Smart Embedded Automatic Braking and Data Monitoring System for Electric vehicle

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ABSTRACT

Electric vehicles (EVs) are becoming increasingly popular in modern society, primarily due to the escalating costs of petrol. This paper introduces an IoT-powered automated braking control system for EVs, accompanied by a real-time monitoring solution. The system continuously tracks the battery's voltage and temperature through a dedicated monitoring and control setup. Key components of this system include sensors, a microcontroller, a Wi-Fi module, and the battery itself. The design is based on the cost-effective ATMEGA 328 microcontroller (Arduino UNO). The system also features an ultrasonic sensor that detects obstacles in the vehicle's path and triggers the automated braking mechanism when necessary. The data collected from the ultrasonic sensor, along with battery information such as voltage and temperature, is processed by the microcontroller and transmitted via Wi-Fi to the Blynk app. This app allows users to monitor the EV's key parameters in real-time, ensuring efficient management and operation of the vehicle.

Keywords: Electric Vehicles, IoT kit, Arduino UNO, Ultrasonic Sensor, Wi-Fi Module, Temperature Sensor, Voltage Sensor, Buzzer.

I. INTRODUCTION

The increasing fuel costs and growing environmental concerns have contributed to the rising popularity of Electric Vehicles (EVs). As a result, many manufacturers are searching for alternatives to gas-based energy sources. EVs are particularly beneficial for the environment, as they produce fewer emissions compared to traditional vehicles. Additionally, EVs help in energy conservation and environmental protection. Most EVs utilize lithium-ion batteries, which are more efficient and durable, compared to lead-acid batteries. Lithium-ion batteries provide a consistent power supply and have a life cycle 6 to 10 times longer than lead-acid batteries. However, factors such as excessive charging or deep discharges can shorten the lifespan of these batteries.

The driving range of EVs is often limited by the size of the battery and the design of the vehicle. This restriction is one of the key challenges that hinder the widespread adoption of EVs. A more significant issue, however, is the safety concerns associated with existing battery technology. Overcharging the battery not only Shortens its lifespan but also increases the risk of safety hazards such as fires. Addressing these concerns Requires the implementation of an EV battery tracking system that can monitor the battery's health and notify users when the power source is in poor condition.

Traditionally, battery tracking systems provided information through in-car displays. These systems would alert users about the battery's condition, such as when the battery needed maintenance or replacement. However, advancements in technology have led to the development of more sophisticated tracking systems using Internet of Things (IOT) technology. These IoT-based systems allow both manufacturers and users to receive real-time notifications about the battery's condition, enabling proactive maintenance and enhancing safety.

The integration of IOT technology into battery management systems is a significant step toward improving the reliability and efficiency of EVs. By enabling seamless connectivity with the internet, IoT technology facilitates remote monitoring and real-time updates, which help extend the battery's life and prevent potential safety issues. This innovation not only enhances user experience but also ensures that EVs can be used more safely and effectively, helping to overcome some of the major limitations of current EV battery technology.

II. EXISTING METHOD [Page Layout]

Many electric vehicles (EVs) currently rely on manual braking, which depends on the driver's immediate reaction, increasing the risk of accidents, especially in emergencies. While high-end EVs have advanced driver-assistance systems (ADAS) like automatic emergency braking (AEB), budget-friendly EVs lack such safety features, leaving drivers vulnerable. Additionally, vehicle health monitoring in most EVs is basic and reactive, often only indicating issues like battery status or overheating after they have become critical. Current IOT-based monitoring systems generally focus only on battery health, not integrating both automatic braking and real-time vehicle health monitoring. This gap presents an opportunity for a comprehensive system that improves both safety and vehicle efficiency.

Table 1 Existing System in Table Format

Aspects	Current Status	Challenges
Braking System	Manual braking System in most EVs; ADAS features Available in high-end Models	Limited availability of automatic braking in budget-friendly EVs.
Obstacle Detection	No automatic obstacle detection in traditional systems.	Increased risk of accidents due to lack of real-time obstacle recognition.
Driver Assistance	Advanced driver-assistance systems (ADAS) available only in high-end EVs	Most budget EVs lack ADAS features like automatic emergency braking (AEB).
Vehicle Health Monitoring	Basic dashboard indicators; Some IoT-based monitoring solutions focus on battery/temperature.	Limited real-time monitoring; often reactive rather than proactive in detecting issues.
Safety Features	Manual intervention required for braking; Some EVs lack collision avoidance.	Manual intervention required for braking; Some EVs lack collision avoidance.

Drawbacks

1. **Increased Risk of Accidents:** Since many EVs rely on manual braking, there is an increased risk of accidents, particularly when the driver is distracted or unable to react quickly. The absence of automatic emergency braking exacerbates this risk.

2. **Limited Availability of Advanced Safety Features:** Budget-friendly EVs generally lack advanced driver-assistance systems (ADAS), such as automatic emergency braking and obstacle detection, which are available only in high-end models. This limits safety for a large portion of the EV market.

3. **Lack of Obstacle Detection**: Without automatic obstacle detection, traditional braking systems can be slow to react to sudden changes in the driving environment, leading to collisions or accidents that could otherwise be prevented.

4. **Reactive Vehicle Health Monitoring**: Most EVs provide basic monitoring indicators for battery levels but lack more comprehensive, proactive vehicle health tracking. This limits the ability to detect issues before they become serious, which can lead to costly repairs or unexpected breakdowns.

5. **Fragmented IoT Solutions:** While some IoT solutions exist for monitoring battery health, temperature, and charging status, they are often disconnected from the vehicle's braking system. The lack of an integrated monitoring system reduces the overall efficiency and safety of the vehicle.

6. **Potential for Increased Maintenance Costs**: The lack of real-time health insights or proactive issue detection can result in unexpected failures, leading to higher maintenance and repair costs over time. Drivers may not be aware of potential issues until they have escalated to a point of failure.

III. PROPOSED METHOD

Proposed System: IoT-based Automatic Braking Control and Monitoring System.

The proposed IOT-based Automatic Braking Control and Monitoring System is designed to overcome the limitations of traditional braking systems and vehicle health monitoring in electric vehicles (EVs). By integrating obstacle detection, automatic braking, and real-time vehicle health assessments, the system significantly enhances both safety and efficiency.

Automatic Braking Control: The system uses ultrasonic sensors to detect obstacles within a predefined range. When an obstacle is detected, a relay is triggered to engage the braking mechanism automatically, allowing for faster response times in emergency situations. Simultaneously, a buzzer alerts the driver to ensure awareness and prompt action. This automatic braking feature reduces the risk of collisions, especially in cases where the driver might be distracted or unable to react quickly.

Vehicle Health Monitoring: The system continuously monitors crucial aspects of the vehicle's health, such as battery voltage and temperature. In case of overheating or power fluctuations, the system provides early warnings to prevent more severe issues, such as battery damage or system failures. This proactive approach ensures that potential problems are identified before they lead to breakdowns or more expensive repairs.

IOT Integration and Data Access: All vehicle data, including braking events, health status, and sensor readings, are transmitted to an IOT platform. This allows EV owners to access real-time updates and historical analytics through a user-friendly interface. With this feature, owners can track their vehicle's performance, monitor the health of key components, and plan maintenance schedules effectively.

Cost-Effective and Scalable: The proposed system is designed to be cost-effective, making it accessible to a wide range of EV owners. It can be easily scaled to accommodate various types of electric vehicles, including personal EVs, electric bikes, and even commercial EV fleets. This flexibility ensures that the system can be adapted to different use cases, enhancing the overall safety and efficiency of diverse vehicle types.

Key Benefits:

Enhanced Road Safety: Automatic braking reduces the risk of accidents caused by delayed driver response, while obstacle detection provides real-time collision avoidance.

Reduced Maintenance Costs: Continuous health monitoring helps detect issues early, preventing costly repairs and minimizing unexpected breakdowns.

Improved Vehicle Efficiency: The system's real-time data analytics ensure that vehicle performance is optimized, improving the overall efficiency of the EV.

Increased Accessibility: The system is cost-effective and scalable, making it suitable for a variety of EV models and users, from personal to commercial vehicles.

By combining automatic braking control with advanced health monitoring and IoT integration, this system provides a comprehensive solution that ensures both safety and efficiency for electric vehicles.

An IOT-based automated breaking Control system for EV vehicles is suggested in this paper, along with a monitoring system. Arduino Microcontroller, Battery, Relay, Load and Node MCU, as well as Temperature, Voltage and Ultrasonic Sensors, make up the system. The suggested method for this system computes a real-time indicator of the battery's temperature and voltage. Wi-Fi module and a microcontroller-based system are utilized to monitor these battery metrics. The voltage sensor is utilized to continuously check the battery voltage. The impediment is located using an ultrasonic sensor, which transmits the information to an Arduino board, which then regulates the braking mechanism. A temperature sensor is used to gauge the heat generated by the battery. Wi-Fi module and a microcontroller-based system are utilized for tracking these battery metrics. Using Node Mcu, the data is transmitted to the IoT cloud where it is tracked before being forwarded to the blynk application.

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Block Diagram

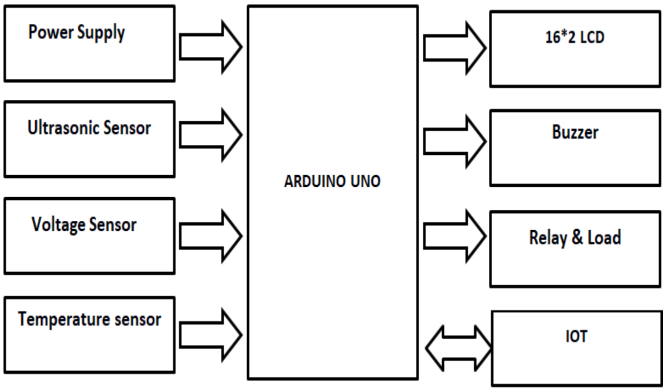

Fig 2 Block Diagram

Ultrasonic Sensor:

An ultrasonic sensor is a device that uses sound waves to measure distance. It emits high-frequency sound pulses (typically above 20 kHz) and calculates the time it takes for the echo to return after bouncing off an object.

How Ultrasonic Sensors Work

Ultrasonic sensors emit high-frequency sound waves (typically above 20 kHz) and measure the time it takes for the waves to bounce back from an object. The sensor then calculates the distance based on the time-of-flight principle.

IOT

IOT (Internet of Things) refers to a network of physical devices embedded with sensors, software, and other technologies that connect to the internet and exchange data. These devices can range from smart home appliances and wearable gadgets to industrial machinery and smart city infrastructure. The main goal of IoT is to enable automation, improve efficiency, and provide real-time data for better decision-making.

Buzzer

A buzzer is an electronic device that produces a sound, often used for alarms, notifications, or signaling. Buzzers can be found in various applications, such as doorbells, timers, game shows, and security systems. There are two main types of buzzers:1. Piezoelectric Buzzer – Uses piezoelectric material to create sound when an electric signal is applied.2. Electromechanical Buzzer – Uses a coil and magnet to produce sound through vibration.

Temperature Sensor:

A temperature sensor is a device used to measure and monitor temperature in various environments. It works by detect changes in heat and converting them into readable data, which can be displayed on a screen or transmitted to a control system. Temperature sensors are widely used in industries such as healthcare, automotive, manufacturing, and home automation. Common types include thermocouples, resistance temperature detectors (RTDs), infrared sensors, and thermistors.

Arduino Uno:

The Arduino Uno is a microcontroller board based on the Atmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Working Principle

Working Principle of IoT-Based Automatic Braking Control & Monitoring System for EVs, The system functions by integrating sensors, a microcontroller, and IoT connectivity to ensure real-time monitoring and automated braking in EVs.

1. Obstacle Detection: The ultrasonic sensor detects objects in the vehicle's path.

2. Automated Braking: If an obstacle is detected, the microcontroller (Arduino UNO) processes the signal and triggers the braking system.

3. Battery Monitoring: Voltage and temperature sensors track battery health, sending data to the microcontroller.

1. **Data Processing & Transmission:** The microcontroller processes sensor data and transmits it via a Wi-Fi module to the Blynk app.

2. **Real-Time Monitoring:** Users can view battery status and braking activity remotely through the Blynk app, ensuring efficient EV operation**.**

Results

This paper presents an IoT-based system for Electric Vehicles (EVs) that automates braking using ultrasonic sensors and monitors battery voltage and temperature in real-time. The system transmits data to the Blynk app via Wi-Fi, enabling efficient management and operation of the vehicle.

The proposed system enhances safety through automated braking, reducing the risk of accidents. Additionally, the real-time monitoring of battery voltage and temperature ensures efficient EV management and operation. The cost-effective design, based on the ATMEGA 328 microcontroller (Arduino UNO), makes this system a viable solution for the EV industry.

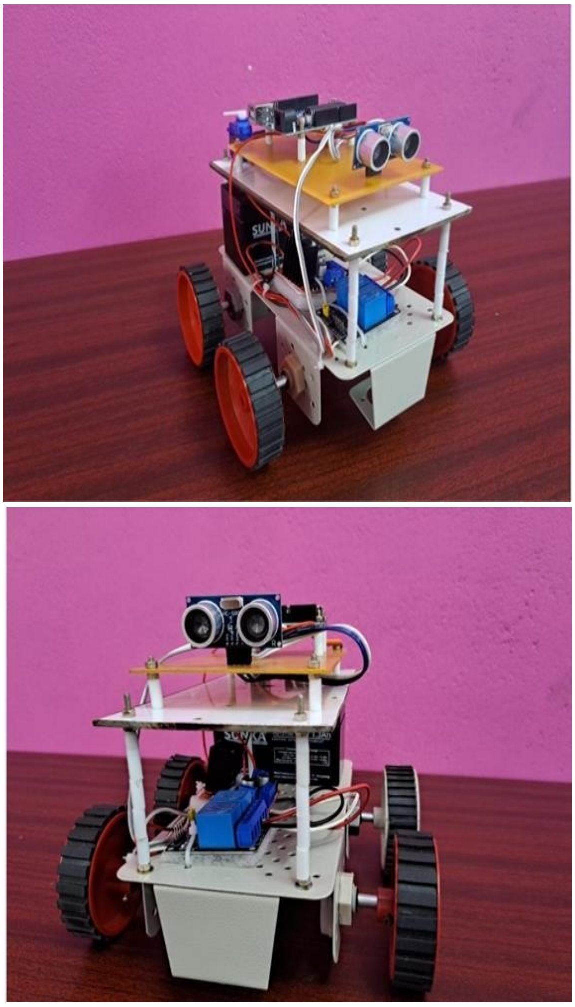

Figure 1 Hardware View

IV. CONCLUSION

This Paper discusses the design and implementation of an IoT-based battery monitoring system for EVs, enabling real-time tracking of battery health. The system includes hardware components like sensors, a CPU, a Wi-Fi module, and is built using the Arduino UNO. It integrates an autonomous braking system with an ultrasonic sensor that detects obstacles and controls the braking mechanism. The microcontroller monitors battery voltage, temperature, and status, transmitting this data via Wi-Fi to the Blynk app for easy tracking of the EV's performance. The system can display important data such as battery life and status and may be further enhanced by adding new features. Additionally, a smartphone app could be developed to help users monitor battery health and detect degradation. This system is adaptable for use in EVs, and future improvements could include upgrading the controller, such as replacing it with an SVGA controller.

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