

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



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Faculty of Engineering and Information Technology
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Graduation Project II

SCAN SHINE

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Dedication

To my family and many friends, a special feeling of gratitude to my loving parents. They are the most important people in my world and I dedicate this work to them.

Siham

To my great family that always stands up with me and gives me everything. Also, to my friends and all these important people, this work is dedicated to them.

Farah

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. Manar Qamhieh for her support and advice to achieve and complete this project in the best possible way.

Abstract

For our graduation project 2, and after a continuous search to provide a multi-use cleaning robot, the project idea that came up was a cleaning robot “scan shine”, It has a three-step cleaning process:

1. Sweeping and dust-removal
2. Mopping
3. Perfuming

It cleans on its own without the need for follow-up by humans, it relies on a combination of sensors and software to navigate their environment. The sensors help the robot detect its surroundings .it can walk and know its way without redoing the cleaned areas. However, hindered it is during its walk, it completes the process smoothly. Furthermore, it gives notifications in case she needs to clean the filters and also in case the amount of water is needed to clean or unload the internal trash.

There are many smart sweepers robots , most of them are specialized only in sweeping, while others are specialized in mopping, but our robot will be different since it will gather both mopping and sweeping.

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 three modes. The vacuum robot handle the obstacle behind it and avoid them depends on the sensors in it.

1.3 Significance of the work

Having a sweeping, mopping and performing vacuum robot can help users to save time and also many, instead of buy 3 vacuums for cleaning, now they can have 3 vacuums cleaner robot in one.

1.4 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 we decide body material to be 3D PRINTING, we initially tried to design the body alone but we could not design small pieces and fine details, so We have asked the Mechatronics' Engineer to design us the robot with it's parts , then sent this design to an architect who printed the design through 3D printer , And this stage took a long time of semester

- **Lidar Sensor:**

It was one of the most difficult constraint we had to deal with, so it took us a long time in the process of finding the right lidar sensor and then finding the right codes and libraries for it's version.

- **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, but if needed, a usb could be connected to the computer to run the program that maps through the lidar

- **dust box:**

We have had difficulty in the process of making the dust box permanently non-stationary for the robot, so we put a Buckle , so the person can easily disassemble it from it's place and turn it back.

- **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 benefited from these research papers so that we have ideas about the most important sensors and parts that must be present inside the robot. At the same time, we have thought of solutions for the negative or missing aspects of these robots and developed them on our robot. for example, our robot has more than one mode of work and the ability to change the mode easily, as well as the distinctive and unique design of the robot and the ability to remove the cleaning parts and unload them which extends the life of the robot.

We have used many resources to rely on and get information from. First, we used the official Arduino website to understand the Arduino Mega in detail with all its ports and pins [3]. Then we dived into the details of each component that we used by reading documentation and watching tutorials. Starting from the lidar datasheet to know its connections and how it works[4], then we look for resources for ESP32 to know how to send data from a webpage to control the robot [5], then we read about ultrasonic and how it works, we read an article [6] also we look for RTC and how we will connect it to esp and get the current time from it .[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.

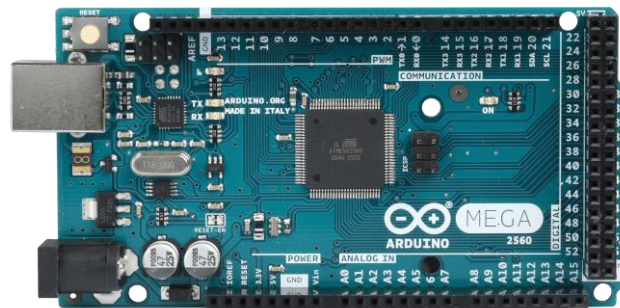


Figure 1:0:1 Arduino Mega

4.1.2 Ultra Sonic Sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. It sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated. We used ultrasonic sensors to control the robot navigation, we use three ultrasonic on three angles to guarantee all the obstacle near the robot



Figure 1:0:2 ultrasonic sensor

4.1.3 IR Sender and Receiver

IR sender sends infrared signals that the receiver detects, if the receiver can receive the signals, this means there is no object. Otherwise, there is an object between them. We used IR sensors to control the robot navigation near non-level grounds.



