Robotic Arm and Rover for Future Low-Latency Telerobotic Assembly Experiments

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Introduction and Background

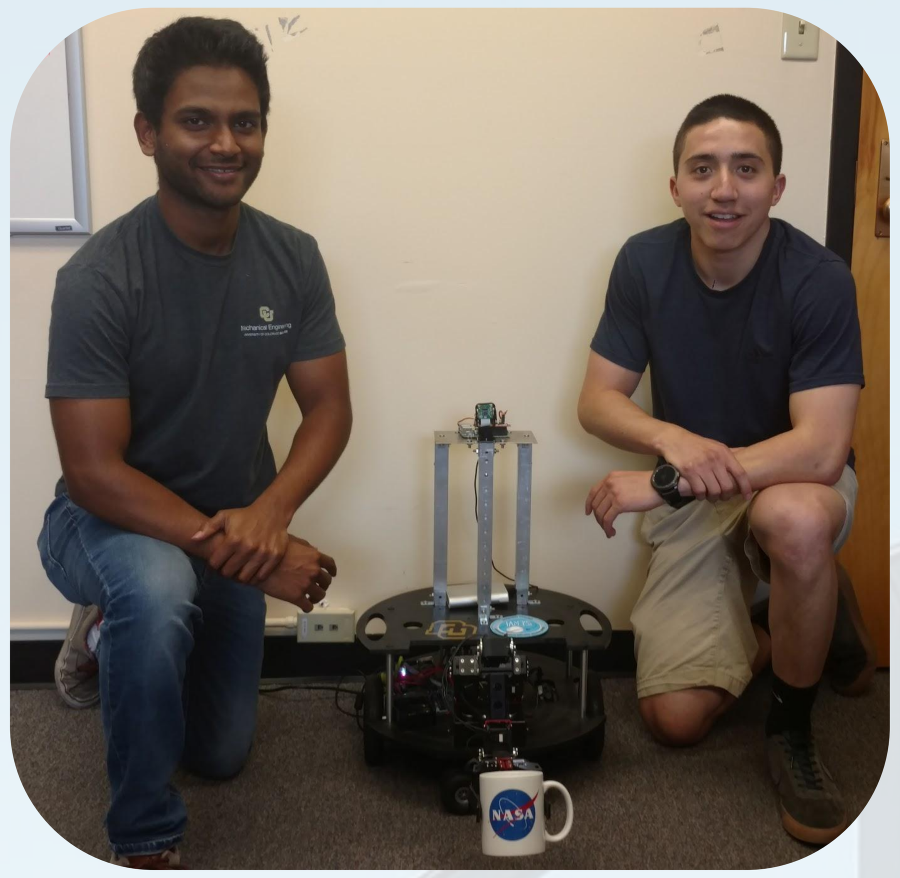

Fig. 1: Arun(left) and Alex(right) with Armstrong.

NASA has set a goal to return to the Moon to conduct lunar and deep space science while also preparing for future human exploration missions. Low-latency surface telerobotics will be useful on the Moon for the assembly of scientific instruments necessary for low-frequency radio astronomy. Using a commercial off-the-shelf robotic arm and rover, our research will attempt to quantify constraints related to this assembly and determine standards for effective teleoperated assembly tasks.

Armstrong

Components

- Crustcrawler Pro-series robotic arm
- 8 Dynamixel Servos
- Arlo Robotic Platform System (rover)
- Telescopic camera stand
- 2 Raspberry Pi's
- Raspberry Pi Camera
- Arduino Microcontroller
- 2 Xbee RF Modules
- Netis Wireless Router
- Computer Workstation

