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Propulsion by active and passive airfoil oscillation A.W. MACKOWSKI, C.H.K. WILLIAMSON, Cornell University — Oscillating airfoils have been the subject of much research both as a mechanism of propulsion in engineering devices as well as a model of understanding how fish, birds, and insects produce thrust and maneuvering forces. Additionally, the jet or wake generated by an oscillating airfoil exhibits a multitude of vortex patterns, which are an interesting study in their own right. We present PIV measurements of the vortex flow behind an airfoil undergoing controlled pitching oscillations at moderate Reynolds number. As a method of propulsion, oscillating foils have been found to be capable performers when undergoing both pitching and heaving motions [Anderson et al. 1998]. While an airfoil undergoing only pitching motion is a relatively inefficient propulsor, we examine the effect of adding passive dynamics to the system: for example, actuated pitching with a passive spring in the heave direction. Practically speaking, a mechanical system with such an arrangement has the potential to reduce the cost and complexity of an oscillating airfoil propulsor. To study an airfoil undergoing both active and passive motion, we employ our "cyber-physical fluid dynamics" technique [Mackowski & Williamson, 2011] to simulate the effects of passive dynamics in a physical experiment.

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