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OBSTACLE AVOIDING ROBOT USING WIFI MODULE ESP 8266

Wrushali Deshmukh[1], Yash Gade[2], Suyog Ghatage[3], Shreyas Palav[4], Manthan Hire[5], Siddhi Borhade[6]

Lecturer, Electronic and telecommunication, Bharti Vidyapeeth Institute of Technology, Navi Mumbai India[1]

Students, Electronic and telecommunication, Bharti Vidyapeeth Institute of Technology, Navi Mumbai India[2-6]

Abstract: The rapid advancement of robotics and Internet of Things (IoT) technologies has enabled the development of intelligent systems that can perform tasks both autonomously and remotely. Robotics is widely used in industries, smart homes, and security systems. One of the major challenges in robotics is ensuring safe navigation in environments where obstacles are present.This project focuses on designing a WiFi-controlled obstacle-avoiding robot using the ESP8266 microcontroller. The system combines wireless communication, embedded programming, and sensor-based obstacle detection. The ESP8266 allows the robot to be controlled remotely through a web interface, where users can send commands like forward, backward, left, right, and stop using devices such as smartphones or laptops. In addition to manual control, the robot operates in an automatic mode where it detects obstacles using an ultrasonic sensor. When an obstacle is detected, the robot stops and uses a servo motor to scan its surroundings and choose the safest path. A 16×2 LCD with I2C interface displays real-time data like distance and movement status, making the system efficient, cost-effective, and suitable for educational and basic automation applications.

I. INTRODUCTION

The field of robotics has grown rapidly with the advancement of Internet of Things (IoT) and embedded systems, enabling the development of smart systems that can operate autonomously and remotely. Robotics is widely used in industries, smart homes, healthcare, and security applications. One of the major challenges in such systems is ensuring safe and efficient navigation in environments where obstacles are present.

This project focuses on the design and development of a WiFi-controlled obstacle-avoiding robot using the ESP8266 microcontroller. The robot can be controlled remotely through a web interface and also operates in an automatic mode using an ultrasonic sensor and servo motor to detect and avoid obstacles. This system demonstrates the integration of wireless communication, sensors, and embedded programming, making it a cost-effective and practical solution for educational and basic automation applications.

II. EXISTING SYSTEM AND ITS LIMITATION

- Basic Obstacle Avoiding Robots: Traditional robots use simple microcontrollers and ultrasonic or IR sensors to detect obstacles, but they work only in predefined conditions.

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- Manual Controlled Robots: Some robots are controlled using wired connections or Bluetooth, limiting their operating range and flexibility.

- Limited Automation: These systems follow simple programmed logic and lack intelligent decision-making for complex environments.

- No Internet Connectivity: Most existing robots do not support WiFi, so they cannot be controlled or monitored remotely over long distances.

III. PROBLEM STATEMENT

Mobile robots often operate in environments that contain obstacles and unpredictable elements. If a robot is unable to detect these obstacles, it may collide with them, causing damage to both the robot and its surroundings. Therefore, safe navigation is an important challenge in robotic systems.

Another major issue is the limitation of traditional wired control systems. These systems restrict the movement of the robot and make it difficult for users to control the robot from a distance. This reduces flexibility and efficiency in real-world applications.

To overcome these challenges, this project focuses on developing a robotic system that can detect obstacles in its path and avoid collisions automatically. It also allows remote control through wireless communication, improving ease of operation.

Additionally, the system provides real-time information about the robot's status and surroundings. By addressing these problems, the robot becomes safer, more efficient, and user-friendly for various applications.

IV. SCOPE OF PROJECT

The scope of this project includes the complete development of a WiFi-controlled obstacle-avoiding robot using the ESP8266 microcontroller, integrating hardware components such as sensors, motors, and display units with embedded software. The robot is capable of both manual operation through a web interface and automatic navigation using obstacle detection techniques.

