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# EV BMS WITH CHARGER MONITORING AND FIRE PROTECTION SYSTEM

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***Abstract***—Electric vehicles are becoming more important because they help protect the environment by using clean energy. These vehicles use lithium-ion batteries, which are powerful but can be unsafe if not handled properly. To keep them safe, a Battery Management System (BMS) is used. The BMS monitors the battery and ensures it operates within safe limits. This project explains the purpose, functions, and design of a BMS. It also discusses different battery models and how they have improved over time. A better battery model is introduced and tested through simulation. The results show that the improved system performs effectively. In this paper, an Arduino UNO microcontroller is used to control the BMS. It is connected to components like a temperature sensor, battery pack, relays, charger, LCD display, and a DC motor. The system shows voltage, current, and temperature on the LCD while the vehicle is running. If the temperature becomes too high, a buzzer gives an alert. The battery charges automatically when its level is low, using fast or slow charging modes. Relays act as switches to control the charging process. The system is programmed using embedded C. This design helps improve battery safety and performance in electric vehicles.

This system improves the safety and efficiency of electric vehicle batteries. It continuously monitors important parameters to prevent damage and extend battery life. The use of automatic charging modes makes the system more reliable and user-friendly. The hardware design is simple and cost-effective, making it suitable for practical applications. Future improvements can further enhance accuracy and performance of the BMS.

***Keywords***— Battery Management System, Temperature Sensor, Voltage Sensor, ATMega328p Microcontroller

## I.INTRODUCTION

The growing demand for sustainable energy solutions has increased the importance of electric vehicles in modern transportation. These vehicles rely heavily on lithium-ion batteries due to their high efficiency and energy storage capacity. However, improper usage of these batteries can lead to safety risks such as overheating or damage. To overcome these challenges, a Battery Management System (BMS) plays a crucial role. It ensures that the battery operates within safe limits and maintains overall performance. A well-designed BMS not only improves battery life but also enhances reliability. Therefore, integrating an efficient monitoring system is essential in electric vehicle applications.

This project focuses on designing and analyzing a smart BMS using a PIC microcontroller. The system continuously observes key battery parameters such as voltage, current, and temperature. It includes



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components like a temperature sensor, relays, charger, LCD display, and a DC motor to simulate vehicle operation. The LCD provides real-time information about the battery status during operation. If any abnormal condition such as high temperature is detected, the system activates a buzzer for warning. The relays are used to control charging by switching between fast and slow modes. This helps in maintaining battery health and preventing overcharging or deep discharge conditions.

The control system is programmed using embedded C to ensure accurate and efficient operation. The automatic charging mechanism improves convenience and reduces manual intervention. By using two different charging modes, the system adapts based on battery condition for better performance. The hardware setup is simple, cost-effective, and suitable for practical implementation. Experimental results show that the system responds quickly to changing conditions. This design can be further enhanced by improving sensing accuracy and adding advanced features. Overall, the proposed system contributes to safer and more efficient battery usage in Electric vehicles.

## II.LITERATURE SURVEY

1.R. Johnson and M. Brown presented a study on battery management systems in electric vehicles, highlighting recent advancements and key challenges. Their work focused on improving battery efficiency, safety, and lifecycle. They discussed issues such as thermal management, charging control, and system reliability. The study emphasized the need for advanced monitoring techniques. However, it provided limited practical implementation details.

2.Y. Zhao, H. Sun, and L. Wu introduced an intelligent battery management approach using a digital twin framework. Their system created a virtual model of the battery to monitor and predict its performance in real time. This method improved accuracy in battery state estimation and fault detection. It enhanced system reliability and efficiency. However, the approach required complex modelling and high computational resources.

3.J. Zhang, X. Liu, and K. Zhao developed an intelligent BMS with end-edge-cloud connectivity Their system enabled real-time data processing and remote monitoring through cloud integration. It improved communication between different system levels. The design enhanced scalability and smart decision-making. However, it depended heavily on network connectivity and data security.

4.S. Patel and R. Mehta provided a comprehensive review of BMS technologies and future trends. Their study covered various battery models, control strategies, and safety mechanisms. They highlighted the importance of advanced algorithms in modern BMS. The review offered valuable insights into future developments. However, it mainly focused on theoretical analysis rather than implementation.

5.T. Nguyen, D. Tran, and P. Hoang discussed state-of-the-art BMS technologies for electric vehicles. Their work explored modern techniques for battery monitoring and control. They emphasized improvements in performance and energy efficiency. The study also addressed safety concerns battery systems. However, it lacked detailed experimental validation.

