MAE Seminar SERIES

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MODELING, ESTIMATION, AND CONTROL FOR MANEUVERING AIRFOILS

ABSTRACT

Increasing efficiency and maneuverability for flight at low Reynolds numbers will enable the future success of autonomous micro-air vehicles. The flow physics in this operating regime often contain unsteady coherent flow structures that can greatly influence the aerodynamic forces. Further, large angle-of-attack maneuvers common in flapping flight can also include nonlinear effects such as lift hysteresis. This seminar will discuss research efforts for flow modeling, estimation, and control for lift regulation at low Reynolds numbers. Three avenues of investigation include: (1) construction of reduced-order, data-driven models of unsteady aerodynamic behavior; (2) estimation of flow past an airfoil using the embedded pressure sensors; and (3) the use of optimal control approaches to design wing maneuvers during a transient event such as a transverse gust encounter. The data-driven modeling technique of Dynamic Mode Decomposition (DMD) is used to create linear flow models and the novel mode-selection algorithm LARS4DMD is introduced. Kalman filtering is performed to estimate the nearby flow using embedded pressure sensors by exploiting correlations of the surface pressure signals and flow modes revealed in the DMD model. Another data-driven modeling approach, an empirical Goman-Khrabrov model, is used within a feedback control loop to maneuver a wing in a transverse gust encounter. Current efforts and future research directions will be discussed.

BIO SKETCH

Francis D. Lagor is an assistant professor of mechanical and aerospace engineering at the University at Buffalo (UB), The State University of New York. He received his Ph.D. in aerospace engineering with an emphasis on dynamics and control and a minor specialization in aerodynamics from the University of Maryland (2017). Prior to attending the University of Maryland, he worked for Lockheed Martin Space Systems Company. He holds an M.S. in mechanical engineering and applied mechanics from the University of Pennsylvania (2009), and a B.S. in mechanical engineering from Villanova University (2006). He is a recipient of the Air Force Office of Scientific Research (AFOSR) Young Investigator award (2021), and he is broadly interested in aerodynamic flow estimation and control.

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