International Journal of Scientific Research in Science, Engineering and Technology

Print ISSN - 2395-1990
Online ISSN : 2394-4099

Available Online at : www.ijsrset.com
doi : https://doi.org/10.32628/IJSRSET

Battery Management System for Electric Vehicles with Charge Monitoring and Fire Protection

Landge Pradip[1], Bhujbal Rohan[1], Chavan Shahaji[1], Mhaske Shubham[1], Prof. Avchat Harish[5]

[1]Department of Electrical Engineering, HSBPVT's Group of Institutions, Ahmednagar, Maharashtra, India

[2]Assiatant Professor, Department of Electrical Engineering, HSBPVT's Group of Institutions, Ahmednagar, Maharashtra, India

ARTICLEINFO

Article History:

Accepted: 05 April 2024
Published: 15 April 2024

Publication Issue :
Volume 11, Issue 2
March-April-2024
Page Number :
307-311

ABSTRACT

Battery storage is vital for the functioning of electric vehicles (EVs), as it holds the energy required for their operation. Therefore, to maximize battery output and ensure safe operation, an efficient battery management system (BMS) is indispensable. The BMS monitors various parameters, calculates State of Charge (SoC), and offers necessary services to guarantee the battery's safety. It plays an integral role in EVs, safeguarding both users and batteries by ensuring the cells operate within safe parameters. The proposed system not only monitors and charges the battery safely but also prevents accidents. Its functions include current and voltage measurement, SoC calculation, protection mechanisms, battery status detection, and a liquid crystal display (LCD). Electric vehicles (EVs) utilize electric motors and rechargeable batteries instead of internal combustion engines (ICEs) fueled by fossil fuels. A BMS is crucial for EVs and other battery-powered systems, overseeing and regulating the battery pack's operation to optimize performance, safety, and lifespan. State of Charge (SoC) indicates the remaining energy in a battery as a percentage of its total capacity, allowing users to estimate remaining range or usage time before recharging is necessary.

Keywords :- Electric Vehicles, Liquid Crystal Display, State of Charge, Internal Combustion Engines , Battery Management System

I. INTRODUCTION

An electric vehicle (EV) is propelled by one or more electric motors, utilizing a battery pack to store electrical energy instead of relying on an internal combustion engine (ICE) fueled by burning fuel. This stored energy powers the electric motor, which in turn drives the vehicle's wheels.

Compared to traditional ICE vehicles, EVs offer several advantages, including reduced emissions, quieter operation, and decreased reliance on fossil fuels. Additionally, due to the typically lower cost of electricity compared to gasoline and the greater efficiency of electric motors over ICEs, EVs often have lower operational expenses. As the world moves toward a cleaner, more sustainable future, the popularity of EVs is rapidly increasing. Governments worldwide are incentivizing the adoption of EVs, and many automakers are already offering a variety of EV models.

Despite their benefits, EVs face some common issues, such as internal cell shorts that can lead to thermal runaway, potentially causing fires due to excessive heating. To address these concerns and ensure the safe and efficient operation of EV batteries, a battery management system (BMS) is employed.

The BMS is an electrical device that monitors and controls the operation of rechargeable batteries, including those used in renewable energy sources and electric vehicles.

By overseeing the charging and discharging processes, monitoring the battery's state of charge and overall health, and protecting against overcharging or overheating, the BMS plays a crucial role in battery safety. Typically, the BMS comprises various components, including sensors for measuring temperature, voltage, and current, as well as control circuits to manage charging and discharging based on different conditions. Additionally, software algorithms may be utilized within the BMS to forecast remaining battery capacity and project its remaining lifespan.