Figure 1:0:3 IR sensors

4.1.4 piezoelectric sensor

A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge. The prefix *piezo-* is Greek for ‘press’ or ‘squeeze’, we use it to detect if the brushes need clean or not, the threads wrap around the brusher and increase the pressure.

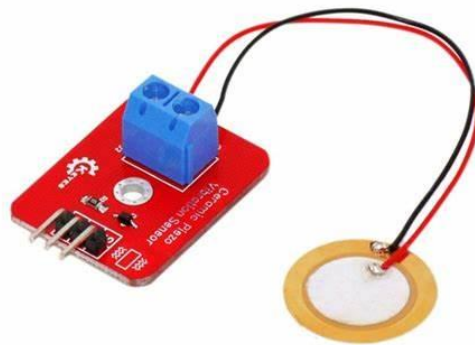


Figure 1:0:4 piezoelectric sensor 1

4.1.5 ESP 32

ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth SoC (System on a Chip), we used it to control our vacuum robot remotely using web.



Figure 1:0:5 ESP32

4.1.6 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 0:6 Fan suction

4.1.7 Robot wheels

In our project, Roomba wheels take center stage to revolutionize robot mobility. These specialized wheels provide omni-directional movement, enabling the robot to navigate seamlessly in any direction. With a focus on precision and low-noise performance, these Roomba wheels elevate the overall functionality of the robot, ensuring a quiet and efficient operation



Figure 1:0:7wheels

4.1.8 Water pump and pipe

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 1:0:8pump and pipe

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 1:0:9Brushers

4.1.10 Sprinkler

The car sprinkler is a key component in our project, specifically employed during the robot's mopping or perfuming mode. This specialized sprinkler system facilitates precise water spraying, ensuring optimal coverage and efficiency. The lightweight make it an ideal choice for water distribution, contributing to the overall success of the robot.



Figure 1:0:10Sprinkler

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 1:0:11DC motor

4.1.12 Relays

In our setup, relays play a crucial role—converting Arduino’s 5V output to the essential 12V. This conversion empowers us to seamlessly control motors and plumbing systems. These compact relays act as efficient switches, ensuring a smooth integration of power, making them indispensable for our automation needs.



Figure 1:0:13:1Relays

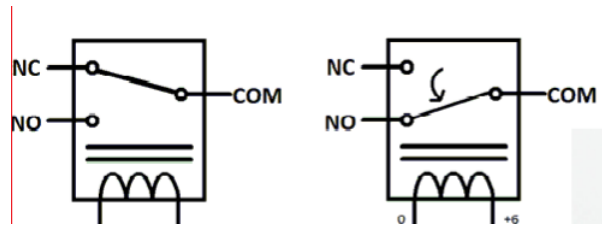


Figure 0:12Relays

4.1.13 Rplidar A1

We use is a remote sensing method that uses light in the form of a pulsed laser to measure ranges, to make a random navigation if no obstacle near our robot.



Figure 1:0:14: Rplidar

4.1.14 RTC

We used it to get always the current time because it contains a special battery, and thus we can compare the current time with the time specified through the webpage to decide accordingly to operate the robot at the specified time.



Figure1:0:15RTC

4.2 Structure Parts

4.2.1 Top cover

In our design the top cover contains several buttons for manual control, and power charger LCD.

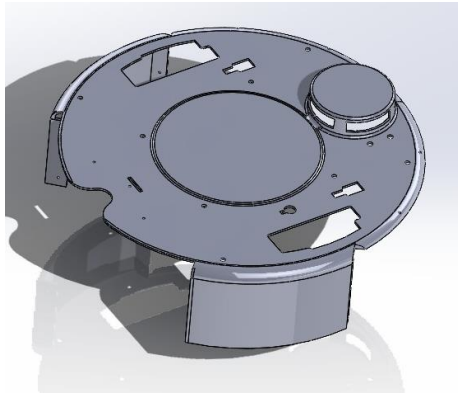


Figure 1:0:17Top cover design



Figure 1:0:16Top cover design

4.2.2 The base

the base is the most important part in our design, it contains most of the hardware components, motors, brushers, Irs, wheels, and sprinkler.

