Title: Electrostatic Spacecraft Relative Control Applications

Abstract:
Recently the concept of controlling the relative motion of spacecraft using electrostatic charging (Coulomb forces) has been proposed. For tight spacecraft formations with separation distances ranging from 10--100 meters, the Coulomb forces between the spacecraft can be exploited to provide an extremely fuel and power efficient means of propulsion with a fast response time and large control bandwidth. This relative motion control methods enables interesting new close proximity flying operators to yield distributed or inter-connected structures with variable size and shapes. Applications range from docking maneuvers, circumnavigation of probes about a mother craft, virtual Coulomb tethers, virtual Coulomb structures to spinning interferometric systems. The presentation will discuss the Coulomb thrusting concept and present 2 recent research projects. First novel closed- and open-loop close-proximity collision avoidance control strategies are discussed. Here the spacecraft charge is servoed to produce a combination of repulsive and attractive forces to enforce a desired minimum separation distance while avoiding drastic changes to the initial relative velocity vectors. Second, a new light weight space structure concept called the Tethered Coulomb Structure (TCS) is discussed. Here the structure is composed of a distributed set of nodes which are interconnected through thin tethers. To enable three dimensional shapes which in Earth's orbit, the nodes are charged to produce repulsive forces which ensure tether tension at all times. This system creates a deployable structure dozens of meters in size which can change its shape and size by varying the tether lengths. The initial studies show that the required repulsive forces are similar to those that occur due to natural charging at GEO.

Speaker-Bio:
Dr. Schaub is an associate professor and an H. Joseph Smead Fellow of the Aerospace Engineering Sciences department at the University of Colorado at Boudler. He is an associate fellow of AIAA and member of AAS. His 13 years of professional interests are in nonlinear dynamics and control applications, with a special emphasis on astrodynamics. He has performed research in spacecraft attitude and control, exploiting nonlinear dynamics of control moment gyros to avoid classical CMG singularities, as well as extensive research in spacecraft formation flying dynamics and control problems. His current interests include charged relative motion dynamics and control, as well as visual servoing of autonomous vehicles. Dr. Schaub's prior work experience includes 4 years at the Sandia National Labs Intelligent Systems and Robotics Center (ISRC), and 4 years at the Virginia Tech aerospace and ocean engineering department as an assistant professor. He has authored about 40+ peer reviewed papers, presented 60+ conference papers, published a text book on analytical mechanics of space systems, and holds a patent on a noncontact position and orientation measurement system.