User's Manual

Snack Distributing Robot

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1 Preface

1.1 Description of the User

- This product is intended to be used by individuals with basic knowledge in microelectronics and not limited to individuals with prior knowledge
- There is no age limit set on this product and users can use it at their own risk

1.2 Conventions Used in this Manual

- In this document, the reference; “board” is used for “Nucleo 64 STM32F103RB Microcontroller board”
- In this document, the reference; “robot” is used for “Snack Distributing Robot”

1.3 Explanation of Safety Warnings

Label	Warning	Prevention
	Shock	- Do not touch exposed wires - Do not connect random wires to the product
	Flammable	- Short circuit may cause fire, in this case please turn off the product and put off the fire
	Hot Surface	- If any module becomes hot; turn off the product

Table 1: Safety Warnings

2 Ordering Information

- This product is not in the market as of right now, but can be produced if required

3 Quick Start

3.1 Getting started

- Place the strip provided around the dining table and glue it to the dinning table. The distance between the corner of the dining table and the strip must be 6 inches.
- Place the center of the Snack Distributing Robot on the black line of the strip.
- Place snack in the bowl of the robot.
- Power the robot on and enjoy.

3.2 Operating

- LCD will display the weight of the snacks left in the bowl.
- In order to access snack, user must place hand Infront of the moving direction of the robot.
- LCD backlight has a diming functionality responsible to light.

3.3 Service

- In occasion of battery low, user must charge the power bank provided.
    - Disconnect the power bank from side of the robot
    - Charge the power bank using appropriate adapter
    - Plug the power bank back in the port of the robot

3.4 Product limitations

- The product cannot operate without the strip. The surface must have black and white strip.
- In some occasion user must charge the power bank to keep operating the robot.

4 Hardware Used

4.1 Components used

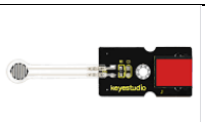
Name	Image	Quantity	Functionality
STM32F103RB		1	A Microcontroller board used as a controller
IR Sensor		2	IR sensor used to follow the strip
DC Gear Motor		4	DC motors used to power the motion of the robot
Driver Module		1	Used to control the speed and the direction of the dc motors
LCD Module		1	Used to output data of the weight of the snacks left
Thin film Pressure Sensor		1	Used to weight the snacks left in the bowl
Ultrasonic Sensor		1	Used to sense hand Infront of the robot in order to stop
Power Bank		1	Power Bank is used to power everything
Photoelectric Sensor		1	Used to sense the intensity of the light to control the backlight of LCD
Potentiometer		1	This is used to control the contrast of the LCD
4 * 2A Battery Holder		1	This is used to power the Driver Module
AA Battery		4	Used to power the Battery Holder

Table 2: Components used in the product

- In addition to the list of the components; wires, N3904 Transistor and 2.2 kilo ohm resistor were used.

