Project Report on
Sewage Cleaning Bot

Submission to The Robotics Club – SNIST as a part of Post Induction'23

Team No – 06

THE ROBOTICS CLUB
Integrating Knowledge...

THE ROBOTICS CLUB – SNIST

SREENIDHI INSTITUTE OF SCIENCE AND TECHNOLOGY

(AUTONOMOUS)

(Affiliated to JNTU University, Hyderabad)

Yamnampet, Ghatkesar, Hyderabad – 501301

2023

CERTIFICATE

This is the project work titled ‘Sewage cleaning bot’ by ‘ T. Hima Avinash, Manichand, R.N. Rohit Chand, Tanmay Sugandhi ’. This is a record of the project work carried out by them during the year 2023-24 as a part of POST INDUCTION under the guidance and supervision of Murgan Saravanan.

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DECLARATION

The project work reported in the present thesis titled “**Sewage Cleaning Bot**” is a record of work done by Team 6 in **THE ROBOTICS CLUB** as a part of **POST INDUCTION – 2023.**

<u>No part of the thesis is copied from books/journals/Internet and wherever the portion is taken, the same has been duly referred in the text. The report is based on the project work done entirely by Team team_number and not copied from any other source.</u>

ACKNOWLEDGEMENT

This project report is the outcome of the efforts of many people who have driven our passion to explore into the implementation of **Sewage Cleaning Bot**. We have received great guidance, encouragement and support from them and have learned a lot because of their willingness to share their knowledge and experience.

We thank our technical heads **Mr. G. Kovidh Addhish and Mr. Aarushraj Puduchery** for being with us till the end of the project completion.

We thank all members of the **Steering Body, Executive Body, Technical Advisory Board and Club's Incubation and Competence Committee** of **The Robotics Club** for helping us with crucial parts of the project. We are deeply indebted to **Mr. N V V S Narayana** – The President, **Ms. Mugala Shravani** – The Vice President, **Mr. N Abinav** – General Secretary and **Ms. Maliha** – SAB Chairman **THE ROBOTICS CLUB** respectively and also every other person who spared their valuable time without any hesitation whenever we wanted.

We also thank our faculty advisor **Dr. A. Purushotham**, Professor Mechanical Department, who encouraged us during this project by rendering his help when needed.

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ABSTRACT

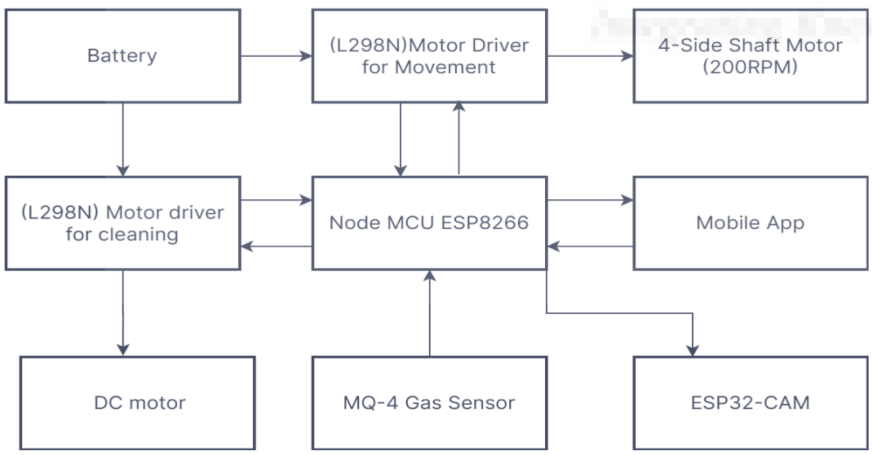
PROBLEM STATEMENT:

Cleaning sewage is a dangerous process that poses health risks. When human workers come into contact with sewage waste it can lead to damage to their physical health. Not only is this environment unsanitary. It also contains hazardous gases and materials that can be harmful for the human worker. Manual cleaning methods are often time consuming and not cost effective. In every city there is a network of sewage pipes that need cleaning and monitoring.However accomplishing this task can be quite challenging. Our project aims to simplify this process by introducing a bot. If the cleaning was done by a human the monitoring of the cleaning and giving direction would be a difficult task , To tackle this problem our bot is equipped with built in video streaming capabilities allowing real time monitoring of the cleaning procedure. This innovative solution eliminates the complexities. Ensures efficient and thorough sewage cleaning.

