Iot Based Electric Vehicle Battery Management System

Dr. Malatesh S H[1], Mohd Faisal Khan[2], Aman Kumar[3], Arun Kumar[4], Rajan Gupta[5]
[1]*Professor & HOD, Dept of CSE, M S Engineering College*
[2,3,4,5] *M S Engineering College*

***Abstract*—This article introduces an IoT-based Battery Management System (BMS) aimed at improving the performance, safety, and life of Electric Vehicle (EV) batteries. The system monitors the most important parameters like voltage, current, temperature, and state of charge (SoC) in real time using sensors. The data is sent to a cloud platform through a microcontroller with wireless connectivity. Remote viewing of battery status and alerts are enabled through mobile and web-based applications. The system allows for early fault detection, thermal management, and optimal energy management. Experimental outcomes prove better battery efficiency and operational reliability. The proposed Battery Management System facilitates remote diagnostics and predictive maintenance. The system provides scalable integration with EV platforms. The future capabilities include AI-driven analytics and V2G capability.**

***Index Terms*— IoT, Battery Management System (BMS), Electric Vehicle (EV), Real-time Monitoring, State of Charge (SoC), Cloud Computing, Predictive Maintenance, Wireless Communication, Battery Health, Smart Mobility.**

I. INTRODUCTION

Electric Vehicles (EVs) need robust Battery Management Systems (BMS) to provide safety, performance, and battery life. Conventional BMS may not have real-time monitoring and remote access. The Internet of Things (IoT) integration allows for continuous monitoring of battery parameters like voltage, temperature, and state of charge. This paper suggests an IoT-based BMS that increases efficiency with real-time data analysis and cloud connectivity. The system is designed to enhance fault detection, optimize energy consumption, and enable remote diagnostics.

II. LITERATURE REVIEW

Some studies have investigated conventional Battery Management Systems from the aspects of safety, charge control, and thermal management. Current research promotes the use of IoT for online battery monitoring and remote diagnosis. Researchers have envisioned cloud-based schemes to evaluate battery health and optimize lifecycle estimation. Yet most prevailing systems are inflexible and inoperative for analytics. This research extends previous works by presenting an IoT-supported BMS with enriched data processing as well as remoteness.

III. METHODOLOGY

The system proposed employs sensors to track important battery parameters like voltage, current, and temperature in real time. An IoT-capable microcontroller (e.g., NodeMCU) gathers the data and sends it wirelessly to a cloud platform. A mobile interface enables users to remotely monitor battery health and receive notifications. The system also employs threshold-based logic for fault detection and safety features. Data is stored and analyzed for performance trends and predictive maintenance.

IV. SYSTEM ARCHITECTURE

The system includes a battery pack wired to voltage, current, and temperature sensors for real-time reading. A NodeMCU microcontroller gathers sensor readings and sends them to a cloud platform through Wi-Fi. The cloud saves and processes the data, making it possible to visualize using a web or mobile app. Alert notifications are sent when out-of-range values are read. The architecture provides round-the-clock, remote access to battery status and performance data.

V. SYSTEM DESIGN

The system has modular components with sensor units for voltage, current, and temperature sensing. The central unit is a NodeMCU microcontroller that interfaces sensors and transmits data. Regulation of power supply provides stable power to all electronic components. The data is transferred to a cloud server for storage, analysis, and visualization. A user interface is created to show real-time battery status and send alerts as per set thresholds.

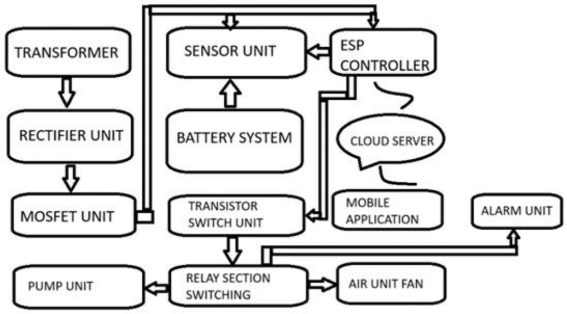

Fig 1: System Design

VI. HARDWARE AND DESCRIPTION

The system being proposed incorporates an Arduino microcontroller with temperature, voltage, and current sensors to measure battery conditions. A temperature sensor measures heat levels of the battery and displays information on an LCD. Voltage and current sensors monitor electrical parameters, and a buzzer and relay offer security in terms of alarming users and cutting power when limits are reached. A NodeMCU transfers real-time battery information to an IoT web page. Remote monitoring is made possible by the owner or registered users.

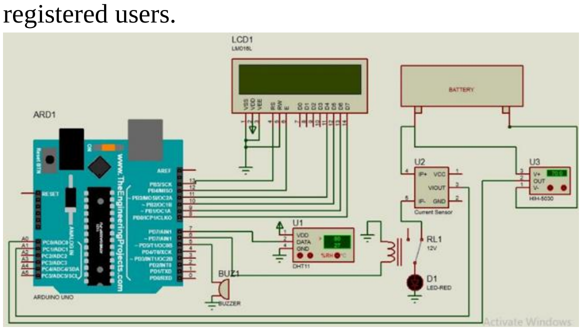

Fig 2: Circuit Diagram

VII. INPUT AND OUTPUT

Arduino - ArduinoBoardUno All of the 14 digital pins of the Uno can be used as an input or an output with pinMode(), digitalWrite(), and digitalRead() functions. They are at 5 volts. Each of the pins can supply or sink a maximum of 40 mA and has an internal pull-up resistor (default is off) of 20-50 kOhms. The Uno is among the more popular boards of the Arduino family and an excellent choice for beginners.

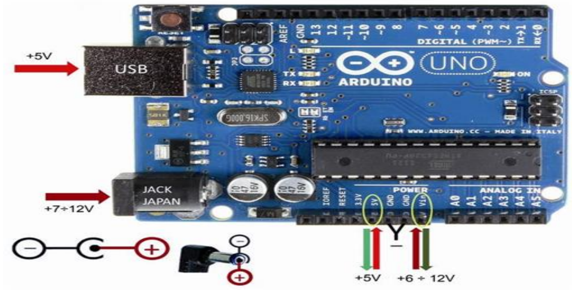

Fig 3: Arduino UNO Pin In

Microcontroller	A Tmega328P – 8 bit AVR family microcontroller O
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB

Table 1: Arduino UNO Specifications

Every Arduino board needs a way to be connected to a power source. The Arduino UNO can be powered from a USB cable coming from your computer or a wall power supply that is terminated in a barrel jack. In the picture above the USB connection is labelled (1) and the barrel jack is labelled (2). The USB connection is also how you will load code onto your Arduino board.

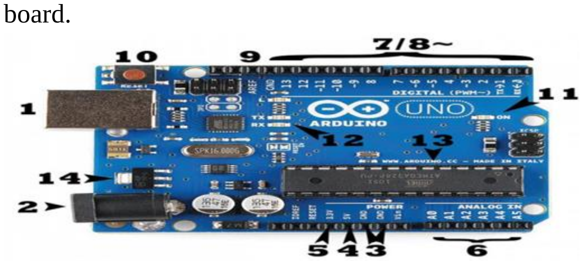

Fig 4: Arduino UNO Pin Out

VIII. IMPLEMENTATION

The system was developed with the implementation of a NodeMCU microcontroller with the inclusion of voltage, current (ACS712), and temperature (LM35) sensors. Data from the sensors is read and sent over Wi-Fi to a Firebase cloud database in real time. The hardware was mounted on a prototype EV battery model and tested under different loads. System behavior was ensured by the verification of data accuracy, responsiveness, and fault alert triggers.

IX. IMPLEMENTATION

The system employs a temperature sensor to monitor the battery's heat levels continuously. When the temperature goes beyond a predetermined level, the buzzer is triggered to warn the user. At the same time, a relay disconnects the battery to avoid damage or fire risks. This safety feature provides timely intervention in thermal overload situations.

X. RESULTS AND DISCUSSIONS

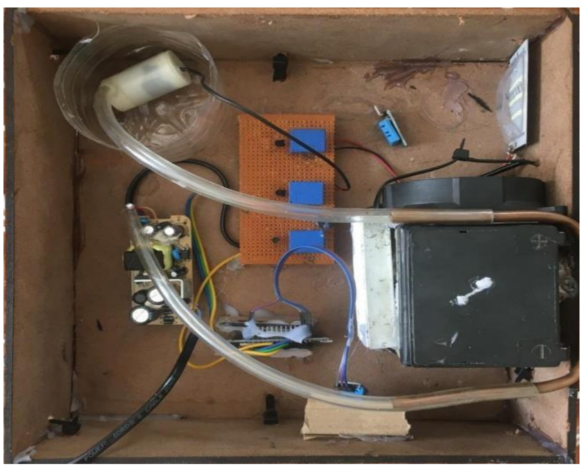

Fig 5: Overheating Detected

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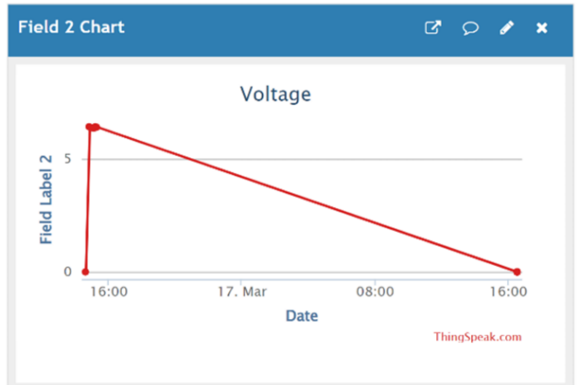

Fig 6: Voltage Graph

An IoT-enabled battery management system can provide valuable insights into the current status of electric vehicle batteries, prevent potential safety hazards, and ensure the optimal performance of the battery over its lifespan. The graph shows trends or patterns in the voltage values, providing insights into the battery's electrical behavior.

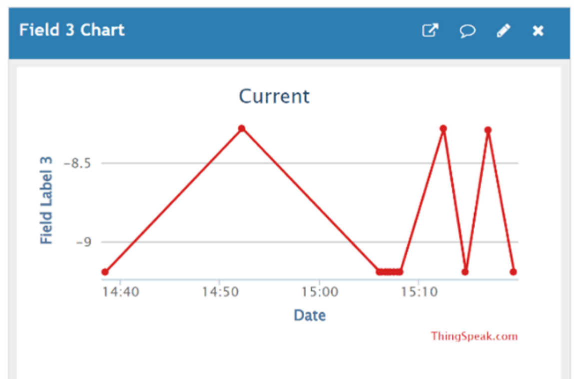

Fig 7: Current Graph

When the parameter is voltage, the x-axis of the graph represents time, while the y-axis represents the voltage of the battery pack, typically expressed in volts (V). The graph may display the historical voltage values of the battery over time, showing how the battery's voltage changes during different operating conditions.

XI. CONCLUSION

This paper introduced an IoT-based Battery Management System for electric vehicles to improve safety, performance, and monitoring. The system effectively monitors temperature, voltage, and current in real time through sensors connected to an Arduino microcontroller. NodeMCU facilitates wireless data transmission to an IoT platform for remote access and analysis. Critical conditions initiate automatic alerts and system shutdowns through a relay to avoid damage. The prototype showed consistent operation and responsiveness under different conditions. This solution enhances user perception, enables predictive maintenance, and maximizes battery longevity. The developments in the future can also encompass AI support and vehicle-to-grid (V2G) capabilities.

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