2024 第七届 IEEE 国际无人系统大会
特邀专题简介表

特邀专题名称

空地协同无人系统的人机交互与共享控制

组织者

1. 毕路拯，教授，北京理工大学

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个人简介

毕路拯，北京理工大学机械与车辆学院教授、博导、机电系统与装备研究所所长。主要研究领域包括脑机接口与脑控智能机器、多机器人协同与多模态智能感知与交互。担任中国脑机接口产业联盟专家委员会资深专家、数据与基础软件工作组副主席、中国计算机学会智能汽车分会专委会常务委员、中国人工智能学会脑机融合与生物机器智能专委会委员、世界机器人大赛专家组成员。主持国家级项目十余项等。第一著者出版学术专著和教材两部。第一或通讯作者在 IEEE TCYB, TBME, TITS, TSMCS, THMS, TNSRE 等发表论文 100 余篇。获授权国家发明专利 30 余项。获教育部自然科学二等奖和中国电子学会科技进步二等奖。指导学生获第九届中国国际“互联网+”大学生创新创业大赛全国金奖，2022 年世界机器人大会-BCI 脑控机器人大赛优秀青年论文一等奖（唯一）。

赵小川，研究员，中国兵器工业集团信息院副总工，兵器集团科技带头人，兼任北京理工大学、北京航空航天大学博士生导师。武警部队装备智能化专家委员会委员;国家高新技术企业认定、陆军装备部、北京市科委、基金委项目评审专家，入选中国兵器“青年英才计划”、“兵器科学家计划”。主要研究方向为人工智能、人机交互等。

李甫，西安电子科技大学人工智能学院副院长，教授、博导。重点项目首席科学家，担任指控学会虚拟现实与人机交互专委会副主任委员、电子学会智能人机交互专委会委员、人工智能学会情感智能专委会委员。2004 年 7 月在西安电子科技大学获测控技术与仪器专业学士学位，2010 年 6 月在西安电子科技大学获电路与系统专业博士学位，2010 年-2011 年在微软亚洲研究院访问研究。主要研究方向为人机混合智能、脑机接口与深度学习、虚拟现实与认知训练。在国内外会议期刊发表论文 50 余篇，申请/授权专利 20 余项。先后获国家自然科学二等奖、陕西省科技进步一等奖、二等奖、电子学会二等奖、西安市科技进步一等奖等。

费炜杰，现任北京理工大学机械与车辆学院机电系统与装备所助理研究员，新加坡南洋理工大学脑计算研究中心 research fellow。主要研究方向为自然场景下的脑机接口。申请者作为负责人主持科研项目 1 项，参与多项国家级项目。获授权国家发明专利 9 项。目前在国际主流期刊上总共发表 SCI 论文 15 篇（其中 10 篇发表在本领域 Top 期刊），其中第一作者或通讯作者论文 9 篇。2022 年获得了世界机器人大赛 BCI 脑控机器人大赛青年优秀论文第一名。2023 年入选国家级人才计划。

特邀专题简介

空地协同无人系统是一种新型的高科技多机器人无人平台，它能够实现空中无人机、地面无人车和传统机器人的协同作业，可广泛应用于灾害救援、环境监测、安防巡逻、仓储物流等领域。在此平台中，异构多机器人之间的相互配合提高了无人系统的智能化水平和任务完成能力，从而有效完成更为复杂的实际任务。

而面对复杂的实际环境，无人系统往往难以通过独立的自主算法和传统手动操作同时完成无人机和无人车的控制和配合。因此人机交互和共享控制是非常重要的一环。

在人机交互方面，空地协同无人系统需要考虑如何完善人类操作员和 UAV（无人机）、UGV（无人车）等智能设备进行交互，让操作员能够更有效地监控、

指挥和调度无人设备。因此需要设计和创新友好的人机界面，便于操作员查看设备实时运行状态，收集运行数据，完成对无人设备的运行检测和协同配合。此外，还需要考虑如何在紧急情况下让操作员能够及时干预决策，确保设备的安全运行。

在共享控制方面，空地协同无人系统不仅需要实现设备之间的协同作业，以提高效率和减小运行成本，而且需要保证设备运行时的安全。这就需要探索如何实现设备之间的信息共享、任务分配以及安全保障，并保证设备之间的协同工作顺畅、高效和安全。因此需要通过设计合适的自适应控制算法，实现设备之间的智能协调，并且在保证设备安全运行的前提下，尽可能满足操作员控制需求。

本特邀专题邀请以下与“空地协同无人系统的人机交互与共享控制”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。

- 人机交互设计与优化
- 协同控制策略
- 智能控制算法
- 分布式控制
- 多机器人协同控制技术
- 移动机器辅助控制器
- 数据共享与处理技术

IEEE ICUS 2024
Invited Session Summary

Title of Session

Human-Machine Interaction and Shared Control of Aerial-Ground Collaborative Unmanned Systems

