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Control of Pitching Airfoil Aerodynamics by Vorticity Flux Modification using Active Bleed[1] JOHN KEARNEY, ARI GLEZER, Georgia Institute of Technology — Distributed active bleed driven by pressure differences across a pitching airfoil is used to regulate the vorticity flux over the airfoil's surface and thereby to control aerodynamic loads in wind tunnel experiments. The range of pitch angles is varied beyond the static stall margin of the 2-D VR-7 airfoil at reduced pitching rates up to $k = 0.42$. Bleed is regulated dynamically using piezoelectric louvers between the model's pressure side near the trailing edge and the suction surface near the leading edge. The time-dependent evolution of vorticity concentrations over the airfoil and in the wake during the pitch cycle is investigated using high-speed PIV and the aerodynamic forces and moments are measured using integrated load cells. The timing of the dynamic stall vorticity flux into the near wake and its effect on the flow field are analyzed in the presence and absence of bleed using proper orthogonal decomposition (POD). It is shown that bleed actuation alters the production, accumulation, and advection of vorticity concentrations near the surface with significant effects on the evolution, and, in particular, the timing of dynamic stall vortices. These changes are manifested by alteration of the lift hysteresis and improvement of pitch stability during the cycle, while maintaining cycle-averaged lift to within 5% of the base flow level with significant implications for improvement of the stability of flexible wings and rotor blades.

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