STUDENT PORTFOLIO

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Autonomous RC SLAM Car

JAN. 2026 - FEB. 2026

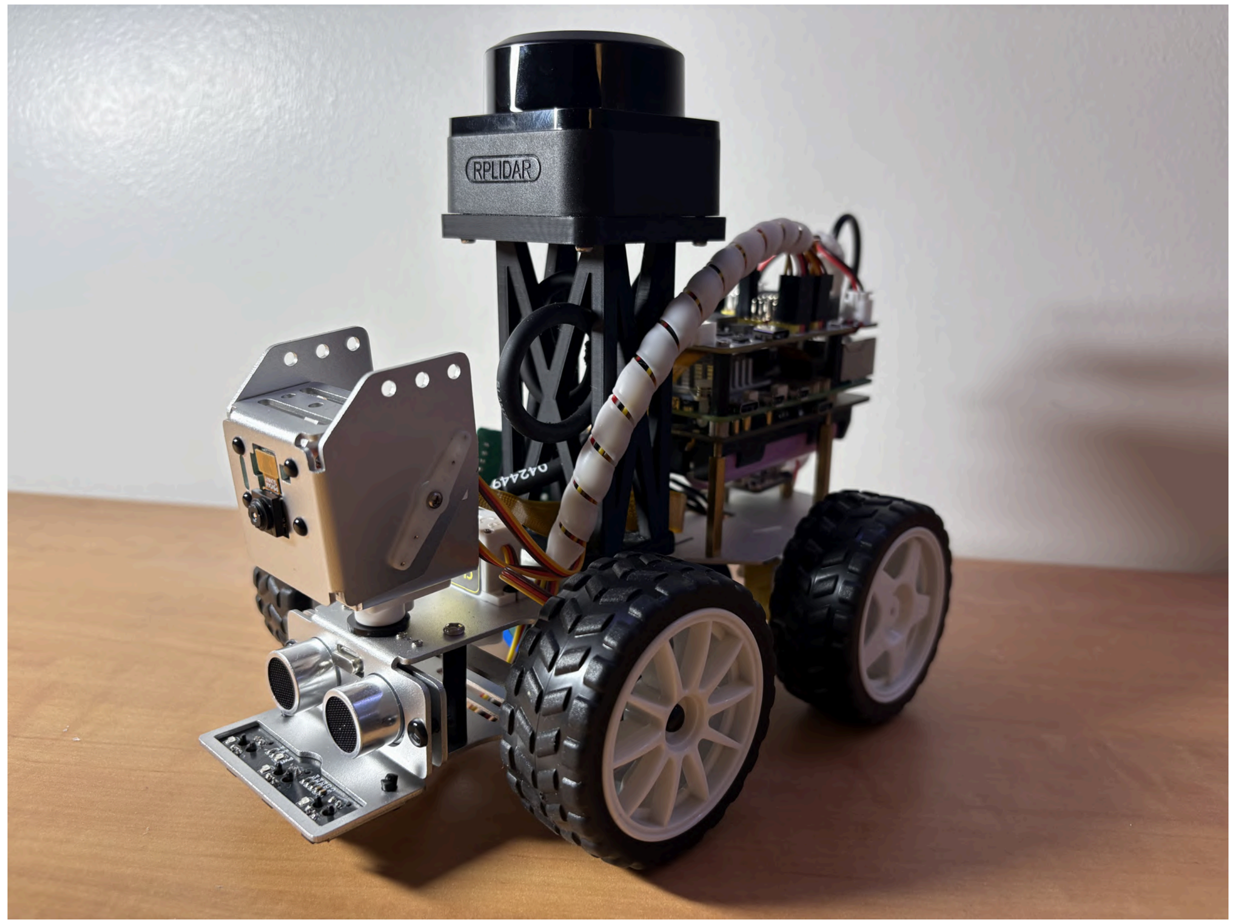
The idea for this project came from a personal desire to develop a physical testing platform to complement my simulation-based senior design capstone. My team's capstone focuses on developing a digital co-simulation platform integrating CARLA and SUMO simulators to study autonomous vehicle merging behavior in highway on-ramp scenarios.

While developing a simulation environment serves as a powerful tool for studying traffic interactions and navigation algorithms, I sought to deepen my physical knowledge of autonomous driving systems. This personal project fulfilled this urge, providing me with hands-on experience working directly with real sensors, microcontrollers, and actuators present in autonomous vehicles.

