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Advanced Techniques In The Battery Management System With Charge Monitor And Fire Indicator

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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 and extract the maximum output 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 lotof 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 NodeMCU which is the Wi-fi enabled microchip that willsend the data or crucial parameters to the server which is the Thing Speak. Therefore, inthis way we can monitor these parameters from anywhere and also monitor battery health.

KEYWORD : ATMEGA 328 SMD Controller, SENSORS, LCD DISPLAY

1. **Introduction** :

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 and extract the maximum output 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 lotof 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 NodeMCU which is the Wi-fi enabled microchip that willsend the data or crucial parameters to the server which is the Thing Speak. Therefore, inthis way we can monitor these parameters from anywhere and also monitor battery health.

History of Electric Vehicles

Electric vehicles, which run on batteries rather than gas engines, are becoming more common. Electric vehicles are preferred by those who want to safeguard the environment and maybe go greener. However, many people are astonished to hear that electric vehicles are not a new technology. While it is unclear who invented the first electric car, electric motors were clearly in use as early as the 1800s. Around 1828, Anyos Jedlik invented the very first electric motor [1]. Using a small electric engine, he developed a self-moving tiny model automobile. A bigger electric motor designed by Scottish inventor Robert Anderson has been used to run a carriage between 1832 and 1839 [2].

American innovators returned to the electric car in the 20th century. William Morrison created what many consider to be the first practical electric car around this period, however it lacked range. During this period, hybrid vehicles were also developed to address a variety of concerns with electric vehicles.

2. Methodology :

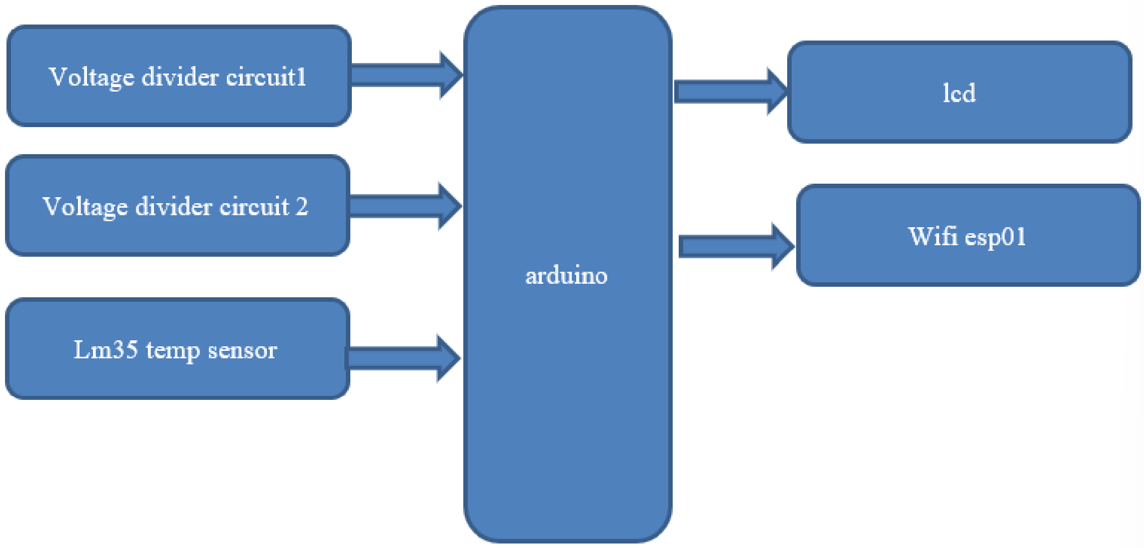


Fig.1 : Module Of System

In the proposed system we are going to monitor Battery voltage, Battery temperature and current. By doing this we would be able to see voltage, current and temperature of the battery every very hour or every minute or whenever we would like. When we replace the battery in an electric vehicle at a swapping station, there is no method to check the battery's health card, including how much battery is depleted and how bad the battery is. In this way, anyone can offer us a used or defective battery, and we'll have to accept it without knowing much about it. Since a result, battery prices will be compromised, as someone might pay more for a less efficient battery with a shorter life cycle than a more efficient battery with a longer life cycle. In this project we are going to use current sensor, voltage sensor and temperature sensor. We are going to connect the current sensor to the battery which would be eventually connected to the PMDC motor. we will do the same thing for temperature sensor and voltage sensor respectively. Then we will send the data to Arduino Cloud. Now when we will put the throttle on the all the three parameters will be sent to the Arduino cloud from where we will be able to read the data and get the various information.

