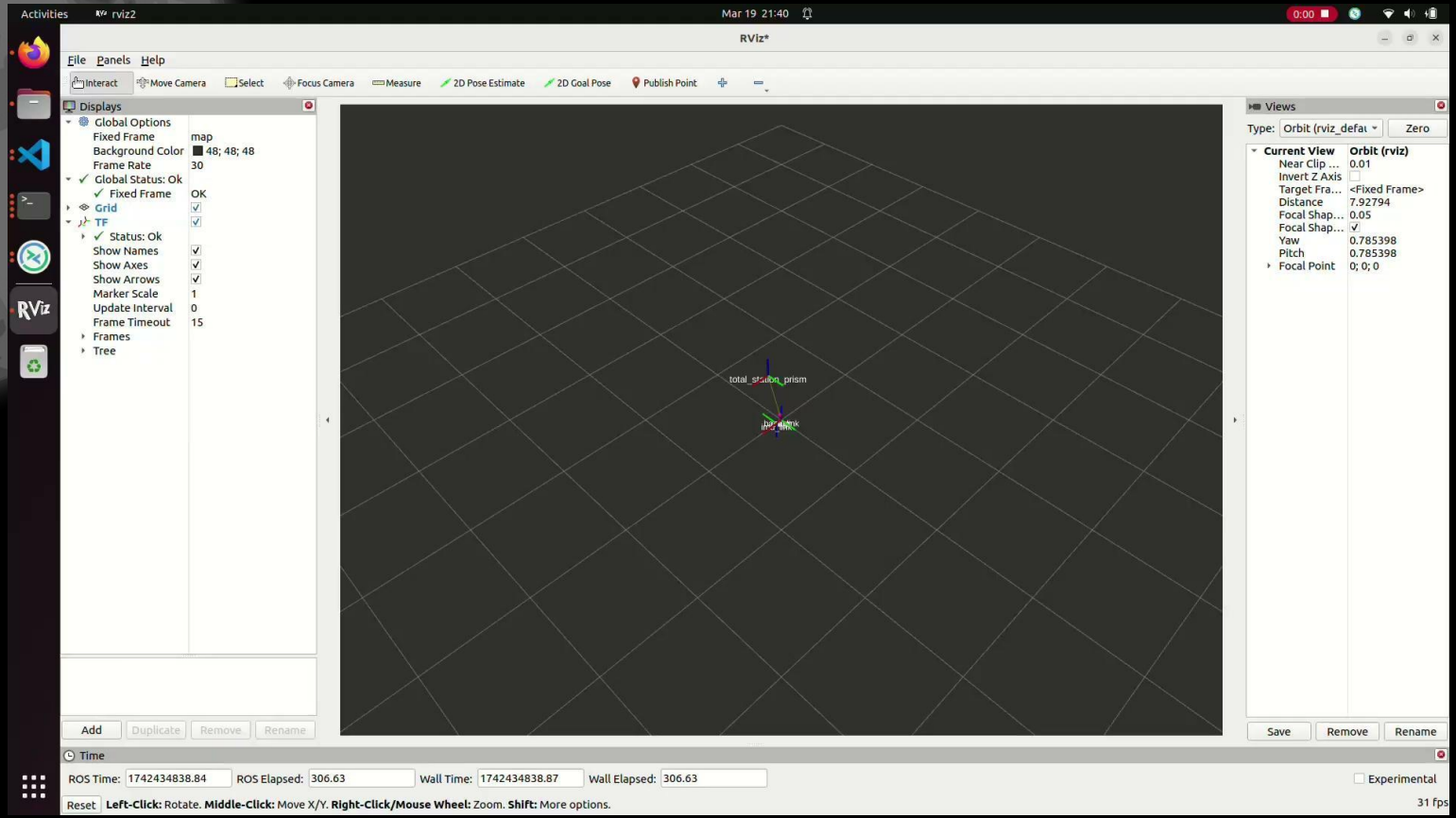
Lunar ROADSTER

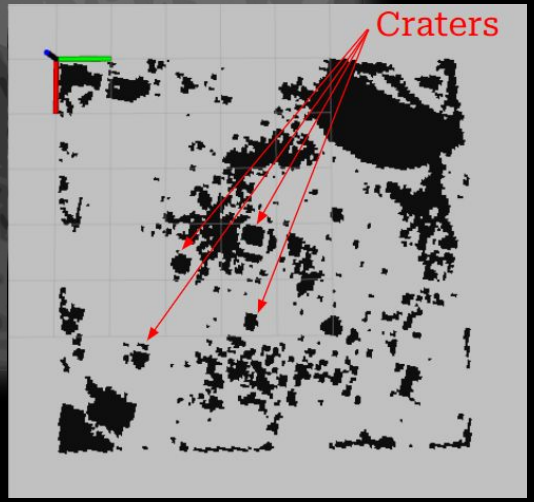
(Robotic Operator for Autonomous Development of Surface Trails and Exploration Routes)

