 Paper ID: 24482

12th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Global Strategy for Space Elevators (3)

Author: Dr. Nahum Melamed
The Aerospace Corporation, United States

Dr. Glenn Peterson
The Aerospace Corporation, United States

REDIRECTION OF TUMBLING ASTEROIDS BY MEANS OF TETHERS

Abstract

Capture and redirect of a near Earth asteroid (NEA) could benefit both space resource extraction as well as planetary defense efforts. Some mission operations and technologies required for these objectives could be applicable to both fields. This study examines the feasibility of capturing a rotating or tumbling target NEA with a space tether system and directing it to an orbit accessible for resource utilization, or alternatively, deflecting it away from an Earth impact if it had been found on an impacting trajectory. This is achieved by a space tether system with a balancing mass at one tip and a capture bag at the other. This approach effectively deals with a range of asteroid mechanical property uncertainties and would work equally well if the asteroid was a rubble pile or solid rock. A sample case was examined consisting of a small asteroid where the mass ratio of the asteroid to the tether was set to 10 with a 5000 km long tether. The orbit elements were chosen to be equivalent to the asteroid 2666 Nereus. While Nereus is a relatively large asteroid at 330 m and therefore much larger than the asteroids under consideration for this study, it was felt that its orbit elements were representative of the type of small asteroid that would be considered for retrieval. Preliminary results show the subsequent position and velocity change in the asteroid's orbit as a result of the tether being initially deployed in each of three directions: along-track, nadir (pointing towards the Sun), and normal to the orbit. When considering that the small sample asteroid, and indeed virtually any asteroid, is in an orbit that would require a delta-V change to rendezvous with the Earth of several kilometers per second, it is immediately apparent that the change in velocity being acquired through even this large tether is insufficient to perform a rendezvous/capture with the Earth. However, the position change results indicate that a tether of this type would be sufficient to potentially alter an asteroid's orbit to miss the Earth. The full paper provides result of a parameter study to determine the size/mass/orbit/rotation-rate element limitations of tethers. The study also examines whether severing the tether at an optimal point might provide improved deflection performance. This information can be used to examine the efficacy of tether techniques to the NEA threat problem.