Synchronized Wireless Robotic Movement (SWRM)

TEXAS A&M UNIVERSITY Engineering

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TEXAS A&M UNIVERSITY
ROBOTICS TEAM & LEADERSHIP EXPERIENCE

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 LPS system to determine position, then individually update pathing and timing relative to the swarm.

Design Requirements

- A scalable system of swarm robots
- The ability to connect and appear as one unified shape, then separate and operate independently

Project Progress

SWRM project is in its infancy, starting its first semester at TAMU in Fall-2025. The goal by the end of the semester is to create one working bot prototype, capable of motion, external communication, and dynamic lighting.

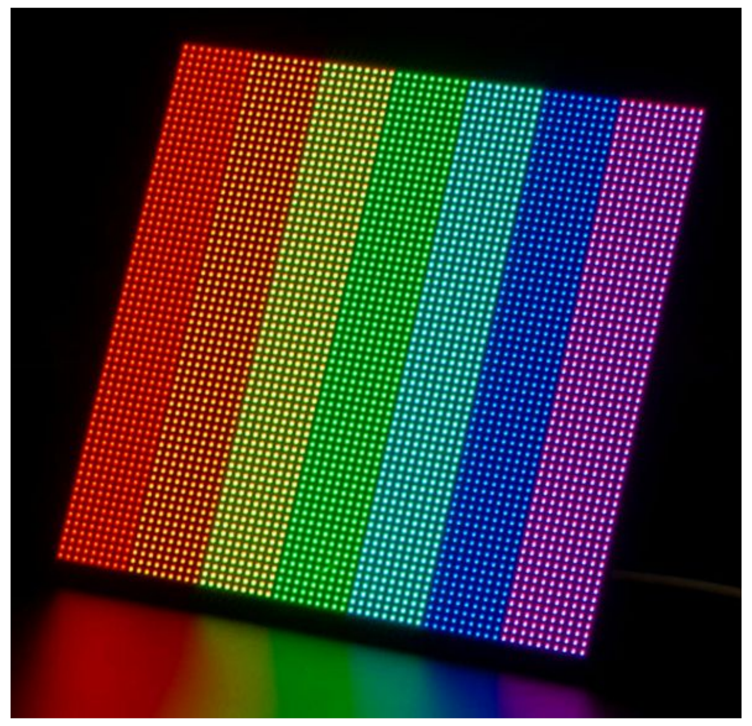

Figure 1: *Product image of Marti 64x64 LED Panel*

Mechanical & Structure

- Cost effective reproducible design
- Omni Wheels
- Internal frame covered by external shell
- Top-Mounted LED Panel
- External Positioning System

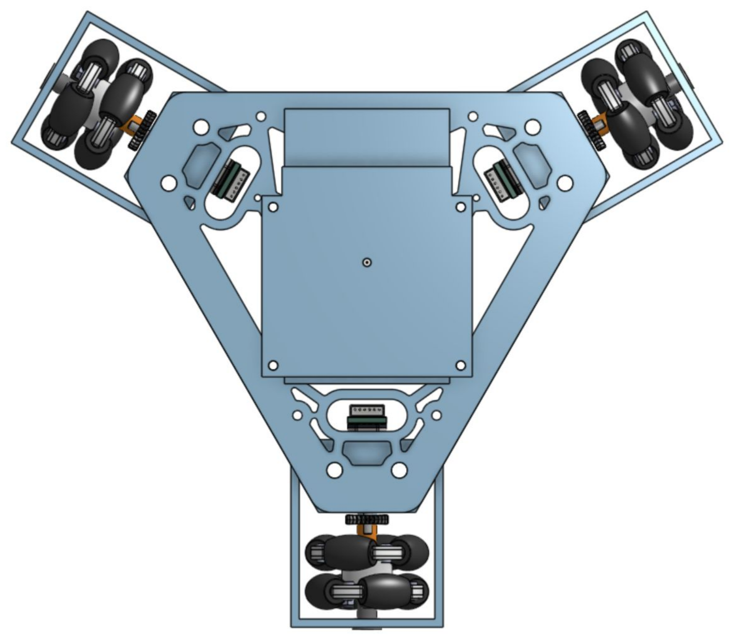

Figure 2: *Chassis and Motor Top View .*

Electrical & Control

Each bot must not only be scalable, but be capable of independent operation over the course of an exhibition. This adds a heavy emphasis on power management. Power budget estimates that the robots will run for around 40 minutes each. With the limitations of the control board, 2 motors will be encoded directly through the built in motor encoders, while 1 will be encoded through the GPIO pins along with the LED board.

