SPACE DEBRIS SYMPOSIUM (A6)
Mitigation, Standards, Removal and Legal Issues (4)

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DYNAMICAL SIMULATIONS AND EXPERIMENTS ABOUT CAPTURING A TUMBLING DEBRIS

Abstract

Using spacecraft to actively remove debris objects are possible measures to reduce existing space debris. In general space debris objects do not possess convenient features, and are non-cooperative. Moreover, most of space debris are tumbling. In such cases, since the conditions for capture are not favorable, tracking errors will lead to loading, and momentum transfer from target to 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. We conducted hardware experiments using a prototype of the contactor. As a means for relieving the loads generated during target tapping, in addition to joint compliance control we propose a new control method which controls the arm tip force according to a contact force profile. The results of dynamical simulations and hardware experiments are also reported. Moreover, we evaluated the scenario for attitude control of the remover spacecraft after capturing a tumbling space debris.