NAVA WU

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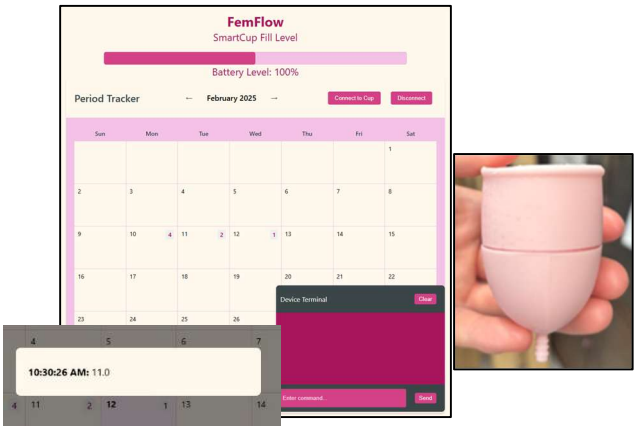
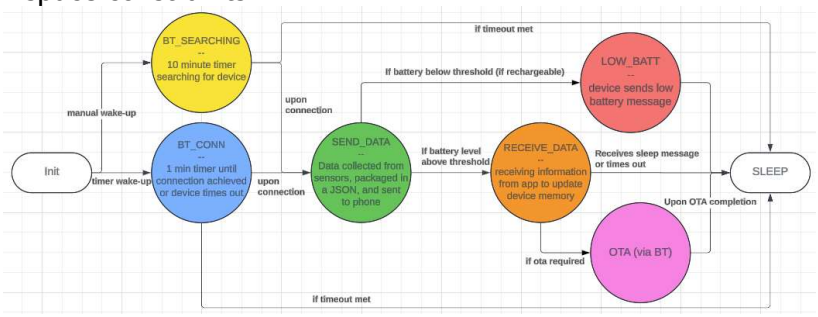
PORTFOLIO



App-Connected Smart Menstrual Cup (Sep 2024 – Present)

I worked in a 4-student team to design and build an app-connected menstrual cup which reads fluid levels present in the cup. I selected a microcontroller and wrote code to take sensor readings and send them over Bluetooth to a web application. I also created the app to store readings in a database in Firebase and pull past readings display past and current data to the user.

- Designed and wrote custom firmware in C on an **ESP32 Pico**, building a state machine for Bluetooth Low-Energy (BLE) communication with the app and a **real-time multitasking system** to prioritize sensor readings. Rewrote firmware on an **STM32WB55** after evaluating current draw requirements and battery options given space constraints.



Firmware State Machine Diagram

- Used **STM32CubeProgrammer** and **STM32CubeIDE** to receive information from sensors, send data to a web application over Bluetooth, and implement an **Over-the-Air (OTA) Update** structure to facilitate remote firmware fixes.
- Developed web application in **HTML, CSS, and JS,** and debugged by running the site locally.
- Wrote device data, including sensor readings, to a **real-time database in Firebase** and pulled information for display to the user on the app.

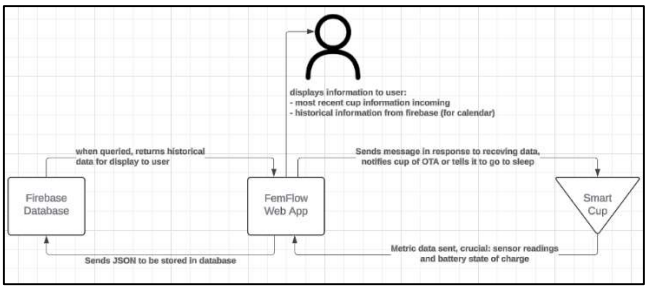


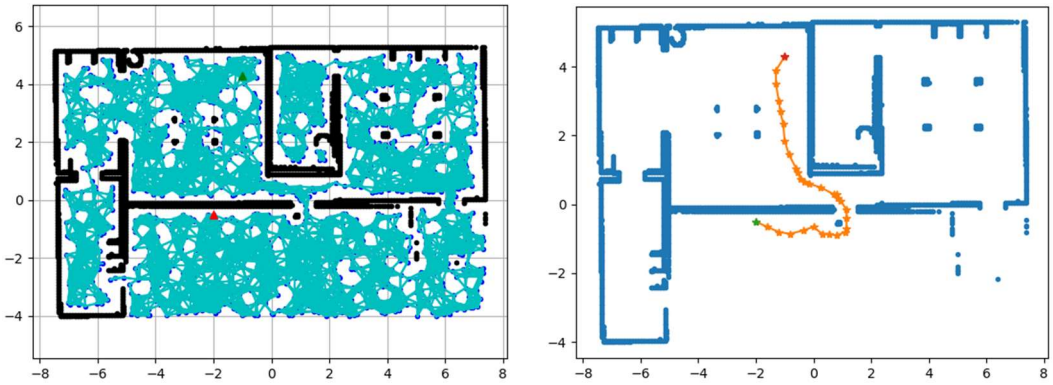
Diagram of Data Flow and Database in Firebase