This project serves as a practical platform for learning and experimentation in the fields of robotics, embedded systems, and IoT. It helps users understand real-time control systems, wireless communication, and sensor-based decision-making. It is especially useful for students and beginners to gain hands-on experience in designing intelligent robotic systems.

In terms of applications, the robot can be used in home automation, security surveillance, industrial monitoring, and exploration of hazardous environments where human presence is risky. It can also assist in basic tasks like object delivery or area scanning in controlled environments.

Additionally, the project has a wide scope for future expansion. It can be enhanced by integrating advanced technologies such as machine learning for smart decision-making, camera modules for live video streaming, mobile app-based control, cloud connectivity for data storage, GPS for location tracking, and voice control systems, making it more intelligent and adaptable for real-world applications.

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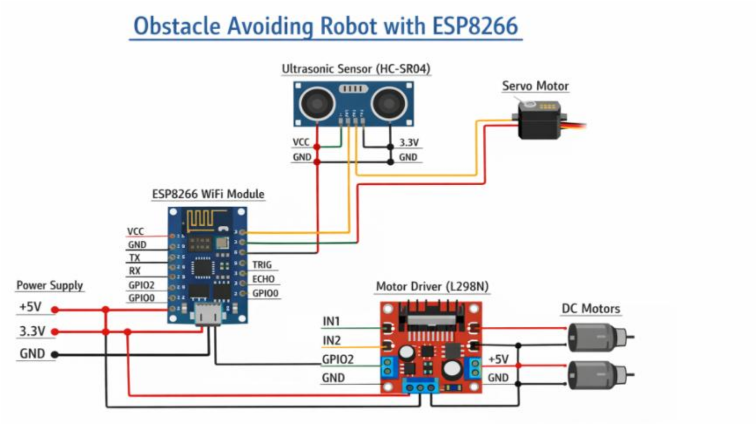
SCHEMATIC DIAGRAM:



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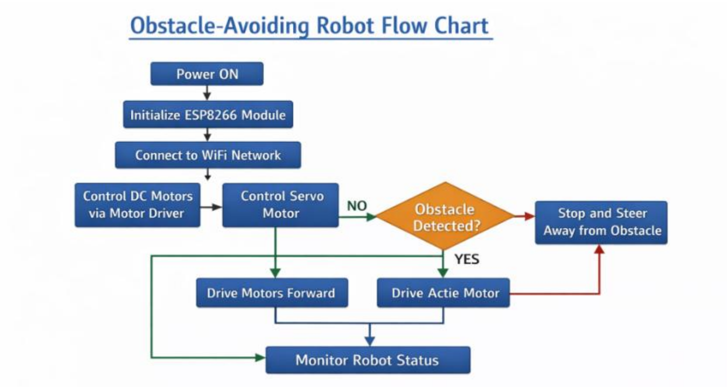
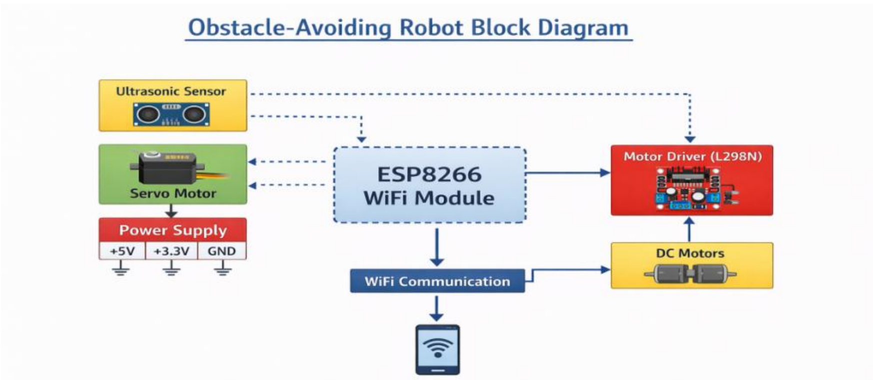


BLOCK DAIGRAM OF OBSTACLE AVOIDING ROBOT:



