institute of Technology
Chen, Chen	Beijing Institute of Technology
<p>Reach-avoid (RA) games serve as fundamental mathematical models for safety-critical autonomous systems. However, in complex environments characterized by dense obstacles, balancing efficient adversarial interception with safe obstacle avoidance presents significant challenges. Traditional analytical methods suffer from the curse of dimensionality, while standard deep reinforcement learning (DRL) approaches often converge to suboptimal policies due to the conflicting dual objectives of safety and mission efficiency. To address these limitations, we propose a hierarchical reinforcement learning (HRL) framework which decouples strategic planning from motion control. The high-level manager incorporates a gated recurrent unit predictor to reconstruct the adversary's belief state under partial observability. By leveraging dynamic temporal abstraction, it generates macroscopic tactical commands, intelligently switching between target protection and active pursuit to maximize long-term game payoffs. Simultaneously, the low-level worker employs a neural module network (NMN) architecture to disentangle task-oriented flows from obstacle-avoidance flows, achieving efficient maneuvering strictly premised on safety compliance. Extensive simulations demonstrate the proposed method's superior robustness against diverse and complex attack strategies, including evasive, orbiting, and composite behaviors. Compared to baseline algorithms, our framework significantly outperforms in terms of capture rate and decision efficiency, validating the superiority of the hierarchical architecture in RA games with non-convex geometric constraints.</p>	
17:00-17:15	FrDT4.6
<p><i>Resilient Formation Control for Vehicle Platoons against Cyberattacks and Uncertainties</i></p>	
Chen, Xiaolong	The Hong Kong University of Science and Technology (Guangzhou)
Zhong, Ruiguo	The Hong Kong University of Science and Technology (Guangzhou)
Liu, Pei	The Hong Kong University of Science and Technology
Shi, Jianxin	Beihang University
Ma, Jun	The Hong Kong University of Science and Technology
<p>This paper investigates the resilient formation control problem for vehicle platoons subject to the synergistic coupling of parameter uncertainties and composite cyberattacks. Unlike prevalent approaches predicated on model linearization, which may prove inadequate against structural nonlinearities and complex threat environments, this work establishes a unified decentralized framework tailored for rigorous nonlinear longitudinal dynamics. Specifically, the system is modeled to account for the specific characteristics of both additive and multiplicative attacks. A novel kinematic evolution based on a bidirectional nearest-neighbor topology is first developed, theoretically revealing a fundamental structural decoupling property where the macroscopic centroid motion of the leaderless platoon remains invariant to microscopic formation errors. Then, a resilient controller is designed according to the kinematic evolution. It incorporates a quadratic compensation term to actively mitigate the worst-case bounds of aggregated uncertainties and attacks without requiring precise estimation. Rigorous Lyapunov stability analysis demonstrates that the controlled closed-loop system is uniformly ultimately bounded. Finally, the efficacy and robustness</p>	

of the proposed strategy are further validated through comprehensive numerical simulations.	
17:15-17:30	FrDT4.7
<i>An Interactive System for Assessing Visual-Cognitive Abilities in Children with Autism Spectrum Disorder</i>	
Tang, Ziyang	Harbin Institute of Technology, Shenzhen
Ji, Haoyu	Harbin Institute of Technology, Shenzhen
Guo, Jinbin	Harbin Institute of Technology, Shenzhen
Yang, Zhihao	Harbin Institute of Technology, Shenzhen
Huang, Wenze	Harbin Institute of Technology, Shenzhen
Gao, Yu	Harbin Institute of Technology, Shenzhen
Liu, Xueting	Southern University of Science and Technology
Liu, Jiao	Lishui Maternal and Child Health Hospital, Zhejiang
Hu, Hui	Lishui Maternal and Child Health Hospital, Zhejiang
Zhang, Peile	Lishui Maternal and Child Health Hospital, Zhejiang
Ren, Weihong	Harbin Institute of Technology, Shenzhen
Wang, Zhiyong	Harbin Institute of Technology, Shenzhen
Liu, Honghai	Harbin Institute of Technology, Shenzhen
<p>The clinical diagnosis of Autism Spectrum Disorder (ASD) currently relies heavily on standardized rating scales and systematic clinical observations. However, these traditional methods are constrained by subjective recall bias and a dependency on specialized medical resources, highlighting an urgent need for objective early assessment tools. To address these challenges, this study proposes a novel desktop touch-based interactive system. The system designs multi-stage testing paradigms for color and shape cognition. It extracts internal interaction data via system event logging, and acquires external behavioral data utilizing camera video recordings and algorithmic processing. A controlled experiment involving 20 subjects (10 ASD, 10 typically developing) demonstrated that children with ASD exhibit significant heterogeneity compared to typically developing (TD) children across task completion, accuracy, reaction time, and attentional metrics. These quantitative results effectively capture atypical cognitive mechanisms, such as Weak Central Coherence and Executive Dysfunction, providing rigorous objective behavioral markers for clinical ASD assessment.</p>	

FrDT5	Room 259
Sensing, Perception, and Control for Autonomous Aerial Vehicles (Regular Session)	
Chair: Jiang, Jiaqi	Beijing Institute of Technology
Co-Chair: Liu, Junhui	Beijing Institute of Technology
Organizer: Jiang, Jiaqi	Beijing Institute of Technology
Organizer: Liu, Junhui	Beijing Institute of Technology
Organizer: Wang, Jianan	Beijing Institute of Technology
Organizer: Shan, Jiayuan	Beijing Institute of Technology
15:45-16:00	FrDT5.1
<i>Improved CST Method for Shape Perception of Flexible Variable-Camber Wings</i>	

Yang, Pengqian	Beijing Institute of Technology
Chai, Shuqiang	Beijing Institute of Technology
Liu, Junhui	Beijing Institute of Technology
Zhou, Feng	Beijing Institute of Technology
Shan, Jiayuan	Beijing Institute of Technology
Ding, Yan	Beijing Institute of Technology
Li, Chunyu	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology
<p>The shape perception and parametric description are prerequisites for the optimization and control of flexible camber-morphing wing surfaces, while traditional Class function/Shape function Transformation (CST) methods are difficult to meet the demand for accurate description of large-scale trailing-edge camber variation. To address this issue, this paper conducts a study on shape perception and high-precision parametric description for wings with fixed leading edge and large trailing-edge camber deformation. A three-segment variable-camber morphing wing configuration is proposed, which adopts concave hexagonal cells combined with sliding skin. And a segmented CST difference fitting method with C^1 continuity constraint is proposed to achieve low-dimensional and high-precision description of complex wing surfaces. Furthermore, a distributed sensing system composed of strain sensor arrays, laser sensor arrays, IMU, and linear displacement sensor is established to achieve shape perception under both static and dynamic wing conditions. Experimental results show that compared with the conventional CST method, the accuracy of the proposed parametric description method has been improved by one order of magnitude, and its representation of large trailing-edge deformation variable-camber wings satisfies the typical wind-tunnel tolerance. The shape sensing system effectively validates the feasibility of real-time application of the proposed method.</p>	
16:00-16:15	FrDT5.2
<i>Communication-Constrained Cooperative Motion Planning for Dubins Formation Turning</i>	
Bi, Changyu	Beijing Institute of Technology
Hu, Xuchi	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology
Jiang, Jiaqi	Beijing Institute of Technology
Li, Chunyu	Beijing Institute of Technology
Liu, Junhui	Beijing Institute of Technology
Wang, Yankai	Beijing Institute of Technology
Ding, Yan	Beijing Institute of Technology
Shan, Jiayuan	Beijing Institute of Technology
<p>This paper investigates cooperative motion planning for communication-constrained formation turning of Dubins vehicles. The vehicles move at constant speed and are subject to sector-limited communication constraints. To ensure connectivity during large-angle maneuvers, a structured cooperative turning strategy is developed. The overall heading change is decomposed into repetitive minimal turning units, each consisting of equivalent approach, steering, retreat, and steering phases. By properly selecting adjustable parameters, the relative distance between neighboring vehicles first decreases and then returns to the desired formation spacing, while the relative bearing remains within the communication sector. Consequently, formation connectivity is preserved throughout the maneuver provided that the communication range exceeds the nominal spacing. Simulation results validate the effectiveness of the proposed cooperative motion planning strategy.</p>	
16:15-16:30	FrDT5.3
<i>An Implementation of the Universal Birkhoff Pseudospectral Theory Using a Generic Nonlinear Programming Solver</i>	
Liu, Chenyang	Beijing Institute of Technology

Liu, Junhui	Beijing Institute of Technology
Shan, Jiayuan	Beijing Institute of Technology
Li, Chunyu	Beijing Institute of Technology
Wang, Jianan	Beijing Institute of Technology
Wang, Yankai	Beijing Institute of Technology
<p>We implement the universal Birkhoff pseudospectral theory over Legendre-Gauss-Radau grid by developing new covector mapping theorem for generic nonlinear programming algorithms. Considering the barriers between the stationarity conditions and optimality, we utilize the tightened Birkhoff theories specifically for nonlinear programming implementations to augment and relax primal conditions, and the relating covector mapping theorem is constructed with the specially modified Lagrangian. Examples of singular optimal control problem are provided, demonstrating the effectiveness and potential generality of our new theories for implementations.</p>	
16:30-16:45	FrDT5.4
<i>Design of an Iris-Inspired Tactile Gripper for Aerial Grasping</i>	
Cao, Zhuang	Beijing Institute of Technology
Jiang, Jiaqi	Beijing Institute of Technology
Zhou, Zhengyang	Beijing Institute of Technology
Li, Guilu	Zhejiang Wanli University
Wang, Jianan	Beijing Institute of Technology
<p>This paper presents an iris-inspired tactile gripper system for aerial grasping. Unlike previous grippers designed for aerial robots, the proposed gripper integrates compliant tactile sensors that provide both passive adaptability and active sensing capability. First, we design the mechanical structure of the gripper based on the radially symmetric contraction mechanism of the biological iris. It uses a single motor to actuate an embedded cable for the synchronized opening and closing of six fingers. Then, three of the rigid fingers are replaced with TacTip optical tactile sensors, which enable contact perception by tracking internal marker displacements and support feedback-driven grasp control. Finally, a multi-stage grasping strategy is developed that uses a finite-state machine to achieve a stable grasp. Experimental results show that the proposed system significantly improves the grasp success rate compared with a baseline gripper without tactile sensing. Preliminary integration with a quadrotor UAV platform is also demonstrated, highlighting the potential of the system for aerial manipulation tasks.</p>	
16:45-17:00	FrDT5.5
<i>System Identification of Multi-Rotor UAV Attitude Dynamics with Direct Model-Based Excitation</i>	
Ke, Yijie	Fuyao University of Science and Technology
<p>Attitude stability plays a key role in flight control performance for unmanned aerial vehicles, especially for the multi-rotor configuration with large propellers that are intrinsically sensitive to wind disturbance and actuator delay. Sophisticated modeling strategies are hence required to achieve desired performance with sufficient bandwidth. In this paper, we propose a system identification method for a multi-rotor UAV under the hovering condition with direct model-based excitation. Experiment setup and implementation details are also given. Results show that the proposed identification method is quite friendly for implementation, and the identified model in transfer function form can capture dynamics frequencies up to 20 rad/s.</p>	
17:00-17:15	FrDT5.6
<i>A Foldable Aerial-Ground Multimodal Robot: Design and Control</i>	
Zeng, Kai	Hunan University
Miao, Zhiqiang	Hunan University
Wang, Haoyu	Hunan University
Wang, Yaonan	Hunan University

Hybrid ground/aerial vehicles possess cross-domain operation capabilities, enabling them to accomplish more complex tasks, thus holding significant application value in various fields. However, existing systems generally suffer from issues such as bulky structure, unsmooth modal switching, and poor ground adaptability. In this paper, a foldable aerial-ground multimodal robot system and its control method are proposed. The flight mode adopts a geometric controller to ensure stable flight, while the ground mode achieves omnidirectional movement through a motion controller. The system features an ingenious structural design, low power consumption, and strong environmental adaptability. The control method exhibits low computational complexity and easily tunable parameters, meeting real-time control requirements. Finally, the effectiveness and performance of the proposed method are verified in the ROS-Gazebo simulation environment.

