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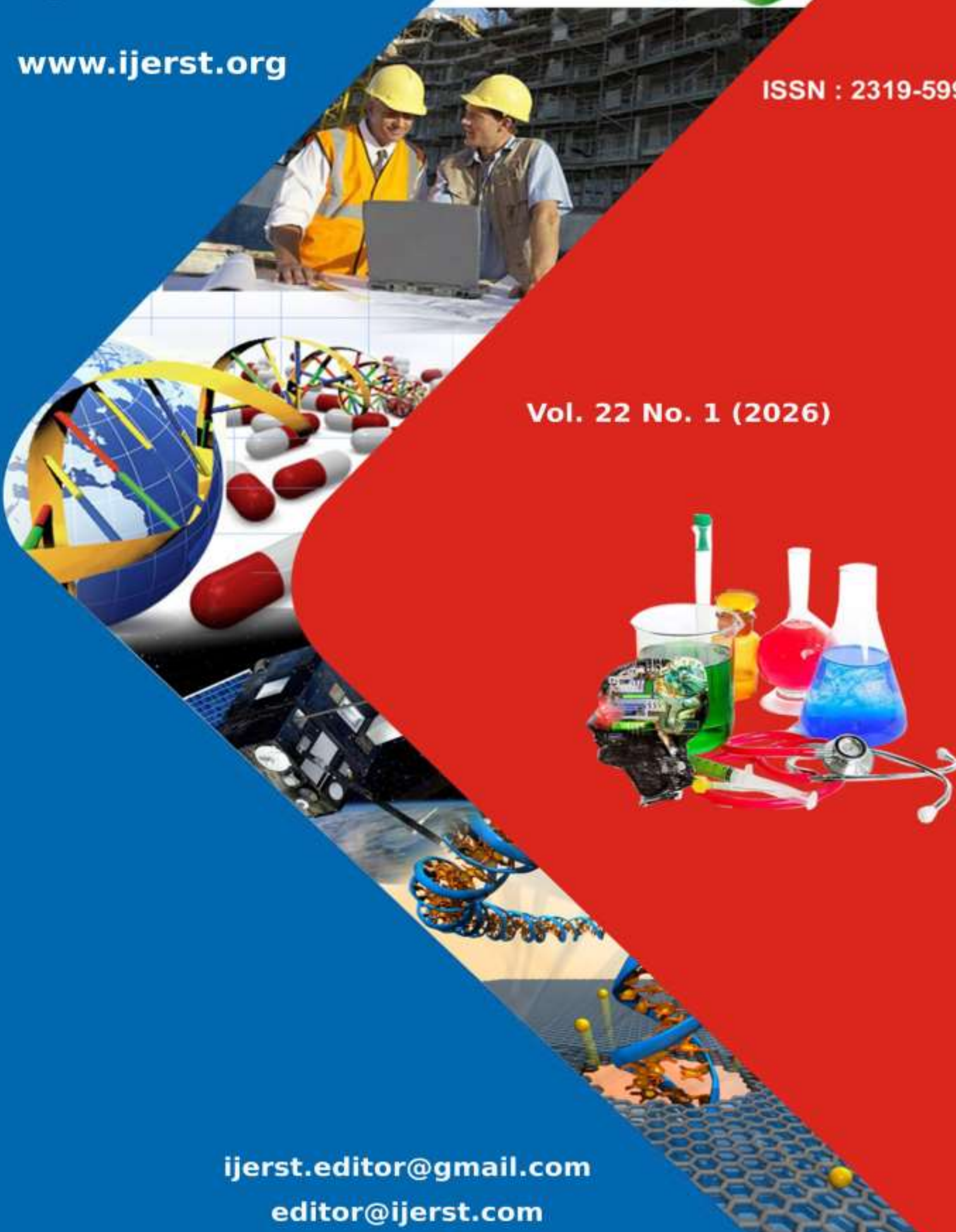

