

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



**An-Najah National University**  
Faculty of Engineering and Information Technology  
Computer Engineering Department

Graduation Project II

**Cleaner Core**

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degree in Computer Engineering.

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# Table of Contents

Dedication.....	4
Acknowledgment .....	4
Abstract .....	5
Chapter 1 : Introduction .....	6
1.1 Statement of the problem .....	6
1.2 Objectives of the work .....	6
1.3 Organization of the report.....	6
Chapter 2: Limitations, Constraints, and Earlier Course Work.....	7
2.1 Limitations and constraints.....	7
• Design: .....	7
• Brushless Motor:.....	7
• Mapping: .....	7
• Roads: .....	7
• Mini space for robot: .....	7
2.2 Earlier coursework:.....	7
Chapter 3: Literature Review.....	8
Chapter 4: Methodology .....	9
4.1 Hardware Components .....	9
4.1.1 Arduino Mega 2560.....	9
4.1.2 Ultra Sonic Sensor.....	9

4.1.3	IR Sensor.....	10
4.1.4	Dual H-Bridge.....	11
4.1.5	Jumper Wires .....	11
4.1.6	Brushless Motor.....	12
4.1.7	Robot Wheels .....	12
4.1.8	Castor Wheel.....	13
4.1.9	Brushes.....	13
4.1.10	Fan Suction .....	14
4.1.11	DC Motor .....	14
4.1.12	IRFZ.....	15
4.1.13	Motor Speed Controller .....	15
4.1.14	ESC / Servo Tester.....	16
4.1.15	3S2P Battery Pack.....	16
4.1.16	LM2596 Buck Converter .....	17
4.1.17	Bluetooth Module .....	17
4.1.18	Potentiometer .....	18
4.1.19	Bo Motor.....	18
4.2	Construction Stages.....	19
4.2.1	Building the base structure.....	19
4.2.2	Connecting of basic components.....	20
4.2.3	Connecting of sensors .....	21
4.2.4	Final structure .....	22
4.3	Circuits .....	24
4.3.1	Ultrasonic with motors circuit .....	24
4.3.2	DC motor speed controller circuit.....	25
4.3.3	IR circuit.....	25
4.3.4	Bluetooth circuit.....	26
4.3.5	Dual H-Bridge circuit.....	26
4.1.1	Assemble circuits .....	27
4.2	Movement Status .....	28
4.2.1	Right movement .....	28
4.2.2	Left movement .....	28
4.2.3	Forward movement.....	29

- ξ,Υ,ξ Backward Movement ..... 29
- 4.3 : Mobile Controlling ..... 30
  
- Chapter 5: Results and Analysis ..... 31
  
- Chapter 6: Conclusion, Recommendation and Future work ..... 31
  - 6.1 Conclusion ..... 31
  - 6.2 Recommendation ..... 31
  - 6.3 What we have learned ..... 32
  - 6.4 Future Work ..... 32
  
- Chapter 7: References ..... 33

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## Dedication

This report was written by students at the Computer Engineering Department, Faculty of Engineering, An-Najah National University. It has not been altered or corrected, other than editorial corrections, as a result of assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of the students. An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

## Acknowledgment

To our university which owes us a huge debt of gratitude for allowing us to finish this project. We are grateful to a few people, who worked tirelessly with us from the beginning until the end of our study, particularly our supervisor Dr. Abdallah Rashed for her support and advice to achieve and complete this project in the best possible way.

## Abstract

These days, due to the increase and large size of buildings, many people suffer from the cleaning process, whether in large halls or in their homes, and due to the great development in technology and the emergence of new technologies, people are looking for alternatives to save time and effort.

Our project is a robot whose function is to clean the floor so that it consists of two sides, the first side, which is the front side, so that it contains a vacuum cleaner to clean the dirt and the back side contains mops to polish the floor.

The robot works automatically, the user just needs to put it in one of the corners of the room and then turn it on and then start cleaning the floor, and because it works automatically, we made it stay away from the objects that are in the room during the cleaning process.

It can also be controlled remotely via a mobile phone, and if the robot is placed to clean a specific area, for example a room two meters by two meters, it will clean it completely and then stop automatically.

Therefore, the main goal of our project is to design robots to clean the floor to save time and effort for people.

# Chapter 1 : Introduction

## 1.1 Statement of the problem

The existing smart sweepers in the market are largely specialized in either sweeping or mopping, limiting their versatility and efficiency. Additionally, these devices often lack the capability to integrate multiple cleaning functions seamlessly into one machine. The need for a comprehensive and multi-use cleaning solution has become evident. The absence of a smart sweeper that can efficiently perform sweeping, mopping, and perfuming in a single unit poses a significant challenge for users seeking an all-in-one cleaning solution. The current market offerings do not fully address the diverse needs of consumers who desire a smart cleaning device that can navigate autonomously, efficiently clean various surfaces, and incorporate intelligent features for maintenance and operation.

## 1.2 Objectives of the work

We design a vacuum robot that sweeping, mopping and performing in two modes. The vacuum robot handle the obstacle behind it and avoid them depends on the sensors in it.

## 1.3 Organization of the report

Chapter1 : introduction, statement of problem and objective of work

Chapter 2: limitations and constraint , course work

Chapter3 : literature review

Chapter4 Hardware components, structure parts, circuits overall design,

Navigation status and software controlling

Chapter5 : Results and analysis.

Chapter 6: conclusion, Recommendation , what we learned and future work .

Chapter 7 : Reference's

## Chapter 2: Limitations, Constraints, and Earlier Course Work

### 2.1 Limitations and constraints

- **Design:**  
Because of the economic situation and the state of affliction and war that the country is going through, we decided to make the design ourselves instead of making it using a three-dimensional printer because it is very expensive, and the model was made from a garbage bucket
- **Brushless Motor:**  
It was one of the most difficult restrictions we had to deal with, so we took a long time in the process of finding the right motor because it is used in drones and this has restrictions from the occupation
- **Mapping:**  
We tried to use Raspberry Pi to display a map for the room and then determine can move through the lidar Sensor information , But unfortunately after long attempts We could not reach the desired result
- **Roads:**  
We have faced difficulty in the process of communication and daily work due to the road conditions, occupation restrictions and daily inspections.
- **Mini space for robot:**  
We expected from the beginning that the space designed for the robot would be enough to expand all the pieces, but in the last stages of the work we had a problem putting all the pieces and wires in addition to the cleaning pieces such as Brushes and dirty box, we tried to exploit all the spaces inside the robot and we sometimes had to drill the outside frame of the robot.

### 2.2 Earlier coursework:

Building our project more efficiently and effectively was made easier by gaining information from university courses like circuits , electronics , Microcontroller, Networks , and other courses like Arduino Basics course with IEE.