FrDT6	Room 264
Vulnerability Analysis, Secure State Estimation and Intrusion-/Fault-Tolerant Control for Cyber-Physical Systems (Regular Session)	
Chair: Huang, Xin	Northeast Electric Power University
Co-Chair: Xiao, Shuyi	Taiyuan University of Technology
Organizer: Huang, Xin	Northeast Electric Power University
Organizer: Xu, Jiapeng	Tianjin University
15:45-16:00	FrDT6.1
<i>Fault Observer Using PI-Type Error Feedback</i>	
Liu, Jing	Northeast Electric Power University
Huang, Xin	Northeast Electric Power University
<p>There is a crucial yet challenging issue in the study on performance improvement of the observer-based fault estimation approaches. That is, the unknown fault signal usually gives rise to very low usage rate of fault estimation error (FEE) information, making it difficult to further enhance the estimation accuracy. To address this, the technical note develops an indirect approach to acquire the FEE by using current and historical sensor measurements along with their estimations and then proposes a novel fault observer with PI-type error-feedback structure. The new structure is able to make good use of the FEE, thereby significantly enhancing the estimation accuracy in comparison to the existing results. An illustrative example validates the presented method.</p>	
16:00-16:15	FrDT6.2
<i>Cooperative Fault-Tolerant Consensus of Heterogeneous Multi Agent Systems with Actuator Failures and Unknown Parameters</i>	
Xiao, Shuyi	Taiyuan University of Technology
Yan, Gaowei	Taiyuan University of Technology
<p>This paper is concerned with the fault-tolerant consensus problem of heterogeneous multi-agent systems with unknown parameters. The design of the cooperative controller is challenging due to the coupling among unknown parameters, actuator failures and network topology analysis. To conquer this challenge, the hierarchical control framework consisting of the virtual layer and the physical layer is put forward in this paper. The virtual layer achieves the virtual cooperative control objective by designing the adaptive virtual cooperative controller. The physical layer estimates unknown parameters via constructing a parameter identifier and further develops a tracking fault tolerant controller to accomplish the consensus control task. The theoretical findings are illustrated by a simulation example.</p>	
16:15-16:30	FrDT6.3

<i>Vulnerability of Remote State Estimation Subject to Physical False Data Injection Attacks</i>	
Huang, Jiahao	Zhejiang University of Science and Technology
Tan, Qi	Zhejiang University of Science and Technology
Xie, Shuzong	Zhejiang University of Science and Technology
Xu, Xiaozhou	Zhejiang University of Science and Technology
Dai, Jiahao	Zhejiang University of Science and Technology
Xu, Jiapeng	Tianjin University
<p>This paper studies the vulnerability of remote state estimation systems under physical false data injection (FDI) attacks. The attacker seeks to keep the attack stealthy with respect to residual-based detectors while causing the bias in the physical process state to diverge to infinity. We establish the necessary and sufficient conditions for achieving this objective, i.e., the measurement matrix is not full rank or the system matrix A is unstable. For the first attack scenario, we show that the resulting security vulnerability can be addressed by employing a moving target defense (MTD) strategy. For the second scenario, however, the attacker can achieve the same objective by only slightly perturbing the initial state, which makes the attack much harder to detect and prevent. This observation suggests an important avenue for future work. Numerical simulations are finally presented to verify the developed theoretical results.</p>	
16:30-16:45	FrDT6.4
<i>Linear Residual Generators for Fault Estimation in Discrete-Time Nonlinear Systems</i>	
Ranjan, Ritu	Texas A&M University
Kravaris, Costas	Texas A&M University
<p>This work presents a systematic method for the design of residual generators that enable both fault detection and estimation in discrete-time nonlinear systems. The proposed residual generator is a linear functional observer built for an extended system that integrates fault dynamics modeled from a linear exo-system. Additionally, the proposed residual generator possesses disturbance-decoupling properties allowing it to isolate the effects of faults from those of unknown disturbances. Necessary and sufficient conditions for the existence of such residual generators for discrete nonlinear systems are derived. As long as these conditions are satisfied, explicit design formulas for the residual generators are obtained. The results are illustrated through a chemical reactor case study, which shows that the proposed scheme estimate faults accurately.</p>	
16:45-17:00	FrDT6.5
<i>AI-Driven Pipeline Leak Detection Using Thermal UAV Imagery & Hybrid CNN–Transformer Networks for Real-Time Infrastructure Monitoring</i>	
Akylbekov, Olzhas	Satbayev University
<p>This paper proposes an AI-driven pipeline leak detection framework based on UAV thermal imagery and a hybrid CNN–Transformer architecture. The proposed method integrates convolutional feature extraction with Transformer-based global attention to effectively capture both local thermal patterns and long-range spatial dependencies. To improve robustness under complex environmental conditions, a physics-aware thermal constraint is introduced, enforcing consistency between predicted and actual temperature gradients. Experimental results on a dataset of 4200 UAV thermal images demonstrate that the proposed method outperforms conventional CNN and Transformer-based approaches, achieving up to 0.90 detection accuracy. Real-time evaluation shows that the system operates at 22 FPS, making it suitable for practical deployment. The proposed approach provides an efficient and scalable solution for intelligent pipeline monitoring and early leak detection.</p>	

17:00-17:15	FrDT6.6
<i>Causality-Enhanced Normalizing Flows with Piecewise Time-Varying DAGs for Anomaly Detection</i>	
Zhang, Ming-Qing	Beijing University of Chemical Technology
Zhou, Liang-Yu	Beijing University of Chemical Technology
Hao, Da-Ben	Beijing University of Chemical Technology
Zhu, Qunxiong	Beijing University of Chemical Technology
He, Yan-Lin	Beijing University of Chemical Technology
Zhang, Yang	Beijing University of Chemical Technology
Lu, Tongwei	The College of Computer Science and Engineering, Wuhan Institute of Technology
Xu, Yuan	Beijing University of Chemical Technology
<p>Anomaly detection aims to identify abnormal patterns in large-scale, dynamically evolving time-series data; however, conventional methods often struggle to effectively model high-dimensional feature representations and long-term dependencies. To address this challenge, this paper proposes a causality-enhanced normalizing flow (CENF) framework that introduces piecewise time-varying directed acyclic graphs (DAGs) to model latent causal structures. The proposed CENF framework integrates conditional normalizing flows with causal graph structures, enabling invertible probability density modeling while capturing time-varying causal dependencies. During training, intervention-consistency and counterfactual-contrastive regularization are incorporated to implement soft intervention mechanisms that guide the dynamic evolution of the causal structure while enforcing approximate invariance among non-descendant nodes. In addition, a fused Lasso constraint is introduced to sparsely detect operating-condition transitions, thereby enhancing the model's adaptability to complex and dynamic environments. Experimental results on real industrial process datasets demonstrate that the proposed CENF method achieves superior anomaly detection accuracy under complex operating conditions.</p>	
17:15-17:30	FrDT6.7
<i>Stabilization Control for a Class of Fractional-Order Memristor-Based Neural Network System, pp. 2119-2124</i>	
Zhang, Zhe	Guangxi University
Miao, Zhiqiang	Hunan University
<p>This paper proposes a new asymptotically stabilized control method for Fractional-order Memristor-Based Neural Networks (FMBNN) with active links to fractional orders. The traditional fractional-order stability criterion is firstly advanced into a form that establishes a scientific relationship with the fractional order. Then, a novel feedback control linking fractional order method is proposed to control the FMBNN based on this propellant criterion. And next, the asymptotic stabilization of the controlled FMBNN is discussed in detail, using the method of combining vector Lyapunov function with M-matrix. Finally, the effectiveness as well as the superiority of the proposed method is verified by comparing the traditional feedback control method with the novel feedback control linking fractional order method by numerical simulation of the controlled FMBNN with larger time delay from low-dimensional to high-dimensional.</p>	

Keyword Index

A	
Adaptive Control	FrAT1.1, FrAT3.3, FrAT4.4, FrAT5.1, FrBT1.7, FrBT3.3, FrBT5.2, FrCT3.5, FrCT3.7, FrCT4.4, FrDT1.5, FrDT6.2, FrDT6.7, ThAT2.1, ThAT2.2, ThAT5.5, ThAT6.4, ThBT1.1, ThCT6.1, WeAT2.1, WeAT4.2, WeAT4.3, WeAT6.1, WeAT6.2, WeAT6.3, WeAT6.4, WeAT6.5, WeAT6.6, WeBT3.3, WeBT5.6, WeBT6.1
Automated Guided Vehicles	FrBT1.3, FrBT4.1, FrCT1.1, FrCT1.5, FrCT3.4, FrDT2.3, ThAT5.1, ThBT1.1, ThBT1.2, ThBT1.3, ThBT1.4, ThBT1.5, ThBT1.6, ThBT2.7, ThBT4.5, ThBT5.2, ThCT1.1, ThCT1.6, WeAT1.2, WeAT1.5, WeAT3.2, WeBT1.1, WeBT2.5, WeBT5.1, WeBT6.5
C	
Control Applications	FrAT3.4, FrAT4.3, FrAT4.4, FrAT4.6, FrAT6.4, FrBT1.5, FrBT1.7, FrBT2.3, FrBT3.2, FrBT3.6, FrBT4.1, FrBT5.1, FrBT6.5, FrBT6.7, FrCT1.6, FrCT2.1, FrCT5.5, FrDT3.4, FrDT3.5, FrDT4.4, FrDT4.6, FrDT5.4, FrDT5.5, FrDT5.6, FrDT6.7, ThAT3.4, ThAT4.5, ThAT6.2, ThAT6.5, ThBT1.1, ThBT1.2, ThBT1.3, ThBT3.4, ThBT4.1, ThBT6.2, ThBT6.7, ThCT1.1, ThCT1.4, ThCT2.3, ThCT4.3, ThCT4.4, ThCT5.6, ThCT6.2, ThCT6.3, WeAT1.1, WeAT1.2, WeAT4.7, WeAT6.1, WeBT2.2, WeBT2.6, WeBT3.7, WeBT5.3, WeBT6.1, WeBT6.2, WeBT6.3, WeBT6.4, WeBT6.5, WeBT6.6, WeBT6.7
Control of Distributed Generation Systems	FrAT6.1, FrBT2.1, ThAT5.2, ThAT5.3, WeAT3.1, WeBT5.2, WeBT6.6
Control of Smart Power Delivery Systems	FrAT6.1, ThAT5.2, WeAT3.1, WeAT6.2, WeBT6.6
D	
Discrete Event Systems	WeBT3.1
E	
Energy Efficiency	FrBT5.5, ThAT3.4, ThAT5.2, ThAT5.4, ThBT1.3, ThBT5.4, WeAT2.6, WeAT3.2, WeAT6.2
Estimation and Identification	FrAT1.1, FrAT1.2, FrAT1.3, FrAT1.4, FrAT1.5, FrAT1.6, FrAT2.5, FrAT2.6, FrAT3.6, FrAT5.5, FrAT5.6, FrBT1.5, FrBT4.4, FrBT5.6, FrCT2.4, FrDT3.2, FrDT5.1, FrDT5.5, FrDT6.3, FrDT6.4, ThAT6.1, ThBT2.3, ThBT3.1, ThBT4.4, ThBT6.1, ThCT1.6, ThCT3.1, ThCT5.4, ThCT5.7, WeAT2.7, WeAT3.7, WeAT5.4, WeAT6.6, WeBT1.2, WeBT1.5, WeBT3.2, WeBT4.5, WeBT6.4
F	
Factory Modeling and Automation	FrAT3.7, WeBT2.1, WeBT4.1
Fault Detection and Diagnostics	FrAT1.2, FrAT5.4, FrAT6.1, FrAT6.5, FrAT6.6, FrBT4.3, FrDT3.1, FrDT6.1, FrDT6.3, FrDT6.4, FrDT6.5, FrDT6.6, ThAT6.5, WeAT1.1, WeAT3.7
Flexible Manufacturing Systems	FrAT2.5, FrCT1.1
Fuzzy and Neural Systems	FrAT2.4, FrAT2.7, FrBT3.5, FrDT2.5, FrDT2.7, FrDT6.5, ThAT2.2, ThBT5.5, WeAT5.5, WeAT6.3, WeBT3.1, WeBT3.2

I	
Intelligent and AI Based Control	FrAT1.3, FrAT1.4, FrAT5.1, FrBT1.3, FrBT3.1, FrBT3.4, FrBT3.5, FrBT4.4, FrBT4.5, FrBT4.6, FrBT5.2, FrBT5.6, FrCT2.2, FrCT2.4, FrCT3.5, FrCT3.6, FrCT4.3, FrCT6.5, FrCT6.6, FrDT1.6, FrDT2.4, FrDT2.5, FrDT3.1, FrDT3.2, FrDT4.5, FrDT6.5, ThAT3.5, ThAT4.4, ThAT6.1, ThAT6.5, ThAT6.6, ThAT6.7, ThBT1.6, ThBT4.3, ThBT5.1, ThBT6.6, ThCT1.2, ThCT2.4, ThCT2.5, ThCT3.1, ThCT4.6, ThCT5.1, ThCT5.3, ThCT6.3, ThCT6.5, ThCT6.6, WeAT5.1, WeAT5.2, WeAT5.3, WeAT5.5, WeAT6.4, WeBT2.2, WeBT5.6, WeBT6.2
L	
Learning Systems	FrAT2.3, FrAT3.2, FrAT5.5, FrBT1.1, FrBT3.1, FrBT3.4, FrBT3.5, FrBT3.6, FrBT4.5, FrBT5.6, FrCT1.2, FrCT1.6, FrCT2.3, FrCT6.5, FrDT2.4, ThAT3.1, ThAT3.5, ThAT4.6, ThBT3.5, ThBT4.4, ThBT5.1, ThBT5.5, ThBT6.4, ThBT6.5, ThCT5.5, WeAT1.3, WeAT4.4, WeAT5.1, WeAT5.4, WeAT5.5, WeAT5.6, WeBT5.3, WeBT5.5
Learning-based Control	FrAT2.2, FrAT3.2, FrAT3.4, FrAT6.2, FrBT2.4, FrBT2.6, FrCT3.3, FrCT6.5, FrCT6.6, FrDT1.3, FrDT1.6, FrDT2.1, FrDT4.1, FrDT4.5, ThAT2.3, ThAT2.4, ThAT2.5, ThAT2.6, ThAT3.2, ThAT3.4, ThAT3.5, ThAT4.3, ThAT4.5, ThAT6.6, ThAT6.7, ThBT2.1, ThBT2.5, ThBT2.6, ThBT3.3, ThBT3.6, ThBT5.6, ThBT6.4, ThCT2.2, ThCT2.4, ThCT2.5, ThCT2.6, ThCT4.6, ThCT5.2, ThCT6.1, ThCT6.5, ThCT6.6, WeAT1.4, WeAT1.5, WeAT4.2, WeBT5.1, WeBT5.2, WeBT5.3, WeBT5.4, WeBT5.5, WeBT5.6
Linear Systems	FrAT1.3, FrAT1.5, FrAT4.6, FrBT2.3, FrDT2.6, FrDT4.1, FrDT6.3, ThAT3.2, ThCT1.3, ThCT4.1, ThCT4.2, ThCT4.5, WeAT1.4, WeAT3.4, WeAT4.5, WeAT5.7, WeAT6.5, WeBT3.4, WeBT5.4
M	
Man-machine Interactions	FrAT3.6, FrBT6.3, FrCT3.6, FrCT3.7, FrCT4.2, FrCT4.6, FrCT4.7, FrCT5.2, FrCT5.6, FrCT6.1, FrCT6.6, FrDT1.1, FrDT1.2, FrDT1.5, FrDT1.6, FrDT1.7, FrDT3.6, FrDT4.7, ThAT6.2, ThAT6.3, ThAT6.4, ThBT6.3, ThCT5.7, WeAT5.2, WeBT1.2
Micro and Nano Systems	FrAT4.1, FrAT4.2, FrAT4.3, FrAT4.4, ThCT2.1, WeBT3.2
Modeling and Control of Complex Systems	FrAT1.2, FrAT2.1, FrAT4.1, FrAT5.2, FrAT5.5, FrAT5.6, FrAT6.2, FrBT1.5, FrBT2.6, FrBT5.3, FrBT6.3, FrCT1.2, FrCT2.2, FrCT2.6, FrCT3.7, FrCT4.3, FrCT5.4, FrCT5.6, FrDT4.2, ThAT1.1, ThAT1.2, ThAT1.7, ThAT3.3, ThAT4.6, ThBT2.2, ThBT3.3, ThBT4.2, ThBT6.7, ThCT1.2, ThCT6.4, WeAT2.7, WeAT4.6, WeAT6.4, WeBT2.3, WeBT2.7, WeBT3.3, WeBT3.4, WeBT6.1, WeBT6.2
Motion Control	FrAT2.7, FrAT3.1, FrAT4.2, FrAT4.6, FrAT5.2, FrAT6.4, FrBT2.5, FrBT4.1, FrBT6.4, FrBT6.6, FrCT1.5, FrCT3.5, FrCT4.6, FrCT5.4, FrCT5.5, FrCT6.1, FrDT1.2, FrDT1.7, FrDT2.7, FrDT5.2, ThAT1.1, ThAT1.2, ThAT1.3, ThAT2.6, ThAT4.4, ThBT1.4, ThBT1.5, ThBT3.6, ThBT4.5, ThCT2.1, ThCT2.2, ThCT3.6,

