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Conceptualizing Space Elevators and Tethered Satellites (3)

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TETHER MATERIAL AND DEPLOYMENT MECHANISM FOR TETHERED SATELLITE CONSTELLATIONS

Abstract

The past several years have shown a profound increase in research and development related to tethered satellite systems (TSS). The tethers are divided into conductive, or non-conductive types. Some of the more popular applications of these systems include current collection, as the tether cuts through Earth's magnetic field lines, or alteration of a satellite's orbit by taking advantage of the laws of attraction and repulsion in electricity and magnetism. Space debris removal or orbital transfer maneuvers are two of the more well-known application concepts, while a TSS may also be used as an in-orbit elevator for transferring payloads from one orbit to another via a robotic climber, which travels up and down the tether. While a robotic climber traversing between two satellites can also be useful for identifying damaged areas in the tether, or changing the orientation of the system, there are limitations imposed by their respective drive mechanisms. Research on climber technologies for in-orbital elevators has been gaining ground, but the friction drive system is still the most common method used for locomotion. This system has made its appearance all over the world in various Space Elevator Challenges held throughout the past decade. Such a system is relatively simple to design, but causes excessive wear on the materials used for the tether and drive wheels, which can not be easily replaced in orbit. One alternative is to use a linear direct drive mechanism, which requires a precise alignment of magnetic fields along the tether in order to move reliably. This paper focuses on the in-orbit elevator concept, by examining the effects of various tether geometries and designs, namely by incorporating specific patterns in the conductive material which makes up the tether. This might be used for the power supply or charging of a friction drive climber, or to create a "rail", along which a linear motor would travel. The later is achieved by electricity passing through the length of the patterned tether, which creates magnetic fields that induce the linear direct drive mechanism to propel the climber back and forth along said tether.