Electric Vehicle Charging and Temperature Monitoring System

Aruna Bharathi M[1], Tharun Kumar Neela[2], Beeram T Sri Raghuram[3], Tanvi P Bhonsle[4]
[1,2,3,4]*Electrical and Electronics Engineering, Geethanjali College of Engineering and Technology, Hyderabad, India*

***Abstract*— In the realm of electric mobility, our paper unveils an innovative Electric Vehicle Battery Management System. Harnessing the power of Arduino Nano and precision sensors, our system pioneers comprehensive charge and temperature monitoring. Real-time data acquisition enables precise control, optimizing battery performance and longevity. Coupled with an intuitive LCD display, drivers gain immediate insights, ensuring a seamless and efficient driving experience. Embark with us on this electrifying journey towards sustainable and intelligent electric vehicle technology. Efficient battery management systems (BMS) are crucial for maximizing output and safety in electric vehicles (EVs), monitoring parameters, determining state of charge (SOC), and providing essential services. Ongoing research focuses on developing increasingly competent BMS to enhance EV performance and reliability. Electric Vehicle (EV) adoption is rising, with batteries as crucial components. Battery Management Systems (BMS) are vital for accurate State of Charge (SOC) estimation; however, existing methods face limitations like accumulative errors and neglecting factors like temperature. This paper proposes a method considering temperature's impact on SOC through a temperature coefficient, enhancing accuracy by incorporating these factors into a state space battery model.**

Keywords—Battery Management System (BMS), Voltage Management, Temperature, Electric Vehicle (EV).

I. INTRODUCTION

In recent years, the demand for electric vehicles has surged due to environmental concerns, government incentives, and battery technology advancements. This trend underscores the critical need for sophisticated Battery Management Systems (BMS) that monitor, control, and safeguard battery processes. Our report focuses on designing and evaluating an innovative Electric Vehicle BMS integrating charge monitoring and advanced fire protection mechanisms. Utilizing Arduino Nano and precise sensors, our system aims to set a new standard in EV battery management. Objectives include charge monitoring, sensor integration, fire protection, and Arduino Nano integration. Components such as 3S Lithium-Ion batteries, 16x4 LCD display, and precision sensors contribute to system functionality. Methodology covers component selection, Arduino Nano programming, and safety algorithm calibration. Expected outcomes include enhanced charge monitoring, proactive fire protection, accurate sensor integration, and seamless Arduino Nano control.

II. DESIGN AND COMPONENTS

A. Block Diagram

The suggested system incorporates an Arduino Nano microcontroller, DHT11 sensor, battery packs, a 16x2 LCD display, Voltage sensor, and Current sensor.

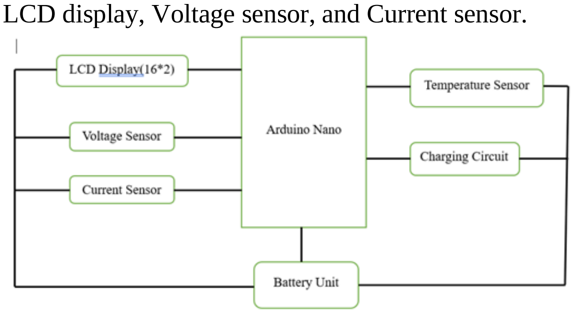

Fig. 1 Block Diagram of the system.

- Arduino Nano serves as the orchestrator, harmonizing the intricate dance of electric vehicle battery management. Like a maestro conducting a symphony, Arduino Nano conducts the flow of data, orchestrating the charge monitoring and fire protection mechanisms with precision. It acts as the brain, interpreting sensor data, making real-time decisions, and ensuring the seamless integration of all system components. In essence, Arduino Nano is the virtuoso, orchestrating the symphony of safety and efficiency in electric vehicle battery management.

