SEARCH FOR THE DISPOSAL ORBITS WITH A GIVEN LIFETIME FOR A NEAR-POLAR SPACE DEBRIS

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One of the measures of guidelines for space debris (SD) mitigation in the maintained near-earth space (NES) orbits is a removal of the big size man-made SD, in particular these ones which have terminated their mission plans, from these regions. For the low-earth orbits (LEO) it means the transfer of SD objects into the new (so-called disposal) orbits having lifetime not more than 25 years. One of the most intensively maintained LEO are the near-polar orbits, including the solar-synchronous ones. Already at present time these orbits are strongly occupied by the anthropogenic (man-made) SD, having a number of hundreds of catalogued objects. These SD objects represent a potential hazard to the operating space vehicles and are capable to orbit the Earth within the mentioned regions for a long period of time - up to several hundreds of years. For that reason the problem on removal of the useless SD objects from the used LEO regions is rather topical.

The task of a search for the so-called disposal orbits, which can ensure the given limited lifetime for the started to move in them space objects (SO), and to which it is necessary to re-orbit the SD objects being in solar-synchronous orbits with the mean altitudes $H_{cp} \sim$ 750-850 *km* is considered.

The disposal orbit is formed on the basis of an original working orbit by the application in some its point of a corresponding impulse of velocity $\Delta\mathbf{V}$, directed against the space vehicle' motion. As a result of such a kind of braking maneuver the inclination of the new orbit will save the original value, the orbital maximum altitude will coincide with the mean altitude of an original orbit and the orbital minimum altitude will accept some value from an interval 200-750 *km*. At an estimation of a required fuel content (ΔV) for a realization of the re-orbital maneuver it is supposed, that this maneuver implements by means of a propulsion system having a specific impulse J_{sp}=360*s*, and the initial mass of a space craft $m_0 \sim 500kg$.

The lifetime of a SO in a disposal orbit for each variant of input data was estimated by means of numerical integration of the equations of motion in which perturbations due to a non-central gravitational field of the Earth, an atmospheric drag and a luni-solar attraction were considered. It was supposed, that SO terminates its life in an orbit when orbital altitude above the Earth' surface ellipsoid satisfies the condition: $H < 80$ *km*. At calculation of an atmospheric density on long-term time intervals the special models for prediction of the solar and geomagnetic activity indexes developed by the experts of IZMIRAN (the Institute of a terrestrial magnetism an ionosphere and distribution of radio waves of the Russian Academy of Sciences) were used.

As a result the estimates of lifetime of SO, starting orbiting in the disposal orbits, depending on the minimal altitudes of such orbits, on initial values of an argument of pericentre ω, longitude of ascending node Ω and inclination i of the disposal orbits and on values of the ballistic coefficients of space objects were obtained. In addition the dependence of SO' lifetime on a solar activity at the beginning of SO' motion on a disposal orbit was studied. The energy costs demanded for the de-orbiting of big size space object from near circular orbit with $H_{mid} \approx$800 km into the disposal orbits with different minimal altitudes were estimated. Recommendations for selection of the disposal orbits for the examined class of the solar-synchronous orbits ensuring lifetime not exceeding 25 years for de-orbited space objects are made.