## III.PROPOSED WORK

The proposed work focuses on developing an efficient Battery Management System (BMS) for electric vehicles using an Arduino UNO microcontroller. The system is designed to continuously monitor and protect the battery during operation and charging. Sensors are used to measure important parameters such as battery voltage, current, and temperature. Based on these values, the system estimates the State of Charge (SOC) to indicate the remaining battery capacity. It also evaluates the State of Health (SOH) to understand battery condition and aging. This



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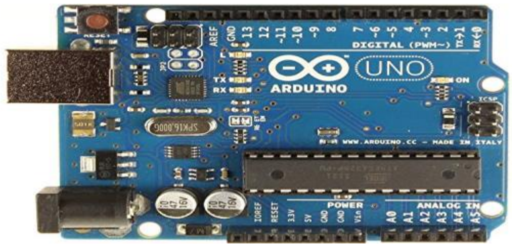
ensures reliable performance and improves the overall lifespan of the battery.

In addition, the system integrates temperature sensors to detect overheating and prevent potential hazards like fire. A relay-based charging mechanism is implemented to automatically switch between fast and slow charging modes. The system activates a buzzer to alert users in case of abnormal conditions such as high temperature or voltage issues. Real-time battery information including voltage, current, SOC, SOH, and temperature is displayed on an LCD screen. The system also ensures automatic cutoff of charging when the battery reaches its safe limit. This helps in preventing overcharging and improves the overall safety and efficiency of the battery system.

## IV.HARDWARE COMPONENTS

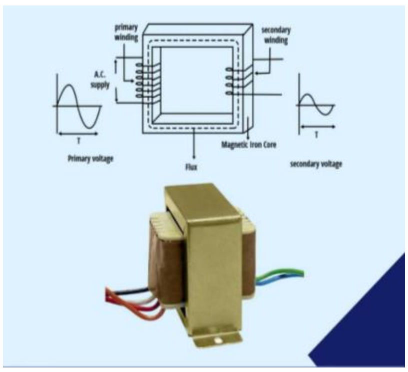
### 4.1 AURDINO UNO




The Arduino Uno is a microcontroller board which has ATmega328 from the AVR family. There are 14 digital input/output pins, 6 Analog pins and 16MHz ceramic resonator.

USB connection, power jack and also a reset button is used. Its software is supported by a number of libraries, which makes the programming easier.

### 4.2 TRANSFORMER



A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors without changing its frequency. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction.

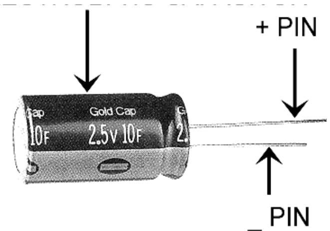
### 4.3 RECTIFIER

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid-state diodes, vacuum tube diodes, mercury arc valves, and other components.

### 4.4 FILTER

The process of converting a pulsating direct current to a pure direct current using filters is called as filtration.

### 4.5 EELECTROLYTIC CAPACITOR




The Capacitor or sometimes referred to as a Condenser is a passive device, and one which stores energy in the form of an electrostatic field which produces a potential (static voltage) across its plates.

### 4.6 VOLTAGE REGULATOR



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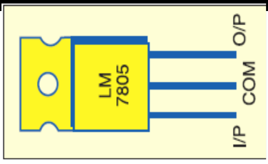


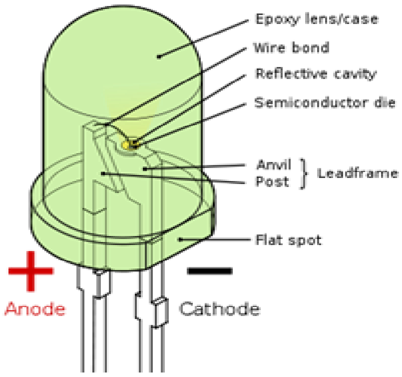

A voltage regulator (also called a 'regulator') with only three terminals appears to be a simple device, but it is in fact a very complex integrated circuit. It converts a varying input voltage into a constant 'regulated' output voltage.

4.7 RESISTOR

A resistor is a two-terminal electronic component that produces a voltage across its terminals that is proportional to the electric current passing through it in accordance with Ohm's law:

$V = IR$

4.8 LED (LIGHT EMITTING DIODE)




A light-emitting diode (LED) is a semiconductor light source. LED's are used as indicator lamps in many devices, and are increasingly used for lighting.

