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

Predictive EV Battery Health and Fire Detection System

1.Mane Harish D., 2.Patil Athrav R., 3. Panwal Aditya M., 4.Prof.P.I.Kinikar
Student Member , Student Member , Student Member Assistant Professor of
DR.ASHOK GUJAR TECHNICAL INSTITUTE'S
DR. DAULATRAO AHER COLLEGE OF ENGINEERING, KARAD
Department Of Electronics & Telecommunication Engineering Shivaji University,Kolhapur

---

ABSTRACT

The Predictive EV Battery Health and Fire Detection System is designed to monitor the health and safety of electric vehicle batteries. Lithium-ion batteries are widely used in electric vehicles, but overheating, battery ageing, and abnormal electrical conditions can reduce battery performance and cause fire hazards. The proposed system monitors battery parameters such as temperature, voltage, and current using suitable sensors. A gas or smoke sensor can also be used to detect abnormal conditions. The collected data is processed by a microcontroller to identify potential battery faults. When an abnormal condition is detected, the system generates an alarm to provide an early warning. A relay can be used to disconnect the battery or load during critical conditions. The system aims to support battery health monitoring, improve safety, and reduce the risk of battery damage. This low-cost system can be useful for electric vehicles and battery monitoring applications.

***Key Words*:** Electric Vehicle (EV), Battery Health Monitoring, Lithium-Ion Battery, Fire Detection, Temperature Monitoring, Voltage Monitoring, Current Monitoring, Thermal Runaway, State of Health (SOH), Fault Detection, Microcontroller, Battery Safety.

INTRODUCTION

Electric vehicles (EVs) are becoming increasingly popular because they provide an alternative to conventional fuel-powered vehicles. They help reduce the use of petrol and diesel and support the development of cleaner transportation. The battery is one of the most important components of an electric vehicle because it stores the electrical energy required to operate the vehicle. Lithium-ion batteries are widely used in EVs because of their high energy density, good performance, and rechargeable nature. However, the performance, reliability, and safety of these batteries depend on their operating conditions and overall health.

During regular use, an EV battery undergoes charging and discharging cycles. Over time, these cycles can cause battery ageing, which may reduce its capacity, efficiency, and overall performance. Battery health monitoring is therefore important for understanding the condition of the battery and identifying possible faults at an early stage. If battery degradation is not identified in time, it may affect vehicle performance, reduce battery life, and increase maintenance requirements.

Another important concern in electric vehicles is battery overheating and the possibility of fire. Abnormal operating conditions, such as overcharging, over-discharging, excessive current, and abnormal voltage, may affect battery performance and safety. An increase in battery temperature can indicate an unsafe operating condition. In severe cases, these problems may lead to thermal runaway, which is a dangerous condition involving uncontrolled heat generation inside the battery. Therefore, continuous monitoring of important battery parameters is necessary to reduce potential risks.

A Battery Management System (BMS) is commonly used to monitor and manage battery operating conditions. It helps monitor parameters such as voltage, current, and temperature and supports the safe operation of the battery. However, monitoring these parameters alone may not always be sufficient to identify every potential fault before it becomes serious. A system that combines battery health monitoring with early fire-risk detection can provide additional support for improving EV battery safety.

The proposed Predictive EV Battery Health and Fire Detection System is designed to monitor important battery parameters and identify abnormal operating conditions. The system uses suitable sensors to measure battery temperature, voltage, and current. A gas or smoke sensor can also be used to identify possible warning signs related to battery faults or fire hazards. The collected sensor data is sent to a microcontroller, which processes the readings and compares them with predefined threshold values to identify abnormal conditions.

When the system detects an abnormal condition, it generates an alert to inform the user about the possible problem. For critical conditions, a relay can be used to disconnect the load or battery through a suitable protection arrangement. This helps provide an early warning and supports the prevention of further damage. The system can also display battery parameters and status information using an LCD or OLED display, making it easier for the user to understand the battery's operating condition.

