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Electric Vehicle Battery Management system with Charge Monitoring and Fire Protection Using Arduino Uno

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ABSTRACT: Electric vehicle (EV) is the future of transportation, But EV technology has not been fully developed with respect to efficiency and safety as of 2023. We know that the batteries are the most important components of an electric vehicles, but most of electric vehicles fire incidents Occur due to improper battery management system (BMS). By using proper battery management system, we can solve these problems. Here we are using an EV BMS with charge monitoring and fire protection system. This system is designed to constantly monitor battery voltage, current, temperature and instantly cut off input and output from battery as soon as any unusual behavior is detected.

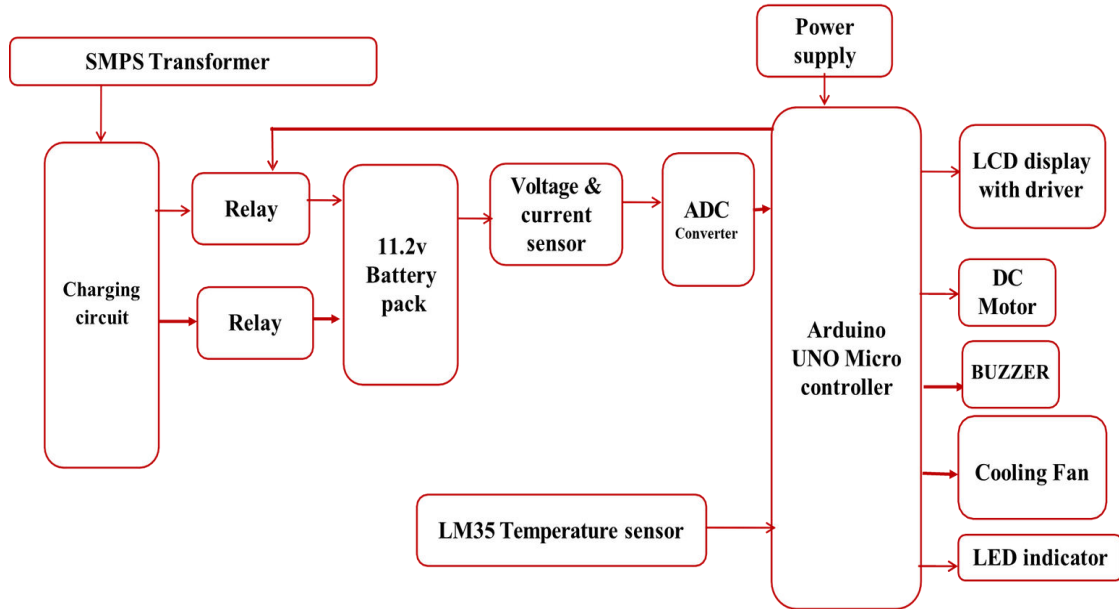
I. INTRODUCTION

The increasing significance of green energy in today's world has made electric vehicles the most environmentally friendly choice for both public and personal transportation. Due to their high energy and current density, lithium-ion batteries have become the predominant choice for electric vehicles. However, it is crucial to operate these batteries within their Safety Operation Area (SOA) to prevent potential hazards. Therefore, the implementation of a battery management system (BMS) is essential for all lithium-ion batteries, particularly those used in electric vehicles.

