



# ENGINEERING PORTFOLIO

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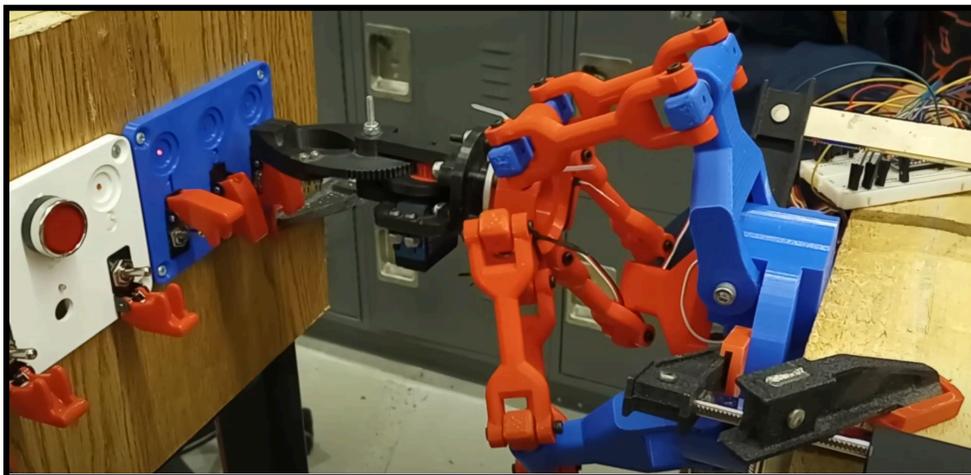
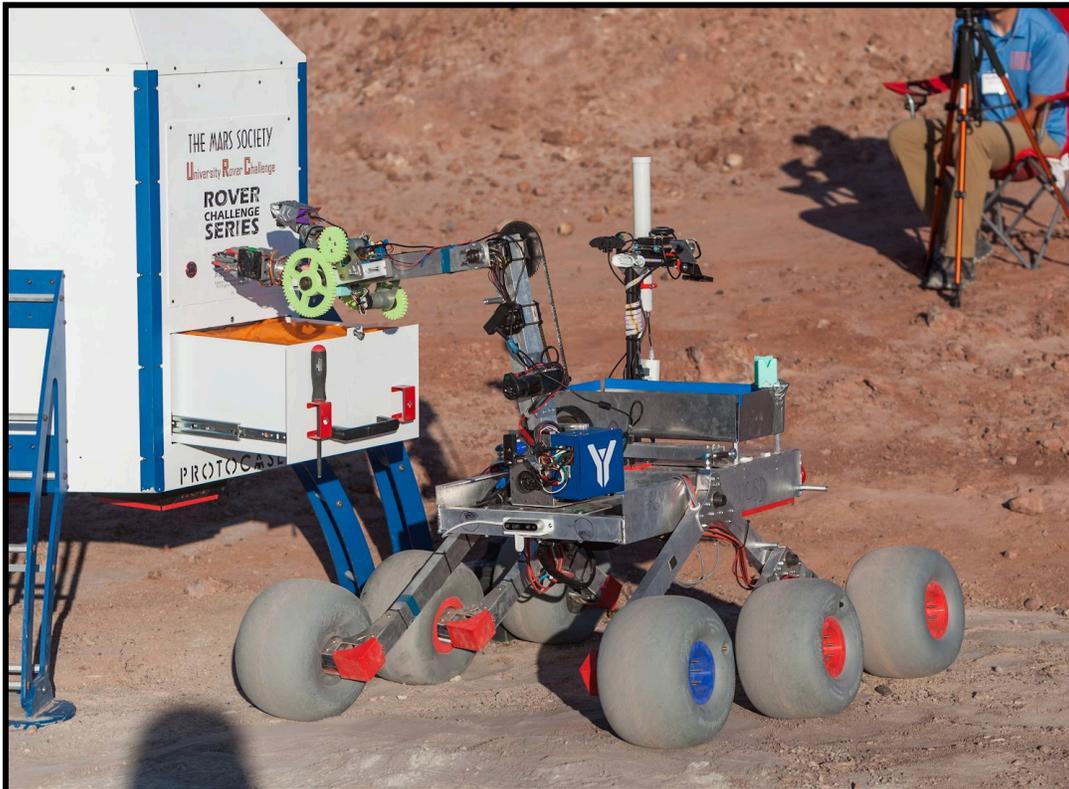
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## Yonder Dynamics - Rover Project

