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SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Issues (5)

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EXPANDING FOAM APPLICATION FOR ACTIVE SPACE DEBRIS REMOVAL SYSTEMS

Abstract

The threat represented for space missions by the increasing number of uncontrolled space objects has led to an international consensus regarding space debris mitigation guidelines. Given the naturally increasing debris population, the congestion of some orbits and the risks related to cascading effects following accidental or intentional breakups, systems might be needed to actively remove debris. Concepts for active debris removal have been discussed in the scholarly literature. The present approach is based on a novel, expanding foam system, which serves as a drag augmentation device: the aim is to increase the area-to-mass ratio of debris such that atmospheric drag causes natural reentry from low Earth orbits. The foam-based method realizes the drag augmentation by exploiting the characteristics of foams. These can nucleate almost spherical envelopes around target debris with very limited effort of the spacecraft carrying and applying the foam. The approach offers the advantage over other methods to not require docking systems and the ability to deal with spinning and tumbling debris. The method can be also conceived as a preventive method embedded in future satellites. This paper presents the method and analyses its performance. Special emphasis is given to the key aspects of expanding foams, to the demonstration to specific debris types, leading to sizing of the carrying spacecraft. It is equipped with an electric propulsion system that enhances the performance of the complete mission scenario. With this approach, the specific foam ball radius can be tailored to the debris. The sizing considers the foam mass, the deorbiting time and the impact probability of targeted objects. An upper threshold of 10 m radius assures the deorbiting of most of the selected debris within a reasonable time. The approach heavily relies on the foam characteristics, e.g. its density and expansion factor. In this study a low order expanding model is introduced and several assumptions close to state-of-the-art for ground-based foam models are considered. First results demonstrate the feasibility to deorbit up to 1 ton debris within 25 years from 900 km altitude with this method. A high power Hall effect thruster assures to deorbit about 3 ton cumulated space debris per year. All in all, the study demonstrates the feasibility of the method, even as a relatively short-term application since most key technology assumptions taken are based on state-of-the-art references.