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Conceptualizing Space Elevators and Tethered Satellites (3)

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TOWING OF SPACE DEBRIS USING A TETHER

Abstract

Tethers have potential for many space applications. One of the possible applications in the near-term is the towing of space debris for its disposal. Space debris can be captured by using either a tether-net or a harpoon located at the end of a tether deployed from a service spacecraft (space tug). After the capture, the debris can be towed to a graveyard orbit or can be sent down to re-enter the atmosphere. Naturally, a thrust will be applied to the tug during the de-orbit phase. The dynamics of the debris-tether-tug system during the towing operation involves many interesting aspects. Although several studies on this topic have already been conducted, there are still many unresolved issues. This paper addresses some of these issues.

During the towing operation, the debris-tether-tug system can either be in a nominally horizontal configuration or in a nominally vertical configuration. The two configurations have somewhat different dynamical behavior. It can be shown that both configurations are stable if there is a sufficiently large longitudinal thrust acting on the tug. Through analysis and simulation, it is shown in the paper that a nominally vertical configuration has better dynamical behavior and is more robust from stability point of view.

Results for the simulation of the coupled orbital and librational dynamics of the system, in the presence of an arbitrary thrust applied to the tug, are also presented in the paper. The de-orbit time clearly depends on the magnitude and direction of the thrust applied. Various scenarios are considered and corresponding dynamical behavior is examined in the paper.