"IOT BATTERY MANAGEMENT SYSTEM (BMS) FOR EV AND BATTERY COOLING SYSTEM"

Prof.Geetanjali Argade, Pratiksha Akarte, Karan Bhosale, Aparna Jagtap

1. *Prof. Geetanjali Argade,Guide, ENTC Engg.,SCOE,Maharashtra,India.*
2. *Pratiksha Akarte, Student, ENTC Engg, SCOE, Maharashtra,India.*
3. *Karan Bhosale, Student, ENTC Engg, SCOE, Maharashtra,India.*
4. *Aparna Jagtap, Student, ENTC Engg, SCOE, Maharashtra,India.*

ABSTRACT

Electric vehicles are the way of the future. The rising EV market, along with the diminishing supply of petroleum fuels, demands the development of more efficient EVs. A battery management system (BMS) is an essential component of any electric vehicle. It consists of a number of electrical and electronic circuits (including converterand inverter circuits) that have been programmed to monitor an d extract the maximumoutput from a battery system. The chemical reactions are what determine the battery's performance. The performance of a battery degrades as chemicals decay. As a result, these features of a battery must be regularly monitored. Because of their high charge density and lightweight, Lithium-ion batteries have proven to be a popular choice amongelectric vehicle producers. Despite the fact that these batteries have a lot of power for their size, they are quite unstable. It is critical that these batteries are never overchargedor discharged, requiring the use of voltage and current regulators. In this research paper, we will monitor various aspects of the vehicles like current, Voltage, SOC and temperature with the help of Node MCU which is the WI-FI enabled microchip that willsend the data or crucial parameters to the server which is the Thing Speak therefore in this way we can monitor these parameters from anywhere and also monitor battery health.

KEYWORDS *BMS (Battery Management System), IOT (Internet of Things), Application Programming Interface, Voltage Measurement.*

INTRODUCTION

Electric vehicles (EVs) have gained significant momentum in recent years as a sustainable and eco-friendly transportation option. The increased adoption of EVs is driven by various factors, including rising fuel costs, environmental concerns, and advancements in battery technology. The heart of an electric vehicle lies in its battery system, which provides the necessary power for propulsion. Battery monitoring plays a crucial role in ensuring the safe and efficient operation of EVs. Monitoring the health, performance, and status of the battery system enables early detection of potential issues, prevents critical failures, and maximizes the lifespan of the battery. By continuously monitoring parameters such as voltage, current, temperature, and state of charge (SOC), engineers can make informed decisions regarding battery management and maintenance.

The complexity of EV battery systems, coupled with the need for real-time monitoring, necessitates the development of sophisticated battery monitoring systems. These systems utilize advanced sensor technologies, data acquisition systems, and intelligent algorithms to gather and analyze crucial battery performance data .Key parameters that require monitoring include battery voltage, which indicates the electrical potential difference between battery terminals; current, which measures the flow of electric charge in and out of the battery; temperature, which affects the battery's internal resistance and overall performance; and SOC, which quantifies the remaining energy in the battery. Battery monitoring systems also encompass data logging and communication capabilities, allowing for remote monitoring and analysis. By collecting and analyzing battery performance data, engineers can identify trends, evaluate battery health, and optimize charging and discharging strategies. The successful implementation of an EV battery monitoring system requires expertise in electrical engineering, sensor technology, data acquisition, signal processing, and software development. Additionally, considerations such as system scalability, power efficiency, and safety are paramount to ensure reliable and accurate monitoring in real-world EV applications.

