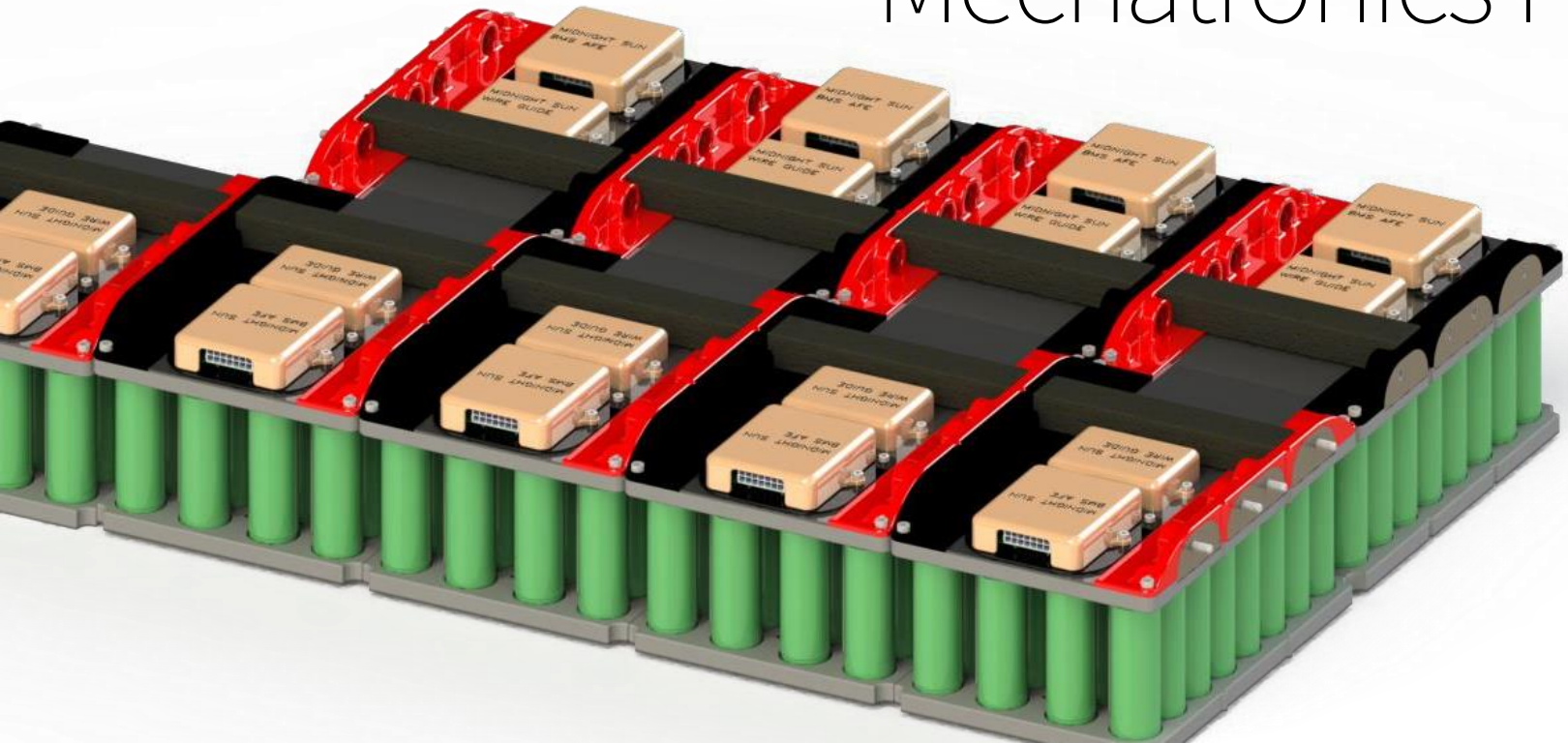
Eric Zhao
Mechatronics Portfolio



University of Waterloo
January 2023

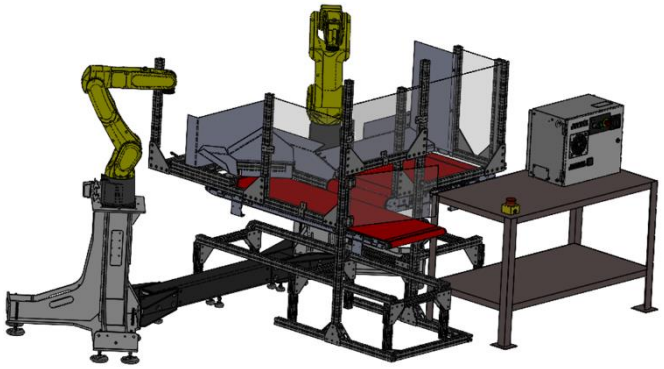
résumé

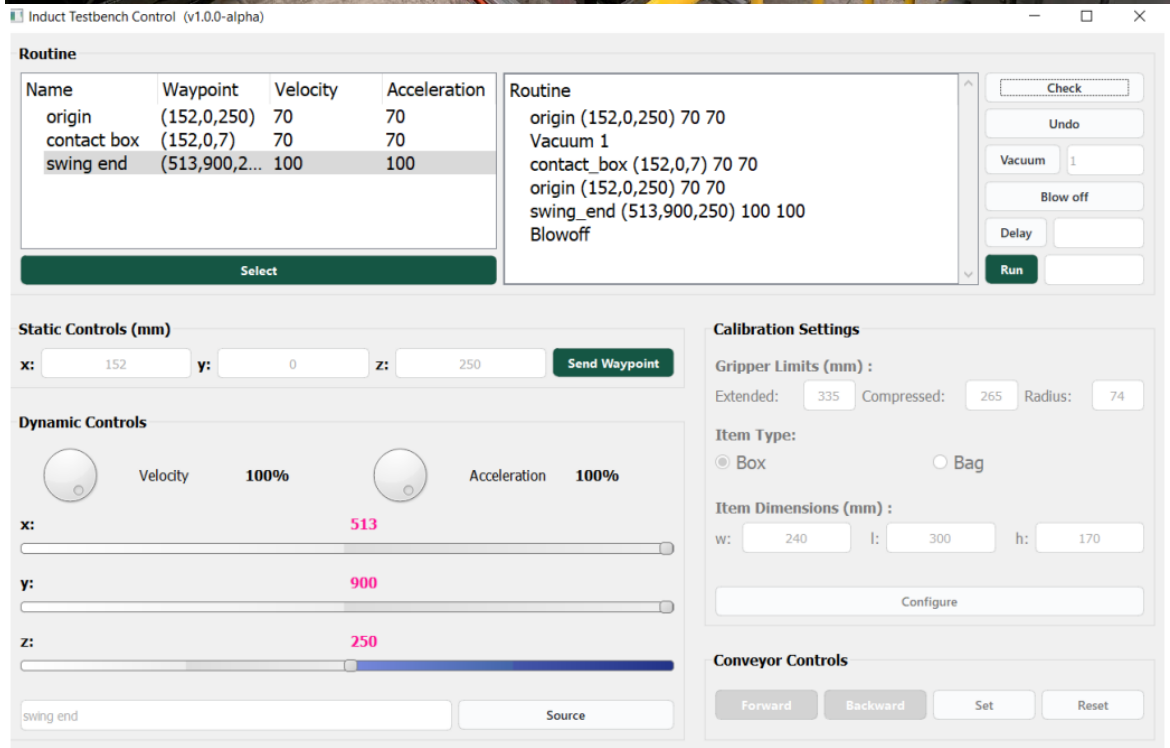
Modular Induction Test Bench

Skills used: Python, SOLIDWORKS

Summary: In order to aid the prototyping process for the hardware team's gripper designs, I designed, built, and programmed a test bench with an intuitive to use GUI that allows for creating and running automated pick and place routines.

