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# DEORBITING OF ELECTRODYNAMIC TETHERED SYSTEMS CONSIDERING TETHER LONGITUDINAL ELASTICITY AND AERODYNAMIC FORCES

**Abstract**

There are many potential applications of electrodynamic tethers (EDT) in space. It is likely that one of the significant applications of EDT will be for space debris removal. An EDT can be deployed at the end of the satellite mission and as a result of the generation of the Lorentz force orbital decay will occur. When the altitude becomes sufficiently low, both the aerodynamic drag and the Lorentz force will contribute to the orbital decay. It is well-known that the attitude dynamics of an EDT is normally unstable. Thus, several schemes have been proposed in the literature to stabilize the attitude dynamics, mostly by using current modulation. In addition, it has been found that the interaction of longitudinal oscillations of a long tether and the aerodynamic force gradient can also lead to librational instability. Clearly, successful debris removal using an EDT must avoid such instability. This study considers the debris removal process using an EDT in more detail by considering the Lorentz and aerodynamic forces as well as longitudinal oscillations of the tether. It is found that, in fact, it is possible to use the aerodynamic force to remove the instability of the attitude dynamics caused by the Lorentz force. A complete framework for analyzing the stability of a fully taut electrodynamic tether considering longitudinal oscillations of the tether and aerodynamic forces is presented in the paper. The equations of motion are derived using Lagrange's equations. The generalized forces in these equations arise from the aerodynamic and electrodynamic forces. The former is determined assuming free molecular motion in the atmosphere. The latter is obtained by using IGRF-12 for the geomagnetic field. The aerodynamic forces are calculated assuming the two end masses to be spherical, but a lifting panel is attached to the subsatellite. It is then shown that the inclination of this lifting device has a key effect on the stability of the EDT configuration. The effects of various EDT system parameters on the equilibrium and stability of the EDT are examined. Nonlinear simulation results are presented to show the time histories of electrodynamic tether orientation in space as well as orbital decay. It is demonstrated by simulation that the attitude stability of the tether is advantageous for orbital decay.