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Closed-loop control of vortex shedding on two-dimensional flat-plate airfoil at low Re.[1] WON TAE JOE, TIM COLONIUS, DOUG MACMYNOWSKI, KUNIHIKO TAIRA, California Institute of Technology — We investigate a two-dimensional model problem related to using closed-loop control to enhance lift on a separated flat-plate airfoil at low Reynolds number. Navier-Stokes simulations are performed using an immersed boundary method. Pulsed mass injection is modeled by treating the actuation slot as a boundary with a pre-defined velocity. Open-loop actuation is examined for different frequencies, angles of attack (AOA), actuator locations (leading or trailing edge), and injection angles. The natural flow undergoes a Hopf bifurcation around 15 degrees after which vortex shedding occurs. When forced, the flow becomes phase-locked up to a certain AOA, but displays a pulling-out phenomena, in which subharmonic resonance is excited, at higher AOA. In this region, the highest maximum lift occurs when actuation is in phase with the lift, and the highest average lift (over the forcing period) occurs with an associated optimal phase shift between lift and actuation. We design a simple controller that feeds back the lift to the actuator in order to phase-lock the flow with either the highest average or maximum lift.

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