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THE CALCULATION FEATURES OF FLYBY MANEUVERS OF A SPACE VEHICLE SEQUENTIALLY TAKING THE OBJECTS OF LARGE-SIZE SPACE DEBRIS TO LOW DISPOSAL ORBITS

Abstract

Regarding the large-size space debris (LSSD) objects with a cross-section more than 5 square meters situated at LEO, it is possible to mark out 5 non-structured groups of such objects according to their spatial distribution. The orbits of objects in a group have approximately the same inclinations whereas the deviations in the Right Ascension of the Ascending node (RAAN) may be arbitrary. The features of orbital planes' mutual orientation change in a group are seen from the RAAN deviations' evolution portrait. The flights between the objects are being executed by a single active space vehicle (SV) which captures an LSSD object and takes it away to the specially calculated circular or elliptical low disposal orbit (DO), and then returns back for the next object. The calculation of flyby maneuvers in fact breaks up into two independent tasks. At first, one can determine the parameters of the DO for each LSSD object using special software, so the coplanar maneuvers can be calculated ensuring the object's transition to this orbit. Secondly, the flight to attain a new object is carried out from the DO of the previous object at the moment of time when their orbital planes will become equal. So it is possible to calculate the maneuvers which help to return back for the next object using numerical-analytical algorithm developed for non-coplanar rendez-vous of middle duration. The time interval for an active SV to stay at the DO is defined by the difference of precession velocities of orbital planes of the de-orbited object and of the following object. The usage of a circular DO allows an LSSD object to leave promptly from the region (over 700 km) where active SVs and other debris exist for a long time, whereas the apogee of the elliptical DO remains in the mentioned belt for 10 years. While forming elliptical DO one will need approximately 30% less of required summary characteristic velocity as compared with circular DO. The collision risk for an object staying at the elliptical DO during these ten years would constitute a half of the collision risk which takes place if no removal operations were carried out. The paper is enriched by the examples of flyby maneuvers calculation for all the five LSSD groups using the described removal scheme.