3. Literature survey:

1. Title: "Battery Health Monitoring for Commercialized Electric Vehicle Batteries: Lithium-Ion"

Author: Fawad Ali Shah, Shehzad Shahzad Sheikh, Umar Iftikhar

Description: Batteries are widely utilised to power electric vehicles, hybrid electric vehicles (HEVs), and many other high-power applications. The battery is critical to their efficiency, safety, and reliability. Reliability. Initially, numerous types of batteries are discussed in this paper. According to the research, utilised in EVs and HEVs are explored. The most recent battery management methods (BMS). Lithium-ion batteries due of their extended life, a preferred source of EVs and HEVs high power density density, and good charging and charging efficiency performance discharge However, there are still some concerns. Li-ion batteries are used in a varietyof applications, including complicated electrochemistry, battery deterioration, and battery accuracy health assessment. Vehicle electrification is a global trend that includes Asia and Pakistan. Following that, the article considers the economic, environmental, and energy efficiency implications of increased use of electric vehicles [7].

2. **Title**: "Battery Swapping Technology"

Author: Shubham Jain, Azures Ahmad, Mohammad Saad Allam

Description: The transportation industry contributes significantly to carbon emissions and pollutes the environment globally. Electric vehicles (EVs) have a significant promise for reducing carbon emissions. A Battery Swapping Station (BSS) is a promising mechanism for providing power to EVs while reducing long charging times at a Battery Charging Station. Swapping Technology is an excellent option for completing a long-distance interstate journey. This study investigates the advantages of establishing the BSS from many perspectives, and as a result, a methodology for swapping out batteries in significantly less time is given, taking into account the position of the battery to be fixed. This new approach can be used as a source of inspiration for a future framework that provides EVs with sensible and dependable charging [8].

3. **Title:** "Scalable and De-centralized Battery Management System for Parallel Operation Multiple battery Packs"

Author: Shreyas Maitreyan, Himani Jain, Priyanka Pallial

Description: Multiple lithium-ion battery packs operating in parallel are required for large-scale energy storage applications. Renewable energy storage systems, batterypacks for large-scale automobiles such as electric trucks, tanks, armoured vehicles, diesel-electric submarines, and so on are examples of such uses. The existing method for parallel operation of numerous battery packs is highly hardware intensive. It necessitates a distinct pack management system acting as a master, as well as battery management systems in each of the battery packs deployed as slaves. This has a huge impact on the scalability of such systems because the number of battery packs that canbe connected in parallel is entirely reliant on the capacity of the master. A decentralisedpack management system is presented as an alternative in this study. Thesuggested technique eliminates the need for master-slave battery pack configurations and eliminates the need for centralised hardware to manage the battery packs. Instead, this system allows individual Battery packs to communicate with one another on their own,allowing for decentralised pack administration [9].

4. **Title:** Battery Management System in Electric Vehicle

Author: Ananthraj C R, Arnab Ghosh

Description: The most crucial component of any electric vehicle (EV) is battery storage, which stores the energy required for the vehicle's operation. So, in order to getthe most out of a battery while also ensuring its safety, it is vital to have an effective battery management system in place. It monitors the parameters, calculates SOC, and provides the services required to ensure the battery's safe functioning. As a result, BMS are a crucial component of any electric vehicle, and more research is being done in thefield to build more capable BMS. System for Managing Batteries [10].

