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Internet of Things Based Electric Vehicle Battery Management System

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***Abstract*—The Battery Monitoring System (BMS) is a critical component in Electric Vehicles (EVs) that ensures the safe and optimal performance of the battery pack. This abstract outlines the importance of a Battery Monitoring System and burning prevention in Electrical Vehicles. The Battery Monitoring System the state of charge, temperature, and voltage of each battery cell and balances the cells to avoid overcharging or discharging, which can lead to reduced battery life or even fire incidents. The burning prevention system involves the use of sensors, software, and other safety measures to detect and mitigate potential risks of battery fires in electrical vehicles with the rapid growth in the electrical vehicle market, battery monitoring system and burning prevention systems are essential for ensuring the safety and reliability of electrical vehicle. Our system monitors and stores parameters that provide an indication of the lithium battery's state of charge, voltage, current, and the remaining charge capacity in a real-time scenario. Wireless local area network is used as the backbone network. The information collect from all the associated battery clients in the system is analyzed. The malfunction of the battery is monitored continuously and sudden charge & discharge voltage of battery bank and battery conditions are viewed with help of Internet of Things (IoT) module.**

***Index Terms*—Battery Management System (BMS), Battery Safety, Electrical Vehicles (EVs), Fire Prevention System, Internet of Things (IoT), Lithium Battery Monitoring.**

I. INTRODUCTION

1.1 GENERAL

The industrial process expansion has become very complex in the electronics system. In such developing industrial field fault detection and fault isolation is very important. This proposed work reduces the system in identifying the fault in the electrical vehicle. The vulnerable part in the electrical vehicle is the battery. Battery performance is influenced by factors such as depth of discharge (DoD), temperature and charging time. This paper attempts to provide the current level and voltage level using Internet of Things. By depending on the output of the battery fault can be analyzed. The battery is a device that converts the chemical energy into electrical energy through electrochemical reaction. Lithium Battery is the most commonly used battery in Uninterruptible Power Supply (UPS). To know the present status of the battery some important parameters are to be measured in regular interval. The important parameters are terminal voltage, load current, discharge current, room temperature of each battery used in the battery. The uninterruptible power supply that are used in the industries require electric power for smooth operation. The systems are equipped with lithium batteries as an alternate source of electric power. Battery management system forms a crucial system component in various applications like electric vehicles, hybrid electric vehicles (HEV), uninterrupted power supplies (UPS), telecommunications and so on. The accuracy of these systems has always been a point of discussion as they generally give an error of maximum 10% considering all the parameters together. Batteries are the heart of the automation system, and its applications are more in all the fields, where the electrical supply requires. The periodical monitoring observations are required for battery source to provide continuous power to the load without any interruption.

1.2 MOTIVATION FOR THE SELECTION OF PROBLEM

The motivation for selecting a battery management system and burning prevention system for electric vehicle batteries as a project can stem from several key factors:

Safety: The motivation for this project may arise from the need to develop robust battery management and burning prevention systems to monitor, protect, and prevent such safety hazards, ensuring the safe operation of electrical vehicle batteries and minimizing the risk of accidents.

Reliability: The motivation for this project may arise from the need to design and implement a reliable and burning prevention system that ensures the optimal performance and longevity of electrical vehicle batteries, thereby enhancing the overall reliability of the electrical vehicle.

Battery performance optimization: The motivation for this project may arise from the goal of developing an advanced battery management system and burning prevention system that can optimize the performance, capacity, and lifespan of electrical vehicle batteries, thereby enhancing the overall performance and range of the electrical vehicle.

Innovation and technological advancement: The motivation for this project may arise from the desire to contribute to the advancement of battery management system and battery burning prevention technology, by developing novel approaches, algorithms, and techniques that can improve the safety, reliability, and performance of electrical vehicle batteries, and potentially pave the way for future advancements in the field

Overall, the motivation for selecting a battery management system and burning prevention system for electric vehicle batteries as a project can be driven by the need for safety, reliability, battery performance optimization, compliance with standards and regulations, innovation, technological advancement, and environmental sustainability, with the ultimate goal of advancing electric vehicle technology and ensuring the safe and efficient operation of electrical vehicle batteries.

II. LITERATURE SURVEY

The increasing complexity and performance demands of electric vehicle batteries have led researchers to explore Internet of Things enhanced Battery Management Systems as a solution to ensure reliability, safety, and efficiency. This section presents a survey of key contributions from recent literature.

S. G. Muntode [1] provided a comprehensive review of conventional battery management system architectures and highlighted their limitations in real-time data acquisition and maintenance prediction. They proposed that integrating Internet of Things could simplify wiring architecture and enable proactive diagnostics, particularly by enhancing communication between sensing units and central controllers.

[2] This designed an Internet of Things based battery management system framework focused on both hardware and software components. Their architecture enabled remote monitoring of electrical vehicle batteries via wireless technologies and addressed issues such as over charging, temperature rise, and uneven cell balancing. They emphasized the role of modular battery management system design and sensor fusion for practical deployment.

V. Radha Krishna [3] investigated the combination of Artificial Intelligence (AI) with IoT-enabled battery management system to improve the accuracy of State of charge (SoC) and state of health (SoH) estimation. They demonstrated that artificial intelligence algorithms can identify degradation trends earlier than rule- based systems, allowing predictive maintenance and longer battery life. Their study also included a robust simulation environment for testing algorithm performance.

III. SCOPE OF PROJECT

For the large-scale adoption of electric vehicles, the development of efficient and reliable battery management systems along with thermal hazard mitigation solutions is necessary. Existing studies indicate that multi-objective optimization techniques, hybrid approaches involving machine learning, and sensor fusion methods combined with thermal management systems, cooling strategies, and fire-resistant protective coatings are feasible directions to consider. The integration of these advancements will enhance the safety, reliability, and operational lifetime of electric vehicle battery systems. Lead acid batteries presently function as the primary energy source in electric vehicles. In an electric vehicle, typical battery pack voltages range between 300 and 800 volts. Since batteries constitute a substantial portion of an electric vehicle's overall weight, regulating pack voltages is important to ensure maximum battery safety. The Battery Management System (BMS) is required to provide sufficient protection to prevent overheating of electrical vehicle batteries. The battery monitoring system is essential not only for the safe functioning of electric vehicles, but also for autonomous operation.

IV. PROBLEM STATEMENT

Despite the growing adoption of Electric Vehicles (EVs), conventional Battery Management Systems (BMS) exhibit several limitations. Major concerns include inadequate thermal control that raises overheating risks, absence of real-time monitoring for parameters, and unpredictable battery degradation caused by improper charge and discharge cycles. Furthermore, traditional systems commonly lack remote access, data visualization, and automated fault detection capabilities. These shortcomings negatively impact performance safety, and maintenance efficiency. Integrating Internet of Things (IoT) technologies into battery monitoring system addresses these issues by enabling live monitoring, remote diagnostics, and intelligent alerts, thereby enhancing reliability in electrical vehicle battery systems overall.

V. OBJECTIVE OF THE PROJECT

a. To design, develop, and deploy an IoT-based battery management system (BMS) capable of providing real-time monitoring of essential battery parameters including voltage, current, and temperature.
b. To collect and transmit battery performance information wirelessly to a cloud-based blynk platform for remote observation and analysis.
c. To analyze the collected performance data to detect patterns related to battery health, efficiency, and overall performance.
d. To deliver real-time alerts and system information to users and operators through an intuitive user interface or mobile application.

VI. METHODOLOGY

System Overview

Development of an Internet of Things Based Battery Management System for Electric Vehicles (EVs) introduces an intelligent solution that combines Internet of Things technologies with a Battery Management System (BMS) to observe and regulate electrical vehicle battery parameters in real time. The system targets major issues such as battery overheating, inefficient charging cycles, and battery degradation. It employs voltage sensors, DHT11 sensor and ESP32 to acquire, process and send data to cloud platform blynk. This supports safe, efficient, and durable battery operation. In this system, sensors are used to measure different battery parameters and transmit the collected data to a microcontroller. The microcontroller processes the data and sends it to an Internet of Things (IoT) platform through a wireless communication network. This enables real-time monitoring of battery conditions from a remote location. The data is displayed through dashboards or graphical representations, allowing users to easily observe the battery performance and status.

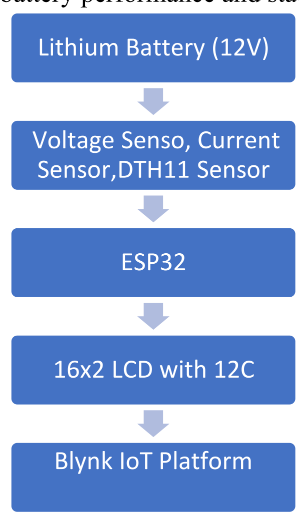

Figure1. Block diagram of the proposed IoT-based Battery Management System

As shown in Figure 1, The proposed Internet of Things based Battery Management System monitors the voltage, current, and temperature of a lithium battery using voltage sensor, DHT11 sensors. The sensed data is processed by an ESP 32 microcontroller and displayed locally on a 16×2 LCD. An ESP32 is used to transmit the processed data to the Blynk IoT

Platform for real-time visualization and historical analysis. This system enables efficient monitoring and improves the safety and performance of the battery.

VII. HARDWARE AND SOFTWARE DESCRIPTION

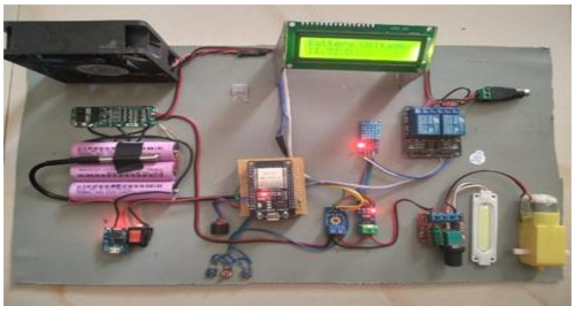

Figure 2. Hardware Setup

The proposed Internet of Things based Battery Management System (BMS) is implemented using a combination of embedded hardware components and supporting software tools to enable real-time monitoring, data communication.

The hardware section contains a lithium battery pack, which functions as the main energy source for the electric vehicle prototype. It includes three 4V cells connected in series to supply 12V. A group of sensors is utilized to measure different battery parameters: a voltage divider circuit reduces the battery voltage to safe levels compatible with the ESP32 microcontroller, a shunt resistor- based current sensor measures current flow, and an negative temperature coefficient thermistor monitors temperature variations. These sensor readings are processed by the ESP32 microcontroller, which operates as the microcontroller unit. The processed information is then used to compute derived parameters such as State of Charge and real time power.

For wireless data transmission, the system employs an ESP32, which sends battery data to the Blynk IoT platform for cloud storage and visualization. current, temperature, and SoC are also displayed locally using a 16×2 LCD with 12C display, enabling quick diagnostics even without cloud connectivity.

On the software side, the Arduino Integrated Development Environment (IDE) is used to write and upload embedded C/C++ programs to the ESP32. It includes necessary libraries for sensor interfacing and Wi-Fi control and real-time data acquisition and communication. The system utilizes Blynk IoT Platform, an open-source IoT cloud platform, to store and visualize transmitted sensor data.

VIII. RESULT AND DISCUSSION

The proposed Internet of Things based Battery Management System was experimentally evaluated to verify its ability to monitor battery temperature and voltage and to provide a local alert during abnormal conditions. The system successfully acquired real-time sensor data and uploaded it to the Blynk IoT platform for visualization. It presents the temperature variation with respect to time obtained during the experimental observation. The recorded temperature values were found to vary between 32.3C and 38°C. The lowest temperature of 32.3°C was observed on 12 March at 06:46, while the highest temperature of 38°C occurred on 12 March at 13:18. Which leads to activation of cooling fan at 33.5°C confirming stable sensor operation and reliable data transmission to the cloud. A threshold temperature of 33.5°C was predefined in the system to ensure battery safety. These components help prevent overcharging, deep discharge overheating and possible battery damage. The overall hardware setup provides continuous monitoring and improves the safety and performance of the electrical vehicle battery system.

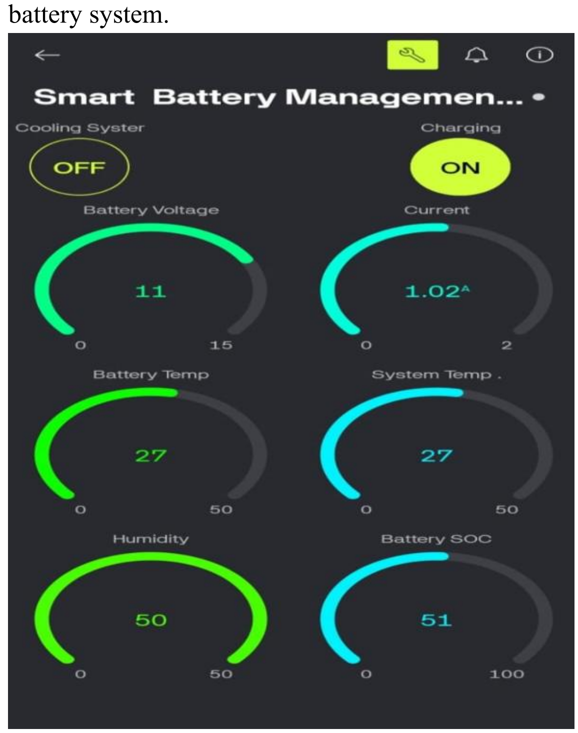

Figure 4. Blynk Cloud Dashboard

This confirms the correct implementation of the threshold-based alert logic. The temperature-time graph displayed on the Blynk IoT dashboard provides clear visual confirmation of the system's monitoring capability. In addition to temperature monitoring, battery voltage was also observed during system operation. The measured voltage values remained within the nominal operating range throughout the experiment, indicating stable battery behavior. Since the voltage variation was minimal during the observation period, the results are summarized in tabular form rather than graphical representation.

Parameters	Observed Value
Maximum Temperature	33.5°C
Maximum Voltage	12V
Minimum Voltage	10V

Table 1: Summary of Experimental Results

The experimental results demonstrate that the developed system is capable of reliable temperature and voltage monitoring with effective cloud integration. The stable performance observed during testing confirms the suitability of the proposed system for low-cost Internet of Things based battery monitoring applications. Indicate stable performance of the temperature monitoring system. The minimum and maximum temperatures recorded were 32.3 °C and 35.7°C respectively, with all temperature values do not remained well below the preset threshold of 33.5°C. Hence, due to overheating condition cooling was activated during the experiment. The system was powered by a nominal 12 V battery. The measured voltage varied between 10V to 12V, which is within the acceptable operating range. This indicates a healthy and stable power supply. Overall, the system reliably monitored temperature and responded correctly under normal conditions.

In the proposed system, notifications are provided through both an 16x2 LCD with 12C display and email alerts. The LCD is used to show real-time information directly on the device, allowing users to monitor the system status instantly. Important parameters and system messages are displayed on the LCD so that the user can easily observe the readings without needing any additional device.

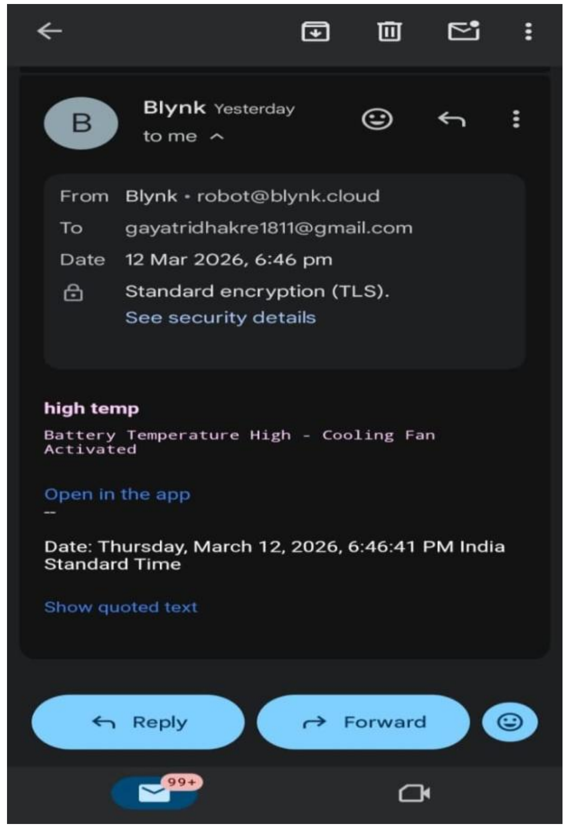

Figure 5. Email Notification

In addition to the local display, the system also sends notifications through email. Whenever a significant event occurs or when the measured values cross the predefined threshold limits, an automatic email alert is generated and sent to the registered user.

This ensures that the user receives timely updates even when they are not physically present near the system. By integrating both liquid crystal display (LCD) display notifications and email alerts, the system provides a reliable and efficient monitoring mechanism. The liquid crystal display enables immediate on-site observation, while email notifications allow remote monitoring and quick response to abnormal conditions.

IX. CONCLUSION

This research examines the development of an Internet of Things based Battery Management System (BMS) for electric vehicles to address a major challenge faced by electrical vehicle technology: reliable and efficient battery monitoring. The proposed Battery Management System integrates sensors, a microcontroller, wireless communication modules, and a cloud-based platform to continuously track essential battery parameters such as voltage, current, and battery temperature levels. Continuous observation enables early detection of abnormalities, maintenance of safe thermal limits for batteries, and optimized charging and discharging cycles to enhance overall safety and efficiency performance. The monitoring system also provides drivers with insights into battery health and performance while making accurate predictions about remaining driving range. Drivers can plan trips with greater confidence based on insights from the battery monitoring system about battery health and performance and avoid unexpected power outages. Additionally, the battery monitoring system also adds significant value by extending battery life and maintenance cost savings, while enhancing overall reliability for electric vehicles. In addition to using the cloud for large data storage, cloud analytics provides an effective method for advanced data analytics and supports viable future developments that could integrate the system to smart vehicle management systems or predictive maintenance. The battery monitoring system proposed in this research illustrates the capability of employing Internet of Things technology to innovate battery management in electric vehicles, which will support future electrical vehicles in being safer, more efficient and sustainable.

X. FUTURE SCOPE

A. Integration with Machine Learning:

i. Implement machine learning algorithms to predict battery health, remaining life, and potential faults more accurately.

ii. Enable adaptive optimization of charging and discharging cycles based on historical and real-time data.

b. Advanced Energy Management:

i. Develop intelligent energy management systems that dynamically balance battery load, improve efficiency, and extend lifespan.

ii. Integrate renewable energy sources like solar charging into the battery management system.

c. Enhanced Connectivity:

i. Incorporate 5G or LoRa-based communication for faster and more reliable real-time monitoring and remote control.

ii. Enable fleet-wide battery monitoring for electric buses, taxis, or logistics vehicles.

REFERENCES

[1] S. G. Muntode, K. P. Muntode, A. S. Muntode, and P. J. Muntode, "IoT-Based Battery Management System", International Journal of Scientific Research in Science, Engineering and Technology, vol. 11, no. 3, pp. 167- 170, May 2024 ijsrset.com

[2] "IoT-Based EV Battery Management System with Charge Monitor & Fire Protection," International Journal of Engineering Research and Science & Technology, vol. 20, no. 4, pp. 99 - 109, Dec. 2024. IJERS

[3] V. Radha Krishna, K. Vijaya, M. Hrishithi, V. Richa Sanjitha, and P. Varshitha, "Smart Solar Powered Battery System for EV for IoT Voltage Monitoring," IJRASET Journal for Research in Applied Science and Engineering Technology, (2023). IJRASET

[4] V. Lohar and M. Suresh Kumar, "Design and Implementation of IoT-Based Wireless Battery Management System for Electric Vehicles," International Journal of Intelligent Systems and Applications in Engineering, vol. 11, no. 10s, pp. 360–369, 2023. IJISAE

[5] K. Insia, A. Ahmed, E. Jahan, S. Ahmad, S. Barua, I. Ali,M.R. Hazari, and M.A. Mannan, "IoT-Based Smart Battery Management and Monitoring System for Electric Vehicles," AJSE (AIUB Journal of Science and Engineering), vol. 22, no. 2, pp. 181 -188, 2023. AJSE

[6] Dr P. Karuppsamy, C. Dinesh, R. Mohana Selvam, "Applying IoT to an Electric Vehicle Battery Monitoring System," International Journal of Engineering Research & Technology (IJERT), vol. 12.

[7] Sayali A. Patil and Atul R. Nigavekar, "Cloud-Based BMS Data Analytics System for EV using IoT," IJRASET Journal for Research in Applied Science and Engineering Technology, 2022. IJRASET

[8] Mrs. S. Francis Shamili, Mohamed Toufiq K., Nandha Kishore O., Naveenkumar S., Nishanth S., "IoT-Based Battery Management System in Electric Vehicle," IJSART, vol. 11, issue 4, April 2025. ijsart.com

[9] (In press) S. Brindha, V. Sri Priya, and G. Rajasekar, “IoT- Based Smart Battery Management System for Electric Vehicles: Real Time Monitoring, AI Driven Predictive Analytics, and Cloud Integration,” vol. 24, no. 01, 2025.
[10] (General foundational work) M. R. Amini, J. Sun, and I. Kolmanovsky, “Two Layer Model Predictive Battery Thermal and Energy Management Optimization for Connected and Automated Electric Vehicles” 2018.
[11] Barrington, S. (2023). The Feasibility of Algorithmic Detection and Decentralized Moderation for Protecting Women from Online Abuse. arXiv preprint arXiv:2301.07144.
[12] Milosevic T, Van Royen K, Davis B. Artificial Intelligence to Address Cyberbullying, Harassment and Abuse: New Directions in the Midst of Complexity. Int J Bullying Prev. 2022;4(1):1-5. doi: 10.1007/s42380-022-00117-x. Epub 2022 Feb 25. PMID: 35233506; PMCID: PMC8872854.
[13] Subramani, Neelakandan & M, Sridevi & Chandrasekaran, Saravanan & Kandavel, Murugeswari & Pundir, Aditya & Sridevi, R. & Lingaiah, Bheema. (2022). Deep Learning Approaches for Cyberbullying Detection and Classification on Social Media. Computational Intelligence and Neuroscience. 2022. 1-13. 10.1155/2022/2163458.
[14] Veer, Baal & Baloch, Sawal. (2024). Legal and Ethical Challenges of AI in Content Moderation Navigating the Intersection of Free Speech and Privacy. 10.13140/RG.2.2.35048.89603