TEAM’S APPROACH TO THE PROBLEM:

The robot utilizes the ESP8266 micro-controller. For navigation within the challenging terrains of sewage systems, the robot is fitted with geared side shaft DC motors having a tank movement mechanism. To do the cleaning tasks, we implemented a high-torque motor combined with a rack and pinion system. Robot with the capability to extend an arm doesn’t damage itself. It is equipped with cleaning tools to reach and clean areas effectively.One of the main features of our robot is its real-time video monitoring capability, facilitated through the ESP32-CAM's Wi-Fi function. This feature helps the operators the bot remotely and view the cleaning process in real-time.Further enhancing the user experience and control, we integrated the robot with the A mobile application. This integration offers a seamless platform for both monitoring the video feed and remotely controlling the robot's movements and functions. The bot is also equipped with and MQ-4 sensor for detection of harmful gases.

BLOCK DIAGRAM:



Sewage Cleaning Bot

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January 8, 2024

Abstract

Cleaning sewage is a dangerous process that poses health risks. When human workers come into contact with sewage waste it can lead to damage to their physical health. Not only is this environment unsanitary. It also contains hazardous gases and materials that can be harmful for the human worker. Manual cleaning methods are often time consuming and not cost effective. In every city there is a network of sewage pipes that need cleaning and monitoring.However accomplishing this task can be quite challenging. Our project aims to simplify this process by introducing a bot. If the cleaning was done by a human the monitoring of the cleaning and giving direction would be a difficult task , To tackle this problem our bot is equipped with built in video streaming capabilities allowing real time monitoring of the cleaning procedure. This innovative solution eliminates the complexities. Ensures efficient and thorough sewage cleaning.

1 Introduction

In urban environments, maintaining sewage systems is paramount to ensuring public health, sanitation, and the overall functionality of a city's infrastructure. Traditional sewage cleaning methods involve manual labor, posing considerable health risks to workers who are often exposed to hazardous conditions, toxic gases, and possible pathogenic microorganisms. Beyond the evident health implications, these conventional methods are time-consuming, labor-intensive, and often lack the precision and thoroughness required for optimal maintenance.

To address these challenges, we embarked on developing the sewage cleaning robot—a state-of-the-art solution designed to revolutionize sewage system maintenance. Combining the capabilities of robotics, real-time video streaming, and sensor technology, this robot is crafted to navigate through sewage pipelines autonomously, providing real-time feedback to operators while performing precise cleaning operations.

The project aims not only to enhance the efficiency and effectiveness of sewage cleaning but also to prioritize the safety of personnel by minimizing direct human intervention in potentially hazardous environments. Through innovative design and the integration of cutting-edge technology, the sewage cleaning robot stands as a testament to leveraging technological advancements for urban and public welfare.

1.1 Existing System

This HVAC Duct Inspection Cleaning Robotic System is equipped with front and rear 1080P color video camera (complete with high intensity illumination), it can up/down the camera and the brush, the brush will work automatically and it can loosen dust or particles that are attached on the side walls of air duct over time, the system come with 3 sizes of the brush. .[3]

1.2 Proposed System

The robot utilizes the ESP8266 micro-controller.The micro-controller is compact and has an in-built camera so the system will be compact. For navigation within the challenging terrains of sewage systems, the robot is fitted with geared side shaft DC motors having a tank movement mechanism. To do the cleaning tasks, we implemented a high-torque motor combined with a rack and pinion system. Robot with the capability to extend an arm doesn't damage itself. It is equipped with cleaning tools to reach and clean areas effectively.One of the main features of our robot is its real-time video monitoring capability, facilitated through the ESP32-CAM's Wi-Fi function. This feature helps the operators can remotely view the cleaning process in real-time.Further enhancing the user experience and control, we integrated the robot with the A mobile application. This integration offers a seamless platform for both monitoring the video feed and remotely controlling the robot's movements and functions. The bot is also equipped with and MQ-4 sensor for detection of harmful gases.

