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Editorial: Advances in autonomous ships (AS) for ocean observation

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Editorial on the Research Topic
Advances in autonomous ships (AS) for ocean observation

Introduction

Ocean observation is the basis for understanding and studying marine science. In recent years, the application of autonomous ships (AS), including Unmanned Surface Vessels (USVs), Autonomous Underwater Vehicles (AUVs), and Remotely Operated Vehicles (ROVs), in ocean observation has gained significant traction due to their capability to perform maritime autonomous tasks of oceans efficiently and safely in challenging marine environments. Compared with traditional technical means, the unique technical capability of ASs in marine environment observation is the ability to maneuver on demand under the influence of complex marine environments. Therefore, giving full play to its controllable maneuverability and realizing its perception, task decision-making, path planning, control, and perception data analysis is the key to its application. Equipped with advanced sensors and instruments, these vessels can gather critical ocean data over large areas and long durations, providing invaluable insights for marine scientists.

This editorial aims to highlight the latest advancements in AS technology and their implications for ocean science, particularly the integration of Artificial Intelligence (AI) and Machine Learning (ML). These innovations have the potential to greatly enhance the efficiency and accuracy of ocean observation, transforming the field of marine science.

Contributing articles and main conclusions

This Research Topic comprises eleven high-quality papers, each contributing to many different aspects of autonomous ships (AS) for ocean observation. In the realm of enhanced data collection techniques, Berild et al. sampled river plume fronts in three-dimensional space using AUVs. This model addresses critical challenges in coastal environments impacted by climate change and human activities. In another study, AUVs equipped with interferometric side-scan sonar were used to monitor aquaculture setups in high-energy shallow water environments (Peck et al.). Lei et al. developed a novel calibration method for the Simulating Waves Nearshore wave model, incorporating the white-capping dissipation term. Validated across diverse global locations, including the South China Sea, Gulf of Mexico, and Mediterranean Sea, this method demonstrates broad applicability in wave modeling. For the detection of small marine targets, Cheng et al. proposed an enhanced method based on the YOLOv7 model to detect small targets in SSS images, and introduced a global attention mechanism to focus on global information and extract target features. Experimental results show that this method can be applied to autonomous target detection in USVs and AUVs, thereby enhancing the autonomous operation capability of unmanned autonomous ocean observation platforms. The development of hydrodynamic simulation tools for ROVs has led to better understanding of the forces acting on these vehicles during operation (Zhang et al.). Such simulations are instrumental in improving the design and maneuverability of underwater vehicles, which is essential for complex tasks such as monitoring volcanic activities around active volcanoes (Tada et al.). In complex ocean environments, multiple ASs are required to collaborate to complete observation tasks. Kang et al. demonstrated the potential to improve the efficiency of maritime operations through collaborative ocean observation research by communicating heterogeneous USVs. Furthermore, adaptive terminal sliding mode control schemes have been developed to maintain the formation of USVs and ROVs even under deceptive attacks (Zhang et al.). In terms of innovative imaging technologies for marine science, to address the challenges posed by adverse weather conditions, such as rain, and haze, a prompt-based learning method was proposed for maritime image restoration by He et al. This method enhances the quality of maritime images, which is essential for navigation, fishing, and search and rescue operations. Additionally, hybrid dynamic transformers have been developed for underwater image super-resolution (He et al.), significantly improving the clarity and detail of underwater imagery. In the aspect of maritime and ocean observation understanding and decision support, Li et al. introduced a framework utilizing knowledge graph technology to analyze maritime data. By integrating Automatic Identification System data with spatial information from port facilities, they created semantic connections among ships, berths, and waterways. This approach enhances ship identification and berth allocation, improving decision-making for intelligent maritime systems.

In summary, these collective efforts underscore a comprehensive approach to advancing maritime research and technology. By leveraging the capabilities of Autonomous Ships (ASs) and integrating sophisticated modeling, autonomous systems, image processing, and data analysis techniques, researchers are addressing complex challenges in marine science. These advancements not only enhance our ability to monitor and understand marine environments more effectively but also improve the efficiency and safety of oceanographic research. The integration of AI and ML within AS technology exemplifies how innovation is transforming ocean observation, offering valuable insights into oceanic systems and facilitating better management of marine resources.

Author contributions

XZ: Writing – original draft, Writing – review & editing. YC: Writing – original draft, Writing – review & editing. GB: Writing – original draft, Writing – review & editing. DW: Writing – original draft, Writing – review & editing. YG: Writing – original draft, Writing – review & editing. CW: Writing – original draft, Writing – review & editing.

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Conflict of interest

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