PROBLEM STATEMENT

As Electric Vehicles (EVs) gain popularity as a sustainable transportation option, the need for an efficient and reliable battery monitoring system becomes imperative. Without proper monitoring, EV owners lack real-time information about the state of their battery, leaving them vulnerable to potential risks and inefficiencies. One of the primary concerns is battery degradation. Over time, EV batteries experience capacity loss and reduced performance. Without a monitoring system in place, users remain unaware of this degradation until it significantly impacts the vehicle's range and overall performance. Moreover, overcharging the battery can accelerate degradation, leading to shorter battery lifespan and increased maintenance costs. Another critical issue is the risk of overheating. EV batteries can generate substantial heat during operation, and without continuous monitoring, users may not be

aware of excessive temperature levels. Overheating not only reduces battery efficiency but also poses safety hazards, such as the risk of thermal runaway or battery fires.
Additionally, the lack of real-time data on battery voltage, current, and state of charge (SOC) hampers users' ability to optimize their EV's performance and range. Without this information, drivers may experience unexpected battery drain or find themselves stranded due to insufficient charge. A comprehensive battery monitoring system would provide timely notifications and accurate data on these parameters, empowering users to make informed decisions regarding charging, driving behavior, and battery maintenance.
To address these concerns, there is a pressing need for a reliable and accurate EV battery monitoring system. This system would utilize sensors to continuously measure critical battery parameters, such as voltage, current, temperature, and SOC. The collected data would be processed and analyzed in real-time, providing users with up-to-date information on the battery's health and performance by implementing a robust battery monitoring system, EV owners can optimize battery usage, extend battery lifespan, and ensure the overall reliability and safety of their vehicles. The system would enable users to detect early signs of degradation, prevent overcharging and overheating, and make informed decisions to maximize their EV's efficiency and range.

OBJECTVES

- Voltage Monitoring.
- Temperature Monitoring and Alerts on IOT Device.
- Battery Cooling if Temperature rising detected.
- LCD Display for voltage battery status.
- IOT Based Monitoring System

1. Develop a comprehensive voltage and current monitoring system for Electric Vehicles (EVs) that accurately measures and records the battery's electrical parameters in real-time.
2. Implement an IOT-based temperature monitoring system that continuously monitors the battery temperature and sends alerts to the user or driver whenever abnormal temperature levels are detected.
3. Integrate a battery cooling mechanism into the system, which automatically activates when the temperature rises above a certain threshold, ensuring optimal battery temperature and preventing overheating.
4. Incorporate an LCD display into the system to provide a clear and user-friendly interface for presenting the voltage battery status, including voltage, temperature.
6. Develop an IoT-based monitoring system that enables remote monitoring and control of the EV battery. This system allows users to access real-time battery data, receive alerts, and perform necessary actions through a web-based or mobile application.

By achieving these objectives, the final year project will result in a comprehensive EV battery monitoring system that ensures accurate monitoring of voltage, current, and temperature,
provides timely alerts and notifications, implements a battery cooling mechanism, displays battery status through an LCD, enables IoT-based monitoring and control. The project will contribute to the efficient and reliable operation of EVs, enhancing user experience and promoting sustainable transportation.

HARDWARE COMPONENT

1.NODE MCU

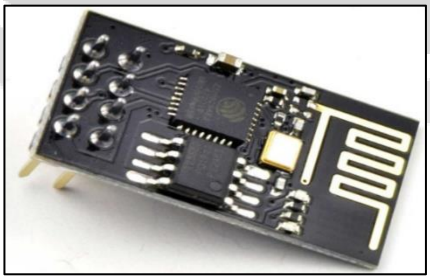


Fig 3.1 ESP 32 Wi-Fi Module

The Node MCU is a popular development board based on the ESP8266 Wi-Fi module. Here are some specifications of the Node MCU: Node MCU boards are widely used for IOT (Internet of Things) projects due to their low cost, ease of programming, and built-in Wi-Fi capabilities. They are suitable for a wide range of applications such as home automation, sensor monitoring, and remote control systems.