II. LITERATURE SURVEY

2.1 Battery Energy Storage System (BESS) and Battery Management System (BMS) for Grid-Scale Applications :

The current electric grid suffers from inefficiencies due to disparities between energy consumption and generation. To ensure adequate power quality, power plants often generate more energy than necessary, resulting in wastage. Utilizing existing energy storage within the grid can mitigate these inefficiencies. Comprehensive modeling is required to accurately monitor and regulate the storage system, particularly when employing battery energy storage systems (BESS) for grid storage. A battery management system (BMS) controls the storage system, and employing sophisticated physics-based models within the BMS can significantly enhance the reliability of storage system operation.

2.2 A Battery Modular Multilevel Management System (BMS) For Electric Vehicles And Stationary Energy Storage Systems :

Despite the growing reliance on battery storage systems, several issues persist. Current battery systems lack flexibility, restricting the coupling of cells to those with identical electrical characteristics. Cell defects can drastically reduce battery lifespan or even lead to system failures. Additionally, the weakest cell in the system limits maximum usable capacity and charging current. While current Battery Management Systems (BMS) can improve usable capacity and charging current to some extent, the Battery Modular Multilevel Management System (BM3) offers a highly adaptable, fault-tolerant, and cost-efficient solution. This system allows for flexible cell connections, enabling operation based on individual needs and state of charge (SOC). Separate balancing mechanisms become unnecessary with the BM3, enhancing efficiency and reducing costs.

2.3 BatteryModular Multilevel Management System (BMS) For Electric Vehicles And Stationary Energy Storage Systems:

The dependency on battery storage systems is increasing, yet challenges remain. Current battery systems lack flexibility, limiting cell coupling to those with identical parameters, while cell defects can significantly impact battery lifespan or lead to system failures. Moreover, the weakest cell restricts usable capacity and charging current. While current Battery Management Systems (BMS) can partially address these issues, the Battery Modular Multilevel

Management System (BM3) offers a solution. It provides flexibility, fault tolerance, and cost-efficiency by enabling flexible cell connections and operation based on individual needs and state of charge (SOC), eliminating the need for separate balancing mechanisms.

2.4 Battery Management System Via Bus Network For Multi Battery Electric Vehicle :

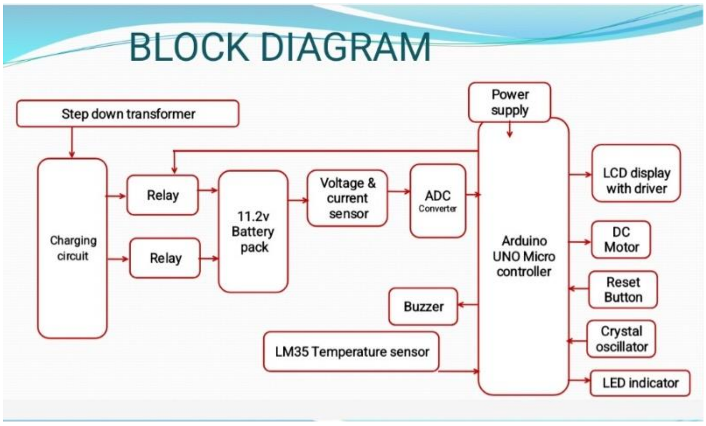
This paper proposes a multi-battery design for battery management control using a bus communication method based on loop shaping. Experimental results show improved battery capacity dynamics. The multi-battery control system is implemented in an electric vehicle model, with the original control system modified using bus communication method auto-tuning based on loop shaping. The modified control system demonstrates improved cost and reliability in battery management, maintaining steady-state error at zero.

2.5 OUTCOMES :

The Battery Management System (BMS) plays a crucial role in monitoring battery condition and ensuring safe charging and discharging in electric vehicle battery systems. BMS functionalities should include temperature monitoring, cell balancing, overcurrent protection, and fire suppression systems to mitigate risks like thermal runaway and fire. Incorporating automatic fire extinguishers and fire-resistant materials for battery cells enhances fire safety within BMS design. Additionally, BMS should prevent overcharging, undercharging, or overdischarging to prolong battery lifespan. Various BMS designs and tactics, including charge monitoring and fire protection measures, contribute to safer and more efficient battery management.