"Starting with a foothold on the Moon, we pave the way to the cosmos"

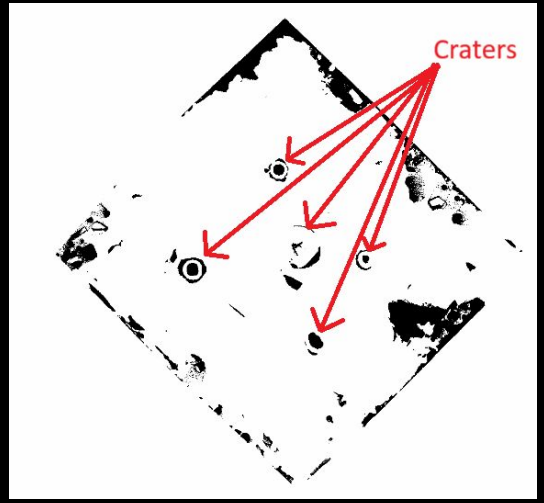
Software: Localization Test (T09)



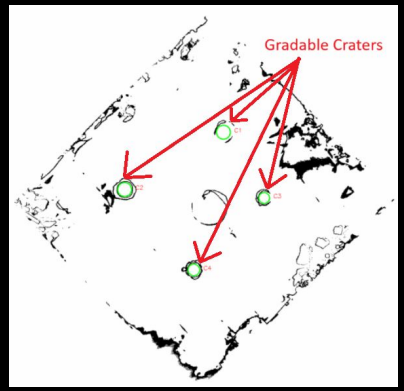
Software: Moon Yard Mapping, Occupancy Grid (T08)



Old Occupancy Grid Map



Refined Global Cost Map

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Centroids of Gradable Craters (World Coordinates):
Crater 1: X = 10.298 m, Y = 3.360 m
Crater 2: X = 7.726 m, Y = 4.857 m
Crater 3: X = 11.359 m, Y = 5.070 m
Crater 4: X = 9.526 m, Y = 6.944 m
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Identified gradable craters based on diameter and depth, extracting their coordinates which will be used for navigation

Software: Navigation Stack (T11)

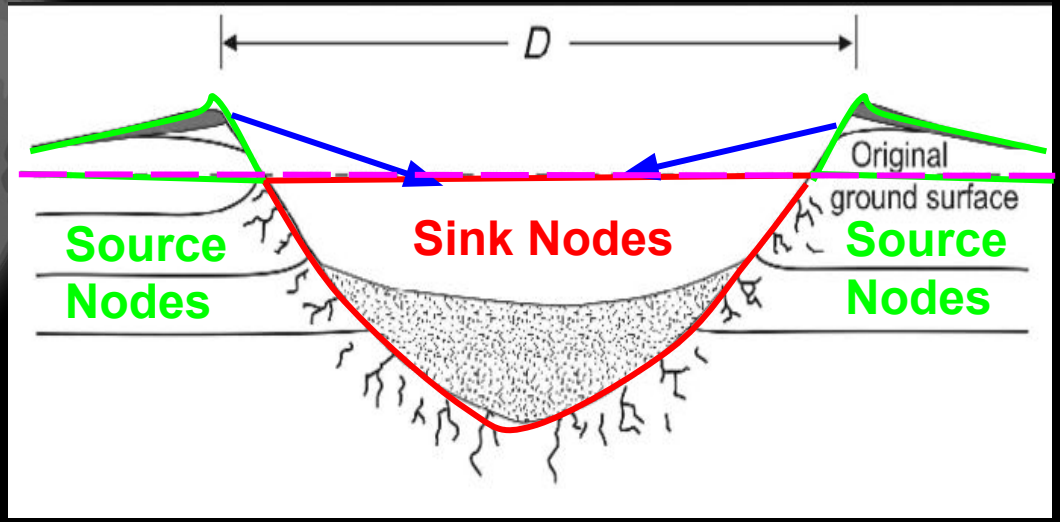
- **Initial Nav2 Setup (Completed):**
  - Resolved issues with gazebo_ros_pkgs, which is incompatible with ARM processors, by removing related files from the Nav2 stack (as they were not required).
  - Modified the launch file to integrate our robot's URDF and configure the costmap.
  - Successfully loaded the costmap in RViz.

