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LAUNCH ADAPTER RING CAPTURE TOOL: CANADIAN ROBOTIC TECHNOLOGY FOR THE AUTONOMOUS CAPTURE OF UNPREPARED AND NON-OPERATIONAL DEBRIS

Abstract

With the wide variety of objects that currently populate the orbital debris environment, one of the key challenges facing missions which aspire to perform active debris removal (ADR) of large intact debris (spent upper stages and non-operational satellites such as Envisat) is determining exactly how to safely apply the necessary forces to a target in order to relocate it into a graveyard or atmospheric re-entry orbit. In general, methods proposed in ADR missions have included rigid capture approaches using a robotic arm or appendages, and flexible approaches using tethers, harpoons, or nets. While each approach has its respective merits, the use of a robotic arm provides the benefit of controllability due to its ability to achieve a rigid link between the target debris and the servicing spacecraft.

While Canada has been a world leader in robotic technology capable of performing the capture of spacecraft for three decades, through the highly successful Canadarm, International Space Station, and DARPA Orbital Express mission robotics, to date robotic capture in space has only been achieved on "prepared" spacecraft. A prepared spacecraft is one that has been designed to aid and simplify robotic tasks by including features such as a grapple fixture that can be captured by a robotic arm. Unfortunately, none of the orbital debris have been designed with on-orbit capture or servicing in mind, so the robotic capture must be achieved using a natural feature available on the target. Finding such a feature that is suitable for capture using a robotic arm is a challenge.

Designed and built through the support of the Canadian Space Agency, this paper presents an overview of MDA's Launch Restraint Capture Tool, a purpose built robotic tool designed to provide the key technology necessary to address the challenges associated with autonomously grasping an unprepared and uncooperative spacecraft with a robotic arm. The paper justifies the need for the technology, outlines the key driving requirements, provides the concept of operations for its application, and summarizes the integrated testing performed to validate and demonstrate the design of MDA's TRL-5 engineering development unit and its applicability to upcoming servicing missions.