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Author: Mr. Liam Flaherty
University of Adelaide, Australia

Mr. Hayden Bignell
University of Adelaide, Australia

IMPLEMENTATION AND TEST OF A LOW POWER ATTITUDE DETERMINATION AND CONTROL SYSTEM FOR A CUBESAT

Abstract

This paper describes the development and test of an attitude determination and control system (ADCS) for a CubeSat, designed to maintain ram direction pointing. The CubeSat is called SUSat and is part of the European QB50 mission. The low power nature of CubeSats call for efficiency in both attitude control and the computation required for attitude determination.

The ADCS uses an Unscented Kalman Filter (UKF) for state estimation. The sensors used include a 3-axis magnetometer, 3-axis gyroscope, nadir sensor and a sun sensor. A combination of 3-axis magnetorquers and a single momentum wheel with a PD controller is used for actuation. The on-board computer provides only a small amount of computational power and memory, which adds significant constraints on the UKF implementation. These constraints mean that storing and processing large amounts of data is undesirable, and an incremental approach to the UKF has been developed. This is an improvement from existing UKF designs as they typically require a larger data storage requirement and a larger computational requirement to process this data.

The testing stage includes a Simulink based model, satellite ground model (SGM), and the final flight satellite. The Simulink model provides a simulation environment and spacecraft dynamics model for testing the control system performance. The SGM is a ground based implementation of the satellite which has been developed for the purpose of physical testing of the ADCS. The SGM operates on similar hardware to the satellite, and runs the same software and implementation of the ADCS. With a Helmholtz Cage to control the simulated orbital position, and a platform for near free movement, the ADCS implementation is tested. As a final step, the software is loaded to the satellite and tested on orbit. Initial results show the ADCS being able to maintain a stable attitude.