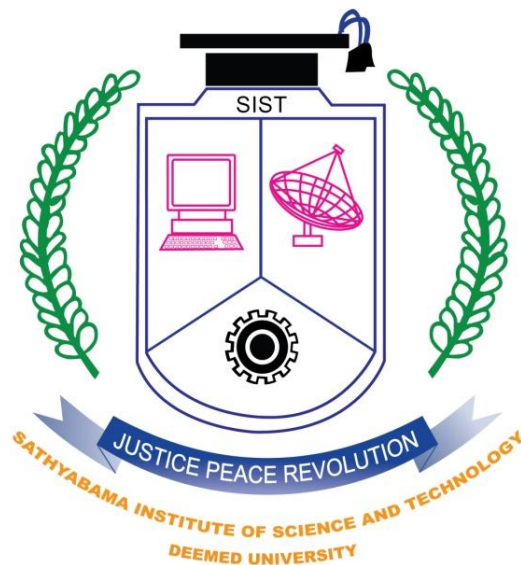


IOT BASED BATTERY MANAGEMENT SYSTEM FOR ELECTRIC VEHICLES

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering
by

HAKHILESH N (Register No. 40140013)

LOGESH C (Register No.40140022)



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A++” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **HAKHILESH** (Reg. No. 40140013) and **LOGESH C** (Reg. No. 40140022) who carried out the project entitled "**IOT BASED BATTERY MANAGEMENT SYSTEM FOR ELECTRIC VEHICLES**" under our supervision from November 2023 to April 2024.

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DECLARATION

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ABSTRACT

The IoT based Battery Management System (BMS) is an advanced system that uses internet technology to monitor, control, and optimize battery performance. It closely tracks the batteries, adjusting and fine tuning them to operate at their best. This innovative system leverages the power of the Internet of Things (IoT) to ensure batteries function efficiently and reliably. The battery pack contains embedded IoT sensors that constantly monitor key parameters like voltage and current levels. These sensors collect real time data on the battery's performance. The sensor information is sent wirelessly to a central control system or an online platform. This uses communication methods like Wi-Fi, Bluetooth, or cellular networks. The data received is carefully analyzed to evaluate the batteries' health status and foresee potential issues or deterioration. Advanced algorithms may be used to optimize the battery's charging and discharging cycles, enhancing its efficiency and lifespan. This system allows you to remotely access the battery management system through web or mobile apps. You can view the real time battery status and get alerts for any issues. It provides a clear and straightforward way to monitor battery's performance from anywhere. The performance data of batteries is highly sensitive, so robust security measures are put in place to safeguard data privacy and prevent unauthorized access or tampering. These precautions help ensure the integrity and confidentiality of the critical information. The IoT-based battery management system is designed to be scalable, making it easy to integrate with different types and sizes of battery packs. It is also flexible enough to accommodate future advancements in battery technology. This system allows for seamless integration and adaptability as battery technology evolves over time.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

Battery Management System using IoT is a project that uses internet-connected devices to quickly detect and report abnormalities about the battery. The system relies on Internet of Things (IoT) technology to monitor for signs of accidents and promptly notify the appropriate authorities. This allows for faster emergency response times, potentially saving life of the battery. The project aims to leverage the power of interconnected devices to enhance public. The system is made up of different parts, like sensors, microcontrollers, communication devices, and a cloud platform. These components work together to collect and transmit information.

The aim of this project is to improve the lives of the battery and emergency response by quickly detecting accidents and informing the appropriate- people. The goal is to promptly identify faults occurs on battery and notify the relevant parties to enhance safety and emergency response. This will help ensure that accidents are addressed quickly, improving overall safety and emergency preparedness. The battery management system is an electronic device made to promptly identify and report battery accidents as they happen. This system is designed to detect and notify authorities about accidents in real time. It helps ensure quick emergency response and can improve battery's lifetime in the event of a serious incident. The device uses different parts like sensors, a microcontroller, a liquid crystal display, a motor driver, and DC motor to effectively detect and respond to accidents.