2. LCD

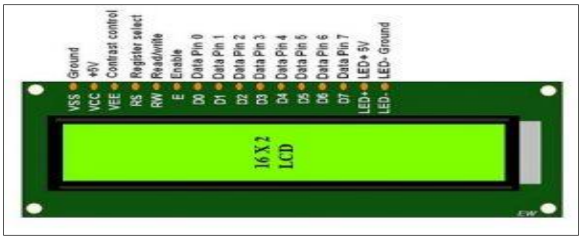


Fig 3.2 LCD 16X2

A 16x2 LCD (Liquid Crystal Display) module is a common type of character display used in various electronic projects. Here are the specifications typically associated with a standard 16x2 LCD module: When using a 16x2 LCD module, you typically control it by sending commands and data through a microcontroller such as an Arduino or a Raspberry Pi, allowing you to display information like sensor readings, messages, or menu options.

3. LITHIUM-ION BATTERY

Fig 3.3 Lithium-ion battery

Lithium-ion batteries are a popular type of rechargeable battery commonly used in various electronic devices, electric vehicles (EVs), and renewable energy storage systems. Here are some key specifications and characteristics of lithium-ion batteries:

4. DC MOTOR PUMPS

Fig 3.4 DC motor pump

5. HEAT SINKS

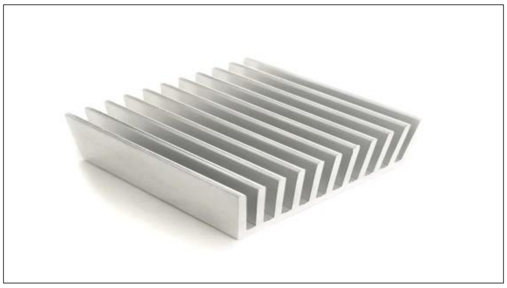


Fig 3.5 Heat sinks

6. COOLING FANS

Fig 3.6 Cooling fans

7. THERMOSTATE

Fig 3.7 Digital temperature controller

8. DIGTAL TEMPERATURE SENSOR

Fig 3.8 Digital temperature sensor

9. WI-FI MODULE

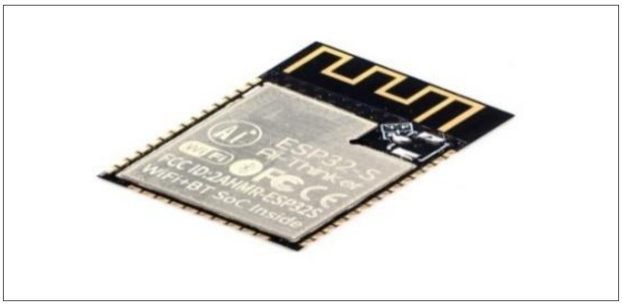


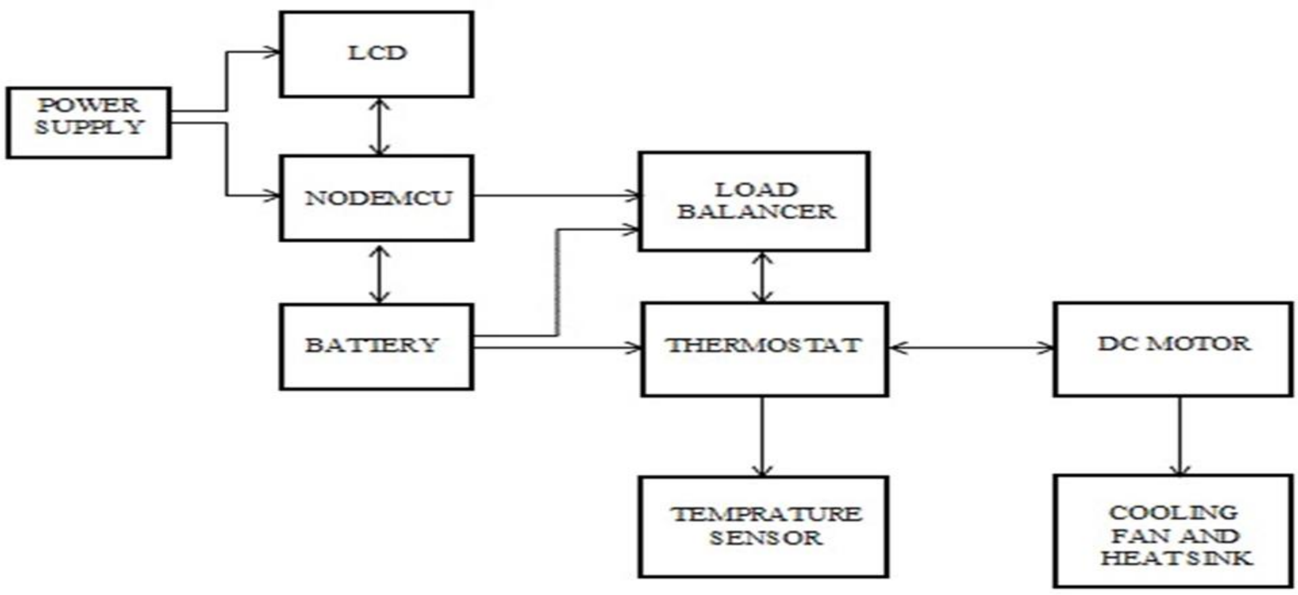
Fig 3.9 Wi-Fi module

METHODOLOGY

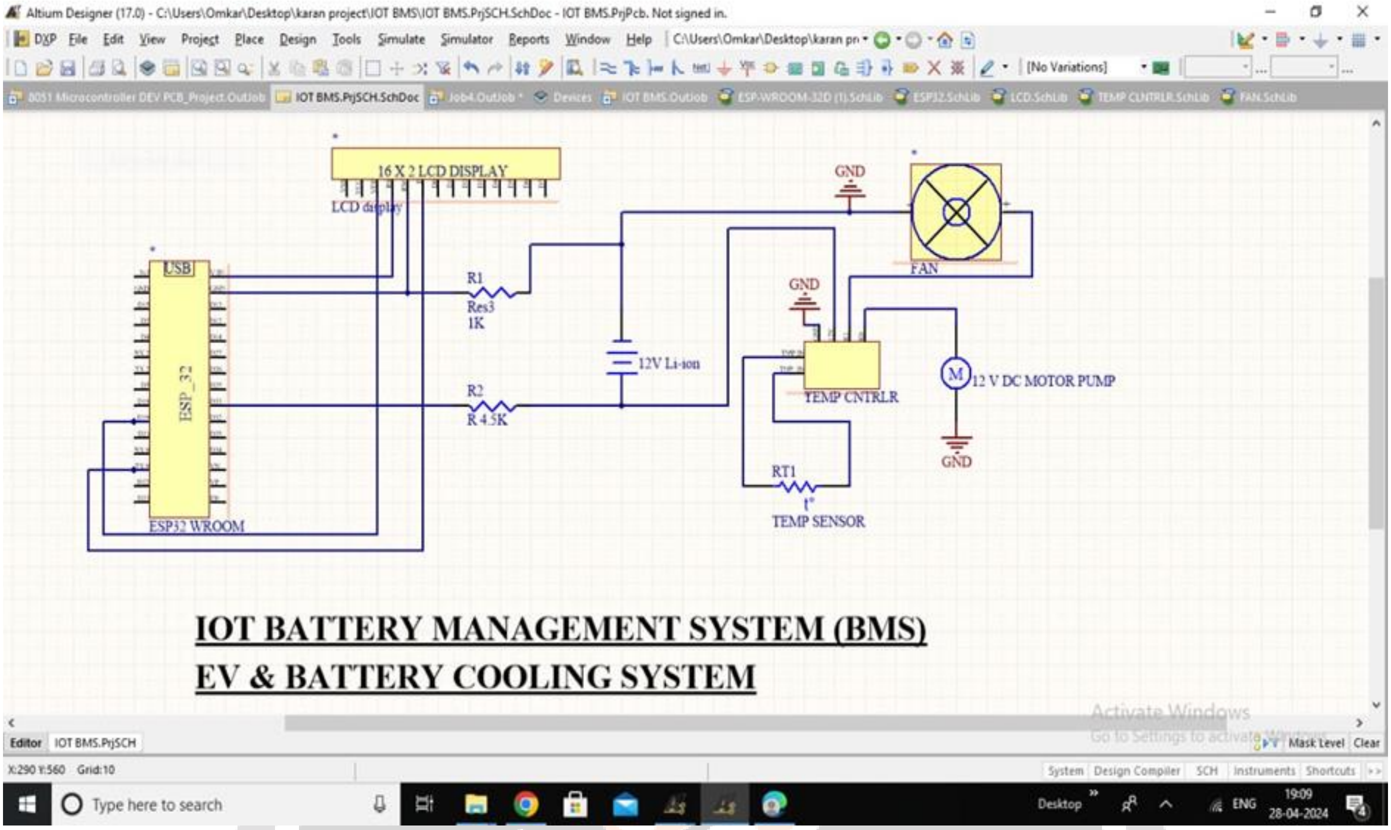
1. System Architecture Design: Begin by designing the system architecture for the EV battery monitoring system. The components required for this system include an NODE MCU, ESP8266 Wi-Fi module, voltage sensor, temperature sensor (digital temperature sensor), lead acid battery, LCD display (16x2), buzzer, cloud platform (such as ThingSpeak.com), Heat sink and a fan for cooling purposes. Plan the connections and interactions between these components.