4. Proposed Method :

In the proposed system we are going to monitor Battery voltage ,Battery temperatureand current. By doing this we would be able to see voltage ,current and temperature ofthe battery every very hour or every minute or whenever we would like. When we replace the battery in an electric vehicle at a swapping station, there is no method to check the battery's health card, including how much battery is depleted andhow bad thebattery is. In this way, anyone can offer us a used or defective battery, and we'll have to accept it without knowing much about it. Since a result, battery prices will be compromised, as someone might pay more for a less efficient battery with a shorter lifecycle than a more efficient battery with a longer life cycle. In this project we are goingto use current sensor ,voltage sensor and temperature sensor.We are going to connect the current sensor to the battery which would be eventually connected to the PMDC motor .we will do the same thing for temperature sensor and voltage sensor respectively.Then we will send the data to Arduino Cloud .Now when we will put the throttle on theall the three parameters will be sent to the Arduino cloud from where we will be able toread the data and get the various information.

5. Software Description And Specification

ARDUINO UNO :

The Arduino Uno development board is based on the Atmel ATmega328, an 8-bit, 16 MHz microcontroller with 14 digital input/output (I/O) pins, 6 of which are capable of pulse-width modulation (PWM), as well as a 6-channel, 10-bit analog-to-digital converter. Digital communication capabilities include UART TTL serial, SPI serial, and two-wire interface serial (I2C). The Arduino development platform features a cross-platform, Java-based IDE as well as a C/C++ library which offers high-level access to hardware functions.

