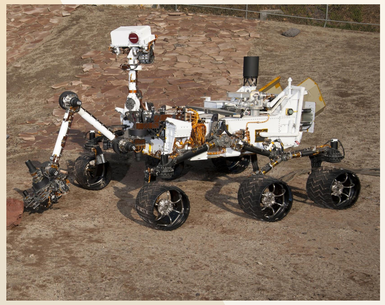
Telerobotic Assembly Recovery Using Virtual Training for Low-Latency Lunar Applications

University of Colorado Boulder
NESS Network for Exploration and Space Science

M. Bell, A. Kumar, P. Curlin, J. Burns

Introduction

NASA has set a goal to return to the Moon to conduct lunar and space science while also preparing for future human exploration missions. Current failure response methods used by NASA for rovers consist mainly of using hardware duplicates which are costly and time consuming to assemble. In response, we propose a virtual reality (VR) training simulation of the rover and its environment.



Curiosity's earthbound duplicate, Maggie, in the Mars Yard, a simulated Martian environment used to simulate the conditions that Curiosity experiences on Mars.

Research Objectives

- Simplify the process of planetary robotic failure recovery
  - Specifically assembly failure
- Create virtual recovery simulation
- Compare the effectiveness of problem solving in a virtual recovery sandox to a physical recovery sandox (Mars Yard).

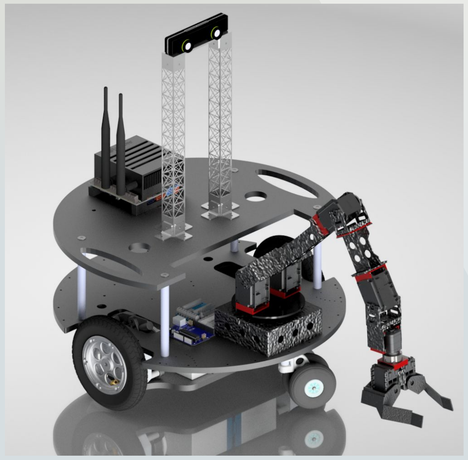
Our Robot

Armstrong Rover

- 6 DOF Crustcrawler Pro-series Robotic Arm
- Differential Drive Base
- Pan/Tilt ZED Mini (Stereoscopic Camera)
- Jetson Xavier (On-board Computing Unit)
- Arduino Microcontroller
- 30000mAh Power Bank

Control Interface

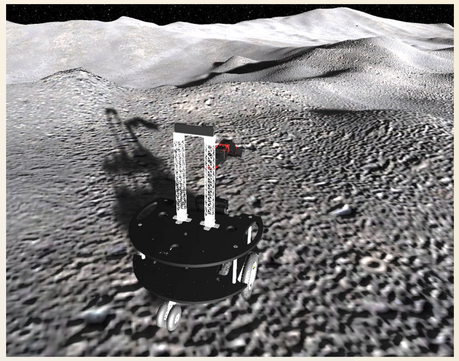
- Oculus Quest
- PC w/ RTX 2060
- Xbox Controller
- Virtual Simulation



Rendered image of the Armstrong Rover. Note that this model does not contain the pan/tilt mounting for the ZED Mini.

Virtual Recovery Sandbox

- Use of CAD models of the rover for accurate simulation
- 3D scans can recreate environment/assembly space
- Ability to manipulate gravity and physics model
- Risk-free solution development sandbox
- Immersive VR perspectives
- Operator use for failure identification and solution development



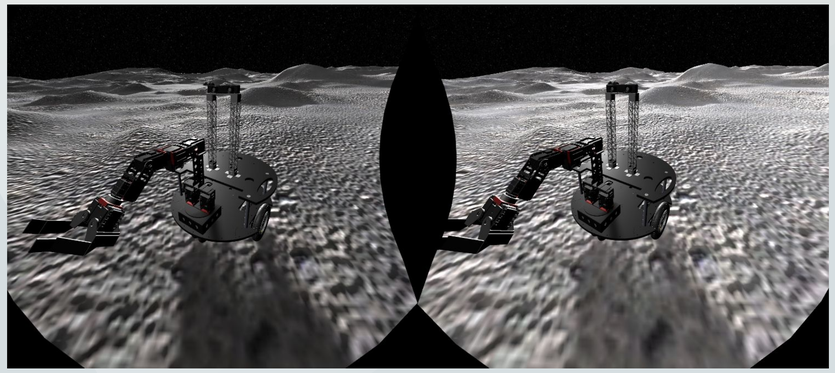
Exocentric Observation

- Free-Moving 3rd Person Perspective
- Failure Assessment

Egocentric Control

- VR Headset viewing through the "eyes" of the virtual rover
- Rover Manipulation

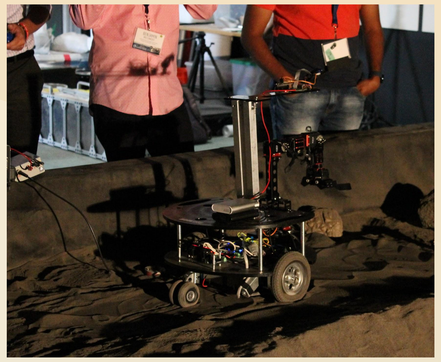
- Operator may switch between perspectives as desired
- Virtual rover control interface mirrors physical model
- Assembly objects and environment may be reset



Ocular view of the Armstrong rover in a virtual simulation space

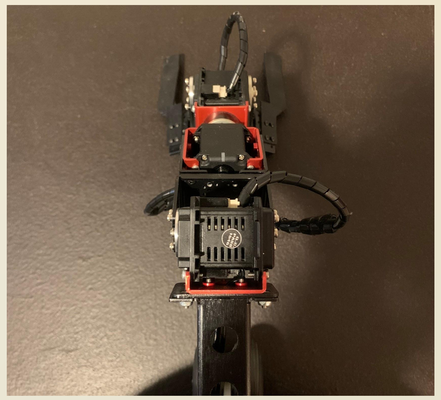
Physical Recovery Sandbox

- Represents current failure response method
- Hardware duplicate of the rover in a reconstructed environment
- Physical access provides tactile feedback



Exocentric Observation

- Free-Moving 3rd Person Perspective
- Failure Assessment



Egocentric Control

- Stereo passthrough to VR Headset viewing through the "eyes" of the physical rover
- Rover Manipulation

Benefits of Virtual Recreation

- Fewer inaccuracies in recreation
- Ability to replicate gravity
- Cost efficient solution
- Accessible to anyone with a VR headset

Future Work

Future missions call for the deployment and assembly of infrastructure across the lunar surface. A prime example, FARSIDE, requires the deployment of radio antennas over roughly 40km of lunar surface to build a low frequency radio array. All of this will be done through collaborative robot-human interactions. These new real time methods call for a faster and more effective failure response model. After developing a virtual recovery simulation, we will compare it to traditional failure recovery methods. If effective, a virtual failure recovery method could save time and resources while providing more accurate information to the operator.

This work is directly supported by the NASA Solar System Exploration Virtual Institute cooperative agreement 80ARC017M0006.

RESEARCH POSTER PRESENTATION DESIGN © 2015
www.PosterPresentations.com