VACUUM CLEANER BOT

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project **“VACUUM CLEANER BOT”** is the bonafide work of **“JECIYAZHINI J”** and **“JEYAPRIYAN M”** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

In the era of smart homes and automation, the integration of Internet of Things (IoT) technology with household appliances has become increasingly prevalent. This project presents the design and implementation of an IoT-enabled vacuum cleaner bot equipped with a Brushed DC (BO) motor, proximity sensor, suction fan, and Arduino microcontroller. The primary objective of the bot is to autonomously navigate through a given space, detect obstacles using the proximity sensor, and efficiently clean the area by directing dust and debris towards the suction fan. The proximity sensor serves as the bot's eyes, enabling it to detect obstacles in its path and navigate around them to avoid collisions. Meanwhile, the BO motor drives the bot's movement, allowing it to traverse the environment smoothly and effectively. The integration of a suction fan ensures thorough cleaning by efficiently collecting dust and debris from the floor. The bot's operation is coordinated by an Arduino microcontroller, which acts as the brain of the system. It processes data from the proximity sensor and issues commands to the BO motor and suction fan accordingly, ensuring seamless navigation and cleaning performance. Through the implementation of IoT technology, users can remotely monitor and control the vacuum cleaner bot using a smartphone or web interface, adding an extra layer of convenience and accessibility to the cleaning process. Overall, this project demonstrates the potential of IoT technology in enhancing the functionality and efficiency of household appliances. By leveraging sensors, motors, and microcontrollers, the vacuum cleaner bot offers a practical solution for automating floor cleaning tasks while minimizing user intervention.

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LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
BO	Battery Operated
HCSR04	High-Conductance ultrasonic sensor
INO	File type - arduINO
PWM	Pule Width Modulation
AVR	Advanced Virtual RISC
USB-ASP	USB AVR Serial Programmer
GPIO	General Purpose Input Output

CHAPTER I

INTRODUCTION

1.1 DESCRIPTION

In addition to its autonomous cleaning capabilities, the vacuum cleaner bot features IoT connectivity for remote monitoring and control. Users can access the bot's status, initiate cleaning cycles, and adjust settings using a smartphone app or web interface. This remote functionality adds convenience and flexibility, allowing users to schedule cleaning sessions or monitor the bot's progress from anywhere with an internet connection.

Furthermore, the integration of IoT technology opens up possibilities for advanced features such as voice control, scheduling based on room occupancy, and integration with smart home ecosystems. Imagine being able to simply say, "Hey, vacuum bot, clean the living room," and watch as the bot springs into action, navigating around furniture and obstacles with ease.

Moreover, the vacuum cleaner bot's efficiency extends beyond its cleaning capabilities. By leveraging IoT connectivity, the bot can provide real-time feedback on its performance, alerting users to maintenance needs such as emptying the dustbin or replacing worn-out brushes. This proactive approach to maintenance helps ensure that the bot remains in optimal working condition, prolonging its lifespan and maximizing its effectiveness.

Furthermore, the versatility of the vacuum cleaner bot extends to its design and construction. With modular components and open-source software, enthusiasts and developers can customize and enhance the bot to suit specific needs and preferences. Whether it's adding additional sensors for enhanced navigation or integrating machine learning algorithms for improved cleaning performance, the possibilities for innovation are virtually limitless.

In summary, the IoT-enabled vacuum cleaner bot represents a significant advancement in household cleaning technology. By combining intelligent navigation, efficient cleaning mechanisms, and IoT connectivity, the bot offers a comprehensive solution for maintaining clean and healthy living spaces. As the capabilities of IoT continue to evolve, we can expect to see further enhancements and innovations in the realm of smart home appliances, ultimately leading to a more connected, convenient, and sustainable way of living.

With its potential to revolutionize household chores and improve quality of life, the vacuum cleaner bot exemplifies the transformative power of IoT technology. By automating mundane tasks and providing valuable insights into home maintenance, the bot frees up time and energy for more meaningful pursuits, enhancing overall well-being and productivity. As adoption of IoT devices continues to grow, we can anticipate a future where smart home appliances like the vacuum cleaner bot become commonplace, seamlessly integrating into our daily lives and contributing to a more efficient and connected world.

