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EVBMS with Surveillance and Safety Control Using IOT

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Abstract—This paper introduces a monitoring system that is intended to monitor the key parameters of an electric vehicle (EV) battery, which are voltage, current, temperature, and level of battery charge. The system employs sensors to continuously observe the battery's performance and will automatically initiate safety measures when specific thresholds are violated, such as turning on a cooling fan when temperatures are excessive or charging when the battery voltage is too low. In addition, the system provides for safe motor operation depending on monitored conditions. Data is transmitted to a cloud platform for distant monitoring and locally displayed for real-time observation. The model envisioned herein aims to improve battery health management, protection, and safety from damage by overheating, overcurrent, or low battery in EVs.

Index Terms—Battery Management System (BMS), Electric Vehicles (EVs), Relays, Overcharging, Temperature Monitoring, IoT-based monitoring, Fire Safety, Battery Protection, DC Motor, Voltage Sensor, Current Sensor, Temperature Sensor, Arduino UNO.

I. INTRODUCTION

Improved battery management, as more electric vehicles (EVs) and clean energy grids are manufactured, has made improved battery life imperative so that the reliability and lifespan of the batteries are maintained. Batteries are the central component in the systems and the manner in which they function makes the efficiency, safety, and equipment-working lifespan of the device being employed. Despite this, battery state monitoring and management as a whole are difficult to achieve because of problems such as temperature variation, voltage drop, and overcurrent, which can lead to system collapse or devastation [1].

The project aims to overcome the drawbacks by suggesting a Battery and Fire Monitoring System integrated as one. The system monitors the critical battery parameters, i.e., voltage, current, temperature, and charge level, round the clock and takes appropriate actions automatically, e.g., running a cooling fan or charging the battery, in the event of perilous conditions detected [2]. With the IoT technology, relays, and sensors, not only is the safe operation of electric vehicles and other battery systems guaranteed, but the platform for real-time monitoring of data is also established. Remote cloud analysis can then be conducted to monitor [3].

By offering a cost-effective, automated, and scalable solution, this project achieves optimal safety and management of battery systems and is the ideal solution for renewable energy systems, EVs, and other battery-based technologies [6].

II. LITERATURE SURVEY

Battery Management System for Electric Vehicles: This review discusses various techniques for monitoring battery performance in electric vehicles (EVs), focusing on voltage, current, and temperature management. It highlights traditional and IoT-based solutions for real-time monitoring and the challenges in battery health management, such as overcharging and overheating. The paper emphasizes the need for integrated systems to ensure safe and efficient battery operation. IoT-Based Battery Health Monitoring System for Electric Vehicles.An IoT-based system is presented in this study for real-time monitoring of EV battery parameters like voltage, current, and temperature. The system uses cloud-based platforms for data analysis and predictive maintenance, aiming to optimize battery performance and prevent failures. It also discusses challenges related to data accuracy, connectivity, and security. Design of a Battery Management System Using Embedded Systems for Electric Vehicles. This paper details a battery management system (BMS) for electric vehicles using embedded systems to monitor battery voltage, current, and temperature. The system protects the battery from overcharging, overheating, and deep discharging by controlling relays and charging circuits, enhancing battery lifespan and safety. It also discusses scalability for other applications like renewable energy storage. Smart Battery Management System for Electric Vehicles Based on IoT, this research presents an IoT-based smart battery management system for EVs, using sensors to monitor battery health and send data to a cloud platform for remote analysis. Automated control triggers actions like cooling or charging when thresholds are exceeded, improving battery safety and performance. The paper highlights the benefits of IoT integration for better battery management.

