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Unsteady Nonlinear Aerodynamic Response Modeling: A Data-Driven Perspective MAZIAR HEMATI, SCOTT DAWSON, CLARENCE ROWLEY, Princeton University — Current real-time-capable aerodynamic modeling strategies are greatly challenged in the face of aggressive flight maneuvers, such as rapid pitching motions that lead to pronounced leading-edge vortex shedding and aerodynamic stall. The inability to accurately and robustly predict, in a low-dimensional manner, the nonlinear aerodynamic force/moment response of an aircraft to sharp maneuvers puts practical approaches for aerodynamic optimization and control out of reach. Here, we propose a parameter-varying model to approximate the response of an airfoil to arbitrarily prescribed rapid pitching kinematics. An output-minimization procedure is invoked to identify the nonlinear model from input-output data gathered from direct numerical fluid dynamics simulations. The resulting nonlinear models have noteworthy predictive capabilities for arbitrary pitching maneuvers that span a broad range of operating regimes, thus making the models especially useful for aerodynamic optimization and real-time control and simulation.

Maziar Hemati
Princeton University

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