**Overview:** The University Rover Challenge prompts university teams to create small Mars rovers that can complete several tasks related to tasks an actual rover might need to be able to do on Mars. The rover can navigate very rough terrain with the Rocker-Bogie suspension system, supported on a differential bar. It is also equipped with a 5 DoF arm that can manipulate various tools and containers and lift up to 14 kilograms. It also has a science module that utilizes a custom-built Raman spectrometer to detect signs of extinct and extant life. We placed 5th overall in the world this year. For next year, extra emphasis on analysis, like the use of strain gauges, will be used hand-in-hand with FEA to further optimize the Rover.

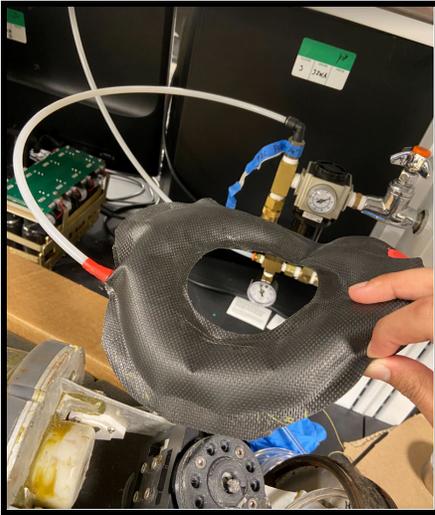
[URC SAR Video \(demonstrates many of the capabilities of the rover\)](#)



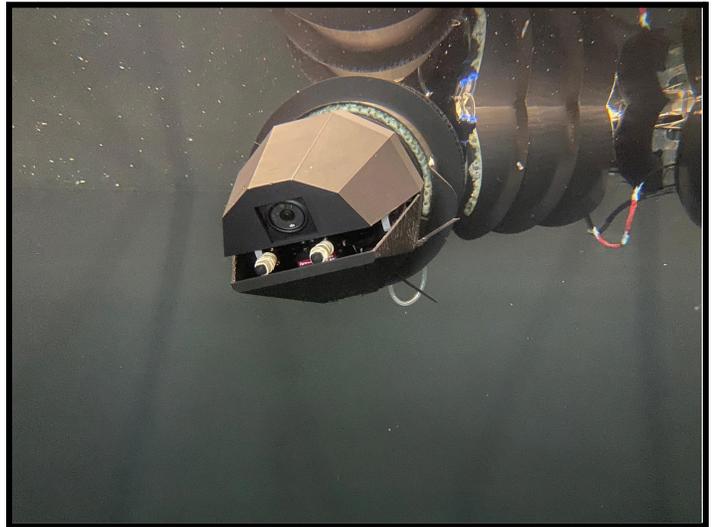
*The Delta wrist attachment was developed as an extra attachment to the arm*

## ARCLab UCSD with NASA Jet Propulsion Laboratory - ARCSnake

**Overview:** ARCSnake is an amphibious snake robot built to be used to explore beachheads and underwater caverns. This project collaborates with [EELS](#), a similar snake-like robot built in parallel with JPL, which is set to explore the icy moons of Jupiter and Saturn. Many design iterations and research on ARCSnake have been/are applied to EELS. The robot has six segments, each driven with an Archimedes screw drive and connected via differential U-joints that allow for finite control of each segment. My research focuses on creating durable and inflatable bladders that will allow us to control ARCSnake's depth underwater. These bladders are placed between each segment of the snake and are fed with an external pressure source. I've also assisted in creating a propeller/fin testing setup, which allows the lab to gather data on the efficiency of different designs of propellers and fins.



