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HARDWARE-IN-THE-LOOP TESTING OF NONLINEAR CONTROL FOR NANOSATELLITE FORMATION FLYING

Abstract

Nonlinear optimal control techniques facilitate accurate position and velocity control for formation flying at large distances in Low Earth Orbit (LEO). The implementation of these techniques on commercial off-the-shelf (COTS) nanosatellite hardware presents challenges due to delays, sensor noise and on-board computational limits. This paper presents the design and development of a hardware-in-the-loop (HIL) experiment for testing nonlinear optimal orbit control in a leader-follower formation flying configuration. Attitude control is integrated in the test as model-in-the-loop (MIL) since the primary purpose is to test the formation flight controller. Orbit propagation is performed by high fidelity orbit dynamics model including aerodynamic drag, Sun and Moon third-body perturbations and solar radiation pressure. The controllers are tested for a large projected circular orbit (PCO) acquisition scenario for the Telematics Earth Observation Mission (TOM). The stability of different nonlinear controllers and their comparative performance in terms of fuel budget as well as computation time on COTS hardware are presented.