The main aim of this project is to develop a low-cost and practical system that combines EV battery health monitoring and fire-risk detection. By continuously observing battery parameters, the system can help identify overheating, abnormal voltage, unusual current, and possible gas or smoke conditions. It also aims to support battery health estimation, improve reliability, and reduce the risk of battery-related hazards.

In the future, the proposed system can be improved by integrating Internet of Things (IoT) technology for remote monitoring and Artificial Intelligence (AI) or Machine Learning (ML) techniques for better battery health prediction and early fault identification. Such improvements could make the system more useful for electric cars, bikes, scooters, and other battery-powered applications.

Overall, the proposed system provides an approach to improving electric vehicle battery monitoring by combining battery condition assessment, abnormality detection, and early

warning mechanisms in a single system. It aims to improve battery safety, support preventive maintenance, and contribute to the reliable operation of electric vehicles.

BASIC IDEA OF PROJECT

The basic idea of the proposed Predictive EV Battery Health and Fire Detection System is to develop a low-cost system for monitoring electric vehicle battery health and safety using sensors and a microcontroller. The system aims to detect abnormal battery conditions and provide early warnings to reduce fire risks.

2.1 EV Battery Monitoring

- EV batteries require continuous monitoring to maintain safety and performance.
- Sensors measure important battery parameters such as temperature, voltage, and current.

2.2 Battery Health Monitoring

- Battery ageing can reduce battery performance and lifespan.
- The system monitors battery parameters to identify possible faults.

2.3 Temperature Monitoring

- The temperature sensor measures the battery temperature.
- Excessive temperature may indicate overheating.

2.4 Voltage Monitoring

- The system continuously monitors battery voltage.
- Abnormal voltage levels may indicate possible battery faults.

2.5 Current Monitoring

- The current sensor measures the battery current.
- Unusual current variations help identify abnormal operating conditions.

2.6 Fire Detection

- A gas or smoke sensor can detect possible warning signs of battery failure.
- The system helps identify potential fire hazards at an early stage.

2.7 Microcontroller-Based Processing

- The microcontroller collects data from the sensors.
- It processes the data to identify abnormal battery conditions.

2.8 Alarm System

- An alarm is activated when a dangerous condition is detected.
- It alerts the user about possible battery problems.

2.9 Battery Safety

- A relay can disconnect the battery or load during critical conditions.
- This helps improve battery safety and reduce the risk of damage.

2.10 Future Improvement

- IoT technology can be added for remote battery monitoring.
- AI/ML techniques can be used to improve battery health prediction.- This makes the system suitable for academic laboratories and small-scale electronics applications.

LITERATURE REVIEW

The literature review of the Predictive EV Battery Health and Fire Detection System focuses on battery monitoring, health estimation, and early detection of fire hazards.

3.1 Battery Management System (BMS)

- Battery Management Systems are used to monitor battery voltage, current, and temperature.
- They help improve battery safety, performance, and reliability.

3.2 Battery Health Monitoring

- Battery health monitoring helps identify battery ageing and performance degradation.
- State of Health (SOH) estimation helps assess the condition and remaining useful life of a battery.

3.3 Temperature and Voltage Monitoring

- Temperature and voltage sensors help identify abnormal battery operating conditions.
- Continuous monitoring supports early detection of overheating and electrical faults.

3.4 Fire Detection and Early Warning

- Lithium-ion battery faults can lead to thermal runaway, smoke, and fire.
- Research shows that temperature, voltage, current, and gas monitoring can help detect warning signs and improve battery safety.

3.5 Research Gap

- Existing battery monitoring methods may face challenges in detecting faults at an early stage.
- Therefore, the proposed system combines sensor-based monitoring, a microcontroller, an alarm, and optional relay protection to provide an affordable battery safety solution.

