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REDIRECTION OF TUMBLING ASTEROIDS AND ORBITAL DEBRIS BY MEANS OF SPACE TETHERS

Abstract

Near Earth Asteroids, or NEAs, are asteroids whose heliocentric orbits could intersect with Earth's orbit, posing a collision risk. Orbital debris are man-made objects whose geocentric orbits could intersect with those of functioning spacecraft as well as other space debris and pose similar collision risk. Therefore, redirection of hazardous objects in either category is desired. Despite the different orbits and velocities, NEAs and orbital debris share similar properties that make them capable of being redirected by a space tether. A tether concept is proposed which attaches itself to the object and slows its rotational motion by wrapping around it. Detumbling or despinning of asteroids can simplify precision docking, resource utilization or redirecting operations. Similarly, detumbling or despinning of large space debris can simplify servicing or redirecting operations. The study examines whether tether systems are beneficial to these objectives. Tether severing is optimized for maximum despinning or redirecting effectivity, depending on mission objectives such as building an adequate Earth miss distance for earthbound asteroids, or actively removing large defunct orbital debris from valuable geocentric orbits. A sample case is examined consisting of a small asteroid in a near-circular heliocentric orbit where the mass ratio of the asteroid to the tether was set to 250, in combination with a with a tether varying in length from 10,000 km to 100,000 km. The simulation of this concept was restricted to the orbital plane. Other sample cases were examined consisting of typical upper stages in a near geocentric circular orbit with a range of mass ratios and tether lengths. The results show the level of efficacy of tether systems in both deflecting and despinning small asteroids and large space debris.