5 Overview of Product

5.1 Block diagram of the system

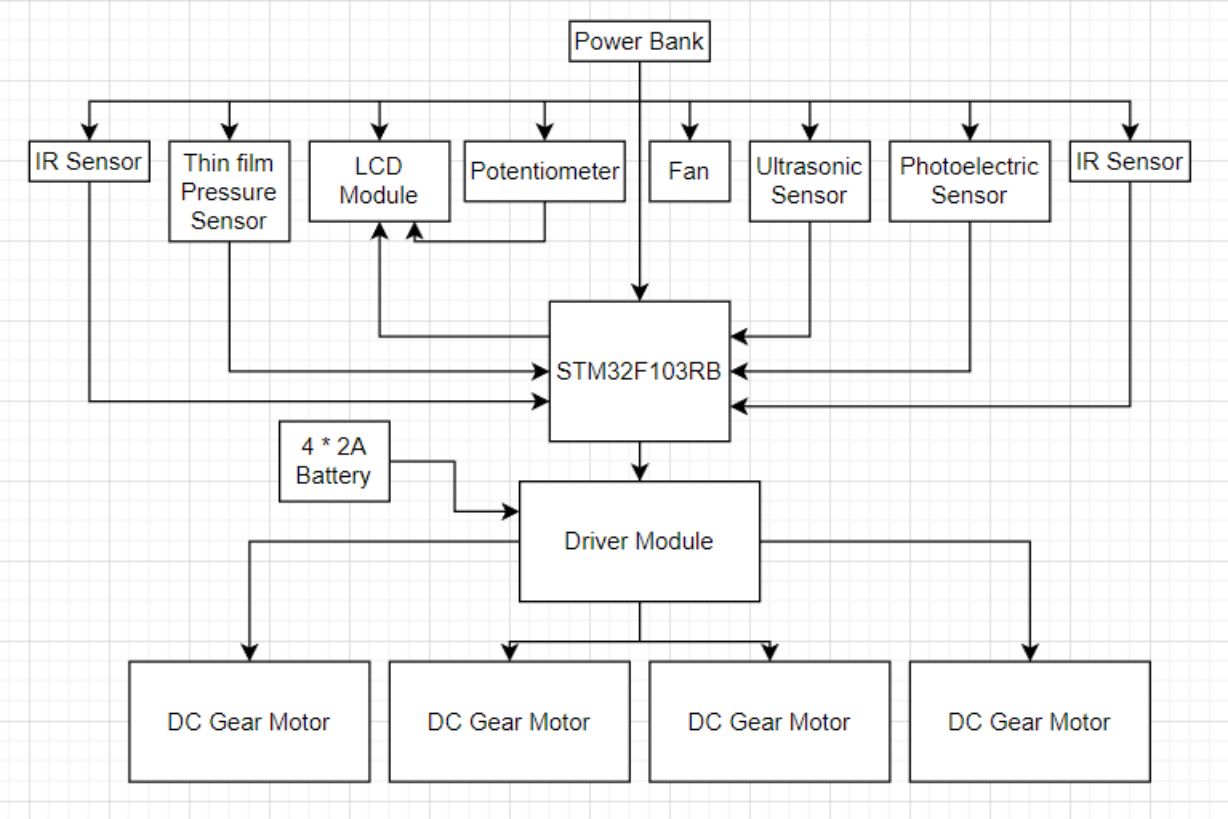


Figure 1: Block diagram of the system

5.2 Connection details of the system

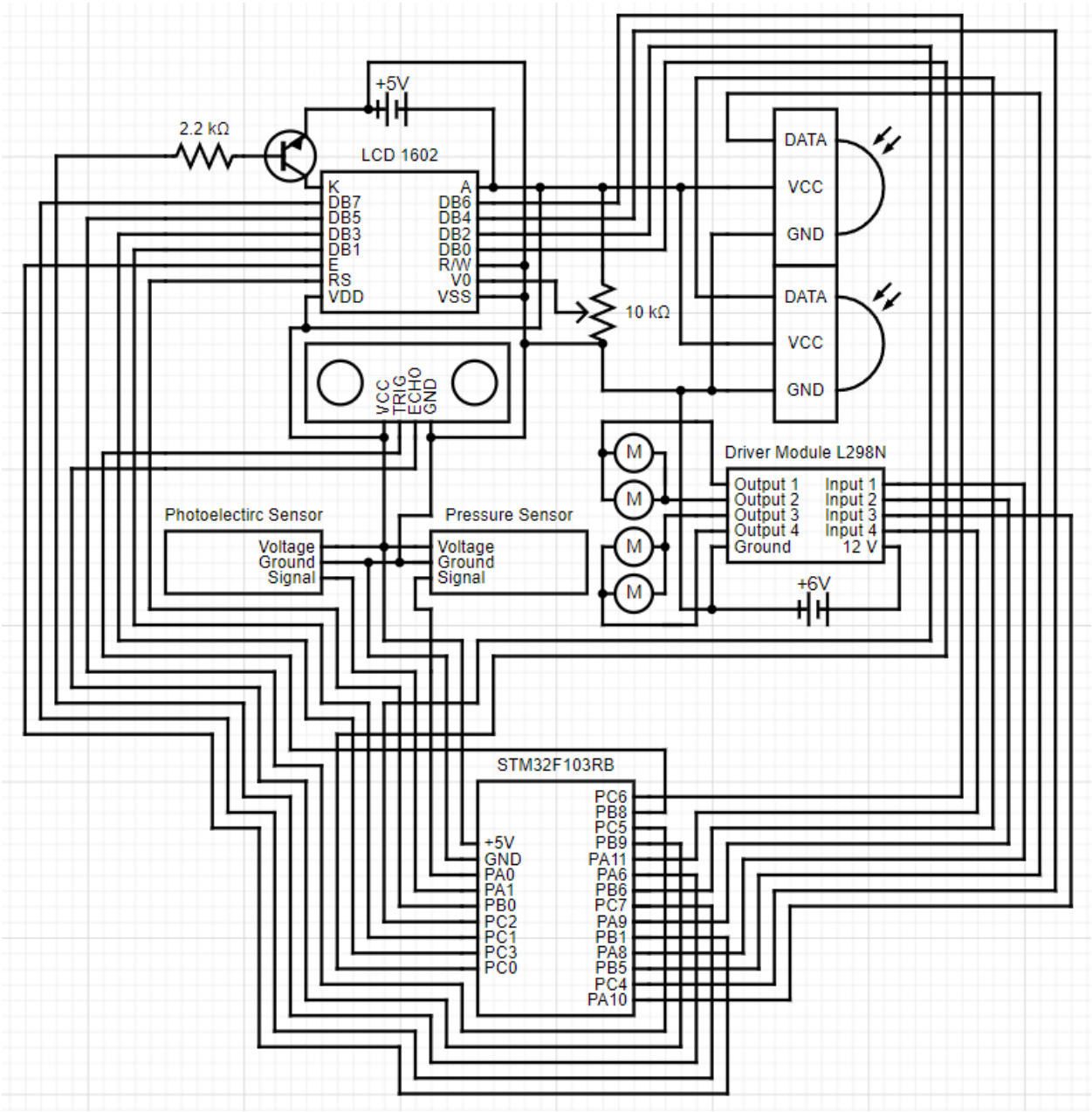


Figure 2: Connection details to Board

5.3 Board Connectivity with Sensors

Pin Name	Pin Configuration as	Module	Module Pin as
PA0	Analog	Pressure Sensor	S
PA1	Analog	Photoresistor Sensor	S
PA6	Digital ~ PWM	LCD	K
PA8	Digital	Driver Module	IN1
PA9	Digital	Driver Module	IN2
PA10	Digital	Driver Module	IN3
PA11	Digital	Driver Module	IN4
PB0	Digital	LCD	RS
PB1	Digital	LCD	EN
PB5	Digital	IR	S
PB6	Digital	IR	S
PB8	Digital	Ultrasonic Sensor	Trig
PB9	Digital	Ultrasonic Sensor	Echo
PC0	Digital	LCD	D0
PC1	Digital	LCD	D1
PC2	Digital	LCD	D2
PC3	Digital	LCD	D3
PC4	Digital	LCD	D4
PC5	Digital	LCD	D5
PC6	Digital	LCD	D6
PC7	Digital	LCD	D7

