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Author: Mr. Roshan Sah
Tata Consultancy Services, India

Mr. Raunak Srivastava
Tata Consultancy Services, India
Dr. Kaushik Das
Tata Consultancy Services, India

OPTIMAL LOW THRUST CONTROLLED MANEUVER DESIGN TO CHASE AND DE-ORBIT THE PSLV DEBRIS.

Abstract

Over the several decades, the space debris at LEO has grown rapidly which had caused a serious threat to the operating satellite in an orbit.To avoid the risk of collision and protect the LEO environment, the space robotics ADR concept has been continuously developed over a decade to chase, capture and de-orbit space debris. This paper presents the designed small satellite with dual robotic manipulators. The small satellite is designed based on CubeSat standards, which uses commercially available products in the market. In this paper, an approach is detailed for designing the controlled chase and de-orbit maneuver for a small satellite equipped with an RCS thruster. The maneuvers are comprised of two phases: a)bringing the chaser satellite to the debris orbit, and accelerating it to close proximity of 1m to debris object by using the low thrust RCS thruster, and b) Once captured, controlled de-orbiting it to 250 km of altitude. A Hohmann transfer concept is used to move our chaser satellite from the lower orbit to the debris orbit by two impulsive burns. A number of the scenarios are simulated, where one or more orbital elements are adjusted. For more than one orbital elements adjustment, the Directional Adaptive Guidance law (DAG- law) and the Proximity Quotient Guidance laws (Q- law) are utilized. These laws synthesize the three direction thrusts to the single thrust force for the controlled maneuver. The amount of propellant consumed and the thrust characteristics at each maneuver are determined by using the performance parameters of the RCS thruster intended for a small satellite. The results show that, for long-term simulation of chaser satellite's maneuver to debris object, an optimum DAG law is most suitable than the Q- law, as it can handle the singularity behaviour of the orbital elements caused due to adjustment of one or more elements more efficiently. Numerous scenarios are simulated to investigate the feasibility of the controlled chase close proximity, and de-orbiting operation to debris objects by using RCS thruster and optimal control law.