Practicable Rotation-Matrix-Based Attitude Control

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ABSTRACT: The attitude of a body, such as a spacecraft, underwater vehicle, or unmanned aerial vehicle, is characterized by the rotation matrix. Historically, set-point and tracking control of rigid bodies has been realized by parameterizing the rotation matrix in terms of quaternions, Euler angles, Rodrigues parameters, or modified Rodrigues parameters (MRPs). However, such parameterizations are problematic. For instance, Euler angles, Rodrigues parameters, and MRPs suffer from singularities. As such, in recent years researchers and practitioners alike have considered attitude control methods that directly use the rotation matrix. In this seminar, practical aspects of rotation-matrix-based attitude control will be considered. Specifically, the use of unit-vector and angular velocity measurements directly within a rotation-matrix-based control law will be presented. Additionally, a rotation-matrix-based attitude control law that prevents actuator saturation and simultaneously ensure closed-loop stability will be discussed.

Bio: James Richard Forbes received his B.A.Sc. in Mechanical Engineering (Honours, Co-op) from the University of Waterloo in 2006. While attending the University of Waterloo James participated in the co-op program; James had the opportunity to work in the manufacturing, automotive, rail, and industrial automation (robotics) industries. James was awarded his M.A.Sc. and Ph.D. degrees in Aerospace Science and Engineering from the University of Toronto Institute for Aerospace Studies (UTIAS) in 2008 and 2011, respectively. He was awarded the G N. Patterson Award for the most outstanding Ph.D. thesis in 2011. From May 2011 to August 2013 James was an Assistant Professor of Mechanical Engineering at McGill University located in Montreal, Quebec, Canada While at McGill University he was also an associate member of the Centre for Intelligent Machines. James is currently an Assistant Professor of Aerospace Engineering at the University of Michigan. The focus of his research is the dynamics and control of aerospace systems including large flexible space structures, spacecraft, unconventional Mars rovers, and cable-actuated systems.