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Author: Mr. vishal ray
India, vishal2108ray@gmail.com

Mr. Ratnesh Mishra
Indian Institute of Technology, India, ratnesh1607@gmail.com
Mr. Shantanu Shahane
Indian Institute of Technology, India, shahaneshantanu@gmail.com
Ms. Manvi Dhawan
Indian Institute of Technology, India, manvidhawan1993@gmail.com
Ms. Ankita Humne
Student, India, ankitahumne.ah@gmail.com

MODELING DYNAMICS OF TETHERED SMALL SATELLITE FOR DE-ORBITING

Abstract

The prevalence of space debris mostly in low Earth orbits increases the likelihood of collisions and creates debris belts that render many orbits unusable. Hence there is a need to de-orbit a satellite at the end of its mission life. De-orbiting of a small student satellite at minimal expense can be achieved using electrodynamic tether. Tether is a conducting longcablewhich works on electromagnetic principles and converts kinetic energy into electrical energy.

This paper presents the stages of modelling and simulation predicting the trajectory and dynamics of system (satellite + tether) during de-orbiting. First stage is to model dynamics of single mass under gravity and predict its trajectory. Second stage is the modelling of two masses initially attached and then separated by momentum transfer. In this model, position, velocity and relative distance of the two particles are analyzed over a period of time. Third model is the up gradation of previous model with two masses connected with an elastic spring. Until the string reaches its maximum length, particles are free under gravity and hence the model identical to model 2. But once the string becomes taut, it tries to apply an equal and opposite force on both the particles and tries to bring them closer towards the center of mass. Similar to the model 2, relative distance between the two masses is plotted with respect to time under the influence of gravitational and elastic forces. EMF generated by the motion of conducting wire is incorporated in fourth model. This current carrying wire moving through Earth's magnetic field produces Lorentz force opposite to the direction of motion and hence decreases its velocity. The current through wire is a function of the magnetic field, plasma electrons, shape of the cable and instantaneous velocity of tether. The shape pf the rope is modeled dynamically it as a solution of forced hyper degrees of freedom system. The magnetic field is modeled using a standard International Geomagnetic Reference Field.

Thus this paper presents modelling methodology of analyzing the trajectory which is a result of complex dynamics among all the forces are modeled and trajectory is analyzed.