Understanding the Challenges of Locomotion, Lab report of EEE 187L Labs 1-3.

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***Abstract* - In the Robotics Lab, our goal is to create a robot that is able to specific tasks. Each lab we build up the robot while adding new functions to the robot.**

I. INTRODUCTION

One of the best ways to learn the basics of robotics is to build a robot yourself, and the aim of the EEE 187 Lab class is to learn these through the process of doing the labs.

In each lab we build up the robot while adding new functions to the robot, and for this lab report we are discussing 3 labs. In the first lab, we built the basics of the robot, built with either a differential or akerman drive, controlled using a microcontroller. The second lab the objective was to get the robot to travel a set path which had 4 checkpoints, as well as to have the robot be able to cross a bridge while trying to travel in a straight line. The third lab was line following - we needed to use IR light sensors to follow a black line and get to one of the ends of the paths.

II. COMPONENTS USED

TABLE I
COMPONENTS USED IN LAB 1-3

Component	Purpose	Used in Labs
Raspberry Pi 3B+	Control Systems	All
L298 Motor Driver	Locomotion Control	All
2x 6V DC Motors W/ Encoder	Locomotion	All
Caster Wheel	Stability	All
AA Battery Holder	Power	All
Phone Battery Bank	Power	All
TCRT5000 (QTI) IR Sensor	Detect Line for Following	Lab 3

III. LAB I

A. Experimental Details

In the first lab, the goal of this lab activity is to build and calibrate your wheeled mobile robot. During this lab we determined the basics of the robot that would dictate how our robots operate for the rest of our labs.

The lab told us how to model of the robot, built with either a differential or akerman drive, controlled using a microcontroller. We decided to build a differential drive car because controlling it was simpler, and we decided to use a Raspberry Pi 3b as our microcontroller because of how flexible the platform is and because of its wireless capabilities.

The lab also wants us to calibrate the robot, and wants us to determine the PWM values:
• when the robot stays stationary.
• that corresponds to clockwise or counterclockwise pure rotational motion.
• that will allow the robot to move forward in a curved path.
•that will allow the robot to move in a straight line

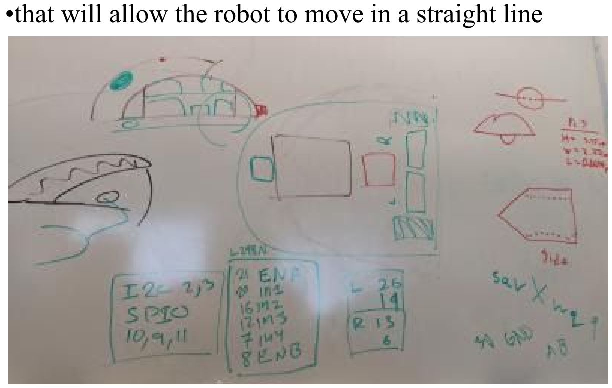

Fig 1. Drawing of our plans of how we wanted to build the robot

We started by drawing and diagramming how we wanted the robot to be oriented and started by labeling the pin outs.

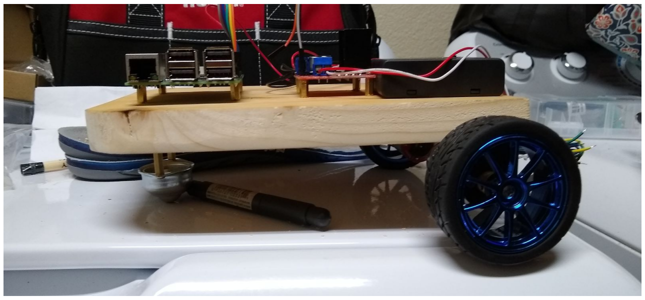

Fig 2. Picture of the robot in construction

Then we cut a piece of wood and started mounting our components onto the platform. In the front, we mounted the Raspberry Pi, in the middle of the robot we mounted the L298N motor controller and at the rear we mounted the battery pack and the tires.