## Chapter 3: Literature Review

The idea and the existence of robot cleaners are not new, it has started to spread recently, and there are many projects and articles similar to the idea such as vacuum cleaner robot [1] and vacuum cleaner robot [2]

We have taken advantage of these research papers to have ideas about the most important sensors and parts that should be inside the robot. At the same time, we thought of solutions to the negative or missing aspects of these robots and developed them on our own robot. For example, our robot has an easy and simple design, easy mode change, the ability to remove and empty cleaning parts, and manual and automatic control.

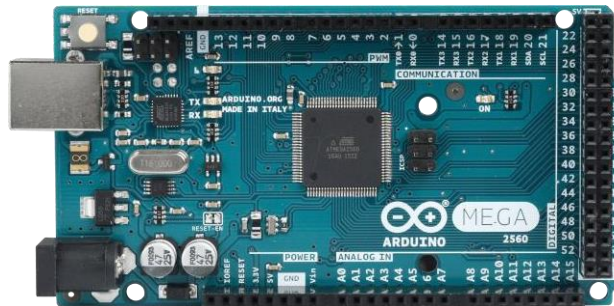
We have used many resources to rely on and get information from. First, we used the official Arduino website to understand Arduino Mega in detail with all its niches and niches [3]. We then delve into the details of each component we used by reading the documentation and watching the tutorials. Starting with lithium batteries and the way they are intertwined in succession and parallel to obtain a suitable volt and current [4], then we look for resources for the brushless motor to know how it works and how it connect with circuit [5], then we read about ultrasound and how it works, we read an article [6] we also look for Bluetooth Model and how we will link it to Arduino and how to write a complete Arduino code correctly and efficiently [7].

## Chapter 4: Methodology

### 4.1 Hardware Components

#### 4.1.1 Arduino Mega 2560

The Arduino Mega 2560 is a micro-controller board based on the Atmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro-controller. We tried to use the Arduino Uno as it supports all of our needs, but the limitation of the number of pins made us shift to the Arduino Mega.



*Figure 1:0:1 Arduino Mega*

#### 4.1.2 Ultra Sonic Sensor

The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Arduino Board respectively and the trig and echo pins to any Digital I/O pin on the Arduino Board. It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance. In our project we use 3 Ultrasonic sensors left, right, front.



*Figure 1:0:2 Ultra Sonic Sensor*

### 4.1.3 IR Sensor

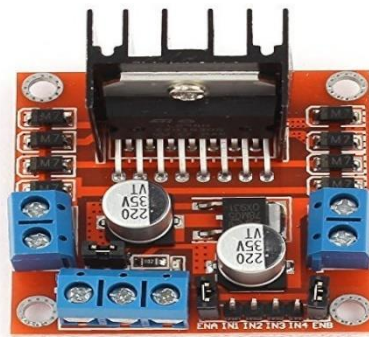
An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component with a spectral sensitivity in the infrared wavelength range 780 nm...50  $\mu$ m. IR sensors are now widely used in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect unwelcome guests.



*Figure 1:0:3 IR Sensor*

#### 4.1.4 Dual H-Bridge

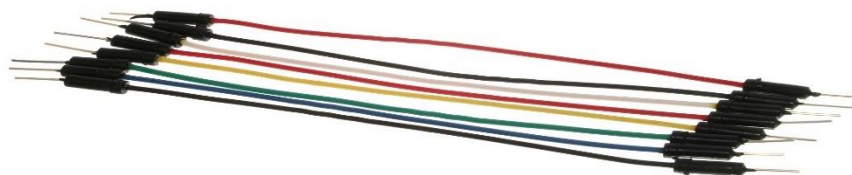
L298N Dual H-Bridge Motor Controller, typically used to control motor speed and rotation direction. It can also be used for other products such as with LED arrays, relays, and solenoids, etc. It's a powerful little motor driver with a heavy duty heat sink. Capable of powering 5-35V motors with a max of 2A. we used this component as a driver to Dc motor for direction clockwise or counterclockwise, this driver requires 7-35V power supplies and produces.



*Figure 1:0:4 Dual H-Bridge*

#### 4.1.5 Jumper Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. we used these wires to make connection between all components and the Arduino and to connect the components together.



*Figure 1:0:5 Wires*

#### 4.1.6 Brushless Motor

A brushless motor is a direct current (DC) electric motor that operates without the mechanical brushes and commutator of a traditional brush motor. It has distinct advantages over a brush motor and is more economical in the long run, although the initial costs are higher.



*Figure 0:6 Brushless Motor*

#### 4.1.7 Robot Wheels

They can be used as drive wheels, wheels that are directly or indirectly powered by a motor. They can also be used as idler wheels, wheels the spin freely and move along with the robot. There is a wide selection of tire treads for these wheels, and they can be used indoors or outdoors.



*Figure 1:0:7 Wheels*

#### 4.1.8 Castor Wheel

The water pump is an important part of the robot as it will pump water while mopping and performing. In this project, a small-size and lightweight water pump were used with relays and transistor that takes its power from battery. A pipe for spraying the façade with water pumped from that water pump.



*Figure 1:0:8 Castor Wheel*

#### 4.1.9 Brushes

It is an important part of our project, as it cleans the surface with its bristles, which are connected to the DC motor, and are controlled by it.



*Figure 1:0:9 Brushes*

#### 4.1.10 Fan Suction

A crucial component within our project, the fan suction plays a pivotal role in creating a partial vacuum. This mechanism induces outside air to suction and remove dusts from the designated space, ensuring an effective and thorough cleaning process.



*Figure 1:0:10 Fan Suction*

#### 4.1.11 DC Motor

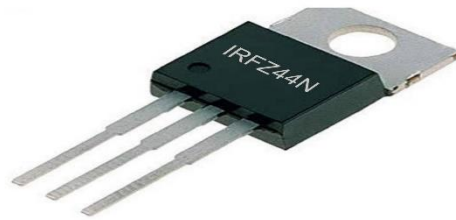
A DC motor is used to move the brush in a circular motion, we use DC motors that require 12 volts to operate. It has been connected to the relays to control its speed.



*Figure 1:0:11 DC motor*

## 4.1.12 IRFZ

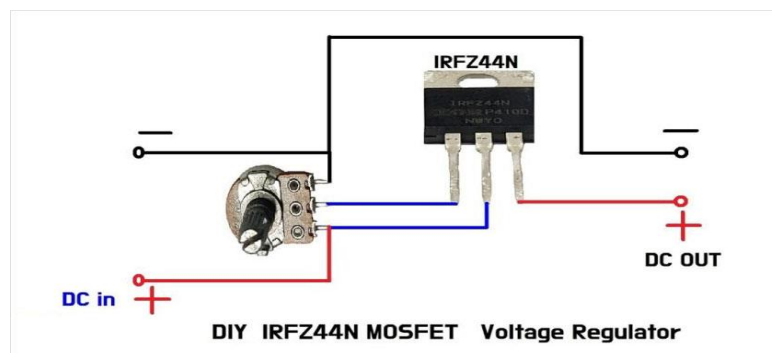
The IRFZ44N is a frequently used part in electronics where there's a need for high current and voltage switching. Such as motor control circuits, power supplies, and lighting control. Therefore, its high current and voltage ratings, low on-state resistance, and fast switching speed make it a preferred choice.



