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Implementation of Real-Time Battery Monitoring System in Electric Vehicle

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Abstract— Modern electronics, electric cars, and renewable energy sources all depend on batteries operating safely and efficiently. In order to monitor and control vital battery properties like voltage, current, temperature, and capacity, this project focusses on creating a Battery Management System (BMS) with an Arduino microcontroller. Battery Management System (BMS) is a key term.

Overview

One important development to guarantee the safe, effective, and dependable operation of EV batteries is the installation of a real-time battery monitoring system in EVs. Since batteries are an electric vehicle's principal energy source, preserving their condition and functionality is crucial to maximising the vehicle's longevity, safety, and range. To give precise and current information about the battery's condition, a real-time battery monitoring system continuously measures important parameters like voltage, current, temperature, state of charge (SOC), and state of health (SOH). The most popular electrical energy storage component used in EVs is the battery.

Anh, N.H. Truc, P.T.: A battery's performance depends on the chemical reactions occurring within it when it is linked to a source or a load. As the battery's energy storage capacity gradually decreases, the chemicals deteriorate with time and use. Even under different load conditions, the battery must be properly conditioned to control its charging and discharging profile in order to slow down the depreciation process.

According to B. P. Roberts and C. Sandberg, the most popular electrical energy storage component in EVs is the battery. The chemical reactions that take place inside a battery determine how well it performs when linked to a source or a load. As the battery's energy storage capacity gradually decreases, the chemicals deteriorate with time and use.

G. Y. Y. Ding-xuan: Even under different load conditions, the battery must be properly conditioned to control its charging and discharging profile in order to slow down the depreciation process. Generally speaking, operating a battery under a variety of temperature settings and many cycles of deep drain and charging, especially at high pulse current, can shorten its lifespan.

N. Watrin, B. Blunier, and A. Miraoui: Batteries are safe when utilised with a power conditioning system that has safety features and automated shutdown, even though there have been cases of explosions or failures. Traditional low-cost battery chargers lack versatility and complete protection since they only use a few protective features designed for that particular battery.

M. Farrokhi and M. Charkhgard: BMS has been the focus of current development and research in EV and alternative energy systems because it is adaptable to safeguard batteries of various types and can offer all the safety features. SOC is one of the crucial factors needed to guarantee safe charging and discharging.

SOC is the battery's current capacity stated in relation to its rated capacity. SOC gives the battery's present condition and permits safe charging and discharging of batteries at a level that prolongs their lifespan. SOC aids with battery management as a result.

Objectives

1. Display real-time battery data on an LCD for user convenience.
2. Provide overvoltage, undervoltage, overcurrent, and thermal protection to prevent damage.
3. Implement a cooling mechanism to manage overheating conditions.
4. Integrate a balancing circuit to equalize charge levels across battery cells, ensuring optimal performance.
5. Develop a modular and cost-effective prototype that can be adapted for various battery-powered Applications.
6. Monitor key battery parameters, including voltage, current, temperature, and SOC.

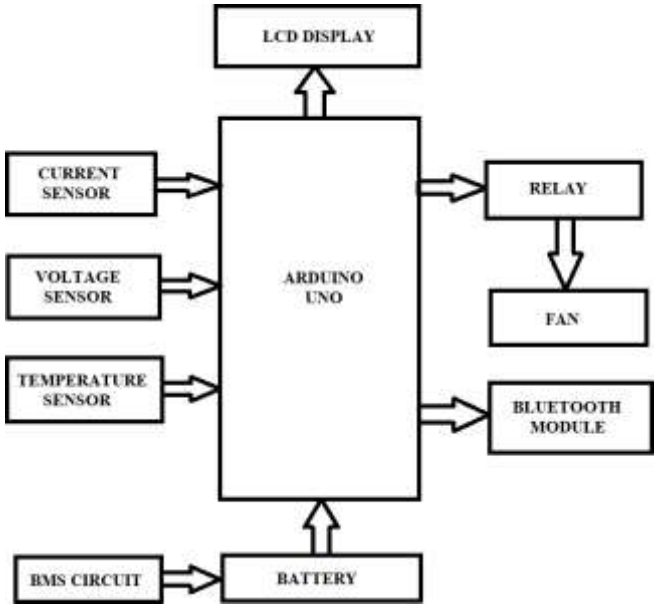
Methodology

Initialising the Arduino UNO and all linked parts, such as the relay, fan, LCD display, Bluetooth module, current, voltage, and temperature sensors, is the first step in the process for the improved battery management system. Through the sensors, the system regularly checks battery parameters. The temperature sensor tracks the battery's temperature, the voltage sensor keeps an eye on the battery's voltage, and the current sensor measures the current flow.

