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Space Debris Removal Issues (5)

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REFINEMENT OF PARAMETERS OF A SPACE VEHICLE DESTINED FOR LARGE-SIZE SPACE DEBRIS FLYBY IN LEO USING DETACHABLE THRUSTER DE-ORBITING KITS

Abstract

The mission devoted to a flyby of large-size space debris (LSSD) objects was studied accurately for the first time by M. Castronuovo et al. (Acta Astronautica, 2011). It was supposed that an active space vehicle (SV)-collector executes flights between the objects situated at Sun-synchronous orbits. Such SV has special detachable units onboard, thruster de-orbiting kits (TDK), which ensure de-orbiting of an LSSD object. The stores of fuel and TDKs are being resupplied by launching refueling vehicle. It was possible to fly between not more than 6-7 objects using a single refueling with available summary characteristic velocity (SCV) up to 2.5 km/sec. The authors of the article used to change the RAAN directly by velocity impulses, resorting to a drift orbit only in several cases (if required ΔV was very huge, 8 flights from 34). Moreover, the parameters of the drift orbits were chosen not rationally. Such approach resulted in covering 35 objects in 7 years (5 objects per year) using one SV and 7 additional resupplies with total SCV costs of 17.076 km/sec. The results of the current research allow the significant refinement of both active SV's characteristics and SCV costs required to execute a flyby of 46 LSSD objects at Sun-synchronous orbits. Two flyby schemes (successive and diagonal) were developed based on the usage of the Earth gravity field's non-centrality. The application of these schemes permitted to decrease dramatically both the SCV costs (7.108 km/sec opposed to 17.076 km/sec) and the number of required resupplies (4 against 7); herewith 11 more LSSD objects are covered and the mission duration de facto still remains the same. The authors have also calculated the flyby maneuvers for all the LSSD objects situated at LEO and classified into 5 groups using orbital inclination as a criterion. The analysis of the obtained results shows that the quantity of TDKs equal to 25 units, which was previously postulated to be placed onboard in some research, is evidently redundant in case of all the five LSSD groups. If the developed maneuvering schemes are implemented, a SV planned to be used for LEO clean-up has to possess SCV resource up to 2300 m/sec and to carry onboard up to 12 TDKs. Using the described active SV it is real to clean all the five groups (to take 160 LSSD objects away to the disposal orbits) only by means of 9 active SVs and 5 resupplies.