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AE 585

UM François-Xavier Bagnoud Building

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On the Virtues of Unsteady Aerodynamics: Perching Aircraft, Aeroelastic Energy and Ornithopters

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Abstract: Fluid-structure interaction is a challenge for engineering analysis. Presented will be several systems that utilize unsteady aerodynamics and coupled fluid-structure dynamics to enable new capabilities. There are opportunities for the creation of new and interesting engineering systems which come from biological inspiration. We are going to discuss a few examples as to how engineers can learn from nature and develop physical models of the phenomena, to arrive at unique systems. *Perching Aircraft* Morphing or shape change represents a new concept for the design aeronautical platforms and especially aircraft. We have developed approaches of modeling and understanding the dynamics of these aircraft systems. We have proposed that morphing aircraft can be enable new maneuvers, namely, perching. An aircraft that can accomplish such a maneuver can be used to extend its mission by reducing power consumption, creating persistence in theater capabilities. *Aeroelastic Energy Harvesting.* We are investigating structures that exhibit limit cycle behavior from ambient flows. Using piezoelectric materials, structural stresses are transduced into electric power and stored. Modeling of individual elements that capture the aeroelastic behavior have been successful and our approach will be presented. *Ornithopters Modeling* of aerodynamic forces on ornithopters have lagged behind our laboratory observations of the physical phenomena. We will present a low order model of the fluid-structure interaction of a pair of wing in a low Reynolds number environment that begin to capture the forces generated by the unsteady motion of the wings.

Short Bio: Dr. Ephrahim Garcia is a Professor in the Department of Mechanical and Aerospace Engineering at the Cornell University, where he is currently the Director of Graduate Studies for the field of Aerospace Engineering. His expertise is in areas of dynamics and controls, especially sensors and actuators involving smart materials with applications to robotics, energy harvesting, and bio-inspired machines. Dr. Garcia served as a Program Manager in the Defense Sciences Office at the Defense Advanced Research Projects Agency (DARPA) from 1998 to 2002. His programs involved the development of new types of actuation systems utilizing smart material transducers, system level demonstrations of smart structures applied to defense platforms, morphing aircraft systems and the development of exoskeletons for human performance augmentation. From 1991 to 1998, Dr. Garcia was an Assist./Assoc. Professor of Mechanical Engineering at Vanderbilt University where he was Director of the Center for Intelligent Mechatronics. From 1991-97, he owned and operated a corporation (Dynamic Structures and Materials, LLC) that designed and fabricated smart material based actuators. Dr. Garcia received the ONR Young Investigator award and was named a Presidential Faculty Fellow by President Clinton. Dr. Garcia is author of more than 275 articles, book chapters, edited volumes, and books. In 2002, Professor Garcia received the prestigious American Society of Mechanical Engineers' Adaptive Structures Prize for "significant contributions to the sciences and technologies associated with adaptive structures and/or materials systems. Since 2006, he has served as Editor-in-Chief to the Smart Materials and Structure Journal. Dr. Garcia is a Fellow of the Institute of Physics, the American Society of Mechanical Engineers, and an Associate Fellow of the American Institute of Aeronautics and Astronautics.

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