SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 1 (2A)

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TESTING ASTRONAUT-CONTROLLED TELEROBOTIC OPERATION OF ROVERS FROM THE INTERNATIONAL SPACE STATION AS A PRECURSOR TO LUNAR MISSIONS

Abstract

Missions to Earth-Moon libration points provide an avenue to develop expertise needed for longer-duration missions to deep space. Libration point missions also provide an opportunity to discover answers to critical scientific questions concerning the origin and evolution of our solar system and the first structures in the early Universe. In particular, NASA's Orion spacecraft, currently under development, could serve as a platform from which astronauts would explore the lunar farside telerobotically from lunar orbit.

During Summer 2013, we conducted initial testing of this mission concept using the International Space Station (ISS) in Low-Earth Orbit as a proxy for Orion orbiting the Moon. Over the course of three test sessions, Expedition 36 astronauts Chris Cassidy, Luca Parmitano, and Karen Nyberg on the ISS remotely operated NASA's "K10" planetary rover in an analogue lunar terrain located at the NASA Ames Research Center.

Preliminary data analysis suggest that: (1) planetary rover autonomy, particularly safeguarded driving, enabled the human-robot team to perform surface tasks safely with low crew workload; (2) interactive 3-D visualization of robot state and activity helped crew to maintain good situation awareness; and (3) command sequencing with interactive monitoring is a highly effective strategy for crew-centric surface telerobotics.

The Summer 2013 tests demonstrate how the ISS can be used as a testbed for testing of crew controlled surface telerobotics concepts. For a future lunar telerobotics mission where astronauts would operate rovers on the moon from a remote location high above the lunar surface (such as a halo orbit or distant retrograde orbit), it is important to design the telerobotics system and operational protocols to work well with variable quality data communications (in terms of data rates, latency, availability, etc.) In addition, the extended distance from Earth means that it will also be important to understand how efficiently and effectively a small crew of astronauts can work when placed in a more independent role.

Future Surface Telerobotics testing with the ISS could be designed to more accurately simulate the data rates and latencies involved in an actual lunar mission. The planetary rover tasks could also be modified to test different mission objectives, such as field geology. The ISS presents a highly configurable and unique opportunity to explore mission constraints with a high-fidelity environment for crew. Potential benefits to future missions include: creating optimized training procedures, reducing operational risk and technology gaps, defining preliminary mission requirements, and estimating development and mission cost.