

REAL TIME BATTERY MANAGEMENT SYSTEM USING ELECTRIC VEHICLE VEHICLE IN IOT

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Abstract:

The rapid adoption of electric vehicles (EVs) has increased the demand for efficient battery monitoring and safety systems. Battery Management Systems (BMS) play a vital role in ensuring battery performance, lifespan, and safety. This paper proposes an IoT-based real-time BMS using an ESP32 microcontroller for continuous monitoring of lithium-ion batteries. The system measures key parameters such as voltage, current, temperature, and state of charge (SOC), and transmits data to a cloud platform for remote access. Additional safety features such as smoke detection and over-temperature alerts are integrated. The proposed system improves battery reliability, prevents hazardous conditions, and enables predictive maintenance. The results demonstrate effective real-time monitoring and fault detection, making it suitable for next-generation EV applications.

Keywords:

Battery Management System, Electric Vehicles, IoT, ESP32, Lithium-ion Battery, Real-Time Monitoring, Safety System.

1.Introduction:

Electric vehicles (EVs) are gaining importance due to their environmental benefits and energy efficiency. The battery is the key component of an EV, and its proper management is essential for safe and reliable operation. Lithium-ion batteries are commonly used, but they require continuous monitoring of parameters such as voltage, current, and temperature to prevent failures. Battery Management Systems (BMS) are

used to monitor and control battery performance. However, conventional BMS lack real-time remote monitoring capabilities. The integration of Internet of Things (IoT) technology enables continuous data monitoring and remote access through cloud platforms. This paper proposes an IoT-based real-time BMS using an ESP32 microcontroller to improve battery safety, performance, and monitoring in electric vehicles.

2. Literature Review

Several research works have contributed to IoT-based BMS development: An IoT-based BMS using ESP32 enables real-time monitoring and alert systems for EV batteries □.

JISEM

Wireless BMS systems improve SOC estimation and battery performance through IoT integration □.

IJISAE

Advanced IoT systems using MQTT and cloud platforms allow remote monitoring and optimization of charging cycles □.

IJPEDS

Recent research also integrates machine learning to predict battery life and improve system efficiency □.

Nature

Despite these advancements, challenges remain in cost-effective implementation and real-time fault prediction.

3. Proposed System Architecture

3.1 System Overview

- The proposed system consists of:
- Lithium-ion battery pack
- ESP32 microcontroller
- Sensors (Voltage, Current, Temperature, Smoke)
- IoT cloud platform.

3.2 Working Principle

Sensors continuously monitor battery parameters. The ESP32 processes the data and transmits it to the cloud using Wi-Fi. Users can monitor battery conditions via mobile or web applications. The system also generates alerts during abnormal conditions such as:

- Overcharging
- Overheating
- Short circuit

4. Hardware Design

4.1 Battery Pack

A lithium-ion battery pack is used due to its high efficiency and compact size. The most commonly used battery type is Lithium-ion Battery due to its high energy density, long life, and lightweight nature. A battery pack consists of the following main components:

Cells – Basic energy storage units

Modules – Group of cells connected together

Battery Management System (BMS) – Monitors and controls battery parameters

Thermal Management System – Maintains safe temperature

Casing/Enclosure – Provides protection and insulation

4.2 Microcontroller (ESP32)

ESP32 is selected because of:

Built-in Wi-Fi and Bluetooth

Low power consumption

High processing capability.

5. DIAGRAM

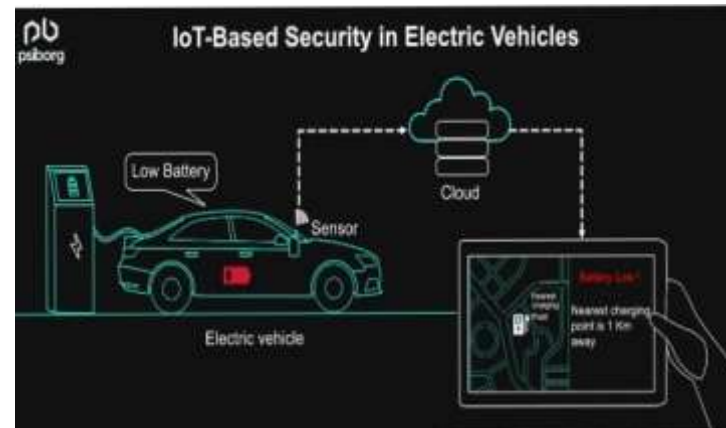


Fig1.IOT Based Battery Monitoring and Security System for Electric Vehicles.

6.SENSOR

Sensors are essential components that continuously monitor the battery and vehicle conditions. They collect real-time data and send it to the controller (like ESP32), which then uploads it to the cloud.

1. Voltage Sensor

Measures the battery voltage of individual cells or the entire pack.

Helps determine the State of Charge (SOC).

Prevents overcharging and deep discharge, which can damage the battery.

👉 Example: Voltage divider circuit



Fig2.VOLTAGE SENSOR

2. Current Sensor

Measures the charging and discharging current of the battery.Used to calculate battery capacity and energy consumption.

Helps detect overcurrent faults and short circuits.

Common sensor: ACS712 Current Sensor

Works based on the Hall Effect.

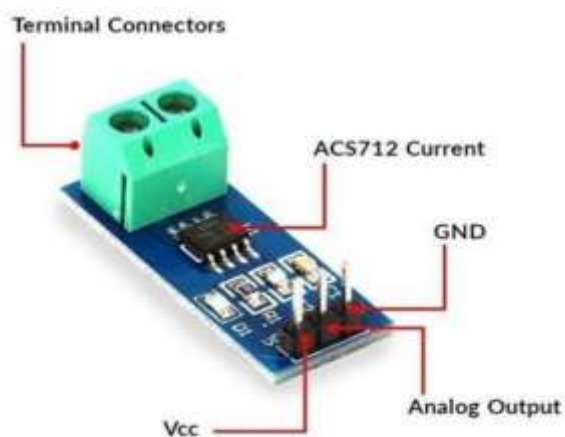


Fig4.CURRENT SENSOR

3. Temperature Sensor

Monitors the temperature of battery cells.Prevents overheating and thermal runaway.Ensures safe operation and increases battery life.

Common sensor: DS18B20 Temperature Sensor

Provides accurate digital temperature readings.

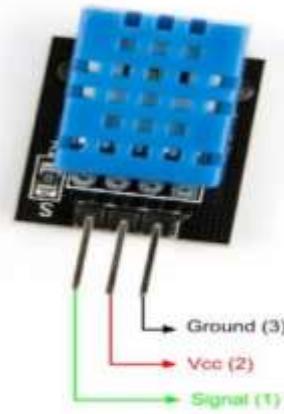


Fig5.TEMPERATURE SENSOR

6..Working of Sensors in the System

Sensors collect real-time battery data.Data is sent to the ESP32.The controller processes and uploads data to the cloud.Users receive alerts (like low battery, overheating, faults) on a mobile app.

7. Programming Environment

- Arduino IDE is used for coding
- Embedded C is used for programming

7.1.IoT Platform

Cloud platforms such as Blynk or ThingSpeak are used.Data is visualized using graphs and dashboards

7.2. Communication Protocol

Wi-Fi is used for data transmission

MQTT protocol can be used for efficient communication

8.BLOCK DIAGRAM:

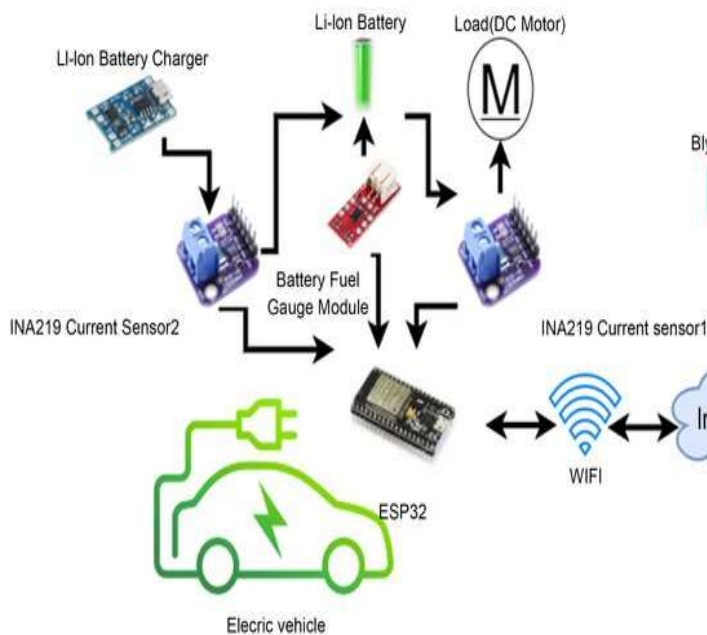


Fig6.REAL TIME BATTERY MANAGEMENT SYSTEM USING ELECTRIC VEHICLES IN IOT

Battery Pack: Supplies power and is monitored continuously.

Sensors: Measure voltage, current, temperature, and smoke.

ESP32 Controller: Processes sensor data and sends it to the cloud.
Wi-Fi Module: Enables communication with IoT platform.
Cloud Platform: Stores and displays data.
User Interface: Allows users to monitor battery status remotely.

9. Future Scope

- Integration of machine learning for prediction
- State of Health (SOH) estimation
- Fast charging optimization
- Mobile app development
- Advanced fault diagnosis.

10.Blynk IoT Platform in This Project

The Blynk IoT platform is used for real-time monitoring and control of the Battery Management System (BMS). It acts as

a bridge between the ESP32 microcontroller and the user interface.

In this project, the ESP32 collects battery parameters such as voltage, current, and temperature from sensors. These values are sent to the Blynk cloud server through Wi-Fi. The Blynk application installed on a smartphone displays this data in the form of graphs, gauges, and alerts.

Functions of Blynk in the Project

- Displays real-time battery parameters
- Sends alerts during abnormal conditions (overheating, overvoltage)
- Stores data for analysis
- Enables remote monitoring from anywhere.

11. Results and Discussion

The system was tested under various conditions. Results show:

- Accurate parameter monitoring
- Real-time cloud data transmission
- Early fault detection
- Improved battery safety,

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