MEGN540 Project Progress Report

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1. Problem:

Many people are unable (or unwilling) to get up, walk to, and grab an item they need or desire around their home. Examples include elderly persons who need to take medication at a specific time daily but may be forgetful, and college students who are thirsty but too incapacitated to get their next beverage themselves.

We are designing and building a product that can deliver a necessary item to those people when they need it.

2. Design Concept:

We are building a two-platform tank-drive mobile delivery robot. The lower platform will secure our electronics, and the upper platform will carry the delivery payload. Upon activation, our robot will identify the person nearest it, drive to that person, and deliver the payload. Our robot will have the ability to:

1. Listen for and react to an activation signal. To begin, this will be a serial command issued via SSH.
2. Identify persons in its FOV and target the nearest person to it (if any).
3. Orient itself toward the person and drive to them in a straight line on a flat, carpeted surface.
4. Carry a payload of at least 16oz.
5. Stop within arm's reach of the target person to deliver the payload.

2.1. Sensors

- *Stereo camera:* Luxonis Oak-D Lite for visual odometry, depth estimation, and object detection.
- *IMU:* MPU-6050 for pose estimation and motion control feedback.
- *Load sensor:* MPS20N00400 sensor and HX711 amplifier to measure payload.
- *Wheel encoder (x2):* Hall encoders for motion control feedback.

2.2. Actuators

- *DC motor (x2):* 12V, 150rpm DC motors to power the robot's drivetrain.

2.3. PCB

- *LED Demuxer:* Our circuit board's primary purpose is to enable us to indicate our robot's status visually without occupying too many pins on our microcontroller. Our PCB will incorporate a 3 to 8 demuxer, a resistor, and ports for 8 LEDs to achieve this. As a second-order effect, the PCB will clean up our robot's wiring by supplying 5V power rails. Our initial PCB design is in Figure 1.

2.4. Software

- *Visual odometry* module for depth perception and pose estimation.
- *Object detection* module for person identification.
- *Path planning* module for trajectory generation.
- *Motion control* module to power motors and follow the trajectory.

3. System Integration:

We worked as a team to assemble our robot's chassis and prototype mechatronic system. We are working in parallel on our robot's software modules. To simplify integration, we use Docker containers to ensure environment compatibility and a GitHub branch/pull/merge workflow to manage our codebase. During April, as a team, we will integrate the software modules with our mechatronic system, troubleshoot, and tune our robot.

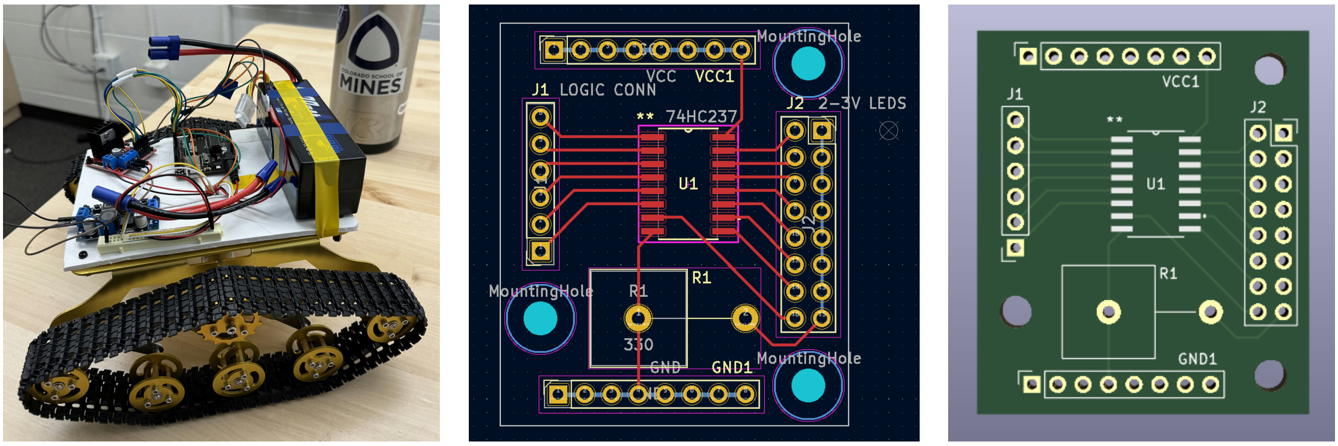

Figure 1: Works completed to date. (L) Prototype mechatronic system, (R) PCB design.

4. Project Plan:

Our work/deliverables are planned in two-week increments to keep tabs on progress and enable us to react quickly to issues that arise. We have created a backlog of deliverables on GitHub and are organizing our work using a Kanban board. Table 1 shows our milestones and their current status. We have completed the first three milestones and are progressing on the rest. Completed works are shown in Figure 1.

Table 1: Project plan and status.

Milestone	Date	Status	Description	Requirements
1	2024-02-07	✓	Material acquisition and planning	• Bill of Materials created • Ordered necessary materials
2	2024-02-21	✓	Software module design	• Project repo instantiated • Module specifications created • ROS framework installed
3	2024-03-06	✓	Prototype build and PCB design	• PCB design finalized • Materials assembled
4	2024-03-20	In Progress	Software implementation	• Visual odometry module implemented • Object detection module implemented
5	2024-04-10	In Progress	Software implementation	• Path planning module implemented • Motion control module implemented
6	2024-04-24	To do	Prototype refinement	• PCB installed/integrated • Path planning and motion control tuned
7	2024-04-30	To do	Deliverables	• Project is demonstrated to the class. • The project report is submitted.

4.1. Work Split

- **As a team:**
- **Individually:**

4.2. Critical Paths

5. Budget Estimate

We are aiming to spend $300 ($100 per team member) or less on parts. To date, we have spent $254 acquiring our chassis, motors, Arduino, motor controller, voltage regulators, batteries, and miscellaneous necessities (wiring, acrylic platforms, tape, etc.). The most expensive components we had to purchase were 4S LiPo batteries and a compatible charger.

The remaining items to be purchased include the PCB parts: the prints, the 3 to 8 demuxers, and the LEDs.

We already owned several more expensive components, including an NVIDIA Jetson Orin Nano the Luxonis Oak-D Lite.

6. Risks

6.1. Technical

6.2. Programmatic