This system is designed to quickly respond to emergencies, give real-time updates about accidents, and enhance everyone's safety. By providing timely information and faster emergency responses, the system aims to improve overall battery conditions and safety for all. The project is equipped with sensors. These sensors are strategically placed within the battery. The placement of these sensors marks the beginning of the system's operations. The sensors can detect shifts in voltage, current, and distance. They monitor these electrical properties effectively. The sensors are designed to identify any variations in these measurements accurately. They can sense sudden shifts in speed or direction, which may suggest an accident has occurred. The microcontroller, in this instance the Node MCU, takes

the information gathered from the sensors and processes it. The Node MCU handles the data collected by the sensor.

The Node MCU is an open-source device designed for creating projects that connect to the internet. It uses the ESP8266 Wi-Fi chip, which allows it to easily connect to wireless networks. The device comes with built-in Wi-Fi, allowing for easy wireless connectivity. It also has General-Purpose Input/Output (GPIO) pins, which enables to connect and control external devices and sensors. This provides flexibility and expanded functionality for projects.

The cloud platform gets the accident alert and saves important details like the seriousness of the accident. The system automatically collects and records this information when an accident occurs. This data can then be accessed and used as needed. The cloud platform receives the accident alert and saves key details like the severity of the accident. When an incident occurs, the system automatically gathers and records this information. This data can then be accessed and utilized as needed. The system is designed to speed up emergency response by giving real-time details about accidents to emergency crews.

This allows them to act quickly and get faster responses. The system provides critical information to help emergency services respond more battery accidents efficiently. The project focuses on being cost-effective by using affordable parts and taking advantage of the scalability of IoT (Internet of Things) technology. It aims to provide a practical and accessible solution while benefiting from the flexibility and growth potential of IoT systems. The battery management system brings together different parts and technologies to quickly spot and report accidents as they happen.

It uses various sensors and algorithms to identify when an accident has occurred and then immediately sends out alerts to emergency responders. This allows for a fast and efficient response to incidents, which can be crucial. The sensors detect changes in current and voltage. The microcontroller processes the sensor data. The LCD display provides immediate feedback. The motor driver controls the DC motors for appropriate actions. Together, these components enhance emergency response, provide real-time accident information, and improve safety of the battery.

This system also periodically monitors the batteries using Global System Monitoring (GSM) technology and addresses any irregularities. The battery management system consists of measurement devices that keep track of voltage,

current and distance covered in the battery.

1.2 OBJECTIVES

The main goal is to improve battery performance by closely tracking key factors like voltage and current. This helps ensure the battery operates efficiently and reliably. By monitoring these parameters, we can better understand the battery's condition and make any needed adjustments to optimize its performance. The battery management system (BMS) can analyze the data continuously to optimize efficiency and extend the battery's lifespan. By carefully monitoring and adjusting the system, the BMS can help ensure the battery operates at its best, providing reliable power for longer periods.

The battery management system (BMS) has a crucial goal of ensuring safety. By closely monitoring factors such as current and voltage, the system can detect and prevent potentially hazardous conditions, effectively reducing the risk of accidents or damage. This vigilant approach helps maintain a secure environment for battery. Another goal is to reduce downtime by detecting and addressing battery problems early on, before they become worse. By monitoring remotely and getting real-time alerts, we can act quickly to fix issues, cutting down on downtime and improving system reliability.

The IoT powered battery management system (BMS) is designed to enhance energy efficiency. It does this by intelligently managing the flow of energy based on demand and available resources. This allows the system to maximize the use of renewable energy sources. By looking at past data and using predictions, the system can forecast potential battery issues or deterioration. This lets teams plan ahead for maintenance and replace batteries before they stop working. With the integration of Internet of Things technology, the Battery Management System (BMS) enables remote monitoring and control of batteries from anywhere with internet access. This capability allows users to view real-time battery data, receive alerts, and adjust settings remotely, improving operational efficiency and reducing the need for in-person visits. The BMS leverages connectivity to provide users with valuable insights and the ability to manage their battery systems conveniently from any location.