1.2 SCOPE OF WORK

The project entails a comprehensive endeavor to develop an IoT-enabled vacuum cleaner bot, integrating a Brushed DC (BO) motor, proximity sensor, suction fan, and Arduino microcontroller. The primary goal is to create an intelligent cleaning solution capable of autonomously navigating spaces, avoiding obstacles using the proximity sensor, and efficiently directing dust towards the suction fan with a brush mechanism.

In detailing the hardware components, the project will delve into the specifications of each component, ensuring compatibility and optimal performance in the overall design. This will involve meticulous consideration of factors such as motor power, sensor sensitivity, and fan airflow to meet the desired cleaning objectives.

System design will encompass the architectural blueprint of the vacuum cleaner bot, outlining how hardware components will be integrated and interact. This phase will involve not only determining the physical layout of the bot but also developing schematics and circuit diagrams to ensure seamless connectivity and operation.

Algorithms will be developed to facilitate autonomous navigation based on data from the proximity sensor. Emphasis will be placed on devising strategies for obstacle avoidance to ensure safe and efficient movement in diverse environments, with a focus on maximizing coverage and minimizing collisions to optimize cleaning efficiency.

The project will also entail designing and integrating a brush mechanism into the bot to effectively sweep dust and debris towards the suction fan. Control algorithms will be implemented to coordinate the activation of the brush mechanism with the bot's movement, ensuring synchronized operation for thorough cleaning.

Software development for the Arduino microcontroller will be a crucial aspect, enabling management of the bot's operation, including motor control, sensor data processing, and communication with external devices. Integration of IoT functionality will allow for remote monitoring and control via a smartphone app or web interface, enhancing user convenience and accessibility.

Comprehensive testing will be conducted to evaluate the bot's performance in simulated and real-world environments. This will involve rigorous assessment of navigation accuracy, obstacle avoidance effectiveness, and cleaning performance, with any identified issues addressed through iterative testing and optimization.

Detailed documentation will be prepared covering all aspects of the project, including design, implementation, and testing. User manuals and technical specifications will be provided to ensure ease of assembly, operation, and maintenance, with reports summarizing project milestones, challenges, and lessons learned.

A project timeline will be established, with clear milestones set for each phase of development. Progress will be monitored regularly to ensure timely completion, with updates communicated to stakeholders to maintain transparency and alignment with project objectives.

Exploration of future considerations will be encouraged, looking beyond the initial scope of work to identify opportunities for further enhancements and refinements to the vacuum cleaner bot. This may include the integration of additional sensors, compatibility with smart home systems, or potential collaborations for continued innovation and advancement in cleaning technology.

1.3 PROBLEM STATEMENT

In today's fast-paced world, the demand for smart and efficient cleaning solutions continues to rise, driven by the need for convenience, productivity, and sustainability. Traditional vacuum cleaners often lack the intelligence and adaptability required to navigate complex environments and effectively clean floors without manual intervention. Additionally, existing robotic vacuum cleaners may struggle to efficiently handle obstacles and obstacles, resulting in incomplete cleaning and potential damage to furniture or walls.

To address these challenges, there is a pressing need to develop an innovative IoT-enabled vacuum cleaner bot that leverages advanced technologies such as Brushed DC (BO) motors, proximity sensors, suction fans, and Arduino microcontrollers. This bot must be capable of autonomously navigating through diverse spaces while intelligently avoiding obstacles using the proximity sensor. Furthermore, it must incorporate a brush mechanism to efficiently push all dust and debris towards the suction fan for effective removal, ensuring thorough cleaning without requiring constant user supervision.

The problem at hand is to design and implement a vacuum cleaner bot that seamlessly integrates these components and functionalities to deliver a comprehensive cleaning solution. This entails overcoming various technical challenges, including optimizing the bot's navigation algorithms to navigate complex environments, coordinating the activation of the brush mechanism and suction fan for efficient cleaning, and ensuring seamless communication and control through IoT connectivity.

Furthermore, the solution must be scalable, adaptable, and user-friendly, catering to diverse cleaning needs and environments while offering intuitive operation and maintenance. By addressing these challenges, the proposed vacuum cleaner bot has the potential to revolutionize the way floor cleaning is performed, offering unparalleled convenience, efficiency, and effectiveness in both residential and commercial settings.