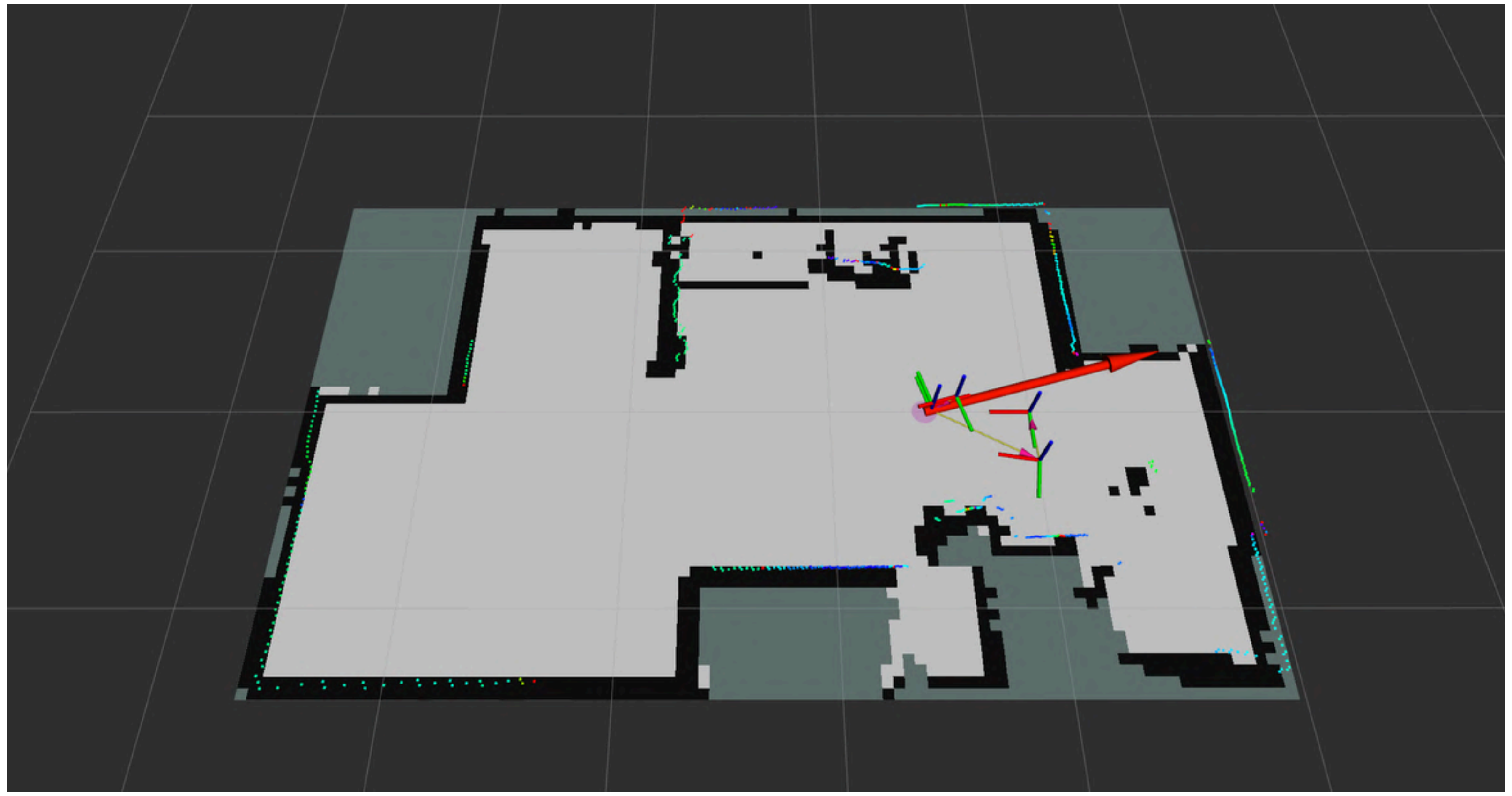
The project, completed in the span of one month, can be broken down into three main phases:

1. Assembly
2. Software Integration
3. Deployment & Testing

Project GitHub Repository:
https://github.com/Juliang0729/Autonomous-RC-SLAM-Car.2k26



