EPSC Abstracts
Vol. 10, EPSC2015-58, 2015
European Planetary Science Congress 2015
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Low-Latency Telerobotics for Mars Exploration

Michael R. Wright
NASA, Goddard Space Flight Center, USA (michael.r.wright@nasa.gov)

Abstract

The future of human planetary exploration will depend on effective integration of both human and robotic systems. Although automated robotics may be utilized for some operations, near-real-time telerobotics will be an important capability for this integrated approach to planetary exploration and science.

Unfortunately, destinations such as Mars are distant enough that the high latency of earth- or ISS-based telerobotics precludes effective telerobotic capability. Round-trip communication times as long as 48 minutes make tasks that necessitate real-time interaction infeasible or risky at best. Incremental progress on surface tasks, such as those being performed by the Curiosity rover, will be insufficiently slow to support a robust human exploration program.

One approach being considered for Mars exploration is low-latency telerobotics (LLT) from an orbiting base, such as on the moon Phobos. In this concept, LLT is utilized to perform relatively complex robotic tasks on the surface prior to a crew landing. This would ensure that systems such as power generation, habitats, landing areas, and ISRU plants are setup and functional in advance of crew landing.

To help assess the feasibility and timing of LLT operations on Mars, NASA's Goddard Space Flight Center developed operations concepts and timelines for several proposed task sequences needed to prepare for human landing. These included landing site assessment, lander offloading, power cable deployment, oxygen production via in-situ resource utilization, and science reconnaissance and measurements.

A summary of the LLT sequences and timelines developed is presented, with associated assumptions, operational considerations, and challenges. An LLT "sensitivity" scale is also introduced.

Finally, implications and lessons learned are summarized for consideration in exploration planning.