Turtlebot 4 Localization and Probabilistic Road Map (Sep 2024 – Dec 2024)

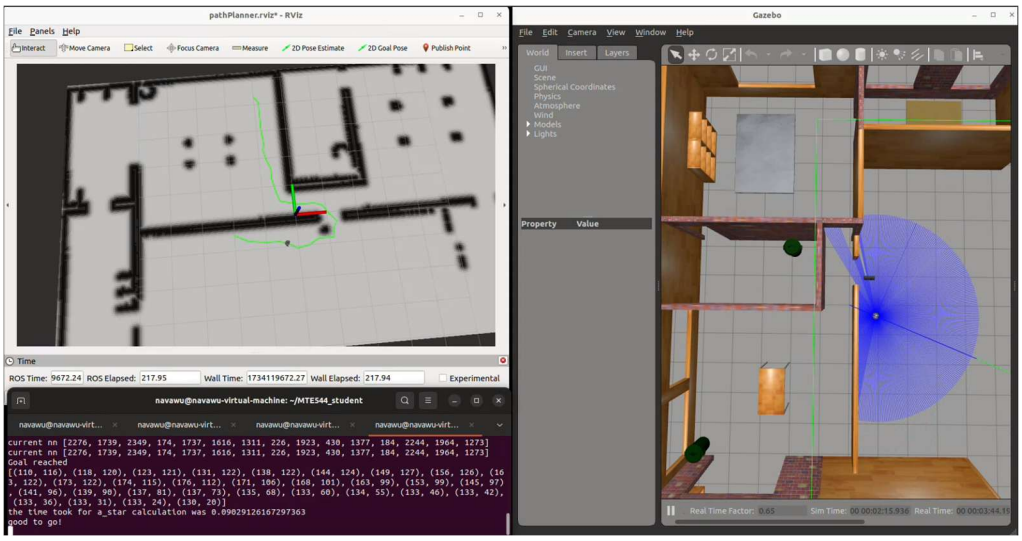
- Mapped a room and detected obstacles around the TurtleBot 4 (by Clearpath Robotics) using **LiDAR readings** and followed paths using a PID controller which used **Odometry and IMU readings**. Wrote code in ROS2 in Python

LiDAR visualization by TurtleBot 4 with planned path in RViz

- Created an algorithm to implement a **probabilistic road** map and find the shortest path between two points **using A* algorithm** in Python. Tested results in simulation on the **Turtlebot3 in Gazebo.**



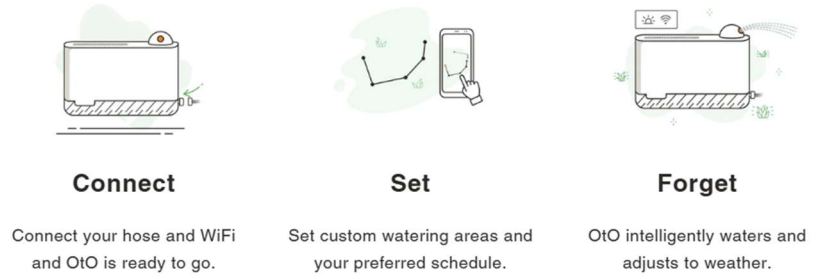
Probabilistic Road Map Visualization



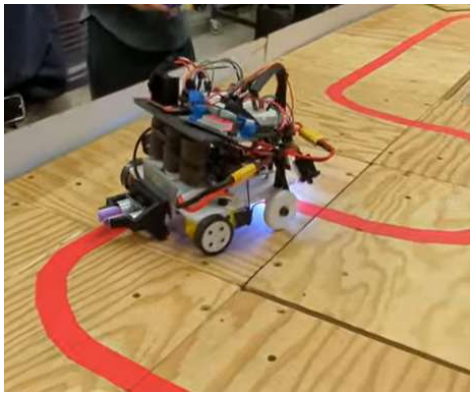
Simulation of TurtleBot behaviour in RViz and Gazebo