- The LCD Display 16*2 serves as the window into the soul of the electric vehicle battery, offering real-time insights with clarity and precision. Like a trusted compass, it guides drivers through the labyrinth of battery health, displaying vital information on charge status and temperature with intuitive elegance. In the cockpit of electric mobility, the LCD Display 16*2 is the navigator, illuminating the path towards safe and efficient travels.
- The voltage sensor acts as the vigilant guardian, monitoring the heartbeat of the electric vehicle battery. When voltage surpasses 14V, it swiftly triggers a power cutoff, preventing overcharging and ensuring battery safety. Conversely, when voltage dips below 8V, it initiates an automatic power-on sequence, heralding a revitalizing charge for the battery's journey ahead.
- The DHT11 temperature sensor stands sentinel, guarding against the fiery embrace of overheating in the electric vehicle's domain. With a discerning eye, it monitors the ambient temperature, ready to sound the alarm and trigger a power cutoff if the mercury dares to breach the 35-degree Celsius threshold. In the delicate balance of temperature control, the DHT11 sensor is the silent sentinel, ensuring the safety and stability of the electric vehicle's heart.
- The current sensor serves as the silent sentinel, meticulously monitoring the flow of electric current coursing through the veins of the electric vehicle's power system. It stands ready to detect any deviations from the norm, acting as a guardian against overcurrent conditions that could jeopardize the system's integrity. In the realm of electric mobility, the current sensor is the vigilant protector, ensuring smooth and safe operation with its watchful eye.
- The lithium-ion battery array serves as the pulsing heart of the electric vehicle, providing the vital energy needed for its electrifying journey. Like a symphony of power cells, each 4V unit harmonizes seamlessly to form a robust 12V powerhouse, fueling the vehicle's every movement with efficiency and reliability. In the electric vehicle's quest for sustainable mobility, the lithium-ion battery array stands as the steadfast conductor, orchestrating power with precision and grace

III. OPERATING PROCEDURE

A. Hardware Setup

In the hardware setup, the Electric Vehicle Battery Management System comes to life through a meticulously crafted symphony of components. At its heart lies the Arduino Nano Microcontroller, a master conductor orchestrating the flow of data from sensors to processing units. The Voltage Sensor acts as the vigilant guardian, measuring the electric potential of the EV battery, while the Current Sensor diligently monitors the flow of electric charge within its confines. Meanwhile, the Temperature Sensor keeps a watchful eye on thermal conditions, ensuring the battery's temperature remains within safe limits. Together, these sensors form a network of vigilant sentinels, constantly feeding data to the Arduino Nano. Accompanying them is the Liquid Crystal Display (LCD), a user-friendly interface that transforms raw data into digestible alerts and battery parameter information, providing users with real-time insights into their electric vehicle's health.

B. Sofware Setup

In the realm of software setup, the code serves as the invisible hand guiding the Electric Vehicle Battery Management System's operations. Written and verified in the Arduino IDE Software, it embodies the intelligence and logic that govern the system's behavior. Once meticulously crafted, the code is uploaded into the proposed system, breathing life into its electronic veins. With each line of code, the system is programmed to continuously monitor voltage, temperature, and current values, ready to trigger alerts and take corrective actions at a moment's notice. As the code executes its commands, the Electric Vehicle Battery Management System stands poised to safeguard the battery's well-being, ensuring a smooth and efficient journey for the electric vehicle and its passengers.

C. Working

The Arduino Nano efficiently gathers data from the sensors at regular intervals, employing an algorithm to analyze incoming information. Through real-time analysis, it swiftly compares data against predefined thresholds (8V < voltage < 14V and temperature > 35°C) to distinguish between normal and critical conditions. Upon detecting low voltage, overvoltage, overcurrent, or overheating, the system promptly triggers alerts and cuts off input or output. These alerts, displayed on the user-friendly Liquid Crystal Display (LCD), provide immediate insights into the battery's status. Empowered by this system, electric vehicle (EV) owners engage with LCD alerts, taking timely actions such as halting charging or adjusting driving patterns to proactively mitigate potential risks. This proactive approach ensures the safety and longevity of the electric vehicle battery, guaranteeing a reliable and secure driving experience.

IV. RESULTS AND DISCUSSIONS

The Electric Vehicle Battery Monitoring System with Charge Monitor and Fire Protection using Arduino Nano successfully demonstrates a practical and cost-effective approach to real-time monitoring of crucial battery parameters in electric vehicles. By employing Arduino Nano as the central processing unit and integrating dedicated sensors for voltage, current, and temperature, the system ensures continuous monitoring. The algorithmic analysis enables prompt detection of critical conditions, triggering alerts displayed on a user-friendly LCD interface. This user accessibility, coupled with the system's versatility and cost-effectiveness, positions it as an effective solution for enhancing the safety and longevity of electric vehicle batteries. Overall, the project's success lies in its ability to provide actionable insights to EV owners, allowing them to proactively address potential issues and prioritize the safety of their vehicles.