*Figure 1:0:12 IRFZ*

## 4.1.13 Motor Speed Controller

Motor speed controllers are electronic devices that control motor speed. They take a signal for the needed speed and drive a motor to that speed.



*Figure 1:0:13 Motor Speed Controller*



#### 4.1.16 LM2596 Buck Converter

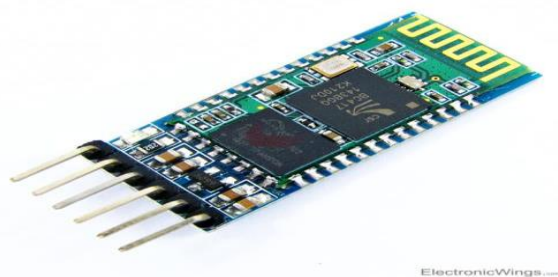
A smart little servo tester than can be used to test servo motor, ESC and also to determine motor direction. Tests up to 3 servos at the same time. The device also can be used as a signal generator for electric speed controller (ESC), for testing your motor system without using a transmitter and receiver.



*Figure 1:0:16 Buck Converter*

#### 4.1.17 Bluetooth Module

Bluetooth module is a basic circuit set of chip which integrated Bluetooth functions and which can be used in wireless network transmission. Generally, the Bluetooth module can be divided into the following types: data transmission module, remote control module, etc.



*Figure 1:0:17 Buck Converter*

#### 4.1.18 Potentiometer

A smart little servo tester that can be used to test servo motor, ESC and also to determine motor direction. Tests up to 3 servos at the same time. The device also can be used as a signal generator for electric speed controller (ESC), for testing your motor system without using a transmitter and receiver.



*Figure 1:0:18 Potentiometer*

#### 4.1.19 Bo Motor

A smart little servo tester that can be used to test servo motor, ESC and also to determine motor direction. Tests up to 3 servos at the same time. The device also can be used as a signal generator for electric speed controller (ESC), for testing your motor system without using a transmitter and receiver.

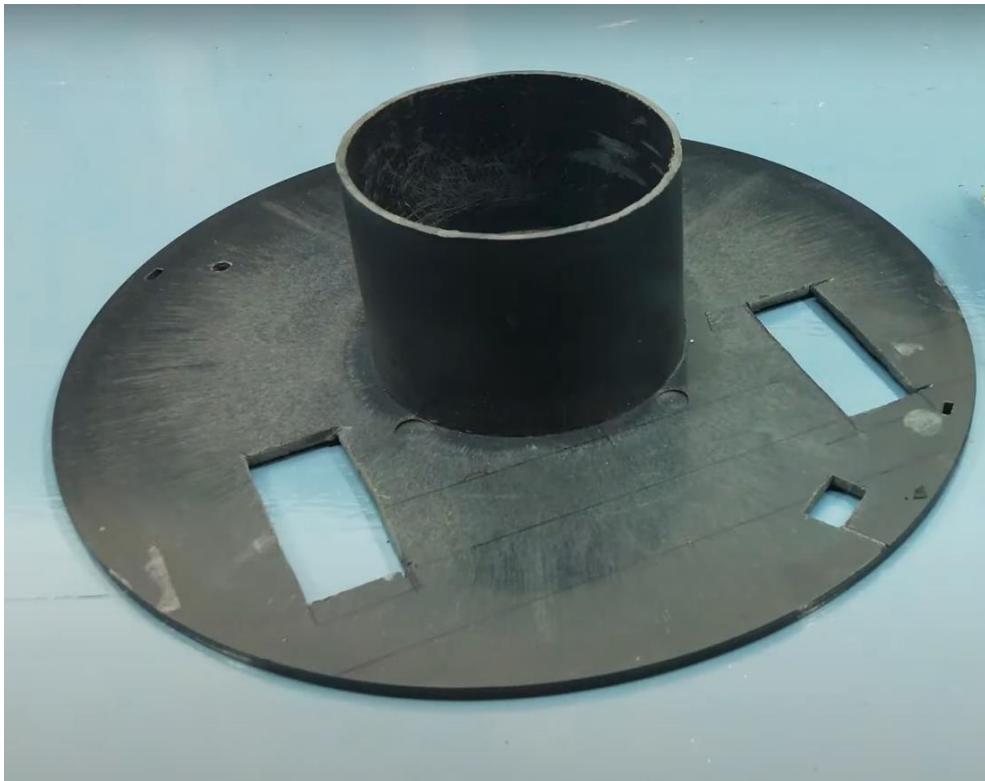


*Figure 1:0:19 Bo Motor*

## 4.2 Construction Stages

### 4.2.1 Building the base structure

The base structure is built using a piece of reinforced plastic, and holes have been opened in the base for each piece that will be installed at the base. There is a cylinder in the middle of the base in which to collect dirt. There are also sides to the model and a roof on top.



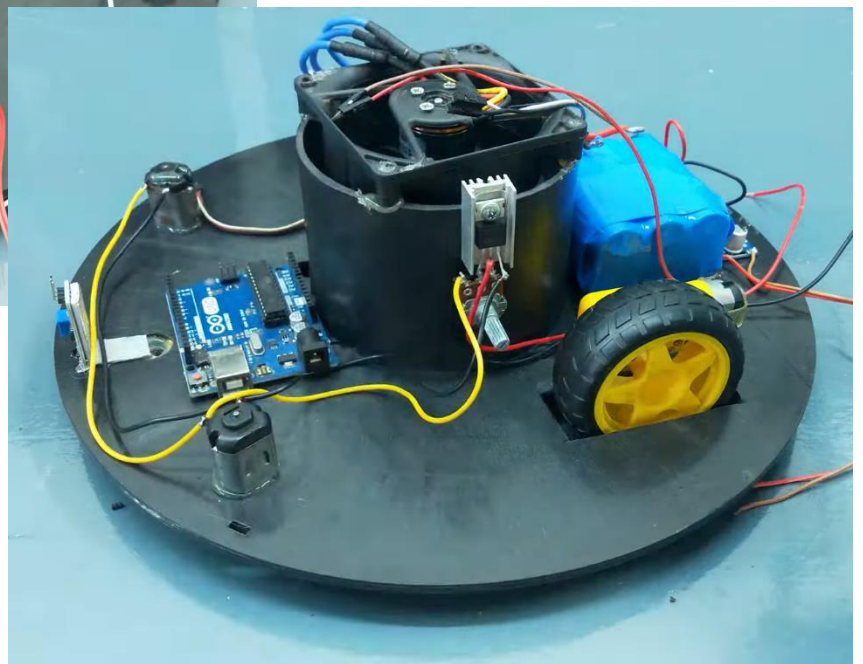
*Figure 1:0:20 Base Structure*

## 4.2.2 Connecting of basic components

In this stage, basic components such as arduino, battery, wheel, motors and control button were connected.