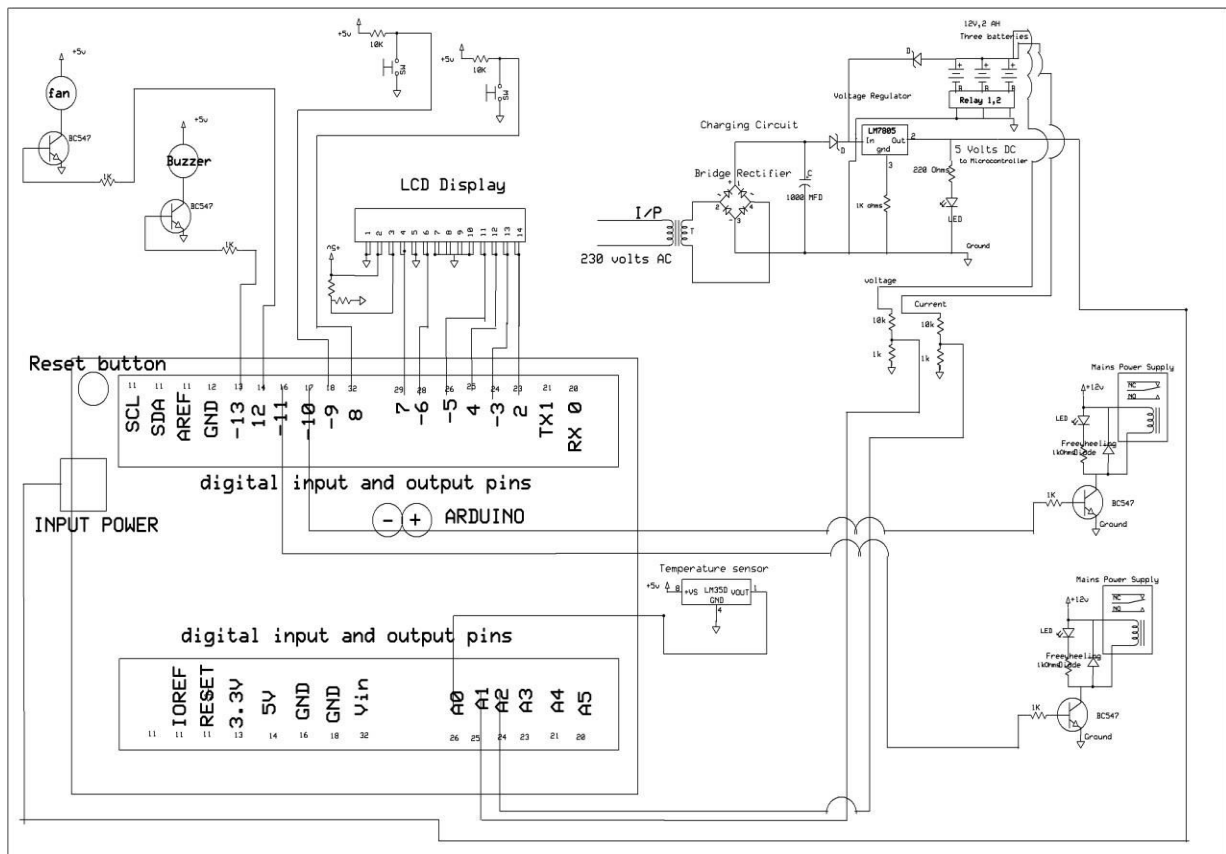
This study extensively discusses the purpose, functions, and configurations of BMS, as well as reviews early battery models, hardware, and system designs for BMS. Furthermore, it introduces an enhanced battery model and presents simulation results to validate its performance. Finally, the design of an innovative BMS hardware system and its experimental results are presented. The paper also outlines potential enhancements for the battery models and BMS hardware in the conclusions and future work section.

The proposed battery management system (BMS) is designed for electric vehicles and is responsible for managing a rechargeable battery (cell or battery pack), ensuring it operates within its safe operating area, and monitoring its status using a PIC microcontroller. The PIC microcontroller serves as the central control device for the entire system, with integrated modules including a temperature sensor, battery pack with relays, charger, and LCD module. When the battery pack requires recharging, it is done through relays, with two relays utilized for fast and slow charging. The DC motor functions as the vehicle, and during operation, the microcontroller displays voltage and current values on the LCD module, continuously monitoring the temperature. If the temperature exceeds the predefined limit, the PIC microcontroller activates the buzzer for alerts. Additionally, based on the battery voltage, it manages the charging process in two modes - fast and slow - using the relay to control the charging connection. The microcontroller executes an embedded C language program to accomplish these tasks.

II. BLOCK DIAGRAM



III. CIRCUIT DIAGRAM



IV. WORKING

A **Battery Management System (BMS)** is an electronic system. That monitors and manages a rechargeable battery in an electric vehicle (EV) to ensure safe and efficient operation. This process can be done with cost effectively by using Microcontroller called Arduino uno. which act as a Brain of the battery management system. It is readily available in the market at low price.

The controlling device of the whole system is the Arduino UNO Microcontroller. It integrates modules to the controller like the temperature sensor and battery pack along with relays, Charger and LCD Module.

When the battery pack gets drained, it will charge through relays. Here we are using two relays for fast and slow charging. Here DC MOTOR works as a vehicle. While running the vehicle microcontroller will display the voltage and current values on the LCD module as well as it displays the temperature continuously.

