Numerical Analysis of DARPA SUBOFF Submarine for Self-Propulsion using ANSYS Fluent GPU Solver

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Abstract

This paper presents a comprehensive numerical analysis focused on key design parameters for submarine performance, including resistance, propeller efficiency, and self-propulsion point. The study explicitly examines the DARPA (Defense Advanced Research Projects Agency) Suboff submarine model, which is propelled by the INSEAN E1619 propeller from the Italian Ship Model Basin.

Initially, steady-state RANS simulations were conducted to evaluate the underwater resistance of the bare hull DARPA submarine. Results were validated against experimental data at various speeds. Following this, the open-water performance of the INSEAN E1619 propeller was analyzed under non-cavitating conditions. Validation over a broad range of advanced ratios was achieved through steady-state RANS simulations and a moving reference frame. Subsequently, the self-propulsion point was determined by attaching the E1619 propeller to the DARPA submarine. ITTC (International Towing Tank Conference) standards were followed to align propeller thrust with hull resistance. These steady-state solutions employ the coupled solver along with the SST k-ω turbulence model and a pseudo-transient approach.

All simulations leveraged the ANSYS Fluent GPU solver, yielding significant performance improvements when compared to CPU-based solutions.