Paper ID: 28257
oral

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (1) (7)

Author: Prof. Vladimir S. Aslanov
Samara National Research University (Samara University), Russian Federation

CONTROL OF A TETHER DEPLOYMENT SYSTEM FOR DELIVERY OF A RE-ENTRY CAPSULE

Abstract

The field of space tethers has received very much attention in recent decades. The central advantage of using tethers in many of these applications is that very little fuel needs to be consumed. The tethered systems offer numerous ways of beneficial implementation on modern spacecrafts and allow to perform multiple tasks including such as payload delivery from the Earth orbit. It is the task of payload delivery from an orbit is the closest to wide practical realization from all other space tether's tasks. As demonstrated by the mission of YES2 a re-entry capsule can be returned to Earth by a tether. Braking of the capsule is achieved using momentum provided from the swinging tether. The more a deflection angle of the tether from the local vertical, the more braking effect of the capsule is achieved. The goal is to find the control law that allows one to increase the angle of deflection of the tether from the local vertical, i.e., to increase momentum provided from the swinging tether. This control law can be applied to the final phase of the deployment of the tether, both for dynamic so the static deployment. The control law is based on the principle of a swing with variable length. An approximate analytical solution for the envelope of the angle between the tether and the local vertical is obtained for the proposed control law. Simulations show that the system can be controlled quite well using the proposed control law for the tether length rate. The effects of orbit eccentricity and viscoelastic properties of a tether were incorporated into the mathematical model to allow more accurate trajectories to be computed. Small orbit eccentricity and viscoelastic properties for the YES2 mission have only minor effects on the trajectories. In this case, the tether tension and the release speed of the tether have been small. The control method allows to reduce a required tether length for deliver capsules on Earth's surface. Using this method, we have shown that it is possible to diminish tether length at 5 km as compared with YES2 mission. Results of the numerical modeling showed that the control law is effective for the final phase of the tether deployment, when the initial deployment occurs by means static or dynamic scheme.