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

从感知到决策：多传感视觉赋能无人系统

组织者

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4. 张鹏，副教授，山东科技大学

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6. 单彩峰，教授，南京大学

个人简介

刘德阳，博士，教授，硕士生导师，悉尼科技大学访问学者，中国科学技术大学先进研究院特聘研究员，安徽省青年拔尖人才青年学者，山东省泰山学者青年专家，国际期刊 Metaverse 青年编委，省级优秀青年研究生导师。近 5 年主持包括国家自然科学基金（面上，青年）在内的省部级科研项目 8 项，发表论文 34 篇，授权国内外发明专利 12 项，先后获得 2024 年度中国图象图形学学会科技进步奖二等奖（序 3）、2024 年度中国商业联合会服务业科技创新奖二等奖（序 1）以及 2021 年度安徽省计算机学会（ACF）自然科学奖二等奖（序 1）。

刘奎，博士，教授，硕士生导师，安庆师范大学科研处处长，安庆市政府“互联网+政务服务”咨询专家组成员，安庆市计算机学会理事长。主持安徽省科技重大专项 1 项，先后承担和参与国家自然基金、安徽省自然基金资助项目、安徽省高校自然基金重点项目 10 余项，发表高水平科研论文 10 余篇，授权国家发明专利 4 项。

肖泽宇，新加坡国立大学博士后研究员，2024 年获得中国科学技术大学博士学位，同年入职新加坡国立大学从事博士后研究工作。主要从计算机视觉、模式识别等研究工作，近 5 年在 IEEE TIP、CVPR、ECCV 等国内外重要期刊以及会议录上发表学术论文 10 余篇。

张鹏，博士，硕士生导师，CCF 会员、山东省人工智能学会会员。2013 年和 2016 年分别于山东大学获得学士学位和硕士学位，2020 年 8 月于悉尼科技大学获得博士学位，同年 11 月加入山东科技大学计算机科学与工程学院智能科学与技术系。从事计算机视觉、机器学习、深度学习、情感计算等方面研究，主要包括行人再识别、步态识别、微表情识别、图像生成等。主持或参与国家自然科学基金项目、山东省自然科学基金项目、教育部人文社科项目等，已授权中国发明专利 17 项，发表学术论文 20 余篇， 谷歌学术被引用 590+次， 受邀担任 IEEE TIP, IEEE TMM, IEEE TCSVT, NeurIPS, ICLR, ICML, AAAI, ICME, ICASSP 等期刊或会议审稿人，ICIGP 2022 领域主席。

张晓林，博士、教授、博士生导师，山东省泰山学者青年专家。澳大利亚悉尼科技大学（UTS）博士、美国伊利诺伊大学厄巴纳-香槟分校（UIUC）访问学者。先后在商汤科技和摩尔线程担任高级算法研究员，主导和参与了多项人工智能项目的攻关，并入选商汤科技“AI 先锋”计划。主要从事计算机视觉、3D 数字人等人工智能领域的课题研究。在人工智能顶级会议和期刊上发表学术论文 10 余篇，包括 CVPR、ECCV、ACM MM 等。谷歌学术被引用 1700 余次，其中单篇最高被引超 600 次。受邀担任多个人工智能顶级会议和期刊的审稿人，包括 IEEE TIP, IEEE TMM, IEEE TCSVT, CVPR, ICCV, ECCV, AAAI 等。

单彩峰，教授、博士生导师，国家海外高层次人才，IEEE 高级会员。主要从事计算机视觉、模式识别、医学图像分析等领域的研究，先后承担多个欧盟项目，包括欧盟 Horizon 2020 计划-玛丽居里(Marie-Curie)学者项目、欧盟 Horizon 2020 计划-ECSEL Joint Undertaking 项目、欧盟 Information Technology for European Advancement 项目等。发表论文 140 余篇、著作 3 本（Springer 出版）、授权国际专利 70 余项（其中美国专利 17 项、欧洲专利 12 项、日本专利 17 项等）。先后荣获飞利浦公司发明奖、SPIE Medical Imaging 大会最佳论文（提名）奖等，入选飞利浦公司“High Potential”人才、山东省“海外科技人才”（领军人才）、山东省高校青年创新团队带头人、青岛市产业领军人才（创新）等。

特邀专题简介

随着人工智能和传感器技术的飞速发展，无人系统正经历着从“感知”到“决策”的智能化变革。多传感视觉技术作为这场变革的重要驱动力，如同为无人系统装上了“智慧之眼”和“决策大脑”，使其能够更精准地感知环境、更智能地分析信息、更自主地做出决策。从智能家居对用户需求的精准识别，到自驾汽车在复杂路况下的安全行驶，再到无人机物流在密集城区的精准配送，多传感视觉技术正赋能无人系统突破应用边界，在更广泛、更复杂的场景中释放巨大潜能。

