RESEARCH ARTICLE OPEN ACCESS

EMBEDDED SYSTEM BASED ON EV FAULT DETECTION

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ABSTRACT: The integration of IoT technology enables continuous monitoring of electric vehicle batteries by tracking important parameters such as voltage, temperature, and fire risk conditions. The collected sensor data is analyzed to detect any abnormal behaviour at an early stage, which helps in identifying possible faults quickly. Through wireless communication, the battery information is transmitted to cloud platforms, allowing remote monitoring and analysis. In case of any critical condition, instant alerts are generated to take necessary actions and prevent accidents or system damage. This system improves the overall performance, safety, and reliability of electric vehicles by supporting real-time monitoring and predictive maintenance.

Keywords— *Electric Vehicle, IoT, Fault Detection, Arduino, ESP 8266, Battery Monitoring, Temperature Sensor, Voltage Sensor, Fire Detection, Wireless Communication,*

I. INTRODUCTION

Electric vehicles require advanced monitoring systems to ensure battery safety, long life, and efficient performance under different operating conditions. By integrating IoT technology, it becomes possible to continuously collect and analyze important data in real time, which helps in the early identification of faults and potential risks. Various intelligent sensors are used to monitor key parameters simultaneously, providing a complete understanding of the battery's condition and overall system status. Wireless communication enables remote monitoring and predictive analysis, reducing the need for manual inspection. This approach supports timely fault detection and preventive actions, thereby improving system reliability, avoiding accidents, and promoting the efficient operation of electric vehicles. The system also helps in reducing manual monitoring efforts by providing automated supervision. It supports efficient utilization of battery resources.

II. EXISTING METHOD

The current electric vehicle monitoring systems mainly depend on manual inspections and basic onboard diagnostic methods, which provide only limited information about the battery condition. These traditional systems are not capable of offering continuous real-time monitoring, making it difficult to understand the exact health status of the battery at all times. In most cases, only a few parameters such as voltage or current are monitored, while other important factors are often ignored. As a result, early-stage faults and abnormalities are not detected in time, which may lead to reduced performance, unexpected failures, or even safety risks. In addition, the data collected by conventional systems is usually processed locally without the support of advanced analytical techniques, which limits the ability to perform predictive maintenance. Most existing systems do not support remote monitoring or cloud integration, reducing the efficiency of tracking and responding to critical conditions. Furthermore, these systems mainly follow a reactive approach, where actions are taken only after a fault occurs rather than preventing issues in advance, which can negatively affect battery life, overall vehicle reliability, and user safety.

A. Drawbacks in Existing System:

- Absence of continuous real-time monitoring of battery conditions.
- Difficulty in identifying faults and potential hazards at an early stage.
- Lack of advanced features for predictive maintenance.
- No availability of remote access or cloud-based monitoring.
- Dependence on manual checking and delayed response mechanisms.
- Decrease in battery life and overall system performance.

III. PROPOSED SYSTEM

The proposed system focuses on improving electric vehicle safety by implementing an IoT-based monitoring solution for the battery. Different sensors are used to observe key parameters such as voltage levels, temperature variations, and possible fire-related conditions continuously. The gathered information is evaluated in real time to recognize unusual patterns or fault conditions at an early stage. A wireless communication module is utilized to send the processed data to an online platform, which allows users to monitor the system remotely. Whenever any abnormal situation is detected, the system produces immediate notifications and can also perform necessary control actions to avoid serious damage. This method ensures better battery protection, improves efficiency, and supports reliable vehicle operation.

IV. WORKING

The operation of the system starts with multiple sensors collecting real-time data from the electric vehicle battery. These sensors measure important factors such as voltage, temperature, and safety-related conditions. The collected data is then sent to a controller unit, where it is continuously checked against predefined safety limits. If any value crosses the allowed range, the system recognizes it as a fault condition. The information is then transmitted wirelessly using a module like ESP8266 to a cloud-based system for further monitoring. Users can view the battery status remotely through this platform. During critical situations, alert messages are generated instantly, and safety measures such as activating a buzzer or cooling mechanism are triggered. This process helps in early fault detection, quick response, and maintaining the overall safety and performance of the vehicle.

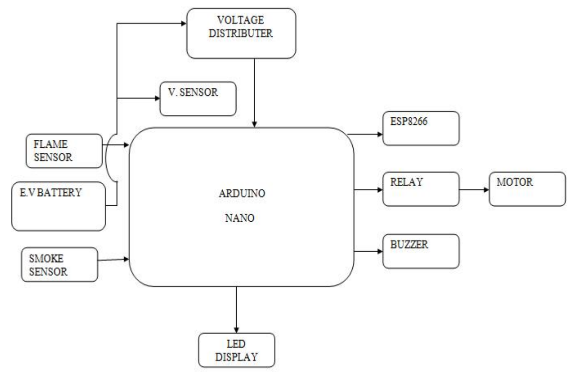


Fig.1 Block Diagram

B. voltage Sensor:

The voltage sensor is used to measure the voltage level of the battery or electrical system. It converts the input voltage into a signal that can be read by the microcontroller. In this project, it continuously monitors the battery voltage to ensure it stays within a safe limit. If any abnormal change occurs, it helps in detecting faults at an early stage. This improves battery safety and overall system performance.

