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DESIGN AND PATH OPTIMIZATION OF A SPACECRAFT FOR SPACE DEBRIS REMOVAL BY BURNING IT INTO THE EARTH'S ATMOSPHERE

Abstract

With increasing space explorations, the amount of space junk is growing and so is the need to remove it. This has also led to the catastrophic failures of some of the space missions. Considering the need to go to space and the upcoming missions, this problem has to grow with time. In view of that, many theories have been given for debris removal. ESA has announced ClearSpace-1 for the same purpose. In light of the problem, this paper deals with the design and control of a spacecraft for active space debris removal. First, the characterization of debris on the basis of size and location is necessary for these kinds of missions. Space debris ranges from very small sizes(mm) to very large (10m). This paper presents the design of a spacecraft used for active space debris removal for different sizes of debris. It considers the possibility of equipping a small spacecraft with adequate thrust power and tools for longevity, and removal of debris of a wide range of sizes. The literature assumes the position and velocity of a cluster of small debris and some large debris to be given, and then proceeds on to optimally put the debris to very low earth orbits such that they burn up into the atmosphere leaving only gaseous residue. For the control part, the paper presents an algorithm to minimize the energy involved in the maneuvers of the spacecraft to burn up all the debris/debris-cluster and set them into a safe burning trajectory. This safe trajectory of debris is chosen considering the general material which comprises the majority of the space debris. In addition, a model for the burning of the debris has been considered so that it does not lose enough altitude to interact with aircraft and other near-earth flying objects.