The successful development of such a vacuum cleaner bot would not only simplify household chores and enhance cleanliness but also contribute to energy conservation and sustainability efforts. By optimizing cleaning routines and reducing the need for manual intervention, the bot can help minimize resource consumption and environmental impact, aligning with the growing demand for eco-friendly and energy-efficient solutions in today's society.

Additionally, the integration of IoT technology enables remote monitoring and control, further enhancing energy efficiency by allowing users to optimize cleaning schedules and minimize idle time, ultimately leading to greater overall sustainability in cleaning practices.

1.4 AIM & OBJECTIVE

This project aspires to engineer an IoT-driven vacuum cleaner bot, incorporating a Brushed DC (BO) motor, proximity sensor, suction fan, and Arduino microcontroller. The primary objective is to engineer a versatile cleaning solution adept at autonomous navigation within varied environments, adeptly sidestepping obstacles using the proximity sensor. Furthermore, the bot will boast a proficient dust collection mechanism, employing a brush to corral debris towards the suction fan for swift elimination. Beyond mere functionality, the project aims to optimize the hardware architecture for seamless integration, develop sophisticated algorithms for precise navigation and operational control, and integrate IoT features for remote access and monitoring. Rigorous testing and refinement will be pivotal to ensure the bot's reliability and efficiency across diverse scenarios. Additionally, environmental considerations will be paramount, with efforts directed towards minimizing energy consumption and assessing the bot's ecological footprint. By encapsulating these objectives, the project seeks to realize a cutting-edge cleaning solution that not only simplifies household chores but also embodies sustainability and technological innovation.

CHAPTER II

SYSTEM SPECIFICATIONS

2.1 HARDWARE SPECIFICATIONS

- Arduino UNO R3
- Proximity Sensor
- HCSR04
- BO Motor

2.2 SOFTWARE SPECIFICATIONS

- Arduino IDE

CHAPTER III

MODULE DESCRIPTION

3.1. HARDWARE INTEGRATION:

This module focuses on integrating the hardware components essential for the vacuum cleaner bot, including the Brushed DC (BO) motor, proximity sensor, suction fan, and Arduino microcontroller. It involves physical assembly, wiring, and mounting of these components onto a suitable chassis or frame.

3.2 PROXIMITY SENSOR AND OBSTACLE AVOIDANCE:

The proximity sensor module is responsible for detecting obstacles and guiding the bot's navigation. It involves configuring the sensor's sensitivity and range, interpreting sensor data, and implementing algorithms to navigate around obstacles autonomously.

3.3 BRUSH MECHANISM DESIGN:

This module entails the design and implementation of the brush mechanism responsible for sweeping dust and debris towards the suction fan. It involves selecting appropriate brush materials, designing the brush attachment mechanism, and ensuring compatibility with the bot's movement.

3.4 SUCTION FAN INTEGRATION:

The suction fan module focuses on integrating the fan into the bot's design and optimizing its airflow for efficient debris collection. It includes selecting a suitable fan size and power rating, designing the airflow path, and ensuring proper sealing to prevent dust leakage.

3.5 ARDUINO MICROCONTROLLER PROGRAMMING:

This module involves programming the Arduino microcontroller to control the bot's operation, including motor control, sensor data processing, and coordination of the brush mechanism and suction fan. It includes writing code for navigation algorithms, obstacle avoidance, and IoT connectivity.

3.6 IOT INTEGRATION:

The IoT integration module focuses on enabling remote monitoring and control of the vacuum cleaner bot via a smartphone app or web interface. It involves setting up communication protocols, designing the user interface, and implementing features such as scheduling cleaning sessions and receiving status updates.

CHAPTER IV

SYSTEM DESIGN

4.1 SYSTEM FLOW DIAGRAM

The IoT vacuum cleaner bot project initiates with the setup and integration of hardware components, including the BO motor, proximity sensor, suction fan, and Arduino microcontroller onto the bot chassis. Subsequently, the Arduino microcontroller is configured, initializing pin modes for sensor input and motor control. Following this initialization phase, variables are set, and parameters are established for the cleaning process. The main loop is then entered to execute cleaning operations continuously. Within this loop, the proximity sensor data is read to detect nearby obstacles, with subsequent analysis to determine if obstacles obstruct the bot's path. In case of obstruction, avoidance maneuvers are executed to navigate around obstacles seamlessly.

