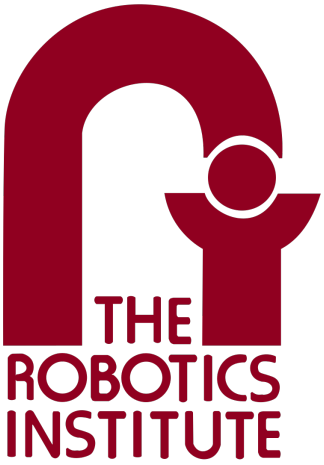
Individual Lab Report - ILR04



Lunar ROADSTER

Team I

Author: **Deepam Ameria**
Andrew ID: dameria
E-mail: *dameria@andrew.cmu.edu*

Teammate: **Ankit Aggarwal**
ID: ankitagg
E-mail: *ankitagg@andrew.cmu.edu*

Teammate: **Bhaswanth Ayapilla**
ID: bayapill
E-mail: *bayapill@andrew.cmu.edu*

Teammate: **Simson D'Souza**
ID: sjdsouza
E-mail: *sjdsouza@andrew.cmu.edu*

Teammate: **Boxiang (William) Fu**
ID: boxiangf
E-mail: *boxiangf@andrew.cmu.edu*

Supervisor: **Dr. William "Red" Whittaker**
Department: Field Robotics Center
E-mail: *red@cmu.edu*

March 21, 2025

Carnegie Mellon University
Robotics Institute

Contents

1 Individual Progress

In this phase of the project (from PR2 to PR3), I have worked on the following tasks:

1.1 Dozer Assembly Actuation

I successfully tested different linear actuators with varying lifting capacities (essentially, other gear ratios). After trying 3 actuators of gear ratios 50:1, 63:1, and 150:1, I selected the one with the highest gear ratio — 150:1. This gear ratio provides the optimal lifting force for the entire dozer assembly at a reasonably good speed.

I integrated the dozer movement with the joystick to make the entire assembly capable of teleoperation. The dozer now moves up or down by 5%, which corresponds to 2.5 mm of linear actuation. (Figure 1). The fully functional dozer assembly was tested in the MoonYard. I observed the operation of the assembly and its ability to push sand and flatten the dunes in front.

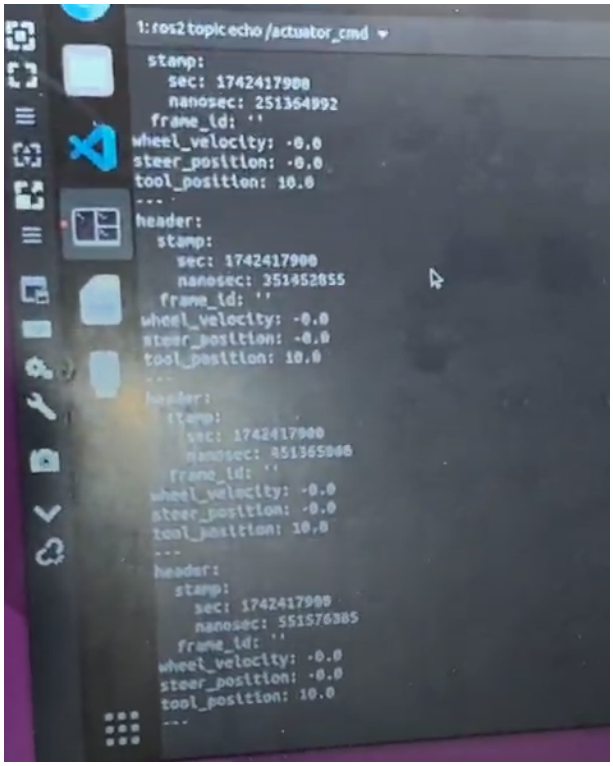


Figure 1: Tool Position updating

1.2 E-Box Manufacturing

I worked on manufacturing the E-Box that Ankit had designed. I primarily focused on the walls of the E-Box. I generated the .dxf files and got them laser-cut at TechSpark (Figure 2). Currently, 2 different sheet thickness (2.5 mm and 5 mm) have been chosen. Based on fastener sizes and sturdiness, I will select the best one for us. I will be working with Simson and Bhaswanth to assemble the new E-Box on the rover when all the electronics and PCBs arrive.

