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

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THROW-NETS AND TETHERS FOR ROBUST SPACE DEBRIS CAPTURE

Abstract

Space debris is an existing and growing problem for space operations. Studies show that for a continued use of LEO, 5 – 10 large and strategically chosen debris need to be removed every year. The European Space Agency (ESA) is actively pursuing technologies and systems for space debris removal under its Clean Space initiative. One of the most promising of these is the use of throw-nets to capture debris, followed by one or multiple deorbitation burns during which the debris is pulled with a tether. This paper demonstrates the results of studies performed within the European Space Agency on the use of throw-nets for space debris capture. We have used the 3D modelling environment Blender and powerful techniques from the gaming industry based on the Bullet physics engine to develop a multi-body simulator that can simulate the full entanglement of the debris by the net, as well as the subsequent deorbitation burn, at several thousand degrees of freedom. We developed the simulator in such a way as to be scriptable and therefore parametrisable. This allowed a large range of relative rotation-rates, shapes, distances and net design parameters to be simulated in a pseudo Monte-Carlo manner. The results demonstrate the effectiveness of the net to entangle a debris regardless of its size or shape, and that it is very unlikely to slip off. They also show the conditions under which it is possible to keep the system controllable during the pulling phase, and that in order to do this effectively one should aim towards a more elastic, rather than a stiff tether. The results also demonstrate that doing so is especially important if a multi-burn deorbitation strategy is chosen since in these cases it is necessary to recover control at the end of the burn, something that we identify as one of the most difficult aspects of a tethered approach to space debris removal. We have developed a framework to simulate debris capture and tether dynamic to what we believe to be unprecedented precision, and used it to show the feasibility of using throw-nets and tethers for space debris remediation.