Low-Latency Telerobotic Assembly of a Low Frequency Radio Telescope on the Moon: Establishing Baselines for User Situation Awareness and Cognitive Load. A. Kumar, B. Mellinkoff, A. Sandoval, J. O. Burns, Center for Astrophysics and Space Astronomy, University of Colorado-Boulder, Boulder, CO 80309

The White House has set a national goal for a human mission to the South Pole of the Moon in the next five years. NASA is tasked to conduct lunar science and space science, and to prepare for future human missions to Mars. Before returning to the Moon, NASA will send astronauts to cis-lunar space using Orion and the SLS, where they will dock with a lunar-orbiting habitation and science module - the Lunar Gateway. The Gateway's proximity to the lunar surface allows for real-time communication with surface assets, therefore enabling the use of low-latency surface telerobotics. Low-latency telerobotics can be used for many remote tasks on the lunar surface, including geological exploration and assembly tasks.

The telerobotics laboratory at the University of Colorado-Boulder has integrated a commercial off-the-self (COTS) robotic arm and rover along with multiple cameras to create the Telerobotic Simulation System (TSS). The TSS consists of two separate parts, the rover and the user interface. The user interface contains video feedback from the rover, a display of the robotic arm's current configuration, as well as the end effector's current x, y, and z position.

The TSS was used in an experiment simulating the telerobotic assembly of a radio telescope array in a laboratory environment (Figure 1). The goal of this experiment is to measure the user's situation awareness and cognitive load while using the TSS to perform low-latency teleoperated assembly tasks. The operator's objective is to deploy an antenna unit and then power it via a magnetic micro USB connection. The operator must successfully deploy and power three antenna units in order to create a simple radio interferometer. The metrics we are using to quantify situation awareness and cognitive load include time to completion, error in antenna placement location, number of dropped components, as well as surveys such as the NASA Task Load Index (TLX), the Situational Awareness Rating Technique (SART), and the System Usability Scale (SUS). Results of this experiment will serve as a baseline for future experiments in which other operating parameters of the TSS are varied in attempt to understand changes in the user's situation awareness and cognitive load while performing telerobotic assembly tasks with off-nominal operating parameters.

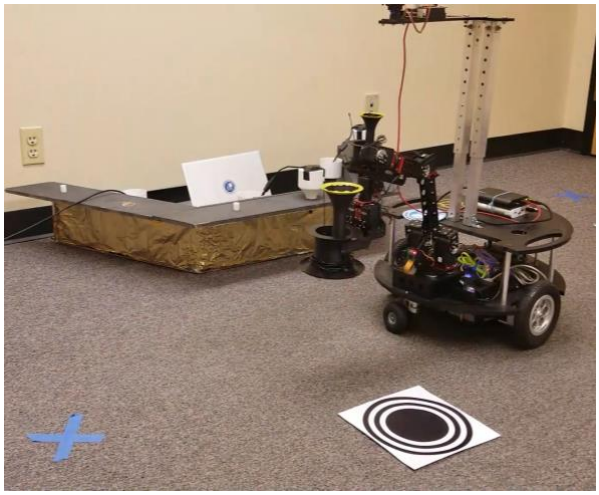

Figure 1. The Telerobotic Simulation System (TSS) being used to deploy an antenna unit.

This work was directly supported by the NASA Solar System Exploration Virtual Institute Cooperative Agreement 80ARCC017M0006.