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POLYURETHANE-FOAM BASED SPACE DEBRIS REMEDIATION: A COST-EFFECTIVE AND EFFICIENT APPROACH

Abstract

The escalating threat of space debris poses a significant challenge to the space industry, particularly in the densely populated Low Earth Orbit (LEO), where collisions contribute to a daily increase in the number of space objects. Existing technologies to mitigate this issue are characterized by low Technology Readiness Levels (TRLs), necessitating the exploration of innovative and effective solutions.\\ This paper delves into a novel space debris remediation method that leverages polyurethane foam technology to enhance the surface-to-mass ratio of debris. The key objective is to provide a cost-effective and efficient approach to diminish the proliferation of space junk in orbit. The utilization of polyurethane foam serves a dual purpose: augmenting the surface area of debris to expedite orbital decay and acting as a protective shield to prevent collision-induced fragmentation.\\ The proposed technique involves enveloping target debris in a sphere of polyurethane foam, thereby transforming their surface characteristics. This alteration increases drag, facilitating a swifter decay of orbital trajectories. Notably, this approach addresses a fundamental challenge in debris deorbitation by simplifying the capture of tumbling objects by other debris removal techniques through the creation of a uniform shape with a softer texture.\\ One of the key advantages of this innovative technology is its versatility. A single desorbitation satellite equipped with a polyurethane foam dispensing system can effectively address multiple debris of varying masses and sizes. With a high Technology Readiness Level, the satellite is poised for rapid deployment within a few years of development.\\ The core structure of the proposed technology consists of two foam reagent tanks, a tank containing a light gas, and a robotic arm serving as the spraying device. This configuration ensures the efficient deployment of polyurethane foam, optimizing its application for space debris remediation.\\ In summary, this paper presents a groundbreaking approach to space debris remediation through the use of polyurethane foam. The demonstrated advantages of increased surface-to-mass ratio, collision protection, and adaptability make this method a promising candidate for addressing the pressing challenges posed by space debris in the ever-expanding Low Earth Orbit.\\