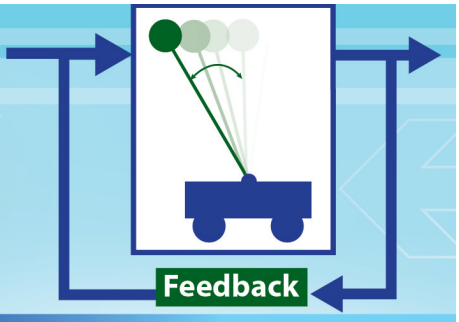
COLLEGE OF ENGINEERING

Control Seminar



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Orientation Control and Consensus Using Piecewise-Continuous Sinusoids with Application to Microrobots and Small-Satellite Swarms

Jesse B. Hoagg

Kentucky University
Department of Mechanical Engineering

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3:30 – 4:30 pm • 1500 EECS

ABSTRACT: Orientation control is critical for applications ranging from aerospace and underwater vehicles to micro-scale devices and robots. This work focuses on rigid-body orientation (i.e., attitude) control for microrobots and small satellites. Conventional flywheel-actuation systems for attitude control are not ideally suited to small-scale applications because they require significant power, are subject to wear, and tend to be heavy. To address these shortcomings, we consider a vibrating-mass actuation system, where reactions beams produce small-amplitude oscillations about each of the orthogonal body-fixed axes. Because of the noncommutative property of rigid-body rotation, small oscillations about two body-fixed axes can produce large-angle rotations about the remaining orthogonal axis. Thus, vibrating-mass actuation can steer a rigid-body to an arbitrary orientation. However, this actuation approach requires new feedback control methods because the angular-velocity control is restricted to be piecewise-continuous sinusoids.

This seminar will present feedback control and consensus methods, where the controls are piecewise-continuous sinusoids. The orientation kinematics are represented by the group of rotation matrices SO(3). We present feedback controllers for setpoint tracking and command following of a single rigid body. Then, we extend these approaches to address orientation consensus for multiple rigid bodies (e.g., satellites). We also present numerical and experimental results on the application of these techniques to microrobots and small-satellite swarms.

BIO: Jesse Hoagg is an Associate Professor of Mechanical Engineering at the University of Kentucky. His research interests include: human learning; cooperative control of aerospace vehicles; orientation control of microrobots and small satellites; and control of highly uncertain systems. Prior to joining the University of Kentucky, Dr. Hoagg was a postdoctoral research fellow at the University of Michigan from 2009 to 2010. He worked for the consulting firm McKinsey & Company from 2006 to 2009. He received the Ph.D. degree in aerospace engineering from the University of Michigan in 2006. He also received an M.S. in mathematics and an M.S.E. in aerospace engineering from the University of Michigan, and a B.S.E. in civil and environmental engineering from Duke University.