SDSU San Diego State University

NASA Robotic Mining Competition Lunabotics 2023

Project Overview

The purpose of the 2023 NASA Lunabotics Competition is to build a rover that can navigate successfully around obstacles in order to excavate and deliver lunar regolith into a hopper. Team Vulcan's rover will hopefully influence future NASA design and delopment.

Team Members


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ME Team Lead


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Design & Engineering


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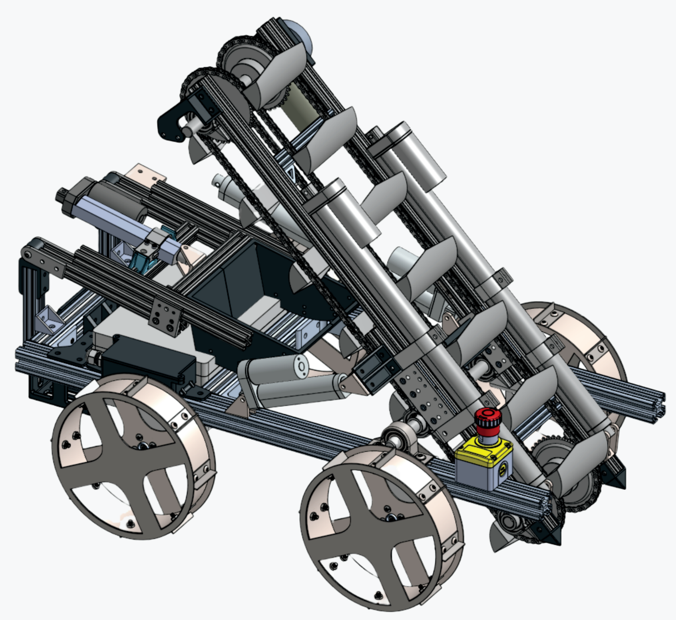
Quality Assurance

Acknowledgements

San Diego State University

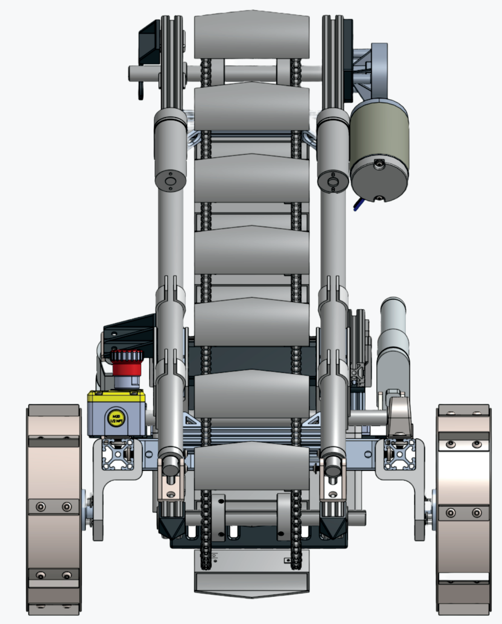
Team Vulcan would like to express appreciation to NASA for hosting the 2023 Lunabotics Competition as part of their Artemis program. We would also like to extend our thanks to San Diego State University for facilitating the project, as well as to our faculty advisors, Dr. Scott Shaffar and Professor Barry Dorr, for their sponsorship and guidance throughout our team's journey.

