2026 第九届 IEEE 国际无人系统大会
特邀专题简介表

特邀专题名称

面向异构无人智能体的群体协同感知、决策与控制

组织者

1. 蔡孟池，助理研究员，清华大学

2. 李卫华，教授，哈尔滨工业大学（威海）

3. 李　欣，教授，大连海事大学

4. 陈湘冬，助理研究员，新加坡国立大学

5. 杨　凯，助理研究员，清华大学

个人简介

蔡孟池，2018 年、2023 年于清华大学分别获得工学学士、工学博士学位，现为清华大学交通工程系助理研究员，入选中国科协青年人才托举工程，获批 ITU 国际标准 1 项、中国汽车工程学会团体标准 1 项。主持国家自然科学基金委青年科学基金（C 类）项目、中国博士后基金会特别资助、国家资助博士后人员计划等项目，与梅赛德斯-奔驰、小米汽车、比亚迪汽车等开展合作课题 6 项。共发表论文 40 余篇，获国际会议最佳青年论文奖 1 次，申请发明专利 20 余项，已获授权 10 余项，获 2025 年度广西科技进步二等奖、2025 年度中国汽车工程学会科技进步三等奖，担任国际期刊 Journal of Intelligent and Connected Vehicles（JICV）青年编委。研究领域涉及多车协同决策与控制、智能网联汽车与交通等。

李卫华，哈尔滨工业大学（威海）汽车工程学院教授，博士生导师，智能车辆工程系主任，泰山学者青年专家。2013.10 至 2015.04 于加拿大阿尔伯塔大学 CSC 联合培养，2016 年获得哈尔滨工业大学航空宇航制造工程专业博士学位；兼任 IFToMM 中国委员会委员、SmartBot 青年编委等；研究领域包括：星球车、特种移动机器人等，部分研究成果应用于“玉兔号”、“祝融号”的结构设计、在轨性能预测等方面，支撑了我国星球探测任务的顺利实施。累

计承担国家自然科学基金面上项目、重大项目子课题、山东省优青等 20 余项，发表 SCI、EI 高水平学术论文 50 余篇，获得中国港口协会科技进步一等奖 1 项、山东省教学成果奖二等奖 1 项等。

李欣，教授，博士毕业于美国威斯康辛大学，入选国家级高层次青年人才计划、辽宁省杰青，2025 年获全国交通运输系统先进工作者表彰（国家功勋荣誉表彰）。致力于智能/智慧交通系统研究，聚焦新一代人工智能驱动的运输调度优化、综合立体交通系统优化与韧性增强。已发表高水平学术论文超百篇，其中第一/通讯 SCI 检索 60 篇；获授权专利 22 项、主编学术专著 2 部。主持国家重点研发计划课题、国自然青年/面上/重点项目、重庆市重点专项、广西自治区人工智能“智果”专项等科研及工程实践项目 40 余项。入选交通运输部交通运输行业青年拔尖人才，牵头荣获中国公路学会科学技术奖一等奖、中国智能交通协会优秀青年科技人才奖、上海市科学技术二等奖等多项省部级重要科研奖励。研究成果在特大型城市重庆市以及辽宁省盘锦市实现了规模化集成应用，多次入选交通运输部、重庆市等交通发展典型案例集。

陈湘冬，博士，新加坡国立大学博后研究员，清华大学土木工程博士，研究领域包括智能与自动化交通控制、多模式交通系统、低空交通管控。陈湘冬博士已在 Transportation Science 和 Transportation Research Part B/C/D/E 等国际顶级期刊发表论文二十余篇。她曾荣获 2026 年亚洲工程领域女性新星奖、2024 年香港交通研究学会（HKSTS）最佳博士论文奖，并多次获得国际学术会议最佳论文奖。

杨凯，博士，清华大学车辆与运载学院助理研究员，入选清华大学“水木学者”计划，长期从事自动驾驶安全决策与控制等领域相关工作。近五年累计发表 SCI/EI 论文 30 余篇，入选 ESI 高被引论文 2 篇，授权发明专利 10 余项，获第八届中国科协优秀科技论文奖、中国机械工程学会优秀论文奖、《机械工程学报》第七届高影响力论文奖以及《汽车工程》年度优秀论文等。主持国

