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Editorial

Unmanned Marine Vehicles

Gabriele Bruzzone *, Roberta Ferretti and Angelo Odetti

CNR-INM, UOS Genoa, Via de Marini 6, 16149 Genova, Italy; roberta.ferretti@inm.cnr.it (R.F.); angelo.odetti@inm.cnr.it (A.O.)
* Correspondence: gabriele.bruzzone@cnr.it

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Water covers nearly 70% of the Earth's surface, and throughout history, oceans, seas, lakes, rivers, etc., have been a fundamental source of food, energy, transport, and commerce. Just to confirm the importance of studying and preserving the so-called "Global Ocean", the United Nations proclaimed the next decade, running from 2021–2030, as the "Decade of Ocean Science for Sustainable Development". Notwithstanding this, due to the risky and difficult environment, more than 80% of the oceans are presently still unexplored and unmapped. On the other hand, in recent years, the use of robotic vehicles has become increasingly widespread for helping and substitution of human operators working at sea. In particular, Unmanned Marine Vehicles (UMVs) have allowed for the automation of many dangerous tasks that were previously carried out manually, either underwater or on the surface. In fact, UMVs are the key tools that will allow human beings to explore, operate, protect, and carry out the sustainable exploitation of oceans in the near future. However, there continues to be significant challenges in this field. Presently, there is a stronger and stronger need for increased autonomy to perform tasks over large spatial and temporal durations, the demand to carry out increasingly complex operations in an intelligent way, in addition to an ever-growing need for UMVs to cooperate and interact with the environment, other robots, or human beings to succeed in performing very complicated tasks.

The aim of this Special Issue of JMSE was to select and publish papers that addressed new developments in the field of UMVs. At the end of the reviewing process a collection of 13 articles were chosen that will be briefly discussed in the following.

As far as the development of innovative UMVs is concerned, Marini et al. [1] are proposing, in the framework of the H2020 ENDURUNS project, a new approach aimed at overcoming the limits of the current state-of-the-art in the field. Their solution is based on the contemporary use of a hybrid Autonomous Underwater Vehicle (AUV) capable of moving either using thrusters or as a glider, working in cooperation with an Unmanned Surface Vehicle (USV) equipped with a satellite communication system. Moreover, a longer autonomy of the two vehicles will be guaranteed using an adaptive energy system managing solar panels, rechargeable batteries and hydrogen fuel cells.

Campagnaro et al. [2] in the first part of their paper carry out a comprehensive review of the different wireless communication systems (acoustic, optical, radio frequency and magneto-inductive) available today for communicating underwater. Then, after analyzing the communication requirements of a typical ROV control system and defining different working modes, they proceed in executing an accurate simulation and evaluation of the performance with the DESERT underwater simulation framework in a scenario involving an underwater hybrid vehicle (HROV) and a control station using a multi-modal communication network.

A conspicuous contribution to the Special Issue was given using Artificial Intelligence (AI) techniques based on neural networks. For example, Gao and Shi [3] propose to solve the problem of collision avoidance for an Unmanned Surface Vehicle (USV) by means of encoder-decoder neural networks using the Seq2Seq model. Their neural networks were trained based on Automatic Identification System (AIS) real data obtained from the Zhousan port.

Always regarding the issue of USV obstacle avoidance by using AIS, Shi and Liu [4] in their work suggest using a Deep Learning technique based on a double-gated recurrent unit neural network (GRU-RNN) for making appropriate automatic collision-avoidance decisions. Also, in this case the neural networks were trained on the basis of real data, related to successful collision-avoidance events, obtained from the Thianjin port.

On the other hand, Wang et al. [5] describe the use of an Improved Genetic Algorithm (IGA) optimized Radial Basis Function (RBF) neural network for an effective application to the tracking control of an USV. For evaluating the performance of the proposed algorithm it is compared to two other ones based on a Fuzzy neural network and a simple RBF network respectively.

Finally, Sun et al. [6] show as an Improved Hierarchical Deep Q Network (HDQN) can be used to perform the 3D path planning of an AUV. The results obtained by simulations and at-field experiments demonstrate the effectiveness of the methodology.

The problem of the path-following for USVs is investigated by Wang et al. [7] which propose a robust output feedback methodology based on a hierarchical control structure using a finite-time Line Of Sight (LOS) guidance algorithm and an (Extended State Observer) ESO-based output feedback backstepping controller. A global stability analysis is carried out based on Lyapunov theory and numerical simulations show the fast convergence of the proposed guidance law.

Singh et al. [8] in their paper describe the use of a Double Layered Hybrid Multi-Robot framework for guidance and navigation of USVs. After a discussion of the different approaches previously proposed in the literature for solving the problem of multi-agent USV path guidance they suggest the use of a constrained A^* path planner with a Virtual Target (VT) combined with the use of a potential field-based swarm aggregation technique for the cooperative navigation of multi-USVs.

Some of the results obtained in the framework of the EU FP7 "Caddy—Cognitive Autonomous Diving Buddy" project, where a set of control algorithms were developed to be used by an AUV diving together with a diver and cooperating, are presented by Nađ et al. [9]. The benefit of the presented algorithms is the joining of diver following and guiding into a single seamless controller without leader/follower role exchange. The authors evaluated the performance of the proposed algorithms carrying out experiments in a pool.

Min et al. [10] developed a model identification method for AUVs with multi-propellers based on Computational Fluid Dynamics (CFD) calculation and maximum likelihood algorithm. The model obtained by this method has got a high accuracy as far as the resistance coefficient and turning-related parameters are concerned while the accuracy related to other parameters, e.g., lateral motion, is lower. The work was evaluated by means of experimental tests.

Mou et al. [11] in their article describe the complete modeling and control design for maneuvering a twin water-jetted USV along a desired path. First, the authors developed a 3-DOF mathematical model of the USV together with an integrated control system for verifying the maneuverability of the proposed vehicle. Secondly, they designed and implemented a Human Simulated Intelligent Control (HSIC) controller and a LOS (Line Of Sight) algorithm. Both the HSIC and the LOS systems were verified with at-field tests.

Hong et al. [12] face the problem of the dynamic modeling and the motion simulation of an unmanned ocean platform composed of a USV and a UUV connected by means of an underwater cable. The developed motion equations, derived from Newton second law and on the lumped-mass method, take in account also wind and currents disturbances. From the analysis of these equations some useful suggestions for the design of a real platform can be derived.

Finally, the work presented by Guardeño et al. [13] focuses on Static Obstacle Avoidance (SOA) methods for USVs and describes a new Auto Tuning Environment for Static Obstacle Avoidance (ATESOA) where different SOA methods can be applied to diverse types of USV and so tested, tuned and evaluated. Also, a simplified model of a LIDAR sensor is proposed that makes it easier the implementation of evolutionary algorithms for autotuning.

In conclusion, the papers contained in this Special Issue cover a broad spectrum of topics and cope with a wide range of open problems in the field of Unmanned marine Vehicles. The Guest Editors believe they can be a solid basis and source of inspiration for achieving further developments in this important research field.

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