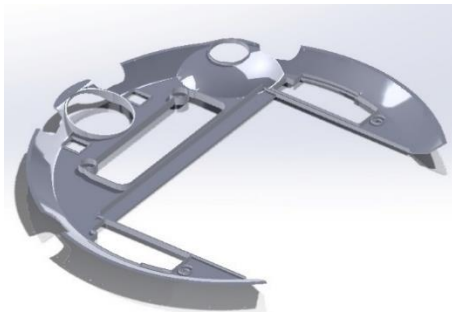


Figure 1:0:19Base



Figure 1:0:18Base

4.2.3 Dirty box

This part contains dust suction and filter .

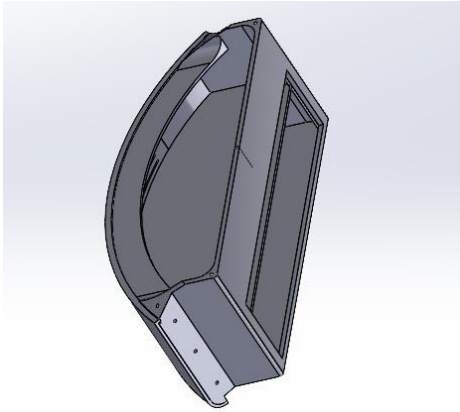


Figure 1:0:21dirty box (a)

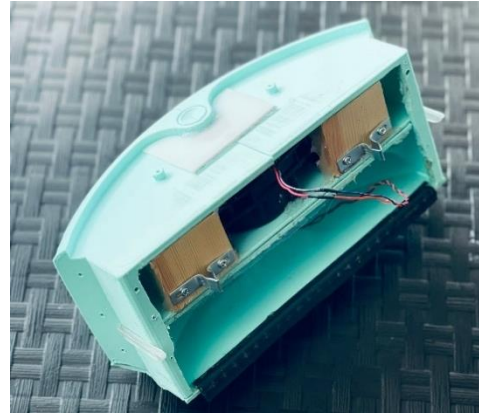


Figure 0:20 dirty box(b)

4.2.4 3D printing side cover

We design this part to contain the ultra-sonic sensors and the perfume sprinkler.

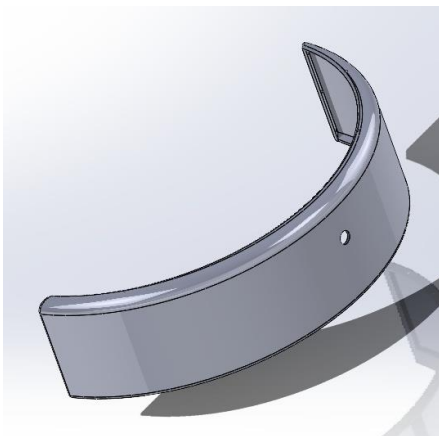


Figure 1:0:23side cover (a)

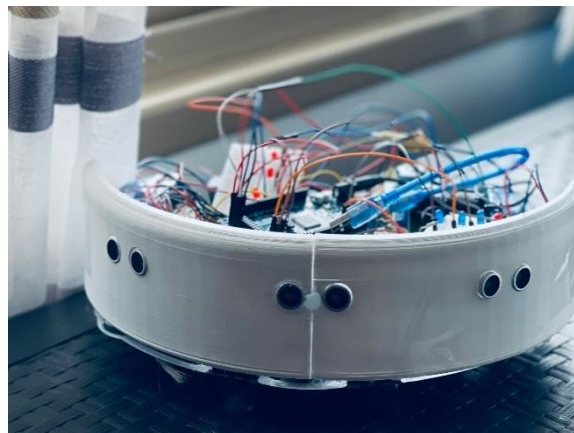


Figure1:0:22side cover(b)

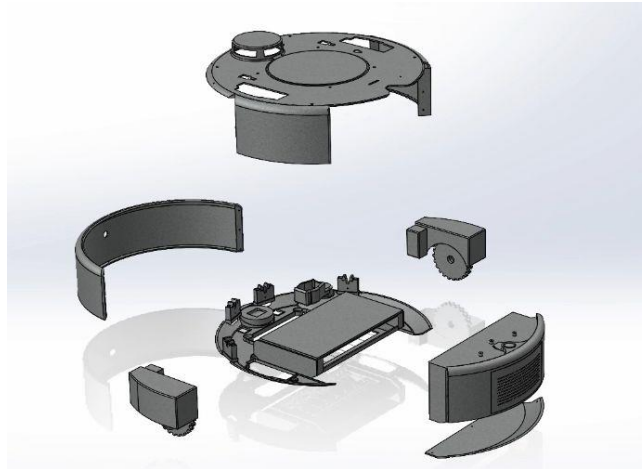


Figure1:0:24Total design components

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.

