Journal of *Marine Science and Engineering*

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Editorial

Computational Fluid Mechanics Methods and Applications in Marine Engineering

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Citation: Du, P.; Ouahsine, A.; Hu, H.; Chen, X. Computational Fluid Mechanics Methods and Applications in Marine Engineering. *J. Mar. Sci. Eng.* **2023**, *11*, 606. https://doi.org/10.3390/jmse11030606

Received: 28 February 2023
Accepted: 1 March 2023
Published: 13 March 2023

Ocean flows and their interactions with marine structures, vehicles, etc., are of great importance for the research of marine science and technology. The revealing of their mechanisms inevitably involves fluid mechanics. Computational fluid mechanics techniques are developing to a higher level nowadays, with the flourishing of computer science. It is possible to predict ocean flow details and hydrodynamic interactions with increasing accuracy.

This book has collected cutting-edge developments in computational fluid mechanics in the area of marine science and technology. Certain numerical methods and their engineering applications have been covered by the 14 collected works. They can be divided into five groups according to the following subjects:

(1) Hydrodynamics of surface vehicles

The dynamic interactions of a cable-laying vessel with a submarine cable during its landing process were investigated in [1]. The effects of the cable length, the current velocity, the incident wave, and the wind direction on vessel stability and the tensions in the mooring lines and cable were investigated. The most unfavorable environmental conditions for submarine cable laying were determined under different environmental conditions. The results are critical to the safety of the cable. The resistance, squat, and ship-generated waves of inland convoy passing bridge piers in a confined waterway were studied in [2]. The existence of piers was found to only influence the transient hydrodynamics of the convoy, but not the averaged properties. Ship-generated waves, especially wave profiles at a specific lateral position, were characterized. The motion of a large-scale unmanned surface vessel in high sea-state waves was studied in [3]. The effects of different sea states, as well as different wave directions, on the motion of a USV (unmanned surface vessel) were compared. Sloshing characteristics in a liquid cargo tank under combination excitation were investigated in [4]. The pressure distribution characteristics at different positions of the cargo tank were discussed, along with the influence of different excitation conditions on the pressure of the cargo tank. This is very significant for the stability and safety of ship navigation.

(2) Hydrodynamics of underwater vehicles

The hydrodynamic characteristics of the tandem gliding of two manta rays were investigated in [5]. A numerical method was used to explore the influence of the front-to-back distance and the angle of attack on the overall and individual hydrodynamic performance of a pair of manta rays gliding. This provides a theoretical basis for understanding the biological habits of manta rays and for the design of an underwater bionic robot group system. Pressure fluctuations in the bow of a submarine at different velocities were studied in [6], and this can provide important clues for the hydrodynamic noise source of underwater vehicles.

(3) Hydrodynamics of trans-media vehicles

The air film fusion of a pressure-equalizing exhaust around the shoulder ventilation of submarine-launched vehicles was investigated in [7]. A numerical calculation method based on the VOF (volume of fluid) multiphase flow model was established to study the fusion characteristics of the air film at the shoulder of the underwater vehicle, as well as the distribution of surface pressure along the vehicle's axial direction. The cavitation and damping force characteristics for a high-speed supercavitation vehicle were studied in [8]. A homogeneous equilibrium flow model and a Schnerr–Sauer model based on the Reynolds-averaged Navier–Stokes method were used. The effect of the navigation speed and angle of attack on the cavitation morphology and dynamic characteristics was investigated. The propulsion performance and wake dynamics of heaving foils under different waveform input perturbations were studied in [9]. This work further explains the effect of different waveform perturbation signals on the base sinusoidal signal and provides a new control idea for underwater vehicles.

(4) Hydrodynamics of propellers

The effects of blade number on the propulsion and vortical structures of pre-swirl stator pump-jet propulsors (PJP) were investigated in [10]. It was found that the blade number was also vital for further PJP design, particularly when the main concerns were exciting force and noise performance. The influence of various stator parameters on the open-water performance of pump-jet propulsion was studied in [11], in order to improve the hydrodynamic performance of pump-jet propulsion. The torque balance locations under various parameters were compared, and each component force was analyzed in detail to explain the reason for performance variation.

(5) Heat and flow characteristics of jets

Convective heat flux on the flight deck of a naval vessel subjected to a high-speed jet flame from VTOL (vertical take-off and landing) aircraft was numerically predicted in [12]. A procedure for analyzing the convective heat transfer imposed on the deck by the high-temperature and high-velocity impact of a VTOL jet was described. A horizontal submerged jet (HSJ) based on the Wray–Agarwal turbulence model was studied in [13], in order to further understand the mechanism of a HSJ. The results have a guiding significance for engineering practice and academic research. The effect of port orientation on multiple inclined dense jets was investigated in [14]. The outcomes may be favorable for outfall system applications involving dilution.

In conclusion, this book presents 14 works regarding numerical methods and their application to five different areas of marine science and technology, including the hydrodynamics of surface vehicles, underwater vehicles, trans-media vehicles, propellers, and the physics of jets. We hope these works provide some clues for related fundamental research and engineering applications.

Author Contributions: Conceptualization, P.D. and A.O.; resources, P.D., A.O., H.H. and X.C.; writing—original draft preparation, P.D.; writing—review and editing, A.O., H.H. and X.C.; supervision, P.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the National Natural Science Foundation of China (Grant Nos. 52201380).

Acknowledgments: The authors wish to thank all contributors to this Special Issue.

Conflicts of Interest: The authors declare no conflict of interest.

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