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SOLVING SPACE DEBRIS BY USING IT AS A SPACE RESOURCE FOR THE EMERGING INDUSTRIAL SPACE ECONOMY

Abstract

In recent years the exponential growth of space debris has been recognized as a serious problem demanding direct action to prevent the worst consequences and maintain, ongoing, sustainable access to Earth orbits. However, most technical and economic approaches currently pursued assume that high-cost, government funded and regulated solutions are required due to the lack of economic incentives for commercial actors to remove existing debris on their own. Without market driven solutions these approaches lack scalability and economic sustainability.

This work advocates for a transformative shift in how we think about space debris; from treating it as a necessary cost that must be minimized to viewing it as an untapped space resource and economic opportunity to be maximized.

An in-depth analysis was performed on the technology, architecture, and broader ecosystem needed to treat space debris as a resource. Based on this analysis a design study was performed and a prototype was built within the framework of a NASA Small Business Innovation Research (SBIR) Phase 1 contract followed by a subsequent Phase 2 contract.

To transform space debris into a useful space resource, an end-to-end on-orbit recycling system is required. The proposed architecture includes active debris removal (ADR) and transportation spacecraft, space station platforms to host the process, and in-space metal recycling and processing systems to make metal propellant rods and materials for in-space manufacturing. To this end, a lab-bench prototype of a robotic, micro space foundry was built, capable of automatically casting a propellant rod from strips of simulated aluminum space debris. Subsequent research will evolve this technology in partnership with leading industry players currently building the remaining technologies in the space debris recycling and On-orbit Servicing, Assembly, and Manufacturing (OSAM) value chain.

By treating space debris as a resource, we can accelerate the development of a robust, vibrant, commercially driven in-space economy, while simultaneously creating and maintaining a sustainable space environment.