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

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DEVELOPING A RELIABLE CAPTURE SYSTEM FOR THE CLEANSPACE ONE MISSION

Abstract

The objectives of the CleanSpace One mission are to raise the awareness of the orbital debris problem, develop and test technologies for non-cooperative rendezvous and as a demonstration de-orbit the SwissCube satellite. Over the last few years several capture systems have been prototyped, from robotic grippers to net to more conventional capture mechanisms. A major trade-off was performed in 2014 taking into account system, operational, reliability, functionalities, cost and manufacturability criteria. This exercise led to the selection of a deployable "pacman" mechanisms. Several requirements were derived for the capture system. First it shall be scalable to the 300-500 kg debris, as it shall serve a longer term purpose. The capture system shall also be designed to allow for two capture trials, in case the first attempt would not be successful. The final capture operations shall not create more debris and shall ensure that once captured, SwissCube is brought to a firmly grasped configuration to avoid changes in the inertia matrix during de-orbiting. The design of the "pacman" shape and closing speeds are tightly linked to the GNC capabilities of CleanSpace One. This paper first presents the capture system criteria, trade-offs and selection. It then details the derived GNC requirements that drive the design, and describes the capture and rebound analyses that drove the design to the current shape. The current prototype design and tests are presented. The deployable booms are designed based on bi-stable reeled with a mix of carbon and natural fiber mesh composites. Analyses were conducted on the cross-section and shape of the boom to ensure good stiffness performances. To achieve high compactness and low mass for the deployment

mechanism, the use of harmonic drives has been selected. The synchronized closing of the Pacman, is achieved by a system composed of a closed loop cable linked to a single linear actuator. A preliminary design and manufacture of the net between the deployable booms has been done. A complete design of the deployment mechanism has been created to validate the concept. A prototype of one deployment unit has been manufactured. The final system is extremely compact and light. The prototype works well and we demonstrated the feasibility of the mechanism.