2 Architecture

2.1 Hardware

2.1.1 NodeMCU ESP8266

NodeMCU ESP8266 is an open-source, low-cost Wi-Fi module with integrated microcontroller capabilities. It's based on the ESP8266 SoC (System on a Chip) and is widely used in IoT (Internet of Things) projects. NodeMCU makes it easy to connect and program IoT devices, offering a simple and accessible platform for building Wi-Fi-enabled projects. It supports the Arduino IDE, making it popular among developers and hobbyists for creating connected applications and prototypes.

Figure 1: NodeMCU ESP8266

2.1.2 Bread board

An electronics breadboard (as opposed to the type on which sandwiches are made) is actually referring to a solder-less breadboard. These are great units for making temporary circuits and prototyping, and they require absolutely no soldering.

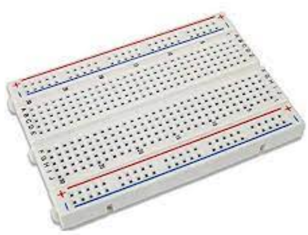

Figure 2: Bread board

2.1.3 Brush

Using a metal brush for cleaning is an effective method for removing stubborn dirt, rust, or debris from various surfaces. These brushes, typically made with wire bristles, offer excellent abrasive properties.The brush can withstand a whooping 4500 rotations per minute to achieve high-scale industrial results.

Figure 3: Brush

2.1.4 MQ-4 Gas Sensor

The MQ-4 Gas Sensor is a popular semiconductor gas sensor used to detect the presence of methane (CH4) and other flammable gases in the air.The MQ-4 sensor operates on the principle of changes in resistance when it comes into contact with the target gas. As the concentration of the gas increases, the sensor's resistance decreases

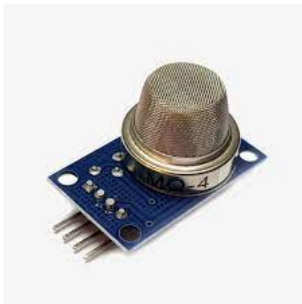

Figure 4: MQ-4 Gas Sensor

2.1.5 Side Shaft Motor

The 200 RPM side Shaft Motor -side shaft motor, also known as a horizontal shaft motor, is a type of internal combustion engine typically used in various applications, such as lawnmowers, small vehicles, and certain power equipment It is an alternative to our metal gear DC motors. It comes with an operating voltage of 12V and is perfect for building small and medium robots..

Figure 5: Side Shaft Motors

2.1.6 Centre Shaft Motor

The single Shaft Motor - is an electro-mechanical device that converts electrical energy from a direct current power source into mechanical motion.They are known for their simplicity, reliability, and ease of control, making them suitable for various tasks.

Figure 6: Centre Shaft Motors

2.1.7 ESP32-Cam

The ESP32-CAM is a versatile development board that combines the ESP32 microcontroller with a camera module.It comes with an OV2640 camera and provides onboard TF card slot. The ESP32-CAM is widely used for projects involving video streaming, image capture, and home security applications, making it a valuable tool in the realm of embedded systems and the Internet of Things (IoT).

Figure 7: ESP32-Cam

2.1.8 Wheels

Wheels with good grip are used so that the bot moves freely through the pipes.They reduce friction, making it easier to transport heavy loads and navigate obstacles. We can traverse through rough terrain as they have good grip. The ones we are using are made of plastic and rubber.

Figure 8: Wheels

.

