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

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ACTIVE SPACE DEBRIS REMOVAL BY HYBRID ENGINE MODULE

Abstract

During the last 40 years, the mass of the artificial objects in orbit increased quite steadily at the rate of about 145 metric tons annually, leading to a total tally of approximately 7000 metric tons. Now, most of the cross-sectional area and mass (97% in LEO) is concentrated in about 4500 intact objects, i.e. abandoned spacecraft and rocket bodies, plus a further 1000 operational spacecraft. Simulations and

parametric analyses have shown that the most efficient and effective way to prevent the outbreak of a long-term exponential growth of the cataloged debris population would be to remove enough cross-sectional area and mass from densely populated orbits. In practice, according to the most recent NASA results, the active yearly removal of approximately 0.1% of the abandoned intact objects would be sufficient to stabilize the cataloged debris in low Earth orbit, together with the worldwide adoption of mitigation measures. The candidate targets for removal would have typical masses between 500 and 1000 kg, in the case of spacecraft, and of more than 1000 kg, in the case of rocket upper stages. Current data suggest that optimal active debris removal missions should be carried out in a few critical altitude-inclination bands.

This paper deals with the feasibility study of a mission in which the debris is removed by using a hybrid engine module as propulsion unit. Specifically, the engine is transferred from a servicing platform to the debris target by a robotic arm so to perform a controlled disposal. Hybrid rocket technology for deorbiting applications is considered a valuable option due to high specic impulse, intrinsic safety, thrust throttle ability, low environmental impact and reduced operating costs. Typically, in hybrid rockets a gaseous or liquid oxidizer is injected into the combustion chamber along the axial direction to burn a solid fuel. However, the use of tangential injection on a solid grain Pancake Geometry allows for more compact design of the propulsion unit. Only explorative tests were performed in the past on this rocket configuration, which appears to be suitable as deorbiting system of new satellites as well as for direct application on large debris in the framework of a mission for debris removal.

The paper describes some critical aspects of the mission with particular concern to the target selection, the engine module, the operations and the systems needed to dock with the target, and to transfer and operate the engine module.