

**Department of Structural Engineering
University of California, San Diego
SE 290 Seminar**



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**"Next Generation Aeronautical Engineering Designs: Exploitation of
Unsteady Aerodynamics and Nonlinear Flight Mechanics"**

Monday, January 22, 2018
12:00 pm - 12:50 pm, Pepper Canyon Hall, Room 122

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Abstract

Aeronautical engineering designs have been discreetly following conventional designs over the last century. Innovative leaps require advanced analysis tools that allow studying unconventional operating regimes at high frequencies and angles of attack, hence, exploiting unsteady aerodynamic phenomena and nonlinear flight dynamics, rather than obviating them, for the creation of novel efficient designs

This talk serves as an initiator for new research ideas and development of advanced analysis tools rather than stating research outcomes. In this talk, I will discuss three main topics. First, I will discuss formulating airplane flight mechanics in a differential geometric control framework that results in recovery of nonlinear controllability when linear

controllability is lost due to hydraulic loss of control surfaces. Moreover, based on this formulation, I will show a novel rolling mechanism, due to nonlinear interactions between elevator and aileron, which has a significantly higher control authority near stall than the conventional linear rolling mechanism due to ailerons. Second, I will discuss the meager state of flutter predictability and its root cause, stemming from a fundamental flaw in the classical theory of unsteady aerodynamics; namely the unsteady Kutta condition. I will show our recent development of a *viscous* extension to the classical theory that does not invoke an auxiliary condition (e.g., Kutta condition). Driven by such a motivation, I will discuss our nascent idea of developing a variational theory for unsteady aerodynamics; novel framework for modeling of unsteady aerodynamics after following Prandtl's formulation for a century. Finally, in the light of these analysis tools, I will talk about a new airplane concept that exploits unsteady aerodynamic phenomena near stall for propulsion by flapping its tails: The Flapping Tail Concept Airplane (FTCA). This concept is expected to provide 25% saving in fuel consumption, if the associated technical challenges are successfully overcome. I will also discuss how the geometric control theory can help in this regard.

Biography

Haithem Taha is currently an assistant professor in the department of Mechanical and Aerospace Engineering at the University of California, Irvine. He earned his BSc and MSc degrees in aerospace engineering from Cairo University, Egypt in 2005 and 2008, respectively. He received his PhD degree from the Engineering Science and Mechanics department at Virginia Tech simultaneously with an MSc degree in Interdisciplinary Mathematics in Dec 2013. His PhD research has focused on aerodynamic modeling, flight dynamics and control of flapping wing micro-air vehicles. Mr. Taha has wide research interests that cover Geometric Nonlinear Control Theory and Unsteady Nonlinear Aerodynamics with application to Flight Dynamics of Flapping-Wing Micro-Air-Vehicles.

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*Sponsored by Professor Gilberto Mosqueda
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