*Prototype bladder (torus)*



*ARCSnake V2 in water*

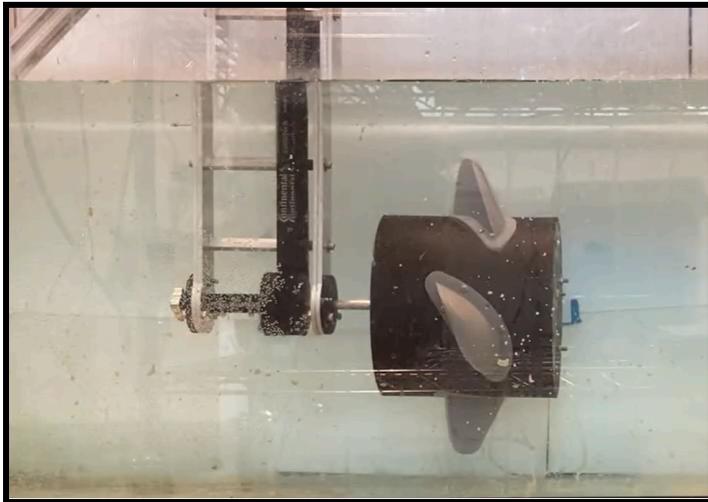


*ARCSnake V2 over sand*

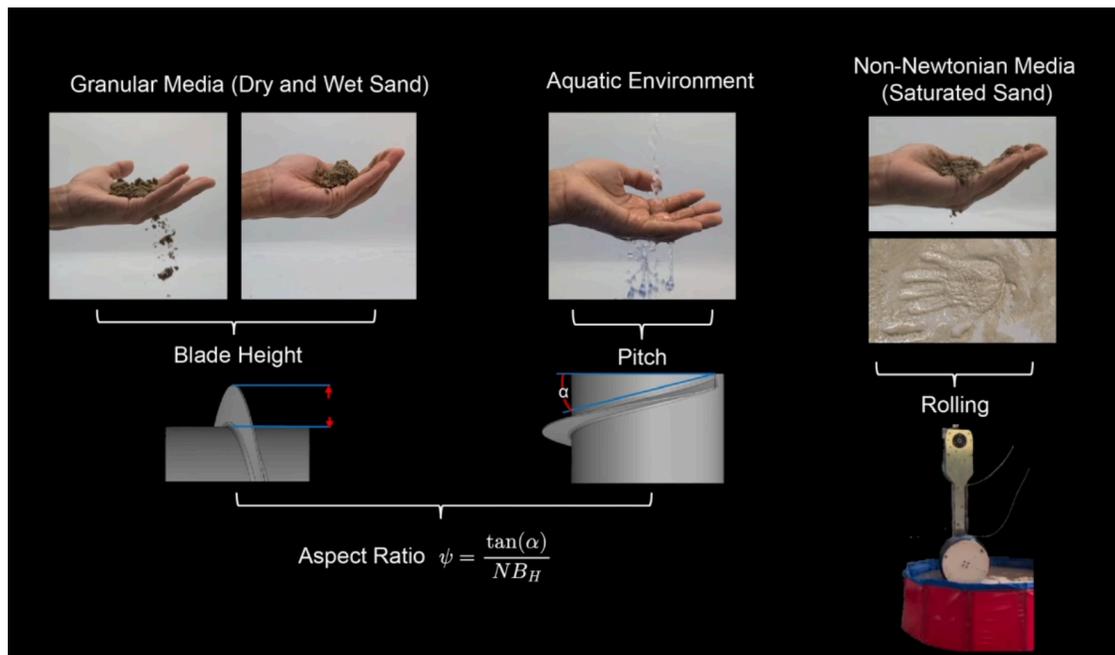
Wickenhiser, S., Peiros, L., Joyce, C., Gavrilov, P., Mukherjee, S., Sylvester, S., Zhou, J., Cheung, M., Lim, J., Richter, F., & Yip, M. C. (2025). ARCSnake V2: An Amphibious Multi-Domain Screw-Propelled Snake-Like Robot. *ArXiv*. <https://arxiv.org/abs/2511.11970>