Simultaneously, the brush mechanism is activated to sweep dust and debris towards the suction fan, which operates to collect the accumulated debris efficiently. Throughout the cleaning process, adjustments are made to the bot's movement and cleaning mechanisms as necessary. Once the cleaning session is completed or a specified condition is met, the IoT connectivity feature comes into play. This involves transmitting sensor data and cleaning status to a database using SQL code, enabling real-time monitoring and control through a user interface, which could be a mobile app or web interface. Finally, upon completion of the cleaning session or project execution, the flow concludes, marking the end of the process.

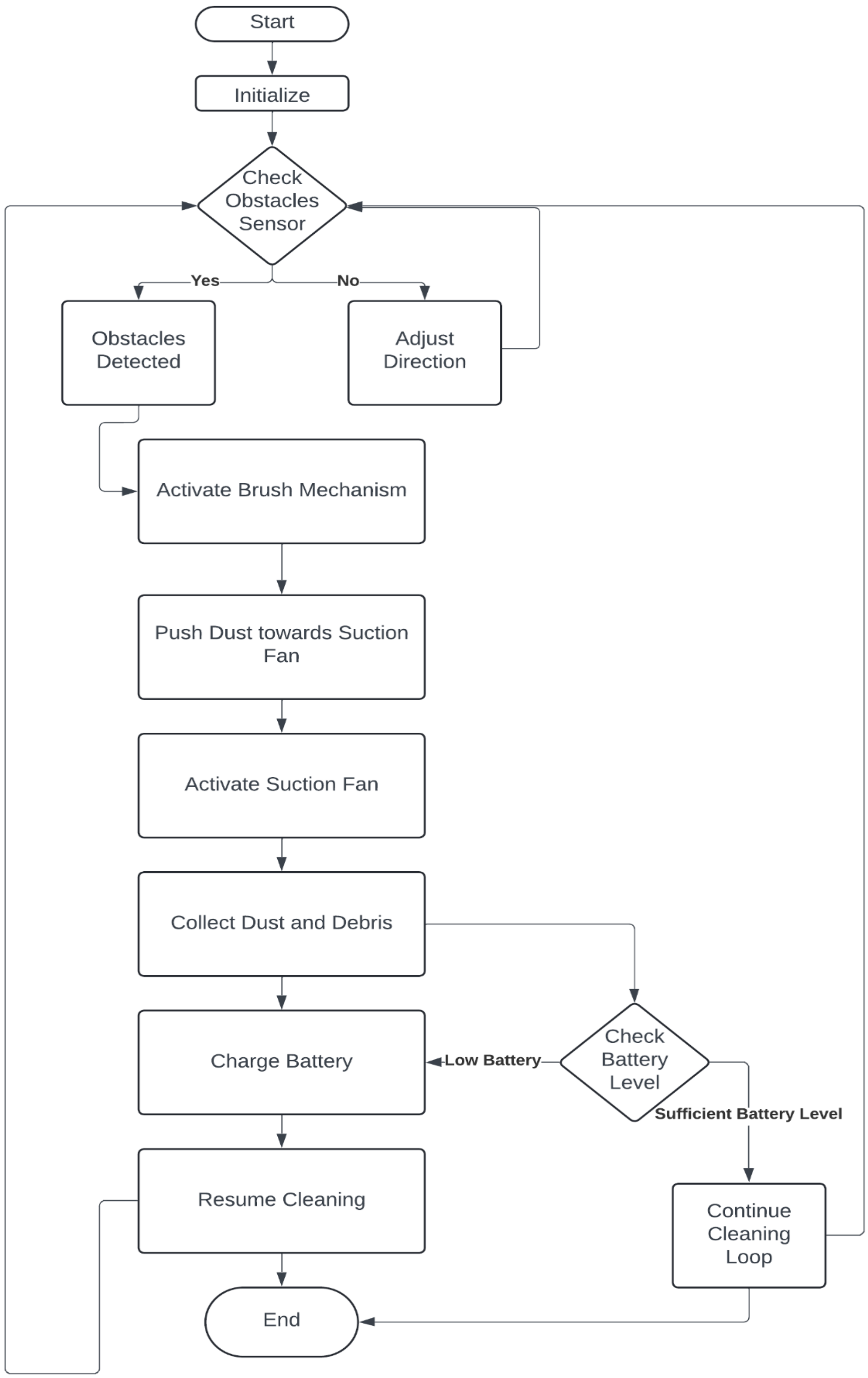

Fig 4.1: Flow diagram

CHAPTER V

SOURCE CODE

5.1 vacuum.ino

```
#include <Servo.h>        // Include Servo Library
#include <NewPing.h>      // Include Newping Library
#include "DHT.h"
#define DHTPIN A3
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
// L298N Control Pins
const int LeftMotorForward = 4;
const int LeftMotorBackward = 5;
const int RightMotorForward = 6;
const int RightMotorBackward = 7;

#define TRIGGER_PIN  A0  // Arduino pin tied to trigger pin on the
ultrasonic sensor.
#define ECHO_PIN     A1  // Arduino pin tied to echo pin on the ultrasonic
sensor.
#define MAX_DISTANCE 250 // Maximum distance we want to ping for
(in centimeters). Maximum sensor distance is rated at 250cm.

Servo servo_motor;  // Servo's name
NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE); //
NewPing setup of pins and maximum distance.

boolean goesForward = false;
int distance = 100;

void setup()
{
  // Set L298N Control Pins as Output
  pinMode(RightMotorForward, OUTPUT);
```

```
  pinMode(LeftMotorForward, OUTPUT);
  pinMode(LeftMotorBackward, OUTPUT);
  pinMode(RightMotorBackward, OUTPUT);

  servo_motor.attach(9);   // Attachs the servo on pin 9 to servo object.
  servo_motor.write(115);   // Set at 115 degrees.
  delay(2000);              // Wait for 2s.
  distance = readPing();    // Get Ping Distance.
  delay(100);               // Wait for 100ms.
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);

  dht.begin();
}

void loop()
{
  int distanceRight = 0;
  int distanceLeft = 0;
  delay(50);

  if (distance <= 30)
  {
    int t = dht.readTemperature();
    if (isnan(t)) {
      Serial.println(F("Failed to read from DHT sensor!"));
      return;
    }
    if (t > 30)