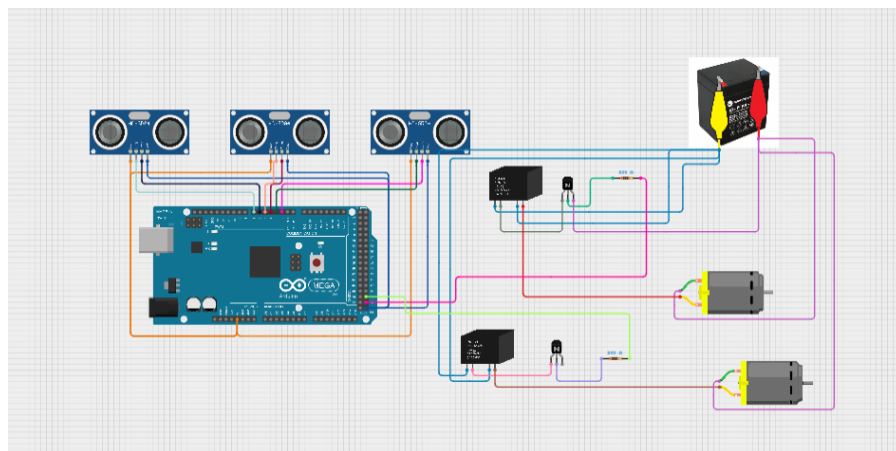


Figure1:0:25Ultrasonic with motors circuit

4.3.2 ESP32 circuit

This circuit, is the ESP32 circuit, using 4 pins of Arduino and 4 pins of ESP32 (2 TX, 2 RX) 2 channels of software serial communication is built between the Arduino and the WIFI board to send and receive data from Arduino, and the circuit below shows a single channel of this software serial communication.

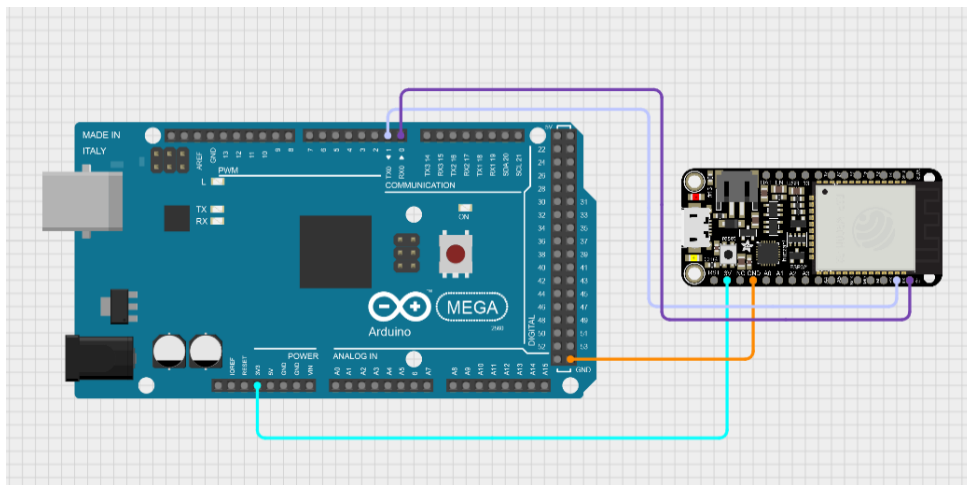


Figure1:0:26ESP32 circuit

4.3.3 IRs circuit

We use 4 Irs sensor, to detect if the robot detects any difference on the ground level.