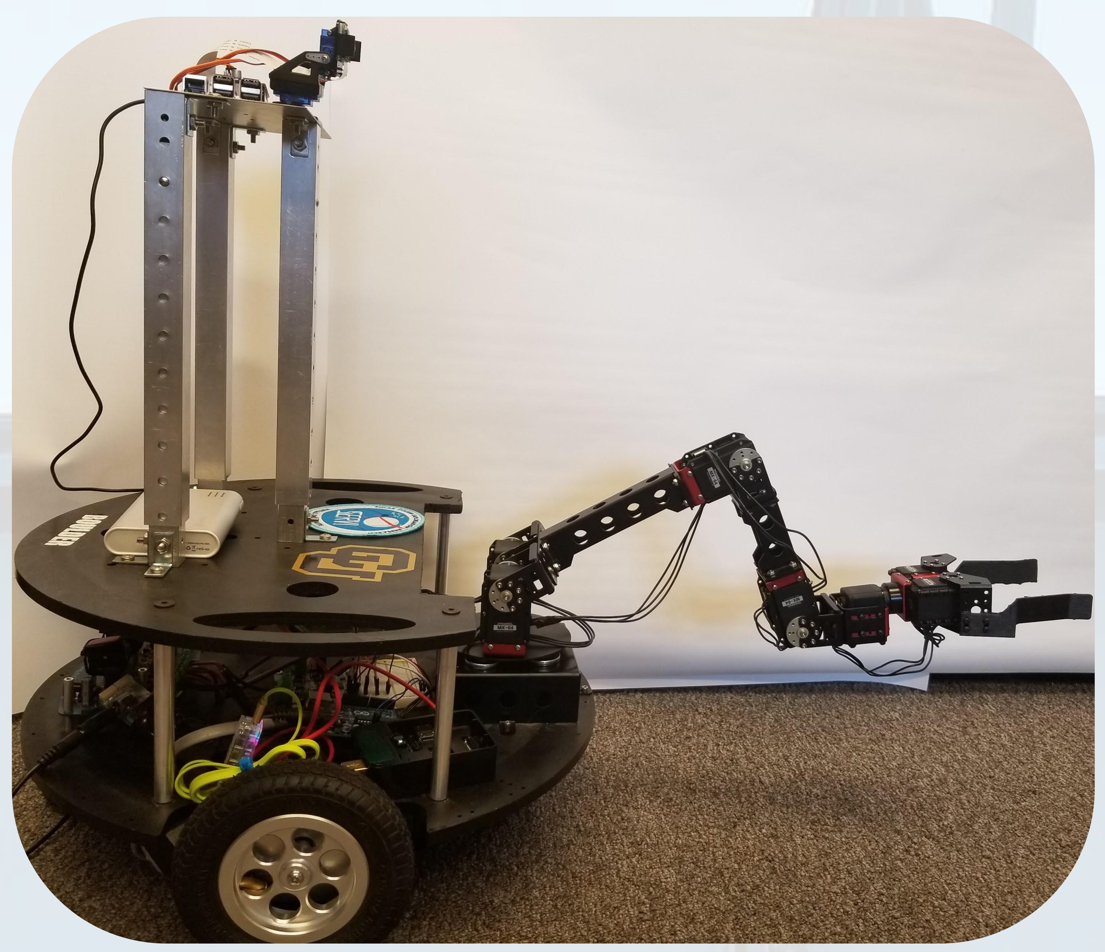

Fig. 2: A complete view of Armstrong.