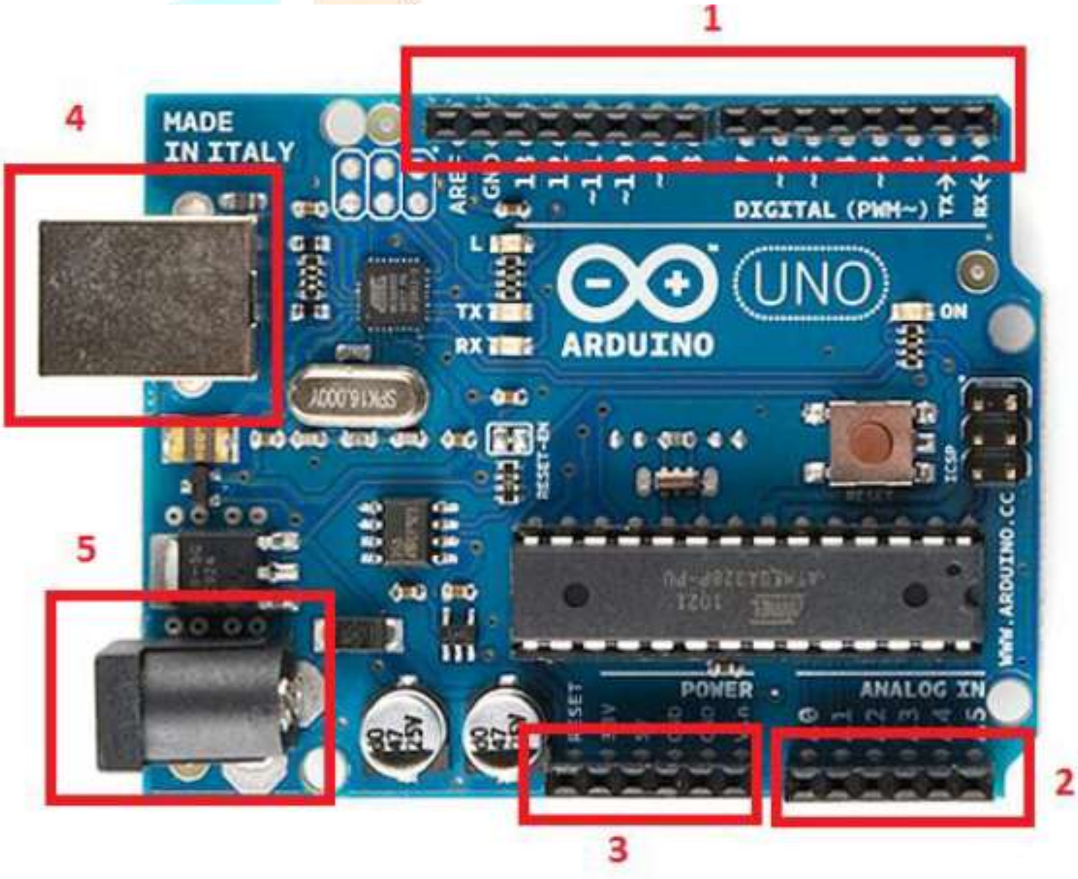


Fig 2: Arduino UNO

The Major Features of Micro Controller ATmega328P:

High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family

• Advanced RISC Architecture

– 131 Powerful Instructions

– Most Single Clock Cycle Execution

– 32 x 8 General Purpose Working Registers

– Fully Static Operation

– Up to 20 MIPS Throughput at 20MHz

– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory Segments

– 32KBytes of In-System Self-Programmable Flash program Memory

– 1KBytes EEPROM

– 2KBytes Internal SRAM

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

6. Hardware Block Diagram

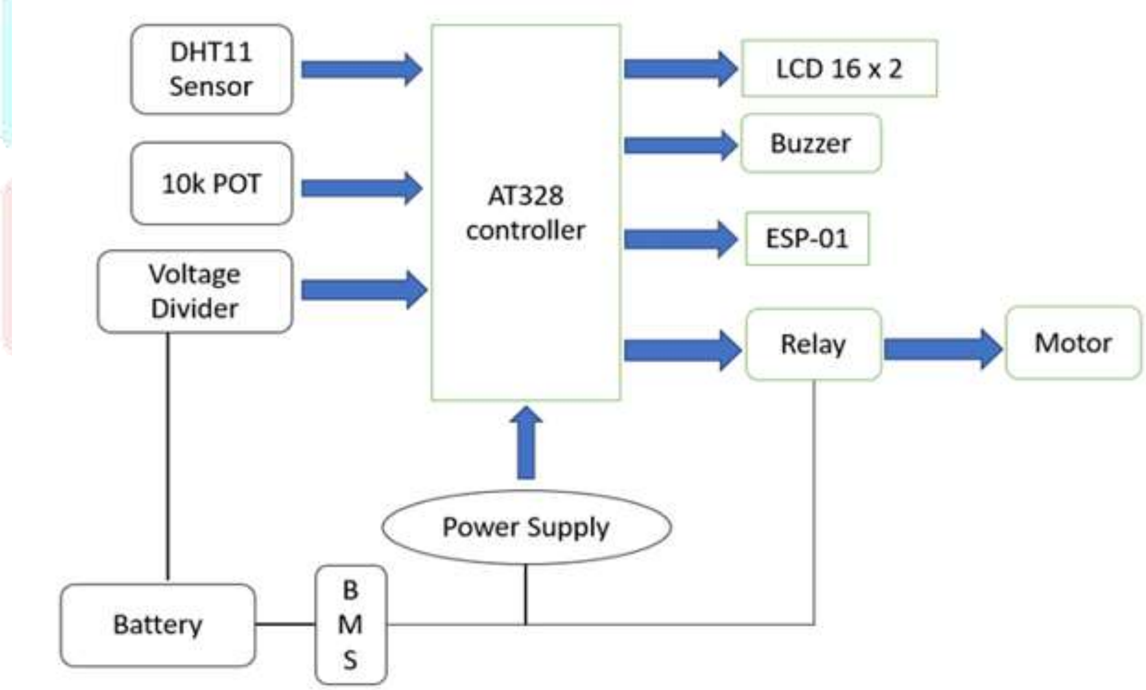


Fig 3: Block Diagram of Hardware

6.1 Hardware Explanation :

This is a block diagram of a system designed for monitoring and controlling various devices. Here's a detailed explanation of its components and their functionality:

Components in the Block Diagram:

1. **DHT11 Sensor:**
a. A digital sensor used to measure temperature and humidity.
b. Sends data to the AT328 microcontroller for processing.

