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

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REQUIREMENTS AND RISKS OF A SWEEPING DEVICE FOR REMOVING SMALL DEBRIS

Abstract

Near-Earth space is an important resource both for commercial and scientific purposes. However, its use is threatened by the growing problem of space debris. In particular, operational spacecraft in low Earth orbit (LEO) are vulnerable to impacts from debris in the 1 to 10 cm size range which have the potential to terminate missions, possibly in a catastrophic manner. Spacecraft cannot manoeuvre to avoid this debris because it is not tracked routinely and the necessary shielding can be costly to implement. Therefore, remediation, whereby debris is removed from the LEO environment, is now being widely considered to reduce the hazard to spacecraft. In this work, we investigate some of the requirements and risks of a 'sweeping' device, operating in LEO and targeted at centimetre and sub-centimetre debris. The investigation was conducted using the NASA Orbital Debris Engineering Model (ORDEM) and the University of Southampton's Debris Analysis and Monitoring Architecture to the Geosynchronous Environment (DAMAGE). Firstly, the sweeping area required to halve the current growth rate of the centimetre-sized debris population was identified. This area was estimated to be of the order of 10 million sq. metres. Clearly, a sweeping area of this magnitude would need to be divided over a very large number of spacecraft. One approach to achieve this would be to mount a sweeping device on new spacecraft and to deploy the device at the end of the spacecraft mission. This would enable de-orbiting, through drag augmentation, in addition to the sweeping capability. In fact, we assumed compliance with the 25-year post-mission disposal guideline as the key driver for the sizing of each device. In the second step of the analysis, the probability of collision on the sweeping area by an object > 10 cm was quantified and found to be approximately 0.000005/sq.metre/year. For the cumulative sweeping area, this amounts to thousands of potentially catastrophic impacts. Therefore, we conclude that it is not feasible to use passive sweeping on such a large scale to remove small debris. However, a more modest application of this type of passive sweeper, whereby the total number of such devices in LEO is kept below a certain threshold, should still be a viable proposition. Although remediation will be limited in this scenario, it could nevertheless be considered a useful secondary benefit of a carefully designed drag augmentation de-orbit device.