IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (2) (4)

Author: Mr. Kirill Chernov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation

Dr. Danil Ivanov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation

APPLICATION OF ELECTRODYNAMIC TETHERS FOR TETRAHEDRAL SATELLITE FORMATION CONTROL

Abstract

Several number of satellites flying in a group can solve different applied and research problems in space. It is required to apply continuous relative motion control to maintain the formation, otherwise the satellites are flying apart. But in case the satellites are connected to each other by tether, the length of the tether limits the distance between the satellites. Nowadays, an application of electrodynamic tethers for orbital motion control using the Lorentz force is a promising concept in astrodynamics.

The paper considers a group of four satellites connected to each other by six flexible conductive tethers. If an electric current flows through the tether, then the Lorentz force acts on it in the Earth magnetic field. The resultant force as a sum of six Lorenz forces acts on the whole formation. Also, these forces produce torque relative to the center of mass of the system. So, the changing the magnitude of the currents allows to control the orbital and angular motion of the formation. This work studies the problem of achieving and maintaining the required motion of the tetrahedron. The required torque is calculated using the direct Lyapunov method. When the value of the required torque vector is set, the currents in the tethers can be computed. The magnetic field is assumed to be the same in all points of the system as the dimension of formation is less than the orbit radius.

The results of numerical simulation of the tetrahedral formation motion in low Earth orbit are presented in the paper. The angular motion control is aimed to unwind the system to the specified angular velocity in order to tense the tethers. The translational motion control solves the problem of achieving the given trajectory relative to reference frame moving along the circular orbit. Such a relative motion can be used for tasks of two tetrahedral systems formation flying. The flexibility of tethers is taken into account in numerical simulation. Investigation of controlled motion performance depending on different parameters is conducted.