ENEL 387 Design Project Final Report
: Firefighter Robot
April 10, 2020

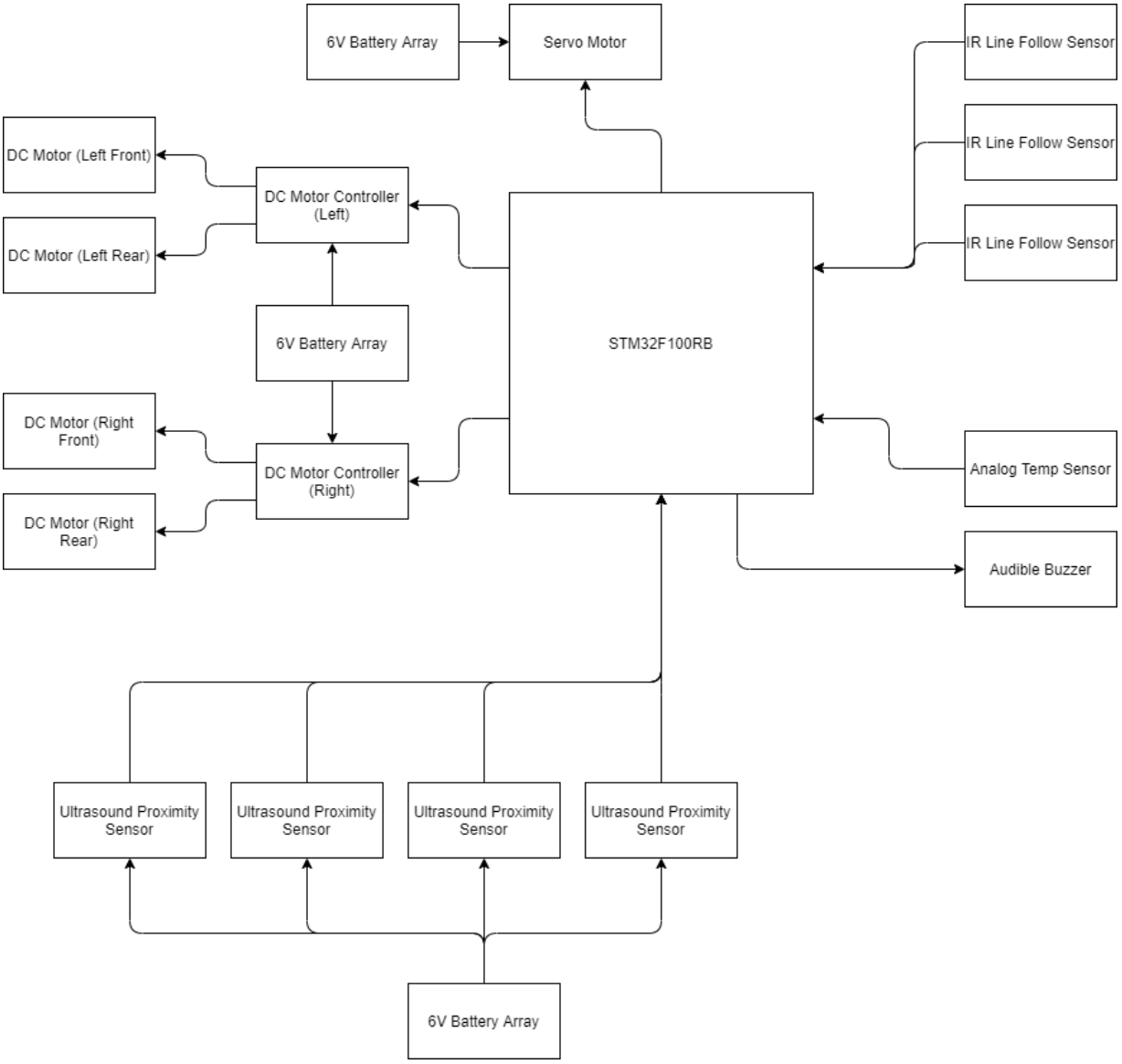
Jiwoun Kim (SID: 200329205)
Noah Rowbotham (SID:200364559)

Introduction

The goal of this design project is to build an autonomous robot that explores and detects designated targets within a predefined course. The robot maneuvers down hallways and into rooms. In each of four rooms, the robot attempts to detect various objects, such as an incandescent light bulb or target blocks which have lines to be recognized by infrared sensors. Walls can be detected by different types of sensors on the robot to aid with traversing the course. The robot generates beeping sounds as a system output to notify the user which room the robot is in and what object it found. After all tasks are complete, the robot returns to home base.