## ARCLab UCSD - Multimedia Testbed

**Overview:** Designed to support the development of ARCSnake, the Archimedes Screw Propulsion Testbed is a multimedia experimentation platform used to characterize the propulsion fluid dynamics of segment robots. The setup allows for the rapid interchange of screw-shell geometries to test propulsive efficiency across varying fluid viscosities and granular media. My work focused on bridging theoretical models and physical hardware. Utilizing dimensional analysis, I derived a custom similar variable, our Aspect Ratio, to correlate experimental data with trends based on screw shell parameters. This process helped inform different screw shells in marine, terrestrial, and multimodal locomotion. This project resulted in a submission to the 2026 IEEE International Conference on Robotics and Automation (ICRA).



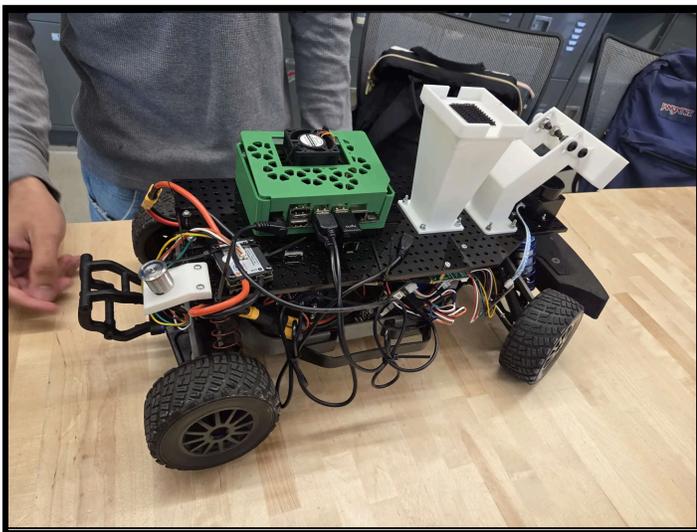
*Experimental setup for testing fins*



Chen, D., Samuels, Z., Peiros, L., Mukherjee, S., & Yip, M. C. (2025). Characterization and Evaluation of Screw-Based Locomotion Across Aquatic, Granular, and Transitional Media. *ArXiv*. <https://arxiv.org/abs/2511.11958>

## Voice-Controlled RC Car with Google Gemini LLM Integration

**Overview:** The voice-controlled autonomous car is designed to interpret natural language commands and navigate dynamic environments. Unlike traditional voice commands, which need keywords, we integrated a Large Language Model (LLM) to parse natural speech into precise VESC motor parameters, calculating RPM, duration, and steering angle. The car also utilizes a 2D Lidar system that interfaces directly with the VESC node in ROS 2 to identify and react to obstacles in real time. To enhance navigation, we implemented a costmap function that partitions Lidar data into sectors and calculates a “risk” in driving to a given area. The system then directs the VESC to steer towards the direction of least resistance. This reactive layer ensures that if an obstacle is ahead, and a user wants the car to go “straight”, the car will try its best to avoid the obstacle before correcting heading. The car was built over a quarter, but the LLM integration was part of a self-selected final project for MAE/ECE 148.

