COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
UNIVERSITY OF MICHIGAN

ME Department Seminar

Low-Order Modeling of Agile Flight

Jeff D. Eldredge

Professor, University of California

Mechanical and Aerospace Engineering Department

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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 work robustly in the regime of separated flows. This regime, generally avoided by human-engineered vehicles, is often exploited by airborne creatures in order to make rapid maneuvers or maintain tolerance to gusts. 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 unsteady non-linear (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 with empirical data from sensors. I will demonstrate progress on several canonical problems in two dimensions, and discuss our extensions to fully three-dimensional flows. I will also discuss the development of a numerical library for conducting high-fidelity simulations of flows with dynamical coupling with systems of rigid bodies.

Bio

Jeff Eldredge is a Professor in the Mechanical & Aerospace Engineering Department 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 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.