V. WORKING

Working of WiFi Controlled Obstacle Avoiding Robot (ESP8266) – Highly Detailed Explanation

1. **Power Supply & Voltage Regulation**

When the robot is powered ON, a battery (typically 7.4V–12V) supplies energy to the entire system. A voltage regulator or buck converter steps down the voltage to suitable levels—3.3V for the ESP8266 and 5V for components like the ultrasonic sensor, servo motor, and L298N motor driver. Proper grounding is maintained across all components to ensure stable operation. This stage is critical because unstable voltage can cause malfunction or resets in the ESP8266.

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2. **System Initialization & Pin Configuration**

After powering up, the ESP8266 executes the embedded program. It initializes all GPIO pins by defining them as input or output depending on their function. Communication protocols like I2C (for LCD) and PWM (for motor speed control and servo operation) are configured. The ultrasonic sensor trigger and echo pins are set up, and the servo motor is initialized to a default central position. This step ensures synchronized functioning of all hardware components.

3. **WiFi Setup & Web Server Creation**

The ESP8266 activates its WiFi module and either creates a hotspot (Access Point mode) or connects to an existing WiFi network (Station mode). It then starts a lightweight web server. The server hosts a control webpage containing buttons for robot movement and mode selection. Each button is linked to specific URLs or commands. When a user presses a button, a request is sent to the ESP8266, which interprets and executes the corresponding action.

4. **User Interaction & Command Processing**

When the user connects to the robot's WiFi network and opens the web interface, they can control the robot in real time. Each command (forward, backward, left, right, stop) is received as an HTTP request. The ESP8266 decodes this request and maps it to predefined motor actions. The response time is very fast, allowing near real-time control.

5. **Motor Driver Interface (L298N Operation)**

The ESP8266 cannot directly drive motors due to low current output, so it uses the L298N motor driver module. The ESP8266 sends logic HIGH/LOW signals to the input pins of the motor driver. Based on these signals:

- Motors rotate forward or backward
- Left/right turning is achieved by controlling different motor pairs
- PWM signals regulate speed for smooth motion

For a 4-motor setup, motors on each side are grouped and controlled together for efficient movement.

6. **Ultrasonic Sensor Working Principle**

The ultrasonic sensor (HC-SR04) works by emitting high-frequency sound waves. The trigger pin sends a pulse, and the sensor emits ultrasonic waves. When these waves hit an object, they reflect back to the echo pin. The ESP8266 measures the time taken for this echo to return and calculates distance using the speed of sound. This process happens repeatedly to ensure continuous monitoring.

7. **Obstacle Detection Logic**

The ESP8266 constantly checks the measured distance against a predefined threshold (e.g., 15–20 cm).

- If distance > threshold → robot continues forward
- If distance ≤ threshold → obstacle detected → robot stops

  This condition ensures that the robot reacts quickly to obstacles and prevents collisions.

8. **Servo Motor-Based Environment Scanning**

Once an obstacle is detected, the servo motor rotates the ultrasonic sensor to different angles (e.g., 0°, 90°, 180°). At each position, distance measurements are taken. This scanning process allows the robot to "look" in multiple directions instead of just straight ahead, improving navigation accuracy.

9. **Decision-Making Algorithm**

The ESP8266 compares distances from different directions (left, right, and sometimes center). A simple algorithm is used:

- Choose the direction with maximum distance (more free space)
- If both sides are blocked, move backward and re-scan

  This logical decision-making enables semi-intelligent navigation without complex AI.

10. **Movement Execution After Decision**

Based on the decision, the ESP8266 sends appropriate signals to the motor driver:

- Turn left → right motors move forward, left motors stop/reverse
- Turn right → left motors move forward, right motors stop/reverse
- Move backward → all motors reverse briefly

  After turning, the robot resumes forward motion.

