

SMU Department of Mechanical Engineering SEMINAR

“Modeling, Simulation and Control of Morphing Wing UAVs”

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Junkins 110

Abstract: An efficient simulation methodology specifically tailored for morphing aircraft has been developed. The methodology handles both the aerodynamic and inertial effects of wing morphing, or other active structural modifications. The aerodynamics is handled by an efficient run-time Vortex-Lattice Model, capable of properly handling the morphing aircraft structure. The equations of motion of the aircraft have been modified to account for the time-dependence of the aircraft configuration by including morphing moments and forces. The methodology is applicable to a wide range of aircraft structures, with arbitrary combinations of planforms and joints possible. The computational requirements are significantly reduced relative to a Multi-Body dynamics scheme. The key limitation relative to a Multi-Body dynamics code is the approximate treatment of the actuator and structural dynamics. The simulation methodology has been applied to various wing morphing states, and the behavior of the aircraft analyzed under both static (“wind-tunnel”) and dynamic (non-linear flight simulation of a morphing-induced turn) conditions. We also investigate the dynamic loads and required power for any morphing wing aircraft, since it ultimately determines the feasibility of a given morphing configuration. A methodology suitable for numerical calculation of the dynamic loads for a morphing-wing aircraft is presented. The dynamic loads are derived from Lagrange’s Equations of a morphing aircraft, modeled as a system of rigid bodies connected by actuated rotational and translational joints. Finally a stability augmentation system is integrated into the framework that enables one to perform trade-offs between morphing and conventional control surfaces.

Bio: Dr. Kamesh Subbarao is currently an Associate Professor in the Department of Mechanical and Aerospace Engineering at the University of Texas at Arlington. Dr. Subbarao has extensive experience in design, development and implementation of flight control systems. His research interests include modeling, control and identification of nonlinear dynamical systems that are subject to large uncertainties. Prior to his graduate studies, he was a Scientist at the Aeronautical Development Agency, Bangalore, India and was involved in the design and implementation of the control laws for high performance combat aircraft and design of validation tools for testing the control laws. For his work on Model Reference Adaptive Control as a graduate student (Texas A & M University), he received the AIAA Foundation award in 2001. Immediately following his PhD, he spent two years at The MathWorks Inc. as an applications developer for the controls and system identification toolboxes group. Since joining UT Arlington in 2003, he has been actively involved in mathematical modeling of morphing wing and flapping flight with embedded sensing and distributed actuation. He is also working on cooperative control and estimation of networked dynamical systems subject to measurement delays, uncertainty characterization in space surveillance problems and design of robust adaptive control laws for synchronization of spacecraft motion for autonomous on-orbit repair and rescue operations. He is an active member of the Autonomous Vehicle Laboratory at UT Arlington and the university representative for Texas Space Grants Consortium. He was nominated by the College of Engineering for the Chancellor’s Council Award for Excellence in Teaching for 2009-2010, President’s Award for Excellence in Teaching (Tenured Faculty) for 2010-2011 and was voted as the “Most Valuable Faculty” by the graduating class in spring 2011.