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Optimized Control of Vortex Shedding from an Inclined Flat Plate[1] WON TAE JOE, TIM COLONIUS, DOUG MACMYNOWSKI, Caltech — Optimal control theory is combined with the numerical simulation of an incompressible viscous flow to control vortex shedding in order to maximize lift. A two-dimensional flat plate model is considered at a high angle of attack and a Reynolds number of 300. Actuation is provided by unsteady mass injection near the trailing edge and is modeled by a compact body force. The adjoint of the linearized perturbed equations is solved backwards in time to obtain the gradient of the lift to changes in actuation (the jet velocity), and this information is used to iteratively improve the controls. We investigate how features of the optimized waveform modify the vortex shedding and lead to higher lift, and compare the results with sinusoidal control. In order to obtain a practically implementable control scheme, the optimized waveform is also implemented in a simple closed-loop controller where the control signal is shifted or deformed periodically to adjust to the (instantaneous) frequency of the lift fluctuations. The feedback utilizes a narrowband filter and an Extended Kalman Filter to robustly estimate the phase of vortex shedding and achieve phase-locked, high lift flow states. Finally, the sensitivity of the flow to the phase shift and other features of the optimized waveform are presented.

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Won Tae Joe
Caltech

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