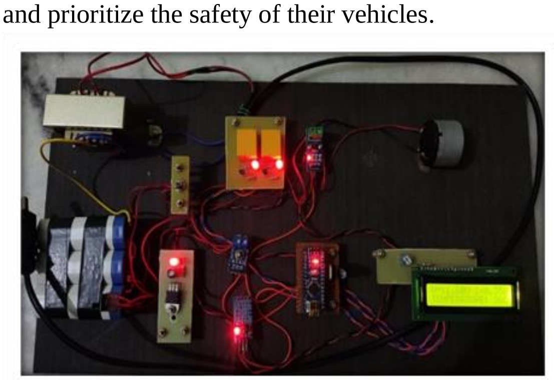

Fig. 2 Working of System

In the figure 2 above, we observe the working model of the proposed Electric Vehicle Battery Management System with Charge Monitor and Fire Protection.

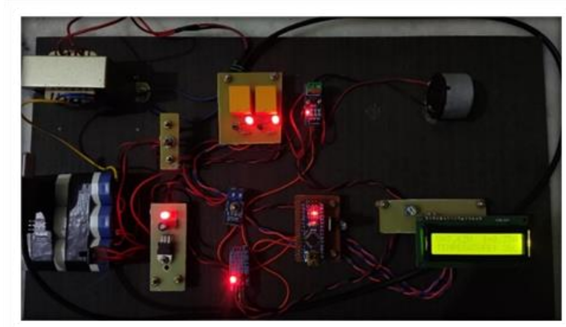

Fig. 3 Charging Mode

In the figure 3, we can see that the charging relay is in the on position, as indicated by the LED, and the voltage reading is 7.62V.

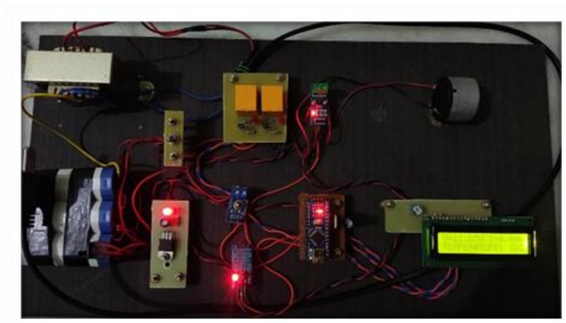

Fig. 4 Discharging Mode

In the figure, we observe that it is in discharging mode, as indicated by the activated discharging relay (highlighted by the LED). With the DC motor in motion, we can confirm its discharging state.

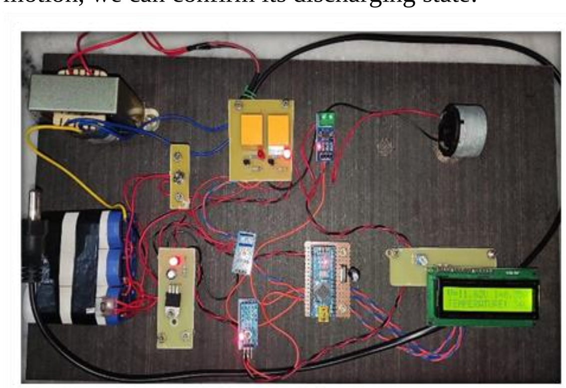

Fig. 5 High Temperature

In the above figure, as we can see from the LCD, the temperature is above 35 degrees Celsius, specifically 38 degrees Celsius. Therefore, there is no output power, and the relay is in the off position.

V. CONCLUSION

In conclusion, The development and implementation of the Electric Vehicle Battery Management System presented in this report mark a significant stride towards enhancing the safety, efficiency, and user experience within the realm of electric mobility. By integrating a range of cutting-edge technologies, including the Arduino Nano microcontroller, a 3S lithium-ion battery configuration, a LCD display, and precision voltage, current, and temperature sensors, the system has been engineered to address critical challenges associated with electric vehicle batteries.

The Electric Vehicle Battery Alert System with Arduino Uno represents a sophisticated yet accessible solution for electric vehicle (EV) owners to monitor and safeguard their battery systems. At its core, the project utilizes the widely used Arduino Uno microcontroller as the central processing unit, demonstrating its versatility and ease of integration across various EV models.

The Electric Vehicle Battery Management System presented herein represents a substantial step forward in the quest for safer, more efficient, and environmentally conscious electric mobility solutions. The integration of charge monitoring, fire protection, and a user-friendly interface showcases the potential of cutting-edge technologies in shaping the future of electric vehicles. As the automotive landscape continues to evolve, the lessons learned and innovations realized in this project contribute to the ongoing dialogue on sustainable transportation and the advancement of electric mobility. The Electric Vehicle Battery Management System stands as a testament to the possibilities that emerge when technology converges with a commitment to safety, efficiency, and environmental stewardship.

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