MQTT Implementation on OtO Lawn Devices (May 2024 – Aug 2024)

- Designed a **finite-state machine** to facilitate **bidirectional communication in MQTT** by rewriting **production-ready** C code on the OtO Lawn firmware stack to the ESP32. Project improved upon past use of HTTP for IoT application.
- Reached out to **MQTT broker providers to set up lines of communication**, choose an appropriate plan, and compare costs with existing HTTP cloud costs, to ensure the project remained on track to be implemented once beta tests were completed.
- Implemented **"modem-sleep" mode to conserve power** while the device is listening for messages from the broker.

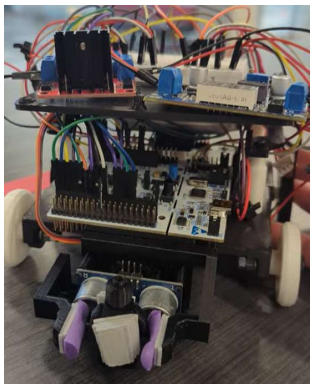


OtO Lawn Device Functionality. MQTT Changed the Device Power Consumption During the Intelligent Watering Schedule



Autonomous Search & Rescue Robot (Jan 2024 – Apr 2024)

- **Designed PID controller on STM32 Development Board** to build a line-following robot, interfacing with colour sensors and ultrasonic sensors, and responding with PWM input to DC motors to drive the robot along the path and detect obstacles.
- **Made engineering decisions** including initial design, part selection, control algorithm design and project planning.

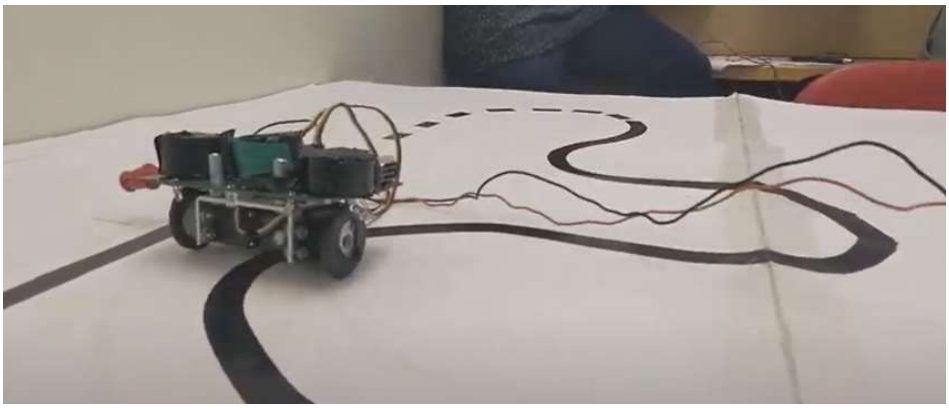
Line Following Course, and Robot Demonstrating Pick and Place Capability

Real-time OS Development on Cortex M4 (May 2023 — Aug 2023)

- Developed a **multithreaded operating system** (OS) on **Cortex M4 (STM23F401RE)** in **VSCode with PlatformIO**, by programming concurrent execution of tasks for real-time responsiveness, improving skills in low-level programming, MMIO, scheduling and task synchronization.
- Engineered a **real-time application** with coordinated tasks; optimized the system with deadline avoidance strategies.

Motorized Seatbelt Retractor Demonstration Fixture (Jan 2023 – Apr 2023)

- Designed a novel motorized seatbelt retractor demonstration fixture as proof of concept for future Tesla models, using **two microcontrollers communicating over I2C** that each connected to a **Model 3 CAN Bus** to trigger haptic responses and pre-crash pre-tensioning upon sensing lane departures and accelerated braking.
- Owned the creation of this device, including hardware part selection and mechanical design, and integrated the device to run independently off **Tesla vehicle power and CAN networks** for demonstration to the leadership team.



Line Following Robot (Sep 2022 — Dec 2022)

- Built a robot that followed a black line using **phototransistors** to detect reflected photodiode light, and detected the presence of magnets with a **Hall effect sensor**
- Used filters and amplifiers to process incoming signals, and wrote **logic in C** to the microcontroller so the robot would take the appropriate action