然而，随着应用场景的不断拓展和复杂化，多传感视觉技术面临巨大挑战。在感知层面，复杂环境感知和多源异构数据融合是两大核心难题。无人系统运行的环境复杂多变对多传感视觉技术的鲁棒性和适应性提出了更高要求。例如，自驾汽车行驶过程中光照变化和天气影响、无人机物流在密集城区的障碍物规避等；此外，不同传感器的数据类型、精度和采样率各异，例如智能家居中摄像头、红外传感器、声音传感器的数据融合，以及自驾汽车中摄像头、激光雷达、毫米波雷达的数据融合，如何实现高效融合并提取有效信息，是多传感视觉技术亟待解决的挑战之一。在决策层面，实时性与计算资源限制是制约技术落地的主要瓶颈。无人系统对感知决策的实时性要求极高，例如智能家居需要实时响应用户需求、自驾汽车需要实时做出驾驶决策、无人机物流需要实

时规划配送路线等，而多传感视觉算法通常计算复杂度较高，如何在有限的计算资源下实现高效处理，是技术突破的关键方向。此外，安全性与可靠性保障是无人系统应用中不可忽视的核心问题。 无人系统的决策直接关系到人身安全和财产安全，如自驾汽车需要保障乘客安全、无人机物流需要保障货物安全等，如何确保多传感视觉系统的安全性和可靠性，是技术研发和实际应用中必须解决的重要课题。

本特邀专题旨在汇聚国内外多传感视觉赋能无人系统领域的最新研究成果，探讨如何利用多传感视觉技术提升无人系统的感知、决策和控制能力，推动无人系统在更广泛领域的应用。本特邀专题邀请以下与“多传感视觉赋能无人系统”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。

- 复杂环境下的视觉感知增强
- 多传感器数据融合与协同感知
- 动态场景下的目标检测与跟踪
- 多传感视觉驱动的智能决策
- 多传感视觉的语义理解
- 多传感视觉的标准化与评测

IEEE ICUS 2025
Invited Session Summary

Title of Session

From Perception to Decision-Making: Multi-Sensor Vision Empowers Unmanned Systems

Organizers

1. Prof. Deyang Liu

Anqing Normal University, China

2. Prof. Kui Liu

Anqing Normal University, China

3. Dr. Zeyu Xiao

National University of Singapore, Singapore

4. Assoc. Prof. Peng Zhang

Shandong University of Science and Technology, China

5. Prof. Xiaolin Zhang

Shandong University of Science and Technology, China

6. Prof. Caifeng Shan

Nanjing University, China

Biosketches of Organizers

Deyang Liu is a professor and master's supervisor, a visiting scholar at the University of Technology Sydney, a specially appointed researcher at the Advanced Research Institute of the University of Science and Technology of China, a Young Distinguished Talent and Young Scholar in Anhui Province, a Young Expert of the Taishan Scholars Program in Shandong Province, and a young editorial board member of the international journal Metaverse. He has also been honored as an Outstanding Young Graduate Supervisor at the provincial level. Over the past five years, he has presided over eight provincial and ministerial-level scientific research projects, including the National Natural Science Foundation of China (both general and youth programs), published 34 papers, and obtained 12 domestic and international invention patents. He has successively received the 2024 CAAI (Chinese Association for Artificial Intelligence) Science and Technology Progress Award, Second Prize (ranked 3rd), the 2024 China General

Chamber of Commerce Science and Technology Innovation Award in the Service Industry, Second Prize (ranked 1st), and the 2021 Anhui Computer Federation (ACF) Natural Science Award, Second Prize (ranked 1st).

Kui Liu is a professor, and master's supervisor. He serves as the Director of the Scientific Research Division of Anqing Normal University, a member of the expert consultation group for "Internet Plus Government Services" in Anqing City, and the president of the Anqing Computer Society. He has presided over one major science and technology project in Anhui Province and participated in over 10 projects funded by the National Natural Science Foundation of China, the Natural Science Foundation of Anhui Province, and the key projects of the Natural Science Foundation of Anhui Higher Education Institutions. He has published over 10 high-level research papers and obtained four national invention patents.

Dr. Zeyu Xiao received his Ph.D. degree from the University of Science and Technology of China in 2024 and is currently a Postdoctoral Research Fellow at the National University of Singapore. His research primarily focuses on computer vision and pattern recognition. Over the past five years, he has published more than 10 academic papers in top-tier international journals and conferences, including IEEE TIP, CVPR, and ECCV.

Peng Zhang is a Ph.D. and master's supervisor. He is a member of the China Computer Federation (CCF) and the Shandong Artificial Intelligence Society. He received his bachelor's and master's degrees from Shandong University in 2013 and 2016, respectively, and his Ph.D. from the University of Technology Sydney in August 2020. He joined the School of Computer Science and Engineering at Shandong University of Science and Technology in November 2020. His research focuses on computer vision, machine learning, deep learning, and affective computing, including topics such as person re-identification, gait recognition, micro-expression recognition, and image generation. He has led or participated in projects funded by the National Natural Science Foundation of China, the Natural Science Foundation of Shandong Province, and the Ministry of

Education's Humanities and Social Sciences Program. He holds 17 Chinese invention patents and has published over 20 academic papers, with more than 590 citations on Google Scholar. He has served as a reviewer for journals and conferences such as IEEE TIP, IEEE TMM, IEEE TCSVT, NeurIPS, ICLR, ICML, AAAI, ICME, and ICASSP, and was a session chair at ICIGP 2022.

