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INITIAL CONDITIONS OF A NOVEL CUBESAT DURING ATMOSPHERIC RE-ENTRY

Abstract

As CubeSats become a more accessible means of collecting scientific data, they are bound to contribute to the increasingly pressing issue of space debris; this can be avoided through the implementation of Design for Demise (D4D), combining the removal of satellites from populated orbits with the minimisation of mission-related debris. Despite the establishment of D4D as a debris mitigation process, little is still known about the conditions under which debris fragment or survive during re-entry. Nonetheless, the versatility of CubeSats can be utilised to provide us with a better understanding of how small satellites may demise.

STRATHcube, a student-led CubeSat project for Space Situational Awareness developed at the University of Strathclyde, aims to contribute to the development of D4D through its secondary payload, providing data on the aerothermal conditions and forces experienced by the satellite during fragmentation upon atmospheric re-entry. The experiment is underpinned by the satellite's stability during re-entry and until fragmentation, which will allow for data to be transmitted in real time.

This paper will explore the configuration of the CubeSat and its attitude during re-entry, and their effect on the viability of the fragmentation experiment in terms of the operating conditions of the components necessary for recording and transmitting data. The aim of this study is to generate insight into the initial conditions the CubeSat must be subject to in order to maximise the output of the secondary payload. A low fidelity model constructed using ESA's Debris Risk Assessment and Mitigation Analysis tool (DRAMA) provides a platform for testing a wide range of angling configurations of the solar panels with respect to the satellite frame, and of angles of attack of the CubeSat, ranging from zenith-facing to rear-facing panels. Temperature data obtained from this model during the aerothermal demise of the solar panels are also used as a reference point for the design of the thermal protection system. Initial results suggest that angle of attack has a lesser effect on the temperature increase experienced by the CubeSat compared to the configuration of the solar panels. This analysis will advise the requirements of the deorbit manoeuvre of the CubeSat, the alignment of its solar panels for re-entry, and of the thermal protection components necessary for STRATHcube to collect and transmit data during the experiment.