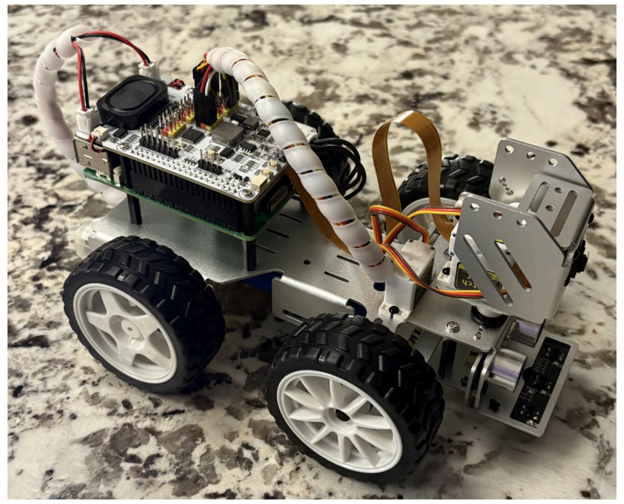
Completed RC SLAM Car



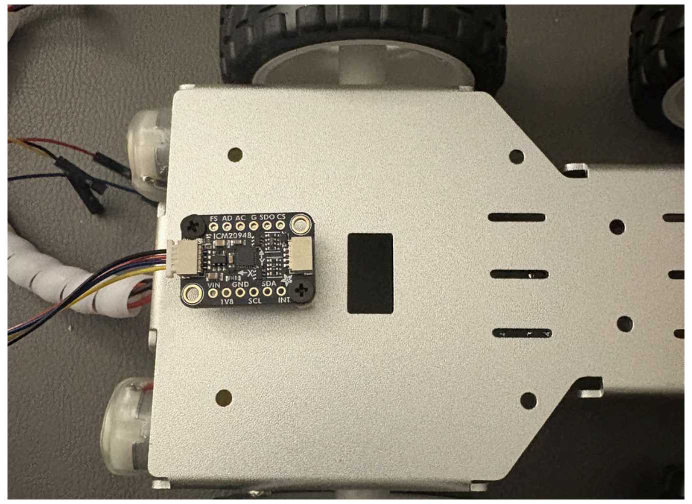
SLAM Visualization

SLAM Car: *Assembly*

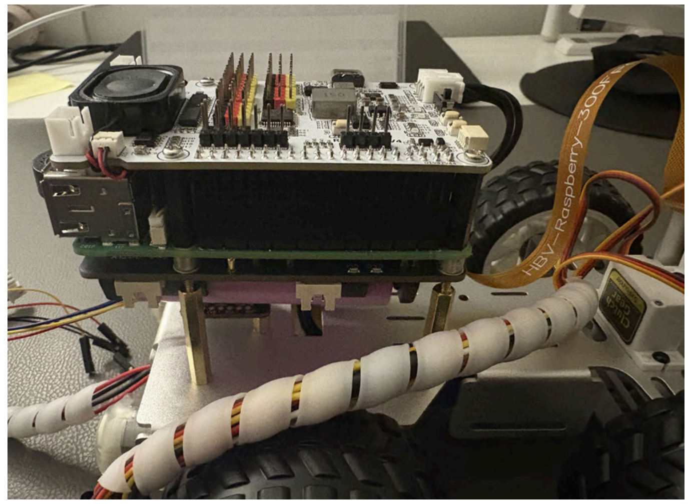
JAN. 2026



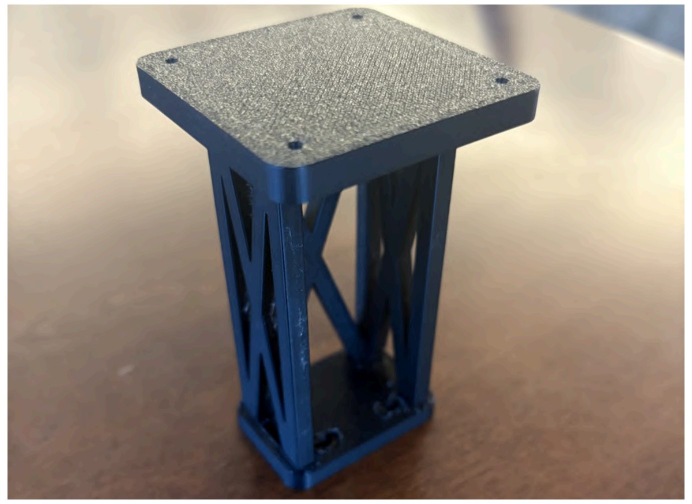
Assembled Base Picar-X



IMU Attachment to Chassis

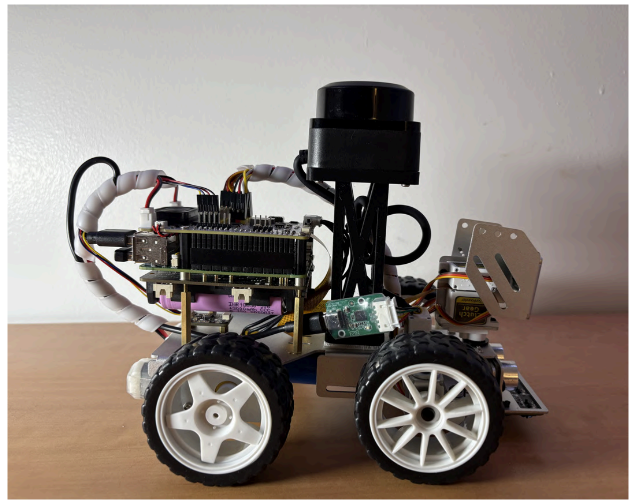


UPS HAT + Pi 5 + Robot HAT “Stack”



3D Printed LiDAR Stand

Attachment w/ Damping Foam



Completed Car

Bill of Materials:

- SunFounder Picar-X
- Raspberry Pi 5 4GB
- Raspberry Pi 5 Active Cooler
- Micro SD Card 64GB + Adapter
- SLAMTEC RPLIDAR C1M1
- 3D Printed LiDAR Mount (Ordered Online)
- Adafruit ICM-20948 9-DoF IMU
- Pimoroni 4 Pin JST-SH Cable
- Geekworm X1200 5V UPS HAT Shield
- 2x Samsung 30Q 18650 3000mAh Battery
- M2.5 Hex Brass Standoff Screws Kit

The SunFounder Picar-X acted as the base for the vehicle, having the motors, servos, Robot HAT, ultrasonic, greyscale, and camera modules included.

From this, the IMU was attached via standoffs and the LiDAR via 3D printed stand.

SLAM Car: *Software Integration*

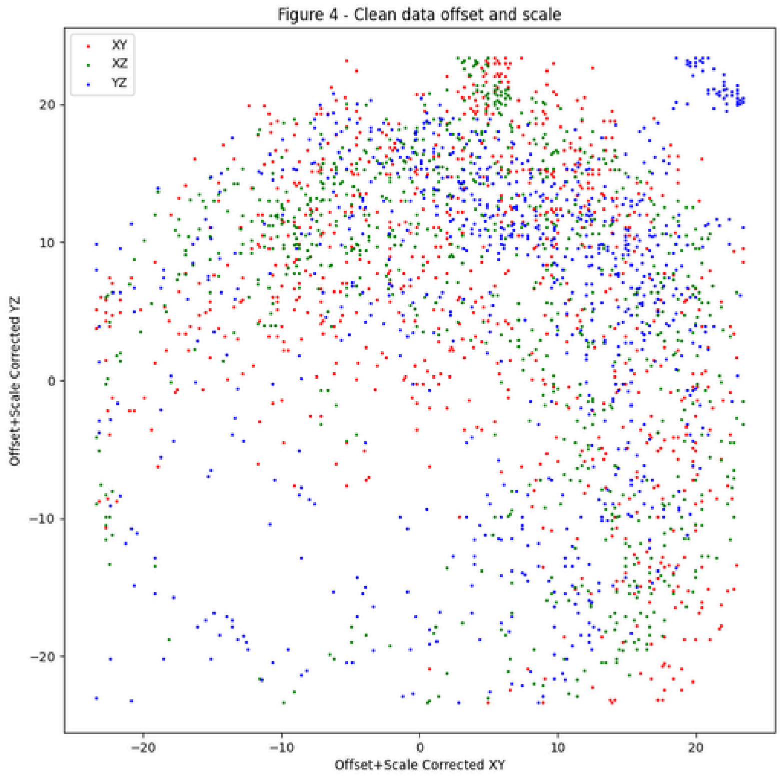
JAN. 2026

A two-device approach was taken to manage communication and software integration with the car. My personal laptop (Ubuntu 22.04) served as the home to the calibration, visualization, and code development side of the project. The Pi 5 (Ubuntu Server 24.04) served as the car's core logic module, responsible for publishing raw sensor data and executing low-level control outputs.

Connecting to the Pi 5 headlessly via SSH and installing ROS 2 on both devices, a low-latency data transfer channel between the onboard system and the remote workstation was established. For localization and mapping, SLAM was implemented using ROS 2's *slam_toolbox*.

Calibrated LiDAR and IMU data was fused through an extended Kalman filter to improve pose estimation and reduce drift. The resulting map and pose estimates were then integrated with *Nav2*, generating dynamic costmaps from the data and enabling waypoint following with real-time object avoidance.

