
Foreword

Special issue on IoT in Enhancing Autonomous Underwater Vehicle (AUV) Operations for Marine Research

Autonomous Underwater Vehicles (AUVs) has become an essential tool of marine exploration, environmental monitoring, and subsea inspection due to their capability to work autonomously in complex and hostile underwater environments. AVUs are fitted with advanced sensing, navigation systems, imaging and communication systems that enable them to collect data continuously in large ocean regions that are otherwise inaccessible or unsafe to humans. Current developments in the Internet of Things (IoT) have radically changed the operations of AUVs by making the process of seamless connectivity, real-time data exchange and intelligent decision-making capabilities. The IoT-enabled AUVs can integrate distributed sensors, onboard processing units and cloud-based infrastructures to improve situational awareness, adaptive mission planning and cooperative vehicle behavior. This kind of integration helps to achieve accurate localization, efficient energy management, fault detection and predictive maintenance, which increases the mission time and reliability. In addition, lightweight composite materials, effective propulsion systems and intelligent control algorithms lead to beneficial maneuverability and low energy consumption. With the growing need of marine research to have high-resolution spatial and temporal data, the convergence of IoT technologies with autonomous underwater systems presents innovative opportunities for scalable, cost-effective, and data-driven ocean exploration. However, challenges related to the limitations of underwater communication, cybersecurity, interoperability, and autonomous coordination are open research issues and they need innovative solutions in multidisciplinary domains.

In the paper titled "Adaptive Curiosity-Driven Proximal Policy Optimization of Hybrid Edge-Cloud Autonomous Underwater Vehicle Systems", the authors suggest an intelligent control framework that combines reinforcement learning with a hybrid edge-cloud computing system to enhance AUV autonomy. The paper presents an Adaptive Curiosity-Driven Proximal Policy Optimization strategy which integrates intrinsic curiosity-driven rewards with stable policy optimization to enhance exploration, navigation, and real-time decision-making in dynamic underwater environments. The framework promotes effective use of resources and scalable AUV operations by assigning latency-sensitive tasks to

edge devices and computationally intensive analytics to the cloud. The article shows that the learning of curiosity and edge-cloud collaboration can be used to develop marine monitoring and autonomous underwater exploration.

In the research titled "Precise Algorithm Implementation and Performance Evaluation of GNSS/INS Coupling Navigation System", Chen Ze-Rui and co-authors explore effective navigation techniques in GNSS/INS integrated systems that can be used in complex and dynamic environments. The paper aims at overcoming the issues related to noise interference and abnormal observations by integrating a Robust Extended Kalman Filter (REKF) into the traditional coupling framework. The proposed approach can increase system robustness and stability in weak signal and high-dynamic conditions by dynamically changing the weights of observations and noise covariance. The article has focused on the precise algorithm design, fusion modeling and systematic performance evaluation, the practicality of the robust filtering methods in autonomous driving, aviation navigation and intelligent transportation systems.

As discussed in the paper titled "Analysis of the Impact of Kelp Farming on Hydrodynamics in Sanggou Bay", the authors inspect the outcome of large-scale kelp aquaculture on the hydrodynamic processes of the coastal waters in a semi-enclosed marine environment. The research employs field observations and three-dimensional numerical simulations with MIKE 3 hydrodynamic model to analyze changes in tidal currents, flow structures and water exchange caused by kelp farming infrastructures. The study examines the various growth stages and the interactions between the growth stages and tidal dynamics by modeling kelp growth using a simplified physical analogy. The work provides a systematic framework for understanding aquaculture-induced hydrodynamic modifications, which can provide scientific knowledge to sustain the management of the coastal environment and environmentally friendly responsible kelp farming practices.

In the article titled "A Strategic Renewal of IoT for Enhancing Autonomous Underwater Vehicle (AUV) Operations for Marine Research", the authors suggested an intelligent IoT-based renewal structure that would address the main drawbacks of traditional AUV systems. This paper presents a combined architecture that integrates adaptive IoT communication, AI-based decision-making, and sustainable energy management to improve autonomy and operational effectiveness in dynamic underwater environments. The framework focuses on flexibility, dependability, and intelligent coordination by combining Sparse Adaptive Modulation and Coding for efficient data transmission and Neuro-Adaptive Transformer Learning for real-time navigation and control. The

article is an in-depth view of how the IoT-enabled AUV operations can be strategically modernized to be used in advanced marine research applications.

Lastly, the guest editors would like to acknowledge the authors who have made significant contributions to the journal and who have also made efforts to polish their manuscripts. The reviewers are given special credit on their keen reviews, constructive remarks, and valuable suggestions, which greatly reinforced the accepted works. The guest editors also recognize the dedicated efforts of the editorial team in terms of professional management and effective coordination of the process of review and publication. We hope that the articles in this special issue can contribute to the further development of IoT-enabled Autonomous Underwater Vehicle research and inspire future research in the area of intelligent, energy-efficient, and autonomous marine exploration systems.

• Introduction to Guest Editors •



Punitha Palanisamy is the Head of the Department of Artificial Intelligence and Data Science at Tagore Institute of Engineering and Technology, Salem, India, and a Research Fellow at INTI International University, Malaysia. She received her Ph.D. in Computer Science and Engineering from Anna University, Chennai. With over seven years of academic and research experience, her expertise spans artificial intelligence, Internet of Things, neural networks, healthcare 5.0, edge computing, and underwater communication.

Dr. Punitha has published extensively in reputed SCI- and Scopus-indexed journals and actively serves as a reviewer for leading publishers including IEEE, Springer, Elsevier, ACM, and Wiley. Her research focuses on intelligent systems, secure communication frameworks, and AI-driven healthcare and marine applications.



Claudia Cherubini is an Associate Professor in Hydrogeology at University of Trieste from 2023. She was an Associate Professor at the University of Ferrara, Honorary Senior Lecturer at the University of Queensland, and Adjunct Professor at the National Institute of Oceanography and Geophysics in 2020. Her research domain focuses on hydrogeological modeling applied to groundwater management. In 2012, she won the prize Division Outstanding Young Scientists Award at the EGU General Assembly. In 2019, she was appointed as an international scientific expert reviewer of the US Department of Defense SERDP Program 'Quantitative Groundwater Plume Characterization to Support Transition Assessments'. She is currently responsible for the University of Ferrara of the European Project 'Air Break' within the UIA (Urban Innovative Actions) program.



Rolyana Ferinia is the Dean of the Faculty of Business and a Senior Lecturer at Universitas Advent Indonesia (UNAI) in Bandung, Indonesia. Specializing in management, her academic expertise includes human resources management, organizational behavior, and research methodology.



El-Abiad Zouhour is a Lebanese Business Scholar and Researcher at the Center for Research, Studies and Documentation (CRED) within the ESA Business School in Beirut, Lebanon. Her work focuses primarily on corporate governance, entrepreneurship, and women's economic empowerment.



Wei-Shinn (Jeff) Ku is an Endowed Alumni Professor in the Department of Computer Science and Software Engineering at Auburn University. He serves as the director of the Auburn Data Science and Engineering Lab (DSE Lab). He earned his Ph.D. and two M.S. degrees (Computer Science and Electrical Engineering) from the University of Southern California (USC), and holds a Bachelor's degree from National Taiwan Normal University (NTNU).
