Line Following Robot

CDA 3631C Embedded Operating Systems – Dr. Hoan

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Introduction

This project consists of building an autonomous robot meant to follow a predetermined path such as a visible line on the ground. Our goal is to design a system that can continuously detect the path, make decisions in real time, and correct itself whenever it begins to drift away from the line. The robot's functionality will rely on the integration of an STM32 microcontroller, motors, and a set of sensors that can read surface contrast or directional cues. By combining these components with basic robotics principles, our project aims to demonstrate how embedded systems and control logic can work together to create a stable, responsive, and fully automated line-following platform.

Materials & Methods

Required Materials:

- STM32 Nucleo-F446RE Board
- L298N Dual Motor Driver Controller
- Infrared Recognition Sensor IR (Black and White Line Recognition Track Sensor)
- 1 Set of TT Motor with Welded Cables and 2 Wheels
- Breadboard Jumper Wires (Female to Female, Male to Male, Male to Female)
- Small Breadboard
- Plastic/Wooden Frame (To place circuit board on and attach wheels and motors to)
- Screwdriver
- Black Electrical Tape
- STM32 Cube IDE Software
- STM32 Cube Programmer

Procedure:

To get started with the line-following robot, we first begin assembling the physical structure of the robot itself which is where the microcontroller will be placed and connected to everything. While assembling, we will be attaching the TT motors securely into place along with the wheels. Next, we're going to be attaching the infrared recognition sensor low and facing the ground so it can distinguish the contrast between the black tape and the surface beneath it Then, we're going to place the STM32 Nucleo-F446RE, L298N Dual Motor Driver Controller, and small breadboard secured on top of the platform. Once everything has been set into place, we then move on to the STM32 Cube IDE Software where we build our code and choose the pins from the STM32 board, Sensor, and Motor Driver Controller board as presented in **Figure 1, Figure 2 and Figure 3** below**.**

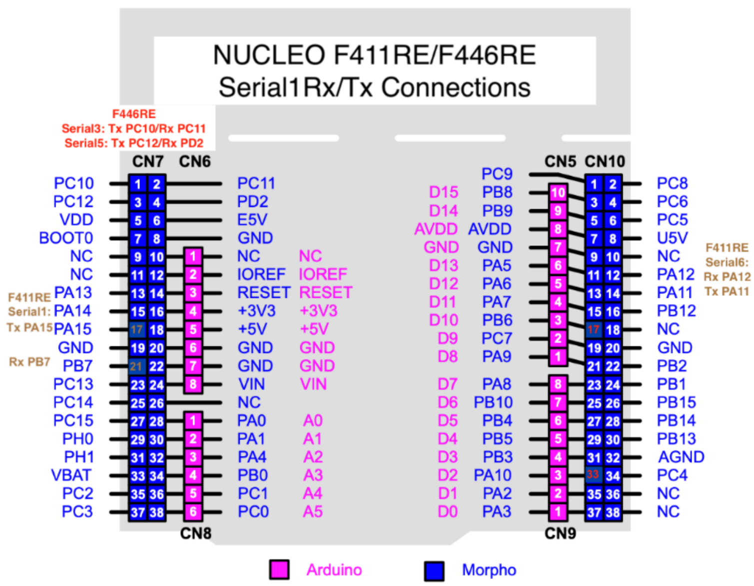

Figure 1

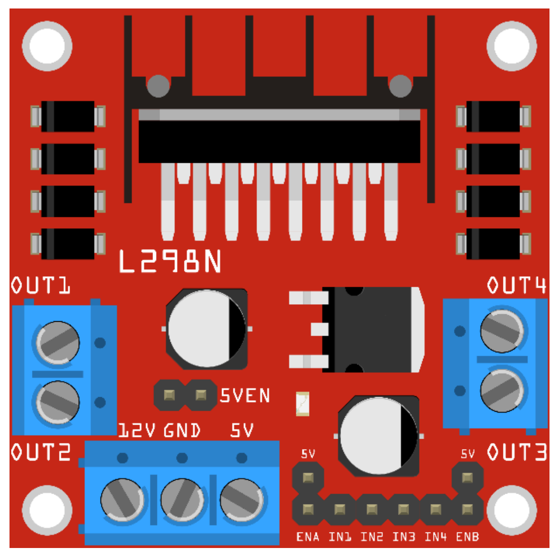

Figure 2

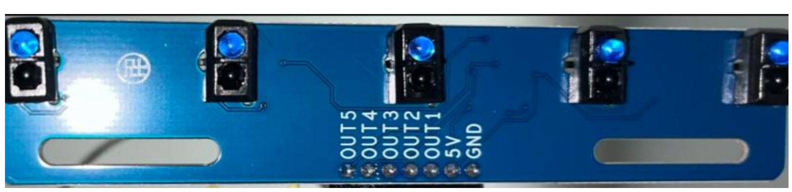

Figure 3

The pins that we will be utilizing are the following:

From **Figure 1** → **Figure 2**

- Wires that control the motors/wheels
  - D6 → ENA
  - D5 → IN1
  - D4 → IN2
  - A3 → IN3
  - A2 → IN4
  - A1 → ENB
- Powering the Motor Driver Controller
  - OUT 1-4 from **Figure 2** are connected to the wires from the left and right motors.
  - 12 V from **Figure 2** is connected into the small breadboard where the +5 V from **Figure 1** will be.
  - GND from **Figure 2** will be connected to GND from **Figure 1** on CN6 Pin 7.

From **Figure 1** → **Figure 3**

- Wires that control the sensors
  - D12 → OUT 1
  - D11 → OUT 2
  - D10 → OUT 3
  - D9 → OUT 4
  - D8 → OUT 5
- Powering the sensors
  - 5 V from **Figure 3** is connected to the small breadboard and placed in between **Figure 2's** 12 V wire and the +5 V from **Figure 1**.
  - GND from **Figure 3** is connected to GND from **Figure 1** on CN6 Pin 6.

After all the pins are connected and the code is set up, we can start testing the robot. We will do this by placing lines of black electrical tape on a white/clear contrast table so it can distinguish and correct its path as it's moving along the black line. Following this, we will make corrections to the speed of the motor and path of the line following robot.

Results & Discussion

We were able to complete most of our desired tasks for this project; however, we had an issue with making it wireless. The IR sensor goes straight if the center sensor reads “off” (black isn’t detected by the IR sensor), when one of the two sensors next to the center read “off” it turns slightly, and when one of the two far sensors read “off” it makes a sharp turn. While it could have been more optimized if we had better turn angles or if it was wireless, it performs as we expected.

Conclusion

We successfully created an autonomous line following robot using the Nucleo Board, Motor Drivers, and an IR Sensor. It uses the IR sensor to detect a black line, and it follows the line. When the sensor isn't aligned at the center, our program will detect it and will turn depending on how far off the line the robot is. We weren't able to make it wireless because the Nucleo board doesn't convert to wireless easily. It needs to be connected to a laptop, so detailed testing is hard to do.

GitHub Repo

https://github.com/Christian10951/Line-Following-Robot-Project.git

Acknowledgement

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References

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