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Data-Driven Vortex Modeling
of Agile Flight

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ABSTRACT

The highly agile flight exhibited by many flying creatures has, for many years, been the promise for the next generation of flight vehicles. However, the reality still falls short, in part because such agility requires flight control strategies that can exploit separated flows rather than avoid them altogether. Recent control strategies based on flapping wings or managed separation over fixed wings have shown promise, but are limited to slow maneuvers because they rely on linearized and/or quasi-steady models of the aerodynamics, only effective at low frequencies or averaged over many flapping cycles. In this presentation, I will report on our recent progress in developing data-driven vortex-based models of separated flows. The premise is to construct a low-degree-of-freedom template model, with the simplest description of the flow that still contains the non-linear vortex-vortex and vortex-wing interactions. The model is then closed in some fashion with empirical data from sensors. In this presentation, I will describe our development of a taxonomy of vortex models that are computationally efficient but still span the range of physical phenomena. Then, I will present a few approaches for closing these models from measured data, using tools from data assimilation, machine learning and optimal control theory. I will demonstrate progress on several canonical problems in two dimensions.

SPEAKER BIO

Jeff Eldredge is a Professor of Mechanical & Aerospace Engineering at UCLA. His research interests are in computational and theoretical studies of problems in fluid dynamics, including those in unsteady aerodynamics, bio-inspired locomotion, micro-particle manipulation, and biomedical and physiological flows. He has received the NSF CAREER Award and is a Fellow of the American Physical Society and an Associate Fellow of AIAA. Prior to starting at UCLA, Prof. Eldredge was a research associate at the University of Cambridge. He received his M.S and Ph.D. at Caltech and his B.S. at Cornell, all in mechanical engineering.