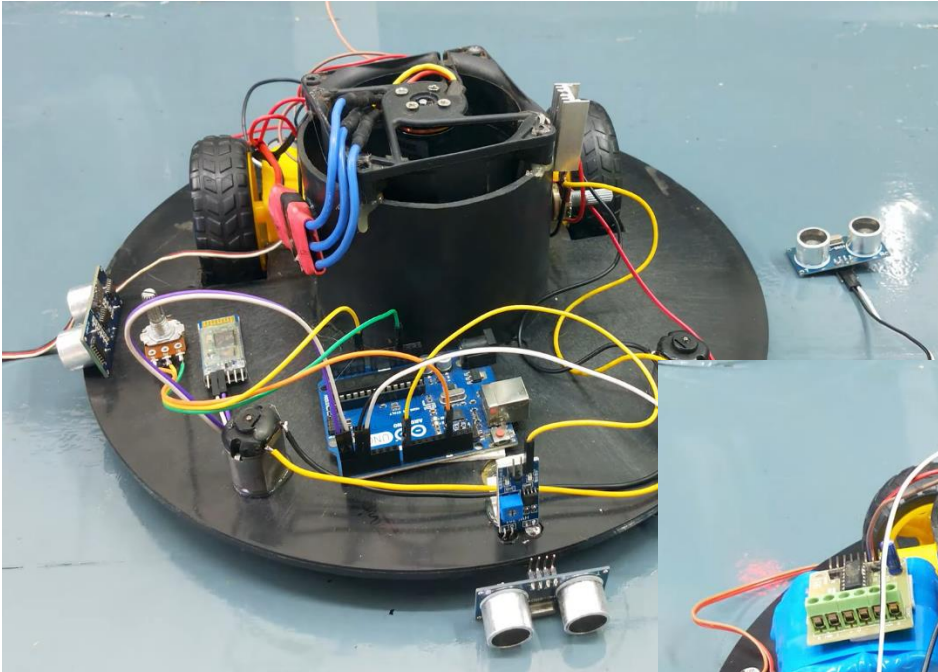
*Figure 1:0:21 Basic Components*



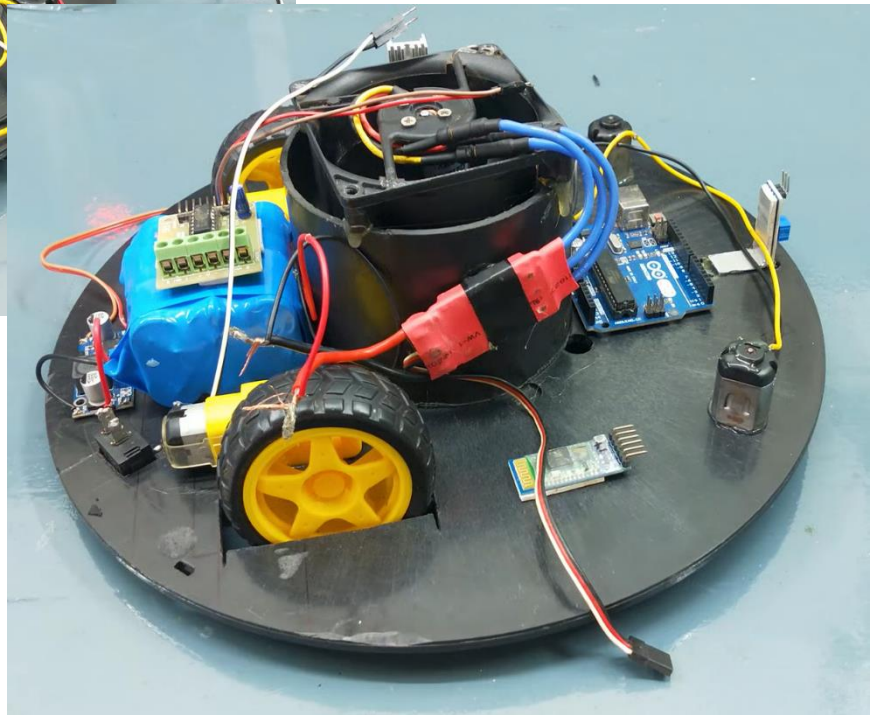
*Figure 1:0:22 Basic Components*

### 4.2.3 Connecting of sensors

In this stage, the robot's sensors were connected, such as IR sensors, ultrasonic sensors, and bluetooth module.

