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THE ROLE OF DEXTEROUS ROBOTICS IN ONGOING MAINTENANCE OF THE ISS

Abstract

On August 28, 2011, Dextre, supported by Canadarm2, successfully removed a failed power-control module (RPCM) from the P1 integrated truss segment of the International Space Station (ISS). Over two days, while astronauts on the ISS slept, ground operators at NASA's Johnson Space Center and at the Canadian Space Agency in St. Hubert, Quebec performed tele-robotic operations to retrieve a spare On-orbit Replaceable Unit (ORU) from a storage container mounted on Dextre and installed it into the P1 truss, restoring full functionality. These dexterous operations required extreme precision in the ISS's harsh, thermally changing external environment, combined with delicate force sensing and accommodation control and successfully demonstrated the first end-to-end robotic maintenance activity on the ISS. This successful set of operations also extended the already proven Canadarm 2 and Dextre ground control technology, demonstrating mission critical automated operations including those relying on Dextre's force-moment control technologies. Together these operations, and the technology and operational techniques utilized to successfully complete them, lay the foundation for future advancements in remote dexterous operations that will fully enable the most delicate unmanned on-orbit servicing operations.

This paper reviews the robotic operations involved in this critical servicing operation, made all the more challenging due to the RPCM not meeting defined dexterous manipulation requirements. It also summarizes the lead-up to these operations and the challenges experienced to date, and the future advancements required to support the ongoing maintenance of the International Space Station. The proposed enhancements to Dextre's payload handling capabilities are made with the goal of enhancing mission success, reducing overall operating times and further minimizing the dependence on EVAs.