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Feedback control of a pitching and plunging airfoil via direct numerical simulation[1] SCOTT DAWSON, STEVEN BRUNTON, CLARENCE ROWLEY, Princeton University — Feedback control is implemented in direct numerical simulations at a Reynolds number of 100 to allow a two-dimensional flat plate airfoil to track desired lift profiles using pitching and plunging motions. Robust controllers are designed using both classical models (Theodorsen) and empirical reduced-order models identified from direct numerical simulations. We investigate the capabilities of a variety of controllers for plunging motion and for pitching about different pitch axis locations. Effective control is achieved across a wide range of angles of attack, despite strongly nonlinear flow physics. The forces caused by rapid airfoil motion may be utilized to achieve high lift coefficients for short periods of time. It is also possible to track periodic lift profiles with average lift coefficients that are significantly greater than those achieved by a steady airfoil. The enhanced lift that arises at certain frequencies appears to be caused by favorable interaction of wake vortices. The ability of the controllers to reject gust disturbances and attenuate sensor noise is also investigated, which is relevant for the implementation of such controllers in an experimental setting.

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Scott Dawson
Princeton University

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