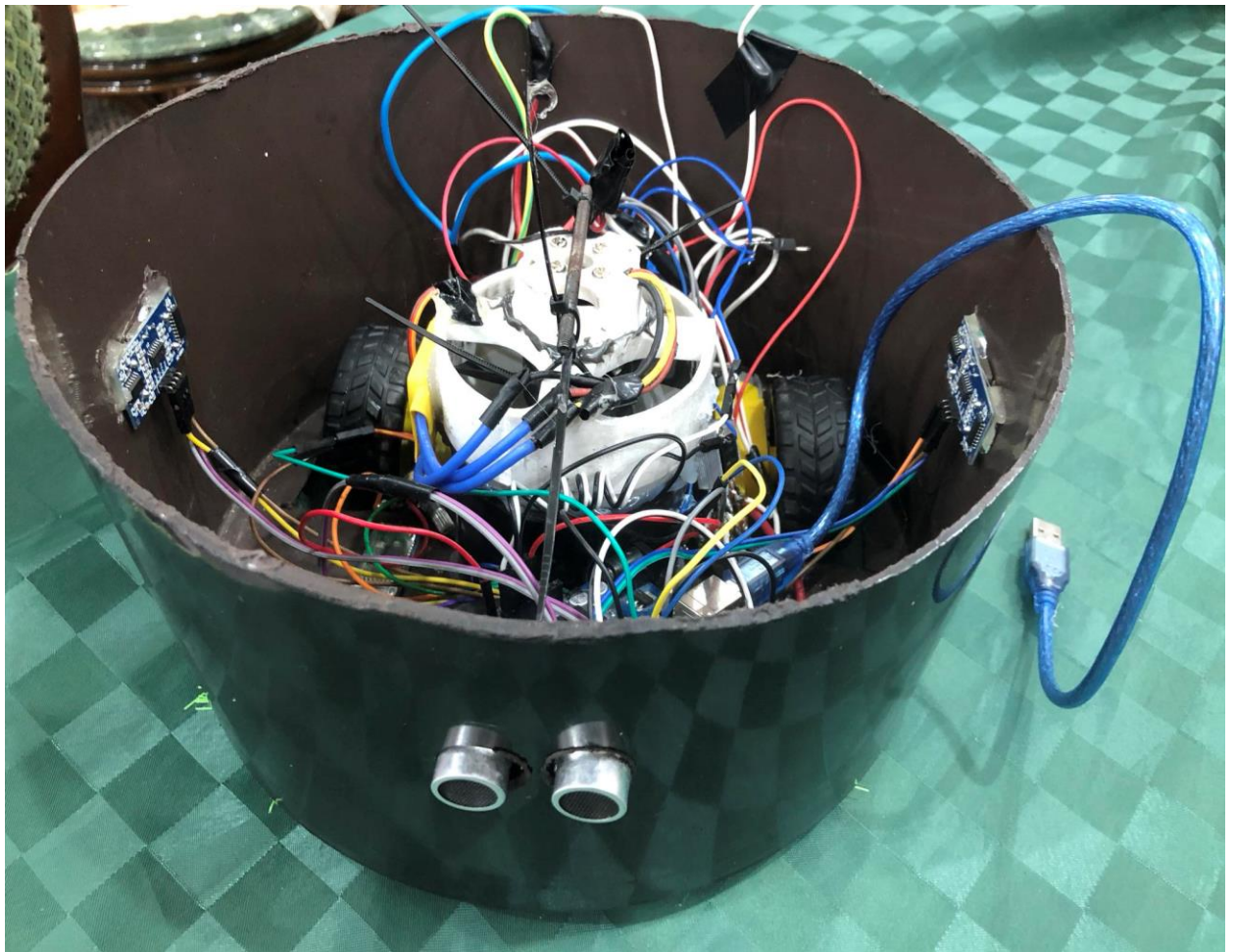


*Figure 1:0:23 Connecting Components*

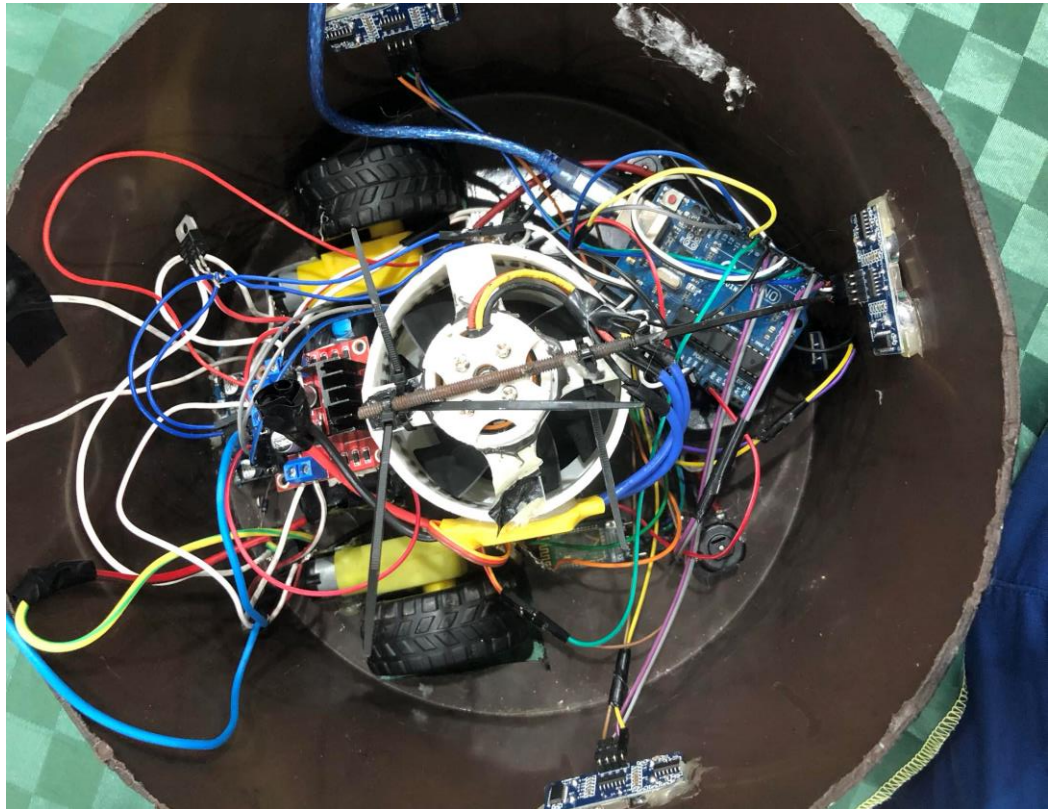


*Figure 1:0:24 Connecting Components*

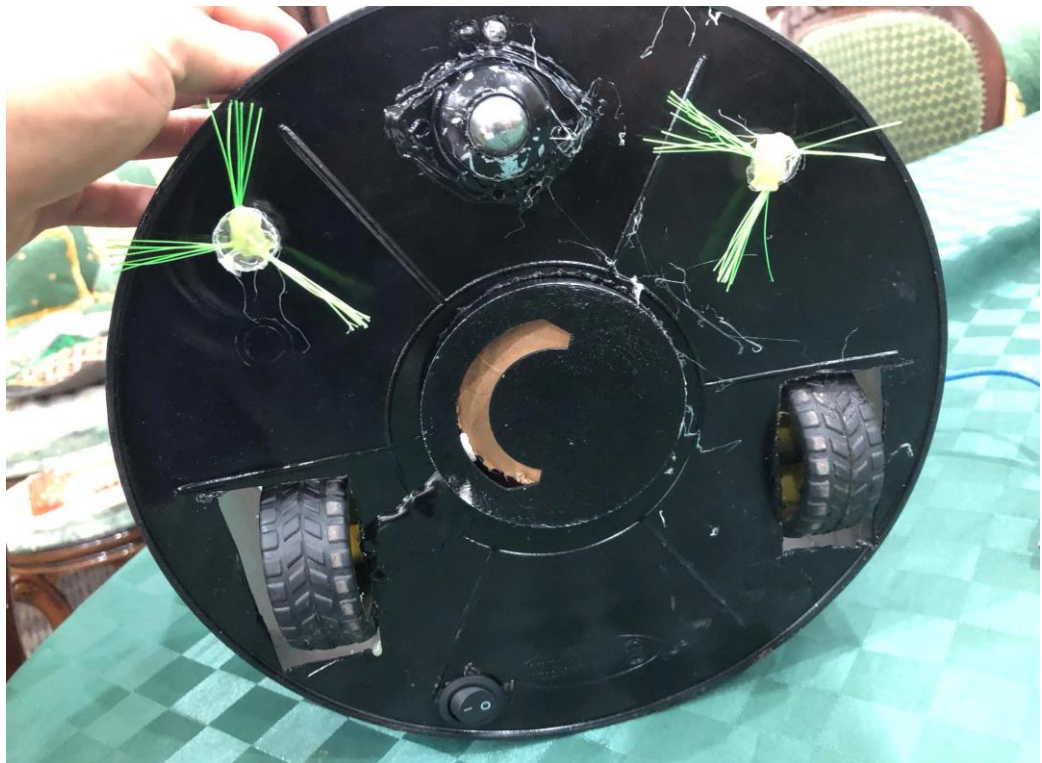
#### 4.2.4 Final structure



*Figure 1:0:25 Final Structure*



*Figure 1:0:26 Final Structure*



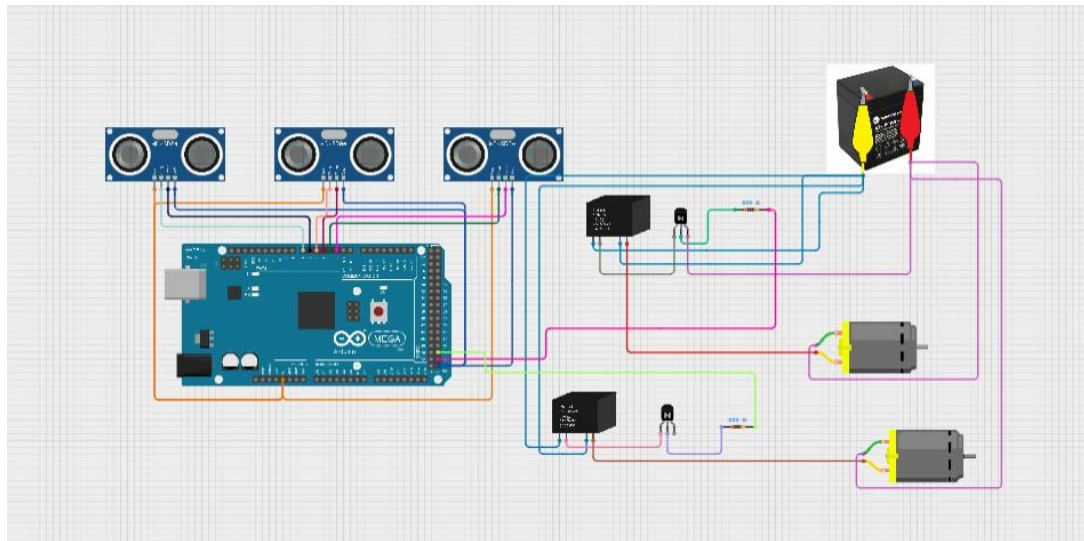
*Figure 1:0:27 Final Structure*

## 4.3 Circuits

### 4.3.1 Ultrasonic with motors circuit

In our project, this circuit takes the reins in controlling the base motors based on ultrasonic data. This circuit involves the utilization of an Arduino Mega, two relays, two transistors, two DC motors, and a 12V battery.

The Arduino processes the ultrasonic data and generates outputs, which are then connected to relays and transistors. This strategic connection serves to modulate the voltage, transforming it to 12V to precisely control the base motors.



