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Improving Vortex Models via Optimal Control Theory MAZIAR HEMATI, JEFF ELDREDGE, JASON SPEYER, University of California, Los Angeles — Flapping wing kinematics, common in biological flight, can allow for agile flight maneuvers. On the other hand, we currently lack sufficiently accurate low-order models that enable such agility in man-made micro air vehicles. Low-order point vortex models have had reasonable success in predicting the qualitative behavior of the aerodynamic forces resulting from such maneuvers. However, these models tend to over-predict the force response when compared to experiments and high-fidelity simulations, in part because they neglect small excursions of separation from the wing's edges. In the present study, we formulate a constrained minimization problem which allows us to relax the usual edge regularity conditions in favor of empirical determination of vortex strengths. The optimal vortex strengths are determined by minimizing the error with respect to empirical force data, while the vortex positions are constrained to evolve according to the impulse matching model developed in previous work. We consider a flat plate undergoing various canonical maneuvers. The optimized model leads to force predictions remarkably close to the empirical data. Additionally, we compare the optimized and original models in an effort to distill appropriate edge conditions for unsteady maneuvers.

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