For user monitoring, the Arduino interprets these inputs and shows the data in real time on the LCD panel. Furthermore, wireless communication is made possible via the Bluetooth module, which enables the Arduino to

provide battery data, including temperature, voltage, and current, to a computer or associated mobile device for remote monitoring and notifications.
Users can assess historical trends and patterns by using the battery monitoring system's ability to log data over time.

Block Diagram



An electric vehicle's real-time battery monitoring system is implemented using a simple block diagram approach.

Working

This system uses an Arduino Uno microcontroller to monitor and manage the functioning of a battery-powered circuit. Three essential sensors are included: temperature, voltage, and current sensors. The temperature sensor makes sure the battery runs within a safe temperature range, the voltage sensor tracks the battery's voltage levels, and the current sensor keeps an eye on the current flowing through the battery.

The Arduino Uno serves as the primary control unit and receives real-time data from these sensors. The complete arrangement is powered by the battery, which is controlled by a Battery Management System (BMS) circuit. The BMS protects the battery from overcharging, overdischarging, and other possible risks.

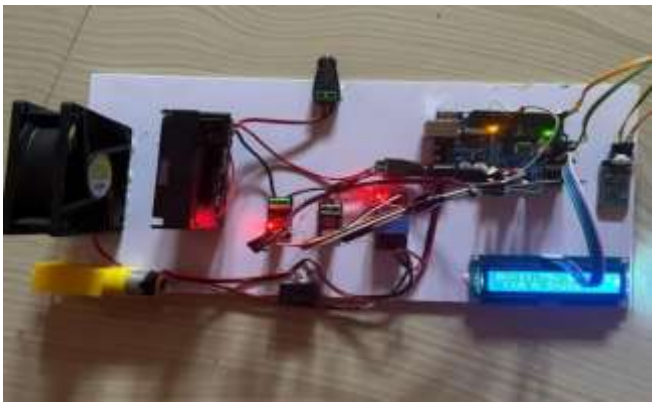
The Arduino processes the sensor data before displaying it on an LCD screen for user observation. When high temperature readings are obtained, the Arduino triggers a relay-controlled cooling fan in the system to prevent overheating.

Additionally, the system has a Bluetooth module that allows the Arduino and external devices, like computers or cellphones, to communicate wirelessly. Users can remotely check battery characteristics and receive system alerts by connecting to the device via Bluetooth and using a compatible software program or custom-designed software. By making system data easily accessible without requiring direct hardware interaction, this wireless capability improves the user experience.

All things considered, the system guarantees safe and effective battery operation by offering remote accessibility, cooling, and real-time monitoring via Bluetooth and the right software.

Results & Discussion

Hardware Implementation:



The solution shown in the pictures shows how to use an Arduino-based setup to monitor an electric vehicle's battery in real time. Important parts like an Arduino Uno, temperature, voltage, and current sensors, an LCD display, an HC-05 Bluetooth module, a relay, and a cooling fan are all integrated into the system. In order to measure battery metrics such as temperature, voltage, current, and state of charge (SOC), the hardware is connected. Clear and straightforward monitoring is made possible by the LCD screen's real-time display of data, which includes temperature measurements, battery voltage, SOC %, and current consumption.

Outcome
By enabling wireless connectivity, the Bluetooth module enables the system to send real-time data to a linked

through the Serial Bluetooth Terminal app on a mobile device. The user can remotely check battery performance thanks to this capability. In order to keep the battery working safely, the cooling fan is controlled by the relay and is turned on when the temperature rises above a certain point.

The outcome of this implementation is a functional prototype capable of monitoring critical battery parameters in real-time, ensuring optimal performance and safety. The system demonstrates its ability to provide accurate data, prevent battery overheating, and maintain reliability through wireless connectivity, making it suitable for applications in electric vehicles.

CONCULSION

The design and execution of an economical, effective Battery features like thermal management, cell balancing, and real-time monitoring.

The system is accessible and scalable for a range of applications thanks to the use of an Arduino microcontroller and reasonably priced components. Future developments like wireless connection and sophisticated prediction algorithms can further increase the prototype's utility and adaptability even though it offers a strong basis. With the aid of cutting-edge technologies like IoT, AI, and machine learning, the future of electric vehicles appears bright, with potential applications in a variety of fields, including transportation, energy storage, and grid management, ultimately leading to a more sustainable and environmentally friendly transportation system. The integration of real-time battery monitoring systems in electric vehicles is a crucial aspect of ensuring optimal performance, safety, and efficiency.

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Management System (BMS) for dependable and safe battery operation are effectively demonstrated by this

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