Robotics Project Report

Electronics Engineering 387 – Microcomputer System Desgin

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1 Introduction

Robots are machines which makes our lives a lot easier by reducing the amount of human effort required in order to finish a task. An example can be a motor vehicle such as “Tesla”, which has brought fully automatic cars to market by making the controller (robot) do all the work whereas the human has to put no effort to get from one point to another.

The main scope of this project is for a robot to be able to navigate through a course avoiding obstructions in its path. If the robot encounters an object it will take an evasive maneuver and adjust to the current situation. The robot will be programmed to be able to adjust in both left and right situations as well as reversing in the case where it can do neither. In addition to the obstacle avoidance the robot must be able to detect a line pattern on the floor. In the course there is a series of three patterns that can be in any order and the robot it required to detect all three patterns.

2 Design Process

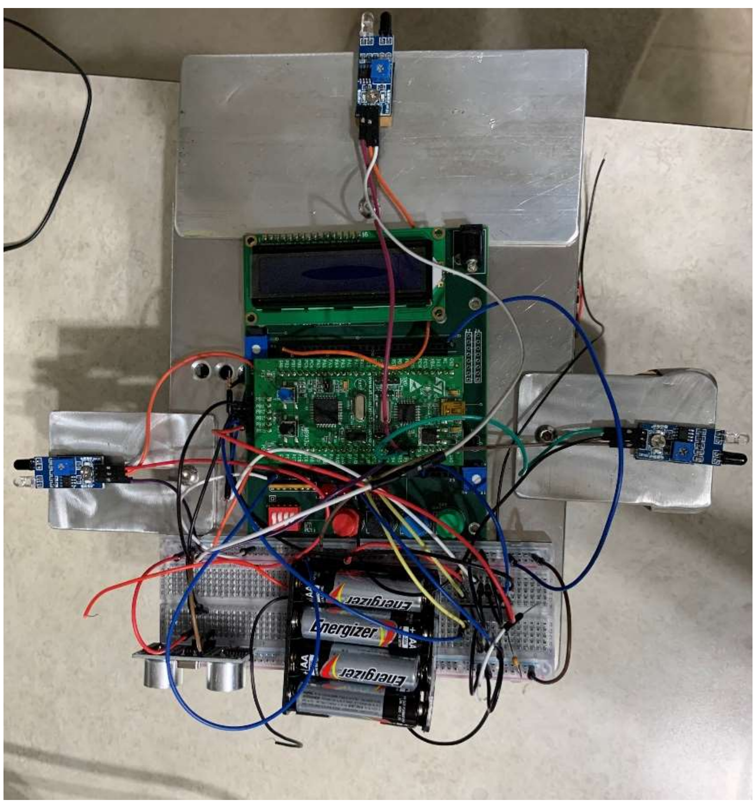
Our Design approach was to plan out how each of the of requirements would need to be handled and determine what parts could provide the required input or output. This included understanding how each part would interact with the outside world and if the part could interact with our current hardware (STM32F100). We also had to consider the rated voltage and current specifications. We then ordered the required hardware:

- Pre-assembled robot car
- Custom manufactured top plate to hold all circuit parts
- Two motors
- Motor Driver
- 4 - IR Sensors
- 1 - Ultrasonic Sensor
- 4 - LEDs
- 3 - 6V battery packs
- 2 - 9V batteries

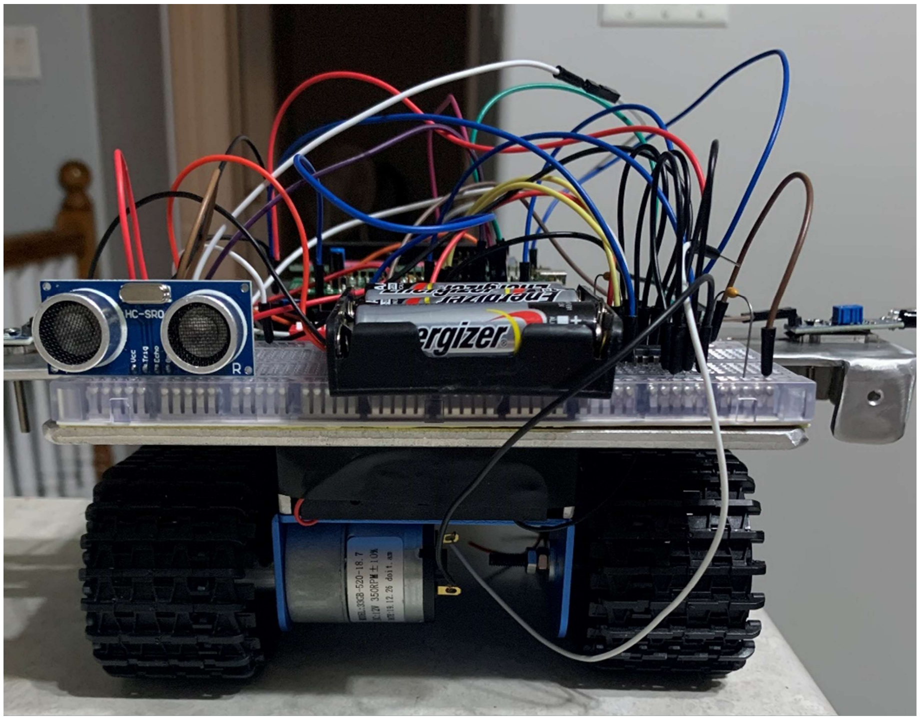
After receiving the parts from the supplier, we then proceeded to preform individual test on each of the parts (more on this in the testing section).