2. Sensor Integration: Connect the voltage sensor, temperature sensor (LM35DT) to the appropriate input pins of the NODE MCU. Ensure that the sensor outputs are compatible with the microcontroller's input voltage range.
3. Sensor Calibration: Calibrate the voltage sensors by comparing their readings with known reference values. This calibration process ensures accurate measurement results and allows for precise monitoring of the EV battery's voltage levels.
4. Data Acquisition and Processing: Program the NODE MCU to continuously read the voltage and temperature sensor data. Use appropriate libraries and algorithms to process and analyze the acquired data.
5. Display and User Interface: Connect the LCD display (x2) to NODE MCU to show real-time information to the user. Display the battery voltage, temperature.
6. Wireless Communication: Utilize the ESP8266 Wi-Fi module to establish a wireless connection with the cloud platform (ThingSpeak.com). Configure the ESP8266 module to send the acquired battery data to the cloud at regular intervals. This enables remote monitoring and data storage for further analysis.
8. Cloud Integration: Set up an account on ThingSpeak.com or a similar cloud platform. Create a channel and configure it to receive the battery data from the EV battery monitoring system. Use the platform's API to send the data to the designated channel and store it for analysis and visualization.
9. Data Visualization: Develop a web-based or mobile application to access and visualize the battery data stored on the cloud platform. Create graphs, charts, and real-time dashboards to provide a clear overview of the EV battery's performance and status.
10. Cooling System Control: Integrate the fan with heat sink into the system to control the temperature of the EV battery. Program the microcontroller to activate the fan when the battery temperature exceeds a predefined threshold. This helps maintain the battery within a safe temperature range and prevents overheating.
11. System Integration and Testing: Assemble all the components together and test the complete EV battery monitoring system. Verify the accuracy of sensor readings, data transmission to the cloud, user interface functionality, alarm system operation, and fan control.
12. Optimization and Refinement: Analyze the system's performance and identify areas for improvement. Optimize the code, algorithms, and system parameters to enhance the system's accuracy, efficiency, and reliability. Refine the user interface and visualization capabilities based on user feedback.

By following this methodology, you can develop a robust EV battery monitoring system that integrates various sensors, communication modules, and control mechanisms. The system provides real-time monitoring, data visualization, and alerts, contributing to the efficient and safe operation of the EV battery.