Table 3: Board Pin Configuration and Connectivity

5.4 Final Product Display

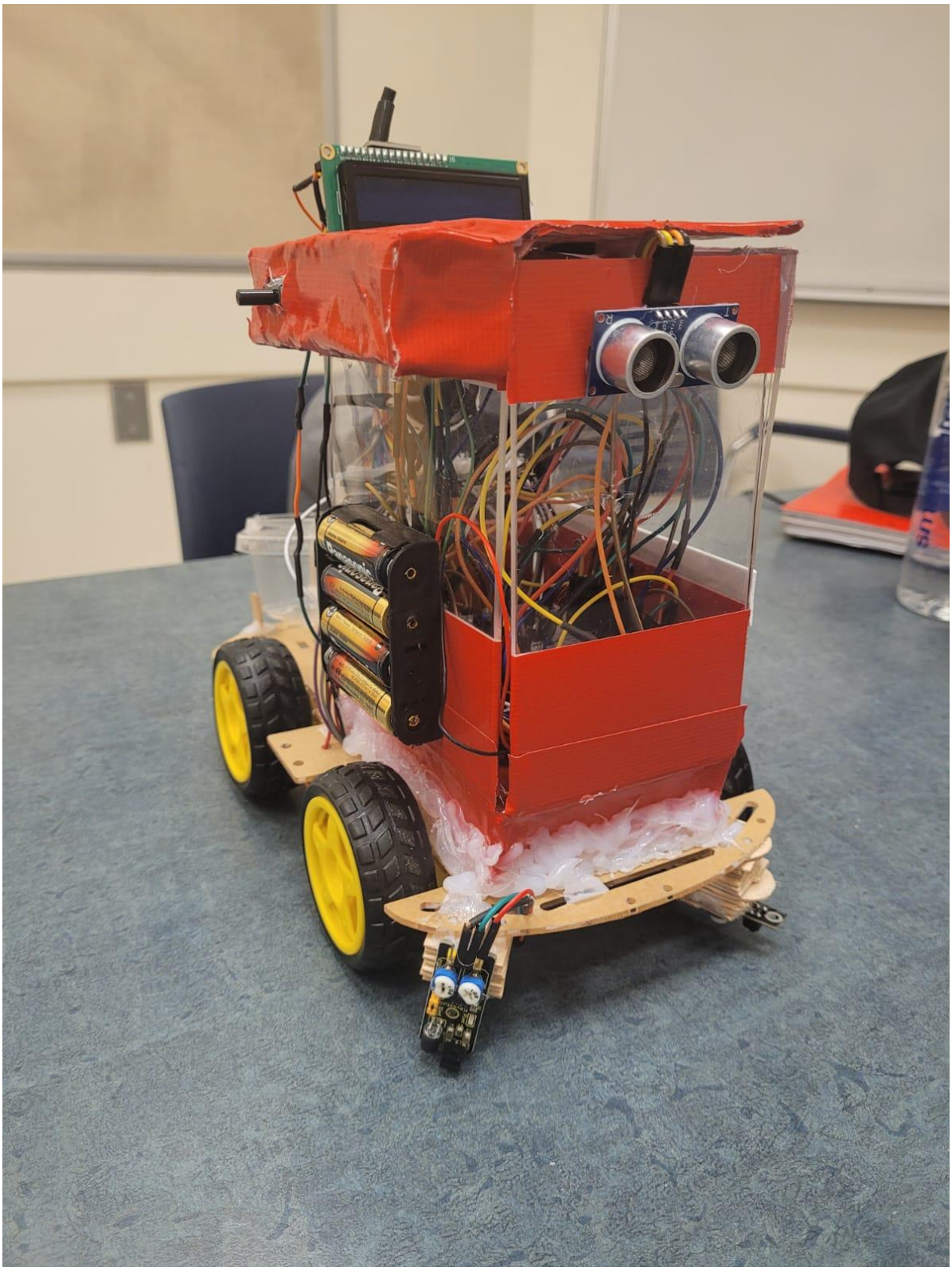


Figure 3: Front View of the Model

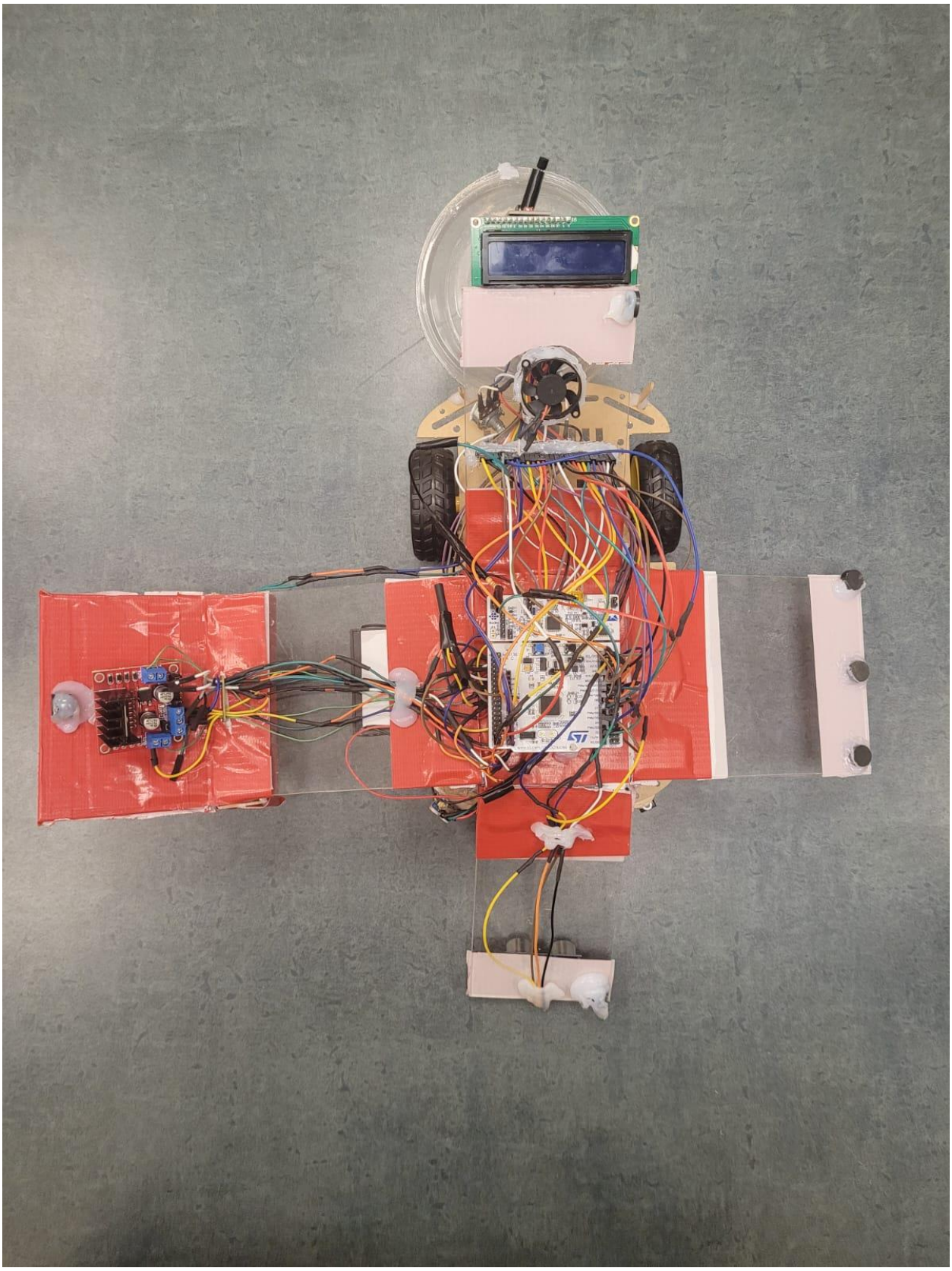


Figure 4: Top View of the Model

5.5 Changes

Hardware

Multiple changes were done throughout the project. The earliest change was made when it was decided to get the hardware from Amazon instead of 3d printing it due to time constraint and scope of the project. The earlier motivation was that the model should look like the main character from Wall -E. Later this model was changed to look like a gaming tower. This required a glass case and something that can open up for easier access. The design was mainly focused on user friendliness and easy debugging. The transparent case was handcrafted and cut to look like a tower. Fan was implemented to as a cooling mechanism for the components. The pins were drilled into to connect and disconnect from outside rather passing them from the sides.

Functionality

The functionality that was promised in proposal didn't change instead more functionality was added. The model is intended to travel; following a line and ultrasonic was used to stop the robot on track. Pressure sensor displayed the weight as intended. The extra feature was added to implement backlight diming phenomena where photoelectric sensor was used to capture light intensity and change the backlight of the LCD. This was accomplished by the circuit that Dave Duguid (https://uregina.ca/~duguidda/) provided.

Software

Software has 11 c files and 1 header file to connect them. Here is the description of what each c file does.

