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SYMPOSIUM ON VISIONS AND STRATEGIES FOR FAR FUTURES (D4)
Space Elevators and Tethers (4)

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TETHER ASSISTED NEAR EARTH OBJECT (NEO) DIVERSION

Abstract

More than 2000 near earth objects with diameters greater than have been discovered by astronomers so far. Asteroids that can get closer than 0.05 AU to the earth, and have diameters larger than 150 m, are considered as potentially hazardous asteroids. There are currently more than 1000 known potentially hazardous asteroids. The impact of any asteroid with the earth could have a catastrophic effect on life on the planet. Potential earth impact threats by asteroids have motivated researchers to find effective NEO diversion techniques.

An asteroid can be deflected from the earth-crossing orbit by perturbing its motion. Many methods have been proposed for this. One of the techniques to perturb the motion of an asteroid and hence its trajectory is to attach a tether and ballast mass to the asteroid.

Attachment of a tether and ballast mass to the asteroid can alter its trajectory in two ways: changing the centre of mass and through the tension induced by the tether. It has been shown that by attaching a very long tether and ballast mass to the asteroid, reasonable deflections can be achieved after several years. The advantage of this technique is that the entire asteroid can be deflected rather than fractured by a direct impact because the fracture could cause unpredictable consequences.

In this paper we investigate the effect of attachment of a tether and ballast mass to the asteroid, and then cutting the tether at an appropriate time, to enhance the diversion achieved, and reduce the lead time needed. The instant of cutting the tether significantly affects the final orbit of the asteroid and thus the resulting diversion.

The dynamical model of the asteroid-tether-ballast system is developed in the paper. The equations of motion of the system are derived using the Lagrangian method. Numerical simulation results based on the Lagrangian equations of motion are presented.

The effectiveness of the new technique is demonstrated through two examples, with baseline parameters close to the parameters of two real asteroids. Numerical simulation results have corroborated that, it is possible to diverge hazardous asteroids, by attachment of a tether and ballast mass to the asteroid well ahead of time, and then cutting the tether at proper time.

It is also noted that, using this technique it is possible to alter the trajectory of asteroids with high eccentricity more effectively than of those with low eccentricity.