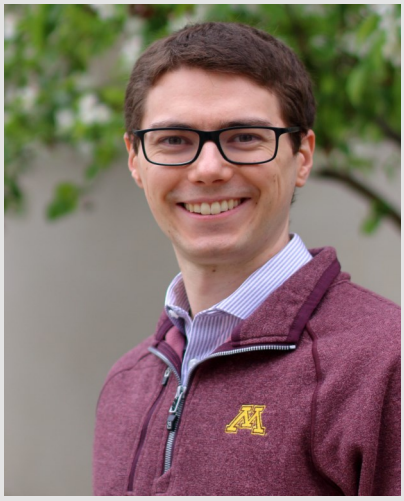
MAE. Semi-SERIES

Spacecraft Station Keeping and Re-Entry Targeting using Model Predictive Control

Thursday, October 7

3:55 pm

Knox 14



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ABSTRACT

The commercialization of space, recent advances in spacecraft technology, and the exploration of distant extraterrestrial bodies have led to the need for increased autonomy in spacecraft operations. The highly nonlinear nature of spacecraft orbital and attitude dynamics complicates the design and analysis of autonomous controllers. These nonlinearities can be beneficial or detrimental to the motion of a spacecraft, which motivates the need for control techniques beyond linear feedback. In this talk, I will present model predictive control (MPC) approaches to spacecraft trajectory tracking that accommodate the nonlinearities of orbital mechanics. In particular, I will introduce an MPC-based approach to perform autonomous Geostationary Earth Orbit (GEO) and Areostationary Mars Orbit (AMO) station keeping, with extensions to spacecraft momentum management and control allocation. The second part of this talk will focus on the Hypersonic Configurable Unit Ballistic Experiment (HyCUBE) being developed at the University of Minnesota. HyCUBE is a low-cost, CubeSat-like spacecraft that will be deployed from low-Earth orbit and re-enter Earth's atmosphere at hypersonic velocities while acquiring valuable aerothermodynamic data. A key part of the HyCUBE mission is the ability to perform re-entry targeting of the vehicle using drag modulation. I will present an MPC-based drag modulation approach we have developed that leverages atmospheric density estimates to minimize the targeting error at the re-entry interface.

BIO SKETCH

Ryan Caverly is an Assistant Professor in the Department of Aerospace Engineering and Mechanics at the University of Minnesota, Twin Cities. Dr. Caverly received his B.Eng. degree in Honours Mechanical Engineering from McGill University, and his M.Sc. and Ph.D. degrees in Aerospace Engineering from the University of Michigan, Ann Arbor. From 2017 to 2018 he worked as an intern and then a consultant for Mitsubishi Electric Research Laboratories in Cambridge, MA. Dr. Caverly is the recipient of a 2021 DoD Defense Established Program to Stimulate Competitive Research (DEPSCoR) Award to develop a unified testing and evaluation approach for hypersonic flight systems. He currently serves as an associate editor for IEEE Robotics and Automation Letters. Dr. Caverly's research interests include dynamic modeling and control systems, with a focus on robotic and aerospace applications, as well as robust and input-output control techniques.

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