*Figure 1:0:28 Ultrasonic With Motors Circuit*

### 4.3.2 DC motor speed controller circuit

A 12V DC motor speed controller circuit is an electronic device that allows you to control the speed of a 12V DC motor. It typically works by varying the voltage or current supplied to the motor, enabling you to adjust its speed.

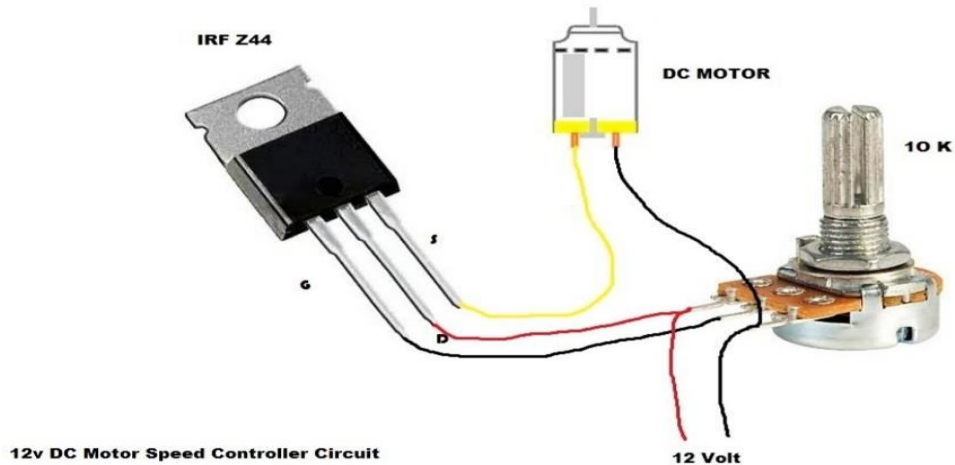


Figure 1:0:29 DC Motor Circuit

### 4.3.3 IR circuit

We use IR sensor, to detect if the robot detects any difference on the ground level.

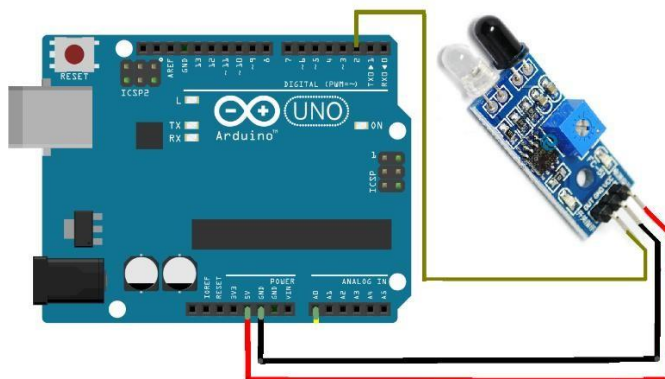


Figure 1:0:30 IR Circuit

### 4.3.4 Bluetooth circuit

Designed to replace cable connections HC-05 uses serial communication to communicate with the electronics. Usually, it is used to connect small devices like mobile phones using a short-range wireless connection to exchange files. It uses the 2.45GHz frequency band.