III. PROPOSED METHOD

The model proposed brings with it an integrated system to monitor electric vehicle (EV) batteries that will monitor voltage, current, temperature, and battery charge. It is equipped with self-contained safety functions that react to fault conditions, like turning on a cooling fan if the temperature level goes above a predetermined threshold, turning on a battery charging relay when

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voltage falls below a threshold level, and providing protection for safe operation of the motor from monitored current and voltage. It further comprises a feature of multiple charger for mobile devices, allowing them to be charged at the same time inside the EV, promoting greater convenience. It offers display of real-time data on an LCD and uplinks data on a cloud platform for remote data monitoring. By combining sensors, automated control, IoT-based data transmission, and the multiple charger feature, the system improves battery health management, avoids overheating and overcurrent conditions, enhances safety in EVs, and introduces user-focused features for better utility.

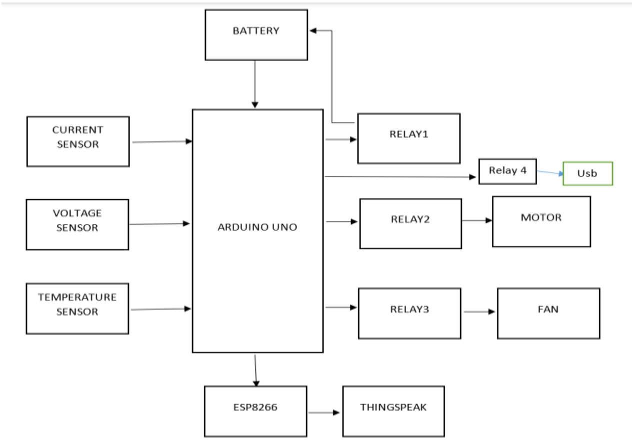

Fig 1 : Block Diagram

A. Arduino uno

The open-source electronics platform Arduino.cc, which is primarily based on the AVR microcontroller Atmega328, created the Arduino Uno microcontroller board. In 2003, Massimo Banzi and David Curtielles started the first Arduino project at the Interaction Design Institute in Ivrea with the objective of providing professionals and students with a flexible and reasonably priced means of controlling a range of real-world gadgets.

Fig 2: Arduino uno

The current version of the Arduino Uno has 14 digital I/O ports, 6 analog input pins, and a USB interface for connecting to external electronic circuits. Six of the 14 I/O ports' pins are available for PWM output. It gives the designers the ability to sense and manage external electronic devices in the real world.

B. NodeMCU

NodeMCU is an open-source development board and firmware designed for IoT uses. It relies on the ESP8266 Wi-Fi SoC and incorporates an ESP-12 module with ease of Wi-Fi connectivity. It has various GPIO pins that support PWM, I2C, SPI, and UART serial communication.

Firmware is written in Lua, an efficient and fast scripting language, whereas hardware components are basic components like MicroUSB port, USB to UART, status LED, and reset/flash buttons. The open-source aspect of NodeMCU gives developers the facility to customize and optimize the module as per project needs.

Pin Configuration:

NodeMCU has a number of GPIO pins, including power pins like VIN (7-12V regulated voltage) and VU (5V USB power). Note that the pin numbers in Arduino IDE are not the same as on the actual board.

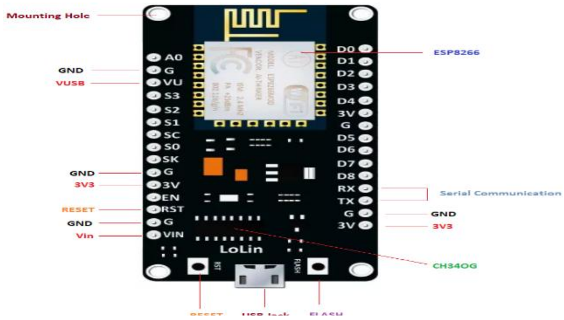

Fig 3: NodeMCU

C. Voltage Sensor

This sensor is used to track, compute, and determine the voltage supply. This sensor can determine the level of AC or DC voltage. The input of this sensor can be voltage, and the output can be switches, analog voltage signals, current signals, audible signals, etc. Some sensors can only generate sine or pulse waveforms, but others can produce outputs like AM (Amplitude Modulation), PWM (Pulse Width Modulation), or FM (Frequency Modulation).

