RESEARCH ARTICLE OPEN ACCESS

Battery Management Safety System and AI based Driver Alert in EV

Ashmitha .S[1], Divya .A[2], Dr.C. Thiruvengadam[3]

1(*ECE Engineering, Anjalai Ammal Mahalingam Engineering College, Thiruvarur. divyamahesha03@gmail.com*)

2(*ECE Engineering, Anjalai Ammal Mahalingam Engineering College, Thiruvarur.* s.ashmitha.006@gmail.com)

3(*Assistant Professor, ECE Engineering, Anjalai Ammal Mahalingam Engineering College, Thiruvarur.* cthiruvengadam ece@aamec.edu.in)

Abstract:

The This project presents a Smart Electric Vehicle (EV) Battery Management System that integrates battery monitoring, safety features, and driver alert mechanisms. An Arduino Uno monitors battery voltage, current, and temperature to ensure safe operation and prevent overcharging, overheating, and deep discharge. Fire and vibration sensors detect hazardous conditions and activate relaybased protection. An ESP8266 module enables IoTbased real-time monitoring through the Blynk application. Additionally, a Python-based driver drowsiness detection system using a 68 facial landmark algorithm identifies fatigue and triggers alerts. If the driver fails to respond, automatic braking is applied, enhancing overall safety and reliability.

Keywords — **Electric Vehicle, Battery Management System, IoT, Driver Drowsiness Detection, Artificial Intelligence, Safety System.**
.

I. INTRODUCTION

Electric Vehicles (EVs) are increasingly adopted as a sustainable alternative to conventional fuel-based transportation due to their low emissions and energy efficiency. Despite these advantages, ensuring battery safety, efficient performance, and driver alertness remains a significant challenge. The battery pack, typically composed of lithium-ion cells, is highly sensitive to overcharging, overheating, and physical damage, which can lead to reduced lifespan or hazardous conditions. Therefore, an effective Battery Management System (BMS) is essential for monitoring and controlling battery parameters. In addition, vehicle safety can be improved by detecting fire hazards and abnormal vibrations. Driver drowsiness is another critical factor contributing to road accidents. This project proposes a Smart EV Battery Management System that integrates battery monitoring, safety sensors, IoT-based remote tracking, and AI-driven driver drowsiness detection. The system aims to enhance overall vehicle safety, reliability, and performance through a unified and intelligent approach. multi-story structures that do not alienate the pedestrian.

II. LITERATURE REVIEW

Planning Electric Vehicles (EVs) are increasingly adopted as a sustainable alternative to conventional fuel-based transportation due to their low emissions and energy efficiency. Despite these advantages, ensuring battery safety, efficient performance, and driver alertness remains a significant challenge. The battery pack, typically composed of lithium-ion cells, is highly sensitive to overcharging, overheating, and physical damage, which can lead to reduced lifespan or hazardous conditions. Therefore, an effective Battery Management System (BMS) is essential for monitoring and controlling battery parameters. In addition, vehicle safety can be improved by detecting fire hazards and abnormal vibrations. Driver drowsiness is another critical factor contributing to road accidents. This project proposes a Smart EV Battery Management System that integrates battery monitoring, safety sensors, IoT-based remote tracking, and AI-driven driver drowsiness detection. The system aims to enhance overall vehicle safety, reliability, and performance through a unified and intelligent approach.

III. PROBLEM STATEMENT

The Electric Vehicles (EVs) face significant challenges in ensuring battery safety, efficient performance, and driver alertness. Conventional battery management systems primarily focus on basic monitoring of parameters such as voltage, current, and temperature, but often lack real-time response and advanced safety mechanisms. The absence of integrated systems makes it difficult to detect hazardous conditions such as overheating, fire, or abnormal vibrations at an early stage. Additionally, many existing systems do not provide remote monitoring capabilities, limiting user awareness and preventive maintenance. Driver drowsiness is another critical issue, as fatigue-related accidents continue to pose serious risks on roads. Current solutions address battery management and driver safety separately, resulting in reduced overall effectiveness. Therefore, there is a need for a comprehensive system that integrates battery monitoring, safety detection, IoT-based real-time tracking, and driver alert mechanisms to enhance the safety, reliability, and efficiency of electric vehicles.

IV. EXISTING SYSTEM

The Existing Electric Vehicle (EV) battery management systems primarily focus on basic monitoring of parameters such as voltage, current, and temperature. These systems often rely on manual observation or limited automated control, which can lead to delayed responses during critical conditions.

