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Reduced-order model-based control of unstable steady states in 2D incompressible flow past airfoils at low Reynolds numbers[1] SUNIL AHUJA, CLARENCE W. ROWLEY, Princeton University — The stable flow past 2-D airfoils at high angles of attack and low Reynolds number is periodic vortex shedding. There also exists an unstable steady state, and here we present controllers that stabilize this. Our control design is based on reduced order models of the equations linearized about this steady state. These models are obtained using an extension of an approximate balanced truncation method, valid for unstable systems. The stable and unstable subspaces are first decoupled, and reduced order models are obtained for the dynamics on the stable subspace. Since the dimension of the unstable subspace is small, they are treated exactly, with the corresponding states being the unstable eigenmodes. We derive stablilizing control laws, first assuming full state feedback, and then using reduced order observers using a few surface pressure measurements. The closed-loop models compare well with the nonlinear DNS simulations for small perturbations to the steady state. The control laws have a large domain of stabilization; they suppress the vortex shedding, but the agreement with the model deteriorates for large perturbations.

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