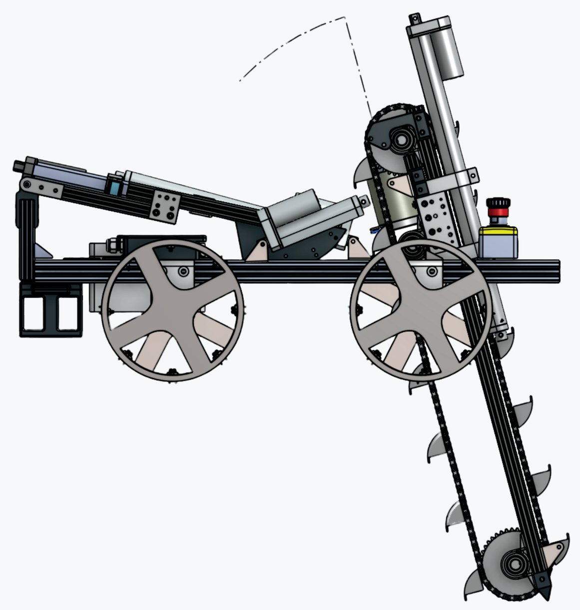
Mechanical Design

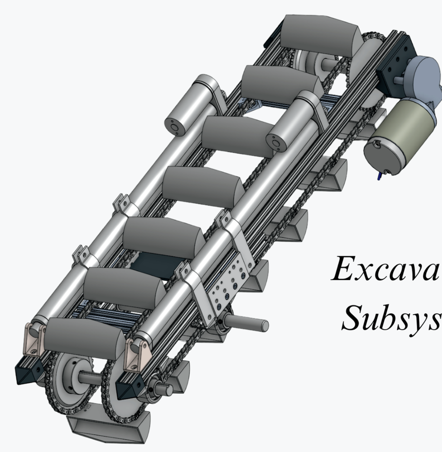


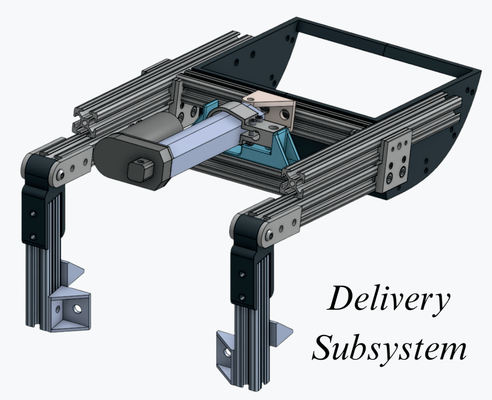
Overall Rover

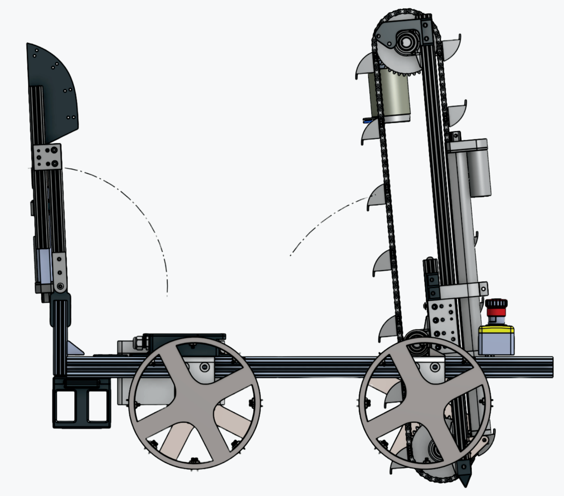
The rover is comprised of three main subsystems: the drivetrain, excavation, and delivery. To power each of the rover's wheels, four independent worm gear motors are utilized. The structure of the rover is primarily constructed from extruded aluminum T-slot frame, which allows for modularity and adjustability. The electronics housing is positioned centrally beneath the delivery subsystem.