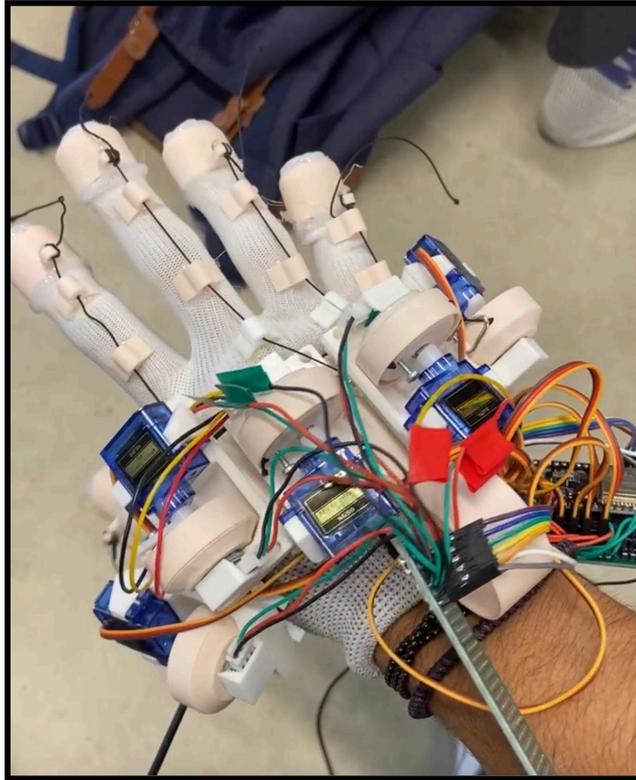


*Github Link:*

<https://github.com/UCSD-ECMAE-148/148-spring-2025-final-project-team-15?tab=readme-ov-fi>

## Haptic Glove Prototype for Humanoid Robot Control

**Overview:** The Haptic Feedback Glove is a wearable controller designed to teleoperate robotic systems while providing physical force feedback to the user. The hardware utilizes potentiometers to measure the position of the user's fingers, mapping these inputs to control a robotic hand. To simulate physical resistance, I engineered a "stopping" mechanism using hobby servos connected to elastic cables that actively pull back against the user's fingers. An ESP32 microcontroller processes real-time data from the robotic hand to determine the appropriate angle for the servos. The final version utilizes a capstan drive with hall-effect encoders to estimate finger position. Photos of the second version with the capstan drive were lost on a computer, but the media of the prototype were finished.