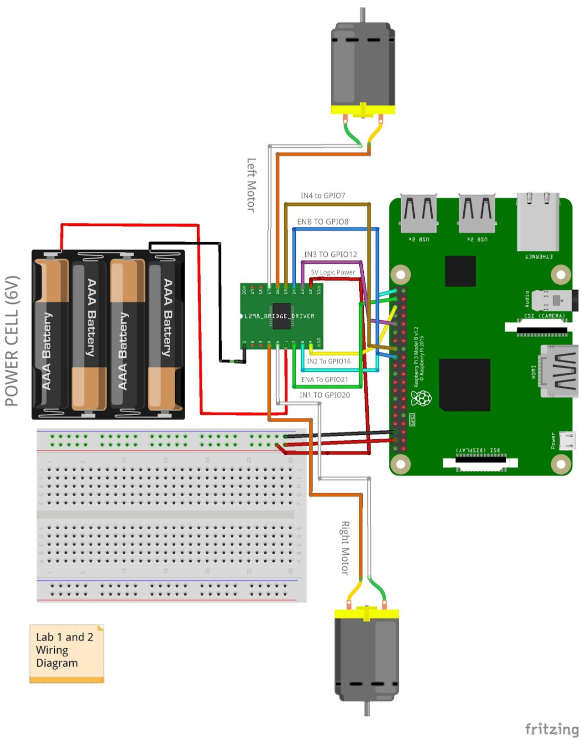

Fig 3. Wiring Diagram for Lab I & Lab II

TABLE II

GPIO PINS ON THE RASPBERRY PI FOR LAB I

Name in Code	Function	Pin
out1	Right Wheel +	20
out2	Right Wheel -	16
out3	Left Wheel -	12
out4	Left Wheel +	7
enA	Enable 1&2	21
enB	Enable 3&4	8

We then wired up the robot according to the figure 3. The Pi GPIO Pins were organized as according to the table II. We then did the code and calibration work to get the robot working.

B. Results

For the code we wrote a simple program that responded to user input. Going straight used PWM Values 73 for right and 79 for left, and for turning we manipulated the L298N with functions to turn. If both motors were running in the opposite direction, it would turn purely rotationally, if only one turned, it would turn in a curved path, if both were going in the same direction then it would go straight.

After writing the code, we got the robot to move and demoed it to the Lab Instructor without problems.

IV. LAB II

A. Experimental Details

In the second lab, we were tasked to program the robot to perform a desired path. The focus of the program is calibration, tuning the system so it is capable of doing the task on hand. The 2 parts of this lab are 1) Path Planning, navigating from Po to Pf while hitting all specific points in the path and 2) Crossing the bridge, being capable of moving in a straight line so it doesn't fall off the bridge.

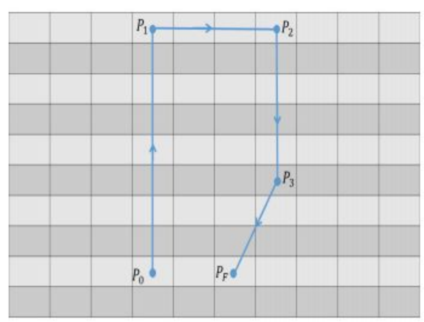

Fig 4. Path Required for Lab II Part I

We didn't need to change any of the hardware so the work required is mostly calibration. The hardest part of calibration was going straight for the path - the floor is not even so even if we tuned the robot to go straight it wouldn't necessarily go the same way every time. Once we got the robot to go straight, we had to calibrate the robot to get the robot to turn at the given time for the various angles, and then after a few shots we got it working

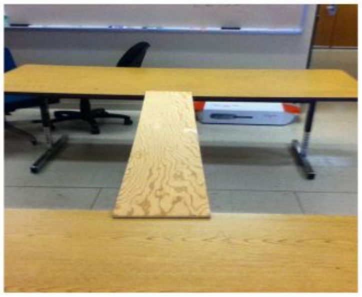

Fig 5. Bridge needed to cross for Part II

For Part 2, we already had going in a straight line working well so it was a matter of just running it. Part 2 went smoothly without any major modifications.

