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DESIGN OF AN ACTIVE SPACE DEBRIS REMOVAL MISSION USING MODIFIED LAUNCH VEHICLE UPPER STAGES

Abstract

During the past few years, several research programs have assessed the current state and future evolution of the Low Earth Orbit region [1, 2, 3]. These studies indicate that space debris densities could reach a critical level such that there will be a continuous increase in the number of debris objects, primarily driven by debris-debris collision activity known as the Kessler effect [4]. This highlights the urgency for active debris removal (ADR).

An Active Debris Removal System (ADRS) should be capable of approaching the debris object through a close-range rendezvous, establishing physical contact, stabilizing its attitude and finally de-orbiting the debris object using a type of propulsion system in a controlled manoeuvre.

Based on previous work [5], it has been shown that a modified upper stage equipped with an electrodynamic tether (EDT) system can be used to de-orbit a Kosmos 3M second stage rocket body from polar orbits while also delivering an acceptable payload to orbit.

In this work, new space debris targets will be identified for active removal based on a statistical analysis of deterministic data from daily satellite conjunction alerts received in 2012. These objects will serve as priority targets for future ADR missions.

The feasibility of the proposed concept, actively removing space debris using modified upper stages, will be assessed for various international launch vehicles. This concept will then be compared to other ADR methodologies (such as using solely chemical or solely EDT propulsion) in terms of cost and performance. Moreover, a re-entry safety analysis will be performed to assess the safety of this concept. This work also highlights some of the methods for initiating physical contact with debris objects and assesses their

suitability for such a mission concept. Mission analysis will be performed using computational tools such as Analytical Graphics Inc. Systems Tool Kit (STK).

References

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