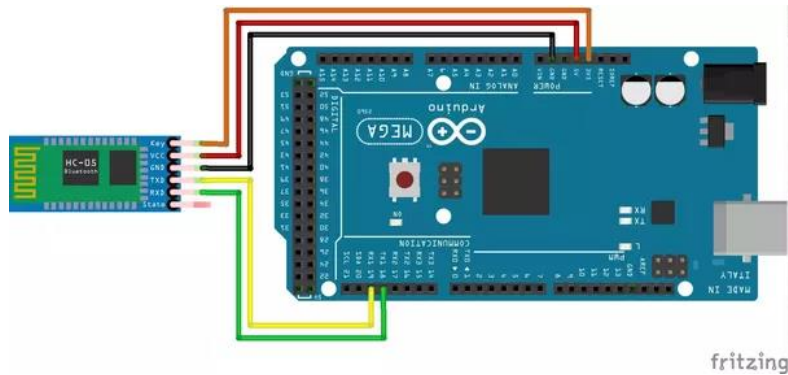


Figure 1:0:31 Bluetooth Circuit

### 4.3.5 Dual H-Bridge circuit

If you want to control the stepper motor with L298N, then keep the jumper on Enable A and Enable B. Keeping the jumper on these pins means that these pins will be High. Logic Pins: Connect the Logic pins to any digital pins of Arduino. These will help in controlling the rotation and speed of DC motors.

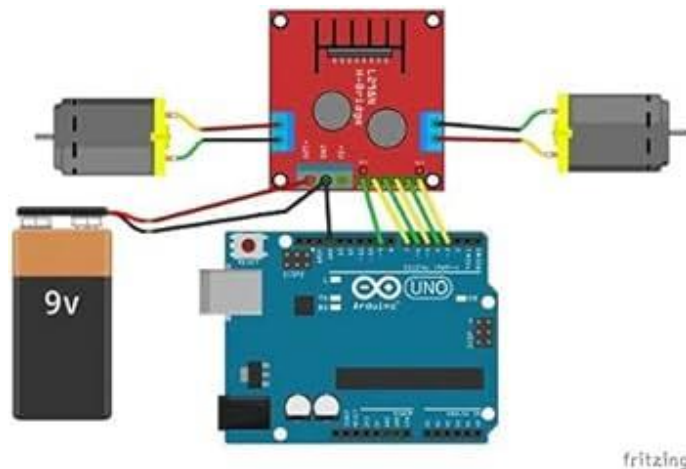
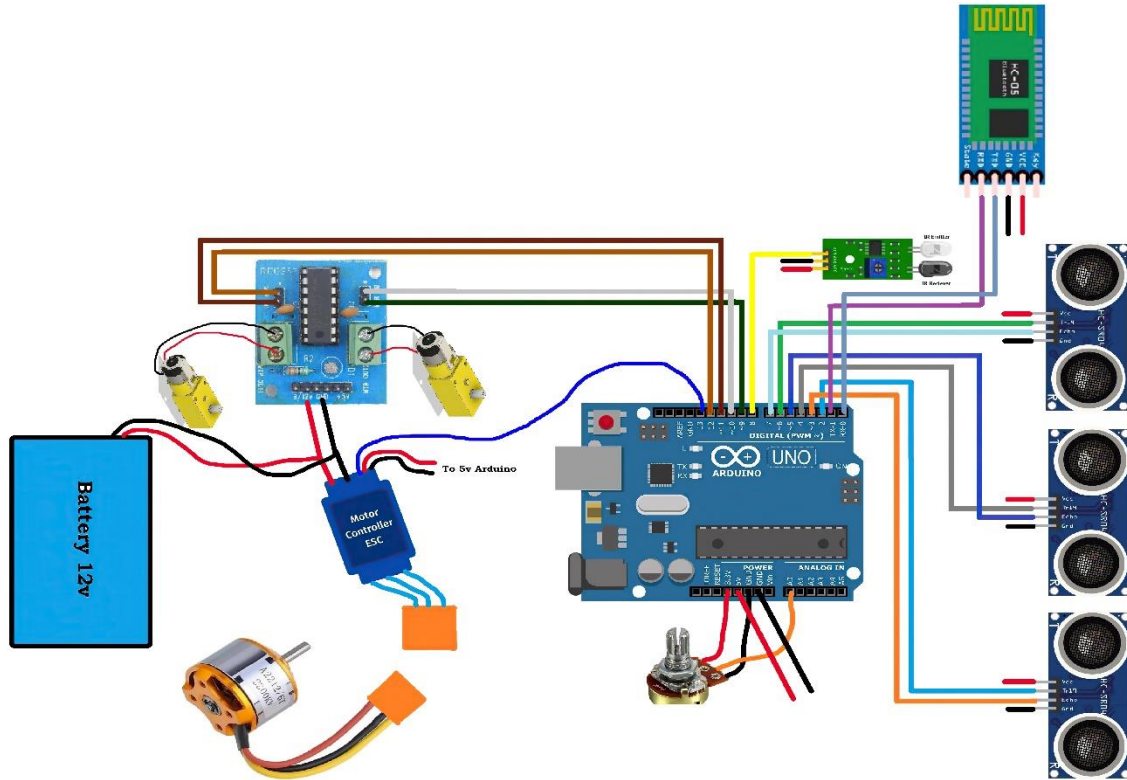


Figure 1:0:32 Dual H-Bridge Circuit

## 4.1.1 Assemble circuits

Assembling the main circuits with each other.



*Figure 1:0:33 Assemble Circuits*

## 4.2 Movement Status

### 4.2.1 Right movement

We build a right movement status depend on obstacle that the sensors detect, if any obstacle be in front of the left sensor, and no obstacle behind the other sensor, the robot will move right.

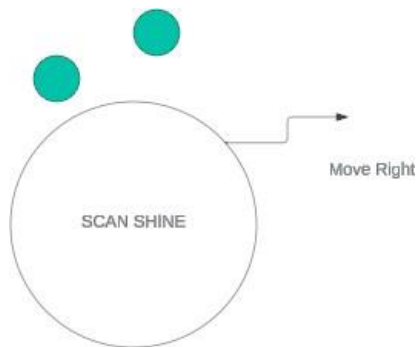


Figure 1:0:33 Right movement status(a)

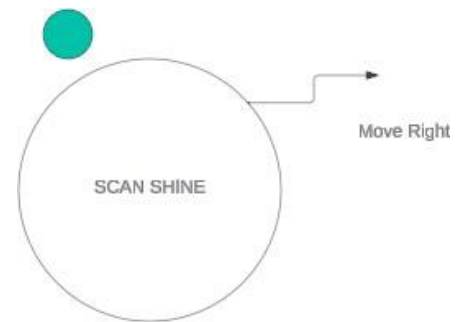


Figure 1:0:32 Right movement status(b)

### 4.2.2 Left movement

The left movement status depend on obstacle that the sensors detect, if any obstacle be in front of the right sensor, and no obstacle behind the other sensor, the robot will move left.