B. Results

https://drive.google.com/open?id=1m5DfGpX31mJVIc7fmKbQc3Oo6bdDI1Ag

After calibrating the robot we got it to follow the path, recorded it which is the video link above, and demonstrated part 1 to the Lab Instructor without problems. Part 2 we demoed it going on the bridge straight in class.

V. LAB III

A. Experimental Details

Fig 6. Obstacle path for Lab 3 that robot needed to get the end of

In the third lab, the goal is to get our robot to follow a line to reach a final destination point at the end of the line. The lab had black tape on the floor with endpoints, the robot had to be capable of following while not getting completely lost in the maze of lines. We had to determine what sensor we wanted to use and we decided on a QTI infrared sensor - The light emitted by the LED bounces off a surface of an object, and is detected by the phototransistor.

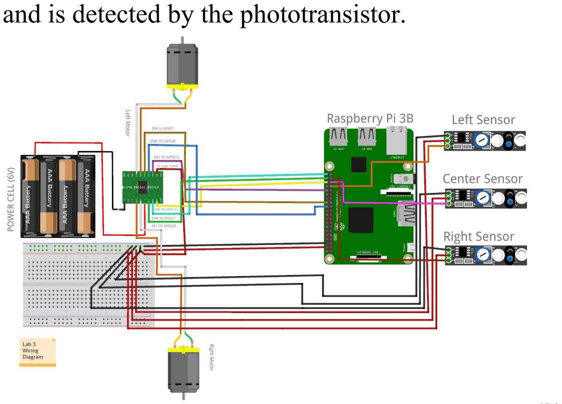

Fig 7. Wiring Figure for Lab III

We started the lab by trying to mount the QTI sensors at the very bottom of the robot but we ran into issues while doing it. We moved the QTI sensors to the front but originally only put 2 sensors on the robot which lead to issues so we had to change it to 3. Once we wired them up as according to Figure 7 above and tweaked our code, we had it line following successfully.

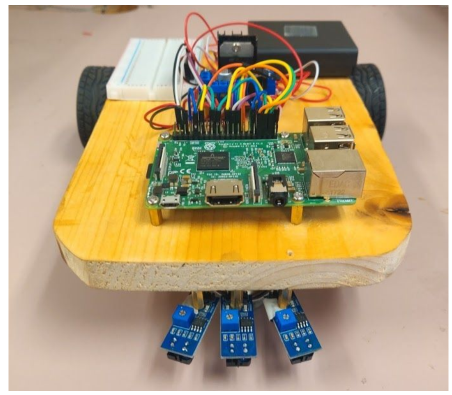

Fig 8b. Robot for Lab III

B. Results

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After calibrating the robot we got it to follow a path and get to an end point, recorded it which is the video link above, and demonstrated it to the Lab Instructor.

VI. CONCLUSION

Throughout these labs we have built a robot that successfully is able to move around, follow a path, and line follow. These labs have taught us how these components work and have taught us how we would implement the component into real devices. These labs were mostly smooth sailing, and we never got stuck at any point in time. For the first lab we were able to do it just in the lab time, while the 2nd and 3rd labs needed a session outside of class for us to finish. There isn't anything we'd change with the labs, the lab was a great learning experience and went well.

VII. REFERENCES

[1] Fethi Belkhouche, EEE 187 Laboratory Activity 1: Building the robot, Aug 2019

[2] Fethi Belkhouche, EEE 187 Lab: Activity 2, Sept 2019

[3] Fethi Belkhouche, EEE 187 Lab: Activity 3, Sept 2019