SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Access to Space for Small Satellite Missions (5)

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COLLISION RISK ANALYSIS FOR NANOSATELLITE CLUSTER LAUNCHES

Abstract

Nanospacecraft are typically launched in clusters from a single launch, in which they are hosted as secondary payloads. The nanospacecraft, e.g. Cubesats, are usually released simultaneously in small groups from one single container, in order to simplify the launcher interface manufacturing and the launch operations procedures. The release sequence must be designed minimizing the risk of collisions between the nanospacecraft and the primary payload and the risk of impacts among the nanospacecraft themselves. Considering the importance of micro and nano-satellites in the recent and future space activity, establishing a methodology for the collision risk analysis and determining appropriate tools for release systems design is of interest. This paper describes the impact risk analysis for a nano-satellite cluster deployment, comparing results obtained with different release mechanisms, procedures and orbital dynamics modeling assumptions. The in orbit collision risk in the first orbits after launch and in the long period depends on the orbital perturbations differential effects on the spacecraft trajectories and on the in orbit injection initial conditions, such as release time delay among successive releases, relative initial position and velocity, which directly reflect on the satellite dispenser configuration, interface concept and mechanical parameters. The assumption is made that the spacecraft have no orbit control capabilities, therefore no collision avoidance maneuvers can be performed after the satellite release. The analytical model for the analysis described in the paper is based on the Euler-Hill equations, considering the main perturbations acting on the satellites, such as Earth gravitational field higher harmonics, Moon and Sun third body perturbations, solar radiation pressure, atmospheric drag. The risk of collision is assessed performing a Montecarlo simulation based on the numerical integration of the equations of motion. The main variables of the simulations are in orbit injection initial conditions, including the effect on separation system faults or non nominal performance. A case study is described in detail, concerning the launch of a cluster of nine Cubesats in a standard Cubesat dispenser and a heavier primary payload. The risk of impact with the launcher is also discussed.