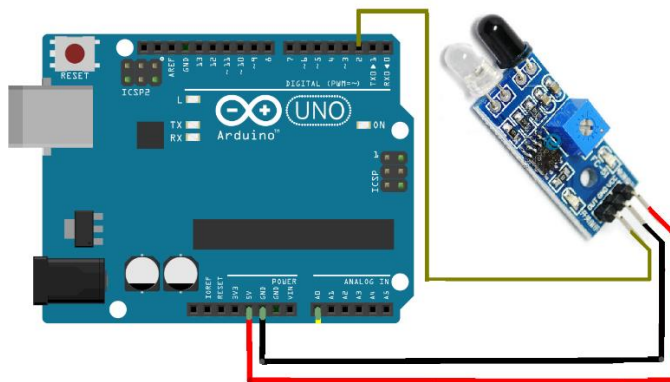


Figure1:0:27IRScct

4.3.4 Lidar circuit

We use RPLidar A1 to make a navigation if no obstacles around our robot with circle that have 1 m diameter, we connect the RX, TX from lidar to TX, RX in the Arduino to get the laser data, and analyzing it.

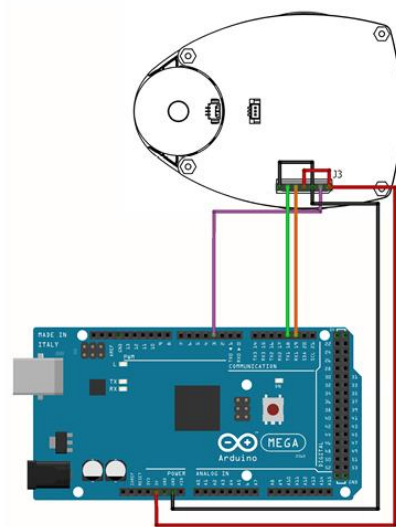


Figure 1:0:28 Lidar circuit

4.3.5 Push buttons circuit

We use 3 push buttons to control the vacuum modes manually, first button is for swiping mode, the second for mopping and the last for perfuming.