2.1.9 LI-ion batteries

A lithium-ion or Li-ion battery is a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy. The anode (negative electrode) of a conventional lithium-ion cell is typically graphite made from carbon. The cathode (positive electrode) is typically a metal oxide. The electrolyte is typically a lithium salt in an organic solvent. If you plan to store Li-ion batteries for an extended period, it's recommended to do so at a partial charge (around 50

Figure 9: LI - ion batteries

2.1.10 Motor Driver - L298N

The L298N is a dual H-bridge motor driver integrated circuit (IC) commonly used to control and drive DC motors, particularly in robotics and mechanics applications. It provides a straightforward way to manage motor direction and speed using control signals from micro-controllers like Arduino. The L298N motor driver has a supply range of 5v to 35v and is capable of 2A continuous current per channel, so it works well with most of the DC motors. The L298N is valued for its efficiency, ease of use, and versatility, making it a popular choice for hobbyists and engineers working on projects involving motor control.

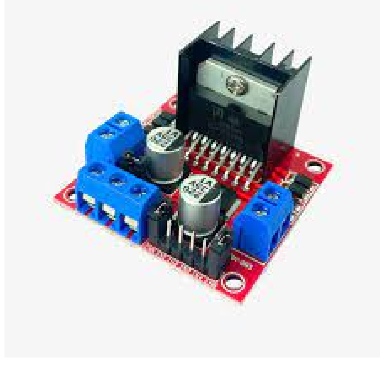

Figure 10: Motor Driver - L298N

2.1.11 Rack And Pinion

Rack and pinion is a mechanical system commonly used to convert rotational motion into linear motion (or vice versa) and is frequently employed in various applications, such as steering systems in vehicles. The system consists of a gearwheel (the "pinion") that meshes with a linear toothed component (the "rack"). When the pinion rotates, it moves the rack linearly, allowing for precise and controlled movement. This setup is valued for its simplicity, efficiency, and suitability for tasks that require linear motion or precise positioning. A rack and pinion drive can use both straight and helical gears.

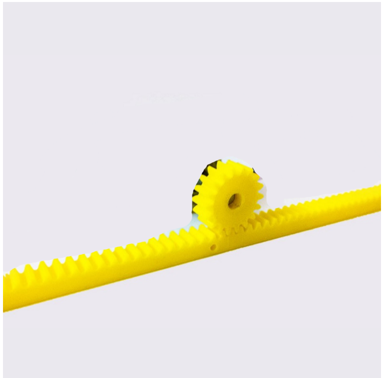

Figure 11: Rack And Pinion

2.1.12 Jumper Wires

A jumper wire is an electrical wire or group of wires used to connect circuits without soldering. They have connectors or pins at their ends. Depending upon the configuration of end connectors, they are classified into three types: male-to-male, male-to-female and female-to-female.

Figure 12: Jumper Wires

2.2 Software

2.2.1 Arduino IDE

Arduino Integrated Development Environment is an open-source application software created by Arduino. It is used to write and upload code on to the Arduino boards. It supports C and C++ programming languages, and has a built-in compiler.

You can compile your code within the IDE to check for errors and then upload the compiled program (known as a sketch) to the connected Arduino board. The IDE handles the compilation and uploading process seamlessly.

Figure 13: Arduino IDE

2.2.2 Fusion 360

Fusion 360 is a computer-aided designing (CAD) software application for 3-D modelling and simulation. It's other functions include computer-aided manufacturing (CAM) and computer-aided engineering (CAE), as well as designing printed circuit boards.

Fusion 360 provides powerful 3D modeling tools that allow users to create complex 3D models of products and components. It supports parametric modeling, direct modeling, and sculpting.

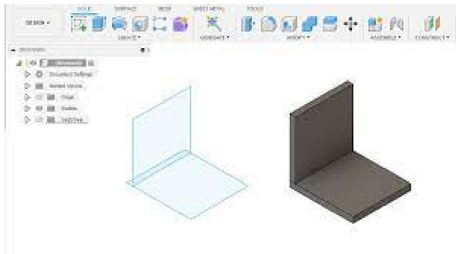

Figure 14: Fusion 360

2.2.3 Fritzing

Fritzing is an open-source electronic design automation (EDA) software to design electronics hardware, printed circuit boards and schematic circuit diagrams. It is an offshoot of the Processing programming language and the Arduino microcontroller.

