

SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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ACTIVE REMOVAL OF LARGE TUMBLING SPACE DEBRIS BY MEANS OF TETHERS

Abstract

Orbital debris have become a factor of increasing significance to space missions and is a constant concern because of the significant damage that can be caused by even very small pieces. Therefore, removal of large space debris before explosions or collisions occur alleviates the hazard posed to space assets by these objects. International guidelines call for reentry within 25 years for non-cooperative objects. This study proposes a method for increasing the eccentricity and lowering the perigee altitude of the debris' orbits. This is achieved by a space tether system with a balancing mass at one tip and a net device at the other, which is made to gracefully entangle with a tumbling debris object without breakup. First order simulations of the proposed technique show that there are three primary benefits that will contribute to a decrease in the on-orbit risk. Two of the benefits the increased eccentricity of the debris object. First, with the lower perigee altitude, decay will be enhanced allowing for a quicker reentry of the debris object. A sample case was examined for a 0-degree capture angle (tether mass is directly above the debris object), mass ratio between the tether and the debris object of 0.1, and tether length of 10 km which resulted in a lowering of the perigee by approximately 50 km. Second, the increased eccentricity results in a lowering of the probability of collision. Simulation for a sample case shows that a 10 km tether will drop the long-term probability of collision by 10%; a 20 km tether by 28%, and a 30 km tether by 33%. A third benefit unrelated to the eccentricity increase occurs if the capture mechanism is designed to contain a drag-enhancement device; this will further decrease the time until the debris object re-enters. As a result, mission assurance of existing assets will be enhanced by making it more probable for active space assets to complete their designed mission lifespan.