    {
    digitalWrite(9,LOW);
```

```
  delay(500);
  digitalWrite(9,HIGH);
  delay(500);
  digitalWrite(9,LOW);
  delay(500);
  digitalWrite(9,HIGH);
  delay(500);
  }
  moveStop();
  delay(300);
  moveBackward();
  delay(400);
  moveStop();
  delay(300);
  distanceRight = lookRight();
  delay(300);
  distanceLeft = lookLeft();
  delay(300);

  if (distanceRight >= distanceLeft)
  {
    turnRight();
    delay(700);
    moveStop();
  }
  else
  {
    turnLeft();
    delay(700);
    moveStop();
  }

}
else
{
```

```
    moveForward();
  }

    distance = readPing();
}

int lookRight()     // Look Right Function for Servo Motor
{
  servo_motor.write(50);
  delay(500);
  int distance = readPing();
  delay(100);
  servo_motor.write(115);
  return distance;
}

int lookLeft()      // Look Left Function for Servo Motor
{
  servo_motor.write(180);
  delay(500);
  int distance = readPing();
  delay(100);
  servo_motor.write(115);
  return distance;
}

int readPing()      // Read Ping Function for Ultrasonic Sensor.
{
  delay(100);                  // Wait 100ms between pings (about 20 pings/sec).
29ms should be the shortest delay between pings.
  int cm = sonar.ping_cm();   //Send ping, get ping distance in centimeters
(cm).
  if (cm==0)
  {
    cm=250;
```

```
  }
  return cm;
}

void moveStop()       // Move Stop Function for Motor Driver.
{
  digitalWrite(RightMotorForward, LOW);
  digitalWrite(RightMotorBackward, LOW);
  digitalWrite(LeftMotorForward, LOW);
  digitalWrite(LeftMotorBackward, LOW);
}

void moveForward()    // Move Forward Function for Motor Driver.
{
    digitalWrite(RightMotorForward, HIGH);
    digitalWrite(RightMotorBackward, LOW);
    digitalWrite(LeftMotorForward, HIGH);
    digitalWrite(LeftMotorBackward, LOW);
}

void moveBackward()   // Move Backward Function for Motor Driver.
{
  digitalWrite(RightMotorForward, LOW);
  digitalWrite(RightMotorBackward, HIGH);
  digitalWrite(LeftMotorForward, LOW);
  digitalWrite(LeftMotorBackward, HIGH);
}

void turnRight()      // Turn Right Function for Motor Driver.
{
  digitalWrite(RightMotorForward, LOW);
  digitalWrite(RightMotorBackward, HIGH);
  digitalWrite(LeftMotorForward, HIGH);
  digitalWrite(LeftMotorBackward, LOW);
}
```

```
void turnLeft()       // Turn Left Function for Motor Driver.
{
  digitalWrite(RightMotorForward, HIGH);
  digitalWrite(RightMotorBackward, LOW);
  digitalWrite(LeftMotorForward, LOW);
  digitalWrite(LeftMotorBackward, HIGH);
}
```