自然科学基金项目青年科学基金，中国博士后科学基金委特别资助等项目 3 项，并参与国家重点研发计划、清华-奔驰国际科技合作等项目多项。

特邀专题简介

异构无人智能体（如无人车、机器人、无人机等）在复杂环境中执行任务时，常面临非结构化地形、动态障碍、通信受限等挑战。传统单智能体遥控或预编程模式难以满足大规模、高效率的集群作业需求，亟需发展群体智能协同技术，使不同构型的无人智能体能够共享环境信息、协商决策、自适应执行任务，最终实现“人机协同、自主为主”的作业范式。

本专题聚焦异构无人智能体在群体协同中的感知、决策与控制问题，旨在突破跨域数据融合、语义对齐、分布式协商、自适应控制等关键技术，使地面操作员或高层监控系统仅需下达高层意图，而具体任务执行由智能体集群根据实时环境自主协同完成。相关成果可应用于月面探测、灾后搜救、自动驾驶车队、工业自动化等领域。

本特邀专题邀请以下与“异构无人智能体群体协同感知、决策与控制”主题相关的包含创新思想、概念、新发现、改进以及新应用的原创论文：

- 多智能体协同感知与定位
- 异构智能体间的语义对齐与通信
- 群体协同决策与任务分配
- 多车/多机协同路径规划与避障
- 多智能体自主导航与队列行驶
- 机械臂-移动平台协同控制
- 人在回路的混合智能与调度
- 非结构化环境下的智能体循迹控制
- 轮式/足式/轮足式多模态智能体协作

IEEE ICUS 2026
Invited Session Summary

Title of Session

Swarm Coordinated Perception, Decision-Making, and Control for Heterogeneous Unmanned Agents

Organizers

1. Dr. Mengchi Cai
Tsinghua University, China

2. Prof. Weihua Li
Harbin Institute of Technology, China

3. Prof. Xin Li
Dalian Maritime University, China

4. Dr. Xiangdong Chen
National University of Singapore, Singapore

5. Dr. Kai Yang
Tsinghua University, China

Biosketches of Organizers

Mengchi Cai received his B. S. and Ph. D. degrees from Tsinghua University in 2018 and 2023, respectively. He is currently an Assistant Research Fellow in the Department of Traffic Engineering at Tsinghua University. He has been selected for the Young Elite Scientist Sponsorship Program by the China Association for Science and Technology (CAST). He leads projects such as the Young Scientist Fund (Category C) of the NSFC, and cooperative projects with companies including Mercedes-Benz, Xiaomi Auto, and BYD Auto. He serves as a Young Editorial Board Member for the international journal JICV (Journal of Intelligent and Connected Vehicles). His research areas include intelligent connected vehicles and transportation, vehicle-road-cloud integrated systems and their applications, and multi-vehicle cooperative decision-making and control.

Weihua Li is a Professor and Ph.D. Supervisor at the School of Automotive Engineering, Harbin Institute of Technology (Weihai), and serves as the Director of the Intelligent Vehicle Engineering Department. He is also a Taishan Scholar Young Expert. He currently serves as a member of the IFToMM China Committee and a young editorial board member of SmartBot. His research interests include planetary rovers and special mobile robots. Some of his research

achievements have been applied to the structural design and on-orbit performance prediction of China's "Yutu" and "Zhurong" rovers, supporting the successful implementation of planetary exploration missions. He has undertaken more than 20 research projects, including a General Program and a sub-project of Major Program of the National Natural Science Foundation of China, as well as the Shandong Provincial Excellent Young Scholars Program. He has published over 50 high-level academic papers indexed by SCI and EI, and has received several awards, including the First Prize of Science and Technology Progress Award from the China Port & Harbour Association and the Second Prize of Shandong Provincial Teaching Achievement Award.

