2025 第八届 IEEE 国际无人系统大会

特邀专题简介表

特邀专题名称

复杂受限场景下无人系统自主导航与运动规划

组织者

1. 陈彦杰，副教授，国防科技大学

2. 缪志强，教授，湖南大学

3. 卢惠民，教授，国防科技大学

4. 张雪波，教授，南开大学

5. 刘康丞，教授，湖南大学

个人简介

陈彦杰，国防科技大学智能科学学院副教授，湖南大学机器人视觉感知与控制技术国家工程研究中心研究员，福州大学外聘教授、博士生导师，英国皇家学会牛顿国际学者（Newton International Fellowships, The Royal Society, UK），中国自动化学会青年工作委员会委员，福建省级个人/团队科特派，福建省级高层次人才，福州大学旗山学者。主要从事空中作业机器人系统、运动规划、动力学建模与控制等研究，获 2022 年中国自动化学会优秀硕士学位论文导师奖，2022 IEEE ICARM 最佳会议论文奖和 IEEE Journal of Oceanic Engineering 2024 年度杰出审稿人等。近年来，承担国家级项目 3 项，以第一/通讯作者发表高水平论文 40 余篇，申请/授权国家发明专利 35 项。

缪志强，湖南大学电气与信息工程学院教授，博士生导师，自动化系主任，机器人视觉感知与控制技术国家工程研究中心主任助理，国家优秀青年基金获得者，中国科协青年人才托举工程入选者，湖湘青年英才入选者。担任湖南省自动化学会副秘书长，中国指挥与控制学会(湖南)青年科学家俱乐部主席，中国仿真学会智能无人系统建模与仿真专业委员会副秘书长。主要从事多机器人系统、跨域无人系统、机器人自主导航与控制等领域的研究，获 2020

年度湖南省科学技术创新团队奖(3/15)、2023 年度中国自动化学会科技进步一等奖、2022 年度湖南省科技进步二等奖、IEEE Robotics and Automation Letters 2020 最佳论文荣誉奖、湖南省优秀博士学位论文奖、中国自动化学会优秀博士学位论文提名奖、国内外会议最佳论文(提名)奖 6 次。近年来，主持国家级项目 10 余项，以第一/通讯作者在 IEEE Transactions 等期刊上发表高水平论文 50 余篇，申请授权国家发明专利 20 余项。担任 ICRA、IROS 等会议 Associate Editor，期刊《机器人》、《SmartBot》青年编委等。

卢惠民，国防科技大学智能科学学院某研究所所长、教授、博士生导师，入选湖南省高层次人才计划特聘教授，兼任湖南省自动化学会副理事长。长期从事智能机器人系统与技术研究，尤其是致力解决机器人复杂场景智能感知与自主控制难题，主持 10 余项国家和军队高水平科研项目，带领团队自主研制五型智能特种机器人样机并得到运用，参加机器人领域高水平学科/学术竞赛获世界冠军 6 项、全国冠军 20 余项，在 IEEE Transactions on Robotics、ICRA、IROS 等顶级期刊/会议发表论文 30 余篇，授权发明专利 20 余项，出版专著 4 部，获湖南省科技进步一等奖 1 项、中国电子学会科技进步一等奖 1 项，军队/湖南省/中国自动化学会教学成果奖 9 项。

张雪波，南开大学教授，博导，人工智能学院副院长，天津市 4 智能机器人技术重点实验室副主任，入选国家级青年人才、天津市杰青。研究兴趣为机器人与人工智能，包括定位建图与场景理解、运动规划与伺服控制、强化学习与智能博弈。承担国家重点研发计划课题、国家自然科学基金重大项目课题、天津市杰青等 20 多项，推动特殊服役环境下机器人技术的发展，如高海拔科考机器人、灾难救援机器人、配网带电作业机器人等。获天津市科技进步一等奖，天津市自然科学一等奖与二等奖、吴文俊人工智能自然科学一等奖。担任 IEEE/ASME Trans. on Mechatronics 等多个国际学术期刊编委。