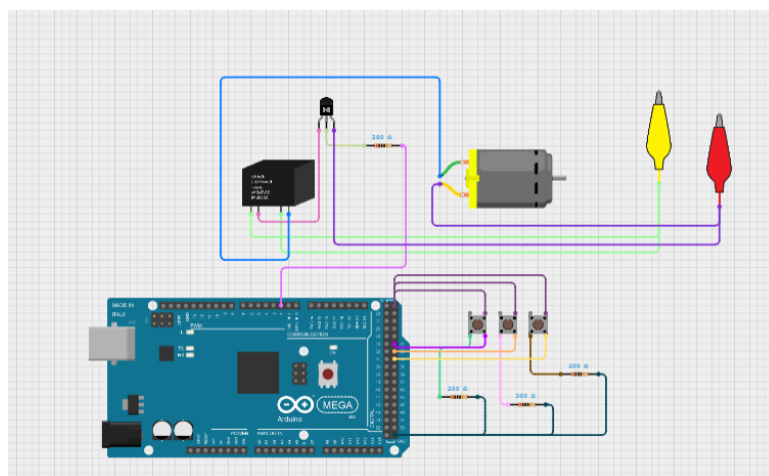


Figure 1:0:29 Push buttons circuit

4.3.6 RTC cct:

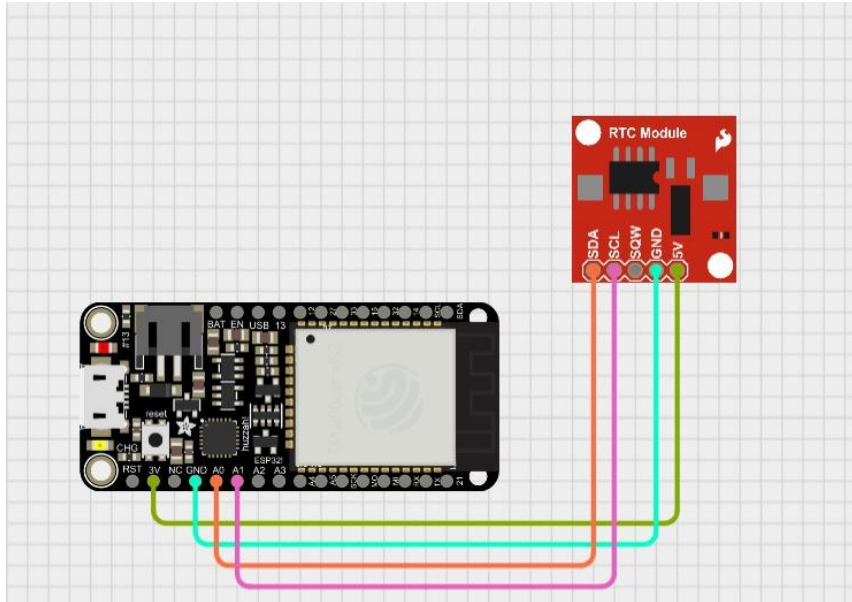


Figure1:0:30RTC cct

4.4 End result



Figure 1:0:31End result

4.5 Movement status

4.5.1 Right movement

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



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

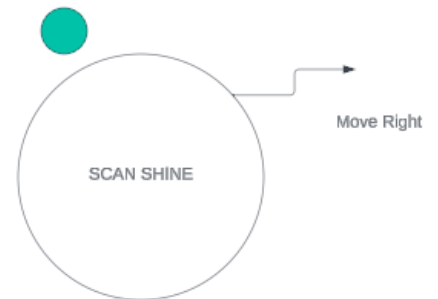


Figure 0:32Right movement status(b)

4.5.2 Left movement

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

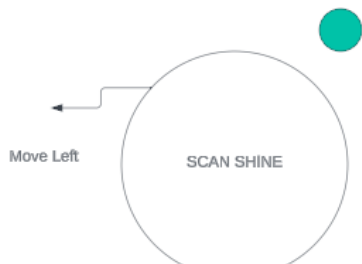


Figure 1:0:35left movement status

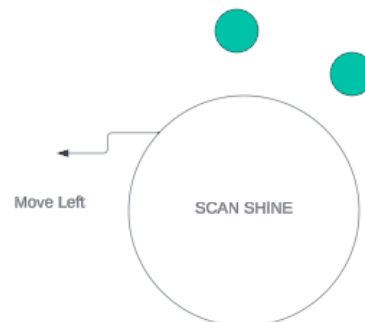


Figure 1:0:34leftt movement status

4.5.3 Forward movement

Our robot move forwarding if no obstacles near any sensors.



Figure 1:0:36 Forward movement status

4.5.4 Stop Movement

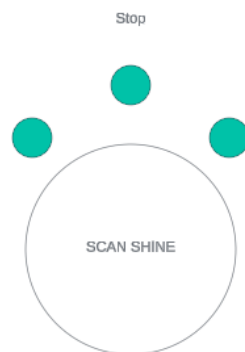


Figure 10:37 Stop movement status

4.6 : SoftWare Controlling

We built a web page through Esp32 , for user to control the robot , can turn on the robot , and change modes as needed , also can set a time to turn on it. Moreover can get the status of sensors from Arduino.

