Marine Robotic Systems

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The marine environment is an exciting and challenging context for the robotics community. Autonomous surface vehicles (ASVs) or autonomous underwater vehicles (AUVs) face a demanding environment with poor perception and actuation capabilities in comparison with most ground-based robotics. In the case of the underwater scenario, for example, communications are complicated by the limited bandwidth, and the position measurement of the vehicles is not obvious. Both underwater and surface vehicles, moreover, suffer from the presence of current and wind disturbances that enhance the complexity of the dynamic control task.

On the other hand, with the ocean covering approximately 70% of the Earth's surface and being at the same time the less studied, the use of robotic platforms is of emerging interest. In the near future, marine robots will be used for homeland security, rise inspection, or intelligent sampling, and researchers will be able to deploy numerous networked robotic ocean observatories, expanding the quantity and quality of data available to scientists and the public worldwide. The introduction of advanced technologies like autonomous manipulation will enable sensing and performing mechanical work in hazardous areas or where humans cannot go, such as natural or man-made disaster regions, deep-ocean, and under ice.

This special issue brings together articles from experts in the field to address recent aspects related to marine robotics. Several topics have been covered, from multiple heterogeneous vehicles to sailing vessels, to a new class of underwater vehicles, and to riser-inspection-developed robots to intervention ones. All the articles are validated by outstanding experimental results.

Smith et al. present an overview of the Center for Integrated Networked Aquatic PlatformS (CINAPS) activities, which is located at the University of Southern California. The aim of CINAPS is to bridge the gap between technology, communication, and the scientific exploration of local and regional marine ecosystems. Their article focuses on the description of the CINAPS setup and recent experiments with marine robots.

Caffaz et al. describe the design and the experimental validation of a new class of AUV, i.e., an underwater vehicle characterized by a hybrid actuation mechanism. The main design targets of this vehicle, named Fòlaga, are of low cost and lightweight, with the aim of combining the design principles of oceanographic gliders with those of standard AUVs. Some field data, collected during an experimental campaign, are provided.

One of the most difficult tasks in the underwater environment is manipulability with a floating-base manipulator.

The work of Erckens et al. describes the design and implementation of a navigation and control system for an autonomous sailing vessel named Avalon. The ASV has been conceived to participate in an international competition requiring autonomous crossing of the Atlantic Ocean. The article focuses in detail on the mechanical design and navigation architecture. Experimental results for several days traveling in different conditions are shown.

Psarros et al. developed a remotely operated vehicle for the underwater inspection of subsea flexible risers. They have developed new, customized under-actuated end effectors to hold the robot on the riser during locomotion or operation, without affecting the riser's integrity. The mechanical design will allow the robot to operate up to 2,000 m depth. Some preliminary experimental results are shown to illustrate the achieved performances.

One of the most difficult tasks in the underwater environment is manipulability with a floating-base manipulator. This is the main research goal with the vehicle SAUVIM, developed at the University of Hawaii. In their article, Marani and Choi focus on the problem, intrinsic to autonomous underwater manipulation, of medium-range target localization for guiding the vehicle toward the target area. Based on the use of acoustic technology, the goal is to acquire the Earth-referenced Cartesian coordinates of a known target, with the necessary accuracy required for positioning the vehicle so that the target falls within the manipulator workspace. Results from a unique experiment of autonomous underwater landing validate the approach discussed in the article.

Given the vastness of the topics related to marine robotics, an exhaustive presentation would certainly require more than a single issue, but we hope that this introduction of the most recent research will stimulate more interest and discussion in this fascinating field.

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