Xiaolin Zhang is a professor, doctoral supervisor, and a Young Expert of the Shandong Province Taishan Scholars Program. He obtained his Ph.D. from the University of Technology Sydney (UTS) and was a visiting scholar at the University of Illinois Urbana-Champaign (UIUC). He has served as a senior algorithm researcher at SenseTime and Moore Threads, leading and participating in several key artificial intelligence projects and being selected for SenseTime's "AI Pioneer" program. His research focuses on computer vision and 3D digital humans, with over 10 publications in top-tier AI conferences and journals, including CVPR, ECCV, and ACM MM. His work has garnered over 1,700 citations on Google Scholar, with a single paper cited more than 600 times. He has also served as a reviewer for prestigious conferences and journals such as IEEE TIP, IEEE TMM, IEEE TCSVT, CVPR, ICCV, ECCV, and AAAI.

Caifeng Shan is a professor and doctoral supervisor, a national high-level overseas talent, and a Senior Member of IEEE. His research focuses on computer vision, pattern recognition, and medical image analysis. He has led and participated in multiple European Union projects, including the EU Horizon 2020 Marie-Curie Fellowship, the EU Horizon 2020 ECSEL Joint Undertaking, and the Information Technology for European Advancement projects. He has published over 140 papers, authored three books (published by Springer), and holds more than 70 international patents, including 17 US patents, 12 European patents, and 17 Japanese patents. He has received awards such as the Philips Invention Award and the Best Paper (nomination) Award at the SPIE Medical Imaging Conference. He has also been recognized as a "High Potential" talent by Philips, a leading overseas talent in Shandong Province, the leader of a youth innovation team at a Shandong university, and an industrial leading talent (innovation) in Qingdao.

Details of Session

With the rapid advancement of artificial intelligence and sensor technologies, unmanned systems are undergoing an intelligent transformation from "perception" to "decision-making." Multi-sensor vision technology, as a pivotal driver of this transformation, acts as the "intelligent eyes" and "decision-making brain" for unmanned systems, enabling them to perceive environments more accurately, analyze information more intelligently, and make decisions more autonomously. From the precise recognition of user needs in smart homes, to the safe navigation of autonomous vehicles in complex road conditions, and further to the accurate delivery of drone logistics in densely populated urban areas, multi-sensor vision technology is empowering unmanned systems to break through application boundaries, unleashing immense potential in broader and more complex scenarios.

However, as application scenarios continue to expand and grow in complexity, multi-sensor vision technology faces significant challenges. At the perception level, complex environment perception and multi-source heterogeneous data fusion are two core difficulties. The environments in which unmanned systems operate are highly dynamic and unpredictable. For instance, autonomous vehicles must contend with varying lighting conditions and weather impacts, while drone logistics must navigate obstacle avoidance in densely populated urban areas. These scenarios demand higher robustness and adaptability from multi-sensor vision technology. Additionally, the diverse data types, precision levels, and sampling rates of different sensors—such as the fusion of camera, infrared sensor, and audio data in smart homes, or the integration of camera, LiDAR, and millimeter-wave radar data in autonomous vehicles—pose a significant challenge in achieving efficient data fusion and extracting meaningful information. This remains one of the most pressing issues for multi-sensor vision technology to address. At the decision-making level, real-time performance and computational resource limitations are major bottlenecks hindering the practical deployment of this technology. Unmanned systems require extremely high real-time responsiveness in perception and decision-making. For example, smart homes must instantly respond to user needs, autonomous vehicles must make driving decisions in real time, and drone logistics must dynamically plan delivery routes. However, multi-sensor vision algorithms often involve high computational complexity, making it a critical challenge to achieve efficient processing under limited computational resources. Furthermore, safety and reliability are

indispensable concerns in the application of unmanned systems. The decision-making of these systems directly impacts personal and property safety, such as ensuring passenger safety in autonomous vehicles or securing cargo safety in drone logistics. Ensuring the safety and reliability of multi-sensor vision systems is a crucial issue that must be addressed in both technological development and practical implementation.

This special issue aims to gather the latest research achievements in the field of multi-sensor vision-enabled unmanned systems from both domestic and international scholars. It seeks to explore how multi-sensor vision technology can enhance the perception, decision-making, and control capabilities of unmanned systems, thereby promoting their application in broader domains. We cordially invite original research papers related to the theme of "Multi-Sensor Vision Empowering Unmanned Systems," including innovative ideas, novel concepts, groundbreaking discoveries, technical improvements, and new applications.

- Visual Perception Enhancement in Complex Environments
- Multi-Sensor Data Fusion and Collaborative Perception
- Target Detection and Tracking in Dynamic Scenes
- Intelligent Decision-Making Driven by Multi-Sensor Vision
- Semantic Understanding with Multi-Sensor Vision
- Standardization and Evaluation of Multi-Sensor Vision Systems