

Automatic Braking System

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Abstract: Road accidents have become a significant global concern due to increasing vehicle density and human error. One of the primary causes of accidents is the delay in driver reaction during emergency situations. To overcome this issue, an Automatic Braking System (ABS) based on ultrasonic sensing and microcontroller technology is proposed. The system utilizes an ultrasonic sensor to detect obstacles, an Arduino microcontroller for processing, a gear motor for driving the vehicle, and a servo motor for braking action. When an obstacle is detected within a predefined distance, the system automatically applies the brakes, thereby preventing collision. This project demonstrates a cost-effective, efficient, and reliable safety mechanism that can be implemented in low-speed vehicles and prototype models.

Keywords: Arduino, Automatic Braking System, Gear Motor, Ultrasonic sensor.

1. Introduction

In modern transportation systems, safety is a major concern due to the rapid increase in road traffic and accidents. According to research, many accidents occur due to delayed braking or driver negligence [1]. Automatic braking systems are advanced safety technologies designed to detect obstacles and apply brakes without human intervention. Ultrasonic sensors are widely used for distance measurement due to their simplicity, low cost, and reliability [2]. This project focuses on designing a prototype of an automatic braking system using:

1. Ultrasonic sensor (HC-SR04)
2. Arduino microcontroller
3. Gear motor (for vehicle movement)
4. Servo motor (for braking mechanism)

2. Literature Review

ABS was initially launched in the 1960s and has since become extensively used in contemporary cars due to its ability to avoid skidding and preserve steering control during emergency braking conditions. ABS has seen tremendous advancements in response speed, dependability, and safety features throughout the years [1], [2], [4] "Development of an Automatic Braking System for Emergency Situations Using Stereo Vision Sensors and a Fuzzy Logic Controller" by S. I. Kim, et al. - This paper proposes an automatic braking system that uses stereo vision sensors and a fuzzy logic controller to detect and respond to emergencies [1].

"Design and Implementation of an Automatic Braking System Using Ultrasonic Sensors" by R. K. Rana, et al. - This

paper presents the design and implementation of an automatic braking system using ultrasonic sensors to detect obstacles and control the vehicle's speed [2].

"Automated Braking System: An Overview of the Current Technologies and Future Trends" by J. D. Kim and S.

W. Lee - This paper provides an overview of current technologies and future trends in automated braking systems, including the use of sensors, algorithms, and communication networks [3].

"A Review on Development of Advanced Driver Assistance Systems with Focus on Automatic Braking System" by S. Khan and N. J. Ahn - This paper reviews the development of advanced driver assistance systems (ADAS) with a focus on automatic braking systems, including the history, benefits, and challenges of these systems [4]. "Simulation and Experimental Study of an Automatic Braking System Using a Fuzzy Controller" by J. Wang, et al.

This paper presents a simulation and experimental study of an automatic braking system using a fuzzy controller to improve the accuracy and reliability of the system [5].

3. Problem Statement

Increasing road accidents are mainly caused by delayed human reaction, driver distraction, and lack of immediate braking response in critical situations. Conventional braking systems rely entirely on driver input, making them unreliable during emergencies. Therefore, there is a need to develop an automatic braking system that can detect obstacles in real time and apply brakes instantly. This project aims to design a cost-effective solution using ultrasonic sensor, Arduino, gear motor, and servo motor [6].

4. Proposed System

The proposed system is an automatic braking mechanism using an ultrasonic sensor and Arduino. It detects obstacles in real time and measures distance. When an object is too close, the Arduino stops the gear motor and activates a servo motor to apply brakes, ensuring safety and preventing collisions efficiently [7].

5. Working of ABS System

The automatic braking system operates using an ultrasonic sensor, Arduino microcontroller, gear motor, and servo motor to ensure collision avoidance. The ultrasonic sensor

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continuously emits high-frequency sound waves and receives the reflected signals from nearby objects [8]. Based on the time taken for the echo to return, the distance between the vehicle and the obstacle is calculated by the Arduino. During normal conditions, when no obstacle is detected within the predefined threshold distance, the Arduino allows the gear motor to run, enabling the vehicle to move forward smoothly. However, when an object comes within the critical distance range, the sensor sends data to the Arduino, which immediately processes the information and identifies a potential collision risk. In response, the Arduino sends control signals to stop the gear motor and simultaneously activates the servo motor [9]. The servo motor then rotates to apply the braking mechanism, bringing the vehicle to a halt. This automatic response reduces human effort and improves safety significantly [10].

