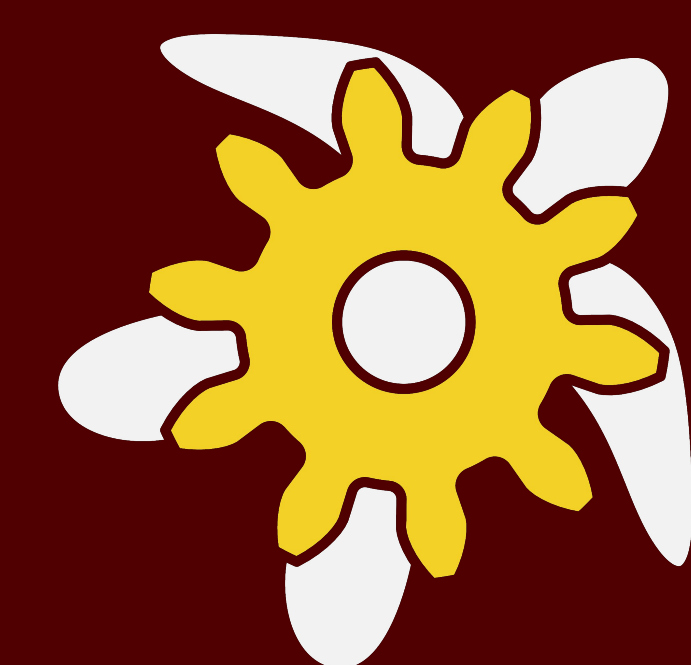


Synchronized Wireless Robotic Movement (SWRM)



TEXAS A&M UNIVERSITY
ROBOTICS TEAM & LEADERSHIP EXPERIENCE



TEXAS A&M UNIVERSITY
Engineering

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Intro & Problem Definition

SWRM is a project to explore the use of ground based swarm robotics in art. Using mounted 64x64 LED Panels, a cohesive swarm of bots will be able to perform unique motion driven light shows. With the end goal to showcase various exhibitions, or supplement existing ones .

Approach & Methods

We plan to use a mesh node network, allowing “Swarmites” to perform scheduled tasks in sync. The robots will interact with an external positioning system to determine position, then individually update pathing and timing relative to the swarm.

Project Objectives

- Create a swarm of bots capable of operating independently and as a cohesive group
- bots should be able to autonomously put on performances
- Bots should be of a reasonable size, cost, and manufacturability
- Create a field tailored for the bots and their performance
- The bots should be capable of putting on an entertaining and interesting show

Project Progress

SWRM project is in its second semester of work. Our goal for the semester was to create one working prototype bot, capable of motion, external communication, and dynamic lighting. In addition, we set out to construct a graphic rendering program to upload photos and videos directly to the LED boards. We have achieved both of these goals, with one moving prototype bot and working code for converting images to pixels.