2.1 Robot Design Process

The design of our robot started with a pre-assembled robot car we purchased from a supplier. We decided to use three IR sensors mounted to the front, left and right of the car. The purpose of these IR sensor is to provide obstacle avoidance. There is an additional sensor facing downward to detect the floor lines. The idea is to be able to read the line as an input and decode the sequence the robot just drove over. For example, if the robot drives over the pattern with three lines the system will output to the top mounted LED with a corresponding sequence. We have also placed a ultrasonic sensor at the rear of the car to provide a distance range when reversing. We build a top plate for mounting all our electrical circuits. Here is a top view of our assembly with all the required circuits connected:



Our robot has two drive motors and we are using one motor driver to control both tracks. The tank can make easy left and right turns due to the ability to control each track at a time. Here is a picture of the back/bottom side:



The project has a list of technical requirements that must be include in the design and implementation of the robotic vehicle. Below is a list of the required task and our overall outcome:

Requirement	**Completed**
Detecting Wall of Object	Our robot can successfully detect a wall or object
Take avoidance action	Once an object is detected it can move both left or right depending on further conditions
Read patterns on floor	Our robot cannot read requirements on floor. (Our STM board became faulty before we could test this requirement.
Accepts outside inputs	We use both an IR sensor and an Ultrasonic sensor

Digital Sensor	We are using the temperature sensor to detect the temperature around the car
Two output devices	We are using two motors and a series of three top mounted LED's to signify the line patterns that are detected.
Two output interfaces	We are using GPIO and PWM
One output device with a current greater than STM32F100	The motor driver

2.2 Desired Robot Functionality

In a perfect world, the robot would perform these tasks according to the situation:

a) If only the front sensor detects an obstacle ahead, it would make a right turn unless the front sensor does not detect anything ahead regardless of the outputs from left and right sensors.
b) If the front and right sensors detect an obstacle, the robot would make a left turn unless the front sensor does not detect anything ahead regardless of the outputs from left and right sensors.
c) If the front and left sensors detect an obstacle, the robot would make a right turn unless the front sensor does not detect anything ahead regardless of the outputs from left and right sensors.

If the front, left and right sensors detect an obstacle, the robot would move backwards unless either the right or left sensor produces an output indicating the robot to make a right or left turn respectively and keeping the wall away from the rear wall using the ultrasonic sensor behind the robot.

3 Testing Procedures

Our testing approach was that of an agile method. This includes using the idea of breaking down the project requirements into sub systems that would be used perform the required tasks. Each part was individually tested to completely understand the operational parameters of the part. The testing procedure for each part consisted of the same general idea. Setup a test circuit and program basic functions to see if we could interact with the parts as expected. Below is the description of procedure taken on a per part basis.

- IR Sensor – The testing procedure for the IR sensor was to setup a test circuit and figure how far and close it would detect.
- Ultrasonic Sensor – The testing procedure for the Ultrasonic was to setup a test circuit and figure how far and close it would detect. Furthermore, we also had to test with the oscilloscope to determine parameters that would be used in the implementation.
- Motor – Simply put power and a ground to the system and visually inspected them moving
- Motor Driver – We used a circuit with just the motors and the motor driver with very basic code to perform the four main maneuvers, forward, left, right and backward.
- Power system – To test the power system we connected all the circuit elements and let the system power up and run until the batteries ran out of power.

After we determined that the robot could perform all our task individually, we began implementing the complete system and build the entire robot car and began doing basic systems testing which included a power test to see if your robot could run with the 6V battery packs. As the project continued, we keep adding a new system to the main project and followed with another systems test. During this process we ended up running into significant problems. Due to an unknown cause and we ultimately destroyed our STM32F100 board. We concluded this by running past labs on the chip and as expected we saw no outcome. During the testing process our group had to switch to an online situation where completed the remaining project requirements at a distance. We used the following sources to communicate:

1. TeamViewer
2. Discord
3. FaceTime
4. Zoom

This caused a rather difficult situation with the project in terms of testing because only one group member had the parts. Considering this project required the both the construction and implementation to complete this ultimately led to the inability to provide the most effective troubleshooting and system testing.

4 Deviation from FRD Specification

Initially the project was to consist additional measures that include in the design but was modified for reason out of our control (COVID-19). After the changes to project description had been implemented out design did not change much. In the original circuit we had planned to used ultrasonic sensor on all sides. Due to changing project specifications the need for the use of both IR sensors and Ultrasonic sensor was no longer necessary.

5 Conclusion

During this time of the term, with a lot happening outside, we could not have any in person communication. All we had for communication options was to call each other and share screens but could not share the robot as only one of us could have it which caused issues with all the troubleshooting. There always are limitations when communicating via an online, especially compared to in-person and over the phone.

Building a robot was not an easy task when one needs to perform the task in the real world, specifically in our case as our STM board kept shorting out. The robot worked fine and performed all the tasks it was designed to do. If the front sensor detects an obstacle and perform an expected function based on the right and left sensor outputs. We used three different STM boards, but all the boards kept shorting out for an unknown reason. We tried to figure out the problem by reconnecting all the connections several times but could not determine the cause of the boards shorting out. At the end, our only option was to record two separate videos explaining the function of each component it was supposed to perform and another video to indicate the pattern on the LEDs and message on the LCD it was actually supposed to perform.

During this project, coming from different cultural backgrounds, we got to learn different things about each other and now are good friends. This was a great teamwork between me and my partner. This project brought us together, even though during the last days our robot shorted and were not able to perform the working demo of the robot.