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Research Paper

AUTOMATIC BRAKING SYSTEM

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ABSTRACT: The increasing number of road accidents caused by delayed driver response and human error has highlighted the urgent need for intelligent vehicle safety systems. This research paper focuses on the design and development of an Automatic Braking System (ABS) that enhances vehicular safety by automatically applying brakes when an imminent collision is detected. The system uses sensors such as ultrasonic or infrared distance sensors to continuously monitor the distance between the vehicle and obstacles ahead. When the distance falls below a predefined safety threshold, the system sends a control signal to activate the braking mechanism, thereby reducing the vehicle's speed or bringing it to a complete stop. The proposed system is designed to work efficiently under varying traffic and environmental conditions, ensuring minimal reaction time and improved reliability. Experimental testing demonstrates that the automatic braking system can significantly reduce stopping distance and prevent collisions, thereby enhancing road safety and minimizing property and life loss. The project's outcomes indicate that integrating such systems into modern vehicles can serve as a cost-effective solution to enhance driver assistance and pave the way for fully autonomous safety technologies in the future.

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I.INTRODUCTION

The Automatic Braking System (ABS) operates on the principle of obstacle detection and automatic actuation of brakes to prevent vehicle collisions. The system uses distance-sensing technology, typically through ultrasonic, infrared, or radar sensors, which continuously monitor the distance between the vehicle and any object or obstacle in its path. The core working principle involves four main stages — detection, processing, decision, and action.

In the detection stage, the front-mounted sensors emit continuous signals that reflect back when they encounter an obstacle. The system measures the time interval between the transmitted and received signals to calculate the exact distance of the obstacle using the formula:

This distance data is then sent to the microcontroller or control unit, which forms the processing stage. The microcontroller compares the measured distance with a predefined safe distance threshold. If the distance between the vehicle and the obstacle is greater than the threshold, the system allows normal vehicle operation.

In the decision stage, when the measured distance falls below the threshold limit, the control unit interprets this as a potential collision situation. The system instantly decides to activate the braking mechanism to avoid impact.

Finally, in the action stage, a signal is transmitted from the control unit to the brake actuator or relay circuit, which engages the braking system automatically. Depending on the design, the system can apply partial braking to reduce speed or full braking to bring the vehicle to a complete stop.

The automatic braking system can also include warning indicators or buzzers to alert the driver before the brakes are applied, providing an additional layer of safety. The system ensures minimal reaction time, improved braking efficiency, and enhanced safety during emergency situations.

Overall, the working of the automatic braking system demonstrates how intelligent sensing and control mechanisms can effectively replace delayed human responses, reducing accidents and improving overall road safety.and modern vehicles. The research focuses on testing the system's accuracy, response time, and performance under various environmental and traffic conditions to ensure dependability and user safety.

II.LITERATURE REVIEW

Automatic braking systems have been an important area of research in the development of intelligent and autonomous vehicles. Over the years, various studies have focused on improving vehicle safety by integrating sensor-based automatic braking technologies to prevent collisions and minimize human error.

Singh et al. (2019) developed an automatic braking system using ultrasonic sensors to detect obstacles and control the braking distance. Their results showed that the system effectively reduced collision risks at low and medium speeds, especially in urban traffic conditions [1]. Similarly, Patel and Mehta (2020) proposed a radar-based automatic braking system that could operate efficiently under poor visibility conditions such as fog and rain, thus improving the reliability of autonomous braking [2].

Kumar et al. (2021) studied the performance of infrared and ultrasonic hybrid sensors for automatic emergency braking. The integration of both sensor types improved obstacle detection accuracy and minimized false triggering during complex traffic scenarios [3]. Another study by Ahmed and Reddy (2021) introduced a microcontroller-based braking mechanism that automatically activates when the distance between the vehicle and the object ahead falls below a critical threshold, thereby enhancing safety in congested environments [4].