adc.c: This file has two functions that are used to collect analog data and pass it as digital. "readPressure" is used to read the pressure of the Pressure Sensor that is passed through A0. SQR3 is first cleared and then ADON is enabled. The while loop waits for EOC flag before passing the data to DR. Same goes for the "readPhotoResistor"

except SRQ3 is set to channel one and ADC2 is used. “readPhotoResistor is used to read the intensity of the light”

clock.c: This file was modified from Dave Duguid (https://uregina.ca/~duguidda/) by Amandip Padda. It was commented in such a way to provide easy accessibility to clock configuration. It mainly is running 72MHz clock speed.

led.c: “led.c” consists of different sequences to run leds. It has delay function that delays the speed of the blink. The only functions that are used in this project are “ledTest” and “stopLedTest”. They are configured to blink user led either on or off respectively.

main.c: “main.c” is calling “clockInit”, “portEnable”, “pinConfiguration”, “lcdSetup” and “powerScreen” to run the clock at 72 MHz, enable required clocks on ports/timer/AFIO/interrupt etc., configure the required pins, setup the functionality of lcd and display messages on the LCD when it powers on. "main.c” also consists of interrupt handler to handle the interrupt on Line 5 and Line 6. It has the highest priority given to the IR sensors since they directly are getting data from changing environment. In the while loop it has a logic and behavior of the robot where it stops when ultrasonic detects an object in front. It also rotates the required set of wheels depending on which IR sensor is fired. There is also an implementation of the LCD to display weights and change back light of lcd depending on ADC values that are coming in from both the Pressure and Photoelectric Sensors.

