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Implementation of CPFD to Control Active and Passive Airfoil Propulsion[1] JAY YOUNG, DANIEL ASSELIN, CHARLES WILLIAMSON, Cornell University — The fluid dynamics of biologically-inspired flapping propulsion provides a fertile testing ground for the field of unsteady aerodynamics, serving as important groundwork for the design and development of fast, mobile underwater vehicles and flapping-wing micro air vehicles (MAVs). There has been a recent surge of interest in these technologies as they provide low cost, compact, and maneuverable means for terrain mapping, search and rescue operations, and reconnaissance. Propulsion by unsteady motions has been fundamentally modeled with an airfoil that heaves and pitches, and previous work has been done to show that actively controlling these motions can generate high thrust and efficiency (Read, Hover & Triantafyllou 2003). In this study, we examine the performance of an airfoil with an actuated heave motion coupled with a passively controlled pitch motion created by simulating the presence of a torsional spring using our cyber-physical fluid dynamics (CPFD) approach (Mackowski & Williamson 2011, 2015, 2016). By using passively controlled pitch, we have effectively eliminated an actuator, decreasing cost and mass, an important step for developing efficient vehicles. In many cases, we have achieved comparable or superior thrust and efficiency values to those obtained using two actively controlled degrees of freedom.

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