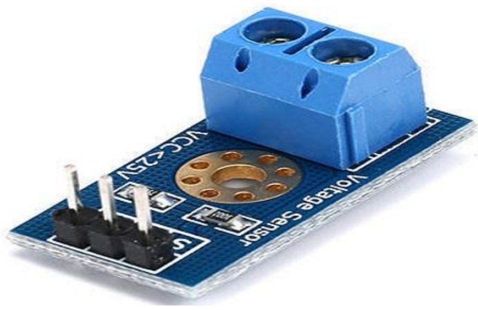

Fig 4: Voltage Sensor

D. Current Sensor

When current flows through a conductor, a voltage drop occurs. Ohm's law establishes the connection between voltage and current. In electronic gadgets, a rise in the quantity of Overloading the device with more current than it needs can cause damage. Devices need current to be measured in order to operate correctly. It is possible to perform voltage measurement passively without affecting the system. However, voltage alone cannot identify current because it is an invasive procedure.

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Electric current in a circuit is measured by a current sensor, which then transforms it into a proportional signal for control and monitoring. These sensors measure AC, DC, or bidirectional currents accurately and in real time using concepts like resistive sensing or the Hall effect. They detect overcurrent or short circuits and are widely used in energy systems, power management, and motor control. Current sensors, which are small and adaptable, are crucial for industrial equipment, renewable energy, electric cars, and Internet of Things applications.

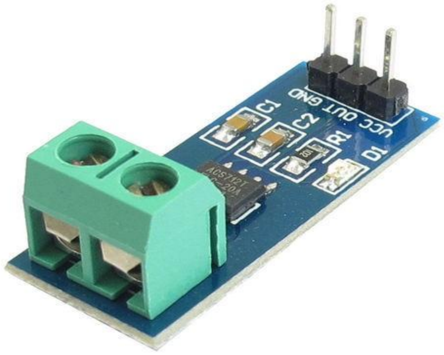

Fig 5: Current Sensor

E. Temperature Sensor DS18B20

Digital temperature sensors such as the DS18B20, with a single wire protocol, digital temperature sensors like the DS18B20 can measure temperatures between -67°F and +257°F (-55°C and +125°C) with an accuracy of +-5%. The 1-wire can receive data that is nine-bit to twelve-bit in size. Due to the single wire protocol that this sensor adheres to, it can be controlled using just one microcontroller pin. This advanced level protocol enables the assignment of a 64-bit serial code to each sensor, enabling the control of multiple sensors using a single microcontroller pin. A DS18B20 temperature sensor overview is covered in this article.

The DS18B20 is one type of temperature sensor that can provide temperature readings ranging from 9 to 12 bits. These numbers indicate the device's temperature. A one-wire bus protocol, which connects to an internal microprocessor via a single data line, can be used to communicate with this sensor. Furthermore, this sensor gets its power straight from the data line, doing away with the need for an external power source. Devices that use the DS18B20 temperature sensor include thermometers, consumer goods, industrial systems, thermally sensitive systems, and thermostats.

Fig 6: Temperature Sensor DS18B20

F. LCD

A common display technology found in notebooks, mini-computers, and other devices is LCD (Liquid Crystal Display). LCDs are lighter and use less power compared to CRTs. They have passive matrix (slow, lower quality) and active matrix (TFT) (fast, better definition) types.

A 16x2 LCD module shows 16 characters per line in two lines in a 5x7 pixel matrix. It is used in place of seven-segment LEDs because it is less expensive, easy to program, and can show custom characters. LCDs are used through Command and Data Registers, where the signals are controlled through RS, R/W, and Enable (E) pins.

LCDs employ DDRAM (for character location) and CGRAM (for user-definable characters). Commands take 39-43µS to execute, while screen clearing ranges from 1.53-1.64ms. Programmability and efficiency make LCDs a ubiquitous display option in electronics.