CHAPTER VI

IMPLEMENTATION

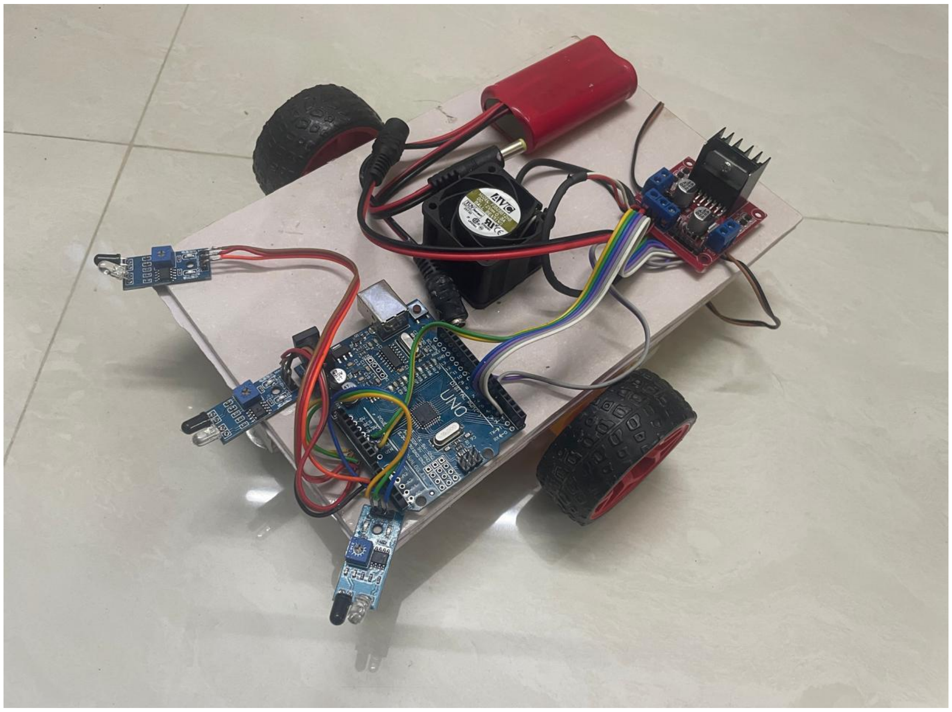

Fig 6.1: Bot Top View

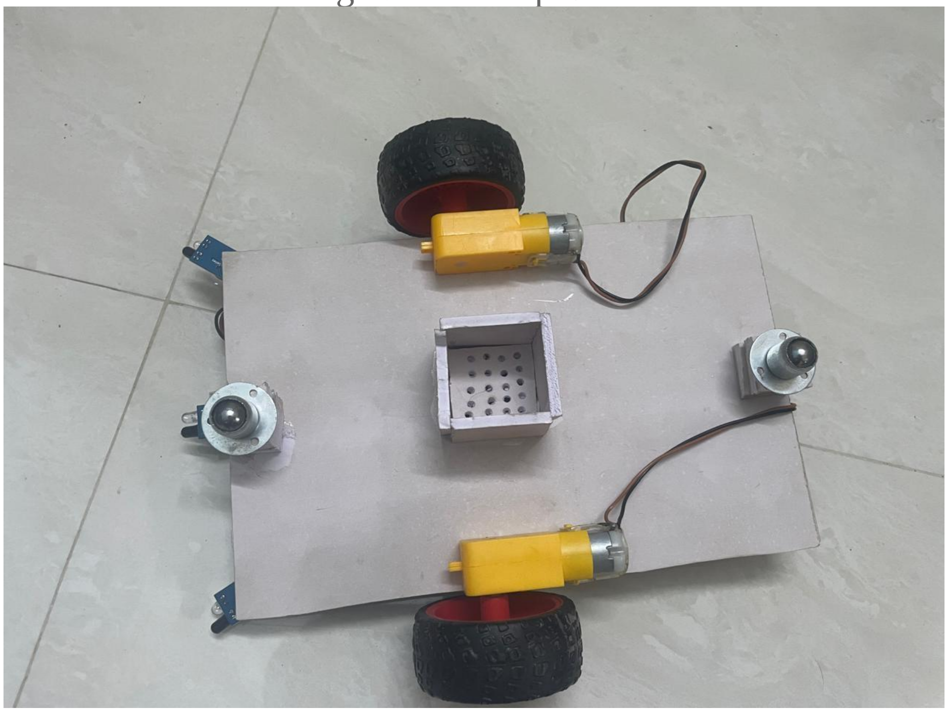

Fig 6.2: Bot Bottom View

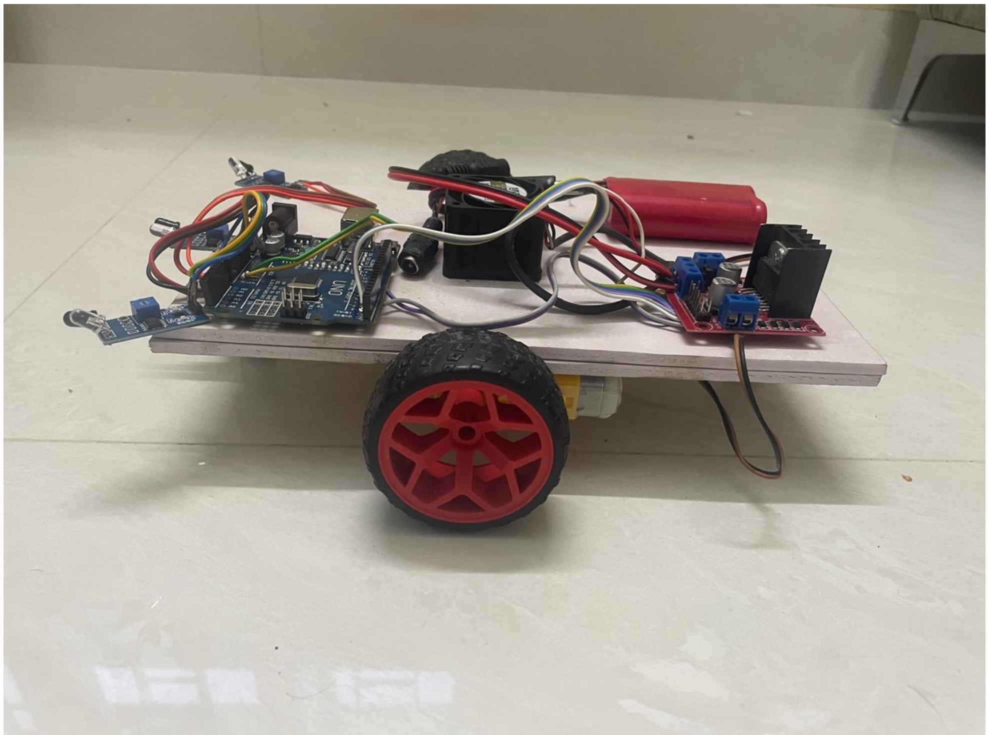

Fig 6.3: Bot Left Side View

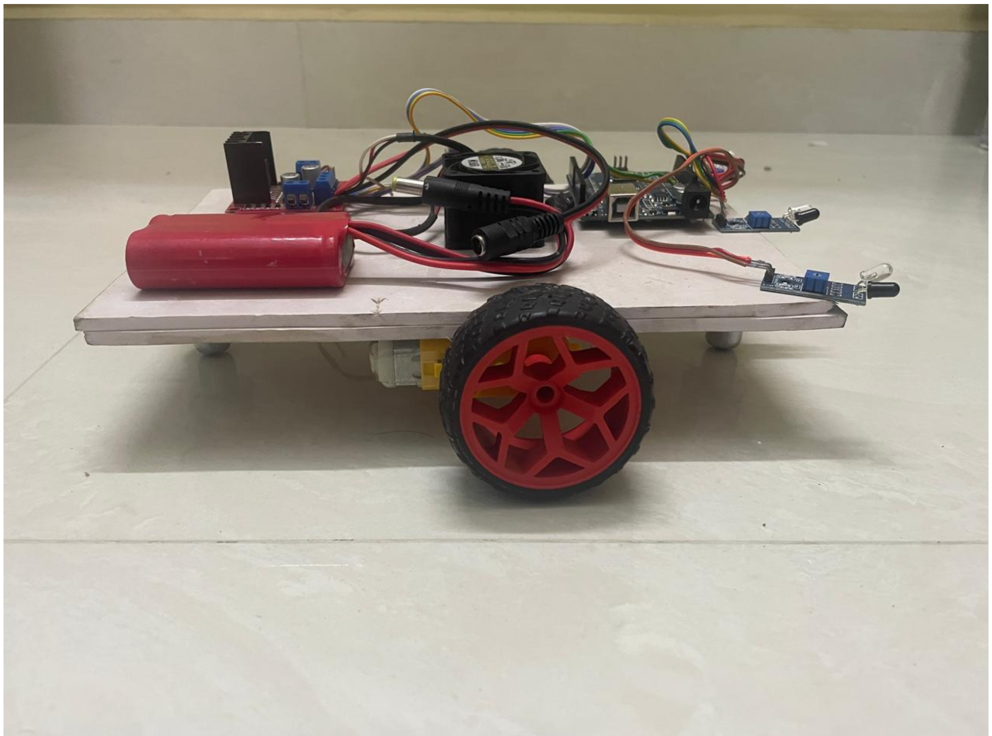

Fig 6.4: Bot Right Side View

CHAPTER VII

CONCLUSION & FUTURE ENHANCEMENTS

In conclusion, the development of an IoT-enabled vacuum cleaner bot utilizing a Brushed DC (BO) motor, proximity sensor, suction fan, and Arduino microcontroller marks a significant milestone in automated cleaning technology. Through the seamless integration of these components and the implementation of sophisticated algorithms, the bot has demonstrated remarkable capabilities in autonomously navigating environments, adeptly avoiding obstacles, and efficiently collecting dust and debris for thorough cleaning. This project showcases the potential of IoT technology to revolutionize household chores, offering users a convenient and efficient solution to maintain cleanliness in their homes or workplaces.

