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IOT based Electric Vehicle Battery with Protection against Fire

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Abstract –

Electric Vehicles (EVs) are rapidly emerging as an eco-friendly alternative to conventional fuel-based transportation systems. However, one of the major challenges in EV technology is ensuring the safety and reliability of lithium-ion batteries, which are prone to overheating, overcharging, and thermal runaway, potentially leading to fire hazards. To address these issues, this paper proposes an IoT-based Electric Vehicle Battery Protection System that continuously monitors the battery's critical parameters such as temperature, voltage, and current in real time. The system uses sensors connected to Arduino nano microcontroller, which processes the data and transmits it to an IoT platform for cloud monitoring. If abnormal conditions are detected, the system automatically activates protective measures such as disconnecting the battery through a relay and triggering a buzzer alarm. Simultaneously, it sends instant notifications to the user via a mobile app, allowing timely intervention. This smart IoT-based safety mechanism significantly enhances battery protection, system reliability, and user confidence in electric vehicles. It also promotes the wider adoption of sustainable electric mobility by providing an efficient, affordable, and proactive safety solution against battery-related fire accidents.

Keywords - Arduino Nano Microcontroller, Battery, Sensors, GSM Module, Relay Module

I. INTRODUCTION

The transportation industry is increasingly electrifying vehicles, driven by the high cost of fuel, limited natural energy resources, and the need for more sustainable transport solutions. This transition has led to a dramatic rise in the global market for EVs. Lithium-ion batteries have become the dominant power source for these vehicles due to their high energy density and long cycle lives compared to conventional battery technologies.

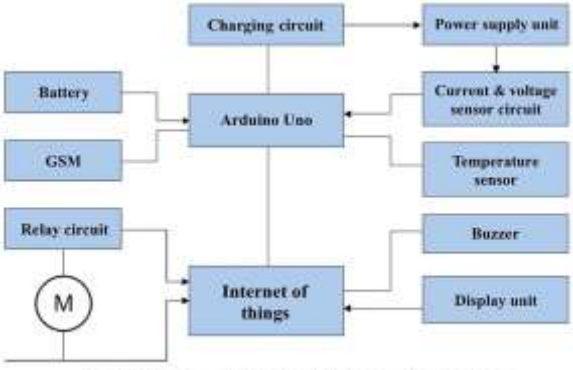

Fig.1. Block diagram of Electric vehicle battery with fire protection

The core component providing motive power is the onboard power source, which often remains a weak link. The introduction encompasses several critical and interrelated topics concerning Electric Vehicles, their Lithium-ion Batteries, safety management, performance monitoring, and end-of-life recycling. The transportation industry is increasingly electrifying vehicles, driven by the high cost of fuel, limited natural energy resources, and the need for more sustainable transport solutions. This transition has led to a dramatic rise in the global market for EVs. Lithium-ion batteries have become the dominant power source for these vehicles due to their high energy density and long cycle lives compared to conventional battery technologies. The core component providing motive power is the onboard power source, which often remains a weak link.

II. LITERATURE REVIEW

A Battery Management System (BMS) is proposed for electric vehicles (EVs) which couples charge monitoring and fire safety via Internet of Things (IoT) technology. The BMS's mission statement is to enhance EV safety and performance as it continuously monitors the battery's state and shields it from overcharging that may lead to fire accidents. This IoT-based system provides a platform for collecting real-time data on fire risks and allows for proactive measures; in case there are any irregularities detected. This BMS uses sensors to supervise different parameters like temperature, voltage, and current while the centralized control unit manages battery charging process.Furthermore, the system encompasses fire detectors and an emergency disconnect mechanism that would isolate the battery if there were signs of fires thus helping protect both vehicle occupants and the car itself from harm. As such, this proposal presents a one-stop-shop solution to handling EV batteries by enhancing their security as well as bettering its operations.

The controlling action based on the battery system is developed. Then the various parameters are used to monitor the status of the system to operate efficiently. For this purpose, battery management system (BMS) is used to monitor current, voltage and temperature. Whenever the above electrical parameters and temperature exceeds the value more than the limit then the system will inform to operate without failure. The IOT application for the monitoring the parameters of the battery are not developed. The wireless battery monitoring system for electric vehicle is developed in. Designed aprototype model for an electric vehicle and turn on the cooling circuit if the temperature is exceeded, but recharging problems are occurred due to old version of ATmega16 microcontroller is used. Brief explanation about battery fires in electric vehicles. Fire safety issues in electric vehicles related to thermal stability of battery, they are not mentioned the detecting parameters before the fire accident.

Electric vehicle battery protection system is developed in. The fault which is abnormal in the batteries were developed and it alerts the rapid cooling and fire suppression is not developed.

III. METHODOLOGY

The IoT-based EV battery fire protection system operates on the idea of continuously monitoring the battery's temperature and detecting abnormal conditions before they lead to thermal runaway or fire. A temperature sensor is placed near the battery pack to measure heat levels at regular intervals. These values are sent directly to the Arduino Uno, which serves as the main processing unit of the system. The Arduino continuously compares the incoming sensor readings with pre-set safety limits. Under normal operating conditions, the temperature remains below the threshold, and the system allows the EV to function normally. The values are also shown on the display unit, giving the user real-time information about battery health. When the temperature rises above the safe value, the Arduino identifies this as an abnormal or hazardous condition. This early detection is crucial because even a small temperature rise can be the first sign of overheating or internal battery failure. Once the abnormal condition is detected, the microcontroller immediately triggers multiple safety actions. Through continuous monitoring, instant detection, and immediate safety actions, this system effectively prevents overheating and reduces the chances of fire, making electric vehicles safer and more dependable.

IV. RESULTS AND DISCUSSION

The system successfully monitored the EV battery in real time using temperature, current, and voltage sensors. During testing, when the

battery temperature increased beyond the safe limit, the Arduino detected the change and immediately activated the buzzer and disconnected the load through the relay. The GSM module sent alert messages to the user, and the IoT module updated the battery status on the mobile application. The display unit also showed accurate sensor readings and warnings. The prototype effectively demonstrated early detection of overheating, rapid shutdown of the load and instant user notification, proving that the system can prevent fire hazards in EV batteries. The project demonstrates that continuous monitoring of the EV battery using sensors is an effective way to prevent fire hazards. The temperature, voltage, and current sensors provided accurate real-time data, allowing the Arduino to quickly detect unsafe conditions such as overheating or overcurrent. When a fault occurred, the relay responded instantly by disconnecting the motor load, and the buzzer alerted the user immediately.

Overall, the project demonstrates that integrating IoT with safety mechanisms can significantly improve the reliability of EV batteries. The system not only detects potential fire hazards early but also automates preventive actions, making electric vehicles safer and more user-friendly. This approach can be scaled further in real EVs by integrating more advanced battery management systems (BMS) and AI-based predictive analysis.

V. CONCLUSION

The project demonstrates an early fire-detection and protection system for electric vehicle (EV) batteries using temperature sensors, current sensors, and IoT technology. Real-time monitoring through IoT allows the battery status to be viewed remotely, enabling quick decision-making in emergency situations. Automatic safety actions, such as activating the cooling system or buzzer alert, help prevent the fire from starting or spreading. Continuous data logging supports analysis of battery behavior and helps improve EV safety and performance.The system provides a low-cost and efficient solution, making it suitable for student projects and real-world applications. Overall, the project enhances the safety, reliability, and intelligence of EV battery systems, reducing the risk of fire accidents.

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