1.3 AIM OF THE PROJECT

In this demonstrative project with the application of IOT that enables the user to have a control over any range of battery. As well as taking a better approach on existing battery management system and providing fast response, better security, connectivity and range. With this approach no new connections has to be provided in this system. The existing battery management system are used in order to communicate with different sensors. The interaction and control is done with a help of Arduino. Along with all these a power module is added to the system to have a better monitoring over the instantaneous power that is being used by this system. This approach enables us to use an alternative power source such as direct source from power adaptor or rechargeable battery to which the user can switch the supply based on the data received from the monitoring instruments, for example if there is no power source on battery side in the battery management system, then the user can switch to the alternate source of power. Such task can also be automated using ai implementation, where the program will automatically determine which this battery discharges more energy on daily basis and switch them to the alternate power supply.

1.4 SCHEME OF THE PROJECT

It starts with the installation of sensors in vehicles, including voltage and current sensors, to monitor and collect data related to battery accidents. The sensors are strategically placed to accurately detect changes in vehicle current and voltage. The collected data is then transmitted to a central hub or cloud-based platform using IoT communication protocols such as Wi-Fi or cellular networks. The platform receives and processes the data, employing algorithms and techniques to analyze the sensor readings and determine if an error in battery has occurred. Additionally, user-friendly interfaces such as mobile or web applications are developed to allow users to access real-time information and interact with the system.

The scheme of the project ensures a comprehensive approach to battery accident detection, notification, and response using IoT technology. The hardware setup consists of sensors, a microcontroller, a communication module, and a battery.

1.5 LITERATURE SURVEY

Harish et al., (2019) IOT Based Battery Management System, Battery is the most essential component of any vehicle. So perfect maintenance of any battery is very much essential for it to function properly. Lead Acid batteries which are more commonly used in the vehicular batteries, need to be efficiently monitored, for it to perform better under all circumstances. So, a more systematic battery management system needs to be implemented so that the performance of the battery can be monitored continuously. When it comes to battery, the two most important parameters are the State of Charging (SoC) and State of Health (SoH) of the battery. There are several coherent methods to calculate these parameters. But these methods cannot provide correct results, as the battery materials, atmosphere surrounding the battery, the load put on to the battery, will affect these parameters. Overcharging of the battery leads to emission of gases like Hydrogen, Oxygen etc. This Battery Management System (BMS) aims at detecting the emission of these gases from the battery, when it is overcharged, and monitors the other basic parameters such as Voltage, Current, Temperature of the battery using STM controller and sensors. It is also equipped with GPS module, which enables tracking of vehicles. Also these values are displayed in Cloud, which brings the concept of Internet of Things (IoT).

Dayal Chandra et al., (2021) IoT Based Battery Management System for Electric Vehicles Using LoRaWAN: A Review, This paper describes the application of Internet-of-things (IoT) in monitoring the performance of electric vehicle battery. It is clear that an electric vehicle totally depends on the source of energy from a battery. However, the amount of energy supplied to the vehicle is decreasing gradually that leads to the performance degradation. system is capable to detect degraded battery performance and sends notification messages to the user for further action. Reliable battery management is necessary for safety purposes. There are several reasons that cause battery breakdown such as deterioration of battery and design defects. Manual battery monitoring system are like normal battery monitoring system which means that it does not save the data into the database. But only show the data collected in real time. Therefore, it is essential to remotely monitor battery systems using wireless technology.

Bharathi S.H¹ et al., The utilization of Web of-things (IoT) in checking the introduction of electric vehicle battery. Doubtlessly an electric vehicle totally depends upon the wellspring of energy from a battery. However, the proportion of energy gave to the vehicle is reducing consistently that prompts the presentation debasement. This is a critical concern for battery creation. In this work, noticing the show of the vehicle using IoT methodologies is proposed, so the checking ought to be conceivable clearly. The proposed IoT-based battery checking system contains of ESP 32 LCD and voltage sensor. These days, electric vehicle (EV) is getting well known since the fuel costs getting more costly. As a result of these circumstances, various vehicle producers looking for alternatives of fuel sources other than gas. The usage of electrical fuel sources may improve the environment since there is less pollution.