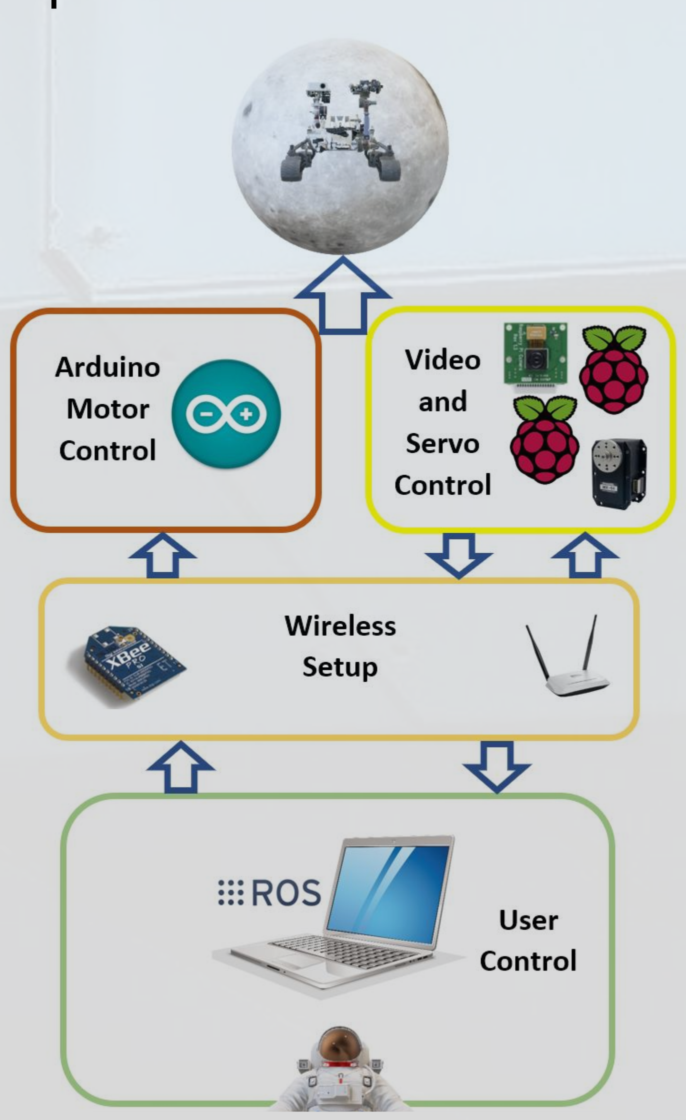

Fig. 3. Armstrong component connection overview.

The design of Armstrong is built around the idea of maximizing the control from an unfamiliar user. We implement a single computer workstation which communicates to Armstrong remotely.

- Router and XBee radio module provide wireless connection.
- Robotic Operating System (ROS) provides arm control.
- Arduino microcontroller provides motor control.
- Raspberry Pis provide video feedback and servo control.

