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

具身智能与船舶数智化系统

组织者

1. 蔡成涛，教授，哈尔滨工程大学
2. 王元慧，教授，哈尔滨工程大学
3. 刘志林，教授，哈尔滨工程大学

个人简介

蔡成涛，哈尔滨工程大学教授、博士生导师，智能科学与工程学院院长。国家高层次人才特聘教授、万人计划青年拔尖人才，享受国务院政府特殊津贴，IEEE 高级会员。美国休斯敦大学、加拿大国家研究院访问学者。现任先进导航与海洋智能装备技术国家地方联合工程研究中心常务副主任、教育部“船海装备智能化技术与应用”重点实验室副主任。长期从事海洋自主无人系统环境智能感知与决策研究。主持国家及省部级课题 60 余项，获国防科技进步一等奖 3 项、省科技进步一等奖 1 项、中国航海技术发明一等奖 1 项等省部级奖励 10 余项。出版学术专著 4 部、译著 1 部，发表高水平论文 100 余篇，授权发明专利 50 余项。兼任黑龙江省计算机学会常务副理事长、《哈尔滨工程大学学报》副主编、《智能系统学报》领域编委。

王元慧，哈尔滨工程大学教授，智能科学与工程学院副院长，龙江学者特聘教授，船舶控制工程教育部工程研究中心副主任、黑龙江省重点实验室主任、海南省国际合作基地主任，长期从事海洋运载器智能控制、海洋机器人领域的基础理论及工程应用研究，担任型号副总师，主持国家级项目 20 余项，参与完成我国首套 DP3 动力定位系统、气垫船智能驾控系统研制，获国家科技进步二等奖 2 项、国防科技进步二等奖 1 项、黑龙江省科技进步二等奖 1 项、中国造船工程学会科技进步一等奖 1 项。发表论文 120 余篇，授权国家发明专利 70 余项，出版著作 5 部，现任《哈尔滨工程大学学报》编委。

刘志林，哈尔滨工程大学智能科学与工程学院教授，黑龙江省教学名师，长期从事智能船舶、机器人控制领域的研究工作。主持国家自然科学基金 3 项，国家重点研发计划课题，企业横向课题 10 余项。任教育部“船海装备智能化技术与应用”重点实验室副主任，黑龙江省头雁团队成员，核心期刊《船舶工程》《应用科技》编委等职务。获国防科技进步奖一等奖 3 项，中国造船工程学会科技进步一等奖 1 项，黑龙江省科技进步二等奖 1 项，国家海洋局海洋工程科学技术奖二等奖 1 项。发表高水平期刊论文 60 余篇，第一完成人授权发明专利 4 项，专著 4 部。

特邀专题简介

当前，全球航运业正加速向绿色、智能、高效转型。船舶作为海上运输、作业与资源开发的核心载体，亟需实现运营自主化、决策智能化及人-船-环境高效协同。传统船舶系统在复杂水域感知、动态环境适应、自主运动控制及远程运维等方面仍存在显著瓶颈，难以支撑全生命周期的数智化运营。具身智能作为人工智能与机器人技术深度融合的新范式，强调智能体通过物理实体与环境实时交互来提升感知、学习与决策能力，为破解上述挑战提供了全新路径。将具身智能引入船舶数智化系统，构建“感知—认知—决策—控制—反馈”闭环，能够推动船舶从辅助驾驶向具备环境自适应与自主协同能力的“数智化智能体”跨越，显著提升运营的安全性、经济性与绿色化水平。

本特邀专题诚邀围绕“具身智能与船舶数智化系统”主题的原创论文，征稿方向包括（但不限于）：

- 数智化船舶理论基础：数字孪生与混合建模、具身感知与场景理解、自主运动规划与鲁棒控制、基于学习的动力学建模、船舶群体智能与博弈决策。
- 关键技术研究进展：船岸协同感知与多源数据融合、人-船-环境交互认知、自主避障与路径跟踪、动力系统智能能效管理、多模态感知（视觉/雷达/AIS/声呐）融合、通信受限下的具身决策与弹性控制。

- 系统集成与验证：智能航行系统架构、远程遥控与有限自主驾驶、船载具身智能代理、虚实融合测试验证平台、人机混合智能驾驶、可解释性与安全评估、云边协同运维。
- 典型装备与平台研发：自主航行试验船、智能无人货船、绿色智能内河船舶、重型作业人机协同平台、数字孪生运维系统、仿生推进集成平台、小型具身船舶机器人、可重构模块化装备。
- 跨域协同与新兴应用：船-岸-天-潜立体协同作业、无人船与水下机器人群智交互、多场景迁移应用、应急自主响应、海上风电运维船舶、绿色能效优化与碳足迹追溯。

IEEE ICUS 2026
Invited Session Summary

Title of Session

Embodied Intelligence and Ship Digital-Intelligent Systems

Organizers

1. Prof. Chengtao Cai
Harbin Engineering University, China
2. Prof. Yuanhui Wang
Harbin Engineering University, China
3. Prof. Zhilin Liu
Harbin Engineering University, China