- Current work (In Progress):
  - Spawn the robot at a defined position in RViz.
  - Remap the required Localization topics with the Nav2 topics. Verify if Nav2-generated commands are received by the hardware interface node on the robot.
  - Configure the local costmap params to utilize point cloud data from the RealSense camera.
  - Fine-tune Nav2 parameters for optimal performance on our robot and ensure accurate robot localization and real-time updates in RViz.

Software: Dozer Teleoperation (T11)

- Dozer actuation integrated with joystick for teleop
- 5% increments for every command
- Will test with another actuator for reducing oscillations

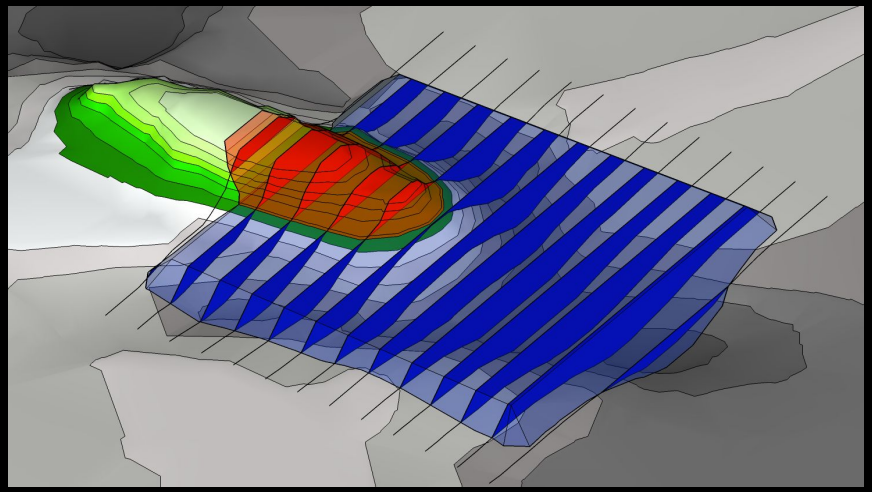
Software: Tool Planner Methodology (T12)



Phase 1: Identifying the volume of sand to be dozed

- Store depth map in a matrix format with each node having x, y and depth
- Traverse through the depth map
- Assign source and sink nodes based on chosen datum (median/mean depth of the map) and calculate source and sink volumes

Software: Tool Planner Methodology (T12)



Phase 2: Solving the optimization problem for a single crater

- Create a cost function based on the depth relative to the datum
- Solve the linear optimization problem (GLOP / Newton's Method) to identify the **source to sink transportation routes**
- Create a manipulation plan based on the output i.e. **generate rover waypoints** on the basis of the required transport routes

Software: Tool Planner Methodology (T12)

Phase 3: Propagate the methodology for multiple craters

Option 1: Solving the linear optimization problem for multiple craters simultaneously

Pros: 1-shot computation with the most optimal answer

Cons: Tougher to implement, will be slower and may introduce non-linearity into the optimization problem

Option 2: Solving for each crater individually in a sequential manner

Pros: Allows for easier computation with a ‘good-enough’ answer

Cons: May output sub-optimal routes causing an increase in manipulation time and complexity

We may go different routes for SVD and FVD owing to time constraints, limited resources and our final goals.

Hardware: Wheel Test - Iteration 3 (T06)

Current iteration slips less and provides greater torque than the stock rubber wheels.

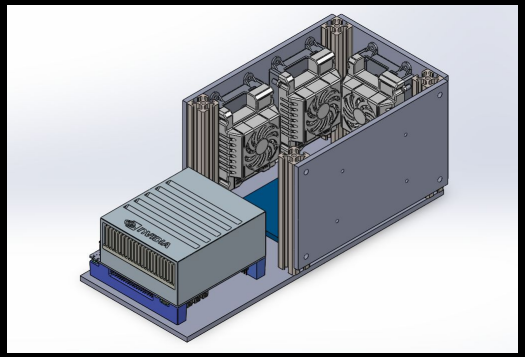
Further testing has been delayed due to delay in receiving prints from the FRC.