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11. **Real-Time Feedback via LCD Display**

The 16×2 LCD (I2C) continuously displays useful information such as:
- Distance from obstacle
- Current mode (Manual/Auto)
- Movement direction (Forward, Left, Right, Stop)
  This helps users monitor system performance and understand robot behavior.

12. **Continuous Loop Execution**

The entire process runs inside a loop in the ESP8266 program. The system continuously:
- Checks WiFi commands (manual mode)
- Reads sensor data (automatic mode)
- Makes decisions and updates motor control
  This ensures real-time responsiveness and uninterrupted operation.

13. **Mode Switching (Manual ↔ Automatic)**

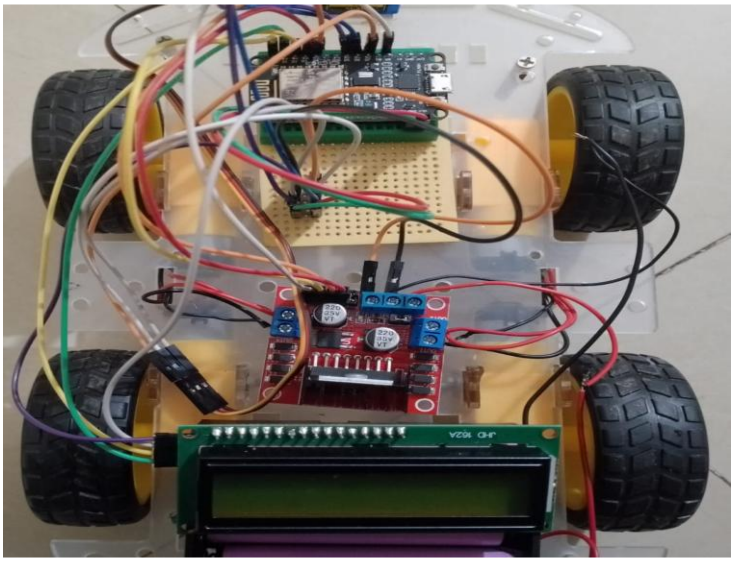
The robot can switch between manual and automatic modes via the web interface. In manual mode, user commands override sensor input. In automatic mode, the robot ignores manual commands and relies completely on sensor-based navigation.

14. **System Efficiency & Reliability**

The integration of WiFi control, real-time sensing, and decision-making improves efficiency and flexibility. The robot minimizes human effort, avoids obstacles effectively, and adapts to changing environments. Proper programming and hardware integration ensure reliable and stable performance.

SPECIFICATIONS OF MALE TO FEMALE CONNECTION WIRES:
- **Type:** Male-to-Female jumper wires (one end male pin, one end female socket)
- **Length:** Typically 10 cm to 30 cm (commonly 20 cm used in projects)
- **Wire Gauge:** 22 AWG to 26 AWG (commonly 24 AWG)
- **Conductor Material:** Copper (for good conductivity)
- **Insulation Material:** PVC (flexible and heat-resistant)
- **Voltage Rating:** Up to 250V (suitable for low-voltage electronics)
- **Current Rating:** Around 1A (depends on wire thickness)
- **Connector Type:** Dupont connectors (standard for breadboards and modules)
- **Compatibility:** Works with Arduino, ESP8266, sensors, motor drivers, and breadboards
- **Color Coding:** Available in multiple colors (red, black, yellow, blue, etc.) for easy identification

SETUP IS GIVEN BELOW:



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VI. CONCLUSION

The project successfully develops a WiFi-controlled and obstacle-avoiding robot using the ESP8266. It can be controlled remotely through a web interface and also operate automatically to detect and avoid obstacles using an ultrasonic sensor and servo motor.The system integrates components like motor driver, DC motors, and LCD display to ensure smooth movement, real-time monitoring, and efficient performance. It works in both manual and automatic modes, making it flexible and user-friendly.Overall, the robot achieves its goal of safe navigation and wireless control, demonstrating a practical application of embedded systems, IoT, and robotics for educational and basic automation purposes.

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