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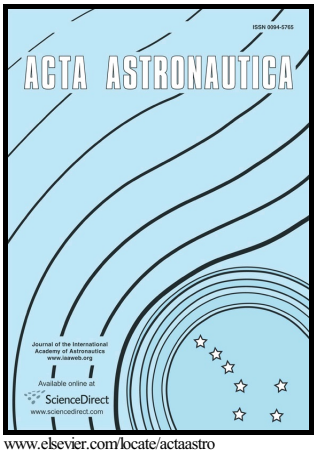

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Deployment Dynamics of Tethered-Net for Space Debris Removal

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Abstract

A tethered-net is a promising method for space debris capturing. However, its deployment dynamics is complex because of the flexibility, and its dependency of the deployment parameters is insufficiently understood. To investigate the deployment dynamics of tethered-net, four critical deployment parameters, namely maximum net area, deployment time, travelling distance and effective period are identified in this paper, and the influence of initial deployment conditions on these four parameters is investigated. Besides, a comprehensive study on a model for the tethered-net based on absolute nodal coordinates formulation (ANCF) is provided. Simulations show that the results based on the ANCF modeling method present a good agreement with that based on the conventional mass-spring modeling method. Moreover, ANCF model is capable of describing the flexibility between two nodes on the net. However, it is more computationally expensive.

Keywords: Space debris, Tethered-Net, Mass-spring model, ANCF model, Deployment dynamics

1. Introduction

Operational space missions, vital for the main services, in low-Earth orbits (LEO), are more and more endangered by millions of space debris. In order to mitigate this situation, many space debris capturing and removal methods have been investigated [1], such as the robotic arm removal method [2], tethered space robot [3], [4], [5], harpoon [6], manoeuvrable tether-net space robot system [7], etc. Among these methods, the tethered-net capturing method, also termed net capturing method, is regarded as one of the most promising capturing methods due to its multiple advantages: it allows a large distance between chaser satellite and target, such that close rendezvous and docking is not mandatory; it is compatible with various dimensions and shapes of space debris objects; and, finally, the net is flexible, lightweight and cost efficient. Figure. 1 shows the

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