Fritzing allows users to create electronic circuits by dragging and dropping various components (e.g., resistors, LEDs, microcontrollers) onto a virtual breadboard. Users can connect components by drawing wires to represent electrical connections.

2.2.4 Blynk IOT

Blynk is an IoT platform for iOS or Android smartphones that is used to control micro-controllers.This application is used to create a graphical interface or human machine interface (HMI) by compiling and providing the appropriate address.

Figure 15: Fritzing

Blynk offers a mobile app for Android and iOS devices that allows users to design and control their IoT projects through a smartphone or tablet.It is great.

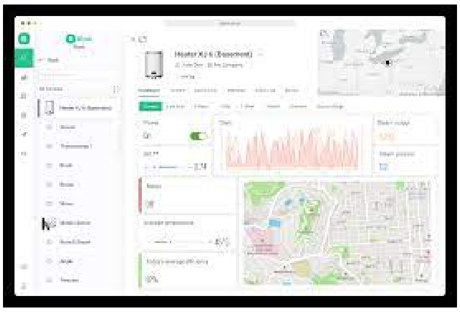

Figure 16: Blynk IOT

2.2.5 ThingSpeak

ThingSpeak™ is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. hingSpeak stores the data in channels, which are like data streams or datasets. Users can create and manage multiple channels to organize their data.

ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak.You can organize data easily. Users can send data from IoT devices, such as sensors and microcontrollers, to ThingSpeak.

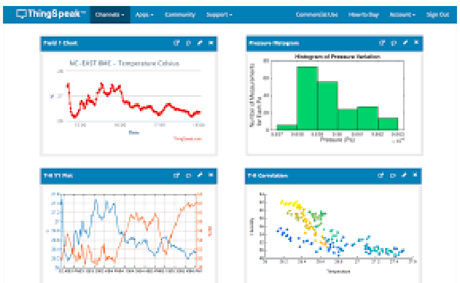

Figure 17: ThingSpeak

3 Implementation and working:

3.1 Circuit diagram

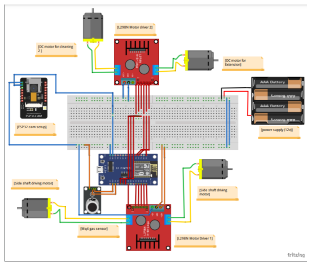

Figure 18: circuit diagram

3.2 Block diagram

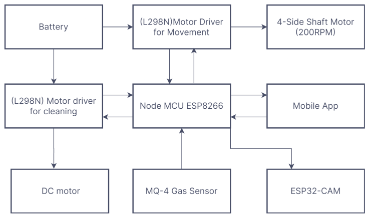

Figure 19: Block diagram

3.3 Working Mechanism

The sewage cleaning robot is designed to navigate through sewage pipelines, providing real-time video feedback and performing cleaning operations while monitoring toxic gas levels.Upon activation, the robot begins by establishing a Wi-Fi connection, allowing for remote control and data transmission to the user interface. The video streaming initiates via the ESP32-CAM module, offering operators a clear view of the sewage environment.As the robot moves, the four geared DC motors, which drive the robot, receive commands from the user interface. Depending on the command, the robot can move forward, backward, left, or right.For cleaning purposes, a high-speed DC motor activates a cleaning mechanism, which could be a brush or blade, to clear obstructions or clean the walls of the pipeline.Additionally, the robot has an extendable arm powered by another geared DC motor and a rack and pinion system. This arm can be extended or retracted based on user input, allowing the robot to reach further into obstructions or specific areas needing cleaning.To ensure safety and provide valuable data, the MQ-4 methane gas sensor continuously monitors the methane gas levels in the sewage. If the levels rise above a certain threshold, an alert can be sent to the operator, signaling a potential hazard.The entire operation is overseen through a user interface, allowing operators to control the robot, view live video feeds, receive methane gas alerts, and make informed decisions in real-time

