

# 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

两栖特种机器人技术

## 组织者

1. 秦洪德，教授，哈尔滨工程大学
2. 杨志新，教授，澳门大学
3. 曲钧天，副教授、特别研究员，清华大学
4. 白桂强，助理研究员，哈尔滨工程大学

## 个人简介



**秦洪德**，哈尔滨工程大学教授、博士生导师，水下智能机器人技术团队负责人，国家杰出青年科学基金获得者，国家重点研发计划首席科学家。长期从事自主水下航行器技术研究，在水下航行器平台总体设计、自主导航与精细控制等方面取得了系列突破，主持研制“星海”系列水下机器人。近5年以第一作者或通讯作者发表SCI论文50余篇，申请国家发明专利122项，牵头发布我国首个水下搜救机器人国家标准。获省部级科技奖励9项，连续4年入选“World’s Top 2% Scientists”年度影响力榜单。现为IEEE Senior Member，担任《Signal, Image and Video Processing》《Journal of Marine Science and Application》等国际期刊副主编，受邀担任“十四五”国家重点研发计划“智能机器人”重点专项指南论证与编制专家，中国指控学会海上指挥控制专业委员会副主任委员、中国计算机学会智能机器人专业委员会秘书长、中国造船工程学会船舶力学学术委员会人工智能学组副组长、中国海洋学会深海技术分会理事、中国光学工程学会海洋信息网络专业委员会海洋装备与工程组组长。



**杨志新**，澳门大学智慧城市物联网全国重点实验室、科技学院机电工程系教授。从事机电设备故障诊断与健康管理和智能机器人技术研究，主持了科技部与澳门科技基金的联合资助项目，国家自然科学基金与澳门科技发展基金联合资助项目、及澳门科技发展基金人工智能重点专项资助等重点项

目，在 IEEE TRO、TCYB、TII、TIE、TMECH、MSSP、IROS、ICRA 等学术刊物及会议上发表了 130 余篇 SCI 论文，连续 5 年入选 “World’s Top 2% Scientists”。其受邀担任澳门科学技术协进会常务副会长、广东省科协港澳特邀委员，荣获首届《全国创新争先奖》，2021 年获广东省科技进步一等奖。



**曲钧天**，清华大学深圳国际研究生院海洋工程研究院副教授、特别研究员、博士生导师。加拿大麦吉尔大学博士，曾在多伦多大学任研究助理，长期从事软体机器人、智能传感、海洋机器人及 4D 打印等交叉研究。在 IEEE T-RO、Advanced Functional Materials、Nano Energy、Ocean Engineering 及 ICRA、IROS 等国内外高水平期刊会议发表 SCI/EI 论文 70 余篇，授权发明专利 40 项，出版学术专著 2 部，参与发布软体机器人领域首个团体标准。主持国家自然科学基金、国家重点研发计划子课题及省部级项目 20 余项。现任广东省教育厅海洋微型生物生态学与应用技术重点实验室副主任、深圳市海洋生态前沿技术重点实验室副主任、IEEE RA-L 副主编等。入选“海洋强国青年科学家”“IROS New Generation Star Project”等人才计划，获日内瓦发明展金奖、全国发明展金奖等多项奖励。



**白桂强**，工学博士，哈尔滨工程大学助理研究员、硕导。现为中国计算机学会智能机器人专业委员会执行委员、中国计算机学会智慧交通委员会委员，从事群体智能、路径规划、水陆两栖机器人总体技术等研究方向，当前主持国家自然科学基金、国家重点研发计划子课题、省自然科学基金、国家重点实验室基金、企业委托项目等近 10 项，以第一或通讯作者发表 SCI 期刊论文 20 篇，申请/授权国家及国际发明专利 20 余项，参与发布我国首个水下搜救机器人国家标准。

### 特邀专题简介

水陆两栖特种机器人对国家安全保障、应急救援等复杂环境作业的支撑作用正日益凸显，以跨介质机动与原位自主作业为主要特征的新一代两栖机器人技术，成为拓展人类在近岸浅滩、湿地滩涂及灾害高风险区域作业能力的重要

突破口。两栖特种机器人在运行过程中需面对跨介质环境中流固耦合强、感知信息退化明显、任务交互复杂且不确定性突出的多重挑战。由此，围绕数据与机理协同驱动的两栖自主系统，在环境感知、动力学建模、运动控制与自主决策等方面的鲁棒性、适应性与可信性问题，衍生出一系列亟待突破的关键科学与技术难题。如何在复杂多变的跨域环境中实现高效机动、稳定作业与安全可信运行，是当前两栖特种机器人设计与应用面临的核心问题。通过提升系统的鲁棒性与作业完备度，可有效推动两栖特种机器人在极端环境中的规模化应用与工程落地，进而在应急保障、资源开发与海洋工程等领域发挥重要支撑作用。