If the temperature value crosses the set limit, then the microcontroller activates the Cooling Fan to cool the battery temperature. Based on the battery voltage it will charge the battery in two modes fast and slow (Normal)Charging mode. Here two relays (1,2) work as a switch to on/off the charging connection. Here for normal charging relay 1 is activated for fast charging both relays are activated. If the battery voltage drops to below 9 volts, we will get a buzzer indication. To achieve this task microcontroller-loaded program written in embedded C language.

V. METHODOLOGY

System Design: Determine the number of cells in your battery pack and choose appropriate voltage and current sensors. Design the circuit schematic for connecting all components to the Arduino.

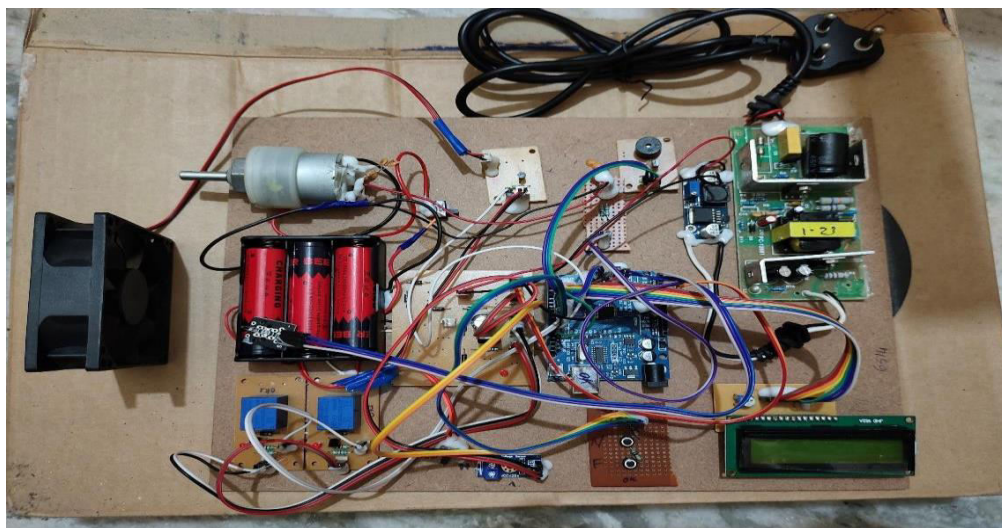
Sensor Calibration: Calibrate the voltage, current, and temperature sensors to ensure accurate readings.

Programming the Arduino: Write code in the Arduino IDE to perform the following tasks:

- Initialize communication with all sensors.
- Continuously read voltage data from each cell and calculate total battery voltage.
- Read current data and determine charging/discharging state.
- Monitor temperature readings.
- Implement safety checks based on voltage, current, and temperature thresholds. If a threshold is breached, trigger the contactor/relay to disconnect the battery to prevent damage.
- (Optional) Write code to display readings on the LCD screen.