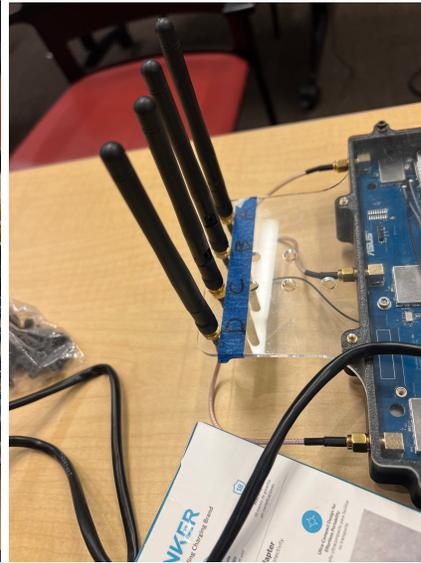
*First prototype of haptic glove*

## WiROS - Hardware Hackathon, WiDar Detection Project

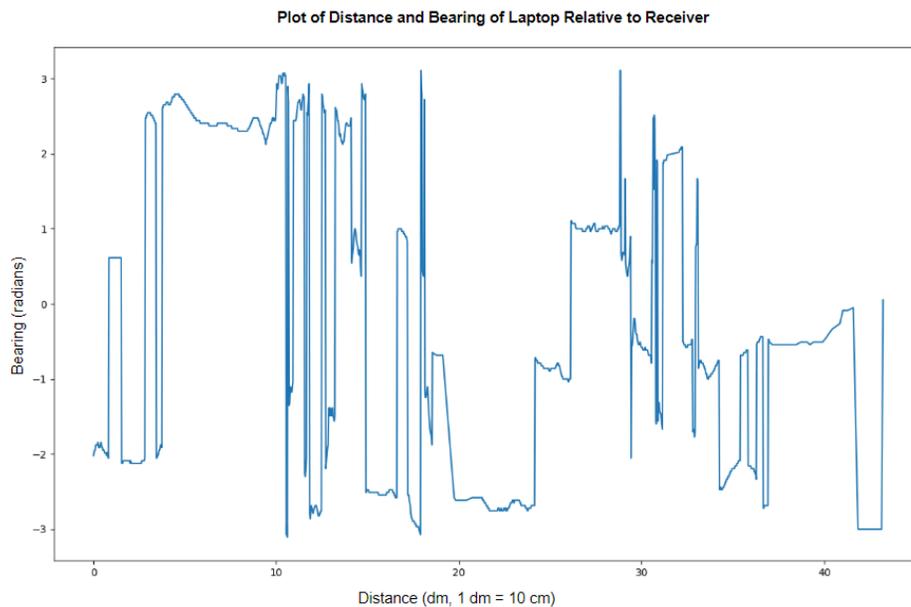
**Overview:** This hackathon had several challenges; our group chose to try and tackle the WiROS challenge, where we were provided custom ASUS routers from a UCSD ECE lab. These routers could stream CSI data onto a Raspberry Pi, data that could be interpreted as bearing or distance. Eventually, we create a small network within the competition area and connect a device. Once connected, we could find the bearing and distance of that device relative to the transmitter.



*Receiver*



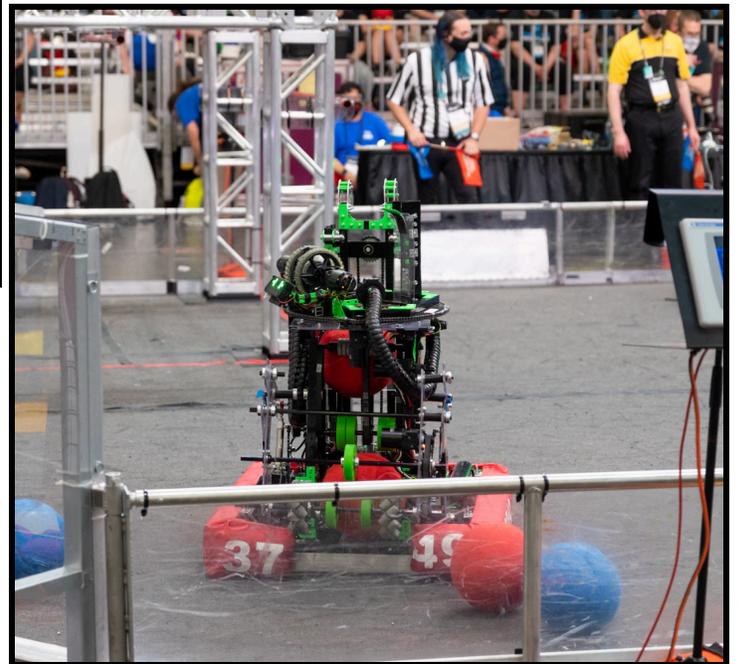
*Transmitter*



All the “flat” areas are regions where our device, connected to the network, was not moving. *We only had a router that could work as a receiver. We utilized the Matplotlib library for Python to present our data, but could not use a polar graph due to the significant noise created by existing Wi-Fi networks.*