本特邀专题邀请以下与“水陆两栖特种机器人”主题相关的包含创新思想、新发现、概念、改进、关键技术及新应用的原创论文，主要接收（并不限于）以下方向的研究论文：

- 两栖机器人总体设计与结构优化
- 两栖机器人跨介质动力学与水动力分析
- 两栖机器人感知、定位与环境建图
- 两栖机器人运动规划与鲁棒控制
- 两栖机器人自主决策与智能作业
- 两栖机器人操作控制与协同作业
- 两栖机器人可靠性、安全性与测试评估
- 两栖机器人仿生结构与驱动技术
- 两栖机器人复杂环境适应技术
- 两栖机器人典型场景应用验证
- 水陆两栖机器人跨介质通信与协同感知
- 强扰动环境下自适应控制与抗干扰技术
- 弱先验条件下环境认知与不确定性建模
- 多机器人协同与群体智能作业方法
- 两栖机器人能源管理与长时自主运行技术

**IEEE ICUS 2026**  
**Invited Session Summary**

**Title of Session**

Amphibious Special Robot Technology

**Organizers**

**1. Prof. Hongde Qin**

Harbin Engineering University, China

**2. Prof. Zhixin Yang**

University of Macau, China

**3. Assoc. Prof. Juntian Qu**

Tsinghua University, China

**4. Dr. Guiqiang Bai**

Harbin Engineering University, China

**Biosketches of Organizers**



**Prof. Hongde Qin** is a Ph.D. supervisor at Harbin Engineering University and Head of the Underwater Intelligent Robotics Research Team. He is a recipient of the National Science Fund for Distinguished Young Scholars and serves as Chief Scientist of a National Key R&D Program of China. His research focuses on autonomous underwater vehicle technologies, with major contributions in overall platform design, autonomous navigation, and precision control of underwater vehicles. He has led the development of the Xinghai series of underwater robots. Over the past five years, Professor Qin has published more than 50 SCI-indexed papers as first or corresponding author and filed 122 Chinese invention patents. He also led the drafting of China's first national standard for underwater search-and-rescue robots. He has received nine provincial- and ministerial-level science and technology awards and has been listed in the World's Top 2% Scientists annual impact ranking for four consecutive years. Professor Qin is an IEEE Senior Member and currently serves as Associate Editor of Signal, Image and Video Processing and Journal of Marine Science and Application. He has also been invited to serve as an expert for the formulation of the Intelligent Robotics key special program under China's 14th Five-Year National Key R&D Program. In addition, he serves as Vice Chair of the Maritime Command and Control Committee of the Chinese Institute of Command and Control, Secretary-General of the Technical Committee on Intelligent Robots of the China Computer Federation, Deputy Head of the Artificial Intelligence Group of the Ship Mechanics Committee of the Chinese Society of Naval Architects and Marine Engineers, Council Member of the Deep-Sea

Technology Branch of the Chinese Society for Oceanography, and Head of the Marine Equipment and Engineering Group under the Marine Information Network Committee of the Chinese Society for Optical Engineering.



**Prof. Zhixin Yang** is a Ph.D. supervisor at the State Key Laboratory of Internet of Things for Smart City and the Department of Electromechanical Engineering, Faculty of Science and Technology, University of Macau. His research interests include health monitoring and prognostics of engineering systems, as well as robot control technologies based on computer vision and artificial intelligence. He has led multiple major research projects funded by local science foundations, the National Natural Science Foundation of China (NSFC), national key R&D programs of the Ministry of Science and Technology, and joint funding schemes involving Macau. Prof. Yang has published over 130 SCI-indexed papers in leading journals such as IEEE Transactions on Robotics, IEEE Transactions on Cybernetics (TCYB), IEEE Transactions on Industrial Informatics (TII), IEEE Transactions on Industrial Electronics (TIE), IEEE/ASME Transactions on Mechatronics (TMECH), and Pattern Recognition (PR), including several highly cited papers. He serves as Vice Chairman of the China South and Hong Kong–Macau Society of Metalworking Engineering, Executive Vice Chairman of the Macau Association for the Advancement of Science and Technology, and Deputy Secretary-General of the Cross-Strait and Hong Kong–Macau Collaborative Innovation Alliance initiated by the China Association for Science and Technology (CAST). He is also an invited committee member of the Guangdong Association for Science and Technology and a Standing Council Member of the Guangdong Young Scientists Association. Prof. Yang received the inaugural National Innovation Award (Certificate) of China. In 2021, he was awarded the First Prize of the Guangdong Provincial Science and Technology Progress Award. Under his supervision, his team won the global championship in the UG2+ Machine Vision Algorithm Challenge at CVPR 2020, and his students achieved the only Grand Prize and First Prize for Macau in the “Challenge Cup” National Competition.



