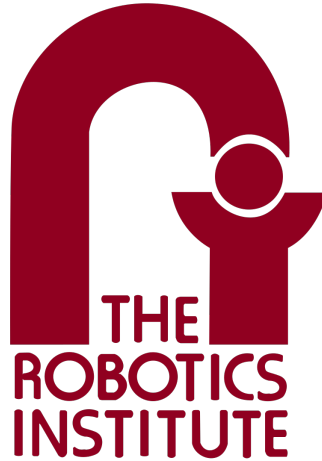

Individual Lab Report - 7



Lunar ROADSTER

Team I

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

Teammate: **Deepam Ameria**
ID: dameraia
E-mail: *dameraia@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*

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1 Individual Progress

1.1 Validation & Perception Methodology

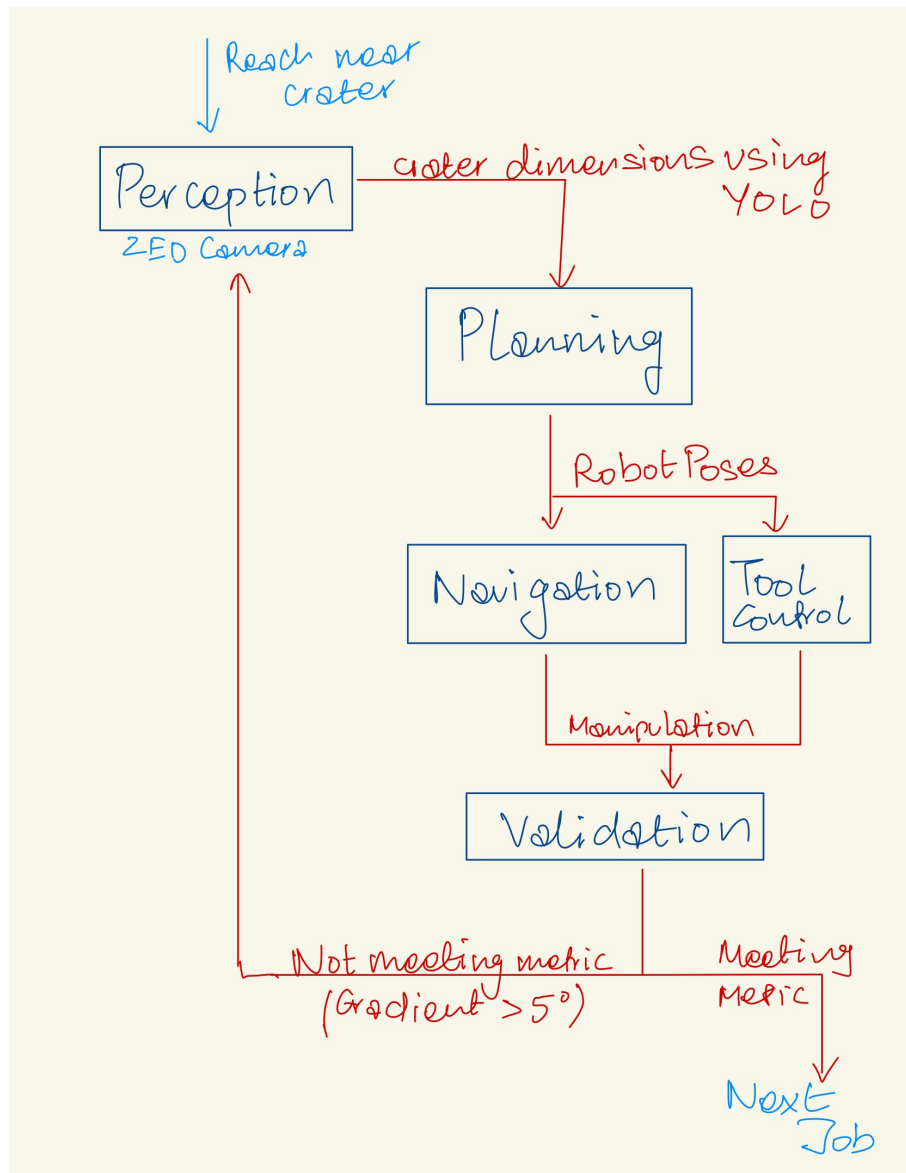


Figure 1: Software Flow Diagram of Crater Grooming

We finalized the methodology for our validation pipeline, illustrated in Fig. 1. To facilitate closed-loop control while manipulating, we will use a Deep Learning Model (YOLOv8/v11). We are in the process of building a dataset with tight-fitting bounding boxes. We will then use these bounding boxes to determine the centroid and diameter of the crater. These dimensions will be sent to the planning node.

