Aeroelastic Response of a Typical Wing Section under Nonlinearities and Gust
Doctoral Dissertation Defense

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Chair of Advisory Committee: Dr. Strganac
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March 12th, 2015
2:00 pm – 4:00 pm
H.R. Bright Building - HRBB 603

Abstract

Aeroservoelasticity (ASE) is the interdisciplinary study of the interaction of structural, inertial, aerodynamic, and control loads for aircraft systems, and is inherently a nonlinear phenomenon. One of the goals of ASE research is to provide active gust load alleviation in aircraft to improve ride quality, minimize airframe fatigue, and increase performance.

The goal of this research is to develop a robust aeroelastic (AE) predictive model for a wing section that represents a typical flexible wing in flight, and which will be used as a platform for developing ASE controllers. The various components of this research, including an unsteady aerodynamic module, a structural module, and a gust module, have been individually developed and validated with experiments. The experimental facility, comprising of a pitch-plunge free vibration apparatus, a real-time gust sniffing sensor, and an oscillating vane gust generator, are designed and developed at Texas A&M as test beds for current and future ASE research.

Both the experiments and predictive model are used to explore nonlinear behavior of the system response. For example, the research has led to experimentally derived bifurcation diagrams depicting possible responses. The limit cycle oscillations (LCO) observed in experiments are captured well by the predictive model. The AE model allows for parametric study of wing response on various system features such as nonlinear structural stiffness, nonlinear Coulomb damping, mass imbalance, and other design features. Also, the response of a wing under oncoming gusts is examined. This AE predictive model will serve as a platform to develop ASE models and controllers, and the experimental facility serves as a test bed for validation of developed controllers.

Yogesh Babbar is a PHD candidate in the Aerospace Engineering Department working under the supervision of Professor Thomas Strganac. His research interests are in the areas of Nonlinear Aeroelasticity and Unsteady Aerodynamics. He is seeking employment within the Aerospace and Wind Energy industry.