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Optimal Hydrofoil Kinematics for Tidal Energy Extraction
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— The pitch and heave kinematics of an oscillating hydrofoil are explored for tidal energy extraction using 2D Direct Numerical Simulation in a non-inertial reference frame. The hydrofoil is modeled by an ellipse of aspect ratio 10 at a Reynolds number of 1000 in uniform freestream. Starting with sinusoidal motion in pitch and heave, the heaving magnitude, pitch angle, frequency, and phase angle between pitch and heave were varied. The optimal case had a maximum heave of .5 chord lengths, a maximum pitch angle of 75 degrees, a non-dimensional frequency of 0.15, and a phase of 90 degrees, which are consistent with similar computational studies, and parallel theory and experimentation. In order to further optimize the hydrofoil's stroke for fluid energy extraction, higher harmonics are systemically added to the kinematics, finding that small perturbations to the heave signal can increase the efficiency by up to 6.0%.

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