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EFFECTIVE CUBESAT DESIGNS FOR PASSIVE ATTITUDE STABILIZATION USING AERODYNAMIC DRAG

Abstract

CubeSats are miniature spacecraft designed for space exploration and experimentation at a low mission cost as compared to conventional satellites. In general, CubeSats require stabilization about at least one of their axes to perform certain mission objectives. The attitude of a CubeSat can be controlled either by power consuming active control modules or through passive control strategies that require no power. Implementation of passive control strategies reduce the overall cost of a CubeSat development by eliminating the use of expensive active control actuators. It also enhances the mission outcomes by allowing for more mass to be allocated to the payload. In this study, we consider an effective approach to passively control the attitude of a CubeSat using the environmental disturbances experienced by the satellite. To achieve this goal, at first a numerical tool was developed and validated using the results from literature and those obtained from commercially available software. The developed tool consists of both an altitude propagator and an attitude propagator. The later simulates the attitude dynamics of a satellite against the external environmental disturbances. Secondly, the significance of the different environmental disturbances was observed on a standard 3U CubeSat design in low earth orbit as a function of altitude. Thirdly, different CubeSat designs with deployable panels were proposed and analyzed to passively stabilize the CubeSat in a ram-facing direction utilizing the aerodynamic drag torque. Moreover, the effect of integrating hysteresis material in the CubeSat structure was also investigated to determine the importance of hysteresis material in the passive attitude stabilization of CubeSats.