Organizers

1. Prof. Luzheng Bi

Beijing Institute of Technology, China

2. Prof. Xiaochuan Zhao

China North Industries Group Corporation

3. Prof. Fu Li

Xidian University, China

4. Dr. Weijie Fei

Beijing Institute of Technology, China

Biosketches of Organizers

Luzheng Bi, Professor and Doctoral Supervisor at the School of Mechanical and Vehicle Engineering, Beijing Institute of Technology, Director of the Institute of Mechatronic Systems and Equipment. His main research areas include brain-computer interfaces and brain-controlled intelligent machines, multi-robot collaboration and multimodal intelligent perception, and human-computer intelligent interaction. He serves as a senior expert on the Expert Committee of the China Brain-Computer Interface Industry Alliance, Vice Chairman of the Data and Basic Software Working Group, Standing Committee Member of the Intelligent Vehicle Branch of the Chinese Computer Federation, Member of the Brain-Computer Integration, and a member of the expert group for the World Robot Contest. He has obtained many grants and contracts,such as the National Natural Science Foundation of China. As the first author, he has published two academic monographs and textbooks. He has published over 100 papers as the first or corresponding author in journals such as IEEE TCYB, TBME, TITS, TSMCS, THMS, and TNSRE. He has been granted more than 30 national invention patents and has received the Second Prize in Natural Science from the Ministry of Education and the Second Prize in Science and Technology Progress from the China Electronics

Society. He has guided students to win the national gold award in the 9th China International "Internet+" College Students Innovation and Entrepreneurship Competition and the first prize for outstanding young paper (the only one) in the BCI Brain Control Robot Competition at the 2022 World Robot Conference.

Xiaochuan Zhao, Deputy Chief Engineer of the Information Institute of China North Industries Group Corporation (NORINCO Group), a leader in science and technology of the Ordnance Group, and a concurrent doctoral supervisor at both Beijing Institute of Technology and Beijing University of Aeronautics and Astronautics. He is a member of the Expert Committee on the Intelligence of the Armed Police Force Equipment, a review expert for the National High-Tech Enterprise Certification, the Army Equipment Department, the Beijing Municipal Science and Technology Commission, and the National Natural Science Foundation. He was selected for the "Youth Talent Program" and the "Ordnance Scientist Program" of China North Industries Group. His main research directions include artificial intelligence and human-computer interaction.

Fu Li, Deputy Dean, Professor, and Doctoral Supervisor at the School of Artificial Intelligence, Xidian University. He is the Chief Scientist of key projects and serves as the Deputy Director of the Virtual Reality and Human-Computer Interaction Committee of the Command and Control Society, a member of the Intelligent Human-Computer Interaction Committee of the Electronics Society, and a member of the Emotional Intelligence Committee of the Artificial Intelligence Society. In July 2004, he obtained a Bachelor's degree in Measurement and Control Technology and Instruments from Xidian University, and in June 2010, he obtained a Ph.D. in Circuits and Systems from the same university. From 2010 to 2011, he was a visiting researcher at the Microsoft Asia Research Institute. His main research directions include human-computer hybrid intelligence, brain-computer interfaces and deep learning, virtual reality, and cognitive training. He has published more than 50 papers in domestic and international conferences and journals and has applied for/been granted more than 20 patents. He has successively won the Second Prize of the National Natural Science Award, the First and Second Prizes of the Shaanxi Province Science and Technology

Progress Award, the Second Prize of the Electronics Society, and the First Prize of the Xi'an City Science and Technology Progress Award.

Weijie Fei, Assistant Researcher at the Institute of Mechatronic Systems and Equipment, School of Mechanical Engineering, Beijing Institute of Technology, and Research Fellow at the Centre for Brain Computing Research, Nanyang Technological University, Singapore. His main research direction is brain-computer interfaces in natural scenes. As the principal investigator, he has presided over one scientific research project and has been granted nine national invention patents. He has published a total of 15 SCI papers in mainstream international journals (10 of which are in top journals in the field), with nine as the first author or corresponding author. In 2022, he won the first prize for outstanding young paper in the BCI Brain Control Robot Competition at the World Robot Conference. In 2023, he was selected for the national talent program.

Details of Session

The Air Ground Collaborative Unmanned System is a new high-tech unmanned platform that integrates aerial drones, ground unmanned vehicles, and traditional robots to conduct collaborative operations. It can be used in disaster rescue, environmental monitoring, security patrols, warehouse logistics, and other fields. The mutual cooperation between these multiple robots enhances the intelligence level and task completion ability of unmanned systems, which enables them to complete more complex practical tasks.

However, with complex practical environments, unmanned systems may face difficulties in controlling and coordinating the drones and unmanned vehicles simultaneously through independent unmanned algorithms or traditional manual operations. Therefore, human-computer interaction and shared control become vital parts.

Regarding human-machine interaction, the Air Ground Collaborative Unmanned System should consider how to improve the interaction between human operators and intelligent devices such as UAVs and UGVs so that operators can more effectively monitor, command, and dispatch unmanned devices. Designing user-friendly human-machine interfaces facilitates operators to view real-time equipment operation status, collect operation data, and complete operation detection and

collaborate with unmanned equipment. It is also necessary to enable operators to intervene in decision-making during emergency situations and ensure the safe operation of the equipment.

In terms of shared control, the Air Ground Collaborative Unmanned System not only needs to achieve collaborative operations to improve efficiency and reduce operating costs but also to ensure the safety of equipment operation. This requires exploring how to achieve information sharing, task allocation, and security between devices to ensure smooth, efficient, and secure collaborative work. Therefore, appropriate adaptive control algorithms must be designed to achieve intelligent coordination between devices while meeting the operator's control needs and ensuring the safe operation of the equipment.

This special invitation invites original papers related to the theme of "human-machine interaction and shared control of air-ground collaborative unmanned systems." The papers should include innovative ideas, concepts, new discoveries, improvements, and new applications.

- Human-computer interaction design and optimization
- Collaborative control strategy
- Intelligent control algorithm
- Distributed control
- Multi-robot collaborative control technology
- Mobile robot assistant controller
- Data sharing and processing techniques