Biosketches of Organizers

Chengtao Cai is a Professor and Doctoral Advisor at Harbin Engineering University, where he also serves as the Dean of the College of Intelligent Systems Science and Engineering. He is a Distinguished Professor of the National High-level Talents Program, a Young Top-notch Talent of the National Ten Thousand Talents Program, a recipient of the Special Government Allowance of the State Council, and a Senior Member of IEEE. He has also been a visiting scholar at the University of Houston in the United States and the National Research Council (NRC) of Canada. Currently, Professor Cai serves as the Executive Deputy Director of the National and Local Joint Engineering Research Center for Advanced Navigation and Marine Intelligent Equipment Technology, and the Deputy Director of the Key Laboratory of Intelligent Technology and Application of Marine Equipment (Ministry of Education). His research has long focused on intelligent environmental perception and decision-making for marine autonomous unmanned systems. He has presided over more than 60 national and provincial/ministerial-level research projects. His outstanding contributions have earned him over 10 provincial and ministerial-level awards, including three First Prizes of the National Defense Science and Technology Progress Award, one First Prize of the Provincial Science and Technology Progress Award, and one First Prize of the Technological Invention Award from the China Institute of Navigation. Furthermore, he has published 4 academic monographs and 1 translated book, authored over 100 high-level academic papers, and holds more than 50 authorized invention patents. In addition to his academic research, Professor Cai serves as the Executive Vice President of the Heilongjiang Computer Society, Deputy Editor-in-Chief of the Journal of Harbin Engineering University, and Area Editor of the CAAI Transactions on Intelligent

Systems.

Yuanhui Wang is a professor at Harbin Engineering University, Vice Dean of the College of Intelligent Systems Science and Engineering. She is a Longjiang Scholar Distinguished Professor, and serves as Deputy Director of the Engineering Research Center of Ship Control Engineering of the Ministry of Education, Director of the Key Laboratory of Heilongjiang Province, and Director of the Hainan Provincial International Cooperation Base. She has long been engaged in fundamental theoretical and engineering application research in the fields of intelligent control of marine vehicles and marine robots. She serves as the Deputy Chief Designer for a key project, has presided over more than 20 national-level projects, and participated in the development of China's first DP3 dynamic positioning system and the intelligent control system for hovercraft. She has won two Second Prizes of the State Science and Technology Progress Award, one Second Prize of the National Defense Science and Technology Progress Award, one Second Prize of the Heilongjiang Provincial Science and Technology Progress Award, and one First Prize of the Science and Technology Progress Award of the China Shipbuilding Engineering Society. She has published over 120 papers, been granted more than 70 national invention patents, and authored five books. She currently serves as an editorial board member of the Journal of Harbin Engineering University.

Zhilin Liu is a professor at the College of Intelligent Systems Science and Engineering, Harbin Engineering University, and a recognized Provincial Teaching Master of Heilongjiang Province. He has long been engaged in research in the fields of intelligent ships and robotic control. He has presided over three projects of the National Natural Science Foundation of China, as well as a National Key Research and Development Program project and more than ten industry-funded horizontal research projects. He serves as the Deputy Director of the Key Laboratory of Marine Ship Equipment Intelligent Technology and Application (Ministry of Education), a member of the Heilongjiang Province Head Goose Team, and an editorial board member for core journals such as Ship Engineering and Journal of Applied Science and Technology. He has received three first-class awards for National Defense Technological Progress, one first-class award for Technological Progress from the Chinese Society of Naval Architects and Marine Engineers, one second-class award for Technological Progress from Heilongjiang Province, and one second-class award for Marine Engineering Science and Technology from the State Oceanic Administration. He has published over 60 high-level journal papers, holds

four authorized invention patents as the lead inventor, and has authored four monographs.

Details of Session

Currently, the global shipping industry is accelerating its transformation towards green, intelligent, and high-efficiency operations. As the core carriers for maritime transportation, operations, and resource development, ships urgently need to achieve operational autonomy, intelligent decision-making, and efficient human-ship-environment collaboration. Traditional ship systems still have significant bottlenecks in complex waterway perception, dynamic environment adaptation, autonomous motion control, and remote operation and maintenance, making it difficult to support full-lifecycle digital-intelligent operations. Embodied intelligence, as a new paradigm deeply integrating artificial intelligence and robotics, emphasizes that agents enhance perception, learning, and decision-making capabilities through real-time interaction with the physical environment, providing a novel path to address the above challenges. Integrating embodied intelligence into ship digital-intelligent systems and forming a "perception-cognition-decision-control-feedback" closed loop can propel ships from assisted driving to "digital-intelligent agents" with environmental self-adaptation and autonomous collaboration capabilities, significantly improving operational safety, economy, and green performance.

This invited special issue cordially invites original papers on the theme of "Embodied Intelligence and Ship Digital-Intelligent Systems". Topics of interest include (but are not limited to):

- Fundamentals of Digital-Intelligent Ships: digital twin and hybrid modeling, embodied perception and scene understanding, autonomous motion planning and robust control, learning-based dynamic modeling, swarm intelligence and game-theoretic decision-making for ships.
- Research Progress in Key Technologies: ship-shore collaborative perception and multi-source data fusion, human-ship-environment interactive cognition, autonomous obstacle avoidance and path following, intelligent energy efficiency management of propulsion systems, multi-modal perception (vision/radar/AIS/sonar) fusion, embodied decision-making and resilient control under communication constraints.
- System Integration and Validation: intelligent navigation system architecture, remote control and limited autonomous driving, shipborne embodied intelligent agents, virtual-real integrated test and validation platforms, human-machine hybrid intelligent driving, interpretability and safety assessment, cloud-edge collaborative operation and maintenance.

- Development of Typical Equipment and Platforms: autonomous navigation test ship, intelligent unmanned cargo ship, green intelligent inland vessel, heavy-duty human-robot collaborative platform, digital twin operation and maintenance system, bionic propulsion integrated platform, small embodied ship robot, reconfigurable modular equipment.
- Cross-domain Collaboration and Emerging Applications: ship-shore-space-subsea stereo collaborative operation, swarm interaction between unmanned surface vessels and underwater robots, multi-scenario transfer applications, autonomous emergency response, offshore wind farm operation and maintenance vessels, green energy efficiency optimization and carbon footprint tracing.