Integration of a COTS Robotic Arm and Rover for Future Low-Latency Telerobotic Assembly Experiments. A. Kumar, B. Mellinkoff, A. Sandoval, J. O. Burns, Center for Astrophysics and Space Astronomy, University of Colorado-Boulder, Boulder, CO 80309

NASA has set a goal to return to cis-lunar space to conduct lunar science, deep space science, and to prepare for future human missions to Mars. 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 known as the Lunar Gateway. The Gateway 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.

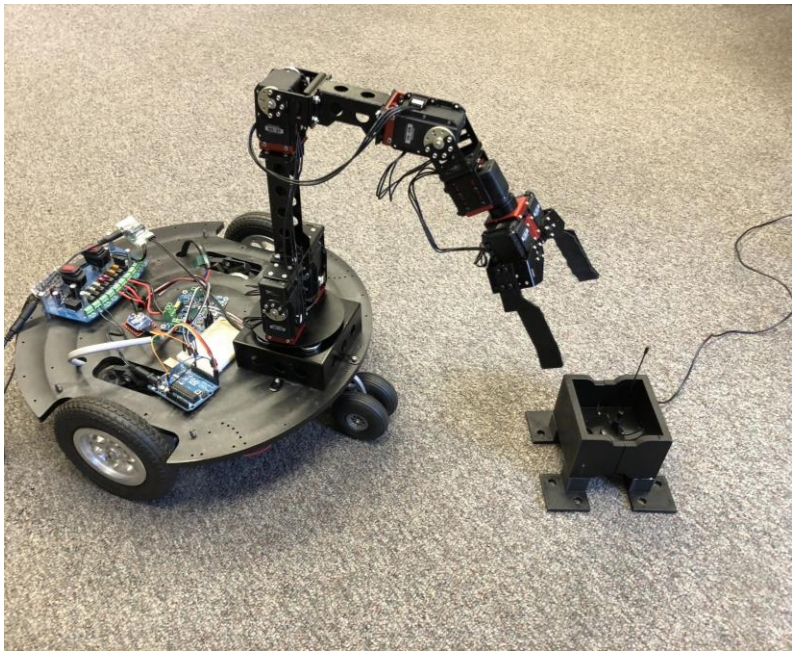

Figure 1: Armstrong system with radio antenna assembly.

The Telerobotics lab at the University of Colorado Boulder has integrated a CrustCrawler robotic arm with a Parallax ARLO rover forming the Armstrong system. The Armstrong system has been developed in preparation for low-latency telerobotic assembly experiments. In Summer 2018, the Telerobotics group is planning to simulate the telerobotic assembly of a radio array while varying the conditions of the video feedback. This experiment plans to quantify the operational video constraints on telerobotic assembly tasks. There are several aspects of the Armstrong system we developed and tested prior to conducting the telerobotic assembly experiment. The underlying system used to control the Armstrong system is the robotic operating system (ROS). We utilized a software package called Moveit! that runs on top of ROS to solve the inverse-kinematics and plan movement between different positions and orientations. This setup allows operators to use a GUI to control the arm's movement, location, and orientation with ease and accuracy. Video feedback is provided to the operator by cameras strategically placed on the robotic arm and rover to maximize situational awareness. We also developed an antenna and antenna housing that will be used for our assembly experiment. The experiment will have the Armstrong system remotely place the antennas in designated locations and make the necessary electrical connections to create a simple radio interferometer (Figure 1).