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BATTERY SAFETY SYSTEM IN ELECTRIC VEHICLE USING IOT TECHNOLOGY

Prof. Kiruthika K[1], Chandana BS[2], Varsha PV[3], Yashwanth GN[4], Vishwanath J[5]

[1]Asst. Professor, Electrical & Electronics, RajaRajeswari College Of Engineering
[2,3,4,5]UG Students, Electrical & Electronics , RajaRajeswari College Of Engineering

ABSTRACT :

, This project introduces an IoT-based battery safety system for smart electric vehicles, addressing critical risks like thermal runaway, overcharging, deep discharge, and hazardous gas leaks through real-time monitoring and automated safeguards.

The system continuously monitors critical battery parameters such as temperature, voltage, using sensors embedded in the battery pack. Real-time data is transmitted to a Blynk platform, enabling remote monitoring and instant alerts to the vehicle owner via mobile applications. This comprehensive approach improves the overall safety and reliability of electric vehicles, supporting safer adoption of EV technology in transportation.

Automated safety responses, including overcharge protection.

Remote access and data visualization for predictive maintenance and efficiency. Rotational energy, Vibrational energy, Piezoelectric system, Dual-source, Sustainable power generation, Micro-energy harvesting.

KEYWORD: BATTERY SAFETY SYSTEM IN ELECTRIC VEHICLES

INTRODUCTION

As the electric vehicles usage has increased nowadays and along with it the Battery risks have also increased. So it is necessary to knew the condition of the battery frequently, so by using certain hardware and software components we can monitor the battery condition and can be aware of the battery condition from, overheating and fire hazards of the battery system in an electric vehicle. The system employs sensors integrated with microcontrollers and communication modules to transmit data to cloud platforms like Blynk for remote visualization, automated alerts, and protective actions such as relay disconnection or cooling activation. Experimental validations in simulated EV environments confirm improved battery efficiency, lifespan extension, and user safety through proactive diagnostics and threshold-based controls. IoT technology addresses these gaps by embedding sensors within battery packs to enable continuous real-time data collection and transmission to cloud platforms via microcontrollers like ESP32 or Arduino with modules.

This connectivity supports remote diagnostics, mobile alerts for anomalies, and integration with vehicle safety systems for actions like cooling activation, relay disconnection, or fire suppression, enhancing overall reliability and user confidence.

PROBLEM STATEMENT:

Now a days the increasing number of fire incidents in electric vehicle due to battery failures, bring out the need for an intelligent-IOT based prevention system. The Proposed embedded solution integrate sensors, micro- controllers and real time cloud communication to detect and reduce fire risks through automated response and user alerts. This problem aligns with current research trends in IOT-enabled fault detection systems for EV's as discussed in multiple studies

LITERATURE SURVEY

1. **[1] Smart electric vehicle with safety system.**

Author: M Sivaram Krishnan and Naveenkumar P. Published in 2023.

The work advances smart EV adoption by prioritizing prevention through AI-assisted features and sensor fusion, contributing to lower fatalities in urban settings. However, it faces integration challenges like sensor compatibility and space optimization in vehicle design, with limited details on scalability or real-world testing. Overall, it provides a practical blueprint for safer EVs, cited in subsequent studies on battery and fault management.

2. **Advanced IOT driven battery management system for EV**

Author: S John and K Suresh Published in 2024

The core idea is to enhance battery safety, longevity, and efficiency by overcoming the limitations of conventional BMS technologies, particularly the challenges associated with real-time monitoring, predictive fault detection, and thermal management proposes an advanced Battery Management System (BMS) for Electric Vehicles (EVs) that leverages the Internet of Things (IoT) and integration with renewable energy sources

3. **Thermal management systems for Electric vehicles**

Author: Kolla Ramya and Sushma Chowdry Published in 2025

These paper indicate the efficient thermal management throughout the battery operation as no overheating events were detected and helps to know about the thermal management system . These are essential for regulating the temperature of battery ,motor and power electronics within optimal conditions.

4. **Electric vehicles battery parameters monitoring system using IOT .**

Authors: Hari Prasanth E and Aruna S published in the year 2025

The literature survey describes a system built around a dedicated monitoring device and a user interface (like a mobile or web application) that leverages IoT connectivity to bridge the gap between the battery pack and the user/administrator. this literature survey details a cost-effective, real-time IoT solution that significantly enhances battery safety and monitoring for EVs by combining sensor data with remote connectivity and automated alert systems.

5. **Intelligent battery management system using IOT for enhanced EV**

Authors : Shivaram Krishnan M and Vijayalakshmi M Published in 2025

This work proposes an advanced Battery Management System (BMS) for Electric Vehicles (EVs) that significantly moves beyond traditional monitoring by integrating Artificial Intelligence (AI) and IoT to deliver predictive maintenance and enhance overall EV efficiency, safety, and lifespan. Real-time monitoring coupled with automated, AI-driven protective actions significantly enhances the reliability and safety of the EV operation

6. **IOT enabled real time monitoring and temperature monitoring in EV**

Authors: Rudra M and Vinod M Published in 2025

The core focus of this work is on using Internet of Things (IoT) technology to provide remote, continuous surveillance of the battery's operating condition, with a critical emphasis on thermal management to prevent battery degradation and the risk of thermal runaway.

PROPOSED SYSTEM

The proposed solution for this is that it continuously monitors the batter safety system in electric vehicle without allowing it to get over heated and then directly turns on the exhaust fan without allowing it to get overheated it works as a battery safety system and sends the alert message to the phone directly through the IOT technology.

1.1. General guidelines for the preparation of your text

Avoid hyphenation at the end of a line. Symbols denoting vectors and matrices should be indicated in bold type. Scalar variable names should normally be expressed using italics. Weights and measures should be expressed in SI units. All non-standard abbreviations or symbols must be defined when first mentioned, or a glossary provided.

METHODOLOGY

The methodology for developing an IoT-enabled Battery Safety System (BSS) for Electric Vehicles (EVs) is a systematic process encompassing hardware design, embedded software development, cloud integration, and rigorous safety testing. It begins with System Design, where safety thresholds (like maximum temperature and voltage limits) are defined and all components (sensors, microcontroller, relays) are carefully selected based on the battery's requirements. This firmware's primary role is to accurately read real-time data from the voltage, temperature, and gas sensors and execute the local safety logic—immediately activating the single- channel relay to disconnect the battery or turn on the exhaust fan if a critical fault is detected. This cloud platform serves two vital functions: remote monitoring via a web/mobile dashboard for users and fleet managers, and advanced analytics where Machine Learning algorithms can run on the historical data to predict long-term degradation and forecast potential failures.

The DHT11 is a common and popular basic digital sensor used to measure temperature and humidity. It is widely utilized in beginner electronics projects, IoT applications, and environmental monitoring systems due to its simplicity, low cost, and ease of use with microcontrollers like Arduino and Node MCU ESP8266. the EV Battery Safety System, the DHT11 is often used for ambient temperature and humidity monitoring inside the enclosure, but a more accurate, faster sensor (like a dedicated thermistor or a high-precision digital sensor) would typically be used for direct, critical monitoring of the battery cells themselves

NODE MCU 8266

The Node MCU ESP8266 is an extremely popular, low-cost, open-source development board specifically designed for Internet of Things (IoT) projects. It is essentially a complete system-on-a-chip (SoC) that combines a microcontroller with integrated Wi-Fi connectivity, making it an ideal choice for connecting devices and sensors to the internet. the EV Battery Safety System, the Node MCU serves as the Control Unit and Communication Gateway, reading sensor data, executing local safety logic, and transmitting that critical data to the remote cloud platform for diagnostics and alerts.

LCD DISPLAY

A Liquid Crystal Display (LCD) is a flat-panel display technology that uses the light-modulating properties of liquid crystals to display images or information. Unlike older technologies, LCDs do not emit their own light; instead, they act as a light valve, controlling the light from a separate backlight to form the image. The core principles of LCDs—low power consumption and clear digital display—make them highly suitable for embedded systems like those used in IoT and EV Battery Management Systems (BMS).

SINGLE CHANNEL REALY

A single-channel relay is an electromechanical switch that uses a small electrical signal (typically from a microcontroller like the Node MCU or Arduino) to control a much larger electrical circuit, which is usually operating at a higher voltage or current (like an AC power source). It is fundamentally a one-way switch that allows an isolated, low-power control circuit to safely turn on or off a high-power load.

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DC MOTOR

A DC Motor (Direct Current Motor) is an electromechanical device that converts direct current (DC) electrical energy into mechanical rotational energy using the principles of electromagnetism. They are prized for their simple construction, high starting torque, and ease of speed control, making them essential in applications from small toys and robotics to heavy industrial machinery and electric vehicles (EVs). Advanced DC motors are designed to provide consistent torque over a wide range of operating speeds.

Exhaust fan

An exhaust fan is an electromechanical device designed to expel stale, humid, or contaminated air from an enclosed space and replace it with fresh air drawn from outside or another designated area. Its primary function is to create a negative pressure environment within a room, which ensures continuous air exchange and improves overall air quality and thermal conditions. when the fan is switched on, the rotating blades draw air from the room and push it out through a vent. which forces fresh air to be drawn in through passive inlets (windows, doors, or dedicated vents) to maintain pressure equilibrium.

VOLTAGE SENSOR

A voltage sensor is a device used to measure the voltage of a power source. In the context of the photo above (a small electronic module), it typically functions as a voltage divider circuit. The low-cost voltage sensor module, typically based on a simple resistive voltage divider, is only one type of sensor used in electronics. a professional EV Battery Safety System relies on galvanically isolated Hall Effect transducers or dedicated, high-precision integrated circuits for reliable and safe voltage measurement

POTENTIOMETRIC

A potentiometric sensor is a type of electrochemical sensor used primarily to determine the analytical concentration (or activity) of a specific chemical component (the analyte) in a solution or gas. It achieves this by measuring the electrical potential difference (voltage) between two electrodes when virtually no current is flowing through the circuit. Potentiometric sensors are superior for real-time monitoring of specific ionic species because they are non-destructive and offer a wide dynamic range.

AURDINO UNO

The Arduino Uno is arguably the most popular and foundational development board in the world of electronics prototyping, making it the gateway for beginners and a robust tool for experienced engineers. It is an open-source hardware and software platform designed for ease of use in building digital devices and interactive objects that can sense and control the physical world. the Battery Safety System projects discussed, the Arduino Uno often serves as the main control unit responsible for reading voltage, current, and temperature sensors before passing the data to a separate Wi-Fi module

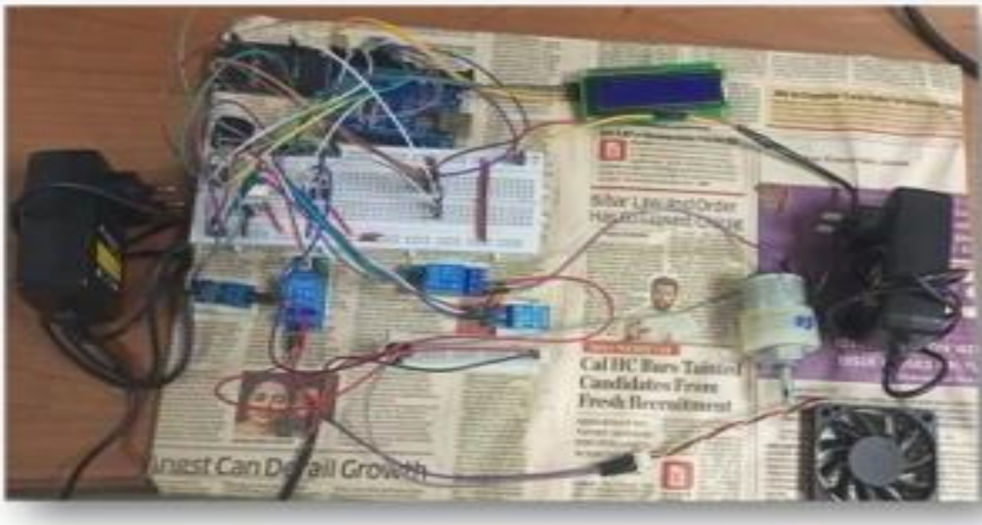
Hardware & Software Components

The battery safety system in an electric vehicle using IoT technology is built around a combination of smart hardware and intelligent software working together. The hardware includes sensors for temperature, voltage, and current that continuously track the battery's operating conditions, along with a microcontroller or IoT module such as an ESP32 or Arduino that processes this data. Protection circuits, relays, and cooling components further ensure safe operation by responding to abnormal conditions. On the software side, embedded firmware manages sensor readings, applies safety rules, and communicates with cloud platforms. IoT dashboards or mobile apps display real-time battery information, generate alerts during faults, and store data for analysis. Together, these hardware and software components create a connected system that improves battery health monitoring, enhances safety, and allows remote supervision of the EV's battery status.

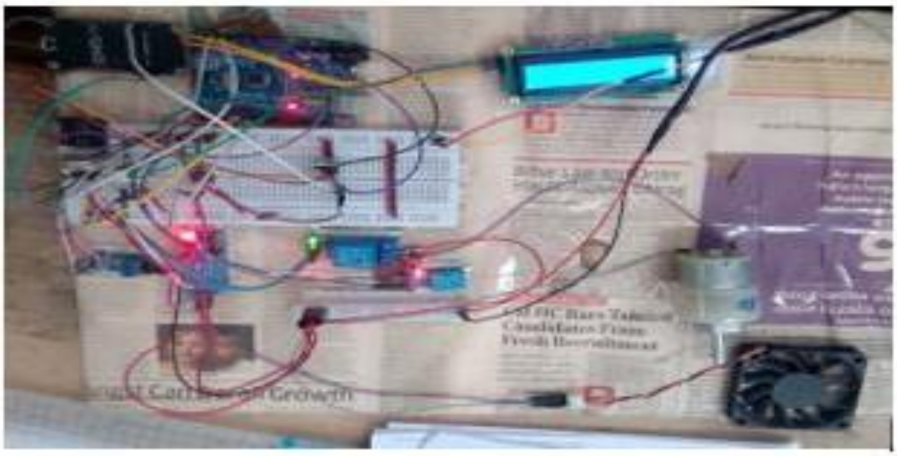
RESULTS

The IoT-based Battery Safety System for Smart Electric Vehicles using Blynk software successfully demonstrates an efficient method for real-time monitoring, protection, and management of EV batteries. By continuously tracking key parameters such as temperature, voltage, current, and state of charge, the system provides early detection of unsafe conditions and triggers immediate alerts to the user through the Blynk mobile application. The addition of automatic protection actions—such as activating the cooling system and disconnecting the battery during critical situations—significantly enhances the overall safety and reliability of the EV

ILLUSTRATIONS



View of the project when Supply is OFF



View of the project when supply is ON

OUTPUT :

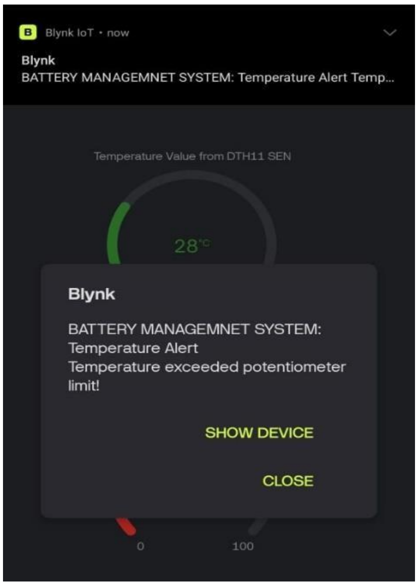
EXHAUST FAN OFF STATE

EXHAUST FAN ON STATE

LCD WHEN NORMAL TEMPERATURE

LCD WHEN HIGH TEMPERATURE

BLYNK APP NORMAL TEMPERATURE



BLYNK APP AT HIGH TEMPERATURE

CONCLUSION

This circuit exemplifies robust control design by integrating critical safety and standardization features alongside core functionality. The use of the 7805 voltage regulator ensures that the sensitive Arduino UNO and its associated digital logic are supplied with a clean, stable 5V, preventing damage from the system's external 12V supply fluctuations. Furthermore, the signal path for the actuation command is intentionally routed through a 6N135 optocoupler. This component, which uses light to transmit a digital signal, achieves complete galvanic isolation between the low-voltage control side (Arduino) and the high-voltage (12V) relay/motor driver side. This isolation is a crucial safety measure that protects the Arduino from harmful back EMF (Electro-Motive Force) generated by the 12V DC Motor and isolates the microcontroller from potential ground loops or current spikes. The control of the motor via a Relay further standardizes the interface, allowing the Arduino to switch a high-current load with a simple digital signal. Finally, the inclusion of a dedicated Voltage Sensor for the 12V DC line and the use of the Arduino's Analog Input Pin (A0) highlights a design commitment to continuous, real-time feedback and control, enabling the system to implement sophisticated protection or adaptive control algorithms based on the voltage and temperature readings. For input, the Arduino receives ambient conditions from Temperature Sensors and voltage data from a 12V DC Sensor through a conditioning Voltage Sensor module, which scales the high voltage down to a range acceptable for the Arduino's analog input pin (A0). The control logic within the Arduino dictates the operation of an external load, specifically a 12V DC Motor, by sending a control signal (potentially a PWM signal) through a digital output pin. The isolated signal then energizes the coil of a 12V Relay, which acts as a switch to connect the dedicated 12V DC power supply to the motor, controlling its ON/OFF state. Finally, the system includes planned LED indicators for both voltage and temperature to provide immediate visual feedback on the system's status or if certain thresholds are met.

FUTURE SCOPE

Integration with Full Battery Management System (BMS)The IoT safety system can be expanded into a complete BMS by adding .advanced features such as cell balancing, charge rate optimization, and fault detection algorithms for improved battery performance. Artificial Intelligence and Predictive Maintenance. using AI/ML algorithms, the system can predict battery failures, estimate remaining battery life (SOH), and identify unusual behavioral patterns before they turn into safety hazards. Integration with GPS and Vehicle Tracking. Adding GPS modules allows tracking of vehicle location, travel patterns, and battery condition simultaneously, making it suitable for fleet management and rental EV systems.

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REFERENCES

[1] Dong Li, Jindong Tian, Yong Tian, "State-of-charge estimation of lithium-ion batteries using an optimal nonlinear observer," presented at the 12th IEEE Conference on Industrial Electronics and Applications (ICIEA), 2017.

[2] Y. P. Zhao, Y. W. Ge, C. B. Zhu, J. L. Sun, and C. Wu, "Investigation of the impact of overcharge and over discharge on Lithium-ion batteries," in Proc. IEEE Veh. Power Propul. Conf., 2015, pp. 1-6.

[3] Y. U. Jeong and H. V. Venkata Setty, "Recent developments in lithium ion and polymer batteries," in Proceedings of the 17th Annual Battery Conference on Applications and Advances, January 2002, pp. 173- 178.

[4] Y. Goto, K. Tsukada, S. Nakano, "Prototype of a Hydrogen Gas WSN," IEEE Sensors 2005 Technical Digest, pp. 159-162, October 31–November 3, 2005.

[5] Mani, N.; Bani-Salma, A.; Lweesy, K.; Fraiwan, L. "Wireless gas leakage for home " in Proceedings of the 1st Middle Conference on Biomedical (MECBME), held in Sharjah, United Arab Emirates, 21–24 February 2011; pp. 11–14.

[6] Y. Chang and Szumanowski proposed a "Battery system nonlinear dynamics" published in IEEE Transactions on Vehicle Technology in May 2008 (vol. 57, no. 3, pp. 1425-1432).

[7] R. T. Hameed, O. A. Mohamad, N. Tăapus, "Implementation of tracking system using Arduino Galileo," in Proceedings of the 8th International Conference on Electronics, Computers, and Artificial Intelligence (ECAI) 2016, pp. 1-6, 2016.

[8] Ali Raza, Waqar Ahmad, Urfa Rasool, Aazim Rasool, Haaris Rasool, "Centralized Monitoring System for Server Room Environment and Battery", presented at the IEEE Conference and Expo on Transportation Electrification Asia-Pacific (ITEC Asia-Pacific) 2014, pp. 1-5, August 31, 2014 - September 3, 2014 International Conference on Intelligent Sustainable Systems (ICISS) | 978-1- 7281-7089-3/20/$31.00 ©2020 IEEE | DOI: 10.1109/ICISS49785.2020.9315868