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Low Reynolds Number Flow Dynamics of a Thin Airfoil with an Actuated Leading Edge using Direct Numerical Simulation[1] KEVIN DROST, SOURABH APTE, Oregon State University — Direct numerical simulations are performed to investigate the effect of a movable leading edge on the unsteady flow at high angles of attack over a flat, thin airfoil at Reynolds number of 14700 based on the chord length. The leading edge of the airfoil is hinged at one-third chord length allowing dynamic variations in the effective angle of attack through specified oscillations (or flapping). A fictitious-domain based finite volume approach [(Apte et al. (JCP 2009)] is used to compute the flow over an airfoil with a flapping leading edge on a fixed background mesh. Cases were run at 20 degrees angle of attack to study the drag and lift characteristics with sinusoidal flapping of the leading edge about the hinge over a range of reduced frequencies ($k = \pi fc/U_\infty$ = 0.57- 5.7). It is shown that high-frequency low amplitude actuation of the leading edge significantly alters the leading edge boundary-layer and vortex shedding and increases the mean lift- to-drag ratio. The concept of an actuated leading-edge flap has potential for development of control techniques to stabilize and maneuver low-Reynolds number micro-air vehicles in response to unsteady perturbations.

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