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CONFIGURATION SCHEMES OF ACTIVE SPACECRAFTS FOR REORBITING LARGE SIZE SPACE DEBRIS

Abstract

There are two kinds of space debris. The first group consists of spent spacecrafts, last stages of launch vehicles, and uppers stages, and the second group, of fragments (parts and pieces) of spacecrafts of various sizes. In course of time, fragmentation makes members of the first group to go into the second group. In this connection, removal of space debris objects (SDO) as a potential source of fragmentation is considered as the most efficient method for mitigating the anthropogenic pollution of the near-Earth space. Calculations show that the most energetically efficient approach is to remove within one mission series of SDOs with close inclination of orbits. The report presents results of study of variants of configuration schemes of spacecrafts aimed at de-orbiting groups of 10-15 SDOs. The first option calls for a spacecraft to de-orbit KAUR-1-type communication spacecrafts, the second variant is concerned with a spacecraft for de-orbiting upper stages of Zenith-type launch vehicles, in the third variant, a spacecraft is required for re-orbiting DM-type upper stages from geostationary orbit. It is shown that for LEO and GEO it is reasonable to use different configurations. It is more efficient to clean LEO by using a space complex consisting of an active spacecraft (ASC) carrying small retrograde propulsion modules (RPMs). An ASC is responsible for transfers between SDOs, orbit rendezvous operations, capture of an object, accommodation of an RPM on it, and attitude and orbit control operations prior to de-mating. An RPM is aimed at performing deceleration burns, using which an SDO is transferred to a disposal orbit. The method of mountings an RPM on an SDO depends on the SDO configuration. For a launch vehicle stage it is proposed to mount an RPM in the main engine nozzle using the original magazine-type loading of RPMs in an ASC. For "KAUR"-type SCs an RPM is proposed in the form of a split-ring which is accommodated by a robotic arm on the SC cylindrical body. It is expedient to clean GEO by a single-stage ASC (without RPMs), which is responsible for the delivery of an SDO to a disposal orbit. In the report we also consider ASC-centering approaches required as RPMs are depleted and discuss methods for minimization of perturbations during SDO grips. The possibility of ASC refueling for enhancing the mission efficiency is also investigated.