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Performance of active and passive control of an airfoil using CPFD[1] DANIEL ASSELIN, JAY YOUNG, C.H.K. WILLIAMSON, Cornell University — Birds and fish employ flapping motions of their wings and fins in order to produce thrust and maneuver in flight and underwater. There is considerable interest in designing aerial and submersible systems that mimic these motions for the purposes of surveillance, environmental monitoring, and search and rescue, among other applications. Flapping motions are typically composed of combined pitch and heave and can provide good thrust and efficiency (Read, et al. 2003). In this study, we examine the performance of an airfoil actuated only in the heave direction. Using a cyber-physical fluid dynamics system (Mackowski & Williamson 2011, 2015, 2016), we simulate the presence of a torsion spring to enable the airfoil to undergo a passively controlled pitching motion. The addition of passive pitching combined with active heaving ("Active-Passive" or AP) provides significantly improved thrust and efficiency compared with heaving alone. In many cases, values of thrust and efficiency are comparable to or better than those obtained with two actively controlled degrees of freedom ("Active-Active" or AA). By using carefully-designed passive dynamics in the pitch direction, we can eliminate one of the two actuators, saving cost, complexity, and weight, while maintaining or improving performance.

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Daniel Asselin
Cornell University

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