15th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Space Mineral Resources, Asteroid Mining and Lunar/Mars insitu (5)

Author: Prof. Alexander Burov
A.A.Dorodnicyn Computing Centre, FRC Computer Science and Control, Russian Academy of Sciences & Higner School of Economics, Russian Federation

Prof. Anna Guerman
Centre for Mechanical and Aerospace Science and Technologies (C-MAST), Portugal
Prof. Ivan Kosenko
A.A.Dorodnicyn Computing Centre, FRC Computer Science and Control, Russian Academy of Sciences, Russian Federation
Mr. Vasily Nikonov
FRC Computer science and control, Russian Academy of Sciences, Russian Federation

TETHERED SPACECRAFT IN AN ASTEROID GRAVITATIONAL ENVIRONMENT

Abstract

We examine dynamics of spacecraft tethered to the surface of an asteroid in the framework of a quite simple analytical model. The problem of existence and stability of equililibria for an inverted pendulum suspended at a point of a uniformly rotating asteroid with an arbitrary mass distribution is considered. Conditions of existence and stability are expressed as functions of pendulum's length. The results are compared with those obtained for terrestrial and lunar gravitational conditions. The feasibility of the asteroid elevator with a massless inextensible tether is also discussed.

It is known that in vicinity of natural bodies an inverted pendulum exhibits instability due to the combination of gravitational and centrufugal forces; this instability relates to the local maximum of the augmented potential. As is also known, a very long inverted penulum is stable due to the local minimum of the augmented potential provided by the centrfugal force. Naturally, it is expected that the interval between the maximum and minimum of the augmented potential should contain bifurcations and intermediate relative equilibria related to a saddlepoint of the augmented potential. This effect has been detected in [1,2] for a lunar pendulum anchored in a plane of the lunar orbit (see also [3,4]). For a pendulum suspended at a point in the Earth equator, similar properties have been detected in [5].

The results are compared with those obtained for terrestrial and lunar gravitational conditions. The feasibility of the asteroid elevator with a massless inextensible tether is also discussed (cf. [6,7]).

[1] Ricard N. Étude en stabilité de l'ascenseur lunaire. Rapport d'activité. Moscou. Juin 2004.35 p.

[2] Burov A.A. and Ricard N. On lunar elevator. Proc.XXIX Academic Conference on Cosmonautics. Moscow,2005.

[3] Burov A.A., Guerman A.D., Kosenko I.I. Equilibrium configurations and control of a moon-anchored tethered system. Advances in the Astronautical Sciences. 2013. Vol.146, pp.251-266.

[4] Burov A.A., Guerman A.D., Kosenko I.I. Dynamics of moon elevator. 65th International Astronautical Congress, Toronto, Canada. IAC-14-D4.3.9.

[5] Burov A.A., Kosenko I.I. Stability and bifurcations of relative equilibria of a pendulum suspended on the equator. Cosmic Research. 2013. Vol.51. Issue 3, pp.209–212.

[6] Synge J.L. On the Behaviour, According to Newtonian Theory, of a Plumb Line or Pendulum Attached to an Artificial Satellite. Proceedings of the Royal Irish Academy. Section A: Mathematical and Physical Sciences. 1959. Vol.60,pp.1-6

[7] Blitzer Leon, Equilibrium and stability of a pendulum in an orbiting spaceship. American Journal of Physics. 1979. Vol.47,p.241.