2**. 10k POT (Potentiometer):**
a. A variable resistor used to adjust or control input values such as brightness or reference voltage for the system.
b. Input goes to the AT328 microcontroller.

3. **Voltage Divider**:
a. A circuit used to step down voltage to a level that can be safely processed by the AT328 microcontroller.
b. Takes input from the battery and sends a safe voltage level to the microcontroller.

4. **Battery Management System (BMS):**
a. Ensures the safety and efficiency of the battery by monitoring charging, discharging, and overall battery health.
b. Supplies power to the system through the Power Supply block.

5.**Power Supply:**
a Regulates and distributes power from the battery to the various components of the system

6. **AT328 Microcontroller**:
a. The core processing unit (likely an ATmega328, used in Arduino boards).
b. Receives inputs from sensors, potentiometer, and voltage divider.
c. Controls output devices based on programmed instructions.

7. **Outputs Connected to AT328**:
a. LCD (16x2): A display unit that shows data such as temperature, humidity, or system status.
b. Buzzer: Used for alarms or notifications based on certain conditions.
c. ESP-01 (Wi-Fi Module): Used for wireless communication, enabling IoT (Internet of Things) functionality.
d. Relay: Acts as a switch to control high-power devices like the motor.
e. Motor: The output device controlled by the relay.

System Functionality:
a. The system is powered by a battery managed by the BMS and regulated by the power supply.
b. Sensors (DHT11, potentiometer, voltage divider) provide inputs to the AT328 microcontroller.
c. The microcontroller processes these inputs and decides the appropriate output actions:
d. Displays data on the LCD.
e. Activates the buzzer for alerts.
f. Sends data to the ESP-01 module for wireless monitoring or control.
g. Controls the relay to operate the motor based on specific conditions.

Pratical View Of : Advanced Techniques in the Battery Management System With Charge Monitor and Fire Indicator