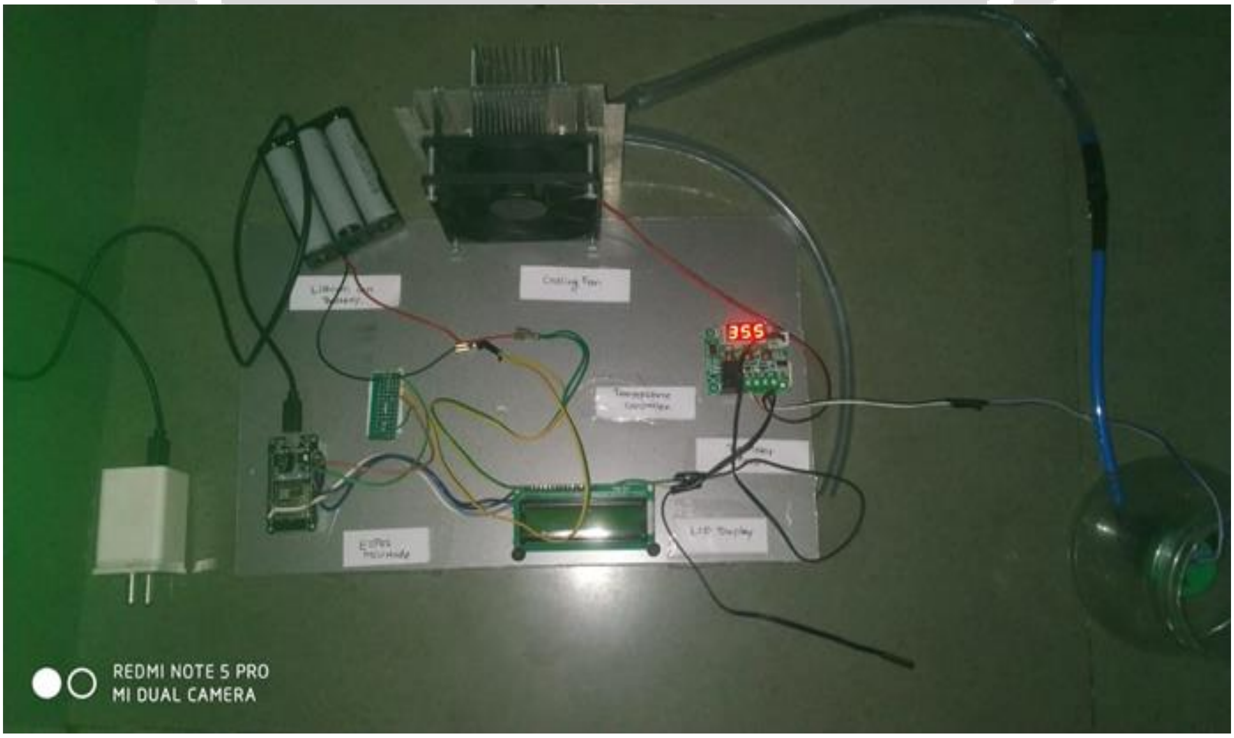
BLOCK DIAGRAM



CIRCUIT DIAGRAM



HARDWARE SYSTEM DESIGN



SOFTWARE SYSTEM DESIGN

1 ARDUINO IDE (Programming)

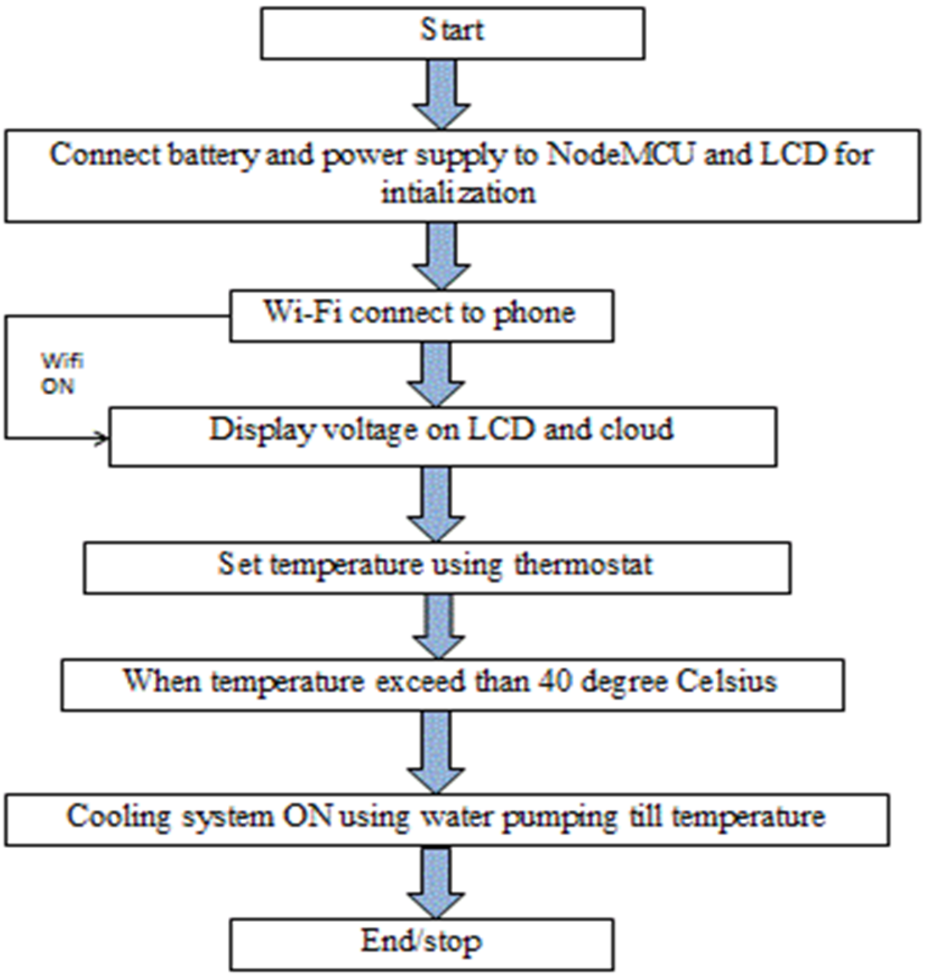
The Arduino Integrated Development Environment (IDE) is an open-source software tool used for programming Arduino boards. It provides a user-friendly interface and a set of libraries that make it easy to write, compile, and upload code to Arduino microcontrollers. Here are some key features and functionalities of the Arduino IDE:

1. Code Editor: The Arduino IDE provides a simple yet powerful code editor with features like syntax highlighting, auto-indentation, and code completion. It supports the C and C++ programming languages.
2. Library Manager: The IDE includes a library manager that allows you to easily search, install, and manage libraries that provide additional functionality for your Arduino projects. The library manager provides access to a wide range of pre-built libraries contributed by the Arduino community.
3. Examples and Tutorials: The Arduino IDE comes with a collection of example sketches and tutorials to help beginners get started with programming Arduino boards. These examples cover various topics and demonstrate how to use different Arduino functionalities Arduino.
4. Board Manager: The IDE includes a board manager that enables you to install and configure support for different Arduino board models. It provides a seamless integration with a wide range of Arduino-compatible boards.
5. Serial Monitor: The IDE features a built-in serial monitor that allows you to communicate with the Arduino board via the serial port. It enables you to send and receive data, debug your code, and monitor the output from your Arduino projects.
6. Sketch Compilation and Uploading: The Arduino IDE handles the compilation and uploading process of your code to the Arduino board. With a simple click of a button, you can compile your code and upload it to the connected Arduino device.

2. THING SPEAK

- Thing Speak is a versatile IOT platform that is widely used for implementing Battery Management Systems (BMS) with advanced features like real-time monitoring, data analytics, and control capabilities
- . When integrated with IOT-enabled BMS, Thing Speak allows for seamless communication between the battery system and the cloud, enabling remote monitoring and management of battery parameters such as voltage, current, temperature, and state of charge.
- One of the key advantages of using Thing Speak in conjunction with IOT-based BMS is its ability to collect and analyze large volumes of data generated by the battery system in real time. This data can be visualized through customizable dashboards and graphs, providing valuable insights into the performance and health of the batteries
- Moreover, Thing Speak supports integration with external systems and services, enabling automated alerts, notifications, and actions based on predefined conditions or thresholds.

