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Fast-flap Actuation for Attenuating Gust Response MICHAEL OL, US Air Force Research Lab, KENNETH GRANLUND‘, North Carolina State University, ALBERT MEDINA, US Air Force Research Lab — Airfoil flow control actuators can respond at perhaps O(10E-3) convective-times, but the flowfield response requires typically 2-4 convective times, and initial force-transients can be negative. A conventional trailing-edge mechanical flap is “slow” to deflect in flight applications, of questionable efficacy in separated flows, and is plagued by a response nonlinear with deflection angle. We consider a half-chord airfoil flap actuated O(10) times faster than one convective time, taking advantage of scaling-effects in a water tunnel. The motivation is recent work on accelerating flat plates at high incidence, where despite zero bound-circulation, the lift transient follows Wagner's solution. Force-measurements for high-rate large-incidence flap deflection show similar trends, and offer promise in cancelling lift-transients from gusts (modeled by plunging or surging the airfoil). Parameter-studies of rate, amplitude and initial incidence suggest first-order-system relaxation to steady-state, with a time constant commensurate with 1-3 convective times, no negative transients and no discernible lag. Rapid flap actuation induces entrainment that augments the flow's propensity to attach/reattach, perhaps paradoxically comporting with theory better, the faster the actuation.

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