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Editorial

Maritime Autonomous Vessels

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Recent years have seen the rapid development of autonomous ships. The maritime industry is currently experiencing a disruptive change in technology through the increased development of advanced autonomy technologies leading to Maritime Autonomous Surface Ships (MASS), Unmanned Surface Vessels (USVs), Autonomous Underwater Vehicles (AUVs), and underwater gliders, to name a few. Automated vessel technology is rapidly transitioning from theoretical to practical applications as the number and scope of unmanned vessels or autonomous ships projects increase around the globe. They have been widely used both in navy applications and even some commercial applications such as marine surveillance, coast patrol, inspection, and the operation of underwater production systems. The most important reasons for the rapid development of autonomous vessels are safety concerns and economic benefits. Maritime accidents cause the loss of human lives, damage to the environment, and economic losses. The development of autonomous marine ships may improve the situation and is expected to become a cost-efficient alternative to conventional ships, improving safety and environmental impact at sea.

The main goal of this book is to address key challenges, thereby promoting research on marine autonomous ships. There are many topics on autonomous vessels involved in this book, for instance, automatic control [1–4], manoeuvrability [5–8], collision avoidance [9–11], ship target identification [12–15], motion planning [16], and buckling analysis [17].

Trajectory tracking or path-following control is the basic requirement for maritime autonomous vessels since it guarantees that a vessel can follow a predefined path. Xu et al. [1] proposed a nonlinear vector field guidance law for path-following and collision avoidance for an underactuated autonomous surface ship model. With the proposed system, the autonomous ship is capable of following the predefined path while avoiding obstacles automatically. Simulations and ship model tests were performed to validate the integrated system of autonomous ships. Jin et al. [2] proposed a twin-PID controller for the trajectory tracking of a twin-hull unmanned surface vehicle (USV), and an adaptive line-of-sight guidance law was designed by regulating the speed and course to track a curved line considering the sideslip angle. The proposed control system was validated in sea experiments by a USV called 'Jiuhang 490'. In [3], the underwater automatic homing and docking control for an autonomous underwater vehicle (AUV) was investigated. A unified approach involving task planning, guidance and control design, and thrust allocation was proposed, and the simulations were undertaken to verify the proposed approach. The underwater glider is one of the important ocean equipment, and it was for the long-duration, wide-range marine environmental monitoring tasks. In [4], a fuzzy adaptive linear active disturbance rejection control was designed for trajectory control. The simulation results show that the proposed method can improve performance with a smaller overshoot.

Manoeuvrability is one of the important topics for autonomous vessels. The prediction of ship dynamics at sea is complicated, considering the various environmental factors. Costa et al. [5] proposed a robust parameter estimation method for nonlinear manoeuvring modelling based on free-running ship model tests. The parameter uncertainties due to noise were reduced by diminishing the multicollinearity using truncated singular value decomposition technology. The validation was carried out by comparing the result of the

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measured values with the predictions obtained using the manoeuvring models. Moreira and Guedes Soares [6] implemented ANNs to predict the heading angle and trajectories of a model ship from the output rudder angle command. The main feature of this study is that it demonstrates that the ANN can learn even from a short and noisy data set. In [7], the manoeuvrability of a fishing vessel in shallow water was predicted using an empirical formula. The results of this study can help in conducting simulations and also provide unique parameters of fishing vessels that lead to the development of autonomous vessels. Nonparametric modelling techniques to predict ship manoeuvrability using Gaussian processes were proposed in [8], the Ship Maneuvering Simulation Methods database was used for the validation, and the results indicate that the identified model is accurate and shows good generalization performance.

Another important topic for the autonomous vessel is collision avoidance since the ship must have the ability to avoid unexpected obstacles. Zhu et al. [9] proposed a novel collision avoidance algorithm based on the modified artificial potential field method. The International Regulations for Preventing Collisions at Sea (COLREGS) and the motion characteristics of the ship were considered in this paper. In [10], a data-driven approach was applied to collect 12-month Automatic Identification System data in the west sea of Korea, and the data were used to identify and systematize objective navigation situation scenarios for the validation of autonomous ship collision avoidance algorithms. The results are expected to be applied to develop a collision avoidance test environment for MASS. In [11], the author proposed a dynamic navigation ship domain (DNSD)-based dynamic obstacle avoidance approach for USVs in compliance with COLREGs. Simulations were carried out, and the results demonstrated the effectiveness and superiority of the proposed DNSD-based obstacle avoidance algorithm.

Ship target identification is of great significance in both military and civilian fields. In [12], a Bayesian-Transformer Neural Network was proposed to complete the ship target identification task using tracking information. The experiments show that the proposed method can improve the identification accuracy by 3.8% compared with traditional methods. To solve the problem of missing ship-type information in AIS, Yang et al. [13] proposed a novel ship-type recognition scheme based on a ship navigating trajectory and convolutional neural network. In [14], a target visual detection system was established for the real-time detection of an unmanned fishing speedboat near a ship ahead using the YOLOv5s algorithm. The results show that the proposed method can realize the detection and identification of multiple types of ships. Object recognition can also be used for the accurate navigation of AUVs [15], where stable high accuracy during the continuous movement of the AUV in SPS space was realized through the regular updating of the coordinate references to SPS objects. The proposed method was validated using the Karmin2 stereo camera under laboratory conditions.

Ship motion planning is one of the most critical parts of the autonomous navigation systems of marine autonomous surface ships (MASS). Wu et al. [16] investigated motion planning for USVs, and the purpose was to obtain the optimal path under the interference of the navigation environment (wind and current). A multi-objective optimization algorithm based on HA* was proposed in this paper, and the simulation was used for validation. The structural design aspects of AUVs were addressed in [17]. To analyze the critical buckling problem of variable stiffness (VS) composite pressure structure of AUV, a discrete finite element method based on the curve fibre path function was proposed in [17].

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