	ThCT4.4, ThCT5.6, ThCT6.2, ThCT6.4, WeAT1.1, WeAT2.2, WeAT3.5, WeAT4.7, WeAT5.7, WeBT1.1, WeBT2.1, WeBT2.4, WeBT2.5, WeBT2.6, WeBT2.7, WeBT3.7, WeBT6.3, WeBT6.7
Multi-agent Systems	FrAT1.5, FrAT2.2, FrAT3.3, FrAT6.2, FrAT6.3, FrAT6.4, FrBT1.1, FrBT1.2, FrBT1.3, FrBT2.1, FrBT2.2, FrBT2.7, FrBT5.1, FrBT5.2, FrBT5.4, FrBT6.1, FrBT6.2, FrBT6.3, FrBT6.4, FrBT6.5, FrBT6.6, FrBT6.7, FrCT2.1, FrCT2.2, FrCT2.3, FrCT2.5, FrCT2.6, FrCT2.7, FrCT3.1, FrCT3.2, FrCT3.3, FrDT2.2, FrDT2.4, FrDT2.5, FrDT2.6, FrDT4.3, FrDT4.6, FrDT5.2, FrDT6.2, ThAT2.2, ThAT4.1, ThAT4.2, ThAT4.4, ThAT5.3, ThAT5.4, ThAT5.5, ThAT5.6, ThBT2.1, ThBT2.6, ThBT3.2, ThBT4.1, ThBT4.2, ThBT4.3, ThBT4.6, ThBT5.2, ThBT6.3, ThBT6.4, ThBT6.6, ThCT2.6, ThCT4.1, ThCT4.3, ThCT4.4, ThCT4.5, ThCT5.1, ThCT5.3, ThCT5.5, ThCT6.5, ThCT6.6, WeAT1.2, WeAT2.1, WeAT4.1, WeAT4.2, WeAT4.3, WeAT4.4, WeAT4.5, WeAT4.6, WeAT4.7, WeAT5.6, WeAT6.3, WeAT6.5, WeBT1.3, WeBT1.4, WeBT4.1, WeBT4.2, WeBT4.3, WeBT4.4, WeBT4.5, WeBT4.6
N	
Networked Control	FrAT1.7, FrAT2.1, FrAT6.3, FrBT2.1, FrBT2.2, FrBT5.3, FrBT5.4, FrBT6.2, FrCT4.5, FrDT2.1, FrDT2.6, FrDT4.3, FrDT6.1, ThAT2.1, ThAT5.5, ThAT5.6, ThBT3.2, ThBT4.6, ThCT5.5, WeAT3.4, WeAT5.7, WeBT1.3, WeBT4.2, WeBT4.6
Nonlinear Systems and Control	FrAT1.6, FrAT2.2, FrAT3.1, FrAT3.3, FrAT3.4, FrAT3.5, FrBT1.2, FrBT1.6, FrBT1.7, FrBT2.2, FrBT2.6, FrBT5.3, FrBT5.5, FrBT6.1, FrCT1.2, FrCT1.5, FrCT2.1, FrDT1.2, FrDT2.3, FrDT4.1, FrDT4.2, FrDT4.4, FrDT4.6, FrDT5.3, FrDT5.6, FrDT6.4, FrDT6.7, ThAT2.1, ThAT2.3, ThAT2.4, ThAT2.5, ThAT2.6, ThAT4.2, ThAT5.3, ThBT2.2, ThBT3.1, ThBT3.3, ThBT4.6, ThBT6.2, ThBT6.7, ThCT1.1, ThCT1.2, ThCT1.3, ThCT1.4, ThCT1.5, ThCT1.6, ThCT2.3, ThCT4.3, WeAT2.2, WeAT3.5, WeAT3.6, WeAT6.6, WeBT1.1, WeBT1.4, WeBT3.5, WeBT3.6, WeBT4.3
O	
Optimal Control	FrAT3.1, FrAT3.2, FrBT1.2, FrBT3.3, FrBT5.5, FrCT2.6, FrCT2.7, FrCT4.3, FrDT1.4, FrDT2.1, FrDT2.2, FrDT5.3, ThAT1.3, ThAT2.3, ThAT3.6, ThAT5.6, ThBT1.5, ThBT2.5, ThBT2.6, ThBT2.7, ThBT3.4, ThBT4.3, ThBT5.6, ThBT6.2, ThCT1.4, ThCT5.2, ThCT5.4, ThCT5.6, ThCT6.1, ThCT6.2, WeAT1.4, WeAT3.2, WeAT3.3, WeAT3.4, WeAT3.5, WeAT3.6, WeAT3.7, WeAT4.4, WeAT5.2, WeBT3.5, WeBT3.6, WeBT5.1, WeBT5.2, WeBT5.4, WeBT5.5, WeBT6.4
P	
Process Automation	ThBT5.5
Process Control & Instrumentation	FrAT1.6, FrBT3.2, FrDT6.6
R	

Real-time Systems	FrAT1.4, FrAT3.7, FrBT2.3, FrBT6.7, FrCT1.3, FrCT5.2, FrDT1.3, FrDT3.6, ThAT1.4, ThBT6.5, ThCT5.4, WeAT1.3, WeAT2.3, WeAT5.4, WeBT1.3, WeBT3.1, WeBT4.1, WeBT6.3
Robotics	FrAT2.3, FrAT2.4, FrAT2.5, FrAT2.6, FrAT2.7, FrAT4.1, FrAT4.2, FrAT4.3, FrAT5.2, FrAT5.3, FrAT5.6, FrBT1.1, FrBT2.5, FrBT3.3, FrBT3.4, FrBT3.6, FrBT4.2, FrBT4.5, FrBT4.6, FrBT6.1, FrBT6.2, FrBT6.4, FrBT6.5, FrBT6.6, FrCT1.1, FrCT1.3, FrCT1.4, FrCT1.6, FrCT3.1, FrCT3.2, FrCT3.3, FrCT3.6, FrCT4.1, FrCT4.2, FrCT4.4, FrCT4.6, FrCT4.7, FrCT5.1, FrCT5.3, FrCT5.4, FrCT5.5, FrCT5.6, FrCT5.7, FrCT6.1, FrCT6.2, FrCT6.3, FrCT6.4, FrDT1.3, FrDT1.5, FrDT1.7, FrDT3.7, FrDT4.2, FrDT4.4, FrDT4.5, FrDT5.4, FrDT5.5, FrDT5.6, ThAT1.1, ThAT1.2, ThAT1.3, ThAT1.4, ThAT1.5, ThAT1.6, ThAT1.7, ThAT2.4, ThAT4.3, ThAT4.5, ThAT6.2, ThAT6.6, ThAT6.7, ThBT1.2, ThBT2.2, ThBT2.3, ThBT2.4, ThBT2.7, ThBT3.1, ThBT3.5, ThBT4.1, ThBT4.2, ThBT4.4, ThBT4.5, ThBT5.2, ThBT5.6, ThBT6.1, ThBT6.3, ThBT6.6, ThCT2.1, ThCT2.2, ThCT2.3, ThCT2.4, ThCT2.5, ThCT2.6, ThCT3.2, ThCT3.4, ThCT3.6, ThCT5.1, ThCT5.3, ThCT6.3, ThCT6.4, WeAT1.3, WeAT1.5, WeAT2.1, WeAT2.2, WeAT2.4, WeAT2.5, WeAT2.6, WeAT2.7, WeAT3.6, WeAT4.3, WeAT4.6, WeAT6.1, WeBT1.5, WeBT2.1, WeBT2.2, WeBT2.3, WeBT2.4, WeBT2.5, WeBT2.6, WeBT2.7, WeBT3.3, WeBT3.5, WeBT3.7, WeBT4.4, WeBT6.5, WeBT6.7
Robust and H infinity Control	FrDT2.3, ThAT3.2, ThAT5.7, ThBT3.4, WeBT3.4, WeBT3.6
S	
Sensor Networks	FrAT1.7, FrBT3.1, FrCT4.5, FrCT5.3, ThAT3.3, ThBT2.1
Sensor/Data Fusion	FrAT3.7, FrAT4.5, FrAT5.3, FrBT1.4, FrBT4.2, FrBT4.3, FrBT4.6, FrBT4.7, FrCT1.4, FrCT2.3, FrCT4.2, FrCT4.4, FrCT5.1, FrCT5.3, FrCT6.3, FrCT6.4, FrDT3.3, FrDT3.6, FrDT3.7, FrDT5.1, ThAT1.5, ThAT1.6, ThAT1.7, ThAT6.1, ThBT1.6, ThBT2.3, ThBT4.7, ThBT6.5, ThCT3.2, ThCT3.3, ThCT3.5, WeAT5.3, WeBT1.2, WeBT1.5, WeBT4.5
Signal Processing	FrAT1.7, FrAT2.6, FrAT3.6, FrAT5.4, FrAT6.5, FrAT6.6, FrBT4.2, FrBT4.3, FrBT4.7, FrCT1.4, FrCT1.4, FrCT2.4, FrCT4.5, FrCT5.1, FrCT5.2, FrCT5.7, FrCT6.4, FrDT2.7, FrDT3.3, FrDT3.7, FrDT6.6, ThBT4.7, ThBT5.1, ThCT3.2, ThCT4.6, WeAT2.3, WeAT5.1, WeAT5.3
Smart Buildings	FrAT5.4, ThBT5.3, ThBT5.4
Smart Structures	FrDT5.1

Author Index

A	
Abdimalik, Almat	WeAT4.7
Abduhalimzoda, Abdukarim	ThAT6.1
Abdunabi, Qosimov	ThAT6.4
Abulkassov, Bakhtiyar	WeAT4.3
Abutalipov, Kaisar	ThAT1.2
Aimashev, Eldar	WeBT1.3
Akylbekov, Olzhas	FrDT6.5
Al Janaideh, Mohammad	ThBT2.3
Al-Farabi, Zaki	FrCT6.4
Alimbayev, Chingiz	WeAT5.3
Alimbayeva, Zhadyra	WeAT5.3
Alipbayev, Daniyar	FrCT4.4
Amangeldi, Arystan	WeAT4.3
Ang Jr, Marcelo H.	ThAT1.7
Antoni, Alfonz	ThCT1.5
Anvarzoda, Daler	ThAT6.3
Ao, Lijuan	FrDT2.7
Arymbekov, Beken	FrCT4.4
Azhdari, Maryam	ThCT1.1
B	
Badihi, Hamed	FrAT6
	FrAT6
	FrAT6.5
	FrAT6.6
Bai, Jianjun	ThAT2
	ThAT2.1
Bai, Weiwei	FrCT2
Bandishova, Risolat	ThAT6.3
Bao, Danyang	FrAT4.1
Bao, Wanlin	ThCT3.5
Bao, Yida	FrCT1.2
Bellinger, Colin	WeAT3.6
Bi, Changyu	FrDT5.2
Bi, Youyi	ThCT3.3
Bian, Wenjing	WeBT4
	WeBT4.4
Bing, Xiao	ThCT3.5
Bo, Tao	ThCT6.3
Bodagala, Balaji	WeBT3.4
Bodagala, Jayawant	WeBT3.4
Bogataj, David	WeAT5.4
C	
Cai, Bo	ThBT3
	FrAT2
Cai, He	FrAT1.1
Cai, Jiajun	FrDT2.2
Cai, Jialei	ThCT4.1
Cai, Luzhao	WeBT6.6
Cai, Mingxue	ThCT2
	ThCT2
	ThCT2.3
Cai, Shibo	FrCT3.7
Cai, Yeyun	ThAT4.5
Cao, Chun	ThAT5.3
Cao, Haosen	WeBT3.7
	FrDT3.7
Cao, Ruikai	FrCT4.2
	FrCT5.2
Cao, Weihua	ThCT6.2
Cao, Weipeng	WeAT1.5
Cao, Wenhan	WeAT2.5
Cao, Wenhan	FrAT1.3
Cao, Wujing	FrCT5
	FrCT5
	FrCT5.1
	FrCT5.3

