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TETHER LENGTH CONTROL IN TETHER-ASSISTED DEORBITING MISSION FROM AN ELLIPTICAL ORBIT

Abstract

Among proposed applications of tethers in space, tether-assisted payload deorbiting projects are closest to the wide practical implementation.Three experiments were carried out successfully to date. The idea is to avoid the use of jet engines to generate a brake pulse, which transfers the payload on the descent orbit.The necessary reduction in velocity can be obtained through the use of features of the orbital motion of the space tether systems. Development of effective tether control methods are of great scientific and technological interest. The majority of research concerns the descent of a payload from a circular orbit.The aim of this research is development of an effective method of the tether control in tether-assisted payload deorbiting mission in the case of elliptical orbit of small eccentricity.

The plane motion of the space tether system, which consists of a satellite, massless tether and payload, is considered. It is supposed that the center of mass of the system moves on a Keplerian orbit with small eccentricity. The tether length control law, which is based on a swing principle, is proposed. The equation of the controlled relative motion of the tether around the center of mass is obtained.The angle of the true anomaly is used as an independent variable. It is shown that in the vicinity of the local vertical a stable limit cycle with period 2 pi may exists for certain values of the coefficient in the control law.An approximate analytical equation of this cycle is obtained. It is shown that considered control law can transfer the system into rotation mode, which is more preferable for the tasks of payload deorbit, as it provides a greater reduction in the payloadvelocity. The optimal value of the control coefficient and the moment of payload separation, which ensure transfer of the payload into the orbit with a minimum altitude of the perigee, are founded numerically for case of small eccentricity.

The proposed control law can be used to develop new deorbiting systems.