ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations (IP)

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PREDICTION OF ATTITUDE MOTION OF NONFUNCTIONAL SATELLITES OR SPENT ROCKET STAGES FOR LONG TIME IN ORBIT

Abstract

The primary purpose of the work is to describe the long-term in-orbit behaviour of the nonfunctional satellites or spent rocket stages, which are represent the space debris. The main consideration is given to the study of the attitude motion. Space debris can remain in orbit for a very long time—from several months to entire decades, for example, Russian rocket "Cosmos-3M". The residence time in orbit is calculated from the end of the active mission satellite or upper rocket stage until a possible removal as debris or until the re-entry into the Earth's atmosphere.

To describe the attitude motion of debris the dynamic Euler equations and the attitude kinematic equations using quaternions are obtained. The keplerian osculating elements are used for locate the debris position in the orbital frame. Non-centrality of the earth's gravitational field, air drag, anomalies of gravitational force, attraction of moon and sun, and solar wind pressure are taken into consideration. The proposed mathematical model can be applied for stochastic modelling of the motion of debris for long periods of time, when it is taken into account the fluctuation of external disturbing factors and parameters of debris. Verification of the mathematical model is carried out by comparing the position of the debris in orbit, obtained by simulation and data telemetry system NORAD.

The obtained results can be applied to study the long-term in-orbit behaviour of the space debris, as well as for choice of the means of capture of space debris (harpoon, robot manipulator, net, lasso ...) and determining the areas falling debris on the Earth's surface.