

DEPARTMENT OF MECHANICAL ENGINEERING SEMINAR SERIES



Modeling Full-Envelope Aerodynamics of Small UAVs in Real-Time

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Abstract: There is growing interest in modeling and understanding full-envelope aircraft flight dynamics, that is, modeling the aircraft over the full ± 180 deg range in angle of attack and sideslip. Flight outside the normal envelope like this can be encountered in airplane stall/spin situations or more generally upset scenarios that can be caused by a host of factors such as pilot, aircraft, and weather. Moreover, aerobatic airplanes routinely enter and exit controlled flight “outside-the-envelope” with precision and grace. Interest in full-envelope aircraft flight dynamics has also been fueled in recent years by the rapid growth in UAVs together with synergistic parallel advances in high-performance RC model aircraft. Within the broad spectrum of UAV/RC configurations has emerged a general category that is capable of extremely agile maneuvers such as V/STOL-like flight, hovering, perching, stop-and-stare, defensive and evasive postures, and rapid roll, pitch, yaw rates and accelerations. The high agility derives from having control surfaces as large as 50% chord with deflections as high as ± 50 deg and propeller thrust-to-weight ratios of near 2:1. These ultra-agile configurations clearly present new challenges to flight dynamics simulation and modeling.

This talk will focus on the development of a full six degree-of-freedom aerodynamics modeling environment for small UAVs that operate at high angles of attack and high sideslip in maneuvers performed using large control surfaces at large deflections for aircraft with high thrust-to-weight ratios. The method follows a component buildup approach that takes into account propeller, wing, fuselage, and tail surface aerodynamics together with interaction effects such as propwash and flow blanketing from one surface on another. Time histories and video footage of example maneuvers predicted by the method will be presented. Finally, the talk will conclude with current research and future directions in flight simulation and modeling of UAVs, including aircraft spin.

Dr. Michael Selig is an Associate Professor of Aerospace Engineering at the University of Illinois at Urbana-Champaign, where he leads the UIUC Applied Aerodynamics Group and is Co-Director of the UIUC Subsonic Aerodynamics Research Lab. He received his BS from the University of Illinois at Urbana-Champaign, MSE from Princeton University, and PhD from Penn State. Dr Selig’s main areas of research are low-speed aerodynamics, low Reynolds number aerodynamics, experimental aerodynamics, airfoil design, wind energy, and real-time flight simulation and modeling, including aircraft icing and aircraft loss of control. His aerodynamics research and design expertise has been applied to general aviation aircraft, unmanned aerial vehicles, kilowatt through multi-megawatt scale wind turbines, record breaking solar powered aircraft, wing-sail and appendage design for the America's Cup, and wing designs for IndyCars/CART and Formula 1. His codes and methods for airfoil design and wind turbine blade design are used in both the aerospace and wind turbine industries. Dr. Selig’s airfoil designs and data are available in the open/online literature and used worldwide.

DATE: Friday, November 15, 2013

TIME: 10:00—11:00 a.m.

LOCATION: Macdonald Engineering Bldg, RM 267



McGill