NASA 2024 RASC-AL Competition: Large-Scale Lunar Propsector

SDSU | College of Engineering

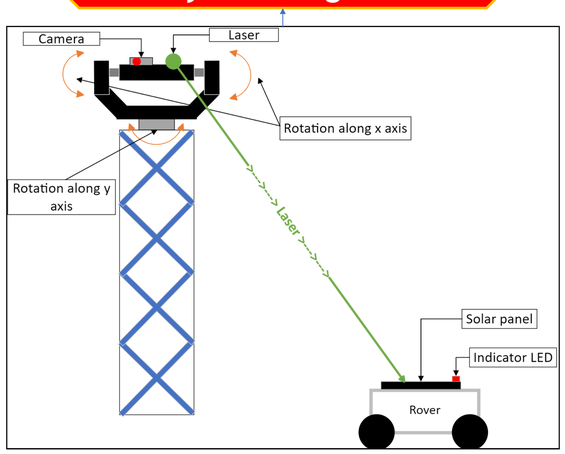
Partnership with: CETYS UNIVERSIDAD

Project Overview

As competitors in the 2024 NASA RASC-AL competition, our mission was to develop a systems engineering concept enabling a lunar rover to operate in the perpetually dark and extremely cold conditions in craters on the lunar south pole. We chose to overcome this challenge by providing the rover with enough on-board power generation to sustain itself, and using a support satellite to beam additional power via microwave radiation during power-intensive prospecting tasks.

To demonstrate the concept of power beaming visually, we constructed a two-axis track-and-aim system featuring a gimbal mounted atop a tower, which tracks a scaled-down rover via RGB indicators and fires a laser onto a solar panel atop the rover. The project involved comprehensive integration of hardware, firmware, and software subsystems. Together, our collaborative efforts aimed to push the boundaries of lunar exploration technology, exploring methods to facilitate sustainable manned lunar missions in the future.

System Diagram



Key Technologies

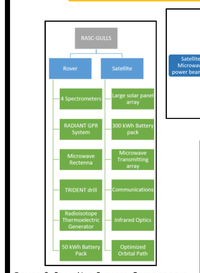
Developed:
- Object Detection & Feedback Control via R-G-B pattern
- Laser Contact Observation System with Adjustable Threshold Voltage (Comparator with Hysteresis)
- Gimbal Control Software

Procured:
- JPL Open-Source Rover
- Microprocessors: Arduino Nano, Raspberry Pi4
- Gimbal Motor Drivers: TB6600 Nema 17 Stepper Motor
- Camera: Logitec USB Webcam

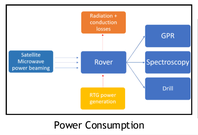
Design Architecture

- Tracking Gimbal: A two-axis system driven by two stepper motors with an attached camera for tracking the solar panel through a fixed RGB pattern, and an attached laser to fire upon the solar panel receiver once it has been acquired.
- Receiving panel: Adjustable voltage threshold control that weaves out ambient lighting to focus on the lighting provided by the laser, this is to be attached to the top of the rover.
- Rover: Independent system that is able to transverse through versatile terrain to mimic exploration tasks.

CETYS Universidad: System Concept



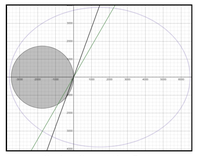
Rover & Sattelite System Components

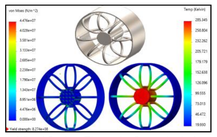


Power Consumption

RASC-GULLS Rover	VIPER
Cryogenically Robust for several years	Freezes after 100 days
Mass, Infrared, Optical, Neutron spectrometers	Mass, Infrared, Neutron spectrometers
TRIDENT Drill	TRIDENT Drill
High-Performance GPR, about 1km of ground penetration	No GPR system
Higher top speed, up to 10 mph	0.45 mph top speed
LIDAR, optical cameras + headlights	Optical cameras + headlights
50 kWh Battery pack, microwave rectenna, RTG, maximum of several kW	Solar powered battery pack, maximum of 450 W
Passive insulation methods to decrease heat losses	Passive insulation methods to decrease heat losses

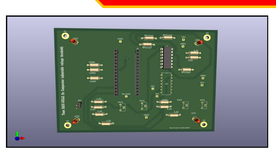
Similarites & Differences to VIPER Rover