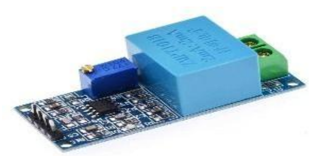


Fig.2 Voltage Sensor

C. Flame Sensor:

A flame sensor is used to detect the presence of fire or flame in a system. It works by sensing infrared light emitted from flames and converting it into a signal for the microcontroller. In this project, the flame sensor continuously monitors for any fire-related hazards in the battery system. If a flame is detected, it helps in identifying dangerous condition immediately. This ensures safety by enable quick action to prevent damage.

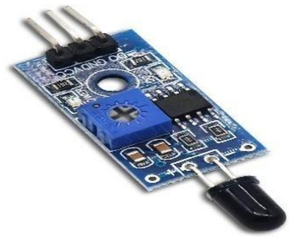


Fig.3 Flame Sensor

D. Temperature Sensor:

A temperature sensor is used to measure the heat level of a system. It converts temperature variations into electrical signals that can be read by the controller. In this project, it monitors the battery temperature continuously. If the temperature rises beyond the safe limit, it helps in detecting overheating conditions. This prevents battery damage and improves system safety.

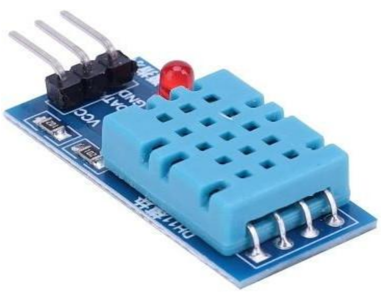


Fig.4 Temperature Sensor

E. Arduino Nano:

Arduino Nano is a compact microcontroller board used for controlling and processing electronic components. It is based on the ATmega328 and supports both analog and digital inputs. In this project, it acts as a main control unit that collects data from sensors and processes it. It also controls the output devices based on the received data. Its small size and easy interfacing make it suitable for embedded applications.

Fig.5 Arduino Nano

F. ESP8266:

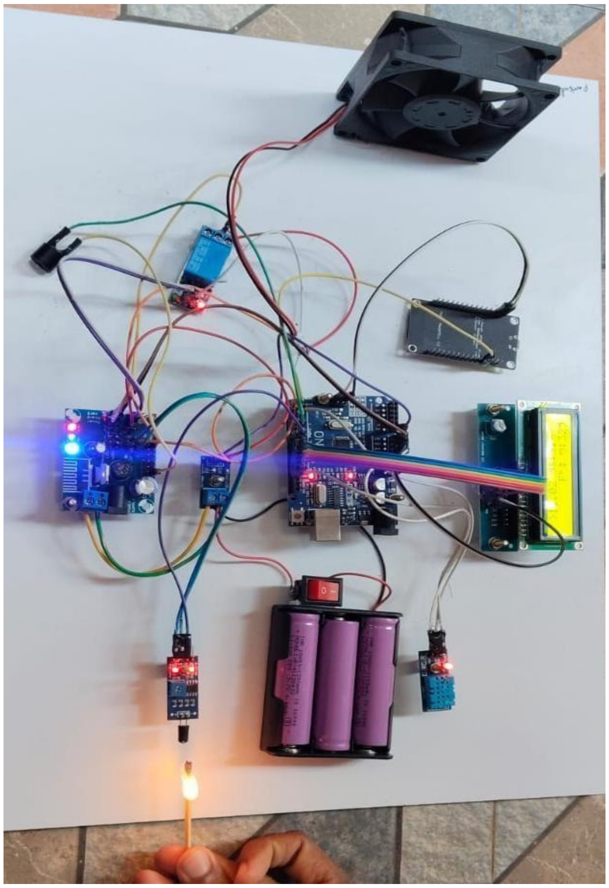
ESP8266 is a Wi-Fi module used for wireless communication in IoT applications. It allows devices to connect to the internet and exchange data. In this project, it is used to send sensor data to the cloud for remote monitoring. It enables real-time updates and alert notifications. This improves system connectivity and smart control.