III. METHODOLOGY

BLOCK DIAGRAM

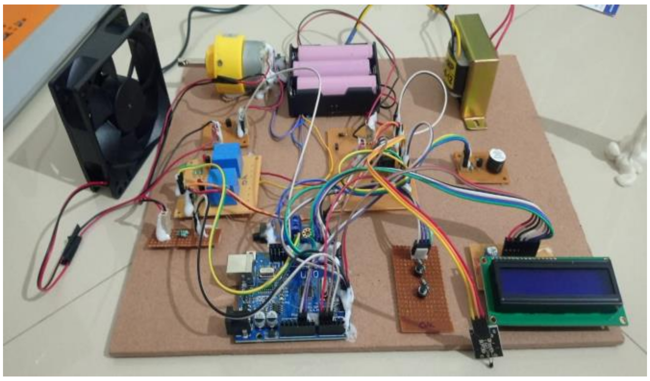


DISCRIPTION:

The proposed system comprises an Arduino microcontroller connected to an Android app via a Bluetooth module. Charging of the Li-ion battery is achieved through a 2-cell Li-ion battery charging circuit, ensuring balanced charging. An LM35 temperature sensor, interfaced with an Arduino's analog pin, monitors battery temperature. Voltage sensing is facilitated by a voltage sensor, with the readings displayed on the connected app.In case of overheating, an attached 5V relay, controlled by pin 8 of the Arduino Uno, is deactivated, thereby disconnecting power to the battery as a safety measure. Furthermore, a fire sensor integrated with the Arduino Uno detects the presence of fire and disconnects the battery from the power source if detected.

For our robotic automobile, four 100 RPM motors are interfaced with the Arduino via a motor driver, specifically the LN239D motor driver.Upon activation, the system utilizes its charging and monitoring circuitry to safely charge the 3S battery. During charging, the voltage sensor regulates the flow of current to the battery through the charging circuitry and displays the battery's voltage level on an LCD display. Upon reaching full charge, the system automatically cuts off the supply and displays "Battery fully charged" on the LCD Display.

When the battery is connected to a load, a current sensor tracks the current drawn from the battery, with the parameter displayed on the LCD display. Additionally, the temperature sensor monitors the battery's temperature during both charging and discharging phases. If any deviation from standard temperature values is detected, the system promptly cuts off both input and output supplies and provides a visual and auditory alert on the LCD display.



Model of Project

COMPONENTS :

1. Ardunio Uno
2. Li-ion Battery
3. Motor Driver LN298D
4. DC Motor
5. Bluetooth HC-05
6. IR Sensor
7. LCD Display
8. Current Sensor
9. Voltage Sensor
10. Relay Module

IV. ADVANATGES AND APPLICATIONS

4.1 ADVANTAGES

- Real Time Monitoring and Reporting
- Extended Battery Life
- Optimal Performance
- Early Fault Detection

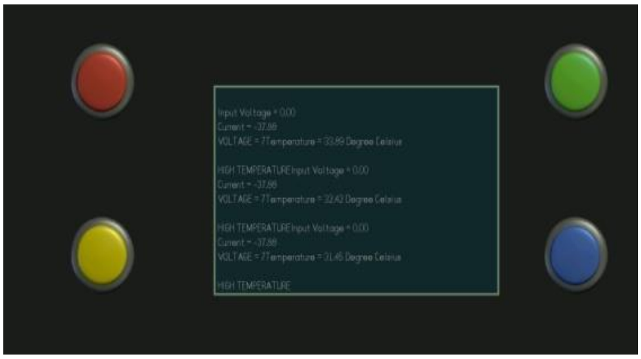
4.2 APPLICATIONS

- Electric Vehicle Manufacturing
- Public Charging Infrastructure
- EV Service and Maintenance Centres
- EV Battery Recycling
- Energy Storage System