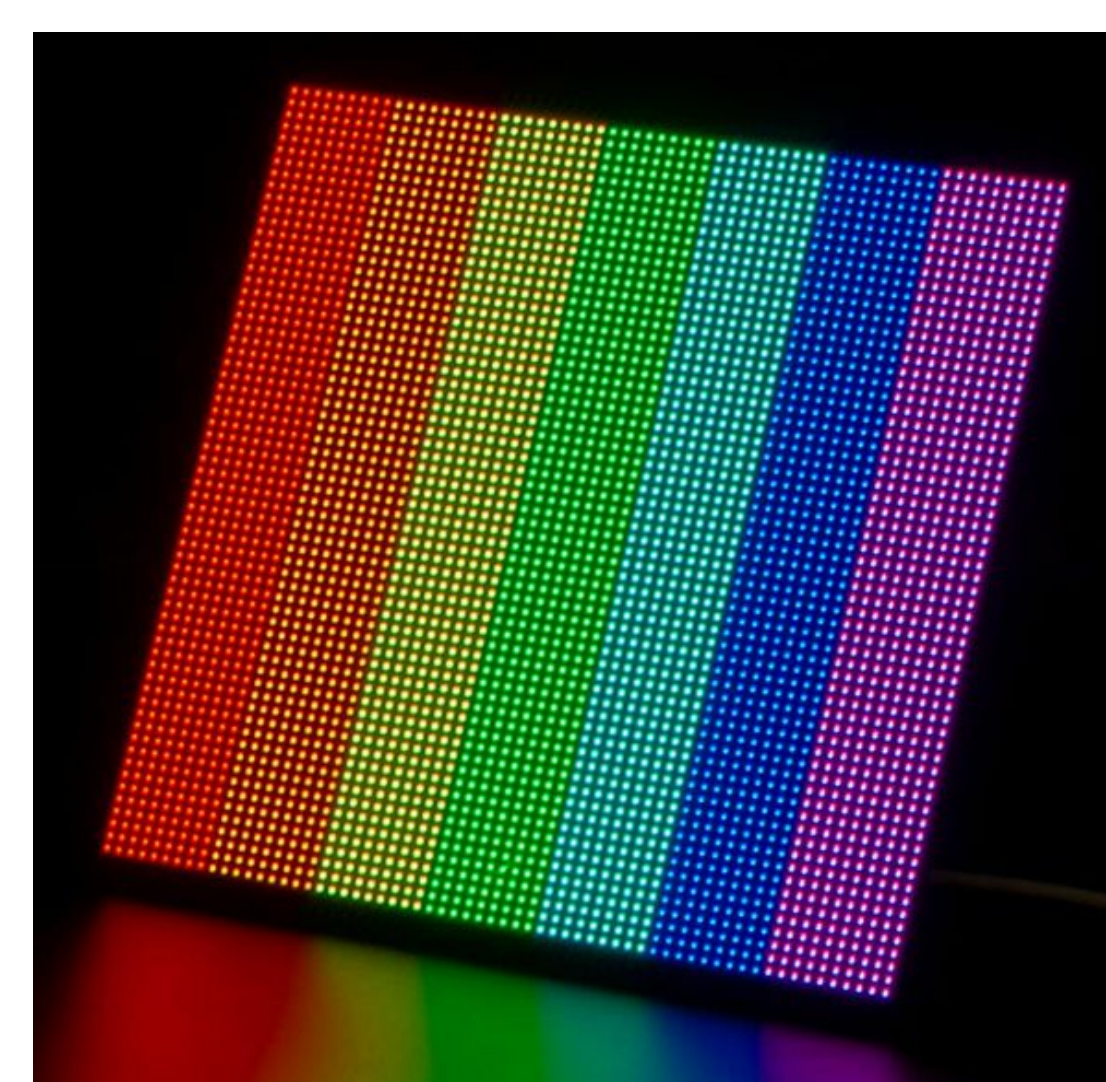


Figure 1: Product image of Marti 64x64 LED Panel

Mechanical & Structure

- Cost-effective reproducible design
- 3D printed Omni Wheels
- Internal frame covered by external shell
- Top-Mounted LED Panel
- Magnetic Linkage System