BLOCK DIAGRAM

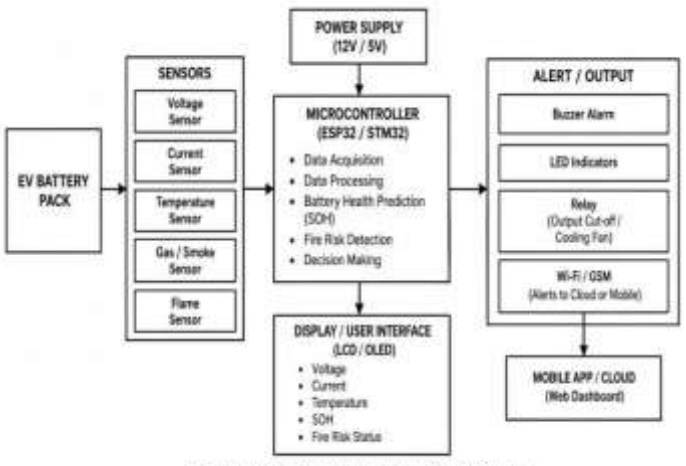


Fig. Predictive EV Battery Health And Fire Detection System

BLOCK DIAGRAM DESCRIPTION

The block diagram represents the working of the proposed Predictive EV Battery Health and Fire Detection System. The system monitors important battery parameters, processes sensor data, identifies abnormal conditions, and provides alerts to improve battery safety.

4.1 EV Battery

* The EV battery is the main component of the system.
* It supplies electrical energy to the electric vehicle.
* Battery performance and safety depend on parameters such as temperature, voltage, and current.
* Continuous monitoring helps identify abnormal battery conditions.

4.2 Temperature Sensor

* The temperature sensor measures the temperature of the EV battery.
* It helps identify excessive heating during battery operation.
* If the temperfault condition* If the temperature exceeds the predefined safe limit, the system identifies a possible overheating condition.
* This helps provide an early warning of potential battery hazards.

4.3 Voltage Sensor

* The voltage sensor measures the battery voltage.
* It helps identify abnormal voltage levels during charging and discharging.
* The measured voltage data is sent to the microcontroller for analysis.
* Abnormal voltage readings may indicate a possible battery fault.

4.4 Current Sensor

* The current sensor measures the current flowing through the battery.
* It monitors current variations during battery operation.
* Unusual current values may indicate abnormal operating conditions.
* This information helps the system identify possible electrical faults.

4.5 Gas or Smoke Sensor

* A gas or smoke sensor can be included to detect possible warning signs of battery failure.
* It monitors the presence of selected gases or smoke near the battery.
* The sensor sends its readings to the microcontroller.
* These readings can help identify potential hazards at an early stage.

4.6 Microcontroller

* The microcontroller acts as the main processing unit of the system.
* It receives data from the connected sensors.
* It processes sensor readings and compares them with predefined threshold values.
* When abnormal conditions are detected, it activates the appropriate warning or safety response.

4.7 Battery Health and Fault Detection

* The system analyzes temperature, voltage, and current readings to identify possible battery problems.
* Changes in these parameters may indicate overheating, electrical faults, or battery ageing.
* The collected data can support battery State of Health (SOH) estimation.
* Advanced prediction methods may be added in the future to improve fault detection.

4.8 Alarm System

* The alarm system provides an alert when a dangerous condition is detected.
* A buzzer or warning indicator can be used to notify the use
* The alarm helps the user respond quickly to abnormal battery conditions.
* Early warnings may help reduce the risk of further battery damage.

