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Using Adjoint-Based Approach to Understand Flapping-Wing Aerodynamics[1] MIN XU, MINGJUN WEI, New Mexico State University — The study of flapping-wing aerodynamics is a problem with very large control space. Adjoint-based approach, by solving an inverse problem, can be used here as an efficient tool for optimization and physical understanding. However, the adjoint equation is typically formulated in a fixed domain. The moving boundary or morphing domain brings in an inconsistency in the definition of arbitrary perturbation at the boundary, which then proposes a new challenge if the control parameters happen to be also at the boundary. An unsteady mapping function, as a usual remedy for such problems, would make the whole formulation too complex to be feasible. Instead, we use non-cylindrical calculus to re-define the perturbation and solve the inconsistency problem caused by moving/morphing solid boundaries. The approach is first validated for a simple case of a plate plunging in an incoming flow. Then we extend the approach to drag reduction and efficiency improvement of more complex cases. The optimized parameters provide a unique opportunity for physical understanding by comparison to the initial parameters.

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