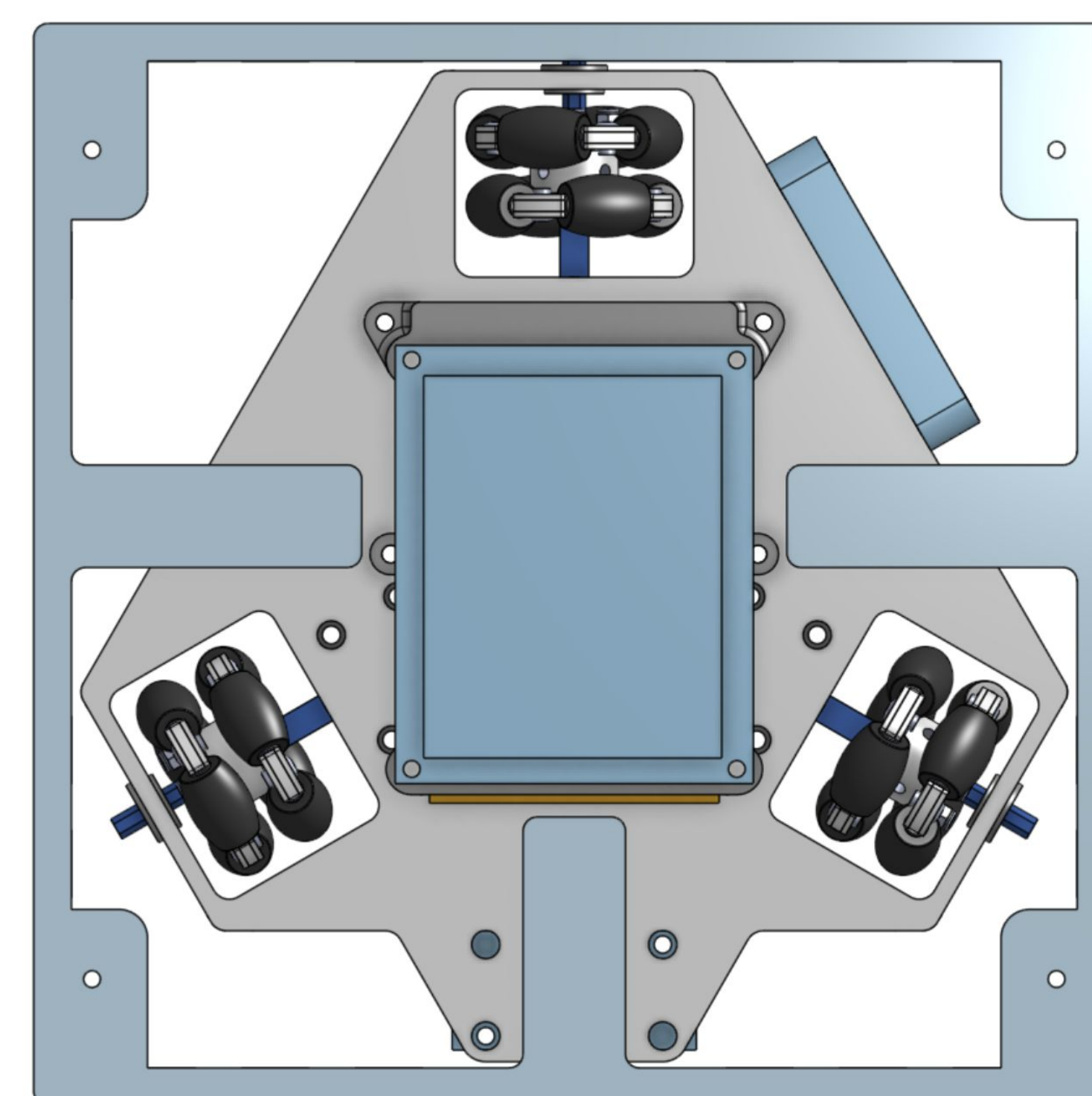


Figure 2: Chassis and Motor Top View .

Electrical & Control

- Each bot must be capable of independent operation
- Run time of around 40 minutes
- Pivoted from a dedicated control board to an ESP32 with breakout board and independent boards for motor control and sensing
- IMU filtered with EKF (Extended Kalman Filter)
- Ultra wideband for more accurate positional data