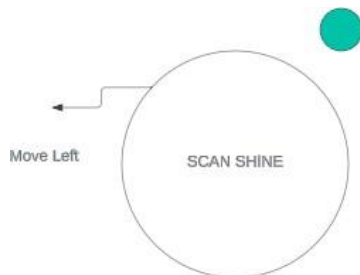


Figure 1:0:35 Left movement status

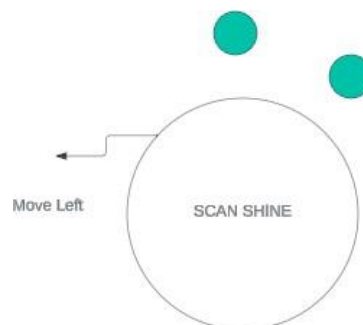


Figure 1:0:34 Left movement status

### 4.2.3 Forward movement

Our robot moves forwarding if no obstacles near any sensors.



*Figure 1:0:36 Froward movement status*

### 4.2.4 Backward movement

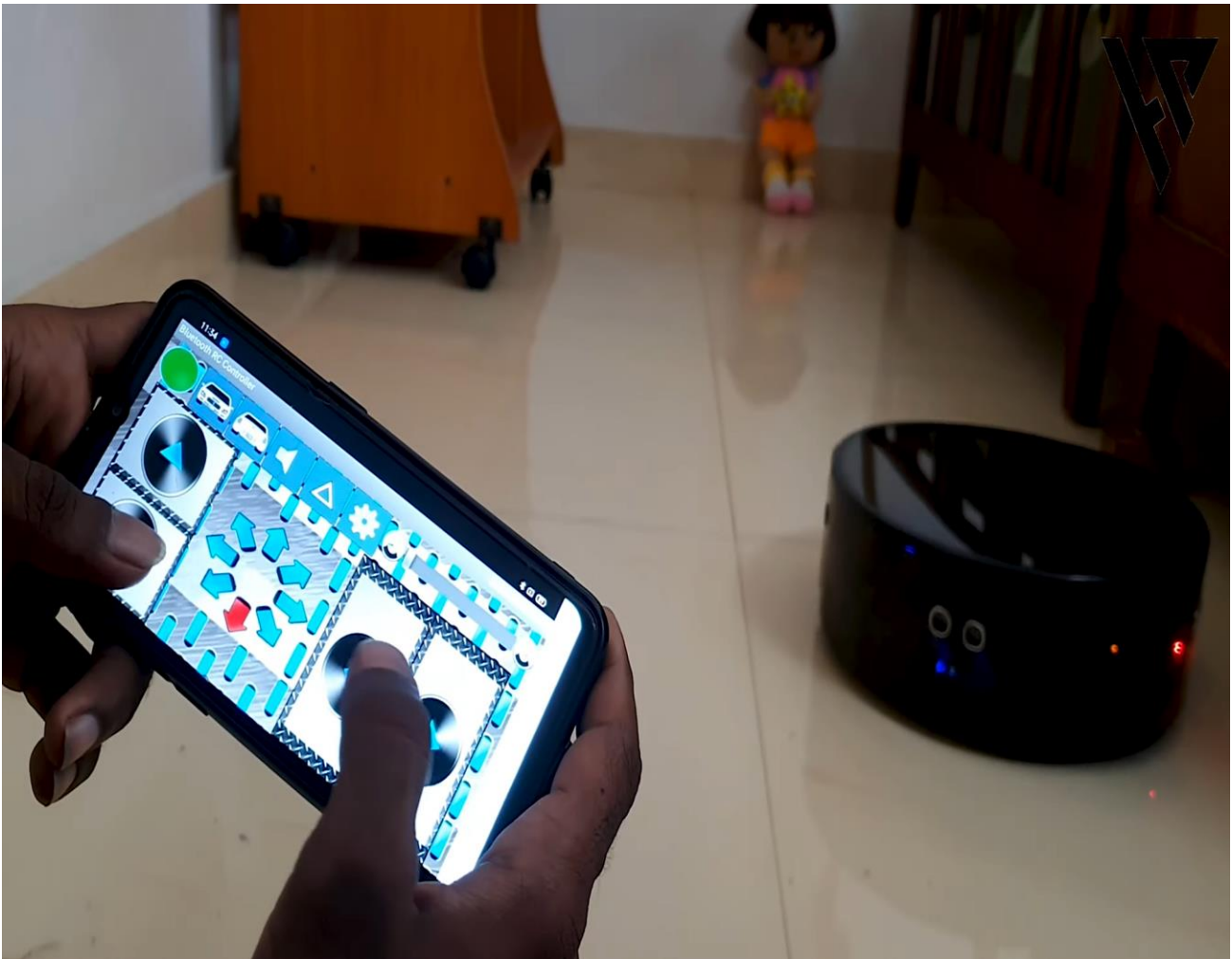
Our robot moves backward if there are obstacles near each sensor (front, left and right).



*Figure 1:0:37 Backward Movement Status*

### 4.3 : Mobile Controlling

The robot can be controlled via Bluetooth. The robot must be turned on, and Bluetooth signals will be sent through the Bluetooth module, and the mobile device will turn on the Bluetooth feature and communicate with the robot.



*Figure 1:0:38 Mobile Controlling*

## Chapter 5: Results and Analysis

- We have created this robot that contains many features. It contains 3 modes: sweeping mode, mopping mode. When it is initially turned on, when choosing sweeping mode it cleans the floor at the same time can detect obstacles and avoid colliding with them, in addition to sensing its arrival at a place where it might fall.
- Moreover, the robot can be controlled from the mobile phone through the Bluetooth module, such as turning it on and off and changing modes easily, and the robot can be placed in closed areas to carefully and cautiously clean it of obstacles and paths.

## Chapter 6: Conclusion, Recommendation and Future work

### 6.1 Conclusion

In the end, we have created this robot that has aspects that distinguish it from other robots, which helps the user with ease of control and obtaining satisfactory results without the hassle of cleaning also by saving time and effort.

### 6.2 Recommendation

1. Before connecting, read about each device to know more about it and to know how many volts each device needs.
2. Be careful when distributing currents and voltages.
3. Test each device separately and write its connection and its pins on the Arduino board to make sure that all of them working correctly.
4. Never just, connect wires, as they can easily break. Solder them instead.

### 6.3 What we have learned

1. How to work with sensors like IR, ultrasonic and motors like BO, DC and brushless.
2. How to connect Arduino to brushless motor and Dual H-Bridge and how use its Wi-Fi and Bluetooth features.
3. How to work with Bluetooth module.
4. How to write Arduino codes and change the control states of the robot.
5. How to build lithium batteries and obtain the required voltage and amperage through series and parallel.

### 6.4 Future Work

1. Developing the robot to work on more than two modes and control and move between modes.
2. Use Raspberry Pi to obtain a map of the place to be cleaned and the ability to give orders to clean a specific area.
3. Use a web page application instead of a mobile and send commands and receive notifications through it.
4. The feature of cleaning and not returning to the previously cleaned place and turning off when cleaning is finished.
5. The size of the robot be smaller to clean narrow places easily. We made it large to accommodate all the pieces.

## Chapter 7: References

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