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TETHERED DEBRIS CAPTURE EXPERIMENT ON POEM PLATFORM USING SPACE ROBOTIC ARM

Abstract

A robotic arm mounted on a spacecraft can be utilized for several tasks conducive to space debris mitigation and sustainable utilization of space-based resources. Some of the tasks include capturing and removing defunct satellites and passive launch vehicle stages from orbit, on-orbit refueling of satellites, on-orbit assembly and servicing of satellites, telescopes, space stations and other space infrastructure. The technology associated with these operations are envisaged to be mastered through multiple missions, with each mission having increased complexity. The technology demonstrator missions are therefore divided into four phases respectively; the capture of a tethered cooperative object, refueling of a tethered cooperative satellite, rendezvous manoeuvres of the base spacecraft for the capture of the free-floating non-cooperative object in orbit, and refueling of a non-cooperative satellite. In order to carry out these experiments, the stabilized upper stage of PSLV i.e. PSLV Orbital Experimental Module (POEM) is made use of. The experiments on POEM will be carried out using a 2m long robotic arm. The experiment setup, associated mission sequence and the results of ground testing of phase one, i.e. the capture of a tethered cooperative free-floating object, will be outlined in this paper. A tethered target debris will be released as part of initiation of the mission. The camera mounted on the end of the robotic arm will continuously scan for the fiducial marker that is attached to the target debris. Once the tag is detected the distance and orientation of the tag is determined using AprilTag algorithm. The robotic arm then moves to reach the debris using Closed Loop Differential Kinematics algorithm. The debris will then be captured using a parallel end-effector and then latched back on to the POEM platform. All operations are envisaged as autonomous real-time decision-based events. Further a fail-safe measure will be adopted to limit the creation of new space debris in case of experiment failure.