The planning node will use these dimensions to calculate robot poses, similar to how we used GLOP output during the Spring semester. However, we plan to make the tool position a continuous variable instead of high and low, and use depth data from the ZED to calculate tool height.

The robot and tool poses will be sent to the navigation node to execute the manipulation task. The validation will kick in after the job is complete. This will use point cloud data from the ZED camera to determine the maximum gradient. If it qualifies our metric of 5°, the robot will move on to the next task. If it doesn't, the loop will run again. However,

only the tool height will be adjusted this time to make a flatter path. The robot poses will remain the same.

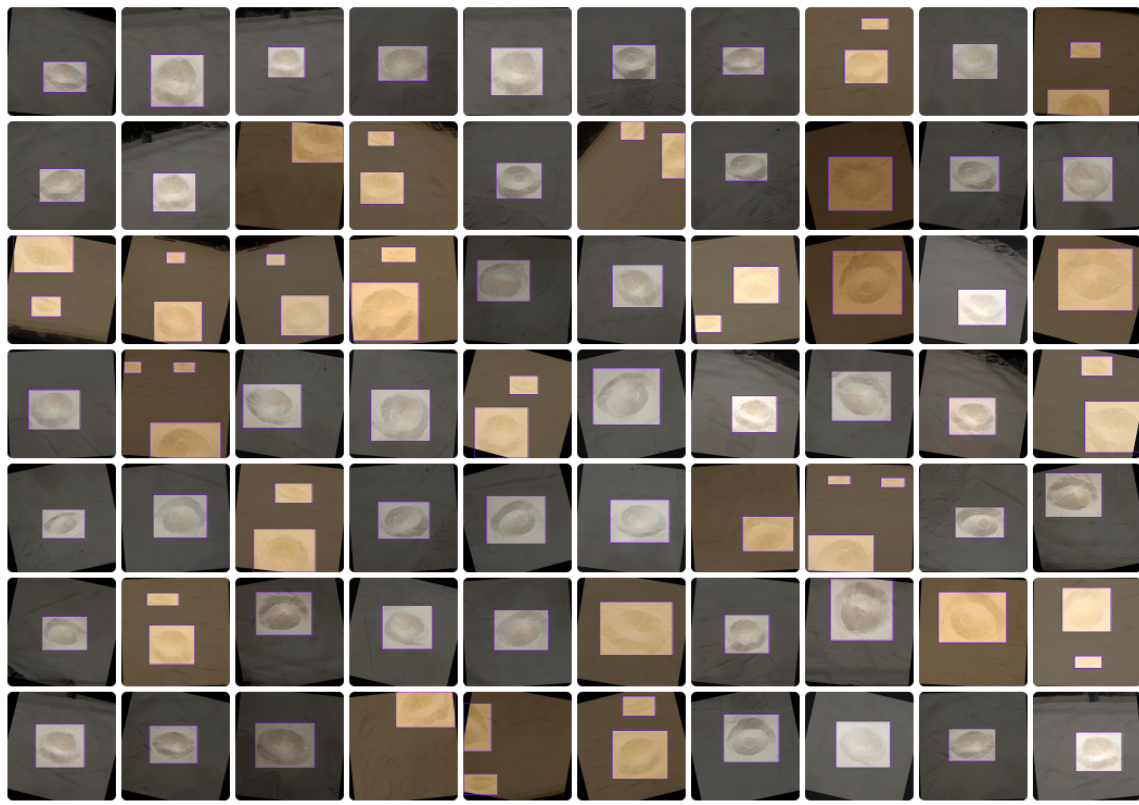


Figure 2: Initial Dataset

We have also begun collecting data for training our YOLO model, shown in Figure 2. We hope to have a pipeline running by the next PR.