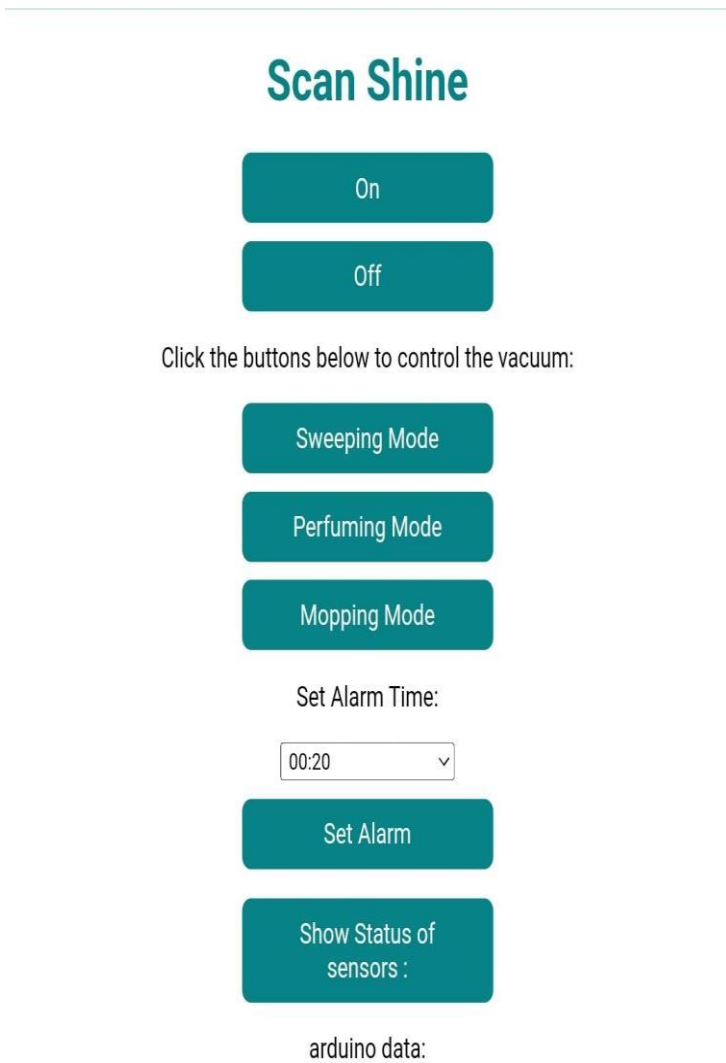


Figure 1:0:39webpage

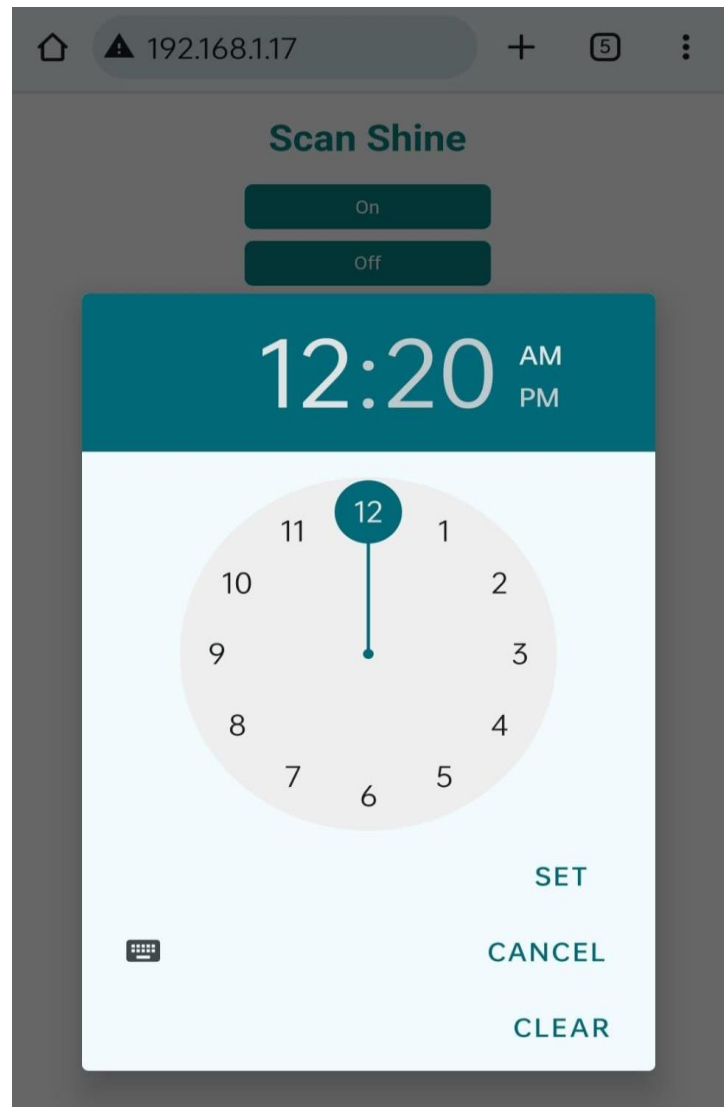


Figure1:38set Time-Webpage

Chapter 5 : Results and Analysis

-We have created this robot that contains many features. It contains 3 modes: sweeping mode, mopping mode, and perfuming 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 webpage through esp32 , such as turning it on and off and changing modes easily, in addition to setting a specific time to run the vacuum to turn on in this time, and displaying information about the cleaning sensors in case it needs to be emptied or the water sensor in case it needs to be filled

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 ,lidar, and motors.
2. How to connect Arduino to ESP32 and use its Wi-Fi features.
3. How to work with RTC module .
4. How to control components remotely also from buttons.

6.4 Future Work

1. The sensing and movement process should be more accurate by relying basically on the lidar sensor.
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 mobile application instead of a web page and send commands and receive notifications through it.
4. The material of the vacuum should be stronger, as 3D printing is light and expensive.
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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