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# ZERO-G SPACE ROBOTICS FACILITY FOR DESIGN, DEVELOPMENT AND VALIDATION OF ROBOTIC SYSTEMS & MISSION OPERATIONS

**Abstract**

Robotics has played an important role in enabling human spaceflight exploration programs. Indeed, space manipulators have been critical to the success of the Space Shuttle and International Space Station programs. The use of robotics to perform operations such as payload capture and deployment, small and large-scale assembly as well as maintenance and repair of complex space systems has been inherent to the success of both programs. With advances in automation and artificial intelligence, robotic systems promise to be indispensable in future space initiatives such as Lunar Gateway and on-orbit satellite servicing. While there are a number of challenges in designing, testing and validating a robotic system for space one of the most difficult is optimizing the control system for Zero-g performance and evaluating the interaction of such systems with free-flying payloads or a variety of worksite interfaces. The influence of gravity on a robotic system can make it difficult to prototype designs and operational concepts with ground-based tools and test equipment. Traditionally, there has been a reliance on software models, air bearing test rigs and expensive, purpose-built gravity off-load systems which can have limitations in terms simulation fidelity/complexity, degrees of freedom represented or not being customizable for more than one application. This paper looks at the recent development of a generic Zero-g robotic ground testbed at MDA which can used to replicate the dynamic performance of different manipulator designs and concepts as well as interact with a dynamic emulator system which has the versatility to mimic a wide variety of free-flying payloads and worksite interfaces. This paper will discuss how the facility enables better design of new control features on existing space robotics (such as those on the International Space Station) as well as new systems that are being considered for Lunar Gateway and other on-orbit servicing initiatives. In addition to the benefits provided in detailed control system design and analysis, the advantages of validating overall mission operations with the use of Augmented Reality to compliment the reality of the hardware in the lab will also be examined.