Accel + Gyro Calibration (imucal)



Magnetometer Calibration (Hard Iron + Soft Iron)

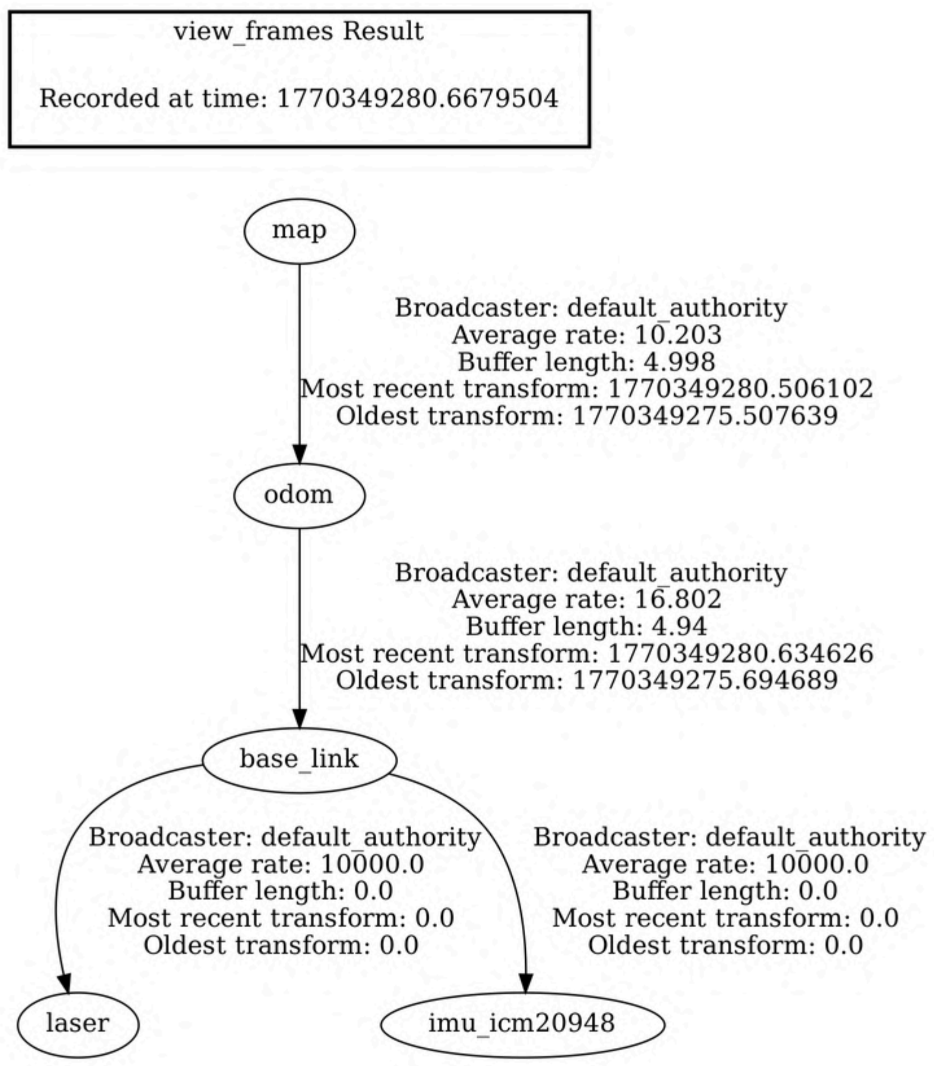
imucal: https://github.com/mad-lab-fau/imucal
Mag Cal: https://github.com/italocjs/magnetometer_calibration

SLAM Car: *Deployment & Testing*

FEB. 2026

Following successful software integration and sensor calibration, the vehicle was tasked with fully mapping my dorm room while avoiding obstacles deliberately placed in its way. Initial testing consisted of controlled motion trials aimed at evaluating odometry obtained through LiDAR scan matching and fine-tuning safe distances. Random waypoints were issued to the car via *RViz* and live mapping data was visualized on my laptop. Through iterative testing, the car evolved into a stable, fully autonomous system capable of real-time mapping and navigation.

