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OPTIMUM PANEL DEPLOYMENT ANGLE FOR PASSIVE AERODYNAMIC ATTITUDE STABILIZATION IN CUBESATS

Abstract

The inaccuracy or lag in controlling the attitude of a CubeSat is one of the main problems many CubeSat missions face. An effective way to control the attitude of a CubeSat is by using the environmental disturbances encountered by the satellite as control torques to achieve passive attitude stabilization. Several disturbances, including the gravitational force, magnetic force, and aerodynamic drag force, are present and affect satellites in low Earth orbits. These disturbances exert a torque on the satellite depending on its geometry, mass distribution, built material, and components of the satellite. The focus of this study is to achieve effective and efficient passive attitude stabilization using the disturbance torque induced by the aerodynamic drag force. The magnitudes of the aerodynamic drag force in LEO make it an excellent candidate for affecting the attitude of CubeSats. Previous studies have indicated that the attitude of a CubeSat can be controlled through the aerodynamic drag torque based on two main conditions. Firstly, by shifting its center of mass in a way that orients the satellite in a ram-facing direction; and secondly, by damping its angular rate to detumble and stabilize the satellite. To satisfy these conditions, we considered a CubeSat design with four deployable solar panels to shift its center of mass and a ferromagnetic material mounted to dampen the angular rate. The rate of stabilization varies depending on the deployment angle of the solar panels. This study presents an extensive analysis to determine the optimum deployment angle at which the CubeSat can stabilize. Moreover, the analysis also highlights the range of the deviation error angle up to which the passive aerodynamic stabilization techniques are limited.