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ON THE PARALLELIZATION OF VELOCITY VECTORS FOR SAFE ORBIT MANEUVERS IN SATELLITE FORMATION FLYING

Abstract

Space missions are starting to explore the concept of satellite formation flying, which implies that multiple satellites can operate together in a group to meet objectives far beyond the scope of a single satellite. Amongst the hypothesized configurations in formation flying, we found to be of interest the chaser-target arrangement in which a satellite (the target) operates independently, whilst the other satellite (the chaser) executes orbital maneuvers based on the target's behavior. One of the commonly arising problem in a chaser-target formation flying configuration is the high risk of collision between the two spacecrafts. Consequently, the paper brings about a direct method for computing an orbital maneuver that successfully places the performing satellite on a safe orbit, with respect to the target. Such an orbit ensures the minimization of collision risk between the satellites, for at least a given number of revolutions. In order to reach the safe orbit, we propose a method for computing an impulse per unit of spacecraft mass, Δv, required for the orbital transfer. The Δv formulation can be determined by imposing the following constraints: i) the total energy to mass ratios of the two satellites is equalized, and ii) the velocity vectors of the two satellites are parallelized. We further show that applying Δv will not break the satellite formation, which would bring hazardous outcomes and may compromise the space mission. To depict that, the Systems Tool Kit (STK) software from Analytical Graphics Inc. (AGI) is used to simulate the behavior of the satellites in different scenarios, thus validating this approach in a statistically relevant fashion.

Keywords: satellite, formation flying, safe orbit, orbital maneuver