



AUTOMATIC OBSTACLE DETECTION AND ELECTRIC DISC BRAKING SYSTEM FOR 4-WHEELER

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ABSTRACT:

Road accidents remain a major concern worldwide, often caused by delayed human reaction and inability to detect obstacles in time. This paper presents the design and implementation of an automatic obstacle detection and electric disc braking system for a four-wheeler to enhance vehicle safety. The system integrates ultrasonic sensing technology with a microcontroller-based control unit to detect obstacles in real time and activate braking automatically. The ultrasonic sensor continuously measures the distance between the vehicle and surrounding objects, while the microcontroller processes this data and triggers braking when a predefined safety threshold is reached. The proposed electric braking mechanism ensures faster response, reduced stopping distance, and improved reliability compared to conventional manual braking systems. Experimental results demonstrate effective obstacle detection within a range of 0.5–10 meters and rapid braking response, significantly reducing collision risk. The system provides a cost-effective and efficient solution for improving road safety and supporting intelligent transportation systems.

KEYWORDS:

AUTOMATIC BRAKING SYSTEM, ULTRASONIC SENSOR, OBSTACLE DETECTION, ELECTRIC DISC BRAKE, MICROCONTROLLER, VEHICLE SAFETY, EMBEDDED SYSTEMS, COLLISION AVOIDANCE, INTELLIGENT TRANSPORTATION.

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INTRODUCTION

The rapid growth of transportation systems has increased the number of vehicles on roads, leading to a significant rise in road accidents and safety concerns [1]. Many accidents occur due to delayed human reaction, poor visibility, and inability to detect obstacles in time [2]. Traditional braking systems depend entirely on driver response, which may not always be sufficient in emergency situations [3].

To improve vehicle safety, modern technologies such as automatic braking systems and Advanced Driver Assistance Systems (ADAS) have been developed [4]. These systems use sensors and embedded controllers to detect obstacles and assist drivers in avoiding collisions [5]. Ultrasonic sensing technology is widely used for short-range obstacle detection due to its simplicity and cost-effectiveness [6].

However, ultrasonic sensors have limitations in range and accuracy, which has led to the development of advanced sensing technologies such as LiDAR and radar systems [7]. These technologies provide improved accuracy and faster response but are often expensive and complex [8].

Microcontroller-based control systems enable real-time processing of sensor data and automatic decision-making [9].

Despite these advancements, many existing systems either provide only warning signals or lack fast automatic braking mechanisms [10]. This paper proposes an ultrasonic-based automatic braking system integrated with an electric disc braking mechanism to improve vehicle safety and reduce accidents

MATERIALS AND METHODS:

The proposed system was developed by integrating sensing, control, and braking components into a unified embedded system. The primary components include an ultrasonic sensor for obstacle detection, a microcontroller for processing data, a motor controller, a wiper motor acting as the braking actuator, and a power supply unit. The ultrasonic sensor continuously emits sound waves and measures the time taken for the reflected signals to return, thereby calculating the distance between the vehicle and obstacles.

The microcontroller receives distance data from the sensor and processes it using programmed logic. If the detected distance is greater than a predefined safety threshold, the system continues normal operation. When the distance falls below the threshold, the microcontroller sends a signal to the motor controller to activate the braking mechanism. The braking system uses an electric disc braking approach, where the motor is stopped immediately to prevent collision.

The system was implemented using embedded programming, integrating hardware and software components to ensure reliable performance. The complete system was tested under various conditions to evaluate its efficiency, response time, and accuracy in obstacle detection and braking.

RESULTS:

The developed automatic obstacle detection and braking system was tested to evaluate its performance under different operating conditions. The ultrasonic sensor successfully detected obstacles within a range of 0.5 to 10 meters with reliable accuracy. The system demonstrated rapid response in detecting obstacles and activating the braking mechanism.

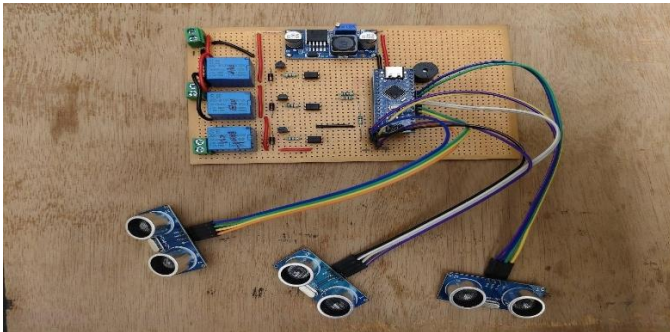


FIG. 1: AUTOMATIC OBSTACLE DETECTION AND ELECTRIC DISC BRAKING SYSTEM PROTOTYPE

The braking system was triggered automatically when the distance between the vehicle and obstacle reached the predefined threshold. The response time of the system was observed to be within milliseconds, significantly faster than human reaction time. The system effectively reduced stopping distance and prevented potential collisions. The prototype system, as shown in **Fig. 1**, demonstrates the integration of ultrasonic sensing, microcontroller processing, and braking mechanism in a single platform.

The results confirm that the system improves safety by providing timely detection and automatic braking action.

DISCUSSION:

The proposed system successfully demonstrates the implementation of an automatic braking mechanism using ultrasonic sensing technology. Compared to conventional braking systems, the system offers faster response and reduces dependency on driver reaction time. The use of a microcontroller enables real-time processing and

decision-making, improving system reliability. The system is cost-effective and suitable for small-scale applications. However, ultrasonic sensors have limitations in long-range detection and performance under certain environmental conditions. Future enhancements may include integration of advanced sensors such as LiDAR or radar, implementation of adaptive braking algorithms, and integration with intelligent transportation systems.

CONCLUSIONS:

This paper presents the design and development of an automatic obstacle detection and electric disc braking system for a four-wheeler. The system effectively detects obstacles and activates braking automatically, reducing the risk of collisions. The integration of sensor technology and embedded control provides a reliable and efficient solution for improving vehicle safety. The system demonstrates the potential of automated braking systems in modern transportation and can be further enhanced for advanced applications.

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