SPACE DEBRIS SYMPOSIUM (A6)
Mitigation and Standards (4)

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STRATEGY FOR CAPTURING A TUMBLING SPACE DEBRIS

Abstract

Since the number of satellites in Earth orbit is steadily increasing, space debris could eventually pose a serious problem to near-Earth space activities, and so effective measures to mitigate it are becoming increasingly important. Equipping each satellite with an end-of-life de-orbiting and orbital lifetime reduction capability could be effective in reducing the number of debris objects by lowering the probability of the inter-object collisions, while the active removal of space debris and the retrieval of failed satellites are considered to be other measures. In general space debris objects do not possess such convenient features, and are non-cooperative. In such cases, since the conditions for capture are not favorable, tracking errors will lead to loading, and momentum transfer will occur during the capture process. In most cases, the detailed mass and inertial characteristics of the target will be unknown, either because design details are unavailable or due to changes as result of damage sustained when failure occurred or gradual degradation over the years, and this makes impedance matching of the capture arm force control system difficult. This led to us to devise "joint virtual depth control" algorithm for robot arm control which brakes the rotation of a target with unknown inertia. This paper deals with a removal work strategy and control method for capturing and braking a tumbling non-cooperative target space debris. We propose a new brush type contactor as end-effecter of a robot arm for reducing the rotation rate of a target debris. As a means for relieving the loads generated during target capture and braking, in addition to joint compliance control we propose a new control method which controls the arm tip force according to a braking force profile. Moreover, we evaluated the load captured for the offset's there between from the capture points to the center of mass of the target. The results of simulations and hardware experiments designed to test the method's feasibility are also reported.