Moreover, Sharma et al. (2022) emphasized the role of Artificial Intelligence (AI) and Machine Learning (ML) in modern braking systems. Their research demonstrated that AI-based predictive models could anticipate driver behaviour and road conditions, allowing earlier activation of brakes and reducing stopping distance [5]. Recent advancements by Li et al. (2023) focused on integrating Automatic Braking Systems with Adaptive Cruise Control (ACC), enabling vehicles to automatically adjust their speed and maintain safe distances without driver intervention [6].

From the review of existing literature, it is evident that automatic braking systems have evolved from basic sensor-based mechanisms to intelligent, AI-driven safety systems. However, challenges such as high implementation costs, sensor calibration errors, and environmental sensitivity remain. The current research aims to design a cost-effective and reliable automatic braking system suitable for general vehicles, ensuring enhanced safety and reduced dependency on human response.

Jones et al. demonstrated that multi-sensor fusion improves detection accuracy by over 40% compared to single-sensor systems. Vision-based braking systems, enabled through convolutional neural networks (CNNs), show increasing reliability in pedestrian detection and classification , making them essential in urban driving.[7]

Critical part of ABS is the **decision-making algorithm** governing when and how braking is applied. Traditional control models used fixed threshold rules based on relative distance and time-to-collision (TTC). However, modern systems incorporate machine learning and predictive control approaches.

Research by Li and Zhao introduced a model predictive control (MPC) algorithm that dynamically adjusts braking force based on vehicle speed, road conditions, and predicted obstacle trajectories. Their study shows that MPC-enabled systems achieve smoother deceleration and improved collision avoidance. [8]

Artificial intelligence has further enhanced decision-making capability by learning braking patterns from large driving datasets. Deep reinforcement learning (DRL) models have demonstrated the ability to adapt to dynamic road environments and optimize braking strategies under complex traffic conditions [9].

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III. METHODOLOGY

Fig. 1 Flow chart

IV. MATERIAL SELECTION

When doing a project, it is important to pay attention to the selection of materials. To prevent waste, the items selection process must be carefully welcomed. A precise selection of items is necessary to ensure that they are long-lasting and safe for usage.

4.1 Ultrasonic Sensor

Fig.2

Ultrasonic sensors are used in automatic braking systems to detect obstacles by emitting ultrasonic waves and measuring the time it takes for the reflected waves to return.

4.2 Arduino

Fig.3

An Arduino can be used in an automatic braking system by acting as the microcontroller that receives data from sensors, processes it, and then activates the braking mechanism.

4.3 Motor

Fig. 4

Motors are used in automatic braking systems to control a vehicle's motion, where a microcontroller detects an obstacle and commands the motor to stop or slow down using braking methods like regenerative braking, dynamic braking, or by directly activating a separate braking mechanism.

4.4 Motor Driver L298N

Fig. 5

The L298N acts as a bridge between the brain (microcontroller) and the wheels (motors).

It receives commands to run, slow down, or stop the motors, enabling the automatic braking when an obstacle is detected.

4.5 Battery

Fig. 6

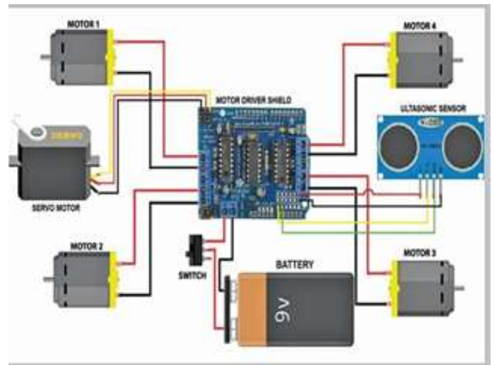
In your Automatic Braking System car, the 2200 mAh battery provides the power needed to run the Arduino, sensors, motor driver, and motors, enabling the system to detect obstacles and automatically stop the car.