Mohammad Asaad et al., The Internet of Things (IoT) technology has immense potential for application in improvement and development of Smart Grid. The rising number of distributed generation aging of present grid infrastructure and appeal for the transformation of networks have sparked the interest in smart grid. The need for energy storage system primarily the electrical energy storage systems is growing as the prospects for their usage is becoming more compelling. Dynamic electrical energy storage system viz., Electric Vehicles (EVs) are relatively standard due to their excellent electrical properties and flexibility but the possibility of damage to their batteries is there in case of overcharging or deep discharging and their mass penetration profoundly impacts the grid. To circumvent the possibility of damage, EVs' batteries need a precise state of charge estimation to increase their lifespan and to protect the equipment they power. Based on ease of implementation and less overall complexity, this paper proposes a real-time Battery Monitoring System (BMS) using coulomb counting method for SoC estimation and messaging based MQTT as the communication protocol. The proposed BMS is implemented on hardware platform using appropriate sensing technology, central processor, interfacing devices and the Node-RED environment.

1.1 OPEN PROBLEMS IN EXISTING SYSTEM

Several open problems and challenges still exist in the field of battery management systems:

Improved State of Charge (SoC) Estimation: Accurately knowing the battery's charge level is crucial for maximizing its performance and lifespan. However, current methods for estimating the state of charge (SoC) often struggle with accuracy, especially when the battery is under changing conditions or has aged. Creating more precise and dependable SoC estimation algorithms remains an ongoing challenge.

State of Health (SoH) Monitoring and Prediction: Knowing the health condition of a battery is crucial to avoid unexpected issues and plan maintenance schedules effectively. Current methods for monitoring the battery's State of Health (SoH) sometimes lack accuracy and may not give early warnings about potential failures. Improving SoH prediction models and techniques is an ongoing challenge.

Thermal Management: Heat production during charging and discharging cycles can cause batteries to overheat, leading to dangerous thermal runaway and reduced lifespan. Maintaining safe operating temperatures is crucial for optimizing battery performance. Developing effective thermal management strategies, such as active cooling and heating methods, remains a challenge, particularly for high-power applications. Addressing this challenge is essential for ensuring the safe and efficient operation of batteries.

Cell Balancing: Cell characteristics can vary, leading to voltage and capacity differences between individual cells in a battery pack. This imbalance can degrade overall performance and lifespan. Researchers are working on designing effective cell balancing algorithms and hardware solutions to address this issue.

Fault Diagnosis and Prognosis: Detecting and diagnosing issues in battery cells or the battery management system is crucial to prevent safety risks and optimize maintenance. Creating robust fault detection and diagnosis algorithms, as well as techniques to predict future failures based on current conditions, is challenging, especially in complex battery systems. Understanding the current state of the battery and potential problems is key to keeping it running safely and efficiently.

Integration with Energy Management Systems: Combining building management systems (BMS) with larger energy management systems, like those in electric cars

or renewable energy setups, has challenges. These include communication methods, data compatibility, and quick decision-making. Smooth integration is key for optimizing energy use, lengthening battery life, and maintaining overall system dependability.

Safety and Reliability: Ensuring the safety and reliability of battery systems is crucial, as they may face various challenges like extreme temperatures, mechanical stress, and electrical issues. Developing thorough safety protocols, designs that can tolerate faults, and robust fail-safe features is essential for battery technology to be widely adopted in safety-critical applications.

Scalability and Cost-Effectiveness: Battery technology is constantly evolving, and as it finds new uses, there is a growing need for battery management system (BMS) solutions that are scalable and cost-effective. Balancing performance, complexity, and cost while ensuring scalability across various battery chemistries and system sizes remains a persistent challenge. Developing BMS solutions that can adapt to these diverse requirements is crucial as battery technology becomes more widely adopted.

Tackling these open issues in battery management systems calls for interdisciplinary research efforts involving electrical engineering, materials science, computer science, and other relevant fields. Collaboration between academia, industry, and government is crucial to drive innovation and overcome these challenges, enabling continued advancements in battery management system.

2.1 CONCEPT EXPLANATION OF BMS

The above figure 2.1 and figure 2.2 shows the general block diagram of battery managementsystem and the hardware circuit diagram respectively. When a violent short circuit occurs, the battery cells need to be protected fast. In hardware circuit diagram, you can see a self-control protector (SCP) fuse, which is meant to be blown by the over voltage control IC in case of over voltages, driving pin 2 to ground. The MCU can communicate the blown fuse's condition, which is why the MCU power supply has to be before the fuse.