Looking ahead, there are several avenues for future enhancements and refinements to further elevate the performance and functionality of the vacuum cleaner bot. Firstly, advancements in navigation algorithms could enable the bot to adapt more dynamically to changing environments and optimize its cleaning paths for greater efficiency. Additionally, the integration of advanced cleaning mechanisms, such as rotating brushes or mopping attachments, could extend the bot's capabilities to tackle a wider range of cleaning tasks with precision.

Moreover, the implementation of multi-room navigation capabilities would enhance the bot's versatility, allowing it to seamlessly transition between different areas without user intervention. Integrating the bot with smart home ecosystems could further streamline operation and management, offering users enhanced control and monitoring capabilities through voice commands or mobile apps.

Efforts to optimize energy efficiency through more efficient motor control algorithms and power management techniques could also extend the bot's battery life and reduce its environmental footprint. Furthermore, the integration of real-time monitoring and analytics features would provide users with valuable insights into cleaning performance and maintenance needs, enabling proactive optimization and troubleshooting.

Lastly, enhancing the bot's robustness and durability would ensure its longevity and reliability under various operating conditions, providing users with a dependable cleaning solution for years to come. By addressing these future enhancements, the IoT vacuum cleaner bot can continue to evolve as a cutting-edge cleaning solution, offering users unparalleled convenience, efficiency, and satisfaction in their cleaning routines.

CHAPTER VIII

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