**Juntian Qu** is an Associate Professor, Special Research Fellow at the Institute of Ocean Engineering, Tsinghua Shenzhen International Graduate School, Tsinghua University; Deputy Director of the Guangdong Provincial Key Laboratory of Marine Microbial Ecology and Application Technology under the Department of Education of Guangdong Province; and Deputy Director of the Shenzhen Key Laboratory of Frontier Technology in Marine Ecology. He received his Ph.D. from

McGill University, Canada, and previously worked as a Research Assistant at the University of Toronto. His research interests include soft robotics, intelligent sensing, marine robotics, and 4D printing. Dr. Qu has published more than 70 SCI/EI-indexed papers in leading journals and conferences, including IEEE Transactions on Robotics, Advanced Functional Materials, Nano Energy, Ocean Engineering, ICRA, and IROS. He has been granted 40 invention patents, published two academic monographs, and contributed to the release of the first group standard in the field of soft robotics in China. He has led more than 20 research projects, including those funded by the National Natural Science Foundation of China, subprojects of the National Key R&D Program of China, and provincial- and ministerial-level programs. He currently serves as Deputy Director of the Shenzhen Key Laboratory of Frontier Technology in Marine Ecology and Associate Editor of IEEE Robotics and Automation Letters. Dr. Qu has been selected for several prestigious talent programs, including the Young Scientist for Building China into a Maritime Power and the IROS New Generation Star Project. He has received numerous awards, including a Gold Medal at the Geneva International Exhibition of Inventions and Gold Medals at the China Exhibition of Inventions.



Guiqiang Bai received his Ph.D. at Jilin University and is currently an Assistant Research Fellow and Master's Supervisor at Harbin Engineering University. He serves as an Executive Committee Member of the Technical Committee on Intelligent Robots of the China Computer Federation and as a Committee Member of the China Computer Federation Technical Committee on Intelligent

Transportation. His research interests include swarm intelligence, path planning, and the overall technology of amphibious robots operating across land and water. Dr. Bai is currently leading nearly 10 research projects, including those funded by the National Natural Science Foundation of China, provincial natural science foundations, national key laboratory funds, and industry-sponsored programs. He has published 20 SCI-indexed journal papers as first or corresponding author and has filed or been granted more than 20 Chinese and international invention patents.

### **Details of Session**

Amphibious special robots are playing an increasingly important role in supporting national security, emergency rescue, and operations in complex environments. Characterized by cross-medium mobility and in-situ autonomous operation, a new generation of amphibious robotic technologies has emerged as a key breakthrough for extending human operational capabilities in nearshore shallows, wetlands, tidal flats, and disaster-prone high-risk areas.

During operation, amphibious special robots must cope with multiple challenges inherent to cross-medium environments, including strong fluid–structure interactions, severe degradation of sensing information, complex task interactions, and significant uncertainties. Consequently, for amphibious autonomous systems driven by the synergy of data and physical models, critical issues arise in robustness, adaptability, and trustworthiness across environmental perception, dynamic modeling, motion control, and autonomous decision-making.

Achieving efficient mobility, stable operation, and safe and trustworthy performance in highly dynamic and uncertain cross-domain environments remains a fundamental challenge in the design and application of amphibious special robots. Enhancing system robustness and operational completeness will effectively promote the large-scale deployment and engineering application of such robots in extreme environments, thereby providing essential support for emergency response, resource exploitation, and marine engineering.

This Special Issue invites original research papers related to Amphibious Special Robots, including innovative ideas, new discoveries, concepts, methodologies, key technologies, and emerging applications. Topics of interest include, but are not limited to, the following areas:

- Overall design and structural optimization of amphibious robots
- Cross-medium dynamics and hydrodynamic analysis of amphibious robots
- Perception, localization, and environment mapping for amphibious robots
- Motion planning and robust control of amphibious robots
- Autonomous decision-making and intelligent operation of amphibious robots
- Manipulation control and cooperative operation of amphibious robots
- Reliability, safety, and testing/evaluation of amphibious robots
- Bio-inspired structures and actuation technologies for amphibious robots
- Environmental adaptability of amphibious robots in complex conditions
- Application validation of amphibious robots in representative scenarios
- Cross-medium communication and cooperative perception for amphibious robots
- Adaptive control and disturbance rejection under strong environmental disturbances
- Environment cognition and uncertainty modeling under limited prior information
- Multi-robot cooperation and swarm intelligence for amphibious systems
- Energy management and long-endurance autonomous operation of amphibious robots