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Free Surface Hydrodynamics of Submarine Masts Configurations

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Sailing at snorkel depth is a necessary but dangerous operating scenario for submarines. The main and straightforward reason is that such an operating condition represents a time of possible vulnerability of the vessel. From a design perspective this condition affects the so-called indiscretion rate, that is exactly the ratio between this time of greater vulnerability and the total operating time. Moreover, when the vessel operates at snorkel depths there are some relevant operations that might be accomplished related to both snorkeling, communications and threats detection. These operations are typically carried out by using a certain number of masts, of slightly different shapes and sizes, that might be used in various configurations.
The proposed study aims at providing some insights into the unsteady hydrodynamics of several submarine masts configurations. The analysis is carried out in terms of behaviors of the developed free surface, considering the non-linear interactions rising among the masts considered. The maximum height and length of the breaking wave generated at the bow of each mast is analyzed in detail both using time instant and phase averaged approaches. Both the near field and the far field unsteady wave patterns are discussed comparing several configurations and focusing on the interaction effects. An analysis of the effect of the size and shape of the masts is also carried out. The computational study is carried out by using an open-source Smoothed Particle Hydrodynamic solver called DualSPHysics, able to exploit the computational acceleration provided by GP-GPU cards. Convergence study and computational effort are discussed too.

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