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CONCEPTUAL DESIGN OF A REUSABLE MULTIPURPOSE TUG WITH A GRAPPLING MECHANISM FOR SPACE DEBRIS MITIGATION

Abstract

Commercialization of orbit is on the rise with the increasing potential of Earth observation and in-space services. Commercialization has caused a steep rise in the number of satellites launched into space as CubeSats of different sizes and is making the orbits congested, increasing the chances of collisions, leading to Kessler syndrome.

This paper details the conceptual design of a reusable space tug – a spacecraft for active orbital debris removal.

Space tugs are the vehicles which are already in orbit which can be exploited to perform the transfer maneuvers of space debris. The space tug presented here is conceived to be used for the transfer of debris and satellites from low to high orbits, and vice versa, if needed.

The paper starts with an overview of the mission scenario, the concept of operations, and the related architecture elements. The main focus of the design of the space tug is based on the type of propulsion system onboard used with an estimation of availability of resources in space after the commercialization of LEO. Hypergolic and Mono propellant propulsion systems are being considered for the space tug design. Then a detailed requirements analysis is performed to give it capabilities of a multi-purpose vehicle with a grappling mechanism to capture debris and also load it with satellites to act as a tug. The entire mission and Space tug design goes through an iterative and recursive design process optimizing according to orbits (for LEO and GEO). The ultimate objective of the research is to create a family of modular, economically feasible space tugs that use a common platform and share various components, which would allow providing relatively inexpensive and responsive on-demand debris removal and tugging services.