Center for Environmental & Applied Fluid Mechanics

Friday, September 11, 2009
11:00 a.m., 110 Maryland Hall

"Bio-Inspired Aerial and Underwater Vehicles for Distributed Mobile Sensor Networking"

Dr. Kamran Mohseni
Aerospace Engineering Sciences, University of Colorado at Boulder

This talk is focused on aerial and underwater platforms for distributed mobile sensor networking applications in which vehicle system, control, communication, and information processing are deeply integrated. Availability of affordable vehicle platforms, mass-produced micro-sensors, and the use of pervasive networking technology enable such systems to be applied to a wide range of real-life applications from environmental monitoring to surveillance and national security. I will present the design, fabrication, and testing of a few generations of bio-inspired aerial and underwater fleet and their applications.

Our current aerial vehicles span from 6 to 30 inches in length and 45 to 580 grams in weight depending on their mission and payload. Most vehicles are equipped with GPS, radio, transmitter, IMU, battery, motor, and some sensing capabilities. The aerodynamic performance and endurance of miniature and micro aerial vehicles are significantly affected by their inherent low aspect ratio and low Reynolds number characteristics. The flow is often unsteady with a potential transitional regime where most of the available design tools are not applicable. I will discuss some recent work in my group in developing design tools, models, calculations, and testing of a few generations of micro aerial vehicles.

The last part of the presentation focuses on a class of unmanned underwater vehicles with a novel propulsion technique loosely inspired by the natural locomotion of cephalopods. I will present visualization of two types of jellyfish locomotion, their numerical simulation, and design of actuators mimicking their operation. The continuous operation of the proposed thrusters creates an effective pulsatile jet. The parameters controlling the jet and its thrust are identified. A model predicting the thrust is presented and validated in direct dynamic thrust measurement test. Furthermore, these devices have thrust tracking times faster than those reported for typical propeller type thrusters, and deliver a fully quantized level of thrust. Finally, a virtual vehicle simulation is developed to test the thrusters with unsteady driving signals. Within this environment using a proportional derivative feedback control algorithm, the thruster/controller was observed to provide sufficient control over the vehicle performing large scale maneuvers. For further information on the research in Mobile Sensor Networking Platforms and Multiphysics Micro/Nano Transport see the group's website at http://enstrophy.colorado.edu/~mohseni/

Kamran Mohseni received a B.S. degree in Mechanical Engineering from the University of Science and Technology in Tehran, M.S. degree in Aeronautics and Applied Mathematics from the Imperial College of Science, Technology, and Medicine in London, and Ph.D. degree in Mechanical Engineering from the California Institute of Technology (Caltech) in 2000. He was a postdoctoral fellow in Control and Dynamical Systems at Caltech for one year before joining the Aerospace Engineering Sciences Department at the University of Colorado at Boulder where he is currently an Associate Professor. His research focuses in the areas of mobile sensor networking, micro scale transport, vortex dynamics, and biomimetic and fluidic locomotion, and wind energy. He has been the co-author of more than 100 articles, a recipient of the DARPA Career Award in 2007, and Provost's Faculty Achievement Award at CU Boulder in 2008 among others. He is an associate fellow of AIAA and a senior member of APS, ASME, SIAM, and IEEE.