IJARSCT ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53 Volume 4, Issue 1, June 2024

Automatic Electromagnetic Braking System

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Abstract*: This project aims to design and implement an Automatic Electromagnetic Braking System that leverages advanced sensors, Arduino (control mechanisms to autonomously engage and modulate braking forces), Relays, adapting to dynamic driving conditions in vehicles (Specially in cars). The project involves integrating sensors for real-time data acquisition, developing control algorithms for automated braking, and ensuring seamless integration with existing vehicle systems. The goal is to create a system that enhances vehicle safety by providing rapid and precise braking response to imminent collisions with other vehicles (accidents) or unexpected obstacles. The system utilizes a combination of proximity sensors, which continuously monitor the distance to nearby objects. Upon detecting a potential collision risk, the sensors send signals to an Arduino microcontroller. The Arduino processes these signals and, if necessary, activates an electromagnetic braking mechanism via relays.*

Keywords: Automatic Electromagnetic Braking System, Advanced Sensors, Arduino Control Mechanisms, Autonomous Braking, Modulate Braking Forces

I. INTRODUCTION

Automobiles ensure the optimization and good control over the vehicles. Braking System should ensure the safety and comfort of the passenger, driver and other road user. The brake must be strong enough to stop the vehicle during emergency within shortest distance. The convention braking system are bulky and power to weight ratio is low. Most of the braking systems utilize friction forces to transform the kinetic energy of a moving body into heat that is dissipated by the braking pads. The overuse of friction-type braking systems causes the temperature of the braking pads to rise, reducing the effectiveness of the system. An electromagnetic brake is a new and revolutionary concept. These are totally friction less. Electromagnetic brakes are the brakes working on the electric & magnetic power. Electromagnetic Braking System is used which is efficient way of braking with high power to torque ratio and also provide less amount of friction. An Electromagnetic Braking system uses Magnetic force to engage the brake, but the power required for braking is transmitted manually. The disc is connected to a shaft and the electromagnet is mountedon the frame. when electricity is applied to the coil a magnetic field is developed across the armature. The eddy- current is created by the relative motion between a magnet and a metal (or alloy) conductor.

1.1 Motivation

The motivation behind developing an Automatic Electromagnetic Braking System stems from the critical need to enhance vehicle safety, improve response times, and reduce the wear and tear associated with traditional braking systems. As road traffic increases and driving conditions become more complex, the risk of collisions and accidents rises. By leveraging advanced sensors and microcontrollers like Arduino, this system aims to provide a proactive solution for collision avoidance through rapid and precise braking responses. Electromagnetic brakes, which offer a non -contact method of slowing down or stopping a vehicle, significantly improve the durability of braking components while ensuring smoother and more reliable performance. This technology not only promises to safeguard lives by reducing the likelihood of accidents but also supports the evolution of autonomous safety systems in modern transportation, making vehicles smarter and more responsive to dynamic driving environments.

1.2 Problem Definition and Objectives

Traditional braking systems in vehicles require manual intervention and are often subject to human error, leading to sub optimal safety outcomes. This project aims to design and implement an Automatic Electromagnetic Braking System

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that leverages advanced sensors and control mechanisms to autonomously engage and modulate braking forces. The goal is to create a system that enhances vehicle safety by providing rapid and precise braking responses, adapting to dynamic driving conditions. The project involves integrating sensors for real-time data acquisition, developing control algorithms for automated braking, To study the efficiency of piezoelectric materials in converting foot pressure into electrical energy.

- To enhance vehicle safety by implementing an automatic braking system.
- To utilize advanced sensors for real-time monitoring of driving conditions.
- To develop control algorithms that enable autonomous braking responses.
- To integrate the braking system seamlessly with existing vehicle technologies.
- To reduce wear and tear on braking components using electromagnetic brakes.

1.3 Project Scope and Limitations

The scope of the Automatic Electromagnetic Braking System project encompasses the comprehensive design and development of an advanced braking system integrating hardware components such as proximity sensors, electromagnetic brakes, relays, and an Arduino microcontroller. This system will be designed to seamlessly integrate with existing vehicle technologies, with a focus on compatibility across a range of common vehicle models. The project includes the implementation and calibration of sensors for continuous monitoring and accurate detection of potential collision risks. Control mechanisms will be developed using Arduino to process real-time data and manage braking responses autonomously.

Limitations As follows:

- Compatibility issues with different vehicle models
- Sensor accuracy limitations in extreme conditions
- Continuous power consumption requirements
- Environmental impacts on system reliability
- Higher implementation costs
- Regulatory and legal constraints across regions

II. LITERATURE REVIEW

Paper Name: Electromagnetic Braking System Analysis:

Summary: Analyzes the reliability of electromagnetic braking systems compared to conventional oil or air braking systems, highlighting resilience to component failures.

Contribution: Emphasizes effectiveness in enhancing braking performance, preventing accidents, and reducing maintenance needs, proposing integration as auxiliary systems.

Paper Name: Exploring Eddy Current Brakes:

Summary: Investigates the use of eddy current brakes (ECB) as alternatives to conventional systems, studying braking torque relationships with coil quantity and air gap.

Contribution: Identifies parameters influencing ECB performance, suggesting optimal configurations to maximize braking torque.

Paper Name: Advancements in Electromagnetic Brakes:

Summary: Examines electromagnetic brakes as competitive alternatives to conventional retarders, offering higher braking power and minimizing brake failures.

Contribution: Aims to enhance road safety by reducing brake failures and maintenancerequirements, advocating for widespread adoption across vehicle types.

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Paper Name: Innovative Magnetic Brake Design:
Summary: Introduces a magnetic brake system controlled by electric power, utilizing magnetic forces to engage and disengage brake discs without continuous electrical supply.
Contribution: Presents a novel design offering remote control capabilities and minimal power consumption, ensuring braking or locking states without continuous electric power.

Paper Name: Enhancing Elevator Brake Monitoring:
Summary: Proposes an elevator drive brake system with compression springs and brake linings, incorporating a sensor to detect wear and trigger safety shutdowns.
Contribution: Introduces a monitoring system for elevator brake devices, enhancing safety by detecting wear and preventing operational risks, emphasizing proactive maintenance.

III. REQUIREMENT AND ANALYSIS

Arduino Uno SMD:
Microcontroller: The heart of the Arduino, it's based on the ATmega328P chip, offering 32KB offlash memory, 2KB of SRAM, and 1KB of EEPROM.
Digital and Analog I/O: Provides 20 digital I/O pins, 6 of which can be used for PWM output, and 6analog input pins.
Clock Speed: Operates at 16 MHz, providing computational power for various tasks.
Connectivity: Features USB connection for programming and power, alongside an ICSP header for direct programming.
Voltage Regulation: Supports an operating voltage of 5V, typically powered by USB or an externalpower source of 7-12V.

Geared DC Motor:
Speed and Torque: Offers a rotational speed of 10 RPM at 12V, with the ability to run smoothly from 4V to 12V, providing a wide range of speed and torque options.
Gear Assembly: Equipped with gears to reduce speed and increase torque, enhancing its utility invarious applications.
Physical Characteristics: Dimensions include a gearbox diameter of 37mm, motor diameter of 32mm, and motor length of 82mm.

Ultrasonic Sensor:
Operating Principle: Emits ultrasound waves at 40,000 Hz, which bounce back upon encountering objects, allowing for distance measurement based on the time taken for the waves to return.
Specifications: Operates at 5V DC, with a maximum range of 4 meters and a minimum range of 2 cm. The measuring angle is 15 degrees.
Calculation: Distance is calculated based on the time interval between sending and receiving the ultrasonic signal, typically using a conversion formula.

Single Channel Relay:
Functionality: Controls high voltage and high current loads such as motors or lamps. It has normally open (NO) and normally closed (NC) terminals for flexibility.
Control Signal: Operated with a TTL level control signal, making it compatible with microcontrollers like Arduino.
Switching Characteristics: Rated for switching voltage of 250VAC/30VDC and switching current of 10A, providing ample capacity for various applications.
Working Principle: Relies on electromagnetic attraction to open or close contacts, thus controlling the flow of current to connected devices.

16x2 LCD Display:

16x2 LCD: The module boasts a 16x2 character LCD configuration, enabling it to display 16 characters per row across 2 rows. This provides a clear and concise interface for presenting information.

IV. SYSTEM DESIGN

System Architecture

The below figure specified the system architecture of our project.

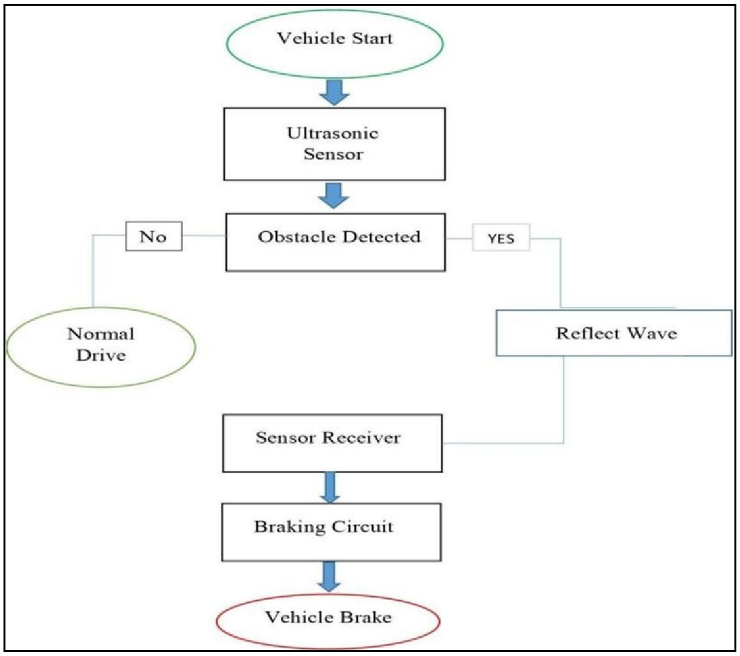

Figure 4.1: System Architecture Diagram

4.2 Working of the Proposed System

The proposed system is designed as a comprehensive solution for various applications, offering functionality across different components to achieve specific goals effectively. At its core, the system integrates an array of electronic modules and devices, each serving a distinct purpose but collectively contributing to a cohesive operational framework.

At the heart of the system lies the Arduino Uno SMD microcontroller board, which serves as the central processing unit orchestrating the interactions among different components. With its versatile input/output capabilities and support for a wide range of sensors and actuators, the Arduino Uno acts as the brain of the system, executing programmed instructions to control and coordinate various operations.

One of the key components in the system is the 1602 LCD display module, which provides visual feedback and user interaction. Through its intuitive interface, users can monitor system status, view sensor readings, and receive real - time updates, enhancing overall usability and accessibility. The I2C interface simplifies communication with the microcontroller, streamlining connectivity and reducing wiring complexity.

In addition to the display module, the system incorporates various sensors and actuators to collect data from the environment and effect changes as needed. For instance, the ultrasonic sensor enables distance measurement, allowingthe system to detect obstacles and navigate its surroundings autonomously. The DC motor, coupled with the single - channel relay, provides mechanical motion control, facilitating tasks such as motorized adjustments or actuator activation based on sensor inputs.

Furthermore, the system includes passive components like diodes and capacitors, which play crucial roles in ensuring stable and reliable operation. Diodes serve to regulate voltage and protect sensitive components from reverse current

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flow, while capacitors act as energy storage devices and noise filters, contributing to smooth and uninterrupted performance.

Overall, the proposed system offers a robust and versatile platform for various applications, ranging from home automation and robotics to industrial control systems. By leveraging the collective capabilities of its constituent components, the system enables seamless integration, efficient operation, and enhanced functionality, catering to diverse user needs and requirements.

4.3 Circuit Diagram

The below figure specified the Circuit Diagram of our project.

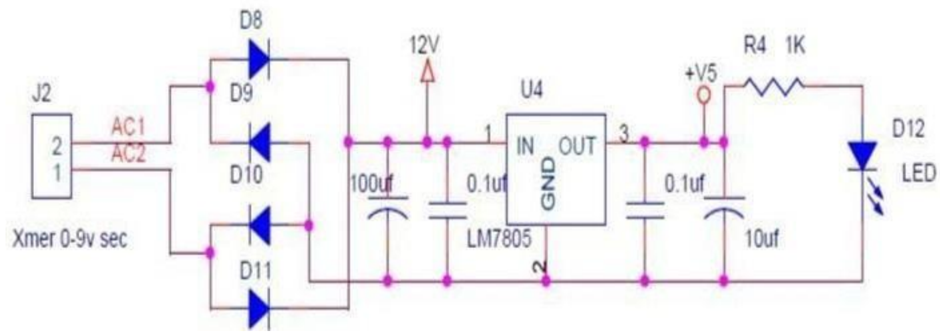

Figure 4.2: Circuit Diagram

V. RESULT

The implementation of the automated braking system marks a significant milestone in enhancing vehicle safety and reducing the risk of accidents, particularly in critical driving conditions. Through meticulous testing and validation, each phase of the system has demonstrated its functionality, culminating in the successful completion of the entire setup. The system operates seamlessly, accurately determining the safety distance and initiating braking maneuvers upon detecting obstacles in the vehicle's path. This proactive approach to collision avoidance is a crucial step towards mitigating accidents and safeguarding lives on the road.

A key element contributing to the system's effectiveness is the ultrasonic sensor, which plays a pivotal role in accurately measuring distances within the prescribed limits. Its precise ranging accuracy ensures that the braking response is triggered only when necessary, thereby preventing unnecessary interventions and optimizing safety measures. By integrating this sensor technology, the system can reliably assess its surroundings and make informed decisions in real - time, enhancing overall responsiveness and effectiveness.

During testing, the system was connected to a power source, and its braking mechanism was controlled using a DC motor. This eco-friendly approach not only demonstrates the system's operational versatility but also underscores its potential to reduce accidents and improve driving conditions, particularly in densely populated areas or high-traffic zones. By automating the braking process, the system minimizes human error and provides a proactive safety net in situations where split-second decisions can make a life-saving difference.

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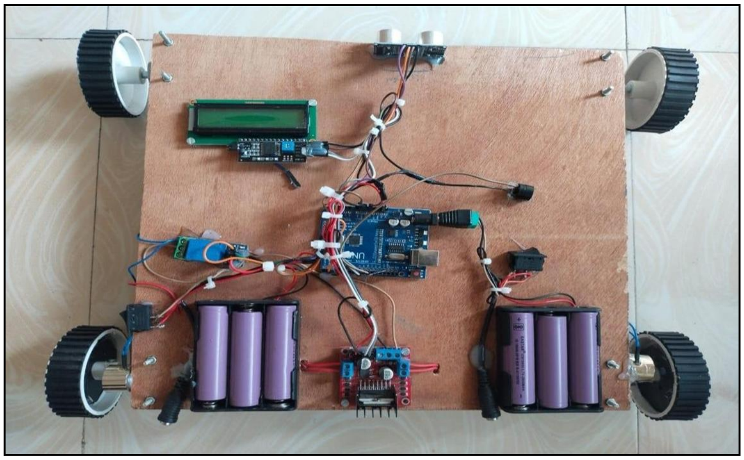

Figure 4.3: Output of Project

The successful validation of the system involved setting up various obstacles in its path and observing its response. In restricted areas, the system halted automatically, demonstrating its ability to adapt to dynamic environments and adhere to predefined safety protocols. Moreover, the system's accurate measurements, interpreted within the specified range of values, underscore its reliability and precision in executing braking maneuvers, further bolstering its credibility as a dependable safety feature

Moving forward, the implementation of an automatic electromagnetic braking system holds immense promise for enhancing vehicle safety and reducing the incidence of accidents. Electromagnetic brakes offer numerous advantages over traditional friction-based systems, including improved response times, reduced wear and tear, and smoother braking experiences. By harnessing the power of Arduino-based control systems, these advancements can be realized in a cost- effective manner, paving the way for widespread adoption and integration into modern vehicles and transportation systems.

In conclusion, the successful fabrication and testing of the automated braking system prototype represent a significant step forward in automotive safety technology. By leveraging cutting-edge sensor technology, precise control mechanisms, and eco-friendly braking solutions, the system embodies a holistic approach to collision avoidance and accident prevention. As research and development efforts continue to refine and optimize the system, it holds the potential to revolutionize vehicle safety standards, saving countless lives and ushering in a new era of road safety and transportation efficiency.

VI. CONCLUSION

Conclusion

In conclusion, the implementation of the automated braking system represents a transformative leap in vehicle safety technology. Through meticulous testing and validation, each component has proven its efficacy in enhancing collision avoidance and mitigating the risks associated with driving in challenging conditions. The system's ability to accurately detect obstacles and initiate braking maneuvers autonomously underscores its potential to revolutionize road safety standards, ultimately saving lives and preventing countless accidents.

Looking ahead, the continued refinement and optimization of the automated braking system hold the promise of even greater advancements in automotive safety. By harnessing the power of emerging technologies and innovative control systems, such as Arduino-based solutions, we can further enhance the system's responsiveness, precision, and reliability. As we strive towards a future of safer roads and smarter vehicles, the automated braking system stands as a beacon of progress, offering a glimpse into a world where accidents are minimized, lives are safeguarded, and transportation becomes safer and more efficient for all.

