21MHC207L-MICROCONTROLLER AND EMBEDDED SYSTEMS LABORATORY MINI PROJECT REPORT

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SEMESTER – IV

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INTRODUCTION

The primary objective of this project is to design, build, and test a line-following robot capable of navigating intricate paths with accuracy and reliability, thereby contributing to the ongoing evolution of autonomous robotics technology. This report outlines the process and outcomes of our endeavour, detailing the design principles, construction methods, testing protocols, and performance evaluations essential for the development of a robust and efficient line-following robot.

Aim:

The objective of this report is to comprehensively document the development process and outcomes of designing and constructing a line-following robot, adhering strictly to ethical principles and guidelines. The project extends its focus on improving efficiency, accuracy, and reliability for real-world use. Through design, construction, and testing, the robot will be optimized for practical applications. The goal is to ensure the robot can navigate paths accurately and efficiently in various environments. Overall, the project targets developing a robust and dependable line-following robot for practical deployment.

Context Discription:

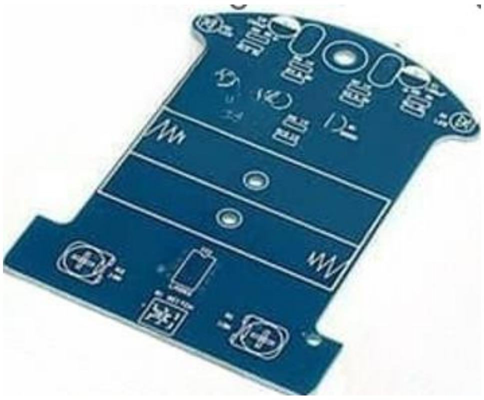
A line-following robot operates by using sensors, typically infrared or color sensors, to detect lines on the ground. The sensors are positioned underneath the robot and continuously scan the surface for changes in contrast between the line and its surroundings. When the sensors detect the line, the robot's control system processes this information and adjusts the motor speeds accordingly to stay aligned with the line.

The control algorithm typically follows a simple logic: if the sensor detects the line on the left side, the robot turns slightly to the right, and if the sensor detects the line on the right side, the robot turns slightly to the left. By continuously adjusting its movements based on sensor feedback, the robot can follow the path defined by the line.

DESIGN AND FABRICATION

Structural Elements

Chassis Board - The design of the chassis board is 3D printed after taking into account the dimensions required to accommodate the components of the line-following robot, such as the microcontroller, sensors, motor drivers, and power supply. Considering the overall shape, size, and layout to ensure efficient use of space and easy access to components for assembly and maintenance.



Wheels - The size and shape of the wheels based on the dimensions of the line-following robot considering factors like wheel diameter, width, and hub size to ensure compatibility with the robot's chassis and motor shafts. Decide whether the wheels have a hollow design, depending on weight considerations and printing complexity.

Electrical Elements

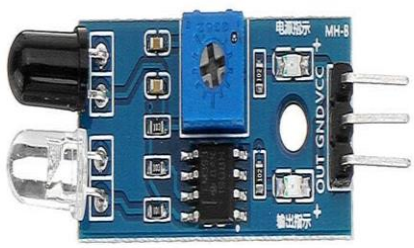
The electrical elements used in the project are two dc motors for motion control.

and two IR sensors for detection of contrast.

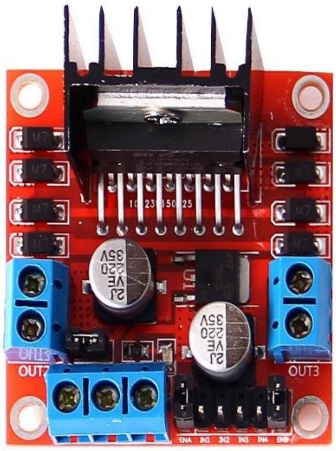
Electronic Elements

The electronic elements used in the project are ESP32 microcontroller and two IR sensors for detection of contrast and l298 H-bridge motor driver for motor control.