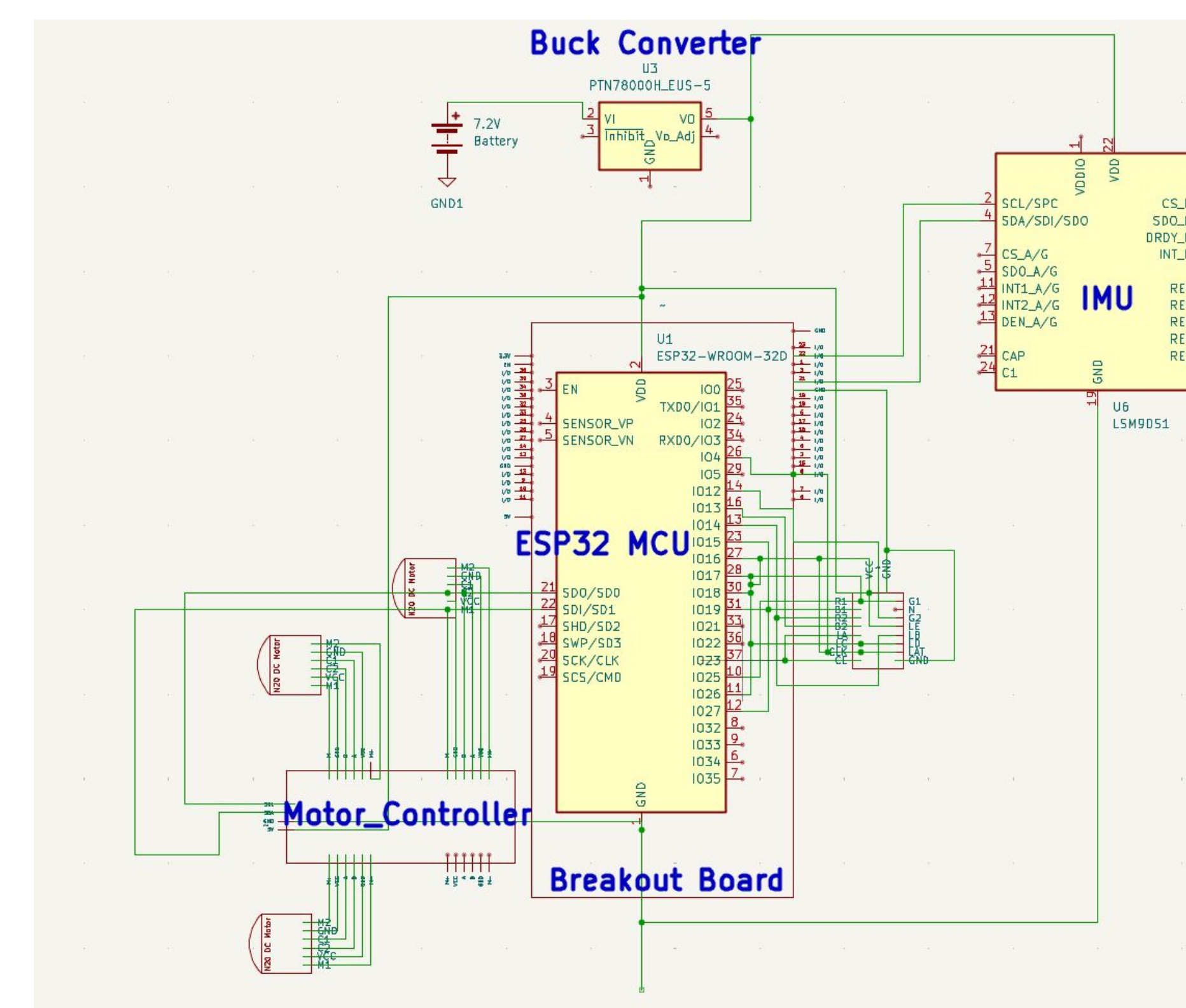


Figure 3: Electrical Diagram

Software

Communication Network (PainlessMesh)

Our swarm communicates using the built-in Wi-Fi capabilities of the ESP32. Instead of relying on a central router, we're using a system called PainlessMesh to create a 'self-healing' mesh network. Every robot passes information to its neighbors. This decentralized setup makes the swarm more reliable and adaptable.

Simulation and Control (ROS & Gazebo)

The software team is developing a virtual version of the robot using ROS2 and Gazebo, a physics-based simulation tool, which simulates the swarm in a digital environment. This allows validation and experimentation of navigation, control, and swarm behavior. Paired with data from ultra wideband triangulation, we plan to use ROS2 to create a live rendering of the positions of each bot.

Future Control Loop: Each robot initializes its position and sends it to the master node. The master determines the formation and assigns target positions. Robots then move to their designated spots while displaying an LED pattern, stopping once the formation is complete.

