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Auto Braking System

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Abstract: *Road accidents are increasing day by day due to human error, delayed reaction time, and lack of attention while driving. To overcome this problem, an Auto Braking System using Arduino is proposed in this project. The main objective of this system is to automatically apply brakes when an obstacle is detected at a critical distance, thereby reducing the chances of collision and improving vehicle safety.*

The proposed system uses an Arduino microcontroller as the main control unit. An ultrasonic sensor is used to continuously measure the distance between the vehicle and an obstacle in front. When the sensor detects an object within a predefined safe distance, the Arduino processes the signal and activates a motor driver circuit connected to a DC motor or servo motor that represents the braking mechanism. The braking action is applied automatically without driver intervention. A buzzer and LED are also included to provide an alert warning to the driver before braking is applied.

This system works on the principle of distance measurement using ultrasonic waves. The sensor emits ultrasonic pulses and receives the reflected waves from the obstacle. Based on the time taken for the echo to return, the distance is calculated and compared with the threshold value programmed in the Arduino. If the distance is less than the critical value, the braking system is triggered instantly.

The proposed Arduino-based auto braking system is cost-effective, reliable, and easy to implement, making it suitable for low-cost vehicles and educational purposes. This project demonstrates how embedded systems can be effectively used to enhance automotive safety. With further development, the system can be integrated with real vehicles to reduce accidents and save lives.

Keywords: Auto Braking System, Ultrasonic sensor, Motor driver circuit, DC motor or servo motor

I. INTRODUCTION

The rapid growth of the automobile industry has led to a significant increase in the number of vehicles on the road. Along with this growth, road accidents have also increased due to factors such as driver negligence, delayed reaction time, over speeding, fatigue, and poor road conditions. According to accident analysis, a large percentage of collisions occur because the driver fails to apply brakes at the correct time. Therefore, improving vehicle safety has become an important area of research and development in automobile engineering.

Modern vehicles are being equipped with advanced safety features such as Anti-lock Braking System (ABS), Electronic Brake force Distribution (EBD), and Advanced Driver Assistance Systems (ADAS). However, these systems are costly and are mostly available only in high-end vehicles. For low-cost vehicles and educational purposes, there is a need for a simple, reliable, and economical safety system. The Auto Braking System using Arduino is a basic attempt to fulfil this requirement.

An auto braking system is designed to automatically apply brakes when an obstacle is detected within a critical distance from the vehicle. This system reduces the dependency on the driver's reaction time and helps prevent collisions. In this project, an Arduino microcontroller is used as the control unit due to its simplicity, low cost, and ease of programming. An ultrasonic sensor is used to detect obstacles in front of the vehicle by measuring the distance using ultrasonic waves. When the sensor detects an obstacle closer than the present safe distance, the Arduino processes the signal and activates the braking mechanism through a motor driver circuit. Along with braking, warning indicators such as a buzzer and LED are used to alert the driver. This system works continuously while the vehicle is in motion and provides real-time safety assistance.

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The main aim of this project is to design and develop a working model that demonstrates the concept of automatic braking using embedded systems. This project helps students understand the application of sensors, microcontrollers, and automation in the automobile field. With further advancements, this system can be integrated into real vehicles to improve road safety and reduce accidents.

II. PROPOSED WORK

The proposed work concept aims to design and develop an Auto Braking System using Arduino to improve vehicle safety and reduce road accidents caused by human error. The system is designed to automatically apply brakes when an obstacle is detected within a critical distance, thereby minimizing the dependence on the driver's reaction time.

An ultrasonic sensor is mounted at the front of the vehicle to continuously measure the distance between the vehicle and obstacles ahead. The sensor emits ultrasonic waves and receives the reflected waves after hitting an object. Based on the time taken for the echo to return, the distance of the obstacle is calculated.

The measured distance is sent to the Arduino microcontroller, which acts as the control unit of the system. The Arduino compares the distance with a predefined safe limit. When the obstacle is outside the safe range, the vehicle operates normally. As the obstacle comes closer and enters the warning range, the system activates a buzzer and LED to alert the driver.

If the obstacle reaches the critical distance and no manual action is taken, the Arduino sends a signal to a motor driver circuit, which operates a DC motor or servo motor connected to the braking mechanism. The motor applies the brakes automatically to slow down or stop the vehicle, preventing collision. The proposed concept is simple, economical, and suitable for educational and low-speed vehicle applications.

The working principle of the Auto Braking System using Arduino is based on continuous obstacle detection and automatic brake actuation. The system operates by measuring the distance between the vehicle and an obstacle in front and applying brakes when the distance becomes unsafe.