FLOW CHART



ADVANTAGE AND LIMITATION

1.1 ADVANTAGES

- Real Time Monitoring
- Performance-based replacements: Replacement batteries can be plan based on their performance, not on a schedule, allowing significant cost reductions.
- Avoid Vehicle burning.
- Avoid the Battery over heating
- Remaining battery charging timing.
- Auto Cut-Off after full charge.
- Real time notification to owner after full charge, discharge or overheating.
- Monitor the car/bike further kilometer cover.
- Battery charging percentage.

1.2 LIMITATION

- Implementing an IOT-based BMS adds complexity to the system due to the integration of sensors, communication modules, and software components. This complexity can increase the development time and cost.
- IOT-enabled components such as sensors, microcontrollers, communication modules, and cloud services can be expensive.
- IOT systems require regular maintenance, software updates, and monitoring to ensure proper functioning. This maintenance effort adds to the operational overhead and may require specialized skills or resources.
- Scaling up an IOT-based BMS to handle a larger fleet of EVs or a more extensive cooling system can be challenging. It may require infrastructure upgrades, enhanced communication protocols, and optimized data management strategies.

Integrating IOT components with existing BMS hardware or software infrastructure can pose compatibility issues. Ensuring seamless integration and interoperability may require additional development and testing efforts.

RESULT

1. Monitoring Battery Condition: The system enables real-time monitoring of the battery condition using an Android phone, including temperature measurements.
2. Enhanced Battery Lifespan: The Battery Management System (BMS) helps extend the lifespan of battery cells in electric vehicles (EVs), while also monitoring and controlling temperature.
3. Stability and Reliability: The BMS contributes to the stability and reliability of the battery pack, including temperature regulation.
4. Effective Voltage Measurement and Control: The BMS system ensures precise measurement and control of battery cell voltages, while also monitoring temperature variations.
5. Constant Battery Monitoring: The BMS provides continuous monitoring of battery cells, including temperature changes.
6. Battery Pack Capability Forecast: The BMS system can forecast the capabilities of the battery pack in the near future, considering temperature as a crucial parameter.
7. Data Saving: The system allows for the storage and saving of monitored data, including battery condition, temperature readings.
8. Graphical Representation: The system provides graphical representation of the monitored data, allowing for easy visualization and analysis of battery performance temperature variations.
9. cooling system. BMS system used cooling system for decreased the temperature of battery.

In summary, the expected results include real-time monitoring of battery condition, enhanced battery lifespan with temperature regulation, stability and reliability of the battery pack with temperature monitoring, effective voltage measurement and control considering temperature variations, constant battery monitoring including temperature changes, graphical representation for easy visualization and analysis of battery performance, battery cooling and temperature variations, data analytics capabilities to identify usage patterns, detect anomalies, and provide performance trends considering temperature variations, such as low battery voltage or high temperature.

CONCLUSION

In conclusion, the integration of IOT technologies into Battery Management Systems (BMS) for Electric Vehicles (EVs) has shown significant promise in enhancing the efficiency, safety, and longevity of EV batteries. Through real-time monitoring, data analytics, and remote control capabilities, IOT-enabled BMS solutions offer precise control over battery charging, discharging, and temperature regulation. This not only optimizes the performance of EVs but also contributes to the overall sustainability and reliability of electric transportation.

Additionally, the incorporation of battery cooling systems further enhances the effectiveness of BMS by mitigating thermal issues that can impact battery performance and lifespan. By actively managing battery temperatures within optimal ranges, these cooling systems play a crucial role in maintaining battery health and extending its operational life.

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