Keeping a time reference and integrating the current over time, we obtain the energy enteredor exited the battery, implementing a Coulomb counter. In other words, we can estimate the state ofcharge (SOC) by using the following formula:

BMS offers a variety of tools for measuring battery voltage, current, and temperature, among other things. It also conducts the diagnostics of the battery to ensure the safe operation. If, BMSidentified any one cell is weak, it will give intimation or alarm for cell replacement. It also provides the protection against overcharging, undercharging, overcurrent, under voltage, short circuit and temperature variations.

The IoT-based BMS is a powerful tool that can help to extend the life of batteries and improve theirperformance. It is also a valuable tool for monitoring and controlling batteries in remote orinaccessible locations. Further, the simulation of proposed work has been carried out using

2.2 BLOCK DIAGRAM DESCRIPTION

Battery: Lead-acid batteries are a cost-effective and reliable option. They can be designed to deliver high power output. Additionally, they are safe and recyclable, making them an environmentally-friendly choice. These batteries are a practical solution for many applications due to their combination of performance.

GPS Module: The GPS device tracks the vehicle's location in real time. It gives precise coordinates that can pinpoint the exact spot of an accident .This information can be valuable in emergency situations.

Wi-Fi Module: The Wi-Fi module- allows the microcontroller to send data to the- cloud platform. It can connect using either Wi-Fi or cellular networks.

Current Sensor: The current sensor is placed in the vehicle to detect changes in current. It senses the supply of current and converts it into an electrical signal.

Voltage Sensor: The voltage sensor is placed in the vehicle to detect changes in voltage. It senses the supply of voltage and converts it into an electrical signal.

Microcontroller (e.g., Arduino UNO):- The microcontroller acts as the central processing unit of the system. It receives data from the sensors and processes it to determine if an accident has occurred. The microcontroller also facilitates communication between the sensors and the cloud-based platform.

Cloud-Based Platform: The cloud-based platform serves as a central hub for receiving and processing accident data. It receives the sensor data from the microcontroller and analyzes it to identify accidents. The platform also stores relevant information such as the location and severity of the accident.

User Interface: The user interface, which can be in the form of a mobile or web application, allows users to access real-time accident information. It provides a graphical representation of accident data, allows users to view accident reports, and enables communication with emergency services.

The diagram outlines the process of data transfer from the sensors to the microcontroller, communication with the online platform, and integration with the user interface.

2.1 IEEE STANDARDS FOLLOWED

The Institute of Electrical and Electronics Engineers (IEEE) has several standards related to the reduction of electricity theft using IoT technology. Some of these standards include:

IEEE 828: This standard provides guidelines for the development of software documentation. While not specific to BMS, adherence to documentation standards is crucial in ensuring the reliability and maintainability of BMS software.

IEEE 1547: This standard covers the interconnection and interoperability of distributed energyresources (DER) with the power grid. While not specifically about BMS, it may be relevant in systems where batteries are used as part of DER.

IEEE 2030: This standard focuses on the smart grid interoperability for the electric power system. It includes aspects related to energy management systems and could have relevance to BMS, especially in grid-connected applications.

IEEE 1725: This standard specifies requirements and tests for rechargeable batteries used in portable computing systems, which may include aspects relevant to BMS design for consumer electronics applications.

IEEE 1868: This standard provides guidelines for the testing of lithium-ion batteries in portable consumer electronic devices. Compliance with these guidelines may inform BMS design for such applications.

IEEE 1625: This standard provides guidelines for the design and testing of rechargeablebattery systems for laptop computers. While specific to laptops, the principles may be applicable to BMS design for other portable electronics.

IEEE 1394: Also known as FireWire, this standard specifies a serial bus interface standard for high-speed communication and power supply between computers and electronic devices. While not directly related to BMS, it may be relevant in systems where high-speed data communication is necessary for BMS functionality.

2.1 CONSTRAINTS

Cost: The cost of implementing IoT-based solutions for battery management system can behigh. IoT devices, sensors, and other components needed for such solutions can be expensive, especially if they need to be deployed on a large scale.

Connectivity: IoