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

对抗环境下的多平台自主协同感知、认知与决策

组织者

1. 吴奇，教授，上海交通大学

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个人简介

吴奇，上海交通大学教授，国家杰出青年基金获得者。主持国防重大专项、杰青、叶企孙重点等项目。研究方向聚焦类脑计算、航空人因、深海人因。任 IEEE Transactions on Neural Networks and Learning Systems 、IEEE Transactions on Systems, Man, and Cybernetics: Systems 等 5 个 Trans 编委。

张兴龙，国防科技大学副教授，入选科协青托。主要研究强化学习与预测控制及其在无人平台中的应用。在 Automatica, IEEE 汇刊，自动化学报以及 ICRA、IROS 等机器人和控制领域重要期刊和会议发表论文 50 余篇。任中国自动化学会共融机器人专委会以及自适应动态规划与强化学习专委会委员、中国人工智能学会青年工作委员会委员。

王曰英，上海大学机电工程与自动化学院研究员，博导。主要从事复杂系统智能感知、智能控制与决策，与新型海洋无人系统研发等方面的研究工作。主持国自然优青、国家重点研发计划课题等国家级课题多项。近年来以第一/通讯作者在 Automatica 和 IEEE 汇刊上发表论文 20 余篇，授权发明专利 20 余件。现为中国自动化学会控制理论和机器人智能等专业委员会的委员，担

任 IEEE TCYB 等 6 本国际 SCI 期刊的副编辑。获得教育部和上海市自然科学二等奖各 1 项。

童伟，南京邮电大学助理教授。主要从事机器人视觉、3D 场景重建、医学图像分析与多生理参数认知状态评估等方面研究。近三年以第一作者/通信作者在 Information Fusion 以及 IEEE T-II IEEE T-ITS、IEEE T-SMCA、IEEE T-IV、IEEE T-ASE、IEEE T-VT、IEEE T-CDS、IEEE T-MRB 等 IEEE Trans. 等级的汇刊上发表学术论文 15 余篇。

徐昕，国防科技大学教授，国家杰出青年基金获得者。主要从事智能无人系统的自主控制与机器学习等方面研究。任中国自动化学会自适应动态规划与强化学习专业委员会副主任、平行控制与管理专业委员会副主任、机器人智能专业委员会顾问委员，中国指挥与控制学会无人系统专业委员会副主任。任 IEEE Transactions on SMC: Systems, IEEE Transactions on Intelligent Vehicles, Information Sciences,等国际期刊的 Associate Editor，CAAI Transactions on Intelligence Technology 副主编以及《控制理论与应用》编委。

特邀专题简介

空战具有极高的动态特性，再加上复杂的空间运动和多重对抗维度，导致其战术组织十分复杂。历史已证明空战极为符合兰切斯特方程,因而在局部形成数量优势，集中兵力打歼灭战的思想在 21 世纪仍然有效。集中意味着多平台协同，其目的在于产生对抗所需的合力。对于人类而言，多平台协同对抗空战早已发展了一个世纪，其瓶颈显而易见：人类能并行处理的任务有限，不但有效协同的数量极为有限，而且难以做到高度的时空协同。即使是顶级王牌飞行员能够实现高级的协同战术，其经验也难以大量复制，无法形成规模效应。而人工智能的发展为多平台协同空战的智能化发展提供了可能性。

对抗环境下的多平台自主协同是指两架或以上的无人战斗机就确定的对抗任务自主开展敌方行为意图识别预测、综合态势威胁分析、协同攻击/防御

规划以及联合作战执行的全任务过程，它强调自主协同完成“OODA”闭环的能力。敌方行为意图识别预测主要通过敌机方位、相对位置关系、飞行轨迹等探测信息判定机动行为和战术类型，并推测后续战术意图，为态势威胁分析和决策过程提供支持。综合态势威胁分析主要根据敌我相对位置关系、敌机行为意图以及全武器状态的威胁包络给出敌我优势区域、威胁等级与发展趋势，为决策过程提供核心依据。协同攻击/防御规划根据任务目标结合当前实时态势，利用敌方行为意图识别和综合威胁分析的结论，生成总体战术方案及各成员的机动、武器使用方案。联合作战执行按决策过程生成的方案相互配合完成作战行为。

本特邀专题邀请以下与“对抗环境下的多平台自主协同感知、认知与决策”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。

- 态势分析与威胁评估
- 意图识别
- 博弈对抗
- 多平台协同控制
- 多平台协同对抗
- 有人/无人协同对抗
- 人-无人系统协同交互与控制

IEEE ICUS 2024
Invited Session Summary

Title of Session

Multi-Platform Autonomous Cooperative Perception, Cognition and Decision-Making in Confrontational Environment

Organizers

1. Prof. Qi Wu

Shanghai Jiao Tong University, China

2. Assoc. Prof. Xinglong Zhang

National University of Defense Technology, China

3. Prof. Yueying Wang

Shanghai University, China

4. Asst. Prof. Wei Tong

Nanjing University of Posts and Telecommunications, China

5. Prof. Xin Xu

National University of Defense Technology, China

Biosketches of Organizers

Qi Wu is the obtainer of National Outstanding Youth Funds. He is a Professor with Shanghai Jiao Tong University, China. He presided over major national defense projects, Distinguished Young projects and Ye Qisun Key projects. His research interests focus on brain-inspired computing, aviation human factors and deep-sea human factors. Prof. Wu is currently the Associate Editors of five Trans, such as IEEE Transactions on Neural Networks and Learning Systems, IEEE Transactions on Systems, Man, and Cybernetics: Systems.

Xinglong Zhang is an Associate Professor with the National University of Defense Technology. He was selected for the China Association for Science and Technology's Youth Talent Support Program. His research interests include reinforcement learning and model predictive control and their applications in unmanned systems. He has published over 50 papers in international journals and conferences. He serves as a committee member of the Tri-Co Robots Technical Committee and the Adaptive Dynamic Programming and Reinforcement

Learning Technical Committee of the Chinese Association of Automation, and etc.

Yueying Wang is a researcher and doctoral supervisor at the School of Mechanical and Electrical Engineering and Automation, Shanghai University. He is mainly engaged in research on intelligent perception, intelligent control and decision-making of complex systems, and the development of new marine unmanned systems. He has presided over a number of national-level projects, including the National Natural Science Foundation of China and the National Key R&D Program. In recent years, he has published more than 20 papers in Automatica and IEEE Transactions as the first/corresponding author, and has been granted more than 20 invention patents. He is currently a member of the Professional Committees of Control Theory and Robot Intelligence of the Chinese Automation Society, and serves as the deputy editor of 6 international SCI journals such as IEEE TCYB. He has won 1 second prize in natural science from the Ministry of Education and 1 second prize from Shanghai.

Wei Tong is currently an Assistant Professor with Nanjing University of Posts and Telecommunications, China. His research interests include robot vision, 3-D scene reconstruction, medical image analysis and multi-physiological parameter cognitive state evaluation. In recent three years, he has published more than 15 academic papers as the first/corresponding author in Information Fusion, IEEE T-II, IEEE T-ITS, IEEE T-SMCA, IEEE T-IV, IEEE T-ASE, IEEE T-VT, IEEE T-CDS, IEEE T-MRB, etc.

Xin Xu is the obtainer of National Outstanding Youth Funds. He is a Professor with National University of Defense Technology, China. His research interests include autonomous control of intelligent unmanned systems and machine learning. He served as deputy director of Technical Committee on Adaptive Dynamic Programming and Reinforcement Learning Technical Committee, deputy director of Technical Committee on Parallel Control and Management, advisory member of Technical Committee on Robot Intelligence, and deputy director of Technical Committee on Unmanned Systems of China Command and Control Society. Prof. Xu is currently the Associate Editors of IEEE Transactions

on SMC: Systems, IEEE Transactions on Intelligent Vehicles, Information Sciences. He is also the co-Editors-in-Chief of CAAI Transactions on Intelligence Technology and the editorial board of Control Theory and Application.

Details of Session

Air combat has extremely high dynamic characteristics, and the complex spatial movement and multiple confrontation dimensions lead to extremely complex tactical organization. History has proved that air combat is very consistent with Lanchester equation, so the idea of forming a numerical advantage locally and concentrating forces to fight annihilation is still valid in the 21st century. Concentration means multi-platform cooperation, which aims at generating the resultant force needed for confrontation. For human beings, multi-platform cooperative confrontation air combat has developed for a century, and its bottleneck is obvious. For example, human beings' ability to process tasks in parallel is limited, which leads to the limited number of effective coordination, and it is difficult to achieve a high degree of space-time coordination. Even if the top pilots can achieve advanced cooperative tactics, their experience is difficult to copy in large quantities and cannot form scale effect. In comparison, the development of artificial intelligence provides the possibility for the intelligent development of multi-platform cooperative air combat.

Multi-platform autonomous cooperation in the confrontation environment refers to the whole process of two or more unmanned combat aircraft independently identifying and predicting the enemy's behavior intention, analyzing the comprehensive situation threat, planning the cooperative attack and defense, and executing joint operations. It emphasizes the ability to complete the "OODA" closed loop, independently and cooperatively. The identification and prediction of enemy's behavior intention mainly uses the detection information such as the orientation, relative position and flight trajectory of the enemy plane to judge the maneuvering behavior and tactical type, and infer the subsequent tactical intention, which provides support for the situation threat analysis and decision-making process. Comprehensive situation threat analysis is mainly based on the relative position relationship between the enemy and the ourselves, the behavior intention of the enemy plane and the threat envelope of the whole weapon state, so as to solve the dominant area, threat level and development trend of the enemy and the ourselves, thus providing the core basis for the decision-making process. According to the mission objectives and the current real-time situation, collaborative attack and defense planning generates the overall

tactical plan and the maneuver and weapon use plan of each member by using the conclusions of enemy behavior intention identification and comprehensive threat analysis. The implementation of joint operations cooperates with each other to complete the combat behavior according to the scheme generated by the decision-making process.

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 "multi-platform autonomous cooperative perception, cognition and decision-making in confrontational environment".

- Situation analysis and threat assessment
- Intention recognition
- Game confrontation
- Multi-platform cooperative control
- Multi-platform cooperative confrontation
- Manned/Unmanned cooperative confrontation
- Cooperative interaction and control of manned/unmanned Systems