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DRAG AUGMENTATION SYSTEMS FOR SPACE DEBRIS MITIGATION

Abstract

Although advances in small satellite technologies have allowed for the development of large constellations and have made space more accessible to all, space debris is a growing concern within the space community. Every year, an increasing number of small satellites are launched, adding to the already high number of objects currently in low-Earth orbit. When considering the infinite possibilities of space mission architectures, it is important not just to focus on the advancements in science and technology, but also to consider the sustainability of the spacecraft and its impact on its environment. If the challenge of space debris is not addressed, the amount of debris generated through collisions could increase exponentially, eventually rendering spaceflight too dangerous to conduct in some orbits. IADC guidelines have now been codified as international standards and are encouraging satellite operators to consider their end of life operations. Low-cost satellites are under increasing pressure to meet debris mitigation guidelines and failure to comply could result in a launch licence being denied.

In response to the growing number of small satellites (10-500kg) unable to de-orbit from low-Earth orbit within 25 years, Cranfield University has developed a family of drag augmentation systems (DAS). The DAS are lightweight, cost-effective sails deployed at end of mission and are reliable solutions for de-orbiting small satellites, aiding in the sustainable use of space. Three drag sails designed, manufactured and tested at Cranfield University are currently in orbit, with two sails already successfully deployed. This paper details the sails and will discuss findings from recent studies. These studies include examining the system's scalability, the post-deployment vehicle dynamics, the medium-term impact of the sail on the satellite's ability to conduct science and the long-term effect of the sail on the satellite's re-entry and demise. To conclude the paper, data from the deployed sails are compared to predictive models, validating previous simulations and highlighting areas for further research and improvement. DAS appear to be a practical and effective means for small satellites to operate sustainably, helping to ensure the responsible advancement of space activities.