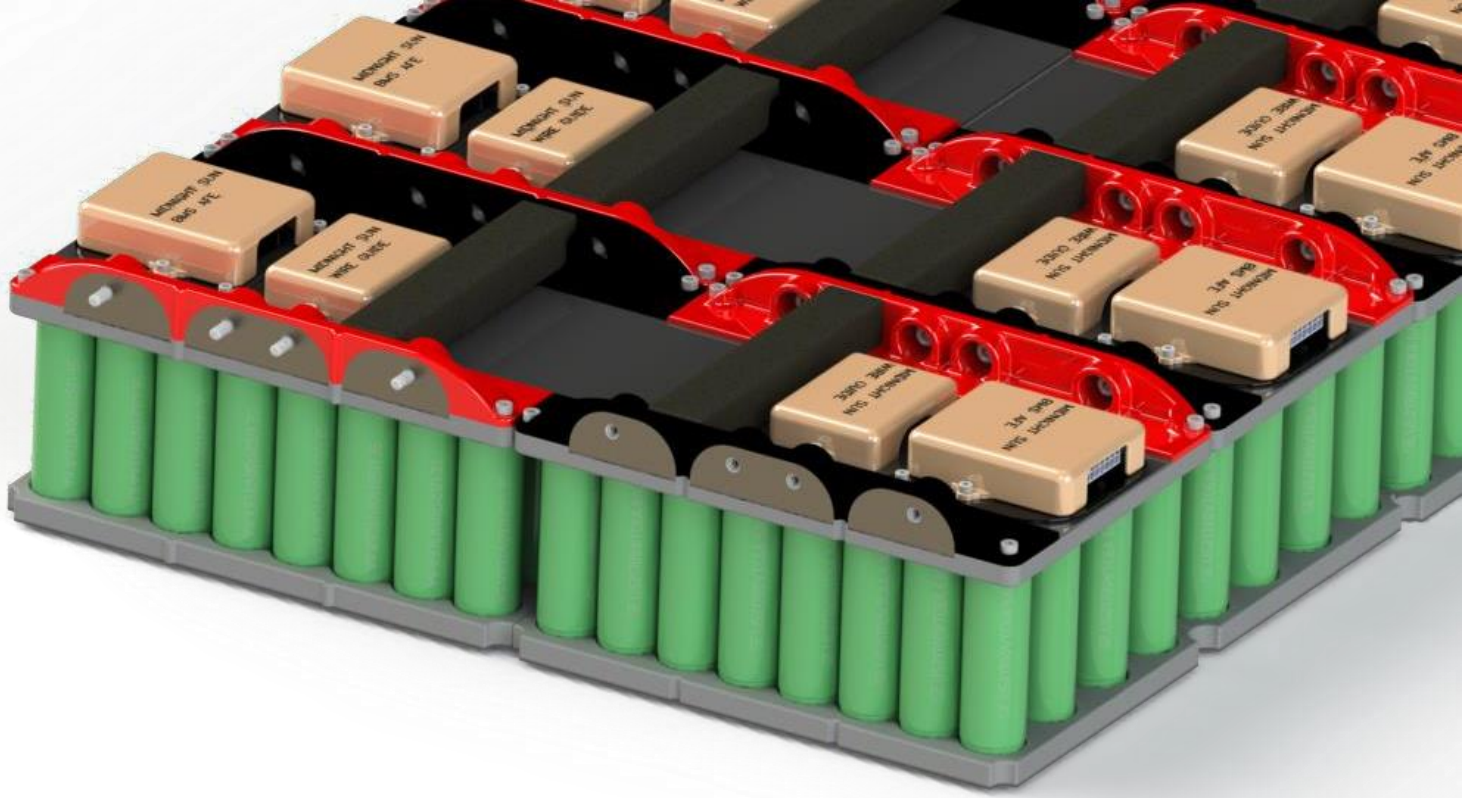
The test bench is able to perform the custom set routine as many times as specified with any gripper cup configuration, allowing for the collection of statistical data for analysis.

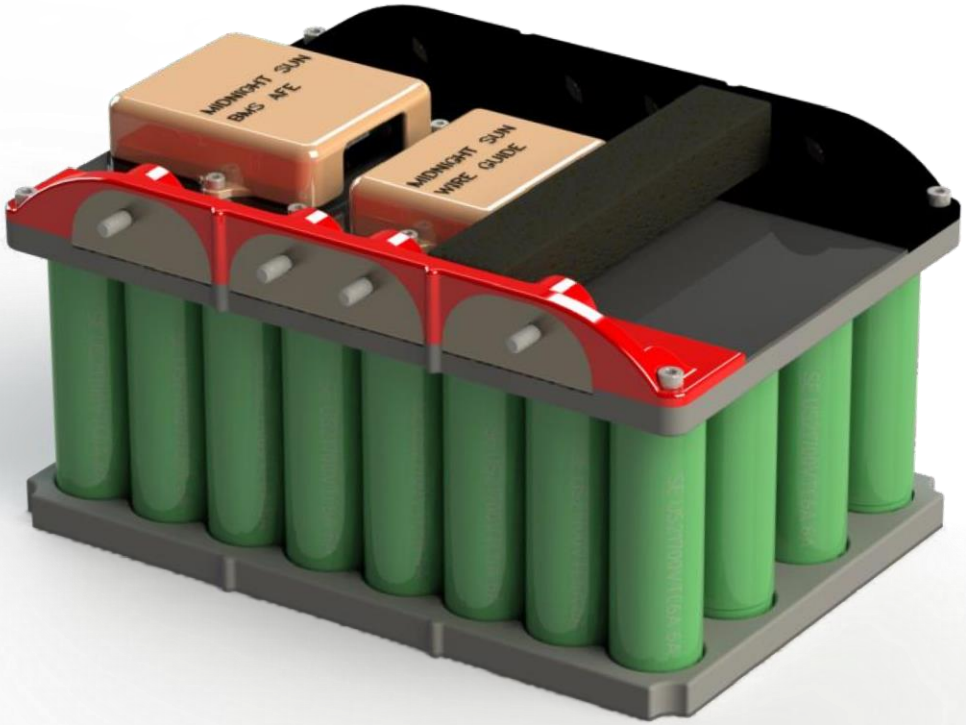




Battery Module Design

Skills used: SOLIDWORKS, Spot Welding





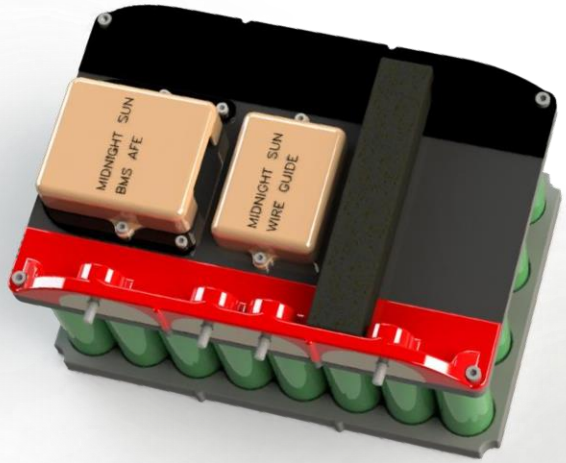
Summary: I am currently leading the design of new battery modules for Midnight Sun's next solar race car, set to compete in ASC2024.

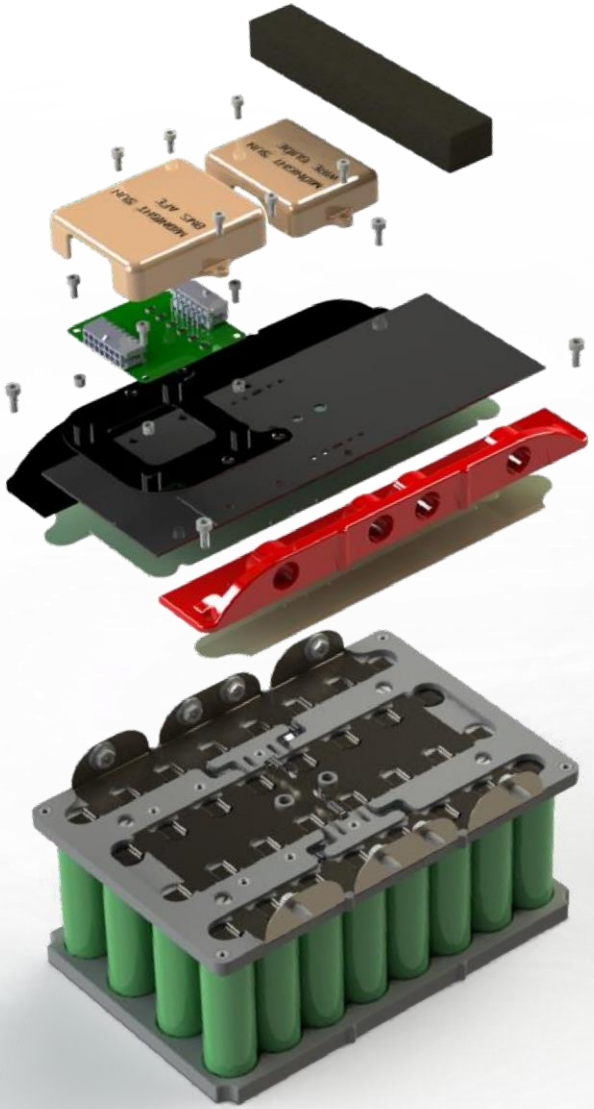
Shown is my current module design, utilizing 21700 sized lithium-ion cells. Each module contains a 4S8P cell configuration. With 9 of these modules assembled in series, the full 36S8P pack will be able to provide up to 5241Wh of energy at a nominal voltage of 130.68V.

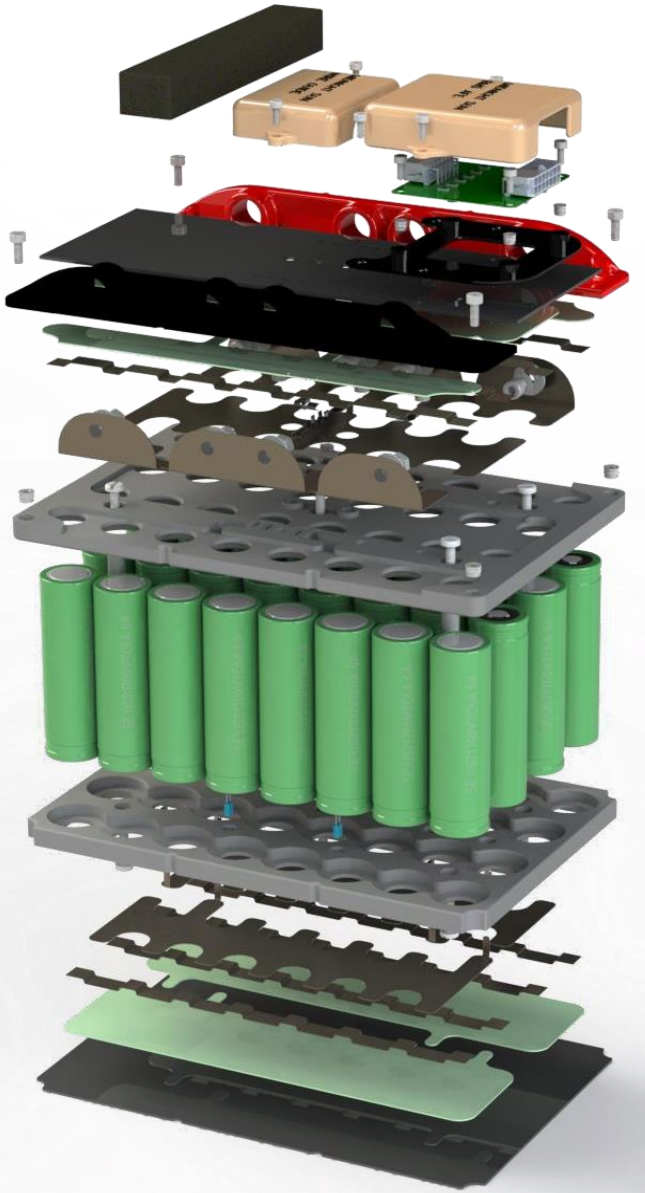
Each module contains 5 thermistors distributed throughout to continuously monitor the temperature distribution of the battery pack.

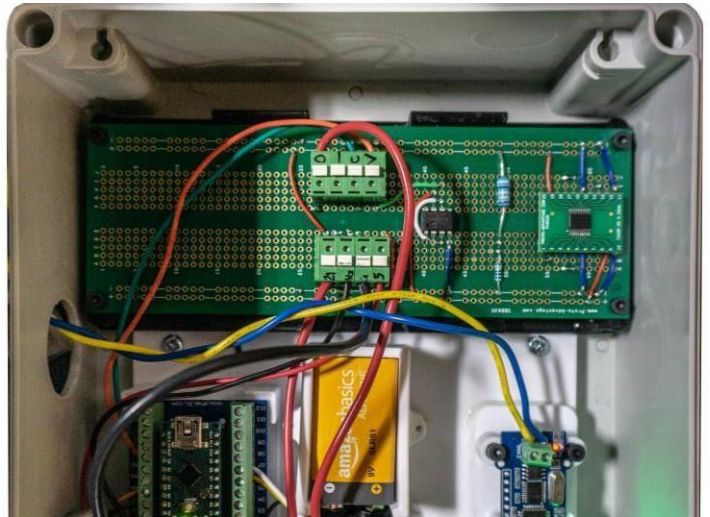
Nickel strips and Sigma Clad 60 are spot welded together for a balance between weldability and electrical conductivity.

Busbars are designed with two crimp connections to allow for accurate BMS voltage readings utilizing remote sensing.









Electric Vehicle Battery Status Monitor

Skills used: Fusion 360, C++, Arduino

Summary: I designed and built a circuit to monitor and display the state of charge, voltage, and current draw of a high voltage system. Using a Serial CAN module, I was able to mask, filter, and decipher extended CAN bus messages transmitted by an electric dolly.

I mounted the system with a custom emergency stop box for easy monitoring, reset, and shut-off of the high voltage system.

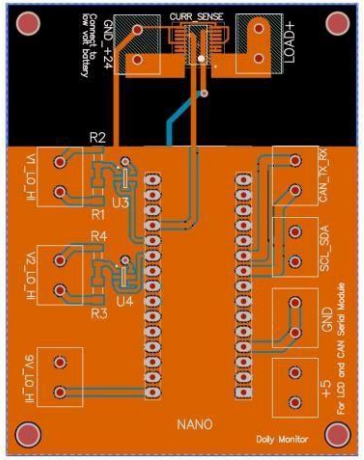
Status Monitor PCB

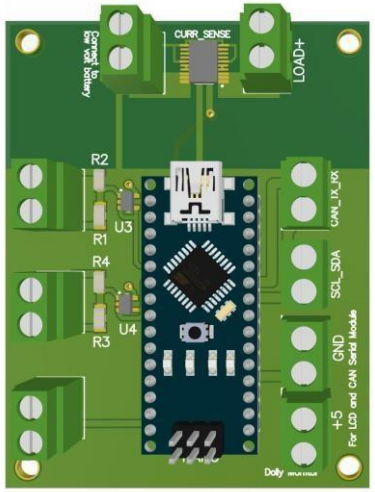
Skills used: CircuitMaker

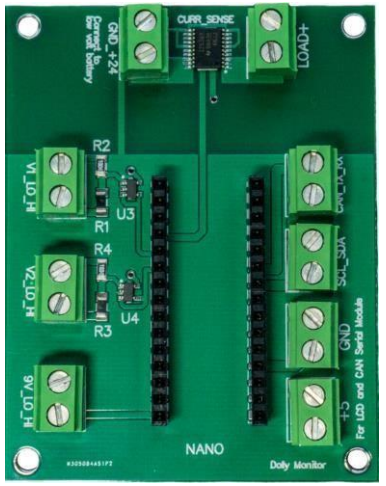
Summary: Utilizing the design of the Electric Vehicle Battery Status Monitor, I was able to create and order a custom PCB to perform the same functionalities at a smaller cost.

The circuit can measure and scale voltages from up to 50V down to appropriate Arduino analog signals with a resolution of 49mV.

I also researched and ordered appropriate current sense amplifiers and shunt resistors to measure up to 12.5Aof current with a 12mA resolution



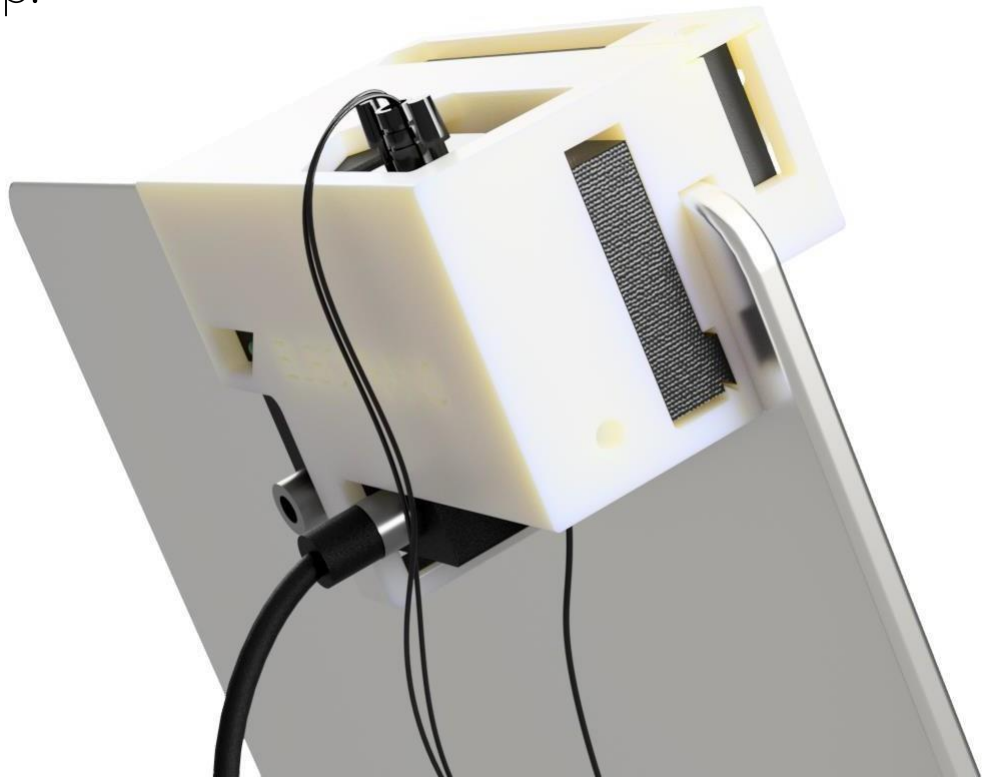




Mobile Hardware Mount

Skills used: Fusion 360

Summary: I designed and 3D printed this mount to compactly secure multiple communication devices for mobile testing.
It was able to hold a DB9 CAN bus connector, a Bluetooth CAN bus transmitter, an USB hub, and a protoboard with soldered terminating resistors to the back of a laptop.

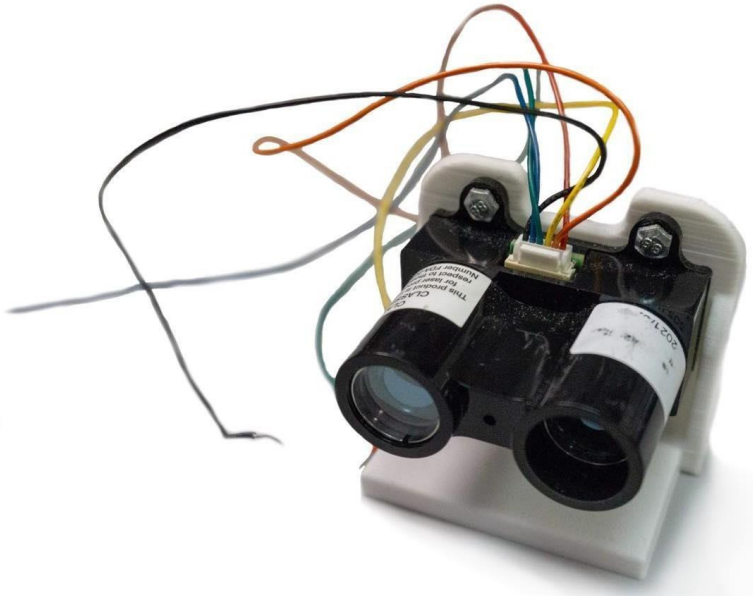


Distance Sensor Testing Rig

Skills used: Fusion 360, Excel, C++, Arduino

Summary: I constructed a sensor testing rig using two tripods, aluminum extrusions, and 3D printed auxiliaries. The testing rig was used to mount, test, and collect data on a variety of distance sensors from a selection of ultrasonic, infrared, and LiDAR sensors.

The testing rig was able to test sensor orientations with up to 1 degree precision.



Misalignment Detection System

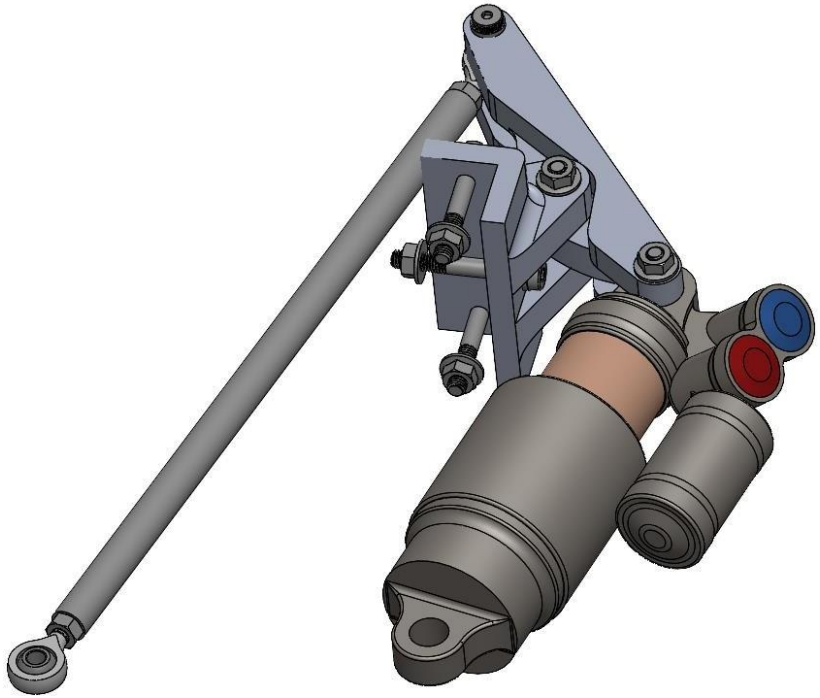
Skills used: Fusion 360, C++, Arduino

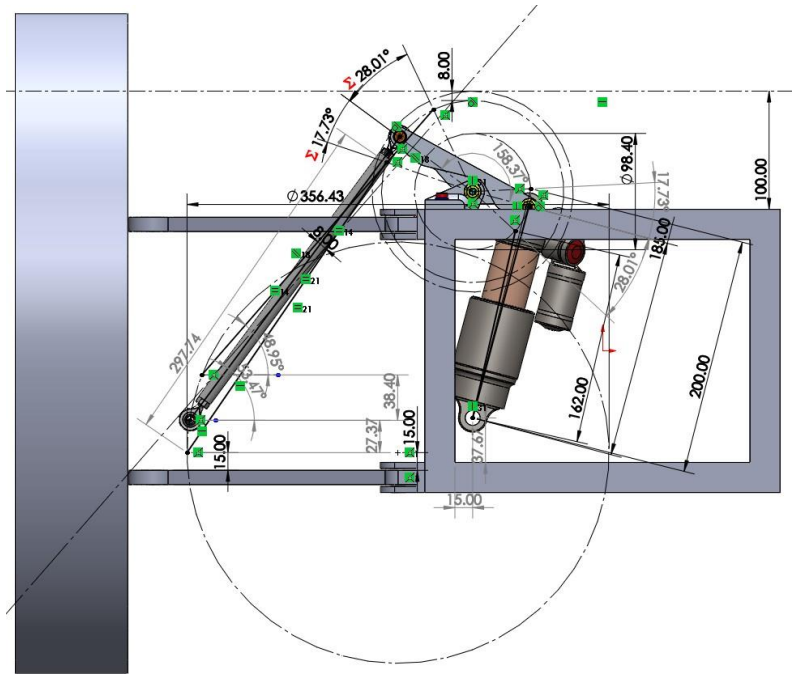
Summary: Using the sensor testing rig, I selected and used two infrared time-of-flight distance sensors to develop and build a system for measuring the misalignment between two commercial vehicles.

The system was able to detect angles with up to 1.4 degrees of accuracy. A LED display was created to simulate signals showing commercial vehicle drivers how to adjust their vehicles.

Basic Pushrod Shock Design

Skills used: SOLIDWORKS
Summary: A basic pushrod suspension assembly utilizing FLOAT X2 shocks, made for a design sprint based on the American Solar Car regulations.
Designed for a 192kg mass vehicle with a 1G turn, 2G bump, and 1G braking force.





POLARIS

Rudimentary Spacecraft Guidance System

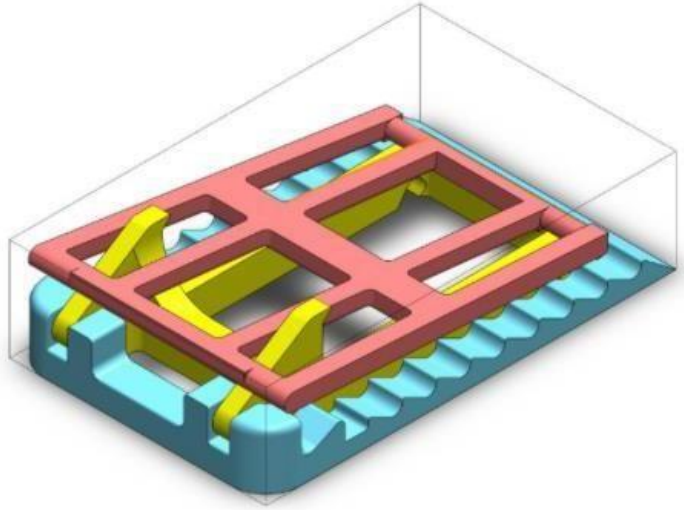
Skills used: Fusion 360, Arduino

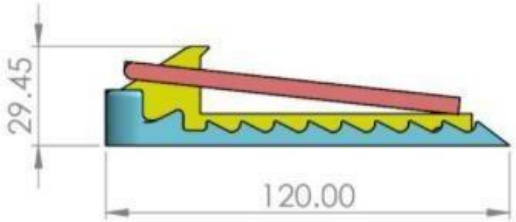
Summary: Three single-gimbal gyroscopes were built to find a model spacecraft's orientation in space. By shining lasers through circular gradients attached to the gimbals of each gyroscope, and analyzing the light intensity of each laser, the spacecraft's rotational position around the 3 axes was measured.

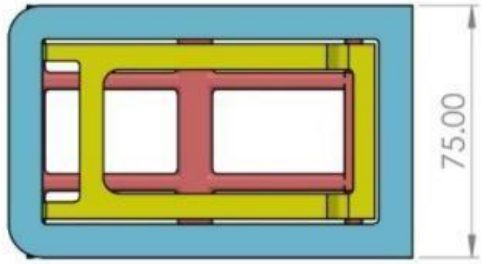
Easy to use.

Simple to disassemble.

Small to carry.







Foldable Phone Stand

Skills used: SOLIDWORKS

Summary: I designed a 3D printable phone stand that can hold a phone at 8 different angles with room for a charging cable. I optimized the design for 3D printing in GrabCAD Print and was able to make a 3D print which I still use today.

The assembly can be collapsed to fit into a 75x120x30 mm box for shipping or storage.

Connection Port

Skills used: SOLIDWORKS

Summary: The connection port of Midnight Sun's 14th solar race car required a redesign, as the original hinged lid did not work. I created an entirely new port housing and cover, converting the hinged design into a 3D printable sliding cover.

The port housing prints in 3 separate pieces: The port housing, the sliding cover, and a glue-on piece which secures the cover, ensuring it doesn't completely slide off the housing.

PCB Mounts

Skills used: SOLIDWORKS, Altium 365

Summary: In order to secure the newly designed printed circuit boards for Midnight Sun's 14thsolar car safely, I was responsible for designing mounts for 9 different boards. Altium 365 was used to pull the most recent board versions into SOLIDWORKS, where personalized board mounts were created for each of the new boards.