SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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INNOVATIVE TECHNOLOGIES FOR NON-COOPERATIVE TARGETS CLOSE INSPECTION AND GRASPING

Abstract

Close inspection and grasping of space objects and local adhesion to spacecraft external surfaces represent key technologies for several on-orbit servicing operations, such as components repair or refurbishment, tanks refuelling and automatic assembly. Furthermore, the capability of capturing and controlling the motion of non-cooperative targets having irregular shape is becoming a crucial issue for active debris removal.

This paper presents the conceptual development and numerical evaluation of an innovative system for attaching to non-cooperative objects, based on (1) a simple and compact infrared sensors assembly for target location and (2) an adhesive hand grip that conforms to the shape of the target interface. The location assembly is based on infrared LEDs which send impulses towards the target and an array of infrared sensitive elements to detect the back-scattered radiation. By measuring the time-of-flight of the reflected impulses with high accuracy, it is possible to determine the target object distance and the target position in the grasping system reference frame. The instrument is compact, made of low-cost components and requires lower computational capabilities than camera-type sensors. To assess the sensors system performance, a numerical model has been realized for the instrument and the environmental noise. Simulation results are finally presented to evaluate the uncertainty of the estimated target position and distance estimations. The hand grip employs a flexible electro-adhesive layer mounted on an active support that is capable of adapting to different target shapes and provides the requested interface rigidity when actuated. Moreover, it benefits from the presence of a damping joint that manages the relative motion between target and grasping system, reducing the reactions transmitted to the base. The passive joint dissipates part of the total kinetic energy possibly reducing the power budget requirements for the active control. A simplified simulation tool is finally presented to assess the gripper operations and performance, as well as the transient disturbances transmitted to the base during grasping.