others.c: “other.c” consists of only one function that is being used by various functions throughout the project. The function is to delay spending on the value you are passing in.

pin.c: “pin.c” consists of an easier access to configure all the available pins on the board.

port.c: “port.c” consists of the clocks that are enabled for all the fucntions to use. It has IO Ports, AFIO Ports, ADC Ports, TIMER and Interrupt.

wheels.c: “wheels.c” consists of functions to run the motos by toggling bunch of pins to on or off.

pwm.c: “pwm.c” has a function to control the brightness of the backlight of lcd by passing the adc value from Photoelectric Sensor. It is producing a duty cycle based on the adc value from Photoelectric Sensor. The timer for this function is timer 3 running on channel 1. It is taking the clock speed and producing the required duty scycle depending on the sensor’s value.

lcd.c: “lcd.c” is basically commands that are being passed to the LCD. There is no R/W for the project since we are not reading anything from LCD. In the schematic it is just connected to the ground.

sonic.c: “sonic.c” has the functionality to calculate the distance from the Ultrasonic sensor. There is a function to delay timer where timer 2 has been used. It has a counter that starts and waits for the UIF to set. This timer delay function is used in the calculate distance function where the required distance is based on the sound speed and the pulse width.

5.6 Challenges

The biggest challenge was the implementation of the Ultrasonic Sensor. It required a lot of research and understanding of the pulse width and the clock speed that effects the timer.

The second biggest challenge was based on the backlight brightness control for LCD. With the help of Dave Duguid (https://uregina.ca/~duguidda/) ‘s schematic, the implementation of this functionality was a success. The schematic consisted of 2N3904 transistor that is taking pwm with 2.2k Ohm resistor. The implementation was done on the “K” port of LCD.

5.7 Furthermore

The next step to further this project is to implement PWM on the wheels and have a potentiometer control the speed of the wheels.

Revision history

Date	Revision	Changes
05-March-2023	1	Initial Release.
11-April 2023	2	*Page 6 – Table 2 [Potentiometer, Functionality] **Changed** "This is used to control the backlight of the LCD" **to** "This is used to control the contrast of the LCD"
11-April 2023	2	*Page 5 – Getting Started **Changed** "Place the center of the Snack Distributing Robot on the white line of the strip." **to** "Place the center of the Snack Distributing Robot on the black line of the strip."
11-April 2023	2	*Page 8 – Connection details of the system **Changed to** Better Schematic that shows selected pins of the board
11-April 2023	2	*Page 6 – Table 2 **Added** [Photoelectric Sensor, :]
11-April 2023	2	*Page 5 – Operating **Added** "LCD backlight has a diming functionality responsible to light."
11-April 2023	2	*Page 5 – Service **Changed** "Disconnect the power bank from back of the robot" **to** "Disconnect the power bank from side of the robot"

Date	Revision	Changes
11-April 2023	2	*Page 6 – Table 2 [Line Tracking Sensor, :] **Changed to** [IR, :]
11-April 2023	2	*Page 6 – Table 2 **Added** [4 * 2A Battery Holder, :]
11-April 2023	2	*Page 6 – Table 2 **Added** [AA Battery, :]
11-April 2023	2	*Page 6 **Changed** “In addition to the list of the components, wires are used and a breadboard for easy connectivity.” **to** “In addition to the list of the components; wires, N3904 Transistor and 2.2 kilo ohm resistor were used.”
11-April 2023	2	*Page 7 – Figure 1 **Changed to** Better Schematic to implement Photoresistor Sensor, Fan and 4 * 2A Battery
11-April 2023	2	*Page 9 – Table 3 **Added** Added Pins for extra sensors used like Photoelectric Sensor
11-April 2023	2	*Page 10 **Added** Took out old model and added Front View of the Model
11-April 2023	2	*Page 10 **Added** Took out old model and added Top View of the Model

Date	Revision	Changes
11-April 2023	2	*Page 12 **Added** Section 5.5
11-April 2023	2	*Page 12 **Added** Section 5.6
11-April 2023	2	*Page 12 **Added** Section 5.7

Table 4: Revision History