	FrCT5.5
Cao, Yiming	WeAT2.6
Cao, Yue	WeAT5.5
Cao, Zhiru	FrAT2.1
Cao, Zhuang	FrDT5.4
Chai, Shuqiang	FrDT5.1
Chan, Tobias	FrAT2.6
Chang, Bufan	FrAT6.4
Chang, Le	ThAT5.2
Chang, Yingxiu	ThBT6.3
Chao, Deng	ThCT5.7
Chatterjee, Subhajit	FrAT6.5
	FrAT6.6
Chen, Ben M.	WeBT3.7
	ThBT4.1
	ThBT5.2
	ThBT5.4
	FrAT5.2
	FrAT5.3
	FrAT5.4
	FrAT5.6
	FrCT1.3
	FrCT1.4
	FrCT1.6
	FrDT3.7
Chen, Binqiang	ThBT5.5
Chen, Boyang	ThAT3.4
Chen, Chao	FrCT2.3
	FrCT2.4
Chen, Chen	WeBT4.4
	ThAT3.3
Chen, Chen	ThCT4.5
Chen, Chen	FrDT4
	FrDT4.5
Chen, Chunjie	FrCT5.5
Chen, Ci	FrBT2
Chen, Delong	ThBT4.2
Chen, Fei	WeAT1.3
Chen, Fei	WeAT4.5
Chen, Fei	WeBT2.1
Chen, Fei	ThBT1.4
Chen, Fei	FrCT4.7
	FrCT6
Chen, Guoqing	ThCT2.2
Chen, Hang	ThAT6.5
Chen, Hao	WeAT2.5
Chen, Haoyao	ThCT3
	ThCT3.2
Chen, Haoyu	ThBT6.1
Chen, Hui	ThBT1.5
Chen, Ji	FrDT2.4
Chen, Jiayu	ThBT4.2
Chen, Jie	FrDT4.3
Chen, Jin	FrCT1
Chen, Jun	FrBT4.1
Chen, Mingqi	FrCT6.1
	FrCT6.2
Chen, Mou	ThBT3.3
Chen, Moxian	FrDT2.7
Chen, Qile	FrBT6.6
Chen, Rujia	WeAT1.2
Chen, Tianjie	ThBT1.6
Chen, Wei	WeBT2.2
Chen, Wei	FrDT3
	FrDT3
	FrDT3.2
Chen, Wen	FrBT3.5
Chen, Wen-Hua	ThCT6
	ThCT6.1

Chen, Wenjie	WeAT5.5
Chen, Wenrui	FrCT3
Chen, Xi	WeBT3.7
	ThBT5
	ThBT5.2
	ThBT5.4
	ThCT4.6
	FrAT5.2
	FrAT5.3
	FrAT5.4
	FrAT5.6
	FrCT1.3
	FrCT1.4
	FrCT1.6
	FrDT3.7
Chen, Xiaolong	FrDT4.6
Chen, Xieyuanli	WeBT2.2
Chen, Xing	ThCT5.5
Chen, Xinqi	FrDT2.3
Chen, Xuanhan	ThCT3.4
	ThCT3.5
Chen, Yan	ThAT6.3
Chen, Yanqiu	FrDT4.5
Chen, Yiming	ThCT5.3
Chen, Yiyang	FrDT2.6
Chen, Yizong	WeBT2.7
Chen, Yubing	FrAT4.1
Chen, Yun	ThAT2.1
Chen, Yunfeng	ThAT5.3
Chen, Zeshuai	FrBT1.5
Chen, Ziyang	FrCT3.2
Cheng, Bin	FrBT1.2
Cheng, Haoshu	ThBT4.6
Cheng, Lan	ThAT3
	ThAT3.1
	ThAT3.5
	ThBT4.4
Cheng, Li	ThCT6.4
Cheng-Hang, Li	FrCT4.1
Chengxin, Xian	FrAT6.3
Chi, Wenzheng	FrDT1.3
Chongyuan, Hu	ThAT4.2
Cong, Shuang	WeBT3.2
Cui, Chenhuan	WeBT2.6
Cui, Hongkang	ThCT3.2
Cui, Jinqiang	ThBT4.1
	ThBT6
	ThBT6
	ThBT6.3
	ThBT6.4
	ThBT6.5
	ThBT6.6
	FrBT1
	FrBT1.4
Cui, Yuhao	WeAT2.3
	WeAT4.4
Cui, Zhongrui	ThAT5.2
D	
Dai, Jiahao	FrDT6.3
Dai, Shenghao	FrCT5.4
Dai, Xunhua	FrBT6.4
Dai, Yingying	FrAT4.4
De, Qixin	FrBT2.6
Deng, Di	WeBT4.5
Deng, Fang	ThAT4.5
	FrDT4.3
Deng, Shijie	ThCT5.6
Deng, Yuguo	ThCT3.5
Deng, Zhichao	ThBT2.2

Diao, Yanan	WeBT3.3
Ding, Dawei	ThAT5.7
Ding, Tao	ThCT6.3
Ding, Wendi	FrAT5
	FrAT5
	FrAT5.6
Ding, Yan	FrDT5.1
	FrDT5.2
Ding, Yulong	ThBT1
	ThBT4
	ThBT4
	ThBT4.2
	ThBT4.3
	FrAT5.3
	FrCT1.6
Ding, Zhaoyun	FrBT3.5
	FrDT2.5
Dong, Mingjie	FrCT5
Dong, Wei	ThAT4.5
Dong, Xiwang	WeBT1.1
	ThAT4.4
	ThCT5
	ThCT5.4
	ThCT5.6
	FrDT2
	FrDT2.2
	FrDT2.6
Dong, Yi	WeAT1.4
	ThCT4
	ThCT4
	ThCT4.1
	ThCT4.6
Dong, Zhipeng	WeAT1.3
Dong, Zicheng	ThBT5.6
Dou, Lihua	ThAT4.6
Dou, Xiaoming	FrCT2.4
Drummond, Chris	WeAT3.6
Du, Mingyu	FrCT3.7
Du, Zhao	FrCT5.3
Duan, Haibin	WeAT1.2
	WeAT4
	WeAT4.6
	ThBT6.3
Duan, Lanzhi	FrAT3.7
Duan, Wenxing	ThCT2.5
Duan, Xingguang	FrDT1.4
	FrDT1.5
	FrDT1.6
	FrDT1.7
Duan, Yansong	FrBT4.7
E	
En-Ming, Shi	FrCT4.1
F	
Fan, Jiaxin	ThBT4.3
Fan, Pengfei	FrAT1.4
Fan, Yonghua	FrAT1.4
Fang, Hao	WeAT2.1
	FrCT3.4
Fang, Jiayi	ThBT1.3
Fang, Peng	FrCT4.6
	FrDT2.7
Fang, Pengfei	FrAT2.3
Fang, Yiming	ThBT1.3
Fang, Yiyuan	FrCT1
	FrCT1
	FrCT1.2
Feng, Kairui	ThBT4.3
Feng, Wenchao	WeBT2
	WeBT2.1

Feng, Yuxuan	FrBT1.4
Feng, Zhi	ThCT5.6
Feng, Zhiqiang	WeBT6.3
Fu, Jianzhong	ThCT3.6
Fu, Junjie	ThAT2.6
Fu, Rao	FrBT6.5
Fu, Shuai	ThBT3.4
Fu, Xinyi	WeAT5.1
Fu, Xiuwei	FrCT1.5
Fu, Yifang	FrAT6.4
G	
Gafiatullin, Farkhad	ThCT1.5
Galimzhanov, Temirlan	FrCT6.2
	FrCT6.3
Gan, Kun	ThCT3.5
Gao, Chong	WeAT3.4
Gao, Daan	ThCT2.3
Gao, Ding	FrCT3
	FrCT3.7
Gao, Haibo	WeAT2.2
Gao, Hongchao	ThAT6.5
Gao, Jing	WeBT2.4
Gao, Jingran	FrBT1.1
Gao, Longlong	FrAT5.1
Gao, Naixing	FrCT5.2
Gao, Yan	FrBT6
	FrBT6.2
	FrBT6.3
Gao, Yu	FrDT4.7
Gao, Yuhan	FrBT5.1
Gao, Zhanyu	ThCT2.4
Gao, Zhi	WeAT5.1
	ThAT1
	ThAT1.5
Geng, Chao	FrAT4.5
Gertrudes, João Bosco	ThAT5.4
Gong, Jianwei	WeAT3.5
	WeBT5.1
Gong, Shiqi	WeAT4.6
Gong, Wei	WeAT5.6
Gongyue, Zhang	FrCT6.5
Gu, Feifei	FrDT3
	FrDT3.3
Gu, Nan	FrBT2.7
Gu, Shuang	FrBT6
	FrBT6.3
Gu, Tianqi	FrCT2.3
Guan, Jinting	FrDT4.1
Guan, Renhe	WeBT4.6
Guan, Xinyu	ThBT1.1
Guan, YaCun	FrAT6.2
Guay, Martin	ThCT1
	ThCT1.1
	ThCT1.6
Gui, Yonghao	WeBT6.1
Guo, Hong ge	ThAT3.6
Guo, Honghao	ThAT1.7
Guo, Huiyu	FrAT2.2
Guo, Jiawei	ThAT2.6
Guo, Jiayu	ThCT4.4
Guo, Jinbin	FrDT4.7
Guo, Kexin	FrAT3
	FrBT1.5
	FrBT1.7
Guo, Lei	WeAT3.7
Guo, Lingxi	FrCT2.3
	FrCT2.4
Guo, Rongkun	WeBT3.6
Guo, Shishang	FrCT5.6

Guo, Shuyan	FrBT3.4
Guo, Weixiang	FrBT2.5
Guo, Xianda	WeAT4.4
Guo, Xianggui	ThAT5.7
Guo, Yi	FrAT1.2
Guo, Yirui	FrAT3.6
	FrAT3.7
Guo, Yuxin	FrBT1.5
Guo, Zhao	WeAT6
	WeAT6.1
Guo, Zheng	ThCT5.3
Guo, Zhengang	FrAT1.2
Guo, Zixuan	FrCT1
	FrCT1.3
H	
Han, Dong	FrAT4.1
Han, Mingqiao	FrAT5
	FrAT5.2
	FrAT5.3
	FrCT1.6
Han, Qihang	FrAT2.4
Han, Qingxin	FrAT4.3
Han, Shuchang	ThAT5.1
Han, Xiangqian	FrBT4.6
Han, Xu	WeAT3.5
	WeBT5.1
Han, Yi	ThAT5.3
Han, Zengliang	ThBT3.3
Hao, Cui	WeBT1.5
Hao, Da-Ben	FrDT6.6
Hao, Fei	FrAT1.7
Hao, Fusheng	ThAT6.6
	ThAT6.7
Hao, Lingguang	ThAT3.5
Hao, Liying	ThAT5.7
Hao, Renjian	WeAT5.7
Hao, Xiaoyue	FrCT5.6
Haoyang, Yang	ThCT6.4
He, Bin	FrBT1.2
He, Chao	FrBT3.4
He, Junlin	ThBT6.5
He, Mengfan	FrBT3.6
He, Qibin	FrCT2.3
	FrCT2.4
He, Rui	ThCT3.2
He, Shiming	WeBT2.6
He, Weiming	ThBT3.6
He, Xiaoyao	ThCT3.3
He, Yan-Lin	FrDT6.6
He, Yuman	ThAT4.6
He, Zeyu	FrAT1.3
He, Zheng	FrCT2.6
He, Zhongyun	WeBT2.6
Hong, Duanqin	ThBT5
	ThBT5.2
	ThBT5.3
Hong, Wenxing	ThBT5
Hong, Wenxing	ThBT5.1
	ThBT5.3
	ThBT5.5
	ThBT5.6
Hong, Yiguang	WeAT1.4
Hong, Yiguang	WeBT4.5
	ThCT6.6
Hou, Baoshen	WeAT2.2
Hou, Jie	ThCT5.1
Hou, Rui	FrDT3.4
	FrDT3.5
Hou, Wenjie	FrBT3.3

Hu, Enze	FrCT1.1
Hu, Guoqiang	ThBT4.6
Hu, Hui	FrDT4.7
Hu, Jiaying	ThCT3.6
Hu, Jinwen	FrBT4
	FrBT4
Hu, Jinwen	FrBT4.2
Hu, Jinwen	FrBT4.3
Hu, Kaiyu	WeBT1.2
Hu, Pengwei	FrAT3.1
Hu, Songyu	ThCT3
	ThCT3
	ThCT3.6
Hu, Tianxin	FrBT2.5
Hu, Xingzheng	ThBT5.5
Hu, Xuchi	FrDT5.2
Hu, Yunqing	FrCT1.1
Hu, Zeyun	WeBT5.6
Hua, Haochen	ThAT5
	ThAT5.4
Hua, Yongzhao	ThAT4.4
	FrDT2.6
Huan, Zhijie	FrAT4.3
Huang, Baoqin	ThAT6.1
Huang, Bo	FrAT2.7
Huang, Chaohong	ThAT5.1
Huang, Dongyue	FrAT5
Huang, Hailong	ThAT1
	ThAT1.3
	ThCT6
	ThCT6.4
Huang, Jiahao	FrDT6.3
Huang, Jie	WeAT6.5
Huang, Jie	FrBT5
	FrBT5
	FrBT5.3
	FrBT5.4
	FrBT5.5
	FrBT5.6
Huang, Jin	FrAT4.6
Huang, Jingli	FrBT5.3
	FrBT5.4
Huang, Junda	ThAT1.7
Huang, JunSong	ThBT6.6
Huang, Nanxi	ThCT2.4
Huang, Renqiang	ThCT3.4
Huang, Shunyuan	ThBT6.6
Huang, Wenze	FrDT4.7
Huang, Xin	FrDT6
	FrDT6
	FrDT6.1
Huang, Xintao	FrCT2.2
Huang, Xiucan	FrCT3
Huang, Yijun	ThBT5
	ThBT5.4
	FrCT1.4
Huang, Zhikun	FrCT1.1
Huang, Zongsheng	FrCT2
	FrCT2.7
Hui, Larry	WeBT3.5
Hui, Wang	FrDT2.7
Huidong, Wang	WeAT2.5
	FrBT4.6
Huo, Mengzhen	ThBT5
Huo, Ziyun	ThAT6.6
I	
Imasheva, Gulnar	ThCT1.5
Iskakova, Aigul	FrCT4.3
Issabekov, Zhanibek	ThAT1.2

