Editorial

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Introduction

Unmanned marine vehicles (UMVs) have found applications in broad areas including transportation, hydrographic, fishing, oil and gas exploration and construction, oceanographic data collection, and scientific characterisation, for instance. Since UMVs work in a complex marine environment, and are subject to disturbances induced by waves, winds, and current loads, it is of paramount importance to study the motion control of UMVs. The motion control for UMVs include, but not limited to, heading control, path-following control, formation control, target following control, and dynamic positioning control. As the advanced control methods will provide a basis for the design and operation of UMVs, these advanced techniques would result in substantial and sustainable benefits.

The main focus of this special issue is on the new developments in theoretical and technological achievements for the motion control techniques for UMVs under complex marine environments.

Highlights of the special issue

With a stringent peer review process, there are twelve papers finally included in this Special Issue, which are covering the following aspects: stability analysis and control design as well as observer design for marine vehicles. A brief summary of the selected accepted papers is discussed in the following.

1 Stability analysis and control designs

Li et al. developed a floating bracket device with visual inspection technology for the autonomous launch and recovery of unmanned surface vehicles (USVs). Specifically, a sectional-type control framework is designed by model predictive control (MPC), which can satisfy the control requirements in different motion stages. The docking experiments demonstrated that the floating bracket with the proposed control system can be applied to launch and recovery missions of USVs. Chu et al. proposed a three-dimensional (3-D) trajectory-tracking control scheme for an underactuated autonomous underwater vehicle (AUV). The backstepping technique was used to design the trajectory-tracking controller for tracking the AUVs reference trajectory. The effectiveness of the developed control method was demonstrated using simulations. Jiang et al. proposed the formation control of multiple unmanned surface vehicles (USVs). Specifically, a distributed formation control algorithm is proposed based on consistency theory and leader-follower mode. Chen et al. developed the finite-time tracking control for an underactuated surface vehicle subject to lumped uncertainties, including actuator faults, external disturbances, and plant uncertainties. Then, an adaptive switching mechanism is devised to avoid chattering of state output and improve adaptation rate to compensate approximation error. Some simulations are presented to prove the excellent tracking performance of the developed method. Li et al. proposed a network-based global pinning synchronisation for unmanned marine vehicles (UMVs) via sampled-data communications. By using Lyapunov stability theory, linear matrix inequality (LMI) technique and free-weighting matrix approach, some sufficient conditions are derived to ensure the global pinning synchronisation of UMVs. Wu et al. investigated capacity degradation of $LiFePO_4$ battery for electric vehicles under different overcharge conditions. The last but not least, Wu et al. proposed motion reliability evaluation of six-axes robot based on non-probability interval theory.

2 Observer-based control designs

Zheng et al. developed a network-based control for an unmanned marine vehicle (UMV) based on sampled data. And the sampled-data controller is designed by analysing the stability conditions. Simulation results show that the sampled-data controller is effective to guarantee that the states of the UMV are stable under the external disturbance. Liu et al. proposed trajectory tracking control problem for an underactuated unmanned surface vehicle under external disturbance and model parameters uncertainty. Within the framework of backstepping control, a trajectory tracking control method based on constant bearing guidance is proposed, which can avoid the singularity that often appears in circular motion of the vehicles by redefining the differential of virtual heading angle. Moreover, disturbance observers are designed to estimate the equivalent disturbance, so that the vehicle can track the desired trajectory stably in the unknown ocean environment. Zhou et al. addressed the point stabilisation control of an underactuated unmanned surface vehicle (USV) by considering input constraints, missing velocity measurement and external disturbance. Then a state observer-based adaptive fuzzy backstepping controller is designed. The missing velocity variables are estimated by an extended state observer (ESO). An adaptive fuzzy algorithm is used to approximate the unknown nonlinear items in the dynamic model of the vehicle, and auxiliary items are introduced to deal with the actuator saturation. Zhao et al. developed an adaptive output feedback formation control strategy based on a high gain observer for the problem of the

formation control of underactuated surface vessels with uncertain dynamics, ocean environment disturbance and input saturation. In this strategy, a high gain observer that only depends on position information is used to estimate the unmeasurable velocity, and in order to solve the 'complex explosion' problem in the conventional backstepping control algorithm, a first-order low-pass filter is adopted to obtain the derivative of the virtual control signal. Liang et al. developed the 3D trajectory tracking control of an underactuated autonomous underwater vehicle under uncertain model parameters and unknown external disturbances. An adaptive dynamic surface control scheme based on a neural network and filters is proposed. In the controller design, the first-order integral filters are employed to estimate the derivative of virtual control. Simulation studies and comparisons with dynamic surface control scheme are used to illustrate the effectiveness and superiority of the proposed control scheme.

Acknowledgement

We really appreciate all the authors and anonymous reviewers who contributed to this Special Issue. Meanwhile, we would like to thank the support from the Editor-in-Chief and Editorial Staff to our Special Issue.