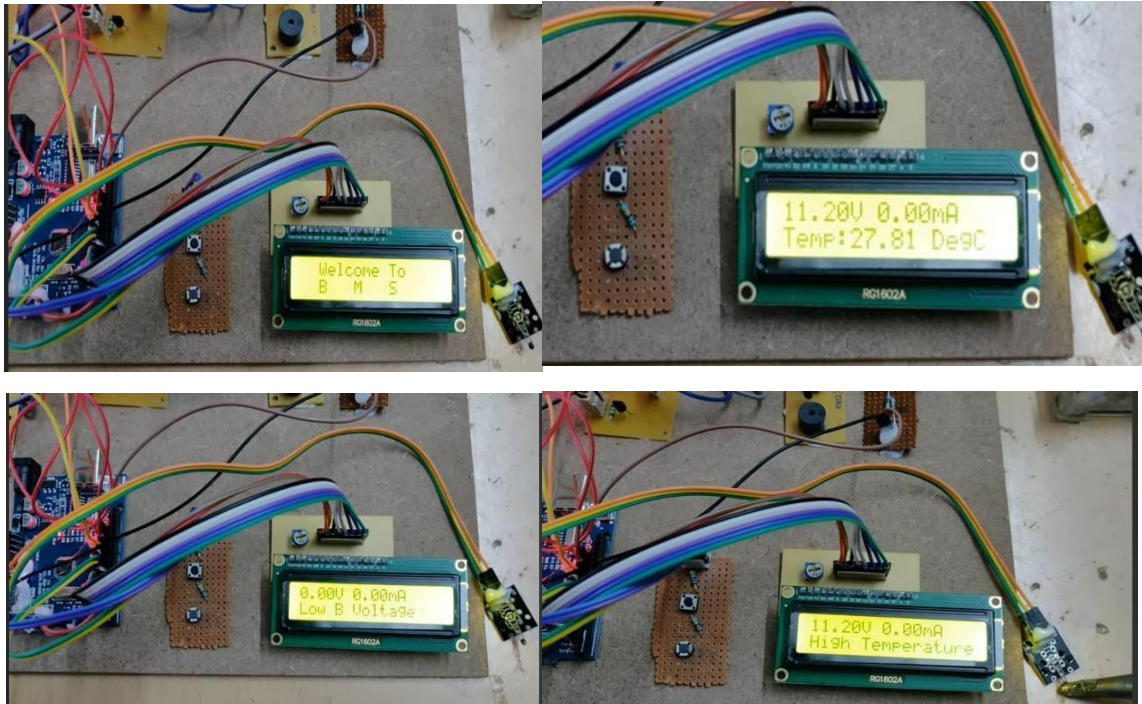
Testing and Validation: Test the system thoroughly with a simulated battery pack (never a real EV battery during initial testing phases due to safety risks). The system should accurately measure voltages, currents, and temperature. It should also trigger the contactor/relay to disconnect the battery when safety thresholds are exceeded.

VI. EXPERIMENTAL SET-UP



VII. EXPERIMENTAL RESULT

The "EV BMS with Charger Monitoring and Fire Protection" project presents a more sophisticated battery model using an enhanced process. We noticed that if the temperature exceeds Greater than 43 degrees, the cooling fan will turn on automatically. Furthermore, there will be an audible beep when the battery voltage drops below 9 volts. And also, by using the two relays we can charge the battery pack in slow mode and normal mode



VIII. ADVANTAGES

A Battery Management System (BMS) in electric vehicles (EVs) offers several advantages:

1. **Enhanced Energy Efficiency:** A BMS optimizes the use of energy stored in the battery, leading to more energy-efficient EVs.
2. **Improved Performance:** EVs equipped with a BMS can deliver consistent and reliable performance.
3. **Safety:** The BMS continuously monitors parameters such as temperature, voltage, and current, ensuring the battery operates within safe conditions at all times. It manages the battery's thermal conditions and can activate cooling and other safety mechanisms if necessary.
4. **Longevity:** A BMS effectively measures and controls the cell's voltage, enhancing the lifespan of the battery cells in EVs.
5. **Environmental Impact:** The use of Battery Management Systems significantly reduces the carbon footprint of electric vehicles, making them a more environmentally friendly transportation option.

IX. APPLICATIONS

Electric Vehicles, often seen in action transporting passengers or luggage at major airports, or moving people and supplies at hospitals and railways, have been utilized by numerous individuals.

Battery Management Systems (BMS) find applications in a variety of fields:

1. **Electric Vehicles:** In electric vehicles, a BMS is a key component that ensures optimal performance, safety, and longevity of the battery.
2. **Renewable Energy Systems:** BMS plays a significant role in managing and optimizing the performance of



batteries used in renewable energy storage solutions.

3. **Portable Devices:** Devices like smartphones, laptops, and other portable electronics utilize BMS to effectively manage their power sources.
4. **Aerospace Applications:** High-voltage battery packs used in aerospace applications often employ BMS for enhanced scalability and fault tolerance.
5. **Energy Storage Systems:** Large energy storage systems use BMS to monitor and manage the performance of their high-voltage battery packs.

A BMS is indispensable in any application that employs batteries, as it guarantees the safe, efficient, and reliable operation of the battery packs.

X. CONCLUSION

The project incorporates the features of all the hardware components used. Each module has been carefully considered and strategically placed, contributing to the optimal functioning of the unit. With the aid of highly advanced Integrated Circuits (ICs) and the benefits of evolving technology, the project has been successfully executed. As a result, the project has been meticulously designed, implemented, and tested, demonstrating its successful completion.

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