Reconfiguration of a Nadir-Pointing 2-Craft Coulomb Tether

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Abstract

The linear dynamics and stability analysis of reconfiguring a 2-spacecraft Coulomb tether formation is investigated. In this concept the tether between two craft is replaced with electrostatic force fields. Here the relative distance between the two satellites is increased or decreased using electrostatic Coulomb forces. The two craft are connected by an electrostatic tether which is capable of both tensile and compressive forces. The resulting virtual structure can change its shape by modifying the desired reference length. As a result, the two-craft formation will essentially act as a long, slender, nearly-rigid body of variable length. Inter-spacecraft Coulomb forces cannot influence the inertial angular momentum of this formation. However, the gravity gradient effect can be exploited to stabilize the attitude of this Coulomb tether formation about an orbit radial direction. Limits of the Coulomb tether expansion and contraction rates are discussed using linearized time-varying dynamical models. These allow the reference length time histories to be designed while ensuring linear stability of the virtual structure.

Keywords: Coulomb tether, formation flying