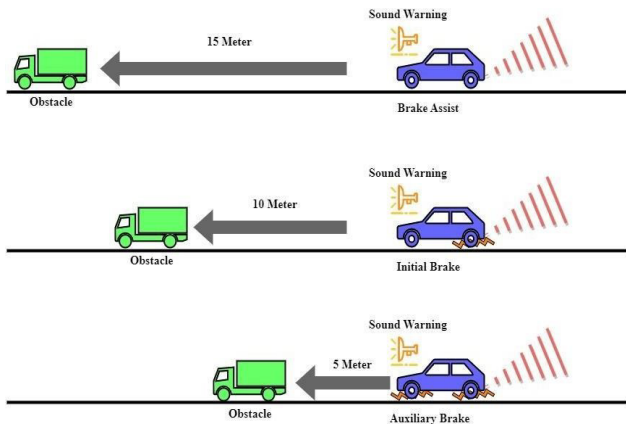


Fig. 1. Working of ABS system

6. System Design

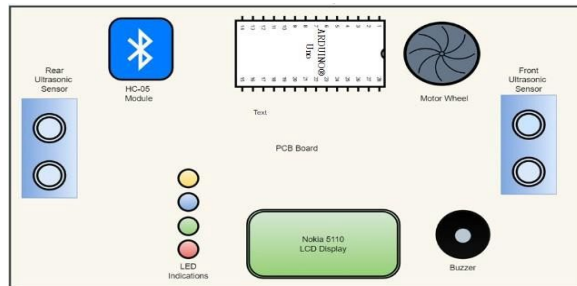


Fig. 2. System design

A. Choice of Hardware

ARDUINO UNO	
Ultrasonic sensor	
Nokia Display 5110 LCD	

Bluetooth Module HC-05	
Motor Driver	
DC Motor	
Buzzer	
LED	

Fig. 3. Hardware

7. Implementation

A. Hardware Implementation

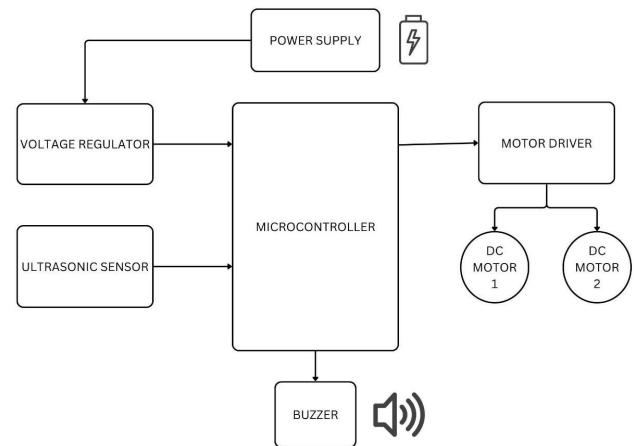


Fig. 4. Block diagram

For this system below pins of ARDUINO are used:

Bluetooth module HC-05 [1], [10]:

- Rx pin is defined as Digital Input from ARDUINO Pin no. PD0
- Tx pin is defined as Digital Output from ARDUINO Pin no. PD1

Ultrasonic sensor HC-SR-04 [3], [10]:

- Trigger_1 pin is defined as Digital Input from ARDUINO Pin no. PD2
- Echo_1 pin is defined as Digital Output from ARDUINO Pin no. PD3
- Trigger_2 pin is defined as Digital Input from ARDUINO Pin no. PD4
- Echo_2 pin is defined as Digital Output from ARDUINO Pin no. PD5

Nokia LCD Display 5110 [5], [10]:

- SCLK pin is defined as Digital Output from

ARDUINO Pin no. PC5

- DIN pin is defined as Digital Output from ARDUINO Pin no. PC1
- DC pin is defined as Digital Output from ARDUINO Pin no. PC2
- CS pin is defined as Digital Output from ARDUINO Pin no. PC3
- RST pin is defined as Digital Output from ARDUINO Pin no. PC6

Buzzer [10]:

- Buzzer pin is defined as Analog Output from ARDUINO Pin no. PC0

Warning LED [10]:

- LED Out pin is defined as Digital Output from ARDUINO Pin no. PD1

Mode indicator LED [2], [10]:

- Drive Modeled pin is defined as Analog Output from ARDUINO Pin no. PB5
- Reverse Modeled pin is defined as Analog Output from ARDUINO Pin no. PD5
- Neutral Modeled pin is defined as Analog Output from ARDUINO Pin no. PD4

Motor Driver [4], [10]:

- MotorPin1 pin is defined as Digital Output from ARDUINO Pin no. PD2
- MotorPin2 pin is defined as Digital Output from ARDUINO Pin no. PD3

Motor Driver [10]:

- MotorPin1 pin is defined as Digital Output from ARDUINO Pin no. D2

B. Circuit Diagram

We created this circuit diagram in the open-source platform that is EasyEDA. EasyEDA is a web-based software platform for designing, simulating, and sharing electrical circuit designs [10], [12].

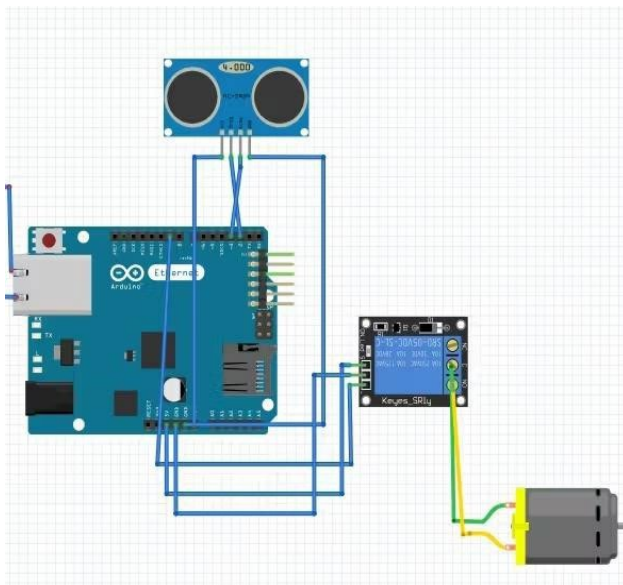


Fig. 5. Circuit diagram

Steps to draw circuit diagram:

- *Identify the components:* Begin by identifying all the components and their corresponding symbols in the circuit diagram [1].
- Identify the power source and how it is linked to the rest of the components [2].
- Follow the connections between the components to learn about the flow of current and how the components interact with one another [3].
- *Voltage and current values:* Confirm that the voltage and current values provided in the schematic are within the safe operating range of the components [4].
- Determine how the ground connection is linked to the components [5].
- *Control logic:* Determine the circuit diagram's control logic and how it interacts with the other components [6].
- Identify the protective devices in the circuit diagram, such as fuses, circuit breakers, and overvoltage protection devices [7].
- *Signal processing:* Locate any signal processing or filtering components, such as amplifiers, filters, or signal conditioning circuits, in the circuit design [8].
- *Testing and verification:* Once the circuit diagram has been completed, it should be tested and confirmed to verify that it functions as planned [9].

