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EXTENSIBLE TETHERS AND SPACECRAFT DYNAMICS IN PROXIMITY OF ASTEROID

Abstract

The increasing activity on exploration of small celestial bodies makes especially interesting studying the spacecraft dynamics near such bodies. One of the principal characteristics of small bodies is their low mass and irregular mass distribution; therefore, in the development of missions to asteroids and comets one must take into account the weakness as well as irregularity of their gravitational field.

Weak and complex gravitational field combined with rather large centrifugal force represent serious difficulties for any operations of spacecraft in the vicinity of asteroid. One of the possible solutions to the problem could be placing the spacecraft near the asteroid and connecting it to the surface by tethers. Modern materials and technologies allow one to produce a tether adequate for such applications, but of course the properties of the materials used will affect the system dynamics. One of the most noticeable impacts on the space tethered systems dynamics is produced by the tether elasticity, so one has to take into consideration deformation properties of the tether in mathematical modelling. In the present paper, the relative equilibria of a spacecraft attached to the surface of a uniformly rotating celestial object with an extensible tether are considered. The domains, where the spacecraft can be collocated using a tether, are described. The curve of locations for possible relative equilibria is obtained. The dependence of relative equilibria on positions of the anchor and on pendulum length is discussed. The stability of the found solutions is studied using the Routh method. The bifurcation diagrams are drawn. The degrees of instability are determined for each branch of the bifurcation diagrams. The results are illustrated by an example showing tether equilibrium locations for a body with a given mass distribution.