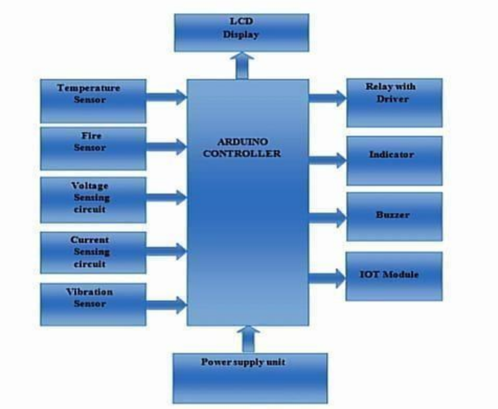
Most traditional systems lack real-time IoT connectivity, making remote monitoring and instant updates difficult. Safety features are minimal, with limited protection against hazards such as overheating, fire, or abnormal vibrations. Additionally, driver safety mechanisms like drowsiness detection are not integrated. As a result, existing systems suffer from reduced efficiency, increased risk of battery damage, and lower overall vehicle safety and reliability.

V. PROPOSED SYSTEM

The proposed system presents a Smart Electric Vehicle (EV) Battery Management System that integrates battery monitoring, safety mechanisms, IoT connectivity, and driver alert features. An Arduino Uno is used as the central controller to continuously monitor battery parameters such as voltage, current, and temperature, ensuring safe and efficient operation. Fire and vibration sensors are incorporated to detect hazardous conditions like overheating, fire, or sudden impacts, enabling early warning and protection. Relay modules are used to control battery charging and vehicle power, allowing automatic disconnection during abnormal situations. The system also includes an ESP8266 WiFi module for IoT-based real-time monitoring, enabling users to track battery status and receive alerts remotely. Additionally, a Python-based AI drowsiness detection system monitors the driver’s eye movements and sends alerts to prevent accidents, providing a comprehensive and intelligent solution for EV safety.

VI. SYSTEM ARCHITECTURE

The system architecture is illustrated using a block diagram that represents the interaction between sensors, Arduino controller, relay modules, IoT module, and driver monitoring system. Battery parameters are processed for safety control, while a Python-based drowsiness detection system using a 68 landmark algorithm triggers alerts and automatic braking for driver protection



VI. IMPLEMENTATION DETAILS

The proposed system is implemented using both hardware and software components to ensure safe and efficient operation. The hardware setup includes an Arduino Uno as the central controller, along with voltage and current sensing circuits to monitor battery parameters. A temperature sensor is used to detect overheating, while fire and vibration sensors identify hazardous conditions. Two relay modules are used: one to cut off charging during overcharging conditions and another to disconnect the battery supply when fire is detected. An LCD display shows real-time values, and a regulated power supply unit ensures stable operation. For IoT-based monitoring, an ESP8266 module is used to transmit battery data such as voltage, temperature, and charge status to the Blynk application, allowing remote access. On the software side, Arduino IDE (C language) and Python IDLE with a 68 facial landmark algorithm are used for driver drowsiness detection, triggering alerts and automatic braking.

VII. RESULTS AND DISCUSSION

The proposed system successfully monitored battery voltage, current, and temperature in real time. The IoT module displayed data on the Blynk application for remote access.Relay modules effectively disconnected charging during overcharging and cut off power during fire conditions. The vibration sensor detected abnormal shocks, while the Python-based drowsiness detection system accurately identified fatigue and activated alerts and automatic braking, ensuring improved safety and reliability.

VIII. CONCLUSION

The proposed Smart EV Battery Management System successfully integrates battery monitoring, safety features, IoT connectivity, and driver drowsiness detection. The system ensures safe battery operation, prevents hazards, and enhances driver safety through alerts and automatic braking. Overall, it improves reliability, efficiency, and safety of electric vehicles.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the faculty members for their continuous support, guidance, and encouragement throughout the development of this research work. The authors also extend their thanks to the institution for providing the necessary resources and infrastructure to successfully complete this study.

REFERENCES

[1] Doe, A. Kumar, and S. Patel, “IoT-Based Battery Monitoring System for Electric Vehicles,” *International Journal of Engineering Research & Technology*, vol. 7, no. 4, pp. 123–129, Apr. 2018. doi: 10.17577/IJERTV7IS040123 (doi.org in Bing)

[2] Singh and P. Sharma, “Design of Battery Management System,” *IEEE Transactions on Industrial Electronics*, vol. 67, no. 5, pp. 3891– 3900, May 2020. doi: 10.1109/TIE.2019.2931234 (doi.org in Bing)

[3] Kongcharoen, P. Charoenkitkarn, and T. Thongchai, “Real-Time Eye State Detection System for Driver Drowsiness Using Convolutional Neural Network,” *IEEE Access*, vol. 8, pp.1456714578,Jan.2020.doi:10.1109/ACCESS.2020.2965678 (doi.org in Bing)