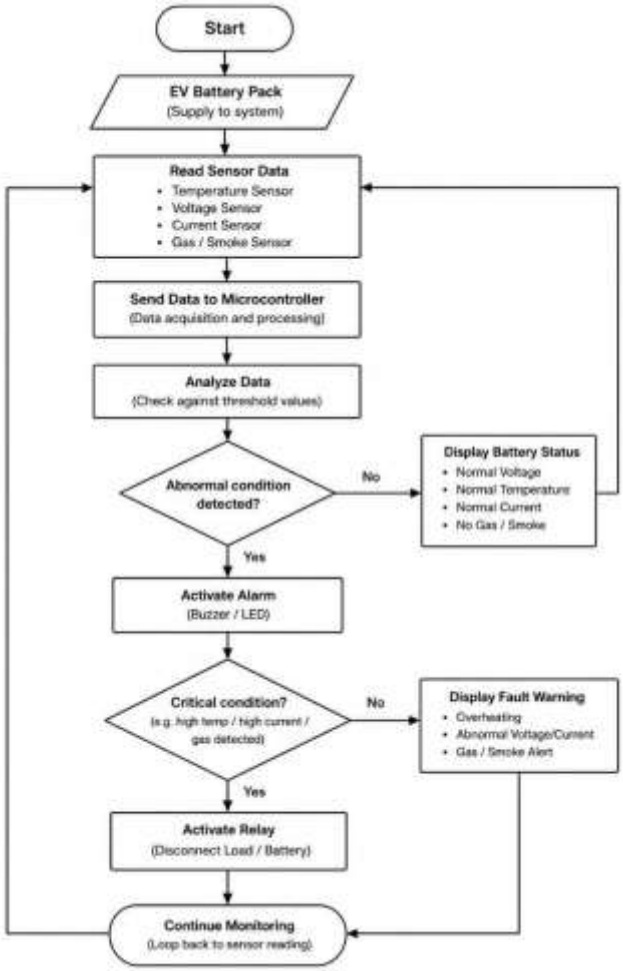
4.9 Relay Control

* A relay can be connected to control the battery or load during critical conditions.
* When a serious fault is detected, the microcontroller can activate the relay.
* The relay can disconnect the load or initiate a suitable isolation mechanism, depending on the circuit design.
* This function helps improve system safety. The actual battery isolation circuit must be designed to handle the battery's voltage and current safely.

4.10 Output and Monitoring

* The system provides information about battery parameters and detected faults.
* The output may include normal status, overheating alerts, abnormal voltage or current warnings, and possible gas or smoke alerts.
* A display or monitoring interface can be added to show sensor readings.
* In future, IoT technology can enable remote monitoring of battery conditions.

FLOWCHART



CONCLUSIONS

The Predictive EV Battery Health and Fire Detection System provides a practical approach to monitoring the health and safety of electric vehicle batteries. The system monitors important battery parameters such as temperature, voltage, and current using suitable sensors. The collected data is processed by a microcontroller to identify abnormal battery conditions. A gas or smoke sensor can also help detect possible warning signs of battery failure. When a dangerous condition is detected, an alarm provides an early warning, and a relay can disconnect the battery or load during critical conditions. The system aims to improve battery safety, support battery health estimation, and reduce the risk of overheating and fire hazards. In the future, IoT and AI/ML techniques can be incorporated for remote monitoring and improved battery health prediction.

REFERENCES

1. D. Li et al., "Battery Thermal Runaway Fault Prognosis in Electric Vehicles Based on Abnormal Heat Generation and Deep Learning Algorithms," IEEE Transactions on Power Electronics, 2022.
2. "State of Health Estimation for Lithium-Ion Batteries Based on Healthy Features and Long Short-Term Memory," IEEE, 2019.
3. Zhang et al., "Multi-dimension Fault Diagnosis of Battery System in Electric Vehicles Based on Real-world Thermal Runaway Vehicle Data," IEEE iSPEC, 2019.
4. Feng et al., "Thermal Runaway Mechanism of Lithium-Ion Battery for Electric Vehicles: A Review," Energy Storage Materials, 2018.
5. Hong, Z. Wang, and Y. Yao, "Fault Prognosis of Battery System Based on Accurate Voltage Abnormity Prognosis Using Long Short-Term Memory Neural Networks," Applied Energy, 2019.
6. Wang et al., "Thermal Runaway Caused Fire and Explosion of Lithium Ion Battery," Journal of Power Sources, 2012.
7. IEEE Xplore Digital Library — Research papers on EV battery health monitoring and fire detection.
8. ScienceDirect — Research articles on lithium-ion battery safety and thermal runaway.