Assembly of Radio Telescope Elements

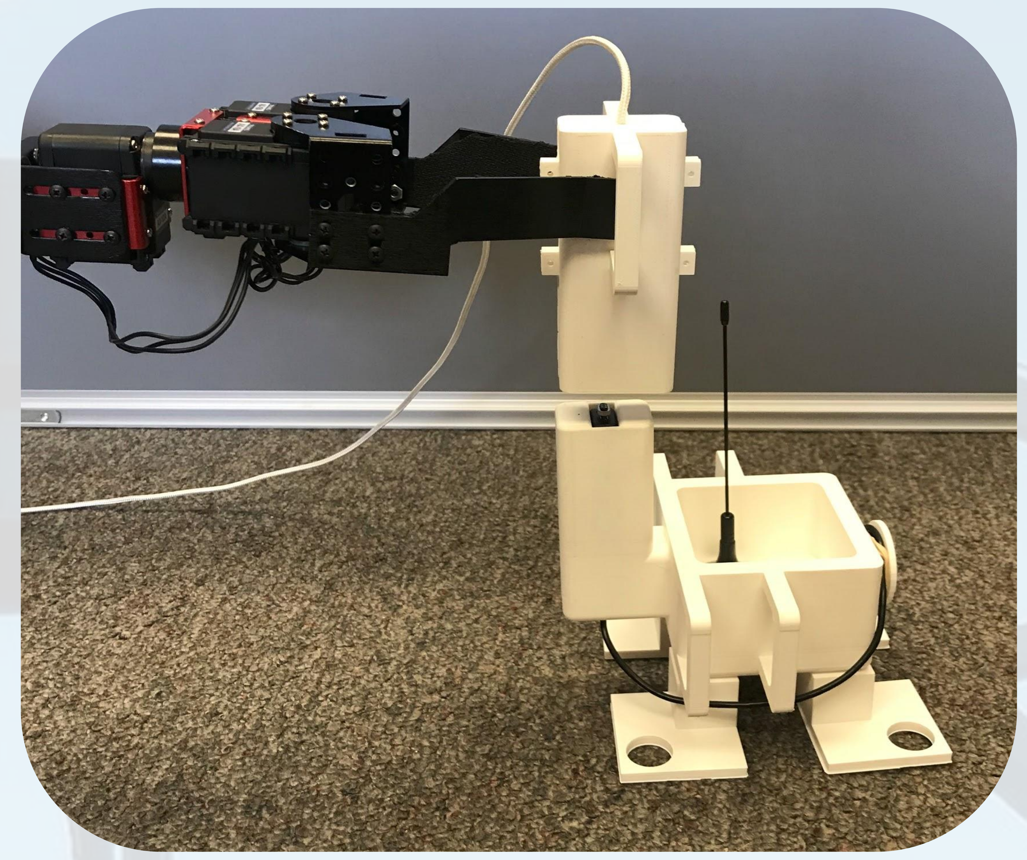

Fig. 4: Robotic arm completing connection to power antenna.

- Four connections power and transmit data from four monopole FM antennas.
- Connection made through magnetic micro USB.
- 3D printed case, gripper, and grid aid the robotic arm.
- Demonstrates how teleoperated rovers could assemble a radio telescope on the lunar farside.

Signal Processing

- Signal centered on 99.9MHz with a bandwidth of 24kHz.
- Waterfall plot, plot of time vs. frequency, shows how the antennas could make real astronomical observations.
- Using normal sample averaging to reduce noise interference.

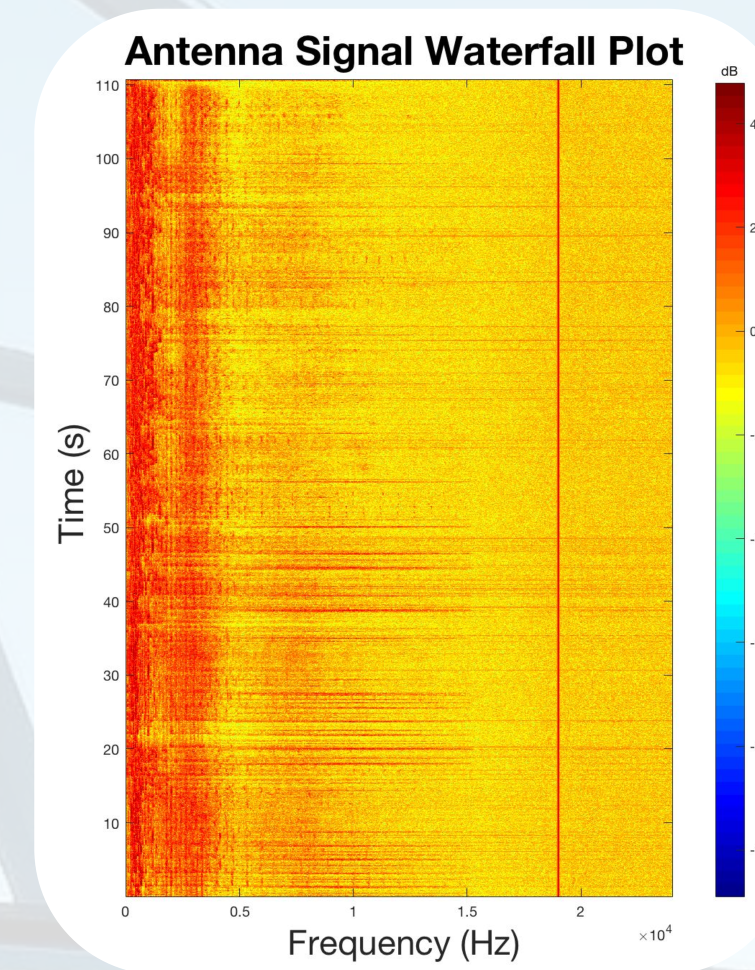

Fig. 5: The waterfall plot is a graph of time vs. frequency of the signal with power depicted in color.