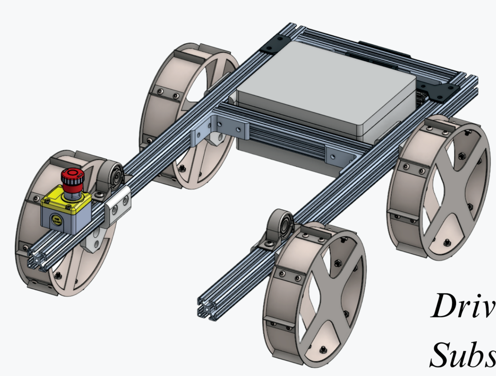

Excavation Subsystem


Delivery Subsystem



Excavation Process

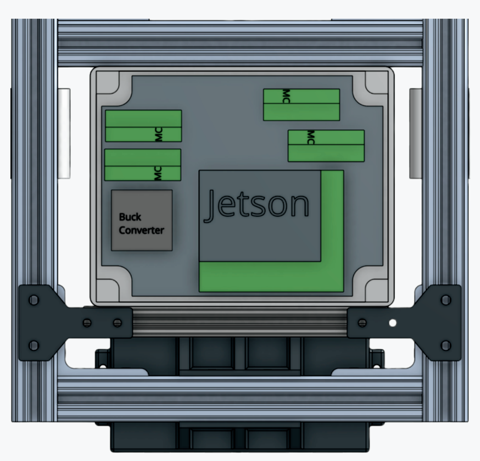
The excavation system is powered by a worm gear motor, which provides 6 Nm of torque to the chain system. Multiple steel scoops are attached to and moved by the chain system, effectively excavating sand and gravel. To adjust the excavation depth, two 18" linear actuators are utilized, while the angular position is controlled by a 6" linear actuator.


Drivetrain Subsystem

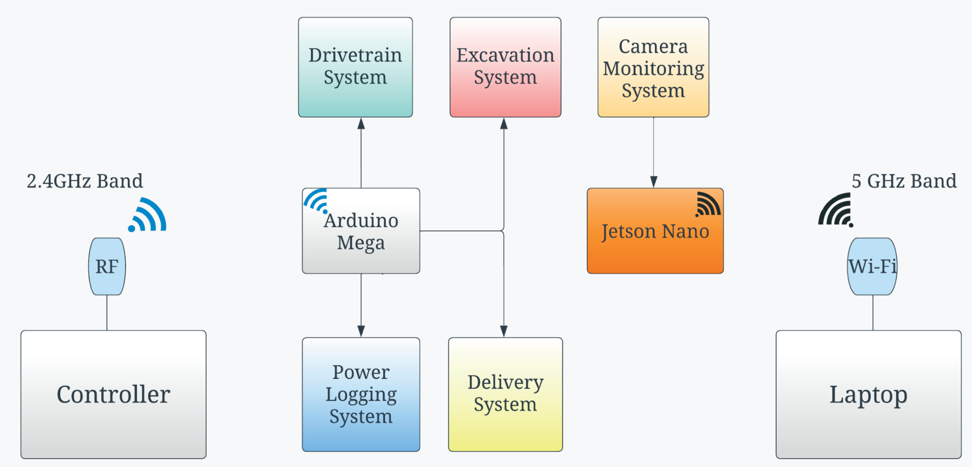
Delivery Process

The delivery system is outfitted with a 4" linear actuator to adjust the basket's position in relation to the excavation subsystem, and a 12" linear actuator for angular orientation, which enables precise delivery to the sieve in the arena. The basket is constructed with an ABS frame and a steel mesh, designed to sift any excess sand with ease. Once the excavation is tilted out of the way, the delivery arm is then swung upward towards the sieve.