Fig.6 Esp8266

G. Hardware Used:

- Battery
- Power supply unit
- Voltage sensor
- Temperature sensor
- Flame sensor
- Arduino nano (ATMMega832)
- IoT module (ESP8266)
- LCD
- Relay
- Switch
- Buzzer

H. Hardware Result:



I. Software Used:

- **PROGRAMMING LANGUAGE:**
  Embedded C
- **COMPILER:**
  Arduino IDE
- **MOBILE APP:**
  Arduino IoT Cloud

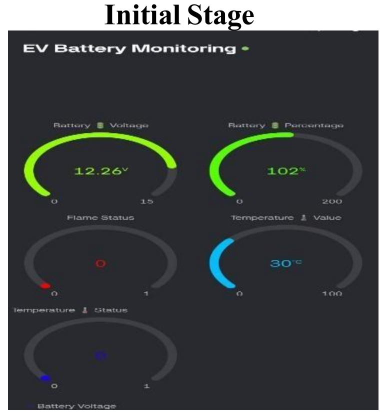
J. Software Coding:

```
voltage1();

if( (f--1)||(s--1) )  /////fire and buzzer
contion
   {

      digitalWrite(5,HIGH);
        delay(1000);
      digitalWrite(5,LOW);
     }

else if( (f--0)||(s -- 0))
{


digitalWrite(5,LOW);

}

 F-digitalRead(7);

if(F--LOW)   ////fire sensor
{
 lcd.setCursor(7,1);

 lcd.print("F_H");

f-1;

 digitalWrite(3,LOW);
}

else
{

lcd.setCursor(7,1);

lcd.print("F_L");
```

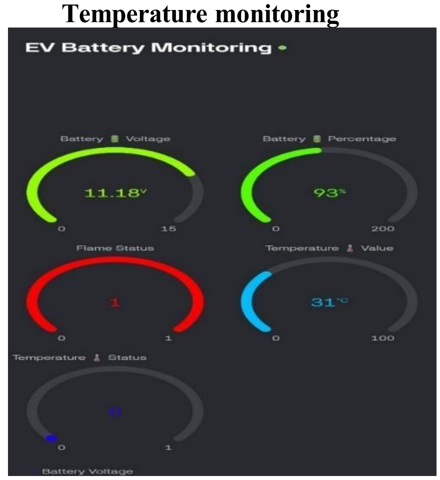
K. Software Implementation:

The IoT-based mobile application is used to monitor battery parameters in real time. It displays values such as temperature, voltage, and fire status. Under normal conditions, the temperature remains around 30°C and the system works safely. The flame sensor continuously checks for fire hazards. When a fire is detected, the sensor value changes and temperature increases. During this condition, the system activates a buzzer and stops the motor. The relay module cuts off the power supply to prevent damage. The system also monitors environmental changes like smoke. If temperature rises beyond the limit, a warning alert is generated. This process ensures safety and improves system reliability.

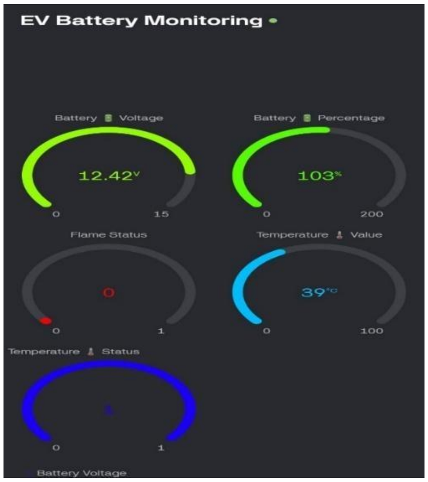
Initial Stage



Temperature monitoring



Battery Monitoring



Advantages:

- Provides continuous real-time monitoring of battery conditions.
- Detects faults at an early stage and prevents major failures.
- Improves safety by generating instant alerts during critical conditions.
- Supports remote monitoring through wireless connectivity.
- Enhance battery life and overall system performance.

Applications:

- Used in electric vehicles for battery monitoring and safety.
- Applicable in smart energy management systems.
- Useful for real-time fault detection in industrial systems.
- Suitable for use in battery management systems for continuous monitoring and protection.

V. CONCLUSIONS

The IoT-based monitoring system improves the safety and reliability of electric vehicles by continuously tracking battery conditions. Real-time analysis of sensor data helps in early fault detection and reduces the risk of accidents. Wireless connectivity enables remote monitoring and quick decision-making. Instant alerts and control actions prevent serious failures and hazards. Overall, the system enhances battery life, efficiency, and supports reliable EV operation.

VI. FUTURE SCOPE

- Growing energy demands highlight the need for efficient electric vehicle solutions.
- Electric vehicles can reduce dependency on conventional fuel sources.
- The system can be related with advanced battery management techniques.
- Real-time monitoring can be improved using AI-based analysis.
- Integration with smart grid system can optimize energy usage.
- The system can be extended for large-scale EV infrastructure.
- Improved fault detection methods can further increase safety.
- Remote access features can be upgraded for better user control.
- This technology can support smart city transportation systems.
- Future developments can focuses on improving battery performance and durability.

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