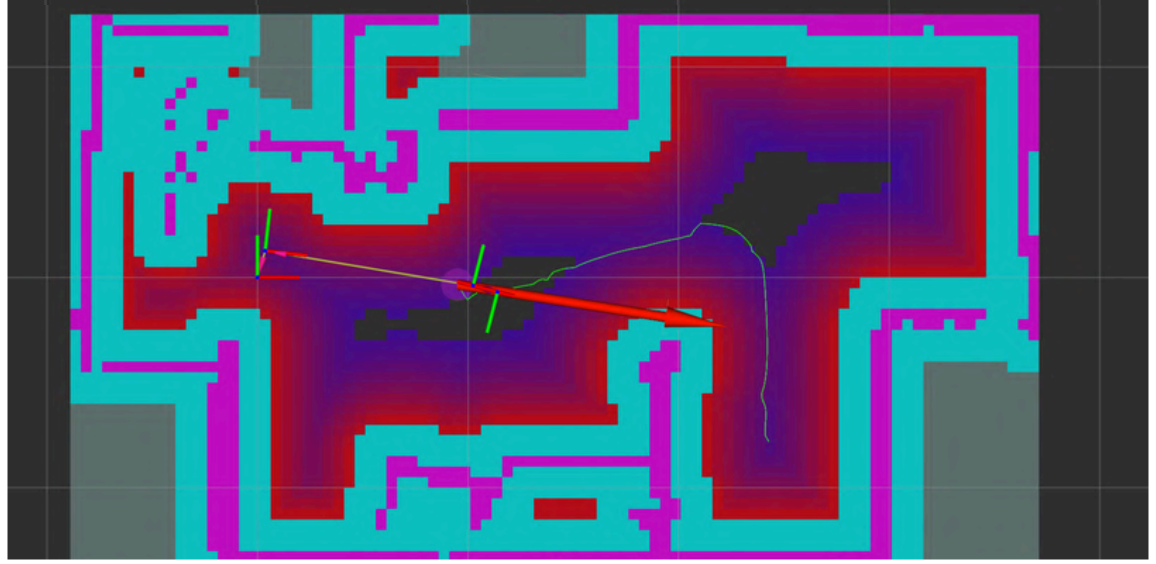
ROS 2 Full TF Tree



Dorm Room Floor Plan

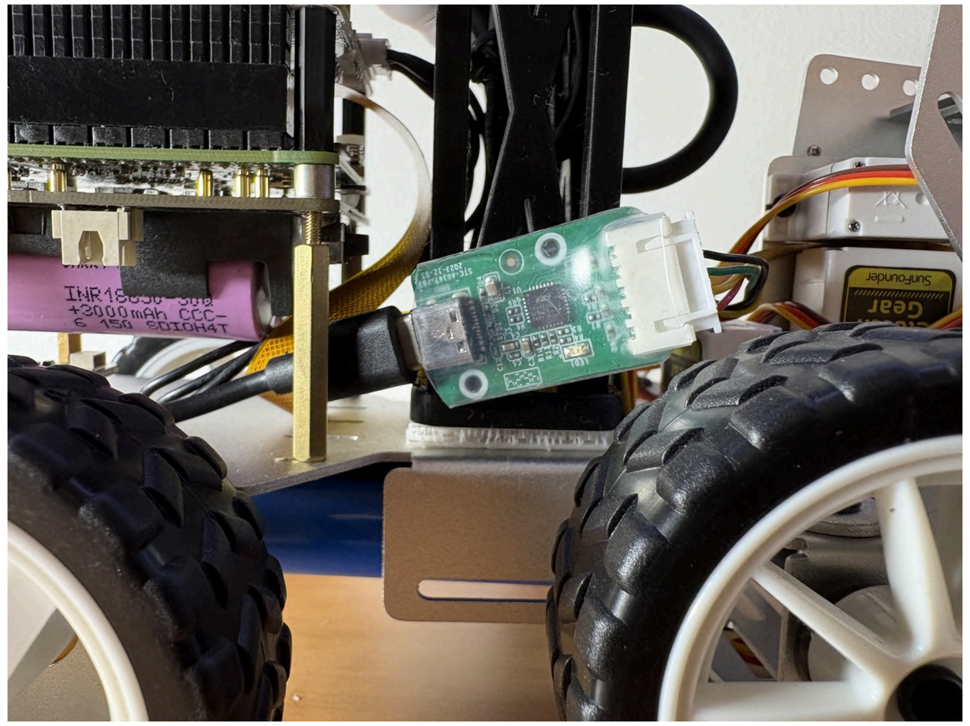
slam_toolbox Map Output w/ Annotations

Costmap w/ Trajectory Planning

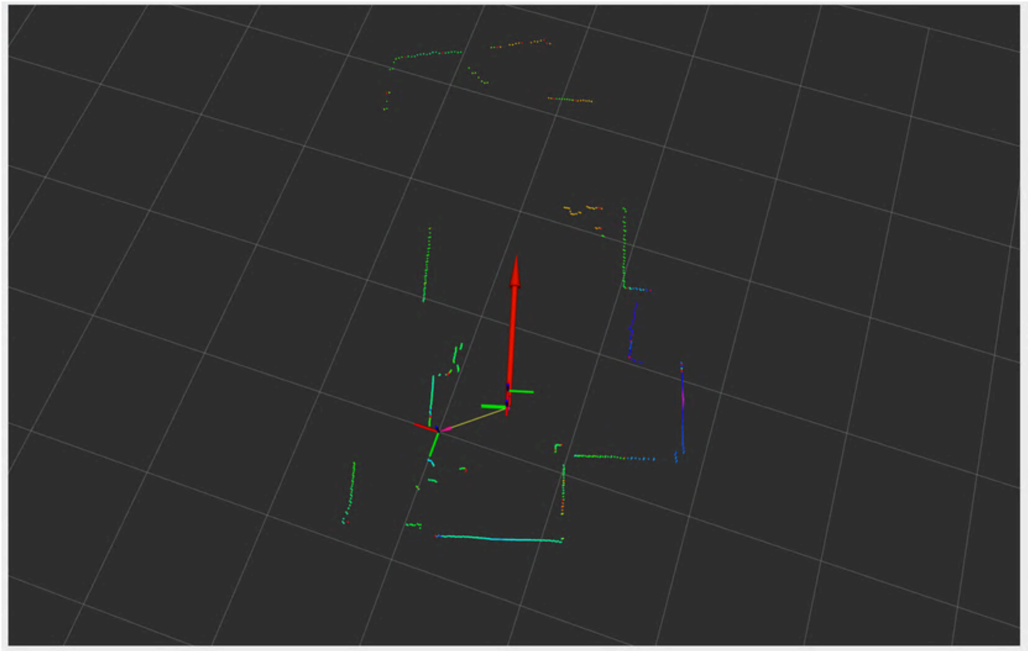


SLAM Car: *Misc.*

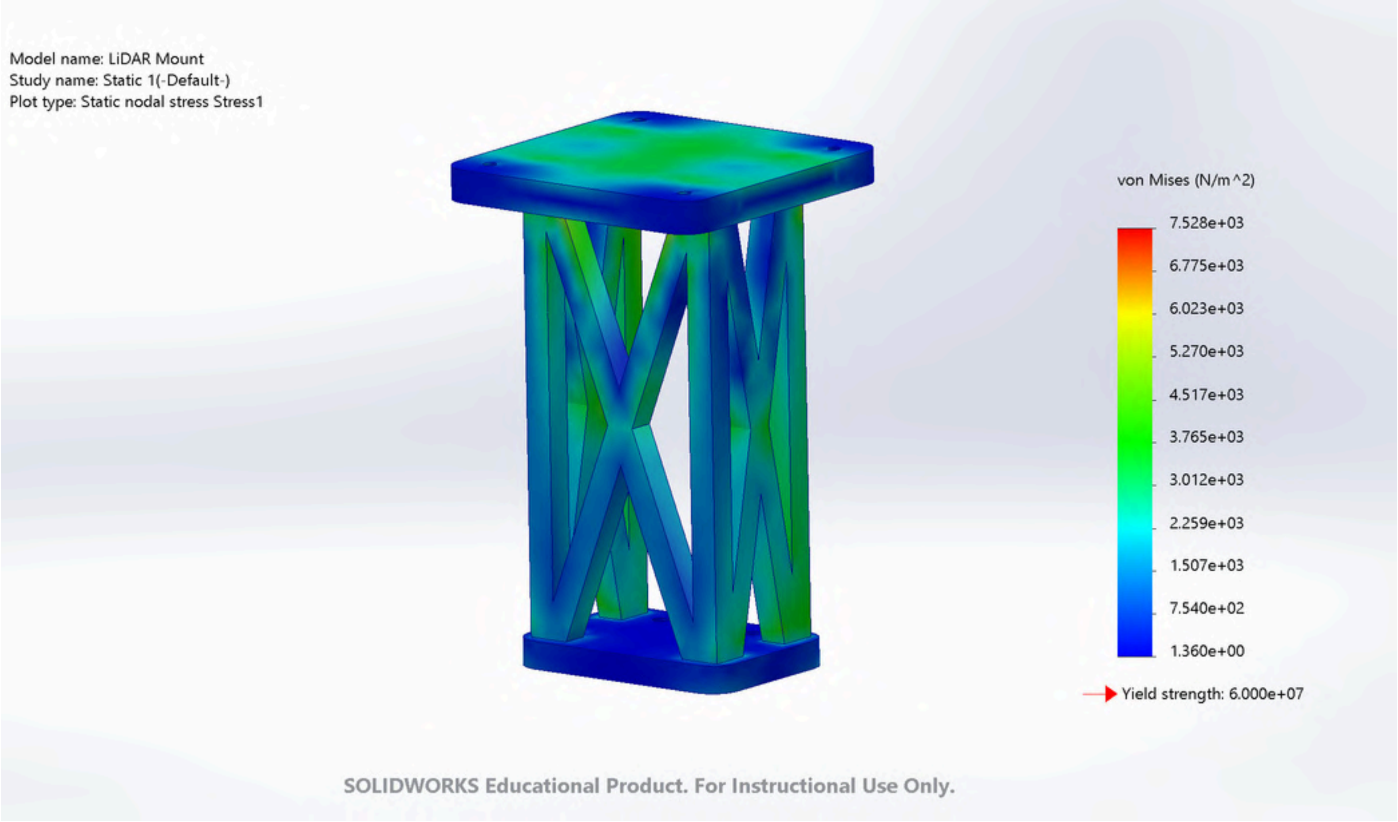
