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Numerical study of a passively deployable flap for aerodynamic flow control NIRMAL JAYAPRASAD NAIR, ANDRES GOZA, University of Illinois at Urbana-Champaign — Birds can perform low-speed maneuvers at post-stall angles of attack (AoAs), owing in part to covert feathers – a set of self-actuating feathers located on the suction surface of the wings. During unsteady flow separation at large AoAs, these feathers protrude into the flow and provide lift enhancements, for reasons that are still not understood. To facilitate the use of covert-feather-inspired designs in bio-inspired aerial vehicles, and to enable plausible hypotheses for the utility of these feathers in biological flight, we investigate a model system in which a passively deployable, torsionally hinged flap is mounted on the suction surface of a stationary airfoil. We perform high-fidelity nonlinear simulations to quantify the effect of flap moment of inertia, torsional stiffness, and chordwise location on aerodynamic performance. Lift improvements as high as 30% relative to the baseline flapless case are observed when the flap is located near the mid-chord. We relate lift benefits for the optimal flap parameters to their effect on formation, strength, and interaction of key vortical structures, and provide governing dimensionless parameters for the system.

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