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BENEFITS OF ROBUST INTRAVEHICULAR ROBOTIC SYSTEMS FOR DEEP SPACE EXPLORATION

Abstract

Robotics and automation are essential for deep space exploration. Space based robotic systems have successfully assisted humans explore new technologies and science for more than 15 years on the International Space Station (ISS) and assisted in the exploration of the Martian surface. The lunar Gateway is a proving ground to test new technologies for future human travel to Mars and other deep space destinations. Collaborative human-robot operations and standalone Intravehicular Robotic (IVR) operations stand to improve the efficiency and productivity of stations like Gateway.

The Extravehicular Robotic (EVR) systems on ISS (SSRMS, SPDM, JEMRMS) benefit from constant support and communication with ground operators. The ISS has also been used as a proving ground for different IVR technologies (Robonaut, Int-Ball, etc.), however the operations have been limited in scope. A Gateway IVR system will face challenges not currently experienced by current space based robotic systems. The Gateway is envisioned to be uncrewed for long periods of time and will have a very narrow communication window of approximately 8 hours per week. Gateway IVR systems will be forced to rely on higher levels of autonomy, reliability and robustness.

IVR systems can be leveraged to assist crewmembers or to act as virtual astronauts by completing routine, mundane and repetitive tasks during uncrewed periods. A review of astronaut work timelines from the ISS suggests that up to 20 percent of the tasks performed by crewmembers may be addressable by robust IVR systems. IVR systems provide a means for continued utilization for science, maintenance, housekeeping, and emergency response.

The operational environment for an IVR system is significantly different from existing EVR systems. IVR systems will be required to operate in close quarters, address mobility challenges such as intra and inter-module translation while transporting payloads such as cargo transfer bags.

IVR systems can be used initially to perform routine inspections and inventory surveys of the internal habitat volumes, and assist in the relocation of cargo. More advanced applications could include the automated arrival and departure of cargo vehicles, deployment of science payloads to external stowage locations, science experiment tending, subsystem maintenance, and emergency response. The variety of tasks require a range of robotic dexterity and grasp methods that may drive the need for specialized systems and tools.