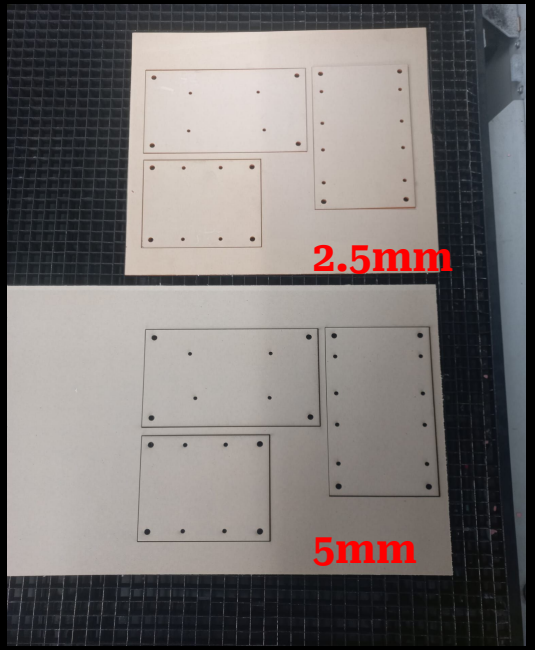
Goal: Have 4 3D printed wheels for SVD and 4 metals wheels for FVD

Hardware: E-Box Laser Cut (T07)

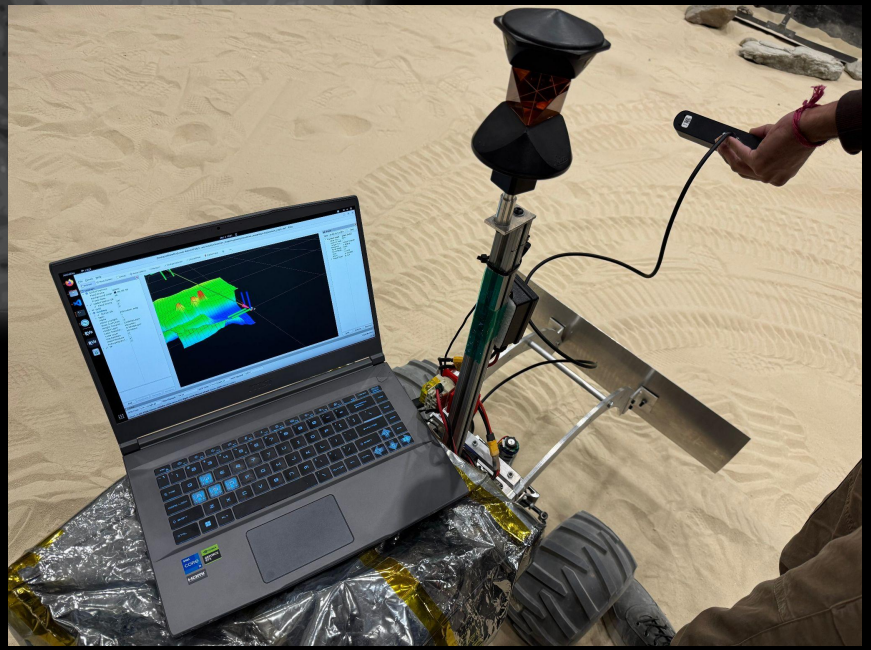
- Walls of the E-box are laser cut
  - 2.5mm and 5mm options
  - Base is pending, subject to PDB manufacturing and delivery

- T-nuts and other fasteners ordered for mounting.





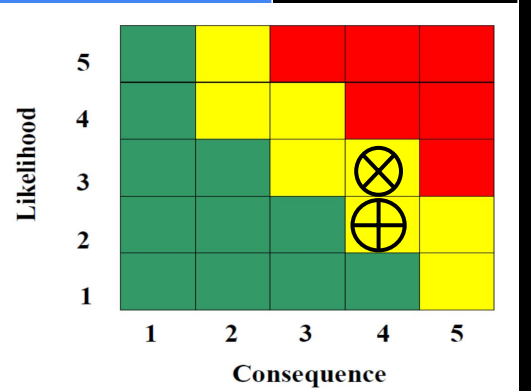
Hardware: Optimal Mast Depth Camera Placement (T10)



- Tried different depth camera placement height and declination to identify ideal placement
- Needs to be clear of dozer when fully raised
- Needs to generate clear point cloud/elevation map of obstacles in front
- Settled on {X, Y, Z, R, P, Y} = {0.5, 0, 0.6, 0, -30, 0} from base_link
- **Goal:** Have triangle bracket mount installed for depth camera

Risk Management

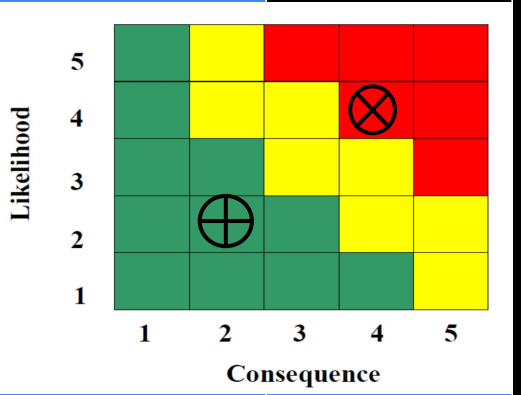
Risk ID	Risk Title	Risk Owner	Risk Type:	Technical, Logistics
R28	Electrical Hardware Finalization	Ankit		
Description		**Date Added**		
E-box Design dependence on to-be manufactured PDB.		2/14/2025		
		Date Updated		
		2/14/2025		
Consequence				
Not meeting the hardware deadline				



