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

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SPACE DEBRIS MITIGATION DEVICE USING DRAG THROUGH A CONTAINED FLUID TO REDUCE DEBRIS VELOCITY

Abstract

Space debris consists of defunct satellites and any other manmade objects in orbit, and is of growing concern to the wider space industry due to the extreme momentum of the debris and its potential effect on active satellites. Kessler syndrome predicts an exponential increase is space debris flux even if there are no further satellite launches. Orbital characteristics of debris vary and hence the required delta-V to remove debris from orbit also varies dramatically. Atmospheric drag will tend to circularise and decay an orbit if its perigee altitude can be sufficiently lowered; it is reasonable to assume that debris will burn up in the atmosphere if the correct re-entry angle is achieved. From this assumption, any debris could be deorbited using a change in velocity to reduce the debris perigee altitude to within the Earth's atmosphere. The majority of proposed systems for space debris removal are limited to removing a predefined number of debris of highly specific characteristics. The development of a system that is able to both remove as many debris objects, and as many debris types, as possible within its design life would prove a significant step forward in solving the space debris problem. This paper proposes the concept of using a contained fluid through which the debris travels in order to reduce the debris velocity. The concept is a system in orbit that is moved into the path of a selected piece of debris to allow the debris to travel through the contained fluid, causing a momentum exchange between the debris and fluid. Methods of containing the fluid are examined and a trade-off is provided and discussed. Plasma windows are discussed in relation to the problem, as a potential fluid containment technology. The choice of fluid to be used is also considered, with emphasis on minimising system length and system thermal requirements. A conceptual system design is presented and subsystem requirements are estimated. A key constraint of the proposed system is a high power requirement for the fluid containment, which suggests that the system should only be powered when debris has been selected and targeted and the device is in active use. Further work on this concept is required to outline its practical and financial viability, with emphasis on plasma window testing, cold temperature hypervelocity fluid flow and advanced design concepts.