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ANALYSIS OF THE INFLUENCE OF PERIODIC LIFT AND DRAG PERTURBATIONS IN CUBESATS IN LOW EARTH ORBITS

Abstract

Due to the advance and popularization of the SmallSats technology, there has been an increase in the number of SmallSats launched in the last decade, with a maximum of 389 launched the last year. The commercial applications of SmallSats are increasing due to the low cost, simplicity in manufacturing, and low requirements in infrastructure for the fabrication, which makes them very attractive for the market. The CubeSat are ideal to be used in large-scale constellations, with applications in Earth Observation/Remote sensing and communications. For the next five years, it is estimated a number of launches larger than 1,800 nano/microsatellites. At the same time, the increase of the CubeSats represents an increase in the space traffic and in the orbital objects, and, consequently, the increase in space debris. Recent space traffic reports show a large population of CubeSat in Low Earth Orbits at inclinations of 52 and 98, with eccentricities lower than 0.02 and insertion altitudes between 400 km to 750 km. These orbits are highly perturbed by the atmosphere, larger than the influence of Solar Radiation Pressure and the Third body. The analysis of the atmospheric perturbations in CubeSat with tumbling is important to understand the influence of the aerodynamic force in the orbit of the satellite, which is essential to calculate the differences in coverage for constellations, the probability of collision, the satellite decay and the Space Traffic Management. In several situations CubeSats are selected due to the simplicity of the geometry and they modeled as flat planes for the interaction with the rarefied flow, so it is useful to implement the panel methods to calculate the aerodynamic coefficient as a function of the fluid, velocity and attitude. The orbits are simulated in a high-fidelity propagator. The results of the unperturbed orbit are compared with the perturbed orbit along half year to observe the influence of Lift and Drag at different angular velocities. Results show a large influence of the Drag in the variation of the semi-major axis and eccentricity for satellites with low angular motion (lower than 1 deg/s) and influence of Lift in the inclination when it is applied orthogonal to the orbital plate at the same angular velocities. In the case of Lift applied in the radial direction, there are changes in the semimajor axis and eccentricity, but they are lower than the influence of the Drag. The use of the angular velocities lower than 1 deg/s gives a behavior equivalent to the use of a mean aerodynamic coefficient.