J	
Ji, Chengtao	FrBT5.1
Ji, Haoyi	WeAT2.6
Ji, Haoyu	FrDT4.7
Jia, Liheng	ThBT1.3
Jia, Wenbo	WeBT6.1
Jia, Yongyi	WeBT2.3
Jia, Zehua	FrCT2
Jiaju, Zhu	FrDT1.2
Jiang, Bin	FrAT6.2
Jiang, Guolai	ThCT2.2
Jiang, Jialin	ThCT2.1
Jiang, Jiaqi	FrDT5
	FrDT5
	FrDT5.2
	FrDT5.4
Jiang, Li	FrAT2.5
Jiang, Taoran	WeBT2.2
Jiang, Tian	FrAT4.5
Jiang, Xiantai	WeBT3.3
Jiang, Yingjin	ThAT5.4
Jiang, Yongpeng	WeBT2.3
Jiang, Yue	WeAT6.3
Jiang, Yuning	WeBT2.6
Jiang, Yuze	ThBT5.6
Jiang, Zhong-Ping	WeBT1.4
	WeBT6.1
Jianquan, Sun	FrCT5.5
Jiao, Guohua	FrDT3
	FrDT3.1
Jiao, Ran	FrCT5.6
Jiao, Xiaohong	WeAT3
	WeAT3.2
Jin, Jiaye	FrBT2.5
Jin, Xin	ThBT3
	ThBT3
	ThBT3.2
	ThBT3.4
Jin, Yu	FrBT6.6
Jin, Yujian	FrAT4.2
Jin, Yulong	WeAT3.1
Jing, Mengjie	WeBT4.4
Ju, Zhiyang	WeAT3.5
	WeBT5.1
Jun, Cheng	ThAT6
	ThAT6.1
	ThAT6.6
	ThAT6.7
K	
Kal, Song	WeAT6.2
Kairolla, Airis	FrCT6.2
	FrCT6.3
	FrCT6.4
Kaliyeva, Amina	WeAT4.3
Kam, Jordan	WeBT3.5
Kamiya, Yushi	FrCT1.2
Kan, Zhen	FrCT3
	FrCT3.1
	FrCT3.2
Kang, Miao	WeAT5.6
Kappassov, Zhanat	FrCT6
	FrCT6.1
	FrCT6.2
	FrCT6.3
	FrCT6.4
Katsuhiko, Tori	ThAT1.6
Ke, Cheng	ThBT5.1
	ThBT5.5
	ThBT5.6

Ke, Weiling	FrCT3.4
Ke, Yijie	FrDT5.5
Kengesbayeva, Sara	FrCT4.5
Kexin, Liu	WeAT3.7
Kong, ShaoHua	FrAT2.5
Korpebayev, Daryn	WeAT6.2
Kravaris, Costas	FrDT6.4
Kun, Wang	FrAT3.5
Kusdavletov, Sanzhar	WeAT4
	WeAT4.3
L	
Lai, Cunzhi	FrAT2.4
Lan, Weiyao	FrDT4.1
	FrDT4.2
Lang, Yilin	ThAT4.3
Le, Jinyang	FrAT4.4
Lei, HongTao	WeAT4.1
Lei, Jinlong	ThCT6.6
	FrDT2.4
Lei, Lei	FrAT5
	FrAT5
Lei, Lei	FrAT5.2
	FrAT5.3
	FrAT5.4
	FrAT5.5
	FrCT1.6
Li, Baoren	FrAT5.1
Li, Bin	ThCT2.5
Li, Binbin	FrBT3.6
Li, Bingyan	FrBT4.3
Li, Changsheng	FrDT1
	FrDT1
	FrDT1.4
	FrDT1.5
	FrDT1.6
	FrDT1.7
Li, Chaofeng	FrAT2.2
Li, Chunyu	FrBT3.6
	FrDT5.1
	FrDT5.2
	FrDT5.3
Li, Cong	ThCT5.2
Li, Dachuan	WeAT1.5
Li, Daofei	FrAT3.7
Li, Dianxi	WeAT1.3
Li, Erhang	ThAT2.3
Li, Fan	FrBT2.1
Li, Fanxing	FrBT2.6
Li, Guanglin	WeBT3.3
	FrDT2.7
Li, Guilu	FrDT5.4
Li, Guowei	ThBT2.5
Li, Hao	FrCT3.1
	FrCT3.2
Li, Heng	WeBT1.1
Li, Heran	WeAT6.2
Li, Huiping	ThAT2
	ThAT2.2
Li, Jiahong	FrBT5
	FrBT5
	FrBT5.6
Li, Jiajia	FrDT3.4
	FrDT3.5
Li, Jiayi	ThCT3.6
Li, Jin	FrAT6.1
Li, Jinbai	ThAT2.5
Li, Junyang	FrAT4.2
Li, Kun	FrAT5.4
Li, Li	WeAT5.6

Li, Lin	FrCT3.2
Li, Min	WeBT6.3
Li, Ming	FrCT1
Li, Peng	ThCT3.2
Li, Peng	FrBT1.6
Li, Peng	FrCT6
Li, Peng	FrDT1.5
Li, Pengfei	FrCT1.5
Li, Qian	FrBT4.7
Li, Qiang	FrCT6
	FrCT6
	FrCT6.1
	FrCT6.2
Li, Qingxiang	FrCT1
Li, Ronghui	FrBT2.7
Li, Rongyan	ThCT4.6
Li, Ruocheng	ThBT4.1
	ThBT6.6
Li, Shanghao	FrCT3.4
Li, Shangqing	FrAT5.1
Li, Shaohui	FrAT3.2
Li, Shaojie	FrBT4.6
Li, Shaoyuan	FrAT1.5
Li, Shengbo Eben	ThCT1.2
	FrAT1.3
Li, Tianxun	FrBT2.4
Li, Tianyang	ThBT4.7
Li, Tieshan	FrCT2.1
	FrCT2.7
Li, Wei	FrCT5.4
Li, Weihong	FrBT4.1
Li, Wenling	FrAT2.3
Li, Xiang	WeBT2
	WeBT2.3
	FrCT3
	FrCT3.5
Li, Xiangpeng	ThCT3.4
	ThCT3.5
Li, Xiangxin	FrCT5.3
Li, Xianwei	ThAT2.4
	FrAT1
	FrAT1.5
Li, Xiaoduo	ThAT4.4
	FrDT2.6
Li, Xiaojie	FrAT1.6
Li, Xiaoliang	FrBT1.6
Li, Xiaoming	FrAT2.3
Li, Xin	FrCT5.7
Li, Xingchen	FrBT2.4
Li, Xingeng	FrCT3.6
Li, Xiuhong	FrCT6.5
Li, Xiuxian	FrDT2
	FrDT2.3
Li, Xudong	FrBT3.3
Li, Xueqing	FrCT6.5
Li, Xukun	WeAT6.3
Li, Yifan	WeBT6.7
Li, Yifan	FrAT3.5
Li, Ying	FrAT4.1
Li, Ying	FrAT5.5
Li, Yinggong	FrCT6
	FrCT6
	FrCT6.1
Li, Yitong	ThAT1.7
Li, Yongze	FrAT6.4
Li, Yu	WeAT1.1
Li, Yu	ThBT5
	ThBT5.4
Li, Yuanlong	ThCT4.3

Li, Yuanyuan	FrBT3.1
Li, Yudi	FrCT5.7
Li, Yujie	WeAT2.5
Li, Yukun	ThBT4.7
Li, Yuzhe	FrBT2.1
Li, Yuzheng	WeBT6.7
Li, Zhaoxu	WeAT2.2
Li, Zhiheng	WeBT5.6
Li, Zhuo	WeAT1.3
Li, Zhuo	ThCT2.4
Li, Zichuang	WeAT5.7
Li, Zihan	FrCT1.5
Li, Zihao	ThAT4.3
Lian, Jibing	FrAT4.1
Lian, Zihan	FrDT1.3
Liang, Dong	ThCT4.1
Liang, Hongtao	ThAT2
	ThAT2
	ThAT2.2
Liang, Quanyi	WeBT4.3
Liang, Ruining	FrDT2.2
Liang, Shuang	WeBT6.3
Liang, Xiaoxin	WeBT3.3
Liang, Xinye	FrDT1.5
	FrDT1.6
Liang, Xudong	FrAT4.6
Liang, Zhihui	ThAT6.5
Liangzheng, Sun	FrBT3.6
Liao, Yueru	WeAT6.1
Liao, Yuting	FrBT6.4
Lin, Feng	WeAT5.1
	ThAT1.5
Lin, Fengyu	WeAT4.1
Lin, Huilong	ThBT1.5
Lin, Jinhai	FrAT4.3
Lin, Shifu	WeBT3.1
Lin, Xubin	FrAT2.4
	FrAT2.5
Lin, Yaohua	WeBT6.7
Lin, Yingtao	ThBT2.6
Ling, Qi	FrAT2.7
Ling, Ren	ThCT5.7
Lining, Sun	FrBT3.3
Liu, Bin	FrBT1.6
Liu, Bingxun	FrAT1.4
Liu, Chang	FrAT1.3
Liu, Chao	ThAT5.6
Liu, Chenyang	FrDT5.3
Liu, Chuanbin	ThBT5
Liu, Chun	FrBT1.3
Liu, Fuqiang	ThBT2
	ThBT2.2
Liu, Geyuan	FrDT4.4
Liu, Henghua	WeAT2.1
Liu, Honghai	FrDT4.7
Liu, Hu	FrDT3.4
	FrDT3.5
Liu, Jianming	ThAT6.6
	ThAT6.7
Liu, Jiao	FrDT4.7
Liu, Jing	FrDT6.1
Liu, Jingting	WeAT2.5
Liu, Jingxuan	ThBT1.4
Liu, Junhui	FrDT5
	FrDT5
	FrDT5.1
	FrDT5.2
	FrDT5.3
Liu, Kezhong	FrCT2.1

Liu, Lian	WeBT6.6
Liu, Lian	ThBT6.4
Liu, Lu	WeBT1.4
	ThAT5.5
Liu, Lu	FrBT2.7
Liu, Lupeng	FrDT4.3
Liu, Pei	FrDT4.6
Liu, Qianyuan	WeBT6.7
Liu, Qiting	WeBT4.1
Liu, Qiyu	FrDT3.3
Liu, Runxiao	FrBT6.3
Liu, Shangkun	FrBT5
	FrBT5.3
	FrBT5.4
	FrBT5.5
	FrBT5.6
Liu, Shengjie	FrCT4.6
Liu, Shiqi	ThCT1.2
	FrAT1.3
Liu, Shuyan	FrCT6.5
Liu, Simin	ThCT6.5
Liu, Siyu	ThBT2.2
Liu, Tao	ThCT4
	ThCT4
	ThCT4.5
Liu, Tao	FrBT2.3
Liu, Tengfei	WeBT1.4
Liu, Tianyu	ThAT5.5
Liu, Wei	ThAT5.1
Liu, Wenjie	ThCT1.4
Liu, Wenquan	FrCT4.6
Liu, Wenrui	WeAT1.3
Liu, Xiao-Kang	WeBT6.6
Liu, Xiaotao	ThAT2
Liu, Xingxun	ThBT3.5
Liu, XinJiang	WeBT2.7
Liu, Xinyi	FrBT4.7
Liu, Xuchen	ThBT4.1
Liu, Xuchen	ThBT6.4
	ThBT6.6
Liu, Xueting	FrDT4.7
Liu, Yan-Jun	FrBT6
	FrBT6.1
Liu, Yaxuan	ThAT3.3
Liu, Yiheng	ThAT2.5
Liu, Ying	ThAT6.5
Liu, Yingjuan	FrCT6.6
Liu, Yiyang	FrAT1.5
Liu, Yongfang	WeBT4.2
Liu, Yuanyuan	FrAT3.6
Liu, Yueyue	FrAT4.6
Liu, Yunhui	WeBT2.2
	ThCT2.5
Liu, Zexu	ThCT6.3
Liu, Zhao	WeBT1.2
Liu, Zhao-Qing	ThAT5
Liu, Zhengyang	ThAT1.7
Liu, Zhishuo	FrBT6.5
Liu, Zhiyao	ThAT2.1
Liu, Zihui	FrBT6.7
Liwang, Minghui	WeAT5.6
Long, Junjie	FrCT6.1
Long, Qinyuan	WeAT6.1
Long, Shike	FrBT6.7
Long, Teng	FrCT1.1
Lu, Bo	FrBT3
	FrBT3.3
	FrBT3.4
Liu, Hanxinyang	FrCT5.6

Lu, Haolin	WeAT6.1
Lu, Linying	ThBT1.3
Lu, Maobin	FrDT4
	FrDT4
	FrDT4.3
	FrDT4.4
Lu, Peng	FrDT2
	FrDT2.3
Lu, Qiyang	WeAT2.3
Lu, Rongxiang	FrBT1.2
Lu, Tongwei	FrDT6.6
Lučan, Jelena	WeAT5.4
Luan, Mengbo	FrCT5.5
Lulu, Song	ThCT5.7
Luo, Delin	WeAT1.2
	WeAT4.6
Luo, Jiaxiang	FrCT1.1
Luo, Kunhong	ThBT5.3
Luo, Mingxiang	WeBT1.2
	FrCT5.1
Luo, Songqi	WeBT5.2
Luo, Tao	FrAT4.4
Luo, Zhibin	WeAT4.2
	WeBT5.4
Lv, Chuanzhi	WeAT3.3
Lv, Mingwei	FrBT4.3
Lv, Xiaokang	ThCT5.4
Lv, Yuezu	WeAT4.2
Lyu, Jingke	FrCT6.1
Lyu, Mingzhe	FrBT1.4
Lyu, Sida	FrDT1.6
Lyu, Xufeng	FrDT1.7
Lyu, Yang	FrBT4.2
M	
Ma, Bin	FrCT1.5
Ma, Chuncan	FrCT3.6
Ma, Fei	ThBT6.5
Ma, Jun	FrDT4.6
Ma, Kexin	WeBT6.6
Ma, Luyao	ThAT5.4
Ma, Runze	ThAT3.5
Ma, Weicheng	FrAT4.3
Ma, Xunju	FrCT3.6
Ma, Yao	FrAT4.4
Ma, Yue	FrCT3.5
Ma, Yue	FrCT5.5
Makhmudova, Valeriya	WeAT4.3
Manabu, Goto	ThAT1.6
Mao, He	FrDT2.7
Masaki, Senzaki	ThAT1.6
Masimba, Collins	WeAT4.7
Mei, Lin	ThBT5.1
Mei, Wenjie	WeAT3.4
Meng, Deyuan	ThCT2.6
Meng, Fanyuan	FrDT2.7
Meng, Guoli	ThAT2.3
Meng, Haotian	FrDT2.7
Meng, Min	FrDT2
	FrDT2.3
Meng, Qiwei	WeBT2.2
Meng, Wei	FrBT2
Meng, Ziyang	FrBT3.6
Mežnarec-Novosel, Suzanna	WeAT5.4
Mi, Shuai	FrDT2.2
Miao, Shu	WeBT2.3
Miao, Song	WeBT6.3
Miao, Zhiqiang	WeAT2
	WeAT2.5
	WeBT2.7