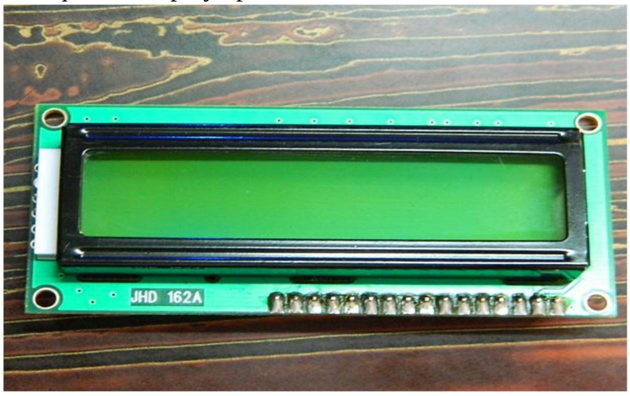

Fig 7: LCD

G. CPU Fan

CPU fan plays a significant role in attaining the optimal CPU temperature by removing heat produced during processing. It avoids thermal throttling and hardware failure, allowing the system to perform and last longer. It typically consists of motor-driven blades to create airflow, sucking in cold air and venting heat. Speed control mechanisms are common among the majority of fans, having varied RPM according to temperature to strike a balance between cooling and noise reduction.

New CPU fans utilize fluid dynamic bearings (FDB) for quietness and will probably be marketed alongside heatsinks, case fans, or liquid coolers in the theme of improved thermal management. Sophisticated versions utilize temperature sensors and control algorithms to determine optimal speed, improving efficiency, prolonging fan lifespan, and conserving power. The higher level of computing, the more critical efficient cooling is to maintaining the system stable and operational.

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Fig 7: CPU FAN

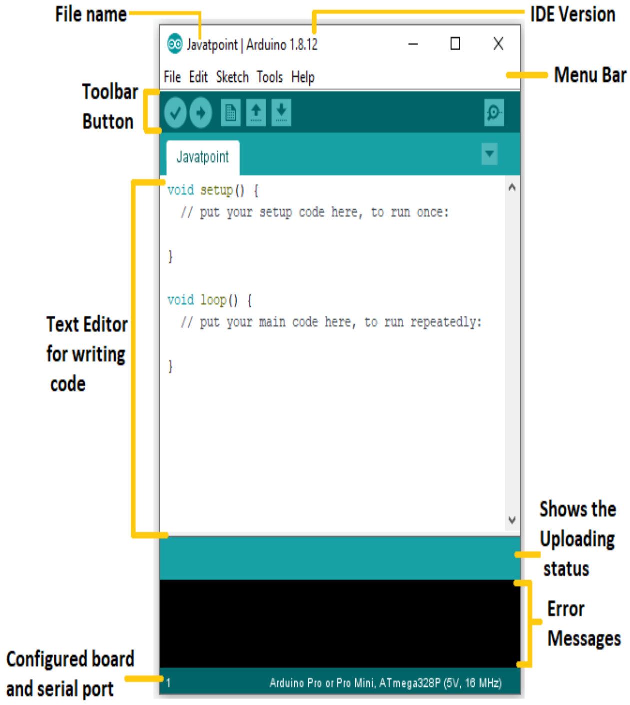
H. Motor

A DC motor is an electrical device that converts electrical energy into mechanical energy. DC motors receive direct current electricity and convert it into mechanical rotation. DC motors use the magnetic fields produced by the electrical currents to turn a rotor that is fixed to the output shaft. The torque and speed of the output are determined by the electrical input and the motor's design. Direct current electricity can be transformed into mechanical energy by any rotating electrical device, which is known as a "DC motor." DC motors can be as small as the motors found in toys and household appliances or as large as the mechanisms found in cars, elevators, hoists, and steel rolling mills.

