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ON THE MANAGEMENT OF THE SATELLITE ANGULAR MOMENTUM TAKING ADVANTAGE OF EXTERNAL TORQUES

Abstract

One of the most important tasks of the Attitude and Orbit Control Subsystem (AOCS) is the management of the spacecraft (S/C) angular momentum onboard (typically stored in reaction wheels). This is specially the case when external torques become important (for example at low altitudes) and specific actuators have to be used for S/C momentum unloading or extra torque needs (greater than reaction wheels capacity). In order to address this issue, one possible solution is the implementation of new guidance laws that exploit in an intelligent way the effect of the environmental torques on the S/C. External torques that are usually considered as unknown perturbations can be predicted onboard, taking profit of them as an opportunity of angular momentum dumping or S/C attitude stabilization. These new guidance laws provide the S/C attitude profile and/or the solar arrays target angle. This type of strategy can be implemented in scenarios where the guidance has one or more degrees of freedom (mission waiting phases, eclipses, deorbiting or safe mode scenarios for instance). The main advantage of this kind of strategies is a more simplified hardware matrix which is translated into a cheaper S/C and a more fuel-efficient mission. On the other side, the main challenge to face is to prove the robustness of this more risky approach from an engineering point of view (such as in S/C failures scenarios). This paper will explore different strategies focused on three external torques: gravity gradient, solar radiation pressure and air drag torques, discussing some of the most important drivers for its profitability: type of orbits (circular such as LEO, MEO, GEO or elliptical as GTO), S/C features (S/C inertia, center of mass position or surfaces geometry) and mission requirements (angular momentum/torque capacity allowed for guidance, GPS availability, sensors layout or power needs).