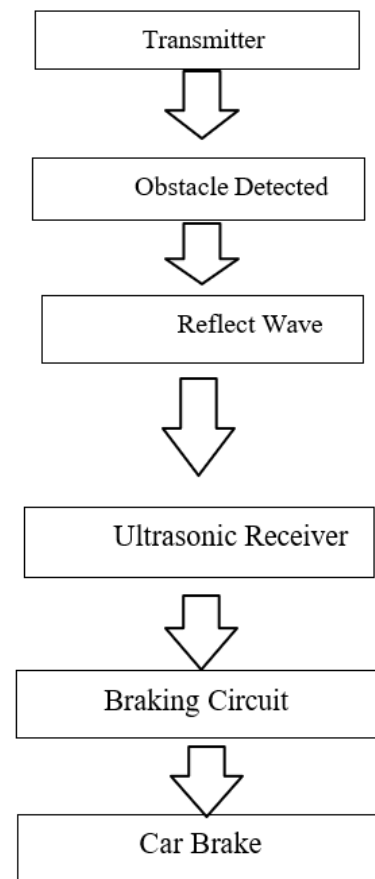


Fig. 6. Flow chart

8. Testing and Evaluation

Table 1
Test summary

Sr no.	Test Case code	Description of test case	Result
1	Test Case_1	When System is turn On Initially, the welcome message is displayed and after that the image of vehicle is displayed on the LCD screen. The vehicle is in still motion and the forward & reverse sensor readings are displayed above the screen	PASS
2	Test Case_2	Mode = Neutral (N). In neutral mode the vehicle mode is indicated by neutral indicating led on system.	PASS
3	Test Case_3	Mode = Drive (D). Distance of obstacle ≤ 5 cm in front of forward sensor.	PASS
4	Test Case_4	Mode = Drive (D). Distance of obstacle ≤ 10 cm in front of forward sensor.	PASS
5	Test Case_5	Mode = Drive (D). Distance of obstacle ≤ 15 cm in front of forward sensor.	PASS
6	Test Case_6	Mode = Drive (D). Distance of obstacle > 15 cm in front of forward sensor.	PASS
7	Test Case_7	Mode = Drive (D). Distance of obstacle ≤ 10 cm in front of reverse sensor.	PASS
8	Test Case_8	Mode = Reverse (R). Distance of obstacle ≤ 5 cm in front of reverse sensor.	PASS
9	Test Case_9	Mode = Reverse (R). Distance of obstacle ≤ 10 cm in front of reverse sensor.	PASS
10	Test Case_10	Mode = Reverse (R). Distance of obstacle > 10 cm in front of reverse sensor	PASS

Advantage:

Accident Prevention: Automatically detects obstacles and applies brakes to avoid collisions [1]. **Reduced Human Error:** Minimizes dependence on driver reaction time during emergencies [2]. **Cost-Effective System:** Uses simple and affordable components for easy implementation [3]. **Enhanced Safety:** Improves overall vehicle safety and reliability in real-time conditions [4].

Limitation:

- **Limited Detection Range:** Ultrasonic sensors operate effectively only within a short distance range, reducing long-range obstacle detection capability [1].
- **Environmental Sensitivity:** System performance may be affected by environmental conditions such as rain, dust, temperature variations, or external noise interference [2].
- **Not Suitable for High Speed:** This system is not reliable for high-speed vehicles due to limited sensing range and response time [3].
- **Accuracy Issues:** Ultrasonic sensors may provide inaccurate readings when detecting soft, small, or irregularly shaped objects [4].

Future Scope:

- **Advanced Sensors Integration:** Can be enhanced using LiDAR, radar, or infrared sensors for better accuracy and long-range detection [1].
- **AI and Machine Learning:** Integration with artificial intelligence for smarter decision-making and predictive braking [2].
- **IoT Connectivity:** Can be connected with IoT for real-time monitoring and data sharing between vehicles [3]. **High-Speed Application:** Future improvements can make it suitable for high-speed vehicles [4].
- **Autonomous Vehicles:** Can be developed further for use in self-driving and smart vehicles [5]. **Improved Accuracy:** Use of multiple sensors to reduce errors and improve system reliability [6].

9. Conclusion

The automatic braking system using an ultrasonic sensor and Arduino is a simple and effective solution to improve vehicle safety [1]. It helps in detecting obstacles in front of the vehicle and automatically applies brakes to avoid accidents [2]. This system reduces human effort and reaction time, which are major causes of road accidents [3]. The use of a gear motor for movement and a servo motor for braking makes the system easy to understand and implement [4]. Although it has some limitations, it works well for low-speed and prototype models [5]. Overall, this project shows how technology can be used to make driving safer and smarter [6].

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