Early LED's emitted low-intensity red light, but modern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness

4.9 TEMPERATURE SENSORS

The Temperature Sensor LM35 sensor series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.


4.10 BUZZER

Basically, the sound source of a piezoelectric sound component is a piezoelectric diaphragm. A piezoelectric diaphragm consists of a piezoelectric ceramic plate which has electrodes on both sides and a metal plate (brass or stainless steel, etc.).

4.11 RECHARGEBLE BATTERY

This is an original 1200mAh 18650 battery. 18650 battery is a Li-ion rechargeable battery with a 1200mAh Battery Capacity. This is not a standard AA or AAA battery but is very useful for applications that require continuous



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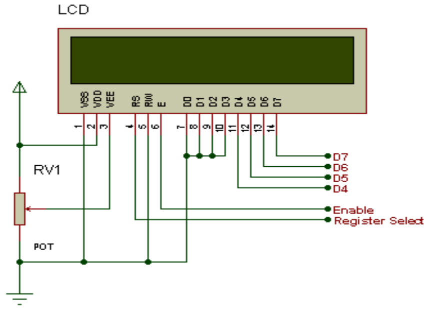
high current or high current in short bursts like in cameras, DVD players, iPod, etc.

4.12 LCD DISPLAY

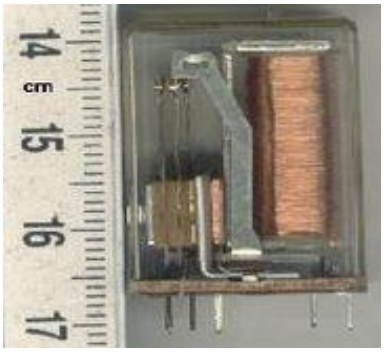
One of the most common devices attached to a micro controller is an LCD display. Some of the most common LCD's connected to the many microcontrollers are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.




4.13 RELAY

A relay is an electrically operated on/off switch. Many relays are used an electromagnet to operate a switched mechanism, but also different operated principles are also used. Relays find all the applications where it is wanted to control a circuit by low-power signals, or where several circuits can also be controlled by only one signal.

Simple electromechanical relay




V.WORKING

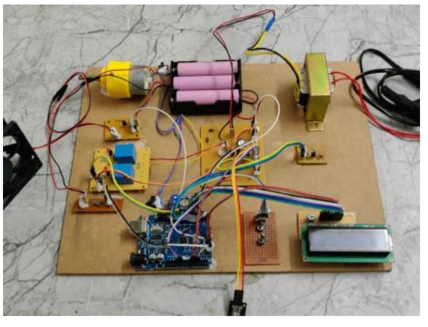
The system is controlled by an Arduino Uno microcontroller that integrates a temperature sensor, battery pack with relays, charger, LCD module, and a DC motor acting as the vehicle. During operation, the microcontroller continuously monitors and displays voltage, current, and temperature values on the LCD. If the temperature exceeds a preset limit, a buzzer is activated to alert the user. This ensures safe and efficient monitoring of battery and system conditions in real time.

When the battery pack is drained, it is recharged through relays that function as switches to control the charging process. Two relays are used to enable fast and slow charging modes based on battery voltage levels. The system is programmed using Embedded C to manage all operations automatically. Additionally, the project explores Battery Management System (BMS) concepts, including models, hardware design, simulations, and experimental validation, along with future improvements.

VI.RESULTS

The Electric Vehicle Battery Management System (EV BMS) is a critical subsystem responsible for ensuring the safe, efficient, and reliable operation of lithium-ion batteries used in EVs.

In modern electric vehicles, the battery acts as the primary energy source. However, improper charging, overheating, or internal faults can lead to thermal runaway and fire hazards. To overcome these risks, a BMS is designed to continuously monitor important



VII.CONCLUSIONS



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This paper "EV BMS with Charger Monitoring and Fire Protection" successfully implements an efficient battery management system using an Arduino Uno to monitor and control key parameters such as voltage, current, and temperature. The integration of dual-mode charging through relays enhances battery performance and lifespan while ensuring safe operation. Real-time monitoring with an LCD display and buzzer alerts improves system reliability by preventing overheating and potential hazards. The use of Embedded C programming enables automated and accurate system control, making the design both practical and effective. Overall, the project demonstrates a reliable, low-cost solution with strong potential for future advancements in electric vehicle technology.

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