Numerical Simulation of an Undulatory NACA0012 Hydrofoil using Overset Mesh

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Synopsis

This report presents a numerical study on the propulsive performance of an undulating NACA0012 hydrofoil using the Overset Mesh framework in OpenFOAM-v2412. The study employs a hybrid swimming kinematics model combining an anguilliform wavelength ($\lambda^* = 0.8$) with a carangiform quadratic amplitude envelope peaking at 0.10 m at the trailing edge. A parametric sweep was performed across Strouhal numbers from $St = 0.20$ to 0.70. The numerical model captures the drag-to-thrust transition near $St \approx 0.30$, and the mean thrust coefficient (C_{Tm}) trends show a close match against the reference data. The propulsive efficiency peaks at $\eta_p = 49.18\%$ for $St = 0.60$ and decreases to 47.74% at $St = 0.70$, exhibiting the characteristic efficiency hump curve.

Keywords: Undulatory Propulsion, Overset Mesh, OpenFOAM, NACA0012, Strouhal Number, Reverse von Kármán Street.