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TESTING FOR THE DEVELOPMENT, VERIFICATION AND VALIDATION OF LARGE ROBOTIC INTERFACES FOR THE LUNAR GATEWAY

Abstract

As humanity extends its reach into deep space and works towards establishing a permanent presence on both the Moon and Mars, autonomous robotic systems will be increasingly relied upon to prepare for, sustain the support structures necessary, and directly aid in active human spaceflight missions. For example, the Lunar Gateway will be largely constructed, maintained, and serviced by extra-vehicular robotic (EVR) services with minimal human intervention.

To meet this need, the Canadian Space Agency (CSA) is leveraging national expertise in space robotics to contribute the Canadarm3, with prime contractor MDA responsible for designing, building, and operating the system. This builds upon the widespread successes of the Canadarm and Canadarm2 programs on the Space Shuttle and ISS respectively.

While a higher quantity of small manipulators has been demanded in the overall space sector, the need for large-scale manipulators persists as a common requirement for space station projects. The Canadarm3 eXploration Large Arm (XLA) is intended to autonomously perform EVR activities, including external inspection and maintenance, payload handling, and module relocation. To facilitate these activities upon the XLA's arrival to Gateway, the Gateway External Robotics Interfaces (GERI) program is delivering the passive-side Low Profile Grapple Fixture (LPGF) to act as an externally-mounted base point for the XLA on Gateway modules. The corresponding active-side Low Profile End Effector (LPEE) has also been matured in support of this goal. Both sides of the XLA interface have also been prototyped and tested through various mediums to promote iterative design.

This paper will present a system-level overview of the LPGF and LPEE, and a summary of tests selected and conducted for verification and validation (V&V) of Gateway's large robotic interfaces, as driven by various international functionality, interoperability and environmental standards. It will also provide an outline of how MDA is leveraging its in-house prototyping, manufacturing, and hardware testing capabilities to assess the XLA interface concept through varied methods developed specifically for large-scale robotic manipulators. These include unique testbeds such as a Dust Testing Lab, the Next Generation Small Canadarm (NGSC), and the Dynamic Robotic Emulation and Mixed Reality (DREAMR) Lab. From having unique experiences from previous Canadarm V&V alongside these newly-developed technologies, a comprehensive suite of tests and methodologies are generated that both further develops the design of and formally validates large scale manipulators like the XLA over the course of its end-to-end development.