Electrical Systems

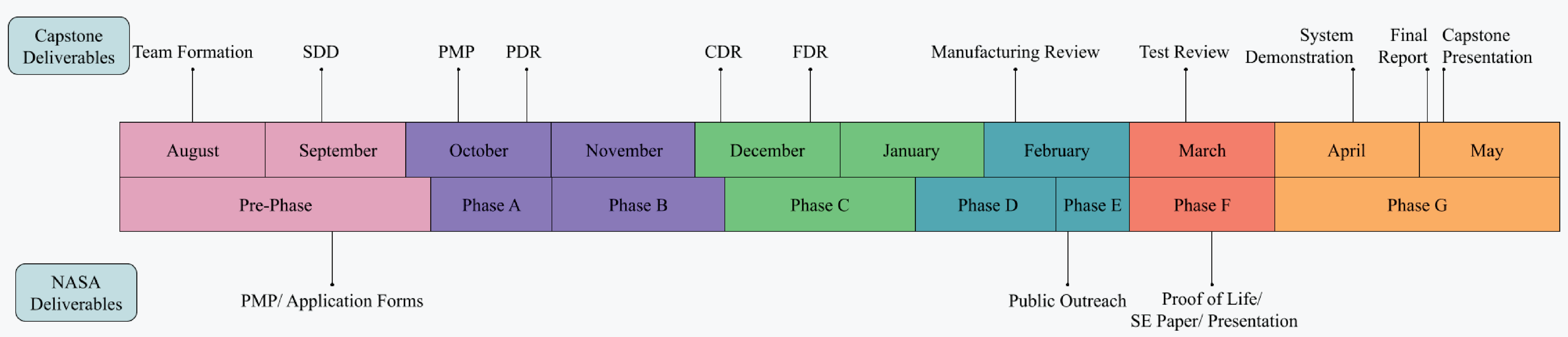


Electronics Housing



System Level Diagram

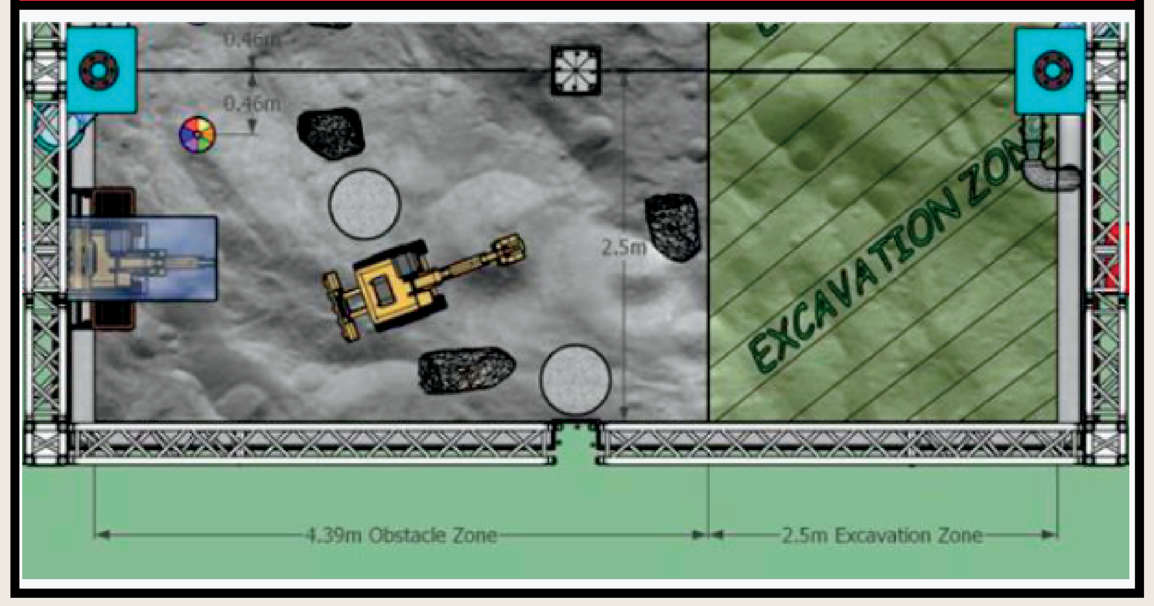
Project Timeline



NASA Requirements

- Rover shall excavate ~30 cm of sand granular over ~15 cm icy regolith simulant with ~2 cm rocks
- Arena obstacles shall consist of 3 boulders, 2 craters, both 30-40 cm in diameter
- Rover shall not exceed 1.1 m length x 0.6 m width x 0.6 m height
- Rover maximum mass of 80 kg
- Mining arena: ~6.9 m long, 1.5 m wide
- Excavation zone: 2.5 m long, 2.5 m wide
- Collection sieve: 1.0m wide, 0.3 m deep, top lid 0.5 m from surface
- Rover shall be equipped with a KILL SWITCH button for emergency shutdown
- Rover shall have 4 lifting points
- Rover shall provide its own onboard power and log power consumption

Arena Schematics



Proof of Life


Rover navigating through obstacle through telerobotic operation


Rover excavating in designated mining zone


Rover delivering simulated lunar regolith to collection sieve

- Final Rover dimensions of 1.04m x 0.58m x 0.6m
- Final Rover mass of 48kg
- Successfully collected 0.813kg of regolith simulant during Proof of Life Video recorded on March 24, 2023

Spring 2023