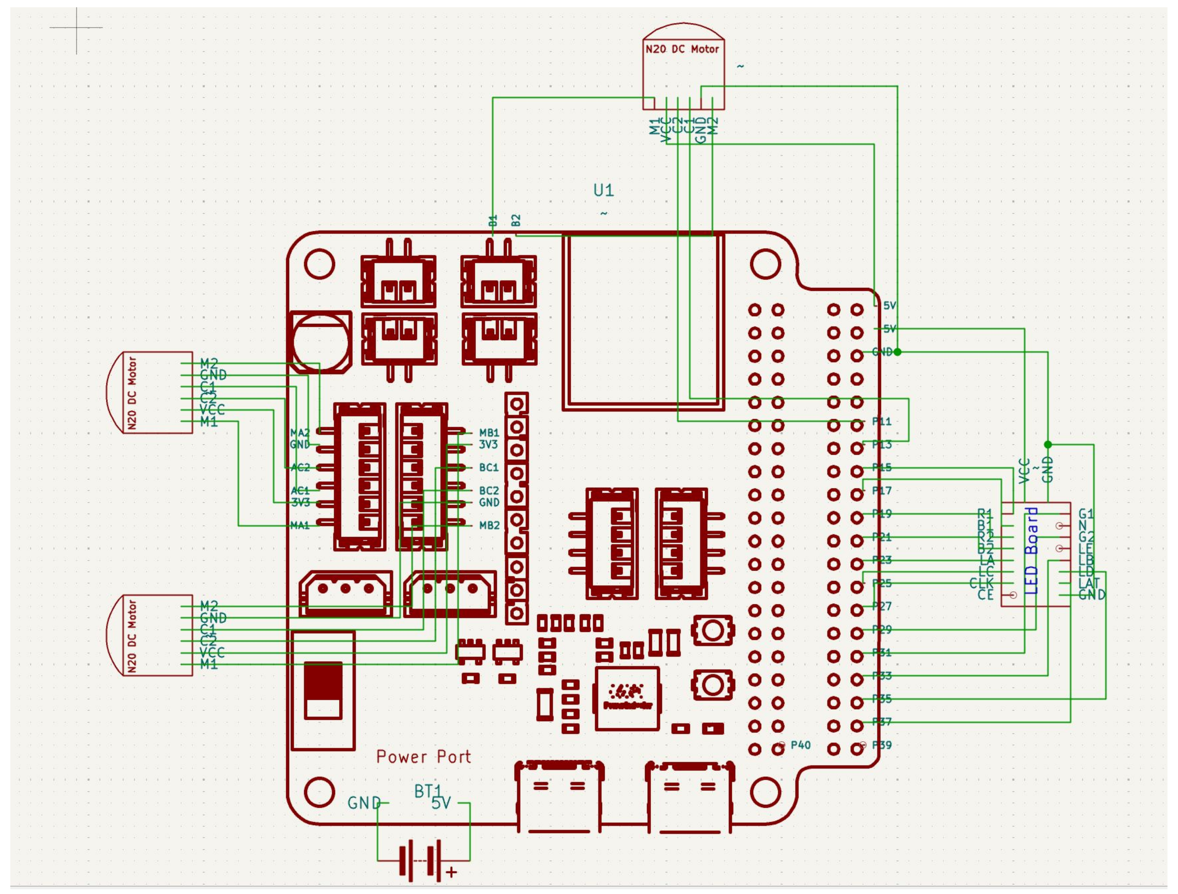

Figure 3: *PID Testing System*

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. Importing 3D models of the bot, and simulating the swarm in a digital environment. This allows validation and experimentation of navigation, control, and swarm behavior.

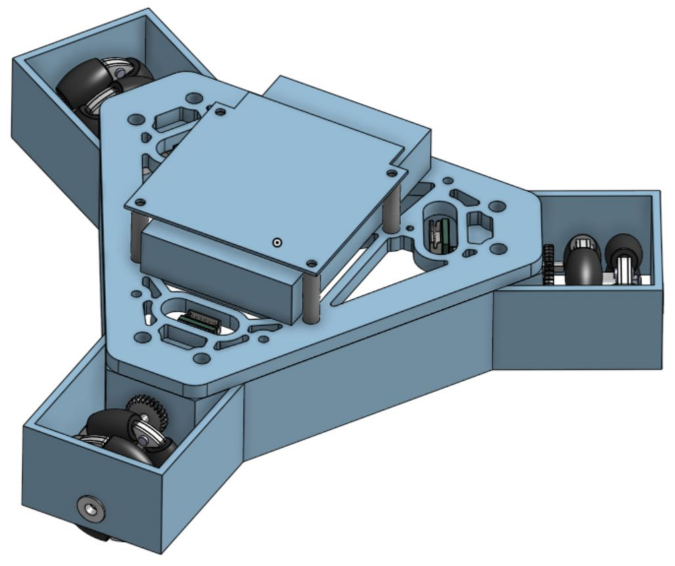

Figure 4: *View of Mounting and Omniwheel*

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. We will validate movement and navigation, ensuring each robot can follow paths accurately and respond over extended time. Work to synchronize visual signals, using LED lights that change patterns and colors in coordination between robots. And work towards a reliable physical linkage system between bots.

Our long-term goals are to scale the swarm, expanding to many robots that can maintain a stable mesh network, and to streamline the design for easier manufacturing and assembly in future iterations.

Documentation