Intelligent Vehicle Speed Optimization in Foggy Weather Conditions

Group 40

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INTRODUCTION

Foggy weather significantly reduces road visibility, leading to accidents and traffic delays as drivers struggle to maintain safe speeds. Traditional approaches rely entirely on driver judgment, which can be inconsistent and error-prone. This project develops a smart vehicle prototype that automatically detects low-visibility conditions and adjusts its speed accordingly. The system monitors environmental conditions in real-time and autonomously controls speed to ensure safer navigation, demonstrating intelligent transportation principles for enhanced road safety.

OBJECTIVES AND GOALS

- Develop an autonomous vehicle prototype that detects fog and adjusts speed automatically
- Implements visibility and obstacle detection systems with adaptive speed control
- Create alert mechanisms and validate system performance in simulated conditions
- Gain hands-on experience in sensor interfacing, motor control, and embedded programming
- Apply multi-sensor integration and automation concepts to transportation safety

BACKGROUND:

In Punjab, dense winter fog and smog often cause poor visibility, leading to traffic jams and accidents. This project aims to develop a low-cost smart vehicle prototype that automatically adjusts speed under foggy conditions. An ESP32-controlled car will use an LDR sensor to detect reduced light intensity and an ultrasonic sensor to measure obstacle distance. For more precision, a laser is being used to directly point at the LDR, whose light gets scattered once fog comes and reduces the light intensity on the LDR. Based on this data, the system will control motor speed via PWM and trigger alerts

using a buzzer and LCD. The project will help us learn sensor integration, motor control, and the basics of intelligent driving systems for safer travel in low-visibility conditions.

IMPORTANCE AND NEED :

Driving in foggy weather is a major cause of road accidents due to poor visibility and slower driver reactions. This project aims to create an automatic system that adjusts vehicle speed according to visibility conditions. Using sensors instead of human judgment, the model will demonstrate how technology can enhance safety.

It will use ESP32 and sensors to detect light intensity and obstacles, allowing us to explore real-world automotive technologies on a smaller scale. The project will test our skills in coding, circuit design, and system integration, while helping us understand how similar concepts—like LiDAR in modern cars—improve driving safety. Overall, it contributes to making transportation smarter, safer, and more efficient during adverse weather.

WHAT THIS PROJECT WILL COVER:

- **Building the Prototype:** Construct a three-wheeled robotic car by assembling the chassis, mounting DC motors, and wiring components to an ESP32.
- **Sensor Integration:** Use an LDR to detect light (simulated fog) and an HC-SR04 ultrasonic sensor for obstacle detection. For more precision of the LDR, we use a laser module that directly pinpoints the LDR.
- **Control Logic:** Write ESP32 code to process sensor data and control motor speed using PWM.
- **Driver Alerts:** Add a buzzer for audio warnings and optionally an LCD display for visibility or speed feedback

COMPONENTS REQUIRED:-

1. Robotic Car Chassis Kit (2 wheels, 1 caster wheel with motors)
2. ESP32 WiFi Module Motor Driver Module (L298N)
3. DC Geared Motors
4. Light Dependent Resistor (LDR) Sensor Module
5. Ultrasonic Sensor (HC-SR04)
6. Buzzer Module
7. 16x2 LCD Display with I2C Module
8. 2 3.74V rechargeable batteries with holder & switch
9. Jumper Wires (Male to Male && Male to Female)
10. Chassis Mounts and Screws

11. Fog/Smoke Source for Simulation
12. Laser Module

CHALLENGES IN ADDRESSING THE TOPIC AND MAKING THIS PROJECT :

Developing a smart vehicle system that adjusts speed in foggy weather conditions presents several challenges.

- Accurately detecting visibility levels using sensors like LDR requires proper calibration to differentiate between fog density and normal lighting variations.
- Synchronizing multiple sensors like HC-SR04 (ultrasonic sensor) and LDR sensor
- Controlling motor speed dynamically, along with all these inputs, requires good handling of PWM values and thus is challenging.
- Handling the code that is to be uploaded to the ESP32 wifi module
- Hardware limits and sensor consistency demand **robust, modular code**.
- Integrating an LCD display with sensors and coding poses a challenge.

TEAM MEMBER RESPONSIBILITIES

- **Garima Kamra** (2024CSB1115)– Coordinates project activities, oversees design, manages component procurement, and handles final assembly.
- **Moinak Goswami** 2024CSB1225)– Designs and builds circuit connections, ensuring correct wiring and sensor interfacing with ESP32.
- **Harshit Sahu** (2024CSB1203)– Programs ESP32 for motor control, LDR sensing, and obstacle detection;
- **Sarthak Keshaowar** (2024CSB1215)– Develops alert systems, integrates buzzer and LCD, and programs visual/audio feedback.
- **Palak** (2024CSB1137)– Conducts testing under simulated fog, analyzes performance, and prepares documentation and presentation.