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Controlled Aerodynamic Loads on an Airfoil in Coupled Pitch/Plunge by Transitory Regulation of Trapped Vorticity YUEHAN TAN, THOMAS CRITTENDEN, ARI GLEZER, Georgia Institute of Technology — The aerodynamic loads on an airfoil moving in coupled, time-periodic pitch-plunge beyond the static stall margin are controlled using transitory regulation of trapped vorticity concentrations. Actuation is effected by a spanwise array of integrated miniature chemical (combustion based) impulse actuators that are triggered intermittently during the airfoil's motion and have a characteristic time scale that is an order of magnitude shorter than the airfoil's convective time scale. Each actuation pulse effects momentary interruption and suspension of the vorticity flux with sufficient control authority to alter the airfoil's global aerodynamic characteristics throughout its motion cycle. The effects of the actuation are assessed using time-dependent measurements of the lift and pitching moment coupled with time-resolved particle image velocimetry over the airfoil and in its near wake that is acquired phased-locked to its motion. It is shown that while the presence of the pitch-coupled plunge delays lift and moment stall during upstroke, it also delays flow reattachment during the downstroke and results in significant degradation of the pitch stability. These aerodynamic shortcomings are mitigated using superposition of a limited number of pulses that are staged during the pitch/plunge cycle and lead to enhancement of cycle lift and pitch stability, and reduces the cycle hysteresis and peak pitching moment.

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