Working principle

The Automatic Braking System (ABS) operates on the principle of obstacle detection and automatic actuation of brakes to prevent vehicle collisions. The system uses distance-sensing technology, typically through ultrasonic, infrared, or radar sensors, which continuously monitor the distance between the vehicle and any object or obstacle in its path. The core working principle involves four main stages — detection, processing, decision, and action.In the detection stage, the front-mounted sensors emit continuous signals that reflect back when they encounter an obstacle. The system measures the time interval between the transmitted and received signals to calculate the exact distance of the obstacle using the formula:This distance data is then sent to the microcontroller or control unit, which forms the processing stage. The microcontroller compares the measured distance with a predefined safe distance threshold. If the distance between the vehicle and the obstacle is greater than the threshold, the system allows normal vehicle operation.In the decision stage, when the measured distance falls below the threshold limit, the control unit interprets this as a potential collision situation. The system instantly decides to activate the braking mechanism to avoid impact. Finally, in the action stage, a signal is transmitted from the control unit to the brake actuator or relay circuit, which engages the braking system automatically. Depending on the design, the system can apply partial braking to reduce speed or full braking to bring the vehicle to a complete stop.

The automatic braking system can also include warning indicators or buzzers to alert the driver before the brakes are applied, providing an additional layer of safety. The system ensures minimal reaction time, improved braking efficiency, and enhanced safety during emergency situations.

Overall, the working of the automatic braking system demonstrates how intelligent sensing and control mechanisms can effectively replace delayed human responses, reducing accidents and improving overall road safety.



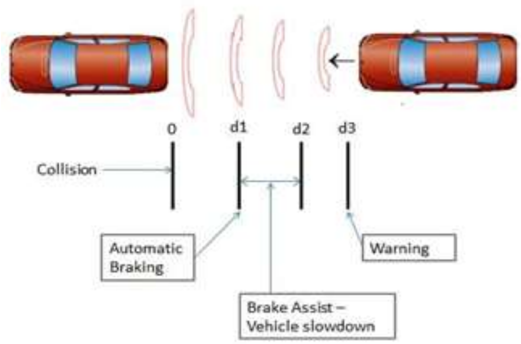


Fig. 7

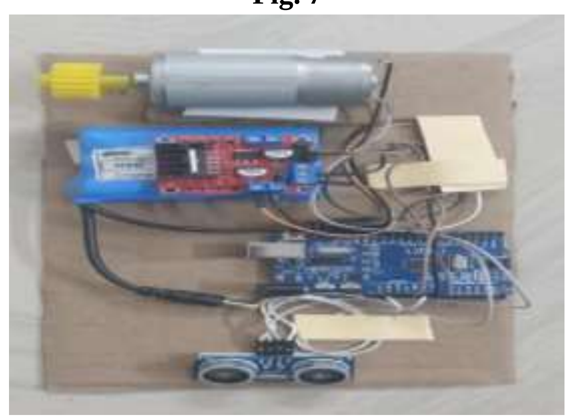


Fig. 8

VI. CONCLUSION AND FUTURE SCOPE

The development of an Automatic Braking System represents a major step toward improving road safety and reducing accidents caused by human error. This system automatically detects obstacles or vehicles in front of the car and applies the brakes when the driver fails to react on time. The designed model ensures quicker response, minimizes collision impact, and protects both the driver and passengers. By using sensors and control units, the system provides reliable and efficient braking in emergency situations, making it a practical and effective safety feature for all vehicles.

In the future, this system can be further enhanced by integrating it with advanced technologies such as Artificial Intelligence (AI), Machine Learning, and Vehicle-to-Vehicle (V2V) communication. These improvements can make the system smarter by predicting possible accidents and reacting even faster. Research can also focus on optimizing the braking algorithms to improve energy efficiency, reduce wear on braking components, and adapt to different weather or road conditions. The automatic braking system can be made more compact and cost-effective, allowing it to be installed in all types of vehicles, from small cars to heavy trucks. Ultimately, this innovation will contribute significantly to achieving safer and smarter transportation systems in the future.

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