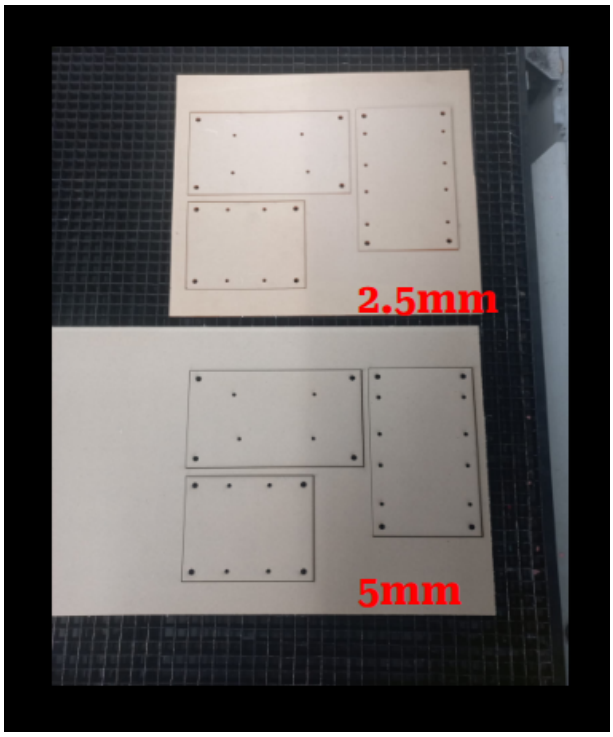


Figure 2: E-Box walls laser cut

2 Challenges

2.1 Linear Actuator Oscillations

We observed a lot of oscillations near the setpoint during the linear actuation of the dozer assembly. If the setpoint command is sent as X mm (sent as the corresponding PWM command), the actuator reaches X mm but oscillates around it. This is a result of PD control that runs inside the Linear Actuator Controller which tries to reduce the error between the current position and the goal position. The controller receives feedback from the potentiometer inside the actuator to determine this error.
A lot of gain tuning was required to fix this issue of oscillations at the setpoint. I was able to solve this for maximum and minimum extension of the actuator using the LAC Software (Figure 3), but the issue persists for intermediate positions. Currently, the dozer is functional and I will be moving on with other tasks and tackling this issue in parallel.

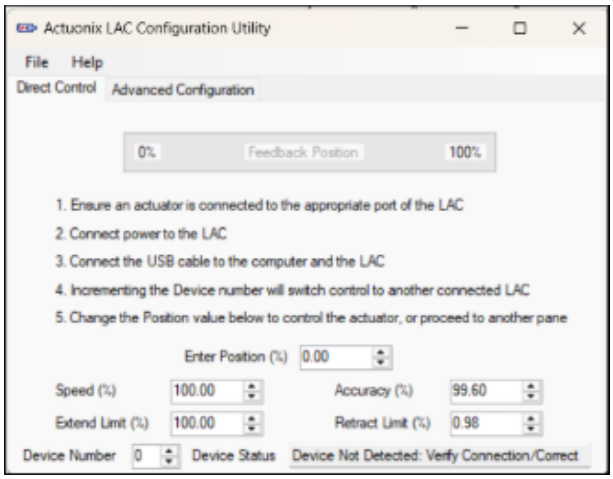


Figure 3: Actuonix Linear Actuator Software

2.2 Replacing Rear-Axle

Our team faced a major challenge in this phase when the rear axle wore out and was disengaged with the driveline. This posed a significant risk and a potential blocker for our project, as the mobility of the rover was compromised. Ankit and I spent a lot of time looking for spares online and also on campus, but couldn't find the same or a similar part.
Fortunately, with Prof. Red and Chuck's help, we found a twin rover in the Planetary Robotics Lab and were able to scavenge the parts off of it. We replaced the axle and tested the mobility in the MoonYard again, thereby solving the issue. However, we have identified this as a major risk and will keep tracking it carefully.

3 Teamwork

The team completed many individual and collaborative tasks this week, which are listed here:

- **Ankit**: Ankit and I collaborated in mitigating the issue of the rover breaking down due to a worn-out rear axle. We looked for spares and replaced the axle with the scavenged parts from a twin rover that we found on campus. Ankit took the lead on the PDB development and completed the final design of it. He also documented the transport planner (which is the tool planner) of the previous team, so that we can understand it better and work on developing over the existing stack.

- **Bhaswanth**: Bhaswanth and William worked on testing the localization stack in the MoonYard, primarily to solve the issue with global localization. He also collaborated with me to implement dozer teleoperation. He also worked with Simson on setting up the initial navigation stack on the Jetson.

- **Simson**: Simson worked on refining the global cost map to obtain an accurate ground plane. I worked with him to flatten the MoonYard and create craters of various shapes and sizes, allowing for a more precise terrain model. He also developed an algorithm to detect gradable craters and obtain coordinates of those craters on the map.

- **William**: He worked with Bhaswanth to debug the localization stack of the rover using the IMU and the wheel encoders. He also worked on the REalSense camera, which is now correctly publishing point cloud data. He will further work on generating an elevation map out of it which can be used by Ankit and I for determining source and sink nodes of the crater.

4 Plans

For the coming weeks, I will be working on the following things:

- Development of the transport planner (tool planner) with Ankit: We will be using the methodology from CraterGrader, and will augment or modify it to fit our use case. I will be also working on integrating it with the navigation stack that Simson and Bhaswanth are developing.
- Assembly of E-Box: I will be working with Simson and Bhaswanth to assemble the newly developed E-Box and integrate all electronics and electrical connections within it.
- Integration and Testing: As SVD is coming up soon, we will conduct several subsystem and system-level tests, both on-bench and in the MoonYard. I will work with the team for all these tests and oversee the integration of the sub-systems.