Engineering Tiny Space Systems: From ChipSats to Starships

Zac Manchester
Assistant Professor
Aeronautics and Astronautics
Stanford University
Thursday, February 8th 4:30 PM WEH 5421

Abstract:
Rapid miniaturization of electronic devices, driven in recent years by the emergence of smartphones, has made many of the key components needed onboard aerospace systems available in very small, low-cost, and light-weight packages. This trend is behind the growing popularity of small consumer “drones,” as well as the recent emergence of the “ChipSat” concept – centimeter-scale spacecraft built with the same parts and processes used in the consumer electronics industry.

Very small systems present an interesting mix of technical challenges and opportunities: The scaling of inertias and natural frequencies forces controllers to operate faster, but also enables greater agility. Small apertures limit resolution for remote sensing, but tiny systems can collect data in situ in places that larger systems cannot reach. Power constraints limit data rates from individual aircraft or spacecraft, but their low cost allows large numbers to be deployed.

This talk will focus on pushing the limits of size, mass, and capability in small space systems, including novel spacecraft architectures like the printed-circuit-board Sprite spacecraft, control and estimation algorithms tailored for implementation in embedded computing hardware, and low-power communication protocols designed for small satellites that lack the ability to point high-gain antennas. I will discuss several ongoing flight projects to demonstrate these new technologies, including the crowd-funded KickSat mission that will deploy 100 Sprite spacecraft in low-Earth orbit.

Bio:
Zac Manchester is Assistant Professor of Aeronautics and Astronautics at Stanford University, a member of the Breakthrough Starshot advisory committee, and founder of the KickSat project. He holds a Ph.D. in aerospace engineering and a B.S. in applied physics from Cornell University. Zac has previously worked at Harvard University, NASA Ames Research Center, and Analytical Graphics, Inc. His research interests include nonlinear dynamics, control, optimization, spacecraft, and robotics.