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DESIGN OF AN AERODYNAMIC ATTITUDE CONTROL SYSTEM FOR A CUBESAT

Abstract

The Cape Peninsula University of Technology in collaboration with Stellenbosch University is developing a 3-unit Cubesat for a low earth polar orbit. The two main payloads are: 1) a camera and 2) a radio frequency beacon that will be used to calibrate the radar antenna patterns of the Hermanus Magnetic Observatory at their base in Antarctica. Stellenbosch University is responsible for the attitude determination and control system design and development. In this paper we present the design and development of a suitable aerodynamic attitude control system for this Cubesat, keeping in mind the restrictions in terms of the mass, power and volume. The satellite is designed to use the aerodynamic disturbance torques on the satellite to our advantage by means of passive antenna feathers for pitch and yaw control and active paddles for roll control. Combining this control with magnetic damping, the satellite can be 3-axis stabilized. Two configurations of the roll control paddles were considered and compared in terms of the required actuator power and the resulting output angle errors. Simulation results show that the satellite can be 3-axis stabilized by means of this aerodynamic control method but not within the specifications needed for sufficient imaging. Reaction wheels were included in the control system which resulted in a pointing accuracy and stability that complied with the requirements of the imaging payload. Based on our simulations, we conclude that the combination of magnetic and aerodynamic control will be sufficient for initial stabilization of the satellite. For the imaging process, the 3-axis reaction wheels will additionally be required.