The ESP32 uses a Tensilica Xtensa 32-bit LX6 microprocessor. This typically relies on a dual core architecture. The clock frequency reaches up to 240MHz. Wireless connectivity – The ESP32 enables connectivity to integrated Wi-Fi through the 802.11 b/g/n/e/i/. Moreover, Bluetooth connectivity is made possible with the v4.2 BR/EDR, and the series also features Bluetooth low energy (BLE). Internal memory for the ESP32 is as follows. ROM: 448 KB (for booting/core functions), SRAM: 520 KB (for data/instructions), RTC fast SRAM: 8 KB (for data storage/main CPU during boot from sleep mode), RTC slow SRAM: 8 KB (for co-processor access during sleep mode), and eFuse: 1 KiBit (256 bits used for the system (MAC address and chip configuration) and 768 bits reserved for customer applications).

The L298N motor driver is a popular dual H-bridge motor driver IC that can control the direction and speed of two DC motors simultaneously. It is widely used in robotics and automation projects due to its versatility and ease of use. The L298N can handle up to 2 amps per channel and has built-in protection features such as thermal shutdown and current limiting. It operates using logic signals from a microcontroller to control the motor outputs, making it compatible with a wide range of microcontrollers and embedded systems.



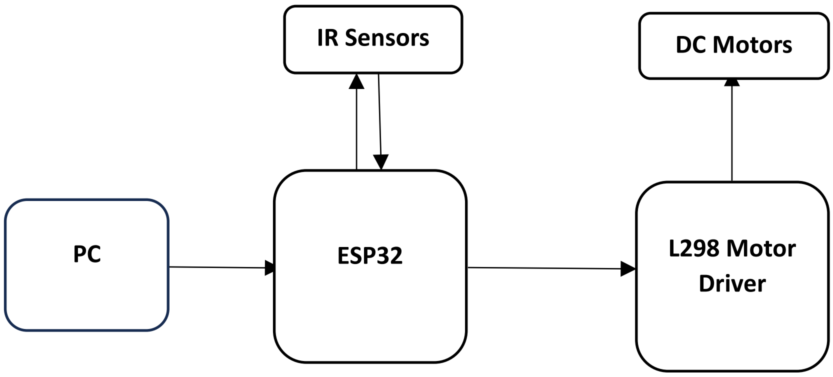
EXPLAINATION AND WORKING

Working

Line-following robots rely on infrared (IR) sensors positioned beneath the chassis, emitting light and analyzing reflections to discern the line's contrast against the surface. Upon detecting the line, the sensor relays a signal to the control system, detailing its precise position relative to the robot's centerline. The control system of a line-following robot processes the sensor data to determine the robot's orientation with respect to the line. Line-following robot have two motors, each connected to a wheel. The control system then processes this data, deciphering the robot's orientation concerning the line's trajectory. Line-following robot have two motors, each connected to a wheel. The control system adjusts the motor speeds independently to turn the robot left or right based on the line position detected by the sensors. For instance, if the robot deviates to the left of the line, the control system dynamically increases the right motor's speed while reducing the left motor's speed, prompting an immediate corrective turn to the right, and vice versa for rightward deviations. To sustain seamless operation, a robust power supply, typically sourced from a reliable battery pack or rechargeable batteries, consistently furnishes adequate voltage and current, ensuring optimal functionality for both motors and electronic components throughout usage. Once activated, the line-following robot's sensors swiftly initiate continuous scans the ground for lines. As the robot progresses forward, the sensors relay detection data to the control system, which swiftly computes necessary adjustments. These adjustments are then translated into precise motor speed alterations, dynamically aligning the robot with the line's path to navigate autonomously. This iterative process of data acquisition, analysis, and corrective action guarantees the robot's sustained ability to effectively follow lines and navigate intricate paths with autonomous precision.

Hardware Diagram

The Hardware Diagram shows the various components of the circuit and how the are connected to each other. The PC is connected to ESP32, the ESP32 is connected to L298 motor driver and IR snesors. The motor driver is connected to two DC motors.