Action/Milestone	Success Criteria	Date Planned	Date Implemented
Use previous knowledge and account for a placeholder in the design.	Successfully design and manufacture E-box compatible with the new PCB using placeholder PCB design	02/14/2025	

Risk Management

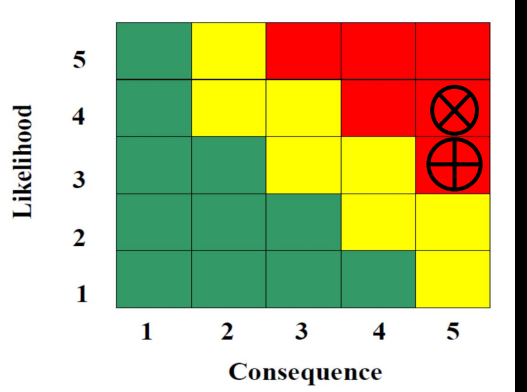
Risk ID	Risk Title	Risk Owner	Risk Type:	Logistics
R29	Access to FRC Workshop	Deepam		
Description		**Date Added**		
Without access, no hardware fabrication/repairs can be carried out in the absence of Tim		2/7/2025		
		Date Updated		
		2/7/2025		
Consequence				
Not meeting the hardware deadline				



Action/Milestone	Success Criteria	Date Planned	Date Implemented
Try other fab-labs on campus.	Successfully access other fab-labs and manufacture components	2/9/2025	
Request Tim, John or Red for getting temporary access, if not permanent	Successfully get temporary/permanent access to FRC Workshop	2/12/2025	

Risk Management

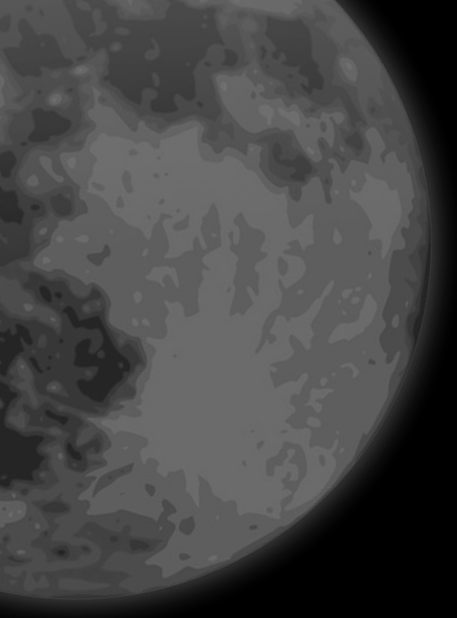
Risk ID	Risk Title	Risk Owner	Risk Type:	Logistics
R30	No spares available	Team		
Description		**Date Added**		
Discontinued model, spare parts unavailable		3/4/2025		
		Date Updated		
		3/4/2025		
Consequence				
The whole project falling through, or redo almost all subsystems on a different rover.				



Action/Milestone	Success Criteria	Date Planned	Date Implemented
Check out eBay and other similar platforms for spares	Successfully find exact spares on these platforms	3/6/2025	
Check out and stock similar parts if not same	Successfully find and stock similar parts	3/6/2025	
Find a twin rover that was used by a previous team on campus	Successfully find the twin rover and scavenge parts	3/6/2025	3/7/2025
Maintain all parts, especially mechanical parts	Successfully avoid future breakdowns and part failures	3/7/2025	

Issues Log

Issue ID	Date Initiated	Date Resolved	Participants	Description	Options	Resolution	Justification
I07	03/04/2025		**Boxiang Fu** **Bhaswanth Ayapilla**	ZED SDK in docker container not working	1. Use ZED SDK outside docker 2. Use a dedicated docker container for SDK		
I08	03/04/2025	03/07/2025	**Team**	Rear transmission axle is broken	1. Ask Red for replacement 2. Look for substitutes	Found replacement chassis with axel in the PRL. Obtained permission from Red to take apart the replacement chassis for the broken part	Replaced the part so that we can continue progress on the rover
I09	03/19/2025		**Boxiang Fu** **Bhaswanth Ayapilla**	Global localization flies off during testing	1. Try different localization technique rather than using robot_localization package 2. Debug		



THANKS!

Team Lunar ROADSTER