Fig 8: Motor

I. SOFTWARE USED

An official program released by Arduino.cc, the Arduino IDE (Integrated Development Environment) is primarily used for writing, compiling, and uploading code to the Arduino device. This software, which is open source and easily accessible, can be used with almost any Arduino module to begin compiling code while on the go. Writing and compiling code for the Arduino Module is the primary function of the open source Arduino IDE software. Since it is official Arduino software, code compilation is so simple that even the average person without any technical background can begin learning.



IV.SIMULATION RESULTS

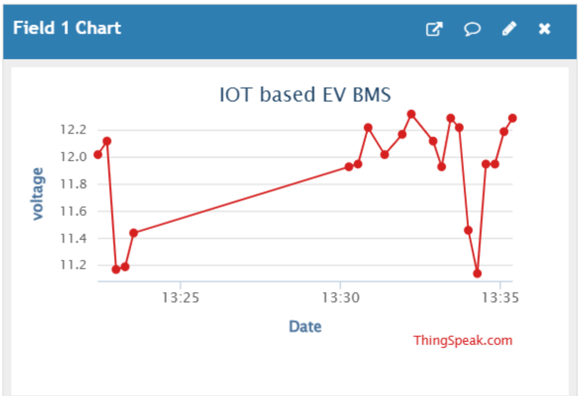


Fig 9: Output Voltage Diagram

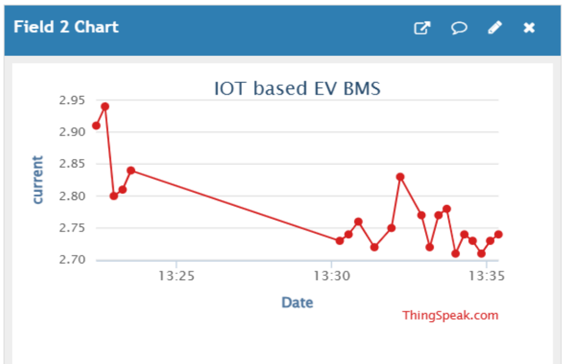


Fig 10: Output Current Diagram.

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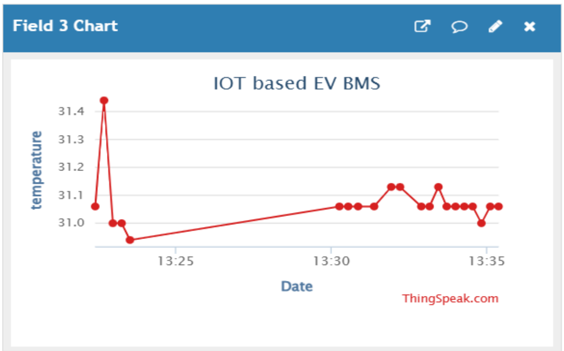

Fig 11: Output Temperature Diagram

The system was tested under various conditions:
Temperature Control: The cooling fan successfully activated when temperatures exceeded 32°C.
Overcharging Prevention: The charging relay switched off when voltage reached less than 7v preventing low voltage.
Real-Time Alerts & Monitoring: Battery data was successfully uploaded to Thing Speak, allowing remote users to track battery health.
Multiple Device Charging: The system enabled simultaneous USB charging, increasing user convenience.

IV. CONCLUSION

The installed Battery and Fire Monitoring System for electric vehicles (EVs) and battery-operated household appliances presents an easy way of ensuring battery health, safety, and performance. Through constant monitoring of important battery parameters including voltage, current, temperature, and charge level, the system provides preventive control and management of the battery state. The combination of sensors, IoT, and automated processes such as cooling and charging guarantees the avoidance of problems such as overcharging, overheating, and deep discharging.

In addition, cloud monitoring with Thing Speak enables remote monitoring and analysis, giving insight into battery health and enabling early detection of potential faults. The flexibility of this system also translates to use in renewable energy storage systems, UPS systems, and other battery-based equipment, and scalability across various industries. Overall, this method maximizes the efficiency, safety, and lifespan of battery systems, enabling mass adoption of electric vehicles and green energy technologies. Spirent36.

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