 Paper ID: 7198

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (2) (2)

Author: Prof. Maurizio Parisse
University of Rome "La Sapienza", Italy, parisse@psm.uniroma1.it

Prof. Fabio Curti
University of Rome "La Sapienza", Italy, fcurti@psm.uniroma1.it

TETHER LENGTH CONTROL FOR ORBITAL MANOEUVRES

Abstract

It is well known that the cable elongation or retraction in a tether system causes pitch oscillations, whose amplitude depends on the radial velocity vector of the tip masses. The Coriolis forces, responsible for such deviations from the local vertical, can be exploited to control the pitch angle. Hereby, we propose a strategy to progressively increase such angle by forcing the system to leave the potential hole where it is trapped by the stabilizing gravity gradient torque. As a result, the tether will start to rotate around the center of mass of the system. This strategy is based on a suitable continuous control that, upon measuring the angular velocity of the pitch angle, shortens and lengthens the tether during the oscillations. The control variable is the radial velocity along the direction of the cable and it is constrained to have a maximum value in the reel- in phase while taking into account the limit of the driver's device. Two approaches are given: the minimum time control and the minimum energy control. Once the dumbbell is spinning, the mass of interest can be released where, for instance, its absolute tangential velocity attains the maximum or the minimum value in order to modify the orbital parameters or in order to begin a re-entry phase. In the spinning mode, the control can increase the pitch angular velocity by decreasing the length of the cable. This allows for the possibility of tuning the tangential velocity of the mass of interest and, as a consequence, to select the parameters of the new trajectory of the mass. The possible applications are however, manifolds and for some of them it is important to explore the importance of the aerodynamical drag acting on the mass, which, for low orbits, plunges periodically into the upper layer of the atmosphere. During the orbital motion, the aerodynamic forces pump rotational energy into the tether system thus, increasing its spin and assisting in the attainment of the desired tangential velocity. By exploiting the interaction with the upper atmosphere, it is then possible to minimize the power budget necessary to put the system into rotation. In fact, once the minimum excess of pitch velocity sufficient to escape the gravity gradient torque has been achieved, the residual energy will be provided by the activity the aerodynamical forces carry out.