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Author: Dr. Feng Zhang
China Academy of Launch Vehicle Technology(CALT), China

Mr. Xiaoding Wang
China Academy of Launch Vehicle Technology, China, China
Dr. Hao Wen
Nanjing University of Aeronautics and Astronautics, China
Prof. Lin Shen
China Academy of Launch Vehicle Technology (CALT), China
Mr. Wang Xiaowei
China Academy of Launch Vehicle Technology (CALT), China

ORBITAL TRANSFER PERFORMANCE AND MISSION APPLICABILITY ANALYSIS FOR BARE ELECTRODYNAMIC TETHERED SPACECRAFT

Abstract

The electrodynamic tethered (EDT) technology is a novel way to enforce space orbit transfer. Different from EDT based deorbit technology, the EDT based orbital transfer requires an auxiliary power supply possibly provided by solor array or other sources, so as to generate the current flowing along the tether by transmitting to and from the ionospheric plasma. The resulting electrodynamic interaction for the deployed conductive tether moving at orbital speeds across the Earth's magnetic field enables to generate a propulsion force (the Lorentz force) on the spacecraft to change the orbit. Due to fuel efficiency and ease of use, the EDT based orbit transfer technology has become a research focus in recent years.

The present paper foucuses on the systematical analysis of orbit transfer performance and applicability for bare electrodynamic tethered (BEDT) spacecraft. To this end, a singularity-free orbital dynamics is firstly developed for the BEDT based orbit transfer mission, where several perturbations are taken into account, including the earth magnetic field, the atmospheric drag, and the earth oblateness effect. Based on this dynamical model, a number of numerical simulations are then undertaken to investigate the orbital transfer performance with various mission parameters involving the initial orbit height, initial orbital inclination and the tether length. To improve the simulation validity, the NRLMSISE-00 model is utilized to compute the atmospheric density, the IGRF 11 data is utilized to determine the magnetic intensity and the IRI 2007 model is utilized to get the electron density. It can be mainly concluded from the simulation that 1) the BEDT based orbit transfer ability shows weak for the cases with the initial orbital height over 1500km, or for the cases with polar orbit; 2) meanwhile, the BEDT technology is mainly able to change the orbit height rather than the eccentricity; 3) the BEDT technology is prone to provide better orbit transfer performace for cases with longer tether, low orbit inclination and low orbital height. Based on the aforementioned analysis, the paper finally gives the applicability analysis and mission proposals for the BEDT based orbit transfer system.