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LIDAR (Light Detection and Ranging) Based Obstacle Detection for Autonomous Vehicles

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ABSTRACT: The LiDAR (Light Detection and Ranging) Based Obstacle Detection System for Autonomous Vehicles is designed to enhance vehicle safety by detecting obstacles in real time. Autonomous vehicles require reliable sensing systems to understand their surroundings and avoid collisions. LiDAR technology works by emitting laser pulses and measuring the time taken for the reflected light to return from surrounding objects, allowing accurate distance measurement and environmental mapping. In this project, the obstacle detection system is implemented using an ultrasonic sensor based on the LiDAR principle for a prototype autonomous vehicle. The sensor continuously scans the surrounding environment and sends distance information to a microcontroller. The controller processes this data and controls the vehicle movement to avoid obstacles by stopping, slowing down, or changing direction.

KEYWORDS: LiDAR, Obstacle Detection, Autonomous Vehicles, Ultrasonic Sensor, Distance Measurement, Robotics Navigation.

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I. INTRODUCTION

Autonomous vehicles represent a significant advancement in modern transportation technology. These vehicles are capable of navigating roads without human intervention by using sensors, controllers, and intelligent algorithms. One of the most critical requirements for autonomous vehicles is the ability to detect obstacles accurately and avoid collisions.

LiDAR (Light Detection and Ranging) is a sensing technology widely used in autonomous vehicles to detect objects and measure distances. It works by emitting laser pulses and calculating the time taken for the reflected signal to return. This process helps generate a precise map of the surrounding environment.

In this project, the obstacle detection system is implemented using an ultrasonic sensor that follows the same time-of-flight principle used in LiDAR systems. The sensor emits ultrasonic waves and measures the echo returned after hitting an obstacle. The measured distance is processed by a microcontroller which controls the vehicle's movement.

II. EXISTING SYSTEM

- **Camera-based systems** used in driver assistance systems.
- **Radar-based systems** for detecting vehicles and large obstacles.
- **LiDAR sensors** for high-precision mapping in autonomous vehicles.

Limitations

- High cost of advanced sensors such as LiDAR.
- Complex hardware and software requirements.
- Some systems perform poorly in poor lighting or weather conditions.
- Limited accessibility for small-scale educational projects.

III. PROPOSED SYSTEM

The proposed system is a LiDAR-based obstacle detection prototype implemented using ultrasonic sensors and a microcontroller to simulate LiDAR functionality.

Working Principle

1. The ultrasonic sensor emits high-frequency sound waves.
2. The waves hit nearby objects and reflect back.
3. The sensor receives the reflected echo signal.
4. The microcontroller calculates the distance using the **time-of-flight principle**.
5. If an obstacle is detected within a predefined distance, the vehicle changes direction or stops to avoid collision.

This system provides a simple, reliable, and cost-effective solution for implementing obstacle detection in small autonomous vehicle models.

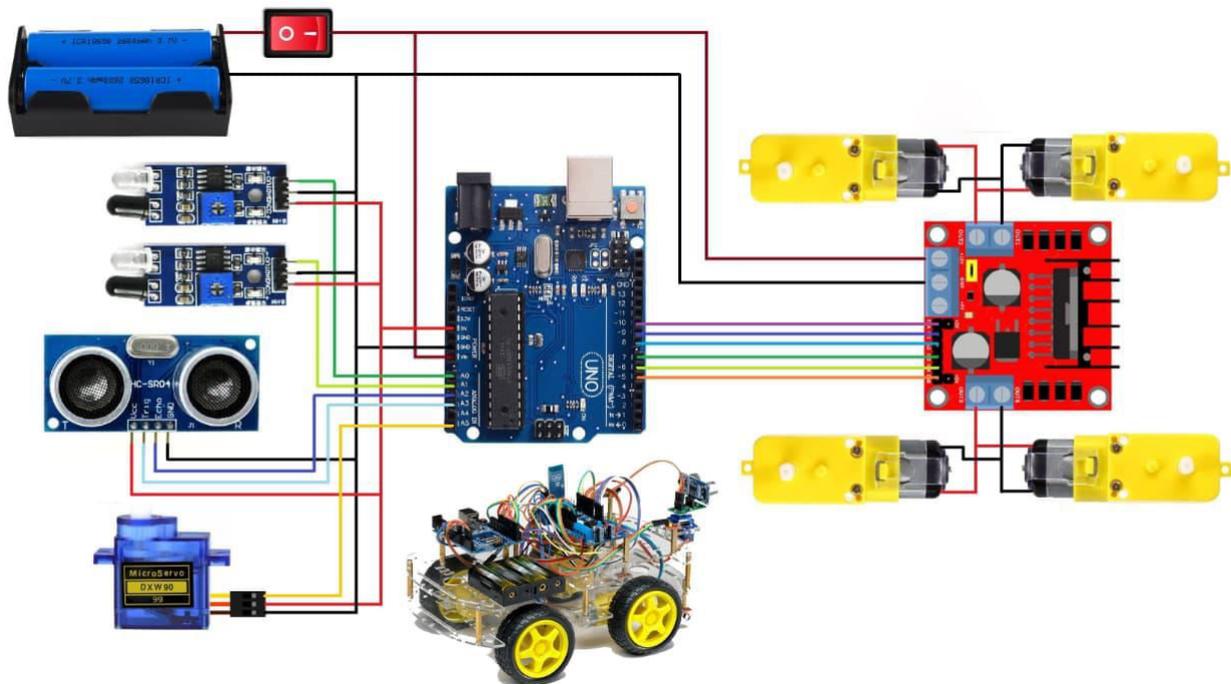
IV. LITERATURE REVIEW

Title: IoT Based Obstacle Detection System in Vehicles Using Ultrasonic Sensor

Journal: International Journal of Engineering Research & Technology (IJERT)

This research presents an IoT-based obstacle detection system that uses ultrasonic sensors to measure distances between the vehicle and nearby objects. The sensor data is processed by a microcontroller and displayed on a monitoring interface. The system provides real-time alerts to prevent accidents and improve vehicle safety.

V. SYSTEM ARCHITECTURE & BLOCK DIAGRAM



VI. OBJECTIVES

- To design an obstacle detection system for autonomous vehicles.
- To detect obstacles using LiDAR principle (time-of-flight).
- To measure distance between vehicle and obstacles.
- To avoid collisions automatically.

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- To develop a prototype autonomous robot vehicle.
- To create a cost-effective and reliable system for educational use.

VII. RESULTS AND IMPLEMENTATION

The developed prototype successfully detects obstacles using ultrasonic sensors and prevents collisions. The system continuously monitors the surroundings and calculates distance in real time.

The results demonstrate that:

- The ultrasonic sensor accurately measures distances up to several meters.
- The vehicle can automatically stop or change direction when an obstacle is detected.
- The system works effectively for small-scale autonomous vehicle prototypes.

This implementation confirms that the LiDAR principle can be simulated using ultrasonic sensors for educational and prototype applications.

VIII. CONCLUSION AND FUTURE SCOPE

The LiDAR based Obstacle Detection System for Autonomous Vehicles provides an effective method for detecting obstacles and improving vehicle safety. The project demonstrates the use of ultrasonic sensors and microcontroller technology to implement distance measurement and collision avoidance. The system is reliable, economical, and suitable for robotics and autonomous vehicle prototypes.

IX. FUTURE SCOPE

Future improvements can include:

- Integration of real LiDAR sensors for high precision mapping.
- Implementation of AI-based object recognition.
- Use of GPS and IoT for autonomous navigation.
- Integration with camera vision systems.
- Development of fully autonomous vehicle prototypes.

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