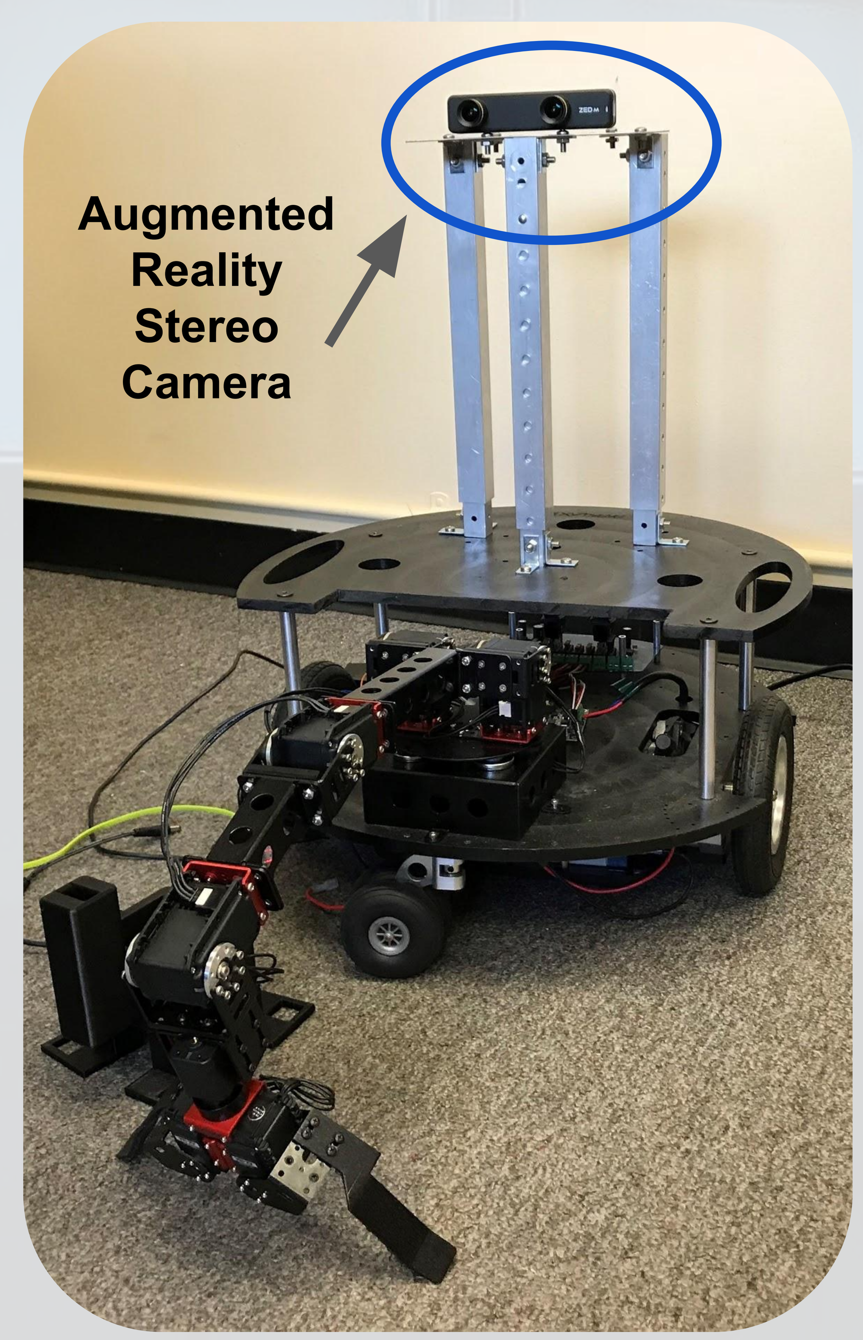

Fig. 6: Armstrong with a stereo camera.

Next Steps and Future Experiments

- Develop a more effective method of controlling the arm.
- Improve GUI to incorporate all controls of Armstrong.
- Add camera to end effector of the robotic arm.
- Augmented reality (AR) stereo camera control.
- Design experiment and select metrics.
  - Time to completion
  - Number of assembly errors
  - Operator situational awareness

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