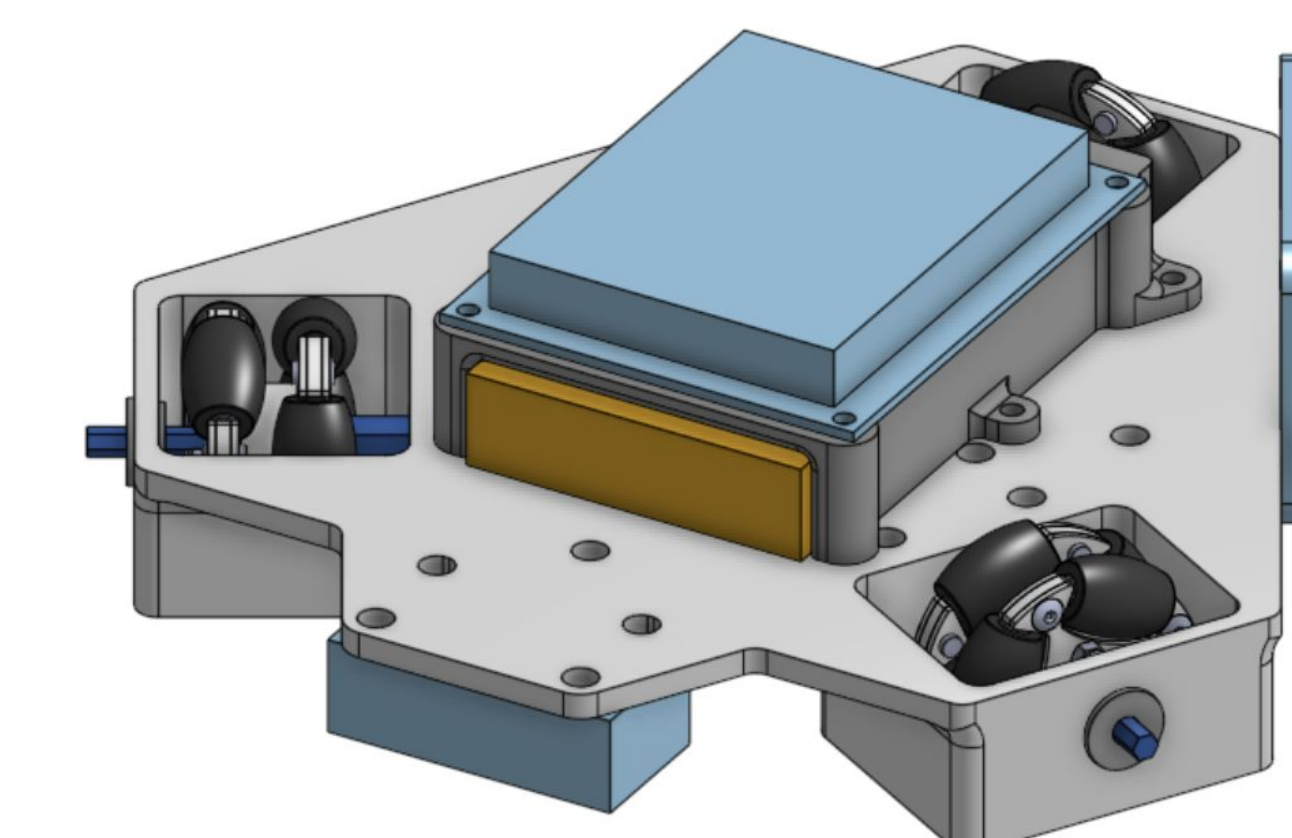


Figure 4: View of Mounting and Omniwheel

Next Steps

In future semesters, we will test system reliability and how long the robots can operate. We will implement LPS tracking so we know the real-time locations, validate movement and navigation to ensure each robot can follow paths accurately, and stress test the bots ability to communicate with each other over an extended time.

Our long-term goals are to scale the swarm, expand to many robots that can maintain a stable mesh network, streamline the design for easier manufacturing, and create thorough documentation to streamline assembly of each “Swarmite” in future iterations.