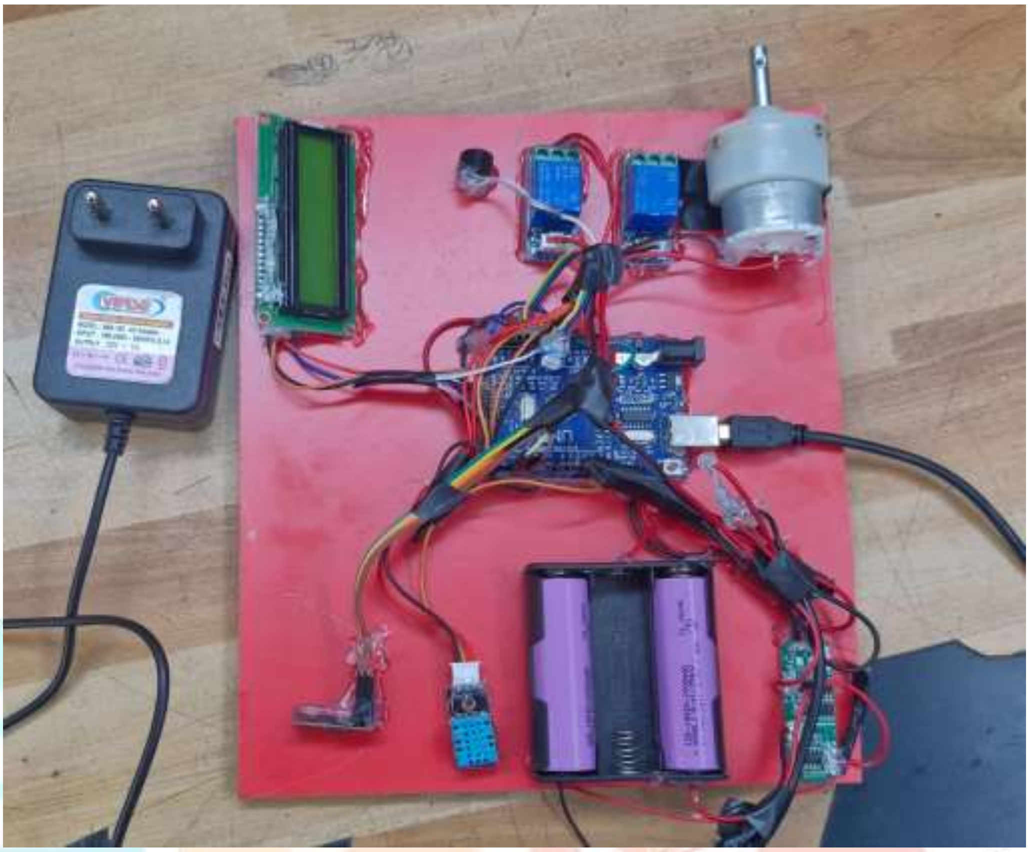


Fig 4: Result Of Hardware

6.2 Power Supply :

The power supply for an advanced Battery Management System (BMS) with charge monitoring and fire indication typically involves a combination of sources to ensure reliable and efficient operation. Here are some key components:

1. **Battery Pack**: The primary power source for the BMS itself, providing the necessary energy to run the system and its sensors.
2. **DC-DC Converter**: Converts the battery voltage to the required levels for the BMS and other electronic components, ensuring stable and appropriate power supply.
3. **Power Management ICs**: Integrated circuits that manage the distribution of power within the BMS, optimizing energy use and protecting against power surges.
4. **Backup Power Supply**: In critical applications, a backup power source (such as a supercapacitor or secondary battery) can be included to ensure the BMS continues to operate in case of primary power failure.
5. **External Power Supply**: For initial setup or maintenance, an external power supply can be used to power the BMS without draining the main battery.

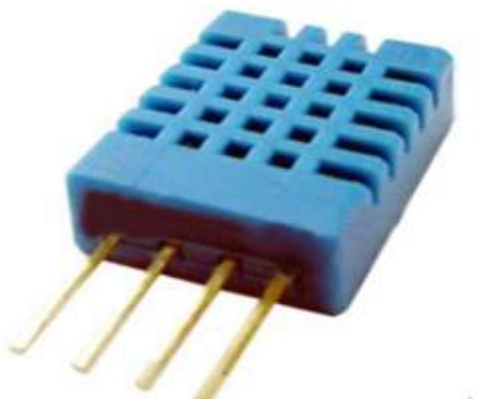
These components work together to provide a consistent and safe power supply, enabling the BMS to effectively monitor and manage the battery pack while ensuring safety through charge monitoring and fire protection.

6.3 Battery Pack :

We made a Battery pack from lithium ion battery pack of 24 Volt and 10.6 Amp. We took each cell of 3.7 Volt and 2600 mA .We took 7 Lithium Ion cells in seriesand weclamped it together. We made 4 sets like this and then we clamped it together to get desired voltage and current

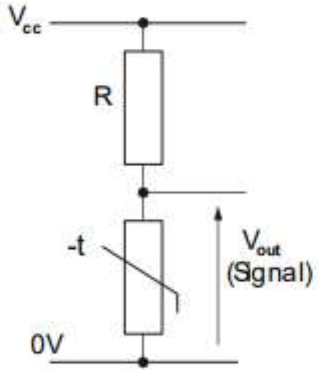
6.4 Temperature Sensor :

- DHT11 Sensor (Temperature Humidity Sensor)
- Measurement Range: 20-90%RH 0-50 ℃
- Humidity Accuracy: ±5%RH
- Temperature Accuracy : ±2℃
- Resolution: 1
- Package: 4 Pin Single Row



6.5 Voltage Divider :

• A **voltage divider** is a simple circuit which turns a large voltage into a smaller one. Using just two series resistors and an input voltage, we can create an output voltage that is a fraction of the input. Voltage dividers are one of the most fundamental circuits in electronics.



