Abstract

Traditional treaded rovers (like iRobot's Packbot) have been the staple platform for virtually all autonomous ground-based robotics tasks. However, the treaded mode of propulsion limits their movement to mostly flat, solid surfaces. Spherical robots that are positively buoyant do not suffer from this limitation. There have been several spherebots designed in recent years around the basic hamster-in-a-ball concept where the movement of the center of mass creates motion. However, these spherebots suffer from fundamental limitations: the sphere's linear acceleration is a function of a boutique mass distribution and the sphere cannot turn in place with any precision.

Our solution to these issues is iceCube. iceCube is a spherical robot that utilizes four control moment gyroscopes (CMGs) in a pyramid configuration for propulsion. A CMG is a gimbaled flywheel which has a fixed momentum. CMGs are considered to be "torque amplifiers" as the stored momentum of the flywheel is leveraged such that effective torque output of the CMG is greater than the torque required to gimbal the flywheel. The result of this attribute is that CMG-based propulsion has greater energy efficiency than direct-drive systems. This talk will introduce a simple, yet elegant approach to deriving the complex dynamics of iceCube as well as practical feedback controller synthesis in spite of the nonholonomic nature of the dynamics.

Biography

Andrew Cavender is currently a PhD candidate at the University of California at San Diego, in the Mechanical and Aerospace Engineering department. Prior to graduate studies, he worked for Hughes/Boeing, Honeywell, and Goodrich. He received a B.S. in engineering mechanics and astronautics from the University of Wisconsin. His research is focused on the dynamics and control of aerospace and robotic systems.