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DESIGN, TEST AND VERIFICATION OF A MINIATURE ATTITUDE CONTROL SYSTEM FOR THE PICOSATELLITE UWE-3

Abstract

The picosatellite UWE-3 is the third generation of **U**niversity **W**ürzburg's **E**xperimental satellites and it is ready to be launched in the second quarter of 2013. UWE-3 is equipped with all necessary satellite subsystems, among them the attitude determination and control system, which will enable the picosatellite to determine its orientation and to control and change its attitude in real time. One of the main mission goals of UWE-3 is the in orbit demonstration of a miniature attitude control system (ACS) based on magnetic torquers and one reaction wheel, which is another important milestone for University Würzburg's ambitious goal of implementing a formation of multiple cooperating picosatellites in orbit.

The optimized design of the magnetic control actuators meets the low power and mass constraints of the picosatellite bus, while maximizing the produced magnetic moment to enhance the efficiency of attitude control maneuvers. Simple control algorithms like the B-Dot controller have been implemented, as well as more sophisticated software controllers for attitude pointing. Their performance was tested and verified in an attitude control simulation environment for different scenarios and under various conditions. In addition, a specially designed attitude control test setup for picosatellites, which is based on a spherical aircushion bearing, allows for various functionality tests and attitude control experiments with the ACS hard- and software.

Besides unit testing of the attitude control system, the aircushion testbed allows for experiments with the entire UWE-3 satellite. This gives a unique chance to test and verify the performance of the attitude control system on ground, while it is being integrated in the UWE-3 satellite bus, as it is in orbit. The successful integration of the miniature reaction wheel in the UWE-3 system could be demonstrated when the initially stable picosatellite changed its viewing direction by performing a slew maneuver on the aircushion testbed. Detumbling experiments have successfully shown the efficient interaction and performance of the magnetic torquers and corresponding control algorithms to stabilize the picosatellite from initial spinning rates up to 65 deg/s.

This contribution will elaborate on technical details and the hard- and software design of the UWE-3 miniature attitude control system and will discuss results of ACS verification experiments performed with the picosatellite aircushion testbed. In addition, first in-orbit experiences and results will be addressed, which are expected to be available for the IAC 2013.