

Seminar



Unsteady Aerodynamics Modeling for Aircraft Maneuvers: A New Approach Using Time-Dependent Surrogate Modeling

A new approach for computing the unsteady and nonlinear aerodynamic loads acting on a maneuvering aircraft is presented. This approach is based on Duhamel's superposition integral using indicial (step) response functions. The novelty of this approach relies on the development of a time-dependent surrogate model that fits the relationship between flight conditions (Mach number and angle of attack) and indicial functions calculated from a limited number of simulations (samples). The aircraft studied in the current paper exhibit highly nonlinear roll moment and therefore a very large number of step functions need to be calculated to accurately predict the aerodynamic behavior at each instant of time spent in aircraft maneuvers. The reduced order model, along with the surrogate model, provide a mean for rapid calculation of step functions and predicting aerodynamic forces and moments during maneuvering flight. The maneuvers are generated using a time-optimal prediction code with the feasible solutions based on the vehicle control and state constraints. Results presented show that the developed surrogate model aids in reducing the overall computational cost to develop cost-effective reduced-order models. It is also demonstrated that the reduced order model used can accurately predict time-marching solutions of maneuvering aircraft, but with an advantage that reduced order model predictions only require on the order of a few seconds of computational time.

In addition, Dr. Cummings will give a brief overview of the laboratory facilities in the Department of Aeronautics to foster future collaboration between U.C. Boulder and USAFA.

Friday, October 24 , 2014
2:00 – 3:00 pm
KOBL 210

Dr. Cummings graduated from California Polytechnic State University with a B.S. and M.S. in Aeronautical Engineering in 1977 and 1985, respectively, before receiving his Ph.D. in Aerospace Engineering from the University of Southern California in 1988. He was named Professor of Aeronautics at the U.S. Air Force Academy in 2004, where he is currently serving as the Department Head, and has served as the Discipline Director for Aerodynamics and the Research Director for the Modeling & Simulation Research Center. Prior to serving at the Academy he was Professor of Aerospace Engineering at Cal Poly from 1986 through 2004, where he served as department chair for four years. He worked for Hughes Aircraft Company in the Missile Systems Group as a missile aerodynamicist from 1979 through 1986. He completed a National Research Council postdoctoral research fellowship at NASA Ames Research Center in 1990, working on the computation of high angle-of-attack flow fields in the Applied Computational Fluids Branch. He was named an AIAA Associate Fellow in 1990, received the AIAA National Faculty Advisor Award in 1995, and is the past chairman of the AIAA Student Activities Committee. In addition, Dr. Cummings has been awarded the USAF Science and Engineering Award and is currently a member of the AIAA Fluid Dynamics Technical Committee, and is author of the undergraduate textbook titled *Aerodynamics for Engineers*. He has published over 60 articles in peer-reviewed journals and over 120 technical meeting papers.