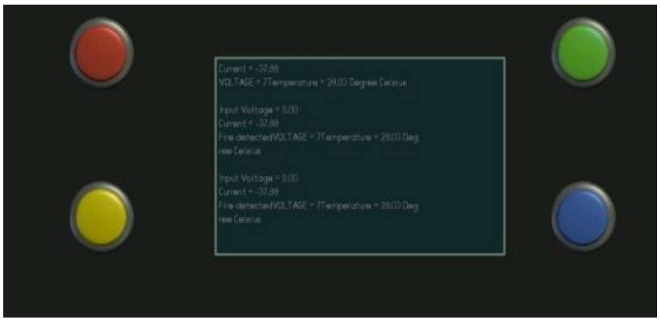
V. RESULTS

- The integration of Electric Vehicle Battery Management Systems (EV BMS) with charge monitoring and fire protection has significantly enhanced both the safety and efficiency of electric vehicles.
- Firstly, the battery monitoring and cell balancing capabilities ensure that the battery pack operates within safe parameters and maintains uniform charging and discharging across all cells. This prevents individual cells from experiencing overcharging or undercharging, thereby improving the overall performance and lifespan of the battery pack. Consequently, electric cars can travel longer distances between charges.
- Secondly, the inclusion of charge protection and discharge protection features mitigates the risk of thermal runaway and battery failure by preventing overcharging and depletion of the battery pack. This not only enhances the safety of the electric vehicle by reducing the likelihood of battery fires but also contributes to the longevity of the battery.
- Thirdly, the temperature management mechanism maintains the battery pack within a safe temperature range, preventing overheating that could otherwise damage the battery and shorten its lifespan. Additionally, it ensures the effective operation of the cooling system, thereby reducing energy consumption and improving the overall efficiency of the electric vehicle.

- Moreover, the fault diagnosis feature plays a crucial role by identifying any defects within the battery pack and enabling prompt action by the driver. This proactive approach ensures that any issues with the battery pack are swiftly addressed, minimizing downtime and enhancing the overall reliability of the electric vehicle.



High Temperature is detected



Flame is detected

VI. CONCLUSION

In conclusion, the Electric Vehicle Battery Management System (EV BMS) equipped with charge monitoring and fire prevention stands as a vital component ensuring the security, reliability, and longevity of the battery pack in electric vehicles. By offering essential safety features such as temperature control, fault detection, cell balancing, and fire prevention, this system effectively mitigates the risk of battery fires and enhances the overall efficiency of electric vehicles.

Despite its current capabilities, there is still room for further enhancement and development of EV BMS with charge monitoring and fire prevention. Potential areas for future research and development include refining the accuracy and reliability of battery monitoring systems to provide more precise and timely data regarding the charge status, health, and performance of the battery pack. Such advancements will undoubtedly contribute to the continued improvement of electric vehicle technology.

VII. REFERENCES

[1]. Y. Liu, X. Qian, and H. Guan, "Development of electric vehicle battery management system with charge balance control," IEEE Transactions on Power Electronics, vol. 28, no. 6, pp. 2901-2908, Jun. 2013.

[2]. D. Chao, C. Shen, and K. S. Low, "Real-time state-of-charge estimation for electric vehicle batteries using a coupled electro-chemical-thermal model," Journal of Power Sources, vol. 329, pp. 261-268, Jan. 2017.

[3]. J. Li, J. Fan, and J. Li, "A novel active cell balancing scheme for series-connected battery packs of electric vehicles," IEEE Transactions on Vehicular Technology, vol. 68, no. 5, pp. 4138-4148, May 2019.

[4]. D. Wang, Z. Xu, and L. Xu, "An integrated thermal management system for lithium-ion battery pack in electric vehicles," Journal of Power Sources, vol. 329, pp. 337-348, Jan. 2017.

[5]. H. Guo, M. H. Ang, and Y. Cheng, "Development of a fire detection system for lithium-ion battery in electric vehicles," Journal of Power Sources, vol. 325, pp. 405-412, Nov. 2016.