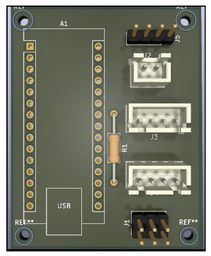

Orbital Calculation Plot


Wheel Design, Thermal + Stress Analysis

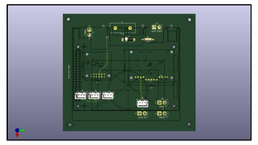
Team RASC-GULLS: CETYS

PCB Designs

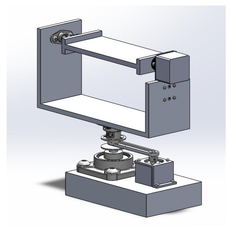

3-D View of PCB: Adjustable Voltage Threshold for Solar Panel

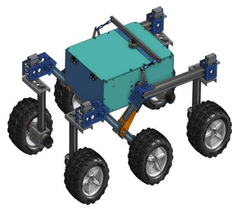


3-D View of PCB: Motor Control Board

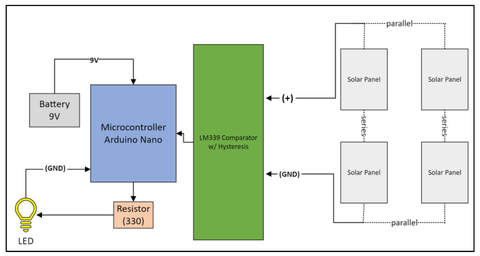

3-D View of PCB: Power Distribution Board Satellite Side

CAD

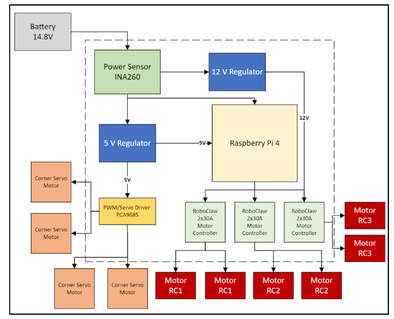

CAD Model of Gimbal


CAD Model of Rover

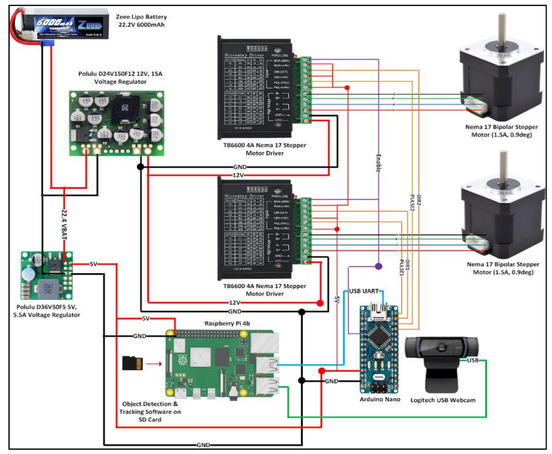
Block Diagrams



Receiving side: Solar Panel

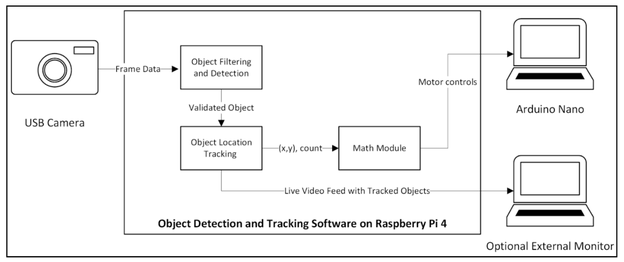


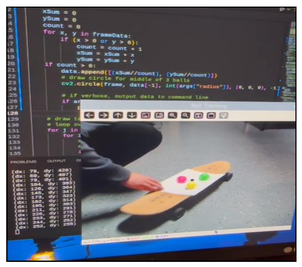
Receiving side: Rover



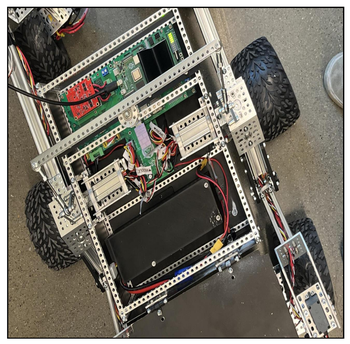
Transmitting side: Gimbal and Tracker

Object Detection & Tracking Software





Finished Project

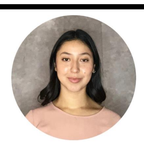

Rover Electronics


Gimbal

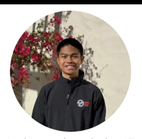

Rover

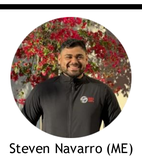
SPRING 2024

Team RASC-GULLS: SDSU


Adeline Guizar (COMPE)


Ethan Milan (EE)


Melmar Almodiel (ME)


Steven Navarro (ME)


Jay Diorio (EE)


Samson Ande (EE)


Zaid Yasin (COMPE)


Dominic Malanga (ME)


Lorans Taquian (ME)

Acknowledgements

We would like to thank the following for the support and contributions for the development of our subsystems: Dr. Scott Shaffar, Professor Barry Dorr, Oscar Correa and SSF, Professor Roberto Salas and the CETYS team!