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.

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