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Author: Ms. Thais Oliveira
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, thais.tata@gmail.com

ANTONIO FERNANDO BERTACHINI DE ALMEIDA PRADO
Instituto Nacional de Pesquisas Espaciais (INPE), *(country is not specified)*, prado@dem.inpe.br

ELECTRODYNAMICS TETHERS REDUCING EXTERNAL DISTURBING FORCES

Abstract

The objective of this work is to create an electromagnetic propulsion in the opposite direction of the disturbing forces that is desired to be eliminated or reduced. The greatest advantage to use the electrodynamic tether instead of the thrusters is that there is only power expenditure and no fuel consumption. The reduction of the magnitude of the external disturbing forces, especially the atmospheric drag in low Earth orbits (LEOS), can result in significant fuel savings. It is assumed that the current of the tether can flow in both ways, than the tether can also be used to de-orbit the spacecraft with no fuel consumption and no power expenditure. The removal of spacecrafts from LEO is essential to guarantee less space debris and less impact risks to current and future missions. The tether proposed in this work is the bare tether, which is the best eletrodynamic tether that can be used in this context. It is capable of allowing larger currents and collecting more electrons than the insulated one. If the current flows along the induced electromotive force (EMF), then the induced Lorentz force can be used as a de-orbiter. If the current flows against the induced EMF with energy provided by a battery, than the induced Lorentz force can be used to reboost the system. This work, at first, considers the use of a battery to drive the current in the desired direction that reduces the disturbing forces. Then, in the second stage of this work, the de-orbit analysis is considered. The disturbing forces that are used in this work are: atmospheric drag, solar radiation pressure, third-body perturbation of the Sun and the Moon, the J2 and C22 spherical harmonics perturbation. The disturbing forces that desired to be eliminated or reduced are defined. Then, it is found the optimal attitude that the tether must have in order to guarantee that the direction of the induced Lorentz force is opposite to the external forces. The current that the tether must have is also computed in order to guarantee that the magnitude of the Lorentz and the external forces is equal or as close as they can be. The physical limitations are the maximum current that the tether can have and the drop of the electron density in the ionosphere due to the umbra and penumbra regions.