Future Work

Looking to the future, there is immense potential for the automated braking system to evolve and expand its impact on vehicle safety. Further research and development could focus on integrating advanced artificial intelligence algorithms to enhance obstacle detection and decision-making capabilities, paving the way for more sophisticated collision avoidance strategies. Additionally, the application of machine learning techniques could enable the system to adapt and learn from real-world driving scenarios, continuously improving its performance and responsiveness. With ongoing advancements in sensor technology, computing power, and vehicle connectivity, the automated bra king system is poised to play a pivotal role in shaping the future of transportation, ushering in an era of unprecedented safety and efficiency on our roads.

BIBLIOGRAPHY

[1]. National Highway Traffic Safety Administration. (2020). Automated Vehicles for Safety.
[2]. https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety
[3]. Goyal, V., Jain, R., & Garg, N. (2018). Automatic Braking System for Collision Avoidance. International Journal of Engineering Research & Technology, 7(3), 263-268.
[4]. U.S. Departmentof Transportation. (2017). Automated Driving Systems: A Vision for Safety.
[5]. https://www.transportation.gov/AV/3
[6]. Simpson, J. W. (2019). Electromagnetic Brake Systems: A Comprehensive Review. Journal of Advanced Transportation, 2019, 1-12. https://doi.org/10.1155/2019/5943624
[7]. Arduino. (n.d.). Arduino - Home. https://www.arduino.cc/
[8]. Altekar, A. A., Joshi, S. S., & Pande, M. R. (2018). Automated Braking System for Collision Avoidance in Vehicles Using Arduino. International Journal of Engineering and Management Research, 8(4), 48-52.
[9]. Bhagat, A. S., & Thool, A. B. (2019). Development of Automated Braking System Using Ultrasonic Sensor.International Journal for Research in Applied Science & Engineering Technology, 7(10), 74-77.
[10]. Ritchie, K., & Valsecchi, G. (2020). Electromagnetic Braking System: A Technical Review. International Journal of Automotive Engineering and Technologies, 9(1), 17-28.
[11]. Cooper, J. D. (2017). Automatic Braking Systems: Implementation Challenges and Opportunities. IEEE Transactionson Intelligent Transportation Systems, 18(4), 938-948.
[12]. Microchip Technology Inc. (n.d.). ATmega328P. https://www.microchip.com/wwwproducts/en/ATmega328P
[13]. Electroprime. (n.d.). ELECTROPRIME C879 5312. https://www.electroprime.in/
[14]. National Instruments. (n.d.). LabVIEW. https://www.ni.com/en-us/shop/labview.html
[15]. Amazon Web Services, Inc. (n.d.). AWS. https://aws.amazon.com/
[16]. Mechatronics. (n.d.). Introduction to Mechatronics. https://www.mechatronics.net.in/
[17]. United Nations. (2020). United Nations Sustainable Development Goals. https://sdgs.un.org/goals
[18]. Khan, A. M., Hussain, I., & Hamed, H. (2019). Design and Implementation of an Automated Braking System UsingArduino. International Journal of Scientific & Engineering Research, 10(7), 145-150.
[19]. Lulu. (n.d.). Lulu: Online Self-Publishing Book & eBook Company. https://www.lulu.com/
[20]. Raspberry Pi Foundation. (n.d.). Raspberry Pi. https://www.raspberrypi.org/
[21]. IEEE. (n.d.). IEEE Xplore Digital Library. https://ieeexplore.ieee.org/
[22]. Arduino. (n.d.). Arduino Programming Language. https://www.arduino.cc/reference/en/
[23]. Hackster.io. (n.d.). Hackster.io: The Community for Hardware and Software Developers. https://www.hackster.io/
[24]. GitHub, Inc. (n.d.). GitHub: Where the world builds software. https://github.com/
[25]. Altium Limited. (n.d.). Altium Designer. https://www.altium.com/
[26]. The Institution of Engineering and Technology. (n.d.). IET Journals & Magazines. https://www.theiet.org/publishing/
[27]. University of California, Irvine. (n.d.). UCI Machine Learning Repository. https://archive.ics.uci.edu/ml/index.php

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[28]. Element14. (n.d.). Raspberry Pi Projects, Tutorials, and Guides. https://www.element14.com/community/welcome

[29]. The MathWorks, Inc. (n.d.). MATLAB. https://www.mathworks.com/products/matlab.html

DOI: 10.48175/568