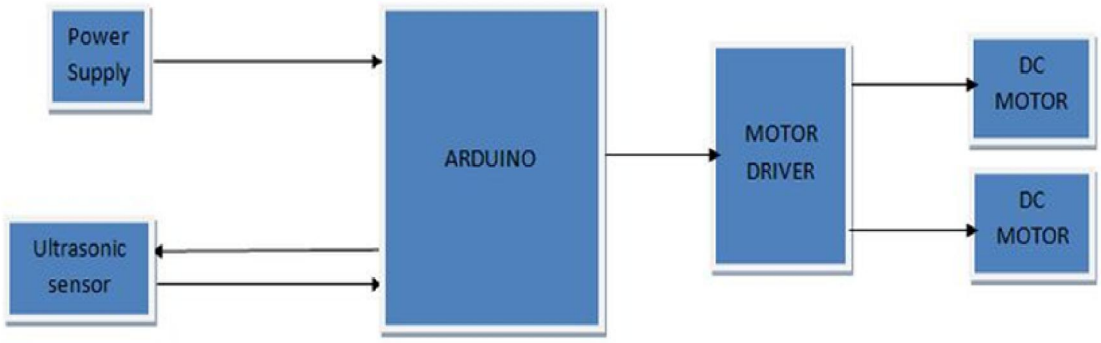

Fig 2.2:- Block Diagram

III. SIMULATION AND PERFORMANCE ANALYSIS

The simulation of the Auto Braking System using Arduino was carried out to analyse the correctness of the circuit connections and overall system performance before hardware implementation. Proper circuit connection is essential to ensure accurate sensor readings, timely braking action, and reliable system operation.

In the simulated circuit, the ultrasonic sensor was connected to the Arduino microcontroller with its Trig and Echo pins connected to the digital input/output pins of the Arduino. The Vcc and Ground pins of the sensor were connected to the 5V supply and ground of the Arduino respectively. During simulation, the ultrasonic sensor successfully transmitted and received ultrasonic pulses, and the Arduino accurately calculated the obstacle distance based on the echo time.

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The buzzer and LED were connected to the Arduino through appropriate current-limiting resistors. In the simulation, these components were activated when the obstacle entered the warning range,
confirming proper signal flow from the Arduino output pins to the alert devices.
For braking action, a motor driver circuit was used between the Arduino and the DC motor/servo motor. The motor driver input pins were connected to Arduino digital output pins, while the motor was connected to the driver output terminals. This arrangement protected the Arduino from high current and allowed proper motor control. In the simulation, when the obstacle distance reached the critical limit, the motor driver received a control signal and activated the motor, representing automatic braking.
The simulation results confirmed that all circuit connections were correct and responsive. The system showed fast response time, stable operation, and accurate braking activation. Hence, the simulated circuit proved to be reliable and suitable for practical implementation.

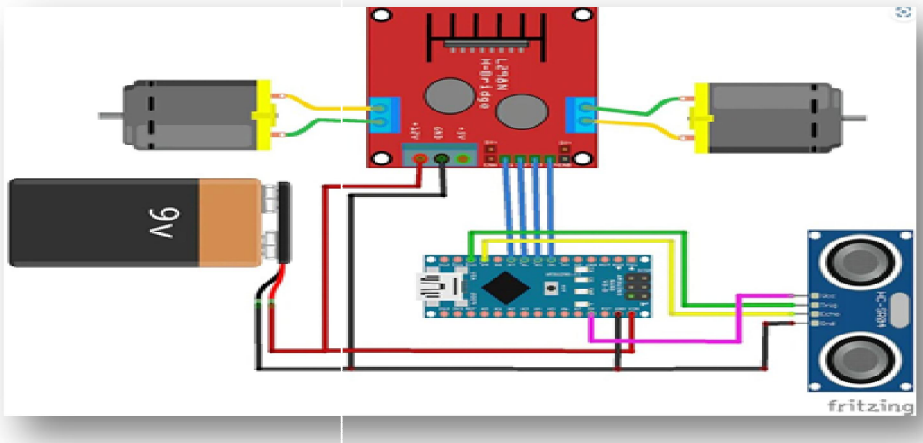

Fig 3.1 :- Circuit Diagram

IV. ADVANTAGES AND DISADVANTAGES

Advantages

- Improves Vehicle Safety: Automatically applies brakes during emergency situations, reducing the chances of collision.
- Reduces Human Error: Minimizes dependence on driver reaction time, which is a major cause of road accidents.
- Low Cost System: Uses low-cost components such as Arduino and ultrasonic sensor, making it economical.
- Fast Response Time: The system reacts instantly when the obstacle reaches the critical distance.
- Simple and Easy to Implement: The circuit design and programming are simple and suitable for diploma-level projects.
- Driver Warning Feature: Provides early warning through buzzer and LED before applying automatic braking.
- Energy Efficient: Consumes less power and is suitable for small and prototype vehicles.

Disadvantages

- Limited Detection Range: Ultrasonic sensors are effective only for short distances and low-speed applications.
- Affected by Environmental Conditions: Performance may reduce in rain, fog, or uneven surfaces.
- Not Suitable for High-Speed Vehicles: Response time and braking power are limited for high-speed driving.
- Single Sensor Limitation: Using only one sensor may not detect obstacles from all directions.

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- Mechanical Braking Limitation: The prototype braking mechanism may not represent real vehicle braking efficiency.
- Requires Proper Calibration: Incorrect threshold values can affect braking accuracy.

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