4 Experimental Results and Conclusions:

4.1 Results

Upon the completion and deployment of the sewage cleaning robot, remarkable improvements in sewage maintenance were observed. the primary achievements of the project was the elimination of direct human intervention within the sewage system which was achieved.Due to which toxic gas exposure, infections were reduced.As the bot was equipped with high speed motor the cleaning was done in an effective and efficient way. Due the video streaming we were even able to inspect the pipe from inside to see if there is any damage.The gas sensor allowed us to monitor the gas levels and take acctions accordingly.Overall, the bot was a success as it wasa cost effectibve and easy to use and understand the controls.

4.2 Future Enhancements

The model developed by our team is a rudimentary prototype. It can be replicated on a large scale by developing sturdier, more reliable designs for cleaning sewers. Depending upon its functionality, the robot can be modified to as to see in multiple directions and can be operated fully automatically.Even the Bot can be made smaller so that the bot could fit in the smaller area. and be even more useful.And also adding multiple ways of cleaning the the pipes instead of using just a brush.

4.3 Conclusion

The sewage cleaning robot project aims to solve the challenges of maintaining sewage systems efficiently and safely. Traditional methods have limitations, including manual labor in hazardous conditions. This robot, using modern technology, provides an semi-automated solution to navigate, monitor, and clean sewage pipelines, improving overall sewage maintenance.

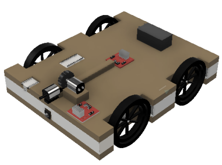

Figure 20: CAD Design of Prototype

4.4 References

[1] International Reserch journel of Engineering and technology(IRJET),Robot to un-colg sewage channels(IRJET-V617317)

[2] International Reserch journel of Engineering andtechnology(IRJET),Implementation of Sewer inspection Robot(IRJETV512361)

[3] Nirmitee Robotics India Ltd , HVAC Duct Inspection Cleaning .