刘康丞，湖南大学电气与信息工程学院，教授，博士生导师。国家级高层次青年人才项目获得者。湖南省高层次人才项目获得者。机器人视觉感知与控制技术国家工程研究中心研究核心导师。曾任加州理工学院 Senior Scientist (高级职称)。现研究方向为具身智能与智能系统。以第一或通讯作者在多种国际 IEEE 汇刊，国际计算机视觉期刊等权威刊物上发表论文 50 余篇。任国际人工智能、计算机科学、控制工程国际权威期刊与会议含 Nature Machine Intelligence、Nature Medicine、International Journal of Computer Vision、International Journal of Robotics Research、Artificial Intelligence Journal、Journal of Machine Learning Research、ACM Transactions on Graphics、IEEE Transactions on Pattern Analysis and Machine Intelligence、CVPR、ICCV、ECCV、IJCAI、AAAI、SIGIR、RSS 等的审稿专家，编委会成员，或研讨会主席。为国际多个开源三维感知、人工智能与多模态大模型相关领域重要软件库的负责人与主要贡献人，获国际 GitHub 开源软件库杰出贡献人奖。任美国计算机学会会员、国际电气与电子工程师协会会员、美国机械工程师学会会员、国际工业与系统工程师学会会员等。

特邀专题简介

在复杂极端环境中，例如地震、火灾或核泄漏等高风险任务区域，人类往往难以直接进入并执行任务。而无人系统可迅速穿越诸如坍塌建筑物、狭窄通道或动态障碍物等复杂地形，自主完成搜索、物资运输以及救援等一系列关键作业任务。虽然当前无人系统已展现了一定的自主能力，但在面对极端复杂受限任务场景时，仍面临着诸多挑战，包括但不限于安全性、实时响应能力和导航精确性等。亟待突破信息不确定下导航、多机协同规划、实时任务决策、精准定位导航等关键技术，从而实现无人系统在复杂受限环境下的自主导航与精准运动。因此，开展复杂受限场景下无人系统自主导航与运动规划关键技术研究具有重要意义。该领域突破将推动无人系统研究从“弱自主”向“强自主”（类人决策）跨越，促进人工智能、机器人学、控制理论等多学科的交叉融合。

本特邀专题邀请以下与“复杂受限场景下无人系统自主导航与运动规划”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。

- 多模态广视场鲁棒感知
- 高维度高光谱鲁棒感知
- 多模态融合定位
- 自主探索
- 克服不确定性导航
- 弹性协同导航
- 动态任务决策
- 多机协同规划
- 实时运动规划
- 不确定感知规划
- 同时覆盖与探索
- 搜索与救援

IEEE ICUS 2025
Invited Session Summary

Title of Session

Autonomous Navigation and Motion Planning of Unmanned Systems in Complex Constrained Environments

Organizers

1. Prof. Yanjie Chen

National University of Defense Technology, China

2. Prof. Zhiqiang Miao

Hunan University, China

3. Prof. Huimin Lu

National University of Defense Technology, China

4. Prof. Xuebo Zhang

Nankai University, China

5. Prof. Kangcheng Liu

Hunan University, China

Biosketches of Organizers

Yanjie Chen (Member, IEEE) received the B.S. degree in electrical engineering and its automation from Southwest Jiaotong University, Chengdu, China in 2011, and the M.S. and Ph.D. degrees in control science and engineering from Hunan University, Changsha, China, in 2013 and 2017, respectively. He is currently an Associate Professor with the College of Intelligence Science and Technology, National University of Defense Technology, China. He was an Associate Professor at School of Mechanical Engineering and Automation, Fuzhou University, Fuzhou, China. He was also a Royal Society Newton International Fellow with Department of Computer Science, Aberystwyth University, Aberystwyth, U.K., and a Scientist with the National Engineering Research Center of Robot Visual Perception and Control Technology, Changsha, China. His research interests include robotics, aerial manipulator, and motion planning.

