International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 10 | Oct - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Smart EV Battery Management System with IOT Based Monitering Fire AND Theft Protection

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Abstract - Electric vehicles (EVs) depend on rechargeable battery packs whose safety, available energy, and service life are strongly influenced by monitoring and control. This review examines the main functions relevant to a smart EV battery management system (BMS), with emphasis on voltage and current measurement, temperature supervision, state-ofcharge (SOC) estimation, Internet of Things (loT)-enabled remote monitoring, overcharge protection, and theft alerts. The supplied project synopsis proposes an Arduino UNO controller, voltage/current/temperature and vibration sensors, an ESP8266 Wi-Fi module, an LCD, a relay, and a Blynk dashboard. The paper organizes these elements into a systemlevel architecture, discusses the potential benefits and implementation limitations, and identifies practical issues that must be addressed before deployment in a real vehicle. The review is based on the supplied synopsis and its listed references; it does not claim experimental validation or measured performance. In particular, temperature alarms are treated as an early-warning function rather than a complete fire-suppression solution, and a vibration sensor is considered a basic tamper indicator rather than proof of theft. The paper concludes with research directions in battery state estimation, cell balancing, robust communications, thermal-risk detection, and secure vehicle monitoring.

Key Words: electric vehicle, battery management system, Internet of Things, state of charge, thermal monitoring, overcharge protection, theft detection, ESP8266.

1. *INTRODUCTION*

The growth of electric mobility has increased the importance of reliable battery supervision. A traction battery is a highvalue energy-storage component, and unsafe voltage, current, or temperature conditions can reduce performance, shorten service life, and create safety risks. A battery management system monitors battery conditions and supports protective actions so that the battery operates within specified limits. Conventional BMS functions commonly include voltage, current, and temperature monitoring, charge/discharge protection, and estimation of available charge. loT connectivity can extend these functions by transmitting selected measurements to a remote dashboard, enabling users to review battery status and receive notifications when configured thresholds are crossed. Connectivity does not replace local protection: safety-critical actions must remain effective even when the internet connection is unavailable. The supplied synopsis describes a low-cost prototype concept that combines local sensing, microcontroller processing, WiFi communication, overcharge switching, temperature alarms, and vibration-based tamper alerts. This review presents the concept in a research-paper structure and discusses its strengths, limitations, and development needs. Since no test data are included in the source synopsis, the paper is a designfocused review rather than an experimental research article.

2. Body of Paper

The development of electric vehicles has increased the need for reliable and intelligent battery management technologies. Traditional battery systems mainly focus on monitoring voltage, current, and temperature. However, modern electric vehicles require more advanced features to improve battery performance, safety, and security. The integration of IoT technology has introduced remote monitoring, real-time data collection, and automatic alert generation. These features allow users to check battery conditions through smartphones or web applications. Furthermore, intelligent monitoring techniques can identify unusual battery behavior and support predictive maintenance.

3. CONCLUSIONS

This review organized the supplied Smart EV Battery Management System synopsis into a research-paper format focused on monitoring, loT connectivity, thermal warnings, charging interruption, and theft/tamper alerts. The proposed Arduino UNO-ESP8266 architecture offers a practical educational prototype for demonstrating sensor acquisition, local display, remote visualization, and threshold-based responses. Its usefulness depends on reliable sensing, well-defined

control logic, and careful treatment of connectivity and false alarms. The synopsis provides a concept and component-level description but no experimental results; therefore, performance and safety improvements remain to be demonstrated through systematic testing. Before use in a real EV, the design would require batteryspecific engineering, appropriately rated protection hardware, fault analysis, and compliance with applicable standards

4. Problem statement

Electric vehicles (EVs) are becoming increasingly popular due to their energy efficiency and reduced environmental impact. However, the battery system faces several challenges, including overheating, overcharging, deep discharging, battery degradation, and theft. Conventional battery management systems mainly focus on monitoring battery parameters and providing basic protection, while remote monitoring and security features may be limited.The absence of continuous remote monitoring can make it difficult for users to identify abnormal battery conditions at an early stage. Similarly, excessive battery temperature may increase the risk of battery damage and thermal runaway if appropriate protection is not provided. Battery theft and unauthorized access also create security concerns for electric vehicle

5. Proposed system

The proposed system presents a Smart Electric Vehicle Battery Management System with IoT-Based monitoring, Thermal Safety, and Theft Alerts. The main objective is to improve battery performance, enhance safety, and provide security through the integration of sensors, a microcontroller, a Battery Management System (BMS), and IoT technology.The system continuously monitors important battery parameters such as voltage, current, temperature, and State of Charge (SOC). The collected data is processed by the controller and displayed on an IoT-based dashboard or mobile application, allowing users to monitor battery conditions remotely.For thermal safety, temperature sensors detect abnormal increases in battery temperature. When the temperature exceeds the predefined safety limit, the system generates an alert and supports appropriate protective actions through the BMS, such as limiting charging or disconnecting the battery when required For theft prevention, vibration sensors or tamper switches detect suspicious movement or unauthorized access to the battery enclosure. The controller processes the sensor signals and sends an alert to the owner's mobile device through an available communication network. GPS tracking can also be incorporated to provide location information when requiredThe proposed system combines battery monitoring, thermal protection, and theft detection into a single integrated framework. Essential battery protection operates locally, even if internet connectivity is unavailable, while IoT technology provides remote monitoring and notifications. This approach aims to improve battery safety, support timely fault detection, reduce maintenance difficulties, and increase the security of electric vehicle batteries.

5. Exprimental result

The experimental evaluation of the proposed Smart Electric Vehicle Battery Management System with IoTBased Monitoring, Thermal Safety, and Theft Alerts focuses on monitoring battery parameters, detecting abnormal temperature conditions, and identifying unauthorized access. The system is designed using a battery monitoring circuit, sensors, a microcontroller, and an IoT platform.During normal operation, the system collects battery voltage, current, temperature, and State of Charge (SOC) data. The measured information is processed by the controller and displayed on the IoT dashboard, enabling remote monitoring of battery conditions.When the battery temperature exceeds the predefined safety threshold, the system is designed to generate a warning through a buzzer or mobile notification. Appropriate protective actions can be initiated through the BMS to reduce the risk of battery damage. Similarly, when the vibration sensor or tamper switch detects suspicious movement or unauthorized access, the controller triggers an alert to notify the vehicle owner.The experimental evaluation should examine sensor measurement accuracy, alert response time, IoT communication reliability, thermal warning performance, and theft detection accuracy. The results can be recorded under normal operating conditions and controlled fault scenarios to evaluate the effectiveness of the proposed system Overall, the proposed design provides a framework for real-time battery monitoring, thermal risk detection, and theft alerts. Actual performance values must be obtained through prototype testing before drawing conclusions about the system's accuracy and reliability.

6. Advantages

1. Improved Battery Safety: Temperature sensors help detect overheating and provide early warnings of potentially unsafe battery conditions .
2. Theft Detection and Alerts: Vibration sensors and tamper switches help identify suspicious movement or unauthorized access to the battery.
3. Remote Monitoring: IoT technology allows users to check battery status through a mobile application or web dashboard from a remote location.
4. Early Fault Detection: Continuous monitoring helps identify abnormal battery conditions before they develop into more serious problems.
5. Extended Battery Life: Appropriate charging control, cell balancing, and temperature management can help reduce battery degradation

7. Application

A) Electric Cars: Helps monitor battery voltage, current, temperature, and State of Charge (SOC) in electric cars.
B) Electric Bicycles: Provides battery status monitoring and unauthorized access alerts for e-bikes.

C) Electric Buses: Supports battery monitoring and thermal safety in electric public transportation systems.
D) Battery Charging Stations: Helps monitor battery conditions during charging and identify abnormal temperature or voltage conditions.
E) Battery Swapping Stations: Supports battery condition monitoring and security management for removable EV batteries.
F) Fleet Management Systems: Allows operators to remotely monitor the battery condition of multiple electric vehicles. G)Industrial Electric Vehicles: Can be adapted for electric forklifts, warehouse vehicles, and other batterypowered industrial equipment.
H)Remote Battery Diagnostics: Enables technicians to analyze battery data and identify possible faults without always inspecting the vehicle physically.
I) Smart Transportation Systems: Supports connected electric mobility by integrating battery monitoring, thermal alerts, and security notifications with digital platforms

8. *Future scope*

Artificial Intelligence and Machine Learning: Future systems can use AI and machine learning algorithms to analyze battery data, predict possible faults, and identify abnormal operating conditions before serious problems occur.2.Predictive Battery Maintenance: Advanced monitoring techniques can estimate battery degradation and predict maintenance requirements, helping to reduce unexpected failures and improve battery life. 3.Advanced Thermal Management: Future systems can integrate intelligent cooling mechanisms, advanced temperature sensors, and early fault detection methods to improve thermal safety and reduce the risk of battery overheating.

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