Hardware Description

1. Block Diagram



Feature 1. Block diagram

2. System Inputs

Component	Quantity - Location	Purpose
Ultrasonic proximity sensor	1 - Mounted on the roof and the front of the chassis	Detecting the presence of walls and maintaining distance from them.
IR line follower	2 - Mounted on the front bottom of the chassis	Allows autonomous traversal of the course's hallways. Scans the identification code of doorways upon entering. Scans the identification code on obstacles in the rooms.
Analog temperature sensor	1 - Mounted on the roof of the chassis.	Detects the presence of an incandescent light bulb.

3. System Outputs

Component	Quantity - Location	Purpose
DC motor	4 - 2 for front wheels and 2 for rear wheels	Propulsion
Audible buzzer	1	Tells the user which mode it is in as well as which obstacle in which room it found.
DC motor controller (H-bridge motor driver)	1 - A side drives left wheels front and rear, while B side drives right 2 wheels of front and rear	When the robot need to turn right its direction, A side drives forward and B side drives reverse and vice versa

Operation

1. Start-up

Once the vehicle has been powered pressing the user input button will transition the vehicle from idle to traversal mode. After transitioning, the user has 5 seconds before the vehicle will begin traversing the course. The vehicle has chimes to notify the user of the transition as well as it's countdown to operation.

2. Robot Translation Chart

In the following table keywords will be used to differentiate a long audible buzz versus a short audible buzz. The two variations are used to create meaning for transmitting information to the user. A long audible buzz is denoted by a *boop,* while a short audible buzz is denoted by a *beep.* These patterns may use different tones to produce more distinct sounds.

Buzz Pattern	Meaning
beep beep beep	"I've transitioned to traversal mode!"
beep (once every second, for 8s)	"I'm counting down before I start!"
beep [pause] (room code) *beep [pause]* (obstacle code or light code)	"I'm trying to tell you some important stuff!"
boop (# of times equal to room #)	"This is what room I am in!"
boop (# of times equal to obstacle #)	"This is the obstacle I found!"
boop boop boop boop	"I couldn't find anything in this room, how sad."
beep beep beep beep beep beep boop	"Ah! I found fire! Nvm, it's a lightbulb."
beep beep boop beep beep boop boop	"I've returned home!"

3. Autonomous Behavior

The robot traverses the room using the navigation line. When it arrives at the home space it signifies its arrival and shuts down.

4. Unexpected Error Behavior

The following features are how we expect the robot to handle these issues, but without further testing these are simply theories. They are subject to change as we understand how to best resolve the issues.

If the robot unexpectedly encounters a wall during hallway traversal the robot will reverse slowly, rotate 180 degrees, and attempt to proceed to follow the line.

If the robot unexpectedly encounters a wall in a room it will attempt to reverse slowly, use the servo mounted ultrasonic sensor to find a wall, and readjust to that wall. The robot will then continue to circle the room.

If the robot cannot find an obstacle or light, it gives up, like most people who can't find what they are looking for. It will signify this with a beep pattern. If the robot could not detect a valid room identification the robot will attempt to pass over the id code again to get another reading.

5. End Cycle

Once the robot has completed the course and returned home it plays its returned home indication. After this, the robot transitions to an idle state that cannot be exited. Once powered off the robot is reset and can be operated again once powered.

Conclusion

1. Features Checklists

Our finished robot is a fast line follower. It can communicate when it is operational, starting to prepare for traversal, and when it arrives back to home base.

2. Unsolved Issues

We were unable to get the target line reading feature and wall detection to operate. The IR sensors we had purchased are not precise enough to read the target lines and getting a replacement was not possible. Furthermore, we could not detect walls with our proximity sensor. We could not get any response on the echo pin after firing the trigger high.

Also, due to the many stresses and difficulties created by the pandemic we stripped many of the features and functionality that were initially proposed in the functional spec document.