	ThBT3
	ThBT3.5
	FrBT4.6
	FrDT5.6
Ming, Aiguo	ThAT1.1
Mo, Hangjie	FrAT4
	FrAT4
	FrAT4.1
Mo, Qianlian	WeAT3.1
Mou, Yanjie	WeAT6.3
Mu, Bingxian	ThBT2
	ThBT2.4
	ThBT2.5
Mu, Biqiang	WeBT4.5
Mu, Changxi	WeAT2.7
Mu, Lingxia	FrAT6.4
Mukashev, Dinmukhammed	FrCT6.2
	FrCT6.4
Mukhanova, Gulmira	ThCT1.5
Muratkanov, Miras	FrCT6.2
	FrCT6.3
N	
Ning, Chuanyi	FrAT1.7
Ning, Yingying	FrBT5.5
Ning, Zian	ThBT6.1
Niu, Fuzhou	FrAT4
	FrAT4
	FrAT4.1
Niu, Yifeng	FrBT4.1
Niu, Yugang	FrAT2.1
O	
Omirebekova, Zhanar	WeAT6.4
	FrCT4.3
Ouyang, Yuhan	FrBT5.4
Ozhikenov, Kassymbek	WeAT5.3
P	
Padilla, Mark Lester Francisco	FrCT4.7
Pan, Hao	ThCT3.4
Pan, JiaHao	FrAT6.2
Pan, Rui	WeAT3.6
Pan, Zhenhua	FrAT2.2
Pang, Bo	ThBT3
Pang, Zhi	FrCT5.1
Pang, Zhiyuan	FrAT2.7
Pei, Wenyuan	ThCT6.5
Peng, Cheng	WeAT6.5
Peng, He	ThAT3.2
Peng, Zhihong	ThBT4.7
Peng, Zhouhua	WeAT6
	WeAT6.3
	FrBT2
	FrBT2.7
Perea, Carlos	WeBT6.4
Ping, Zhaowu	ThCT4.4
Pingao, Huang	FrCT4.6
Pumasupa, Alvaro	WeBT6.4
Pun, Chi-Man	ThAT6.2
Pun, Man ON	WeBT5.6
Q	
Qi, Guoyuan	FrBT6.2
Qi, Qihan	ThBT3.6
Qi, Yiwen	ThAT4.1
Qi, Zixi	ThBT4.4
Qian, Chao	FrDT1.7
Qian, Rui	FrBT2.5
Qian, Yuan	FrBT3.2
Qiao, Jianzhong	WeAT3.7
	FrAT3.1
	FrAT3.4

	FrAT3.5
Qie, Rongkai	FrCT2.4
Qieshi, Zhang	ThAT6
	ThAT6.2
	ThAT6.3
	ThAT6.4
Qin, Dawei	FrDT3.1
Qin, Huabiao	WeAT2.3
	WeAT4.4
Qin, Zhengyan	WeBT1.4
Qinhe, Jin	FrAT3.3
Qiu, Jingru	WeBT3.2
Qiu, Mengqi	FrBT1.7
Qu, Xiaolei	WeAT6.6
Quan, Quan	FrBT6
	FrBT6
	FrBT6.3
R	
Rakhimzhanov, Rustem	ThAT1.2
Rakhmetkali, Ayan	WeAT4.7
Rakhmetova, Perizat	ThAT1.2
Ramadan, Omar A.	ThBT2.3
Ramezanzadeh, Nasrin	FrAT6.5
Ranjan, Ritu	FrDT6.4
Rei, Ito	ThAT1.6
Ren, Bin	FrDT3.6
Ren, Lu	ThBT3
Ren, Mifeng	ThAT3.4
Ren, Qinyuan	ThAT4.3
	ThBT1.1
Ren, Weihong	FrDT4.7
Ren, Xiaoqiang	FrBT1.3
Ren, Yatao	WeBT4.2
Ren, Zhang	ThCT5.3
Ren, Zhanyan	FrAT3.6
Ruan, Mengxin	ThAT5.4
S	
Sagynuly, Sanzhar	WeAT6.4
Samigulin, Timur	WeAT4.7
Sandykbayeva, Danissa	FrCT6.3
Sato, Ryuki	ThAT1.1
Schofield, Hunter	WeBT6.5
Sha, Fan	ThCT5.7
Shan, Jiayuan	FrDT5
	FrDT5.1
	FrDT5.2
	FrDT5.3
Shan, Jinjun	WeBT6
	WeBT6.5
Shan, Wei	FrCT2.2
Shang, Jinxin	ThAT4.1
Shang, Xiruo	ThBT2.2
Shao, Jingheng	WeBT3.7
	FrCT1.4
	FrDT3.7
Shao, Xiaojuan	ThCT5.7
Shao, Xingyu	FrBT3.6
Sharma, Nalin Kumar	WeBT2.5
Shavkat, Kholov	ThAT6.4
She, Zhikun	WeBT4.3
Shen, Chao	ThBT2
	ThBT2.6
	ThBT2.7
Shen, Tielong	WeBT6.2
Shen, Xiaoman	ThAT5.1
Shen, Xinjing	FrAT3.2
	FrAT3.3
Shen, Zhipeng	ThAT1.3
Shen, Zhixi	WeBT2.3

Sheng, Yixuan	WeBT1.2
	FrCT4.2
	FrCT5
	FrCT5.2
Sheng, Yuanxiu	WeBT1.4
Sheng, Zhaoming	FrBT2.2
Sheng, Zimao	WeBT3.6
Shi, Dawei	WeAT5.7
Shi, Jiangbo	FrBT1.6
Shi, Jianxin	FrDT4.6
Shi, Liangren	ThCT4.3
Shi, Mingming	FrBT5
	FrBT5.1
Shi, Xiang	ThAT4.5
Shi, Yang	WeAT3.6
	ThCT6.3
	FrBT2.1
Shi, Yangxi	WeAT2
	WeAT2.1
	WeBT1.5
Shi, Yu	ThBT3.1
Shiryayeva, Olga	FrCT4.3
Shokouhi, Shahab	ThBT2.4
Shu, Yi	WeBT3.3
Sidorov, Denis	ThAT5.4
Singh, Larissa	WeBT6.5
Singh, Padmini	WeBT2.5
Smailov, Nurzhigit	FrCT4.5
Song, Chengqun	ThAT6.1
	ThAT6.6
	ThAT6.7
Song, Jia	FrAT2.3
Song, Jiliang	WeAT5.7
Song, Liansheng	FrAT4.2
Song, Peng	FrCT3.3
Song, Shichen	ThBT3.5
Song, Shiji	FrCT3.5
Song, Yanyan	FrBT4.2
Song, Yunfeng	WeBT6.2
Song, Zhan	FrDT3.3
Song, Zhan	FrDT3.6
Song, Zhenjun	FrCT2.2
Su, Jiangcheng	ThCT6.4
Su, Shaoka	ThBT1.5
Su, William	WeBT3.5
Su, Youfeng	FrAT1.1
Su, Youtao	WeAT3.5
	WeBT5.1
Subedi, Sunil	WeBT6.1
Sun, Bin	FrCT5.2
Sun, Changqing	FrAT3.5
Sun, Chengfeng	FrDT1.3
Sun, Chuanyu	WeAT6.2
Sun, Fangyu	FrBT2.6
Sun, Haiwen	FrCT2.4
Sun, Hao	FrDT3.5
Sun, Hongwei	ThBT3.1
Sun, Jian	ThCT2.4
Sun, Lining	ThCT3.4
Sun, Qiming	ThAT4.2
Sun, Shanlin	FrBT6.7
Sun, Siyang	FrDT2.5
Sun, Xiang	FrBT4.1
Sun, Xiaojian	WeAT4.5
Sun, Xiaoqin	ThCT3.5
Sun, Yichong	FrAT2
Sun, Yinghao	FrBT4.2
Sun, Youping	FrCT3.6
Sun, Yuanyingyi	ThCT4.1

Sun, Yutong	FrDT4.1
Suzuki, Keisuke	ThAT1.1
Suzuki, Masakazu	WeAT5.2
T	
Ta, La	WeBT6.2
Tan, Junkai	ThCT6.1
Tan, Qi	FrDT6.3
Tan, Qiyun	FrDT2.7
Tan, Yu Heng	ThBT4.3
Tang, Chaoying	ThBT6.7
Tang, Heng	ThAT5.3
Tang, Jiabao	FrCT5.6
Tang, Jiacheng	FrBT6.6
Tang, Jingqi	FrBT5.5
Tang, Luohao	WeAT4.1
Tang, Wei	FrAT4.6
Tang, Wenbin	WeAT3.2
Tang, Xiaozhen	FrBT6.2
Tang, Xuyin	ThAT5.3
Tang, Yang	ThBT3.2
Tang, Yifeng	ThCT2.2
Tang, Yutao	ThAT4.2
Tang, Zeyu	FrBT6.7
Tang, Zhonghuan	WeAT5.6
Tang, Ziyang	FrDT4.7
Tao, Gang	WeBT5.1
Tao, Qianle	FrAT6.3
Tao, Zichen	WeBT1.5
Targynova, Zhanerkem	FrCT4.5
Teng, Hao	WeAT3.7
	FrAT3
	FrAT3
	FrAT3.1
	FrAT3.2
	FrAT3.3
	FrAT3.4
	FrAT3.5
Teng, Yuxin	ThAT5.6
Thein, May-Win	ThBT2.4
	ThBT2.5
Tian, Baolin	WeAT2.2
	WeAT2.7
Tian, Ye	FrAT4.3
Tian, Ye	FrDT1.5
Tianyang, Tian	FrDT2.1
Tie, Lin	ThCT1.3
Tokmurziyev, Issatay	FrCT4.7
Tong, Mingjing	WeBT4.3
Tong, Yicheng	ThBT5.1
Toregali, Nargiza	ThCT1.5
Trinitatova, Daria	FrCT4.7
Tu, Niehua	ThAT5.3
Tu, Yuantao	WeAT3.5
	WeBT5.1
Tuimebay, Yelnur	WeAT5.3
Tuleshov, Yerkebulan	ThAT1.2
U	
Ueno, Satoshi	WeAT3.4
Urrunaga, Yahir	WeBT6.4
W	
Wang, Anqing	WeAT6.3
	FrBT2.7
Wang, Ban	FrAT6.4
Wang, Biao	ThBT6.7
Wang, Bin	FrBT6.1
Wang, Binyan	FrCT5.4
Wang, Can	ThCT3.1
Wang, Changhai	FrAT3.7
Wang, Chaoli	ThCT4.1

Wang, Chenxiao	FrAT5.3
	FrCT1.6
Wang, Chunyan	ThAT4.5
Wang, Danjing	FrCT3.4
Wang, Enliang	FrAT5.4
Wang, Gang	WeBT2.2
Wang, Gang	ThCT1.4
Wang, Hao	WeBT6.5
Wang, Haoliang	FrBT2.7
Wang, Haoyu	FrDT5.6
Wang, Hong	WeBT6.1
Wang, Hongkun	FrBT1.1
Wang, Honglun	ThAT2.5
	FrBT4.4
Wang, Hongman	ThCT4.6
Wang, Hongxia	WeAT3.3
	WeBT5.5
Wang, Hui	FrCT4
	FrCT4.6
Wang, Huiting	ThCT6
	ThCT6.2
Wang, Jiahao	FrDT1.4
Wang, Jiale	FrDT2.5
Wang, Jialiang	FrDT3.7
Wang, Jianan	FrDT5
	FrDT5.1
	FrDT5.2
	FrDT5.3
	FrDT5.4
Wang, Jiapeng	FrDT1.5
	FrDT1.6
Wang, Jieyu	FrCT1
Wang, Jinghua	FrCT6.5
Wang, Jingyu	FrAT2.7
Wang, Junkai	FrCT2.5
Wang, Junnan	FrBT3.2
Wang, JunYang	FrAT2.5
Wang, Lili	ThCT4.5
Wang, Lin	FrDT1
	FrDT1
	FrDT1.1
	FrDT1.2
Wang, Lingqi	ThCT1.4
Wang, Maonan	WeBT5.6
	FrCT1
Wang, Meng	FrBT1.5
Wang, Miao	ThBT4
	ThBT4.5
Wang, Ming	WeBT1.1
Wang, Mingzhuo	FrBT6.5
Wang, Nan	ThCT5.7
Wang, Pei	WeBT3.7
Wang, Pei	WeBT6.7
Wang, Pei	FrCT1.4
	FrDT3.7
Wang, Peng	FrCT2.4
Wang, Ping	FrCT1.5
Wang, Qiang	WeBT3.1
	ThAT1.4
Wang, Qing	WeBT1.1
Wang, Qing	ThCT4.6
Wang, Qing	ThCT5
Wang, Qing	ThCT5.4
Wang, Qingyun	WeBT5.4
Wang, Qishao	WeAT4.2
	WeBT5.4
Wang, Shimin	ThCT5.4
Wang, Shuai	FrCT5.1
Wang, SiWei	FrAT6.2