6.6 10k Potentiometer :

• Potentiometers are very useful in changing the electrical parameters of a system. It is a single turn 10k Potentiometer with a rotating knob. These potentiometers are also commonly called as a rotary potentiometer or just POT in short. These three-terminal devices can be used to vary the resistance between 0 to 10k ohms by simply rotating the knob. A potentiometer knob can also be used along with this POT for aesthetic purposes.

7. Flow Chart :

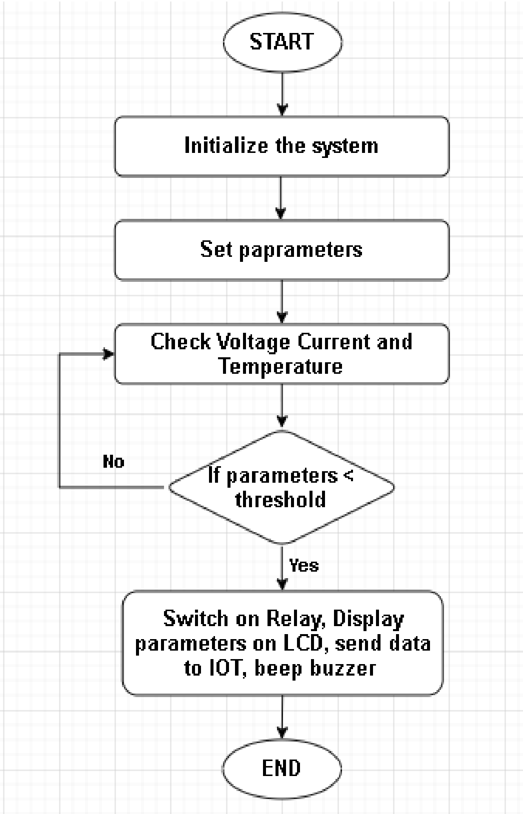


Fig 5: Flow Chart Of Battery Management System

7.1 Advantages And DisadvantagE :

Advantages:

1. **Enhanced Safety**: Advanced techniques such as fire indicators and thermal management significantly reduce the risk of battery fires and thermal runaway, ensuring safer operation.
2. **Improved Performance**: Continuous monitoring of voltage, current, and temperature optimizes battery performance, leading to better efficiency and longer lifespan.
3. **Remote Monitoring**: IoT integration allows for real-time data collection and remote monitoring, enabling timely intervention and better management of the battery system.
4. **Preventive Maintenance**: Early detection of potential issues through advanced sensors helps in proactive maintenance, reducing downtime and repair costs.
5. **Optimized Charging**: Advanced charge monitoring ensures the battery is charged within safe parameters, preventing overcharging and prolonging battery life.

Disadvantages:

1. **Higher Cost**: Implementing advanced techniques and integrating IoT capabilities can increase the overall cost of the BMS.
2. **Complexity**: The complexity of the system increases with the addition of multiple sensors and IoT components, requiring more sophisticated design and maintenance.
3. **Power Consumption**: Additional sensors and IoT devices can increase the power consumption of the BMS, potentially impacting the overall energy efficiency.
4. **Reliability Concerns**: More components and advanced features can introduce new points of failure, requiring robust design and testing to ensure reliability.

8. Conclusion :

The proposed system is useful in monitoring and tracking the properties of the battery in real time. The battery plays a vital role in an Electric vehicle .Therefore monitoring of the Battery is very important. The project proposed a new way monitoringthe battery with the help IOT. The sensors incorporated in the proposed system can collect the data of battery such as voltage, temperature and current, these data is then sent to Arduino IOT Cloud . Thus the real time data collection, storage and monitoringof the battery of an electric vehicle is possible with the system. By tracking these variables, it will be easier to determine the battery's health or longevity, and pricing will be adjusted accordingly, as a less efficient battery with a shorter life cycle will costmore than a more efficient battery with a longer life cycle. This helps in identifying andsolving a problem before a failure without human dependency. In addition measured data helps to develop a battery swapping station and its price fixing.

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