JAN. 2026 - FEB. 2026



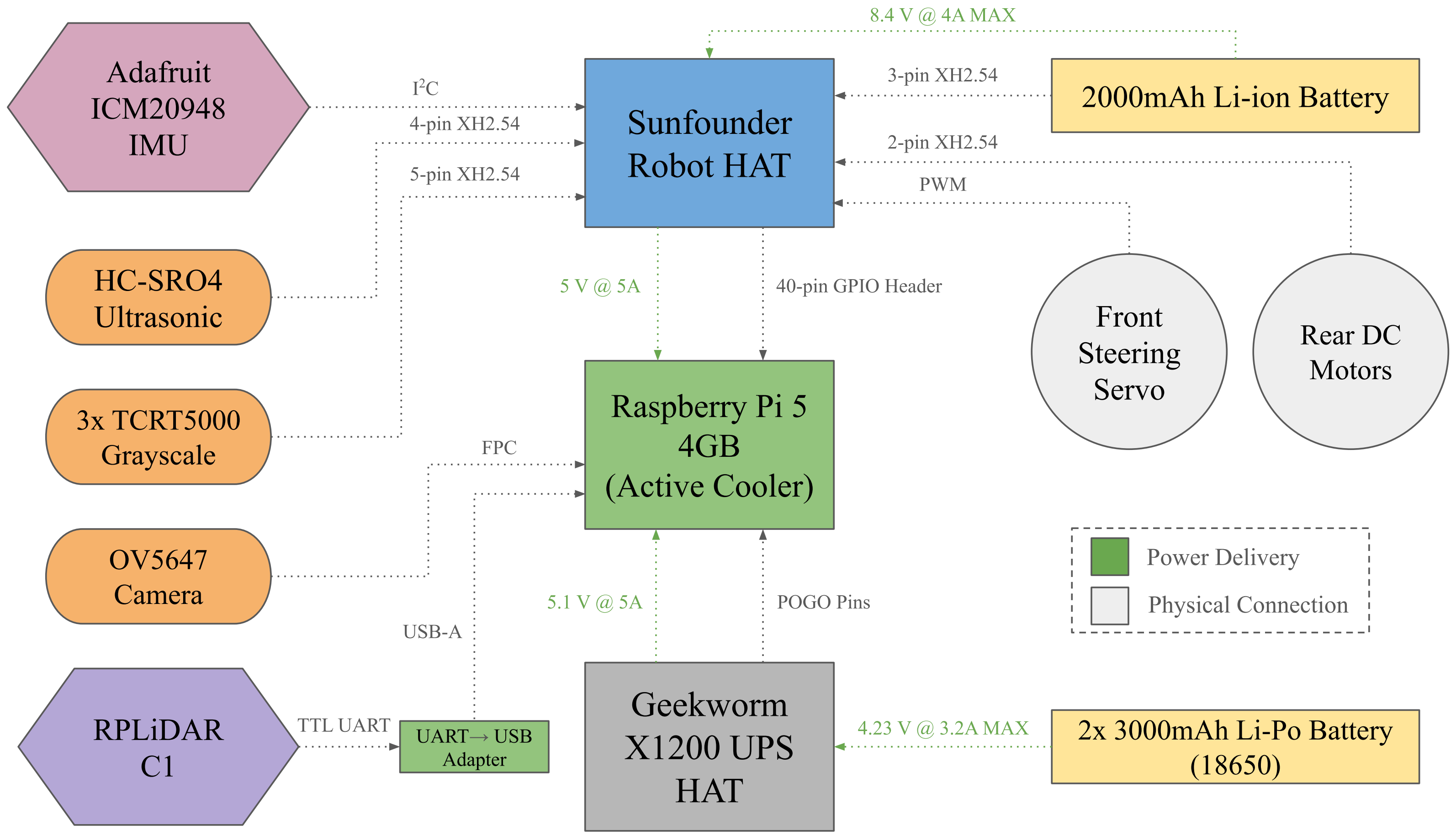
LiDAR Mount Attachment to Chassis



Point Cloud Visualization + Pose Estimate



LiDAR Mount Static Stress Test



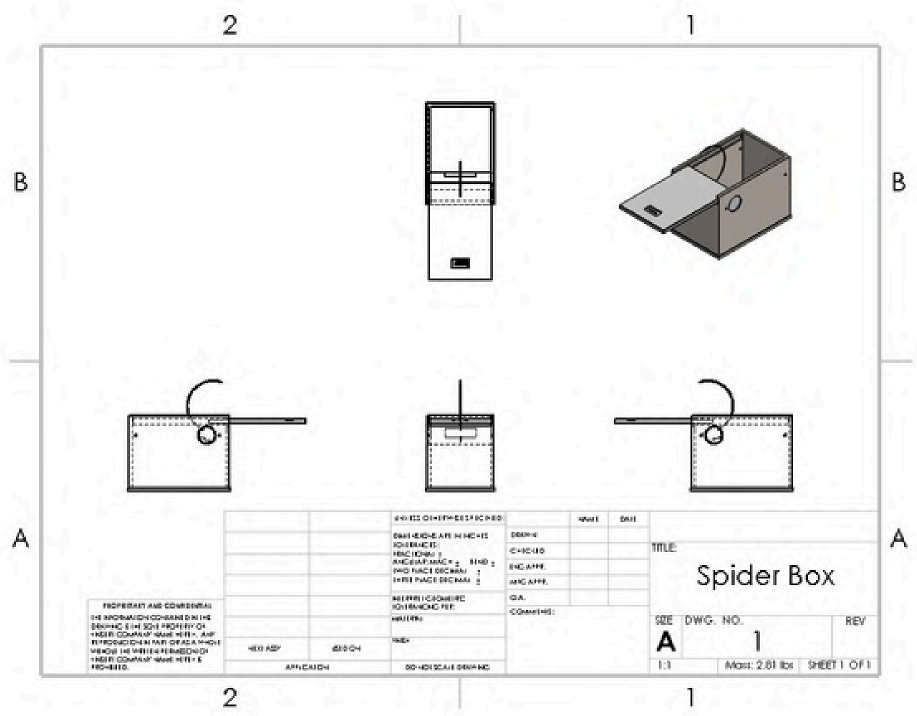
SLAM Car Wiring + Power Delivery Diagram