Wang, Tianqi	WeAT1.4
Wang, Weize	FrDT1.7
Wang, Wenxian	ThCT2.6
Wang, Xiangyang	ThAT6
	FrCT5.5
Wang, Xianyi	ThBT5.3
Wang, Xiaofan	FrBT1.3
Wang, Xiaojun	WeAT2.7
Wang, Xiaoxiao	ThCT6.6
Wang, Xibo	WeBT4.5
Wang, Xinyang	ThBT6.2
Wang, Xuehe	FrBT2
	FrBT2
	FrBT2.3
Wang, Xueqian	WeAT1.5
Wang, Xufei	FrCT5.5
Wang, Yan	WeBT4.6
Wang, Yan-Wu	WeBT6.6
Wang, Yankai	FrDT5.2
	FrDT5.3
Wang, Yanxiang	ThAT2.5
Wang, Yanyi	FrCT6.1
Wang, Yaonan	WeBT2.7
	ThBT3.5
	FrDT5.6
Wang, Yi	ThBT2.4
Wang, Yichen	FrAT5.5
Wang, Yihang	FrAT4.3
Wang, Yijian	FrCT2.5
Wang, Yijing	ThCT6.1
Wang, Ying	WeAT3.1
	WeBT5.2
Wang, Yongcai	FrBT1.4
Wang, Yongjun	FrBT6.7
Wang, Yu	FrAT4.1
Wang, Yuanxin	ThAT2.3
Wang, Yuhan	FrAT5.1
Wang, Yunan	ThAT4.4
Wang, Yunli	WeAT3.6
Wang, Yuqi	FrAT4.4
Wang, Yuxiang	FrBT4.3
Wang, Yuzheng	WeAT2.2
Wang, Ze	WeBT6.3
Wang, Zekun	FrCT2.6
Wang, Zeyu	FrDT1.4
Wang, Zhenmin	ThBT6.4
Wang, Zhipeng	FrBT1.2
Wang, Zhishen	WeAT6.6
Wang, Zhiyong	FrCT4
	FrCT4.2
	FrDT4.7
Wang, Zhongkui	WeAT2.6
Wani, Sameer	WeBT2.5
Waterman, Adam	ThCT1.6
Wei, Dapeng	WeAT2.7
Wei, Hejun	ThBT6.6
Wei, Hongqian	ThAT2.3
Wei, Shaozhun	WeAT2.1
Wei, Wei	FrCT3.7
Wei, Xing	ThBT6.7
Wei, Yiran	FrAT2.2
Wei, Yue	FrBT1.1
Wei, Yuzhou	ThCT1.4
Wen, Chih-Yung	WeAT1.1
Wen, Jiwei	ThAT3.2
Wen, Junjie	ThBT6.5
	FrAT5
Wen, Qi	FrAT4.2
Wen, Youpeng	WeBT2.2

Weng, Yongjie	FrCT3.7
Wu, Delong	WeBT1.5
Wu, Fuxiang	ThAT6.1
	ThAT6.6
	ThAT6.7
Wu, Guobin	FrAT4.4
Wu, Haiwen	WeBT2.2
Wu, Hao	ThAT1.7
Wu, Hao	ThBT6.3
Wu, Haoyu	FrAT2.2
Wu, Hongmin	FrAT2.4
	FrAT2.5
Wu, Jiaao	FrAT3.4
Wu, Jianfa	FrBT4.4
Wu, Linchao	FrAT4.6
Wu, Peixi	WeBT3.3
Wu, Tao	ThCT4.2
Wu, Tiancai	FrBT4.4
Wu, Wenjie	WeAT6.3
Wu, Wentao	ThCT6
	ThCT6
	ThCT6.1
Wu, Xinyu	ThCT3.1
	FrCT5.1
	FrCT5.3
	FrCT5.5
Wu, Xipeng	FrDT1.7
Wu, Xuyang	ThCT4.2
	ThCT5.2
Wu, Yan	FrDT3.4
	FrDT3.5
Wu, Yezhen	ThAT1.4
Wu, Yuhu	WeBT6.2
Wu, ZhiHong	WeAT2.5
Wu, Zongzhou	WeBT3.7
	X
Xi, Junqiang	WeAT3.5
	ThAT2.3
Xi, Lele	FrBT1.1
Xia, Ming	FrAT3.7
Xia, Zhiwei	FrBT1.3
Xiang, Linying	WeAT4.5
Xiao, Jian	WeAT2.7
Xiao, Shunyu	ThAT5
Xiao, Shuyi	FrDT6
	FrDT6.2
Xiao, Wei	ThCT1.4
Xiaoli, Luan	ThAT3.2
Xie, Bowei	FrDT4.4
Xie, Kaiyi	WeBT6.7
Xie, Kedi	FrDT4.4
Xie, Le	WeAT2.4
	ThBT1.6
Xie, Lihua	WeAT1
	WeBT1
	FrBT2.5
Xie, Mengjie	WeAT5.1
Xie, Mingyang	ThCT3.3
Xie, Shuke	FrCT1
Xie, Shuzong	FrDT6.3
Xie, Tao	FrDT4.2
Xie, Xin	FrAT3.7
Xie, Yuejiao	WeBT5.6
Xin, Bin	WeAT1.4
	WeBT4
	WeBT4.4
	ThBT4
	ThBT4
	ThBT4.1

	ThBT4.5
	ThCT4.6
Xing, Cheng	FrCT2.6
Xing, Fei	FrBT3.6
Xiong, Li	ThBT2.1
Xiong, Wei	WeAT1.4
Xu, Bingyan	ThAT5.3
Xu, Binyan	ThBT2
	ThBT2.3
Xu, Chengzhi	ThAT4.2
Xu, Dabo	ThBT1.2
Xu, Fuguo	WeBT6.2
Wu, Gen	WeAT1.2
Xu, Hongyang	FrAT1.4
Xu, Jiahang	ThCT3.6
Xu, Jiangwen	ThBT2.1
Xu, Jiapeng	FrDT6
	FrDT6.3
Xu, Jingzhong	ThAT1.5
Xu, Jinming	ThCT5
	ThCT5.1
Xu, Jiwen	ThBT5
	ThBT5.2
Xu, Kunhao	WeAT2.7
Xu, Lei	ThCT6
	FrBT2.1
Xu, Liang	FrAT1.1
Xu, Liang	FrDT2
	FrDT2.1
Xu, Qian	WeAT1.5
Xu, Qiang	FrAT3.1
	FrAT3.2
Xu, Qianyin	FrBT4.5
Xu, Ruoyu	FrBT4.2
Xu, Sheng	ThCT2
	ThCT2
	ThCT2.2
Xu, Wenying	ThCT5.5
Xu, Xiang	ThCT4.2
	ThCT5.2
Xu, Xiaozhou	FrDT6.3
Xu, XinYing	ThAT3.1
Xu, Xuan	FrDT2.7
Xu, Yuan	FrDT6.6
Xu, Yunjian	WeBT5
	WeBT5.3
Xu, Zhao	FrBT4
	FrBT4.3
Xu, Zhenyu	ThAT6.2
Xu, Zhuang	FrCT4.1
Xue, Dong	FrBT5
	FrBT5.2
Xue, Hanqing	FrCT2.3
	FrCT2.4
Y	
Yakimenko, Oleg A.	WeBT1.3
Yan, Chao	ThBT3.3
Yan, Cong	WeBT2.4
Yan, Gaowei	FrDT6.2
Yan, Hongjiao	ThBT1.2
Yan, Qilin	FrDT4.4
Yan, Rui	FrDT2.2
Yan, Ruixin	FrAT5.6
Yan, Tao	FrCT2.6
Yan, Wenxi	FrDT3.2
Yan, Wu	FrAT2.5
Yan, Yamin	ThBT4.6
	FrCT2.7
Yan, ZhiQiang	FrBT3.6

Yang, Chen	FrCT5.2
Yang, Chunxi	ThBT3.1
Yang, Guidong	FrAT5
	FrAT5.2
	FrAT5.3
	FrCT1
	FrCT1
	FrCT1.4
	FrCT1.6
Yang, Hao	FrAT6.2
Yang, Hao	FrDT1.3
Yang, Hong'an	WeBT3.6
	FrCT3.3
Yang, Jiahao	WeBT4.6
Yang, Jiahui	FrBT3.1
Yang, Jiankun	ThBT6.3
Yang, Jiabin	ThBT1.5
Yang, Jiayu	FrBT3.2
Yang, Jing-yu	ThAT5.7
Yang, Junyi	FrCT5.1
	FrCT5.3
Yang, Kun	FrDT4.5
Yang, Lan	FrCT5.7
Yang, Lidong	ThCT2
	FrBT4
	FrBT4.5
Yang, Pengqian	FrDT5.1
Yang, Qingkai	WeBT1.5
	ThAT4
	ThAT4
	FrBT1
	FrBT1
Yang, Runbang	ThBT1.4
Yang, Shaofu	ThCT5.5
Yang, Shuxiang	WeBT3.6
Yang, Tao	FrBT2.1
Yang, Wei-hsiang	FrCT1.2
Yang, Wenbin	ThAT1.5
Yang, Wentuo	WeAT2.4
Yang, Xia	FrBT6.6
Yang, Xiaokang	ThAT3.6
Yang, Xin Mei	ThAT4.5
Yang, Xingchen	FrCT4
Yang, Xinsong	ThBT3.6
Yang, Xuecong	WeAT2.2
Yang, Yingying	WeBT6.7
Yang, Yue	FrCT2
	FrCT2.1
Yang, Yuhong	FrBT3.2
Yang, Zeyu	ThBT3.5
Yang, Zhe	FrCT2.3
Yang, Zhihao	FrDT4.7
Yang, Zhiyuan	FrBT4.4
Yang, Zihan	FrBT4.7
Yano, Ken'ichi	ThAT1.6
Yao, Jiaojiao	FrAT3.7
Yao, Taike	ThCT3.3
Yaokun, Lu	WeAT3.7
	FrAT3.4
Ye, Haifu	FrAT4.6
Ye, Maojiao	ThAT5
	ThAT5.6
Ye, Ying	ThAT5.3
Ye, Yuping	FrDT3.6
Yelenov, Amir	FrCT6.4
Yi, Peng	WeBT4.5
	FrDT2.4
Yi, Shuowen	WeAT6.1
Yi, Xinlei	FrBT2.1

	FrDT2.1
Yi, Yinfan	FrCT5.4
Yin, Meng	FrCT5.3
Yin, Peiyi	FrAT5.1
Yin, Xiang	FrCT3
Yin, Xunyuan	FrAT1
	FrAT1.6
Yin, Zeyang	ThBT3
Yin, Zhen	ThBT4.2
Yin, Zhun	WeBT6.1
Ying, Ruobing	ThBT4.4
Yixuan, Zhang	FrAT3.3
	FrAT3.4
	FrAT3.5
Yong, Kenan	ThBT3
	ThBT3.3
Yongqiong, Yuan	WeAT4.6
You, Keyou	ThAT5
	FrBT2.4
	FrDT2
You, Zijing	WeBT3.3
Yparraguirre, Mathias	WeBT6.4
Yu, Haitao	WeAT2.2
	WeAT2.7
Yu, Hao	WeAT5
	WeAT5.7
Yu, Huilong	ThAT2.3
Yu, Jianglong	WeBT1.1
	ThCT5.3
	ThCT5.6
Yu, Junzhi	ThAT2.2
Yu, Limin	WeAT1.2
Yu, Shicong	FrAT1.1
Yu, Wei	FrAT4.2
Yu, Xiang	FrAT3
	FrBT1.5
	FrBT1.7
Yu, Xiao	FrDT4
	FrDT4.1
	FrDT4.2
Yu, Yang	WeAT4.2
Yu, Yuanyuan	ThCT5.5
Yu, Zhouyang	ThCT1.2
Yuan, Chang	FrAT5.1
Yuan, Haozhong	FrBT3.1
Yuan, Shenghai	FrBT2.5
Yuan, Tianshuo	FrDT3.1
Yuan, Ye	FrBT2.1
Yun, Qu	ThBT4.5
Z	
Zahid, Sana	ThBT2.7
Zang, Hao	WeBT5.2
Zang, Yuechao	WeBT4.1
Zaoxu, Zhu	FrAT3.3
Zeinulla, Rassul	WeAT4.7
Zeng, Kai	FrDT5.6
Zeng, Qiang	FrBT6.1
Zeng, Qiming	WeBT1.2
	FrCT4.2
Zeng, Xianlin	ThAT4
	ThAT4.6
	ThCT5
	ThCT5
	ThCT5.1
Zha, Wenzhong	ThBT4.7
Zhang, Bi	FrCT4
	FrCT4.1
Zhang, Chunmei	ThAT3
	ThAT3