Zhiqiang Miao received the B.S. and Ph.D. degrees in electrical and information engineering from Hunan University, Changsha, China, in 2010 and 2016, respectively. From 2014 to 2015, he was a Visiting Scholar with The University of New Mexico, Albuquerque, NM, USA. From 2016 to 2018, he was a Post-Doctoral Fellow with the Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong, China. He is currently a Professor with the College of Electrical and Information Engineering, Hunan University. His research interests include multi-robot systems, unmanned systems, visual navigation, and nonlinear control. He is (was) an Associate Editor for ICRA and IROS, the Program Co-Chair of the IEEE RCAR 2024, and the Organizing Co-Chair of the IEEE RCAR 2023.

Huimin Lu received the B.E. degree in automation and the M.E. and Ph.D. degrees in control science and engineering from the National University of Defense Technology (NUDT), Changsha, China, in 2003, 2005, and 2010, respectively. He joined the College of Intelligence Science and Technology, NUDT, in 2010, where he is currently a Professor. His research interests include mobile robotics, robot vision, and human-robot interaction

Xuebo Zhang received the B.Eng. degree in Automation from Tianjin University in 2006, China, and the Ph. D. degree in Control Theory and Control Engineering from Nankai University in 2011, China. From July 2011, he joined the Institute of Robotics and Automatic Information Systems (IRAIS), Nankai University, China. Currently, he is a full professor of Nankai University, serving as vice dean of College of Artificial Intelligence, and deputy director of Tianjin Key Laboratory of Intelligent Robotics. His research interests focus on robotics and AI, including SLAM and scene understanding, motion planning and control, reinforcement learning and intelligent game. Prof. Zhang is the PI of more than 20 projects across both academic and industrial fields. He is a Technical Editor of the IEEE/ASME Transactions on Mechatronics and the Associate Editor for ASME Journal of Dynamic Systems, Measurement and Control.

Kangcheng Liu, Professor, and the Doctoral Supervisor at Hunan University. His research interests include embodied intelligence and intelligent systems. He has published more than 50 papers as the first or corresponding author, within a variety of international authoritative journals. He served as the reviewer or the program committee member of Nature Machine Intelligence, Nature Medicine, International Journal of Computer Vision, International Journal of Robotics Research, Artificial Intelligence Journal, Journal of Machine Learning Research, ACM Transactions on Graphics, IEEE Transactions on Pattern Analysis and Machine, CVPR, ICCV, ECCV, IJCAI, AAAI, SIGIR, RSS, etc. He is the principal and main contributor of several international open-source software in 3D perception, artificial intelligence and multi-modal large model related fields. He is a member of the American Computer Society, the International Institute of Electrical and Electronics Engineers, the American Institute of Mechanical Engineers, and the International Institute of Industrial and Systems Engineers.

Details of Session

In complex and extreme environments, such as high-risk areas during earthquakes, fires, or nuclear leaks, humans often face significant difficulties in directly entering and executing tasks. Unmanned systems, however, can rapidly traverse challenging terrains like collapsed buildings, narrow passages, or dynamic obstacles, autonomously completing a series of critical missions including search, material transportation, and rescue operations. While current unmanned systems have demonstrated a certain level of autonomy, they still face numerous challenges when operating in extremely complex and constrained task scenarios. These challenges include, but are not limited to, safety, real-time response capabilities, and navigation accuracy. There is an urgent need to break through key technologies such as navigation under information uncertainty, multi-agent collaborative planning, real-time task decision-making, and precise localization and navigation, to enable unmanned systems to achieve autonomous navigation and accurate motion in complex constrained environments. Therefore, conducting research on the key technologies of autonomous navigation and motion planning for unmanned systems in complex constrained scenarios holds great significance. Breakthroughs in this field will drive the evolution of unmanned system research from "weak autonomy" to

"strong autonomy" (human-like decision-making), promoting interdisciplinary integration of artificial intelligence, robotics, and control theory.

The invited session invites original papers of innovative ideas and concepts, new discoveries and improvements, and novel applications relevant to the following selected topics of “Autonomous navigation and motion planning of unmanned systems in complex constrained scenarios”.

- Wide-area robust perception
- Multi-modal fusion localization
- Autonomous exploration
- Navigation under uncertainty
- Resilient collaborative navigation
- Dynamic task decision-making
- Multi-agent collaborative planning
- Real-time motion planning
- Uncertainty-aware planning
- Simultaneous coverage and exploration
- search and rescue