Prof. Xin Li received his Ph.D. from the University of Wisconsin, US and has been selected for the National High-Level Young Talent Program and the Liaoning Distinguished Young Scholars Program. His research focuses on intelligent transportation systems, with particular emphasis on next-generation AI-driven transportation scheduling optimization, integrated multimodal transportation systems, and system resilience enhancement. He has published over 100 high-quality academic papers, including more than 60 SCI-indexed papers as first or corresponding author. He holds 22 authorized patents and has edited two academic monographs. Professor Li has led more than 40 research and engineering projects, including National Key R&D Program projects, NSFC Young Scientists Fund, General and Key Programs, as well as major regional initiatives such as key projects in Chongqing and the "Zhiguo" AI program in Guangxi. He has received several prestigious awards, including the First Prize of the Science and Technology Award from the China Highway & Transportation Society, the Outstanding Young Scientist Award from the China Intelligent Transportation Systems Association, and the Second Prize of the Shanghai Science and Technology Award.

Xiangdong Chen is a Postdoctoral Researcher at the National University of Singapore. She received her Ph.D. in Civil Engineering from Tsinghua University. Her research interests include intelligent and automated traffic control, multimodal transportation systems, and low‑altitude air traffic management. Dr. Chen has published over 20 papers in leading international journals such as Transportation Science and Transportation Research Part B/C/D/E. She is the recipient of the 2026 Asia Rising Star in Engineering (Female) Award, the 2024 Hong Kong Society for Transportation Studies (HKSTS) Best PhD Thesis Award, and several best paper awards at international academic conferences.

Kai Yang, Ph.D., is an Assistant Researcher at the School of Vehicle and Mobility, Tsinghua University, and was selected for Tsinghua University's "Shuimu Scholar" Program. He has long been engaged in research on safety-oriented decision-making and control for autonomous driving. Over the past five years, he has published more than 30 SCI/EI-indexed papers, including two ESI Highly Cited Papers, and has been granted more than 10 invention patents. He has received the 8th China Association for Science and Technology Award for Outstanding Scientific and Technological Papers, the Outstanding Paper Award of the Chinese Mechanical Engineering Society, the 7th High-Impact Paper Award of the Journal of Mechanical Engineering, and the Annual Outstanding Paper Award of Automotive Engineering. He has led three projects supported by National Natural Science Foundation of China and China Postdoctoral Science Foundation, and has participated in multiple projects, including projects supported by the National Key R&D Program of China and Tsinghua University–Mercedes-Benz international cooperation projects.

Details of Session

When heterogeneous unmanned agents (e.g., unmanned vehicles, robots, drones, etc.) perform tasks in complex environments, they often face challenges such as unstructured terrain, dynamic obstacles, and communication constraints. Traditional single‑agent teleoperation or pre‑programmed modes are inadequate for large‑scale, high‑efficiency swarm operations. There is an urgent need to develop swarm intelligent collaboration technologies that enable heterogeneous unmanned agents to share environmental information, negotiate decisions, and adaptively execute tasks, ultimately achieving an operational paradigm of "human‑machine collaboration with a dominant autonomous role."

This special session focuses on the perception, decision‑making, and control problems of heterogeneous unmanned agents in swarm collaboration. It aims to break through key technologies such as cross‑domain data fusion, semantic alignment, distributed negotiation, and adaptive control, so that ground operators or high‑level monitoring systems only need to issue high‑level intentions, while the specific task execution is autonomously completed by the agent swarm based on real‑time environmental perception. Relevant outcomes can be applied to fields such as lunar surface exploration, post‑disaster search and rescue, autonomous driving fleets, and industrial automation.

This invited special session solicits original papers presenting innovative ideas, concepts, new discoveries, improvements, and novel applications related to the theme of "Swarm Collaborative Perception, Decision‑Making, and Control for

Heterogeneous Unmanned Agents":

- Multi-agent collaborative perception and localization
- Semantic alignment and communication among heterogeneous agents
- Swarm collaborative decision-making and task allocation
- Multi-vehicle/robot collaborative path planning and obstacle avoidance
- Multi-agent autonomous navigation and platooning
- Manipulator-mobile platform collaborative control
- Human-in-the-loop hybrid intelligence and scheduling
- Agent trajectory tracking control in unstructured environments
- Coordination for wheeled/legged/wheel-legged multimodal agents