IAF ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (1)

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A FREE-FLOATING 3-AXIS ATTITUDE CONTROL TEST ENVIRONMENT WITH OPTICAL TRACKING FOR HIGH-PRECISION POINTING VERIFICATION OF CUBESATS

Abstract

QUBE is a 3U CubeSat which establishes a secure communication link between a satellite and Earth using quantum key exchange. An accurate Attitude Determination and Control System (ADCS) is a crucial aspect of this mission. To calibrate the sensors and verify the system performance pre-flight, the team has developed a realistic ADCS test environment. This paper describes the development of a test setup for an ADCS designed specifically for CubeSats and Small Sats. The setup is currently being used for the verification of QUBE, which is scheduled to be flight-ready in 2023, as well as subsequent similar CubeSats. Initial results of the sensor calibration and attitude determination verification are presented.

The test setup places the CubeSat on a lightweight 3-axis air bearing, where it is observed by an optical tracking system to measure the satellite's attitude. The air bearing is situated within a Helmholtz cage to simulate the magnetic field of Earth. The measured attitude is fed into an external simulation environment, which can provide additional data such as star tracker measurements to the system under test through a wireless interface, so as to provide the option of full closed-loop hardware testing.

Two different optical tracking systems are compared against a high-precision motion simulator to assess their accuracy. The first optical tracking system utilizes a high-definition Logitech C920 camera which detects the orientation of two fiducial markers to determine a CubeSat's pose on the testbed. One marker attached to the CubeSat, and the other one fixed to the test setup in a known attitude. The second system uses an Optitrack motion sensor camera that triangulates the position of retroreflective balls in space. This system has a set of cameras to capture the motion of the passive markers in the Helmholtz cage with less than 0.2 mm of position measurement error. A custom visualization shows the observed attitude in a static reference frame during the test.

This contribution shows that the test setup offers a reliable and accurate means of verifying the

performance of a CubeSat ADCS by comparing the internal telemetry of the tested satellite and the external attitude measurements. The setup will be used for the calibration of the magnetometers on the air bearing, as well as to assess the attitude determination accuracy and target pointing capability.