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Development of Hydrodynamic Drag Calculation and Cavity Shape Generation for Supercavitating Torpedoes

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Abstract : In this paper, firstly supercavitating phenomenon and supercavity shape design parameters are explained and then drag force calculation methods of high speed supercavitating torpedoes are investigated with numerical techniques and verified with empirical studies. In order to reach huge speeds such as 200, 300 knots for underwater vehicles, hydrodynamic hull drag force which is proportional to density of water (ρ) and square of speed should be reduced. Conventional heavy weight torpedoes could reach up to ~50 knots by classic underwater hydrodynamic techniques. However, to exceed 50 knots and reach about 200 knots speeds, hydrodynamic viscous forces must be reduced or eliminated completely. This requirement revives supercavitation phenomena that could be implemented to conventional torpedoes. Supercavitation is the use of cavitation effects to create a gas bubble, allowing the torpedo to move at huge speed through the water by being fully developed cavitation bubble. When the torpedo moves in a cavitation envelope due to cavitator in nose section and solid fuel rocket engine in rear section, this kind of torpedoes could be entitled as Supercavitating Torpedoes. There are two types of cavitation; first one is natural cavitation, and second one is ventilated cavitation. In this study, disk cavitator is modeled with natural cavitation and supercavitation phenomenon parameters are studied. Moreover, drag force calculation is performed for disk shape cavitator with numerical techniques and compared via empirical studies. Drag forces are calculated with computational fluid dynamics methods and different empirical methods. Numerical calculation method is developed by comparing with empirical results. In verification study cavitation number (σ), drag coefficient (CD) and drag force (D), cavity wall velocity (U

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