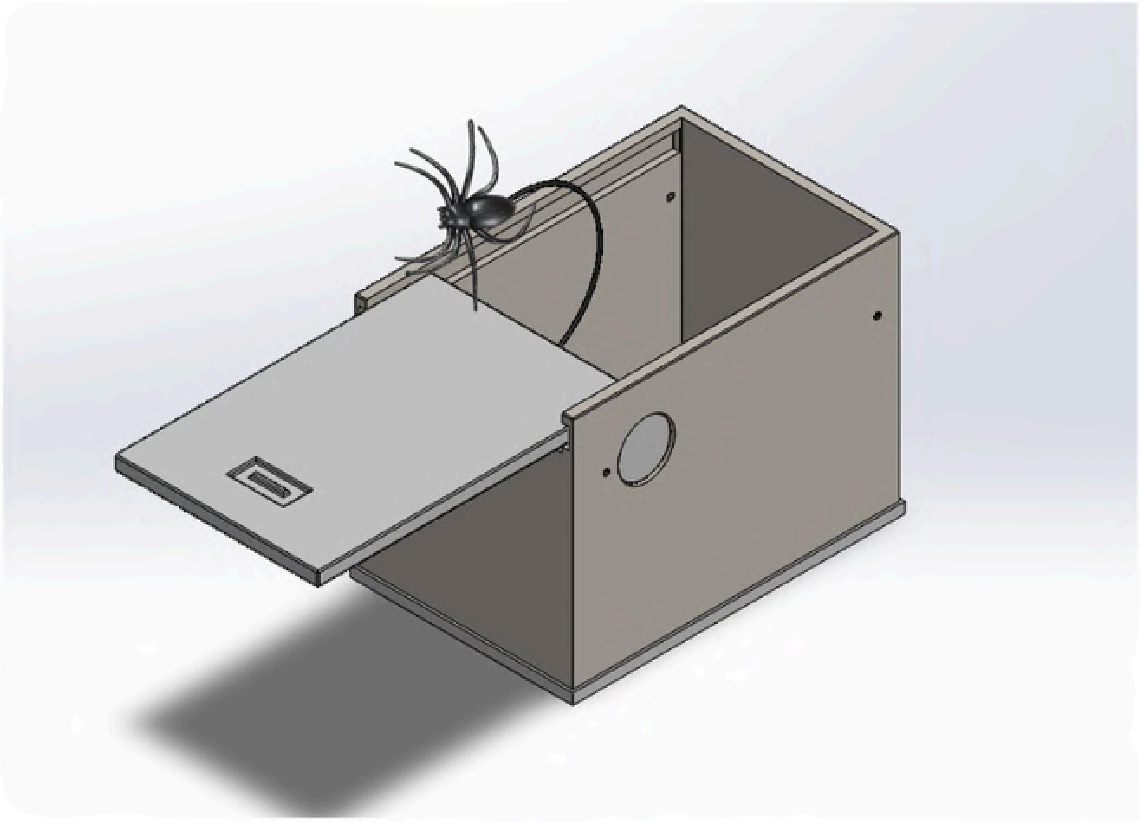
SpiderBox

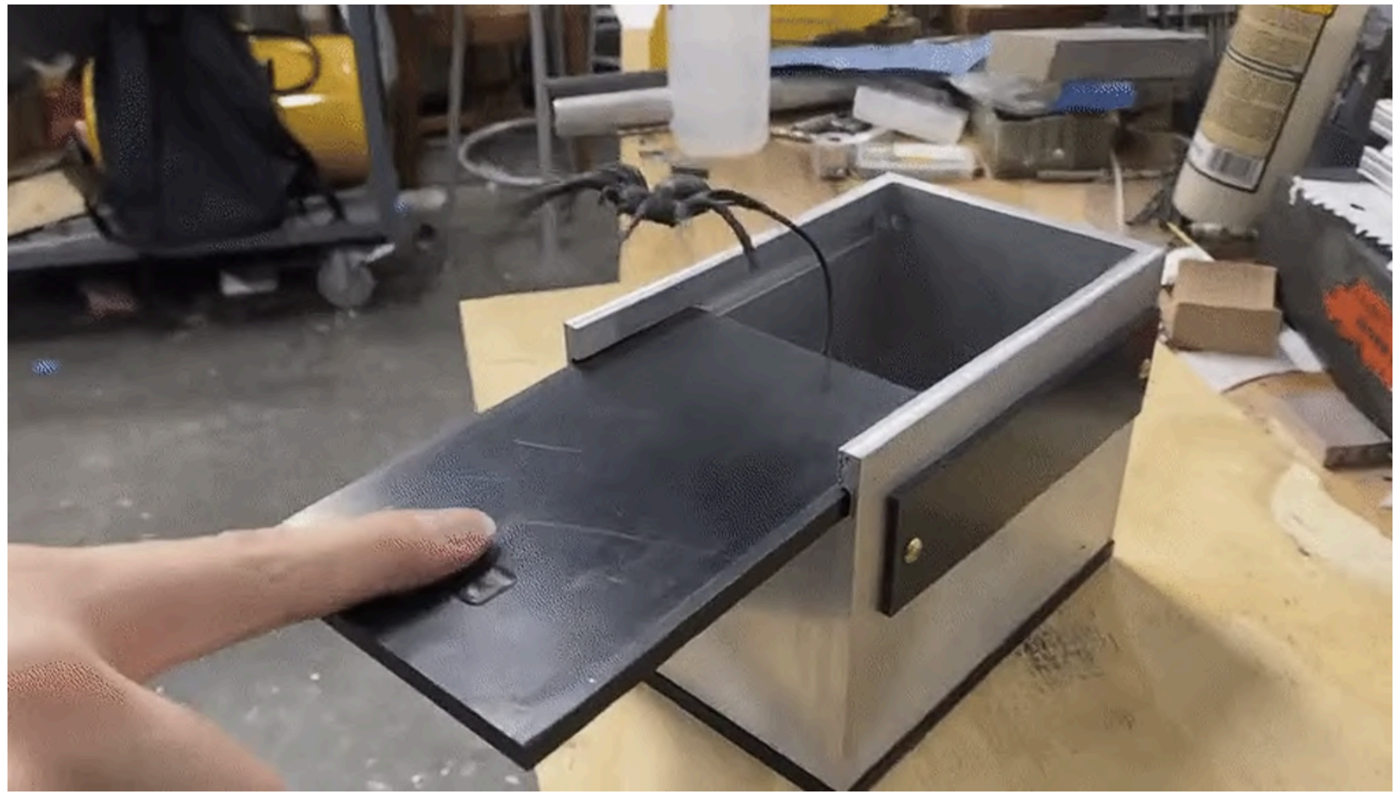
SEPT. 2024 - DEC. 2024

During the fall semester of my junior year, I worked in a team of four engineering students to design and manufacture a “SpiderBox” toy engineered to scare its users. Over the course of this project, we designed a fully functional 1:1 model in SOLIDWORKS, manufactured the components in our school’s machine shop, tested the device’s operation extensively, and presented the final product to our peers at the end of the semester.

Through this experience, I gained hands-on knowledge operating CNC machinery and applying principles of GD&T to ensure proper fit and function. I also strengthened my ability to work collaboratively, connecting with my peers to resolve budgeting and material procurement issues as well as develop detailed project timelines.

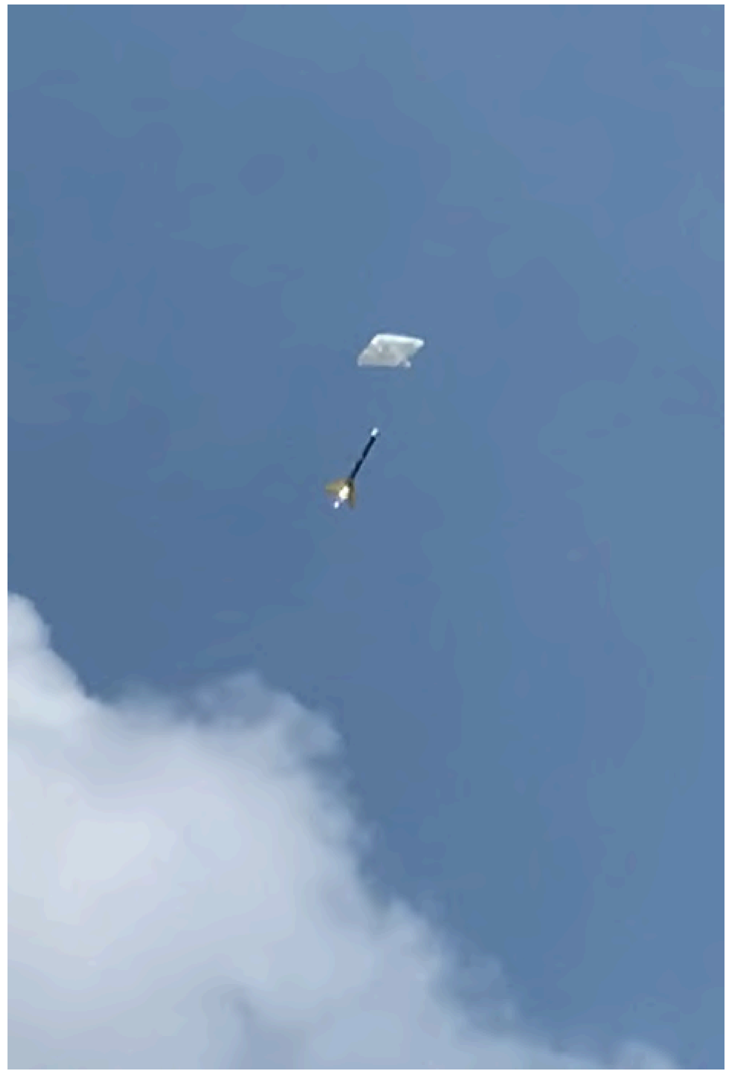






Solid Fuel Rocket

MAY 2020 - AUG. 2020



Through a summer opportunity hosted by my high school, I was given the chance to participate in a model rocketry design project going into my Junior year. For this project, I was tasked with designing, manufacturing, and successfully launching a solid fuel rocket using everyday materials within strict budget constraints.

Understanding the importance of mass reduction for performance, I began with selecting lightweight materials such as PVC and corrugated plastic for the body and fins of the rocket. To create an aerodynamic nose cone, I repurposed a plastic champagne flute, sanding it down to achieve a smooth profile before fitting it to the rocket's body.

The recovery stage, which consisted of a plastic parachute attached via elastic shock cords, was housed directly beneath the nose cone. The idea for the recovery stage was that when the rocket reached apogee and upward velocity fully dissipated, gravity would pull the center of mass downwards and flip the vessel on its head. As a result, the nose cone would safely separate and deploy the chute for a controlled descent.

On launch day, the rocket performed exactly to expectations, ascending to an altitude of approximately 500 ft and descending safely for recovery and reuse.