1.2 Actuator Oscillations

Our dozer actuator has been jittery since the time we purchased it. We have tried multiple ways to control this, but nothing has worked. The datasheet mentions that PWM control is the best way to use the actuator with a microcontroller. However, since we went through every possible way to try this, I decided to pivot to analog control. Luckily, the Arduino Due has two pins (DAC0 and DAC1) that give true analog output. Using this, we could control the actuator directly from the Arduino without jittering at any point in the stroke. The next step will be integrating this into our micro-ROS control code and testing it out.

1.3 Sensor Mounts

I printed both sensor mounts shown in Figure 3. The ZED Camera had to be an iterative print (3 iterations) as the datasheet did not have very accurate dimensioning. I used a vernier caliper to get the correct dimensions. Both of these will be mounted on our scheduled hardware days (9/26 and 9/27).

Additionally, depending on our hardware troubleshooting, a new mount may need to be designed for our IMU.



Figure 3: Manufactured sensor mounts

1.4 Rover Hardware Maintenance

We ordered multiple spare steering motors and a slightly different pinion for rover maintenance. During the initial assembly, it looks like the new pinion should work without causing any issues in performance; however, this will only be confirmed after the full rover is assembled.

Our aim with the hardware days(9/26 and 9/27) is to finalize hardware completely and not re-open the ROADSTER until FVD. This will be critical to ensure that our testing schedule remains on track.

2 Challenges

One challenge we faced was the tele-operation not working due to the Arduino reset issue. This is an ongoing problem, and I am working with Bhaswanth and Deepam to resolve it. Hardware, as a whole, is a challenge, and we hope to resolve it by 9/27.

Other than that, no big challenges yet, although I do think getting YOLO running to our requirements will be challenging. This is due to it being our first time training a deep learning model on a custom dataset.

3 Teamwork

I worked with Deepam and finalized a Deep Learning method to detect craters and extract geometry information. We collected a preliminary dataset for the YOLO Model and a video to run inferences. I also worked with Deepam to refine the dozer performance by debugging the jittery motion. Additionally, I worked with both Bhaswanth and Deepam on the Arduino reset issue.

Bhaswanth Ayapilla: Bhaswanth worked with Deepam and me on the Arduino reset issue. He also figured out the resection method on the total station. He is working with Simson on the navigation subsystem to finalize the global navigation controller

methodology. He also worked with William to debug connection issues between the Orin and the Arduino

Deepam Ameria: Deepam and I worked closely on finalizing the perception methodology, data collection for YOLO, and refining the dozer actuator jittering. He is also working with Bhaswanth and me on the Arduino reset issue.

Simson D'Souza: Simson has been working on finalizing the crater selection methodology from the global path planner. He iterated through several methods and decided that using CV on an image of the costmap was the best way forward. He collaborated with Bhaswanth to finalize the global navigation controller methodology.

Boxiang Fu: William's work since the last progress review focused on debugging software connections between the new Orin compute with the Arduino (in collaboration with Bhaswanth) and the joystick. William also collaborated with Bhaswanth in resolving the sudden jolts caused by steering commands. Finally, William worked on researching how to implement the rover's validation unit using point cloud sensor data and elevation mapping.

4 Plans

The team plans to have an implementation of validation ready, a basic global navigation pipeline running, and hardware finalized. My plans are:

1. Finalize hardware
2. Test the new dozer actuator analog control using MicroROS
3. Collect a good enough crater detection dataset and annotate
4. Train a YOLO model and run inferences on collected video
5. Finalize an integration methodology between the ROADSTER FSM and perception
6. Work on the MRSD Wiki proposal