4.5 Source Code

```
#define BLYNK_TEMPLATE_ID "TMPL32GSQIhe6"
#define BLYNK_TEMPLATE_NAME "Quickstart Device"
#define BLYNK_AUTH_TOKEN
    "cno9TktK1ZRK2Q2WZqoa5WEpWi8TeDRY"

#include <BlynkSimpleEsp8266.h>
//Movement
// Motor A
const int motor1A = D1;  // D1
const int motor1B = D2;  // D2
const int enA = D0;      // D0

// Motor B
const int motor2A = D3;  // D3
const int motor2B = D4;  // D4
const int enB = D5;      // D5

// Extension
const int motor3A = D6;  // D6
const int motor3B = D7;  // D7
int const en2A = D8;     // D8

// Spinning
const int motor4A = 3;   // GPIO3
const int motor4B = 1;   // GPIO1
int const en2B = 10;     // GPIO10

void setup() {
  Serial.begin(00);
  Blynk.begin(BLYNK_AUTH_TOKEN, "The Robotics Club",
  "trcsnist@2022");

  //Movement
  pinMode(motor1A, OUTPUT);
  pinMode(motor1B, OUTPUT);
  pinMode(motor2A, OUTPUT);
  pinMode(motor2B, OUTPUT);
  pinMode(enA, OUTPUT);
  pinMode(enB, OUTPUT);
  //Extension and Spinning
  pinMode(motor3A, OUTPUT);
  pinMode(motor3B, OUTPUT);
  pinMode(motor4A, OUTPUT);
  pinMode(motor4B, OUTPUT);
  pinMode(en2A, OUTPUT);
  pinMode(en2B, OUTPUT);
}


BLYNK_WRITE(V0) { //Forward Button
  int value = param.asInt();

  if (value == 1) {
    Serial.println("Switch on V0 is ON");
```

```
    forward();
  } else {
    Serial.println("Switch on V0 is OFF");
    stopMotorsDrive();
  }
}

BLYNK_WRITE(V1) { // Backward
  int value = param.asInt();

  if (value == 1) {
    Serial.println("Switch on V1 is ON");
    backward();
  } else {
    Serial.println("Switch on V1 is OFF");
    stopMotorsDrive();
  }
}

BLYNK_WRITE(V2) { // Right
  int value = param.asInt();

  if (value == 1) {
    Serial.println("Switch on V2 is ON");
    right();
  } else {
    Serial.println("Switch on V2 is OFF");
    stopMotorsDrive();
  }
}

BLYNK_WRITE(V3) { //Left
  int value = param.asInt();

  if (value == 1) {
    Serial.println("Switch on V3 is ON");
    left();
  } else {
    Serial.println("Switch on V3 is OFF");
    stopMotorsDrive();
  }
}

BLYNK_WRITE(V5) { //Extension And retraction
  int value = param.asInt();

  if (value == 1) {
    Serial.println("Switch on V3 is ON");
    extension();
  } else {
    Serial.println("Switch on V3 is OFF");
    retraction();
    stopMotorsEs();
  }
}

BLYNK_WRITE(V4) { //Spinning
  int value = param.asInt();

  if (value == 1) {
    Serial.println("Switch on V3 is ON");
    spin();
  } else {
    Serial.println("Switch on V3 is OFF");
    stopMotorsEs();
  }
}

void loop() {
  Blynk.run();
}
//Driving Functions
void forward() {
  analogWrite(enA, 255);
  analogWrite(enB, 255);
  digitalWrite(motor1A, HIGH);
  digitalWrite(motor1B, LOW);
  digitalWrite(motor2A, HIGH);
  digitalWrite(motor2B, LOW);
}

void backward() {
  analogWrite(enA, 255);
  analogWrite(enB, 255);
  digitalWrite(motor1A, LOW);
  digitalWrite(motor1B, HIGH);
  digitalWrite(motor2A, LOW);
  digitalWrite(motor2B, HIGH);
}

void left() {
  analogWrite(enA, 255);
  digitalWrite(motor1A, HIGH);
  digitalWrite(motor1B, LOW);
  analogWrite(enB, 255);
  digitalWrite(motor2A, LOW);
  digitalWrite(motor2B, HIGH);
}

void right() {
  analogWrite(enA, 255);
  digitalWrite(motor1A, LOW);
  digitalWrite(motor1B, HIGH);
  analogWrite(enB, 255);
  digitalWrite(motor2A, HIGH);
  digitalWrite(motor2B, LOW);
}

void stopMotorsDrive() {
  analogWrite(enA, 0);
  analogWrite(enB, 0);
  digitalWrite(motor1A, LOW);
  digitalWrite(motor1B, LOW);
  digitalWrite(motor2A, LOW);
  digitalWrite(motor2B, LOW);
}
```

```
//Extension and Spinning Functions
void extension() {
  analogWrite(en2A, 255);
  digitalWrite(motor3A, HIGH);
  digitalWrite(motor3B, LOW);
  delay(250);
  stopMotorsEs();
}

void retraction() {
   analogWrite(en2A, 255);
  digitalWrite(motor3A, LOW);
  digitalWrite(motor3B, HIGH);
  delay(250);
  stopMotorsEs();
}

void spin(){
  analogWrite(enB, 255);
  digitalWrite(motor4A, HIGH);
  digitalWrite(motor4B, LOW);
}

void stopMotorsEs() {
  analogWrite(en2A, 0);
  analogWrite(en2B, 0);
  digitalWrite(motor3A, LOW);
  digitalWrite(motor3B, LOW);
  digitalWrite(motor4A, LOW);
  digitalWrite(motor4B, LOW);
}
```

4.6 List of Expenses

Components	Price(in INR)
ESP32-CAM	475
Node MCU ESP-8266	196
L298N Motor driver (×2)	254
Rack and pinion gear	200
Wheels (×4)	164
Geared DC motor(x2)	400
Side Shaft motor (x 2)	700
MQ-4 methane gas sensor	100
Battery	500
Jumper wires	80
Brush	250
Total(approximate)	3,500