	ThAT3.6
Zhang, Dingze	FrCT2.1
Zhang, Dongxu	FrBT3
	FrBT3.2
Zhang, Fumin	FrCT2.5
Zhang, Hao	WeBT6.5
Zhang, He	FrBT3
	FrBT3.1
Zhang, Hong	FrBT1.4
Zhang, Hongwei	ThBT6
	ThBT6.2
	ThCT4.4
Zhang, Hongying	FrCT2.6
Zhang, Huanghe	FrCT3.6
Zhang, Huanshui	WeAT3.3
Zhang, Jia	ThAT3
	ThAT3.1
Zhang, Jiandong	FrBT4
Zhang, Jiangang	FrBT3.3
Zhang, JiangMing	FrAT2.5
Zhang, Jianhua	FrCT5.6
Zhang, Jianxing	FrAT5
	FrAT5.1
Zhang, Jihan	ThBT5
	ThBT5.1
	ThBT5.2
	ThBT5.3
Zhang, Kaifeng	WeAT3.1
	WeBT5.2
Zhang, Kaifeng	FrBT1.7
Zhang, Kunpeng	FrBT2.1
Zhang, Kunwu	ThBT2
	ThCT6.2
Zhang, Lele	ThAT4.5
Zhang, Limin	FrBT1.6
Zhang, Linzuo	FrBT2.6
Zhang, Liping	WeAT3.3
Zhang, Liyao	FrAT3.1
	FrAT3.2
	FrAT3.4
Zhang, Luobin	FrCT3.7
Zhang, Manting	ThBT3.2
Zhang, Menghua	FrBT4.4
Zhang, Mengyu	FrAT4.2
Zhang, Ming-Qing	FrDT6.6
Zhang, Ning	FrAT2.1
Zhang, Peile	FrDT4.7
Zhang, Qianzhen	WeBT4.1
Zhang, Rui	ThBT5.3
Zhang, Shuai	ThBT4.1
Zhang, Shuai	FrCT5.4
Zhang, Teng	WeAT2.4
	ThBT1.6
Zhang, Ting	ThBT1.3
Zhang, Weichen	ThBT6.6
Zhang, Weidong	ThCT6
Zhang, Weijun	FrDT1.5
	FrDT1.6
Zhang, Weiqiang	ThAT3.5
Zhang, Weizhao	WeBT2.1
Zhang, WenJie	ThAT3.4
Zhang, WenKai	ThCT3.4
Zhang, Xiangteng	ThCT1.2
Zhang, Xiangyu	ThBT2.5
Zhang, Xinyue	ThCT3.4
Zhang, Xiufeng	ThBT3.1
Zhang, Xiujie	WeBT4.1
Zhang, Xueli	FrBT3.3
Zhang, Yafen	FrBT5.2

Zhang, Yahui	WeAT3.2
Zhang, Yang	FrDT6.6
Zhang, Yanjun	WeAT6.6
	ThCT2.4
Zhang, Yechen	FrBT2.6
Zhang, Yibo	WeAT5.1
Zhang, Yichi	FrCT2
	FrCT2.2
Zhang, Yin	ThBT6.1
Zhang, Yingfeng	FrAT1.2
Zhang, Youmin	WeAT1.1
	FrAT6
Zhang, Youmin	FrAT6
Zhang, Youmin	FrAT6.1
	FrAT6.2
Zhang, Yu	WeBT6.6
Zhang, Yuhao	ThCT6.3
Zhang, Yun	ThAT5.2
Zhang, Zejun	FrBT1.7
Zhang, Zhanpeng	FrAT3.6
	FrAT3.7
Zhang, Zhaorong	WeBT5.5
Zhang, Zhe	ThBT4.4
Zhang, Zhe	FrDT6.7
Zhang, Zhen	FrAT5.4
Zhang, Zhen	FrDT3.3
Zhang, Zhenning	FrDT2.1
Zhang, Zhenyuan	FrCT6.1
Zhang, Zhixuan	FrAT3.1
	FrAT3.2
	FrAT3.3
Zhang, Zhuowen	FrBT3.1
Zhang, Zihao	WeBT6.7
Zhang, Ziheng	ThBT2.1
Zhanibekov, Askhat	FrCT6.3
Zhao, Benyun	FrAT5
	FrAT5.4
Zhao, Bin	ThBT2.2
Zhao, Chengyan	WeAT3.4
	WeBT2.4
Zhao, Chunhui	FrBT4.2
Zhao, Dong	WeAT3.7
	FrAT3
Zhao, Guoru	WeBT3.3
Zhao, Haoran	FrBT2.5
Zhao, Jiachi	FrBT4.5
Zhao, Jianxin	FrCT2.6
Zhao, Jiayi	ThAT3
	ThAT3.1
Zhao, Jie	FrBT3.1
Zhao, Juan	FrDT3
Zhao, Shiyu	ThBT6
	ThBT6.1
Zhao, Tingting	FrBT5.3
Zhao, Wenyu	ThCT1.3
Zhao, Xingwei	ThCT6.3
Zhao, Xuechen	FrDT3.4
	FrDT3.5
Zhao, Yifan	FrAT2.7
Zhao, Yihang	ThCT6.6
Zhao, Yinxiang	WeAT4.2
	WeBT5.4
Zhao, Yu	WeBT4.2
	FrAT6.3
Zhao, Yuxuan	FrCT2.5
Zhao, Zeyuan	ThAT2.4
Zhao, Zhiliang	ThAT3.2
Zhao, Zuoquan	WeBT3.7
Zhao-Han, Wang	FrCT4.1

Zheng, Bowen	FrDT3.3
Zheng, Jianshu	ThCT3.1
Zheng, Liushuai	FrAT4.2
Zheng, Tao	WeAT3.1
Zheng, Yanqiu	WeAT3.4
	WeBT2.4
Zheng, Yufeng	FrCT4.6
Zheng, Zewei	ThCT6.5
Zheng, Zhiyuan	ThCT3.1
Zheng, Zhuoqing	ThCT5.2
Zhuihui, Yang	FrCT4.1
Zhong, Jindi	WeBT5.5
Zhong, Lingye	ThAT6.7
Zhong, Ruiguo	FrDT4.6
Zhou, Boming	FrDT3.1
Zhou, Chi	ThCT4.1
Zhou, Feng	FrDT5.1
Zhou, Guanzhong	ThCT6.4
Zhou, Hui	FrCT5.7
Zhou, Jianshu	WeBT3
	WeBT3.5
	ThAT1.7
Zhou, Jun	ThAT6.4
Zhou, Junyu	ThAT2.4
Zhou, Liang-Yu	FrDT6.6
Zhou, Liutao	FrAT3
Zhou, Mingchuan	FrBT3
Zhou, Qi	ThCT3.3
Zhou, Ruixiang	FrDT3.2
Zhou, Shiyu	ThAT1.3
Zhou, Tianyi	ThCT4.3
Zhou, Tianyi	ThCT4.3
Zhou, Wei	FrAT4.4
Zhou, Weichen	ThBT3.1
Zhou, Xionghui	WeAT2.4
Zhou, Xuanjie	FrBT5.2
Zhou, Xuefeng	FrAT2.4
	FrAT2.5
Zhou, Yang	ThAT5.4
Zhou, Yuantai	FrAT4.3
Zhou, Yun	FrCT6.6
Zhou, Zhangli	FrCT3.1
	FrCT3.2
Zhou, Zhao	FrBT5.2
Zhou, Zhengyang	FrDT5.4
Zhou, Zhisong	FrCT1
Zhou, Zhiyu	ThAT1.5
Zhou, Zixiang	WeBT1.2
	FrCT4.2
Zhu, Bo	FrBT6
	FrBT6.6
Zhu, Cheng	WeAT4.1
	WeBT4.1
Zhu, Haifeng	FrBT3.1
Zhu, Haojie	ThBT3.3
Zhu, Jiacheng	ThBT5
	ThBT5.1
	ThBT5.5
Zhu, Lei	FrDT3.4
	FrDT3.5
Zhu, Qingmiao	ThCT6.3
Zhu, Qunxiong	FrDT6.6
Zhu, Ruiyi	ThAT3.3
Zhu, Shuyi	ThAT2.1
Zhu, Weikun	WeAT4.1
Zhu, Xianqiang	WeAT4.1
	WeBT4.1
Zhu, Yiming	ThAT4.3
Zhu, Yong	FrAT2.7

Ziliang, Ren	ThAT6
	ThAT6.2
	ThAT6.3
	ThAT6.4
	ThAT6.5
Zong, Guangdeng	ThAT2
Zou, Danping	FrBT2.6
Zou, Hongfei	FrDT1.1
Zou, Jiani	FrCT5.7
Zou, Longyin	FrBT3.5
Zou, Qikai	WeBT2.3
Zou, Yuxuan	ThCT6.5
Zuo, Lei	ThBT2
	ThBT2.1
Zuo, Zhiqiang	ThCT6.1

Local Information

Conference Venue

The 20th IEEE International Conference on Control and Automation (IEEE ICCA 2026) will be held on June 16–20, 2026, Almaty, Kazakhstan.

Address: 6. Mining and Metallurgical Building (MMB), Satbayev University, Almaty, Kazakhstan

Tel: +7 (727) 292 60 25

URL: <https://satbayev.university/en>

Currency

The local currency in Almaty, Kazakhstan is the Kazakhstani Tenge (KZT). Credit and debit cards are widely accepted throughout Almaty, including in taxis, restaurants, and shops. While cash is accepted (especially for small transactions like bus fares or street vendors), contactless and mobile payments are increasingly common, and ATMs are readily available in urban areas, shopping malls, and near Satbayev University. There is usually no need to exchange large amounts of cash in advance, and currency exchange desks are available at Almaty International Airport and major banks.

Emergency Call

Emergency Number: **112** (universal emergency number). You can dial 112 from anywhere in Kazakhstan to reach emergency services, including the police, ambulance, and fire department. Additionally, specific emergency numbers are available: 101 for fire services, 102 for police, and 103 for ambulance. Operators can assist you in Kazakh and Russian, and many can also provide support in English, especially in urban areas like Almaty.

Airport Transfer – Car Rental

The distance from Almaty International Airport (ALA) to the city center is approximately 15 km, or about a 25–40-minute drive depending on traffic. Public transport options include city buses (routes 79, 86, 92, 106) which take 40–60 minutes, cost 150–300 KZT per person, and are ideal for budget travelers with light luggage. Taxi services, ride-hailing apps (like Yandex Go and Uber), and prebooked private transfers are also widely used and reasonably priced—taxi fares from the airport to the city center range from 2,500–5,000 KZT per car. For those planning to explore beyond the city, car rental is available at the airport with daily rates starting from 10,000–18,000 KZT plus fuel and deposit. For further information on local transport, you can use local map apps like 2GIS or Yandex Maps.

Language

The official languages of Kazakhstan are Kazakh (a Turkic language) and Russian. In Almaty, Russian is widely spoken and used for daily communication, especially among the older generation and in urban settings. Kazakh is also commonly used, particularly among the local Kazakh population. English is increasingly spoken, especially in tourist areas, hotels, restaurants, and at Satbayev University (which offers programs in English), making it easy for international conference attendees to communicate. Most staff at hotels, airports, and conference venues have basic to intermediate English skills.

Electricity

Almaty, Kazakhstan uses electrical standards of 220 volts at 50 Hz. The standard plug type is the Europlug with two round prongs (Type C sockets), which is consistent with many European countries. Travelers from countries using different voltage (e.g., 110V in the US) or plug types (e.g., Type A/B in the US, Type G in the

UK) may need a power adapter for their electronic devices. Voltage converters are generally not required for most modern devices (e.g., laptops, phones) which are dual-voltage compatible.

Time

Almaty operates on Kazakhstan Time (KZT), which is UTC+05:00 year-round. Unlike many countries, Almaty does not observe Daylight Saving Time, so the time remains consistent throughout the year. The IANA time zone identifier for Almaty is Asia/Almaty, and it is 9 hours ahead of New York, 4 hours ahead of London, and 3 hours behind Tokyo.

Weather

Almaty has a continental climate with warm, dry summers and cold, snowy winters. In June (the month of the conference), summer temperatures typically range from 15°C to 28°C, with occasional warm spells reaching 30°C. The weather in June is generally pleasant, with low precipitation, but it is still advisable to bring light layers for cooler evenings. The weather can be slightly unpredictable in spring and early summer, so visitors should come prepared for sudden changes. For up-to-date forecasts, you can check local weather services or reliable online platforms.

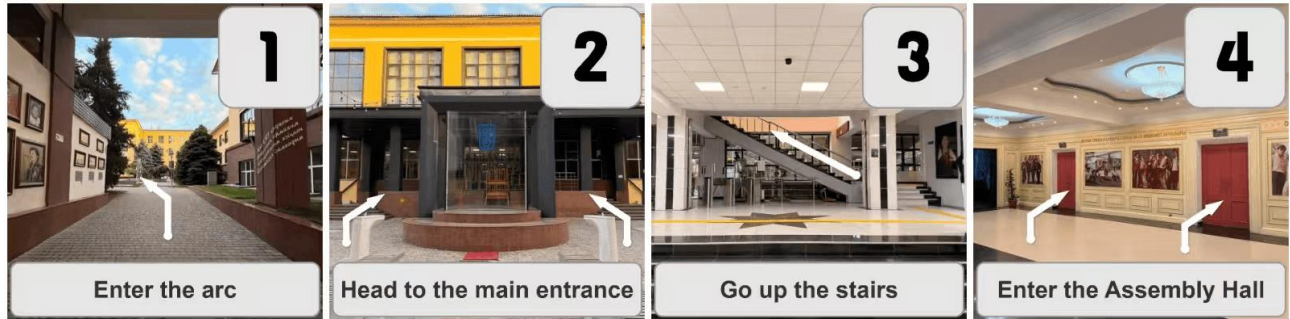
Conference Venue Floorplan and Maps



Main Conference Hall



1. Main Academic Building (MAB)
 2. Admissions Committee (AC)
 3. Student Registrar Office (ORS)
 4. Fab-Lab
 5. Petroleum Corps (OB)
- 6. Mining and Metallurgical Building (MMB)**
 The Assembly Hall and Rooms 259, 264, 256, 267, and 269 listed in the program are all located on the second floor of this building. 📍 MAIN VENUE
7. UniHUB Creative space and coffee shop
 8. "Dos-Mukasan uyasy" dormitory
 9. Institute of Energy and Mechanical Engineering (IEME)
 10. Small Academic Building (SAB)
 11. Engineering and Mechanical Engineering Building (EMEB)
 12. Faculty of inVision U
 13. Kazakh-Korean Center (KKC)
 14. Training ground of Mining and Metallurgical Institute
 15. Technopark (educational and production workshop)
 16. Teplokorpus
 17. Institute of Military Affairs
 18. Medical Center
 19. Dormitory # 1,2,3
 20. House of young scientists
 21. Monument to K.I. Satbayev
 22. Summer student area



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

Рахмет

谢谢