PROGRAM

```
int EnB=13;   // Initializing pin numbers
int In3=14;
int In4=12;

int EnA=27;
int In1=26;
int In2=25;

int ir1=33;
int obj1;
int ir2=32;
int obj2;

void setup()
{
  pinMode(EnB,OUTPUT);  // Configuring pins as inputs or outputs
  pinMode(In3,OUTPUT);
  pinMode(In4,OUTPUT);
```

```
 pinMode(EnA,OUTPUT);
 pinMode(In1,OUTPUT);
 pinMode(In2,OUTPUT);

 pinMode(ir1,INPUT);
 pinMode(ir2,INPUT);
}

void loop()
{
 obj1=digitalRead(ir1);  // Reading sensor 1 to check line presence
 obj2=digitalRead(ir2);  // Reading sensor 2 to check line presence

 if(obj1==0 && obj2==0)  // If both sensors detect the line
 {
  analogWrite(EnA,255);  // Setting motor A speed
  digitalWrite(In1,0);   // Setting motor A direction
  digitalWrite(In2,1);

  analogWrite(EnB,255);  // Setting motor B speed
  digitalWrite(In4,0);   // Setting motor B direction
  digitalWrite(In3,1);
  delay(200);  // Delay for stability
 }

 if(obj1==0 && obj2==1)  // If only sensor 1 detects the line
 {
  analogWrite(EnA,100);  // Setting motor A speed
  digitalWrite(In1,0);   // Stopping motor A
  digitalWrite(In2,0);

  analogWrite(EnB,100);  // Setting motor B speed
  digitalWrite(In4,0);   // Setting motor B direction
  digitalWrite(In3,1);
  delay(200);  // Delay for stability
 }

 if(obj1==1 && obj2==0)  // If only sensor 2 detects the line
 {
  analogWrite(EnA,100);  // Setting motor A speed
  digitalWrite(In1,0);   // Setting motor A direction
  digitalWrite(In2,1);

  analogWrite(EnB,100);  // Setting motor B speed
```

```
  digitalWrite(In4,0);   // Stopping motor B
  digitalWrite(In3,0);
  delay(200);  // Delay for stability
 }

 if(obj1==1 && obj2==1)  // If no sensor detects the line
 {
  analogWrite(EnA,0);  // Stopping motor A
  digitalWrite(In1,0);
  digitalWrite(In2,1);

  analogWrite(EnB,0);  // Stopping motor B
  digitalWrite(In4,0);
  digitalWrite(In3,1);
  delay(200);  // Delay for stability
 }
}
```

RESULTS

The analysed working is on the basis of the bot to follow a definite pathway an to comemorate the movement to the program being run. The microcontroller aids in the running and formal execution of the motion of the project. Utility in areas like item dispatch in factory etc….

CONCLUSION

In conclusion, the development and implementation of the line-following robot project have been a successful endeavor with several notable achievements and challenges. The project's primary objective was to design, build, and test a robot capable of autonomously navigating predefined paths by detecting and following lines, focusing on optimizing efficiency, accuracy, and reliability in real-world applications. The project has demonstrated significant success in achieving its goals. The robot successfully detects lines using infrared sensors and adjusts its movements accordingly to stay aligned with the path. The implementation of PWM control for motor speed regulation has further enhanced the robot's performance, ensuring efficient movement and responsiveness to line deviations. The project required iterative testing and adjustments to ensure the robot's stability and accuracy. Additionally, integrating and synchronizing multiple components, such as motors, sensors, and the control system, posed technical challenges that demanded careful coordination and debugging. Overall, the project has delivered a functional and efficient line-following robot that meets the initial objectives. The successful completion of the project highlights the team's dedication, problem-solving

skills, and ability to overcome challenges in robotics and automation. Moving forward, further refinement and enhancements could be explored to improve the robot's performance in diverse environments and scenarios, contributing to advancements in autonomous robotics technology.
The future scope for line-following robots is promising, with potential advancements in sensor technology, control algorithms, and integration with other robotic systems. Improved sensor capabilities, such as higher resolution and enhanced detection range, could enhance the robot's ability to navigate complex environments with greater precision and reliability. Integration with machine learning and artificial intelligence algorithms could enable the robot to adapt and learn from its surroundings, making autonomous decisions and optimizing its navigation strategies over time. Furthermore, advancements in battery technology and energy-efficient designs could extend the robot's operational duration and allow for sustained performance in various applications. Collaboration with other robotic systems, such as robotic arms or drones, could create synergistic capabilities for multi-purpose tasks, expanding the versatility and practicality of line-following robots in diverse industries and scenarios.