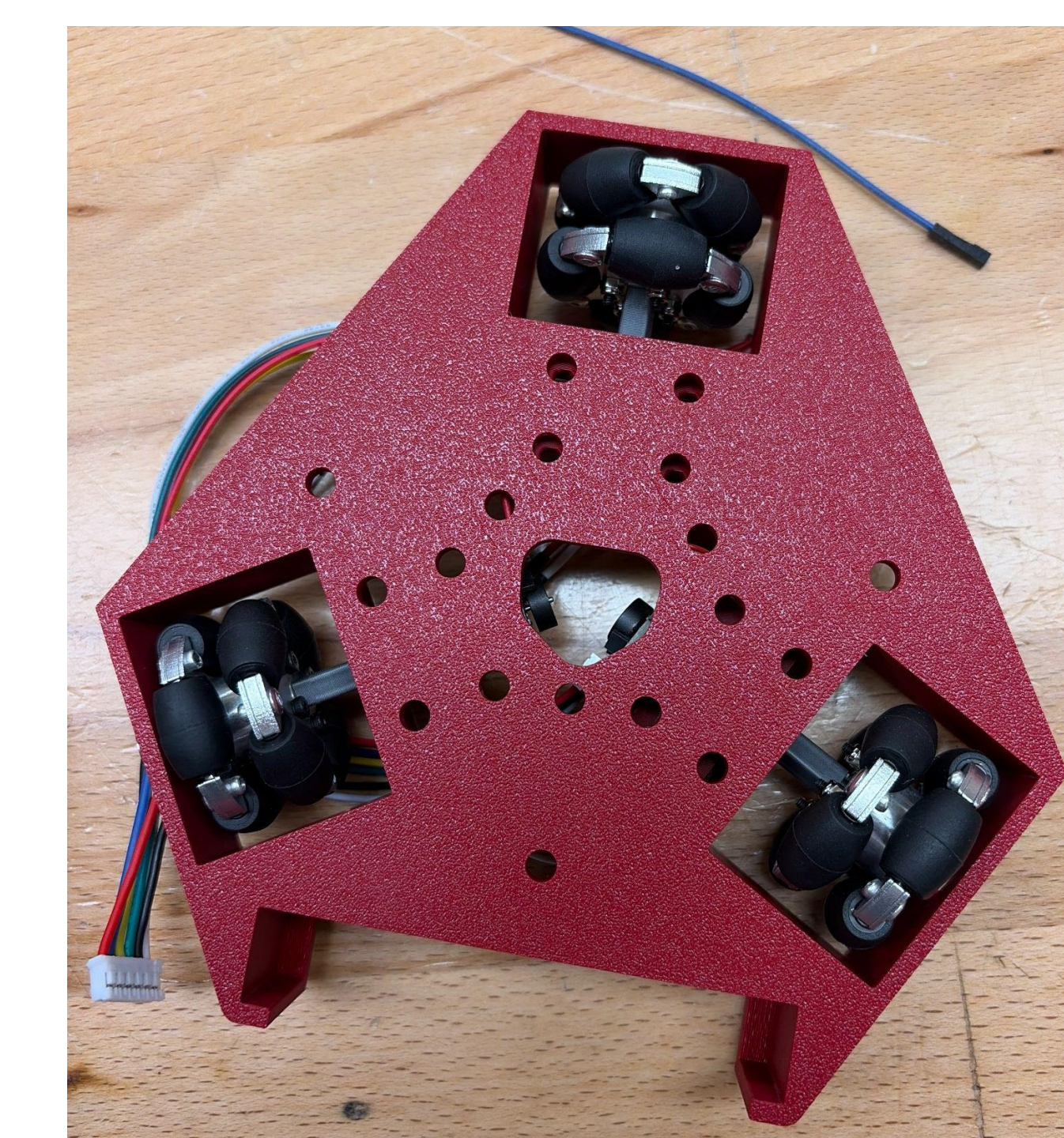


Figure 5: Chassis Prototype