Paper ID: 32658
student

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (2) (2)

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DEVELOPMENT OF A COMBINED ATTITUDE AND POSITION CONTROLLER FOR A SATELLITE SIMULATOR

Abstract

The Test Environment for Applications of Multiple Spacecraft (TEAMS) laboratory at the Institute of Space Systems of the DLR in Bremen, Germany is a test facility for formation flying simulation. It is equipped with a smooth granite surface 20 square meters in area over which air cushion vehicles float in order to simulate in-orbit torque- and force-free dynamics. The vehicles are outfitted with thrusters and reaction wheels on a rotatable upper platform which allow them to move in 3 rotational and 2 translational degrees-of-freedom. This paper presents an overview of the work done at the TEAMS laboratory in designing, implementing and testing a combined attitude and position control system for these vehicles in order to enable the use of the facility for testing of GNC formation flying algorithms. A computational model of the vehicle was created in order to simulate the system and speed up control algorithm development. Automated procedures were developed for the identification of certain key vehicle parameters such as moments of inertia and thruster actuation torques. Suitable control laws for position and attitude were designed and tuned according to requirements. Both static and trajectory-following controllers were implemented. Finally, the control algorithm was successfully tested on a vehicle in the TEAMS facility using a predefined position trajectory while the attitude pointed to a fixed spot inside the laboratory. Such a test emulates the requirements of a situation when formation satellites have to point to one another – typical examples are craft-to-craft optical communications and telescopes with a distributed aperture. A model for the unbalancing created by depletion of the onboard compressed air tanks was created. From this, an estimator was developed and a system of moving weights on the platform – originally intended for static balancing – was used in order to correct for the gravity disturbances arising during the tests. Simulation and experiment results are presented and verified to be in agreement.