## FIRST Robotics Challenge 2022 Robot

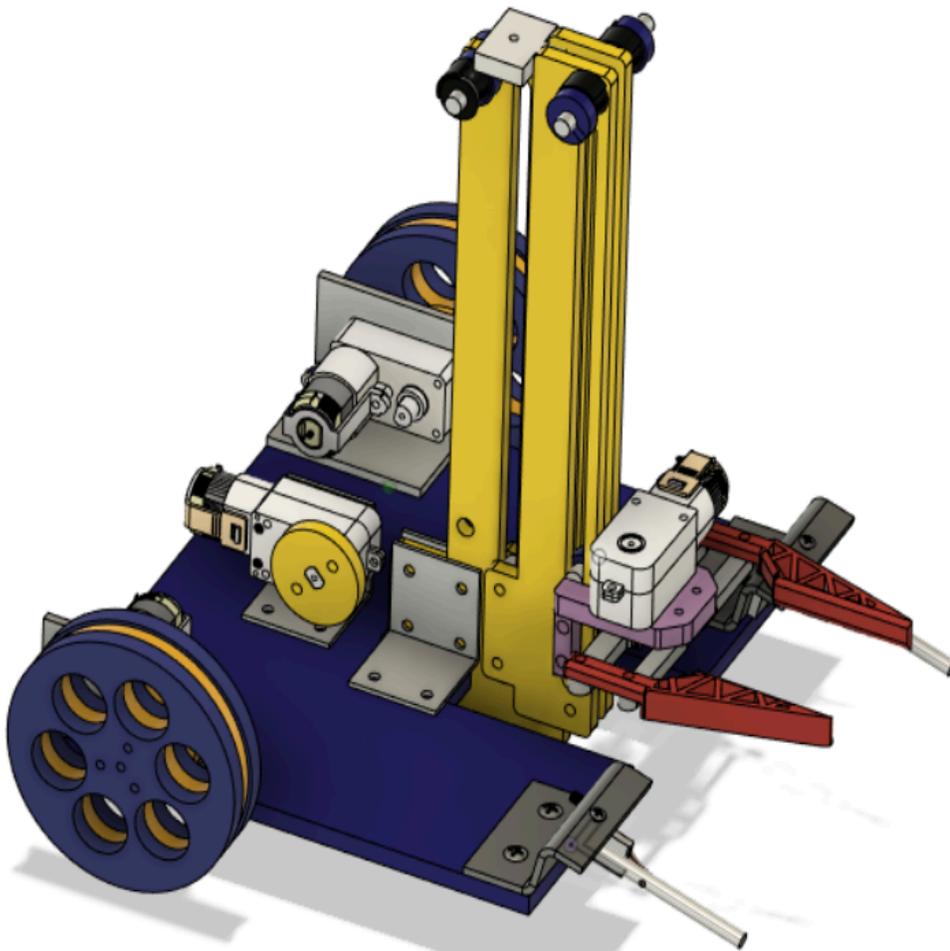
**Overview:** The First Robotics Challenge is a high school competition in which robots compete in 3-on-3 games and earn points by completing various tasks. For the 2022 challenge, robots had to shoot basketball-sized balls into a central hoop and climb monkey bars, with each monkey bar being a different height. Our robot features a 4-bar pneumatically actuated intake system, allowing it to quickly pick up balls from the ground and feed them into our spool shooter. The intake system was my main project and represented the greatest point of research and development, as our team had never attempted pneumatic systems before. The limelight camera on the mount could track reflective tape on the hoop, allowing the shooter to lock onto the hoop. The turret was originally set atop a slip ring, but with the current feed to the shooter being too high, we opted for a simple lazy-susan ball bearing that gave the turret 290 degrees of rotation.



*I created a contingency plan that anyone could use if a mechanical and electrical system broke down, viewable [here](#)*

## MAE3 Robot Project - Best Manufacturing Award

**Overview:** MAE 3 is a mechanical engineering course at UCSD in which students learn the basics of CAD, manufacturing/assembly, and analysis of static systems through various projects. One of these projects involved a competition across all sections of the class, where teams of 3-4 would create robots that could pick up blocks at various locations and heights and stack them on a central platform for points. Our robot features a cascade-lift system that can quickly and easily move a motorized claw up and down 14". The robot also featured an alignment mechanism that would assist the driver in placing the blocks by self-righting the position of the robot with springs. Our team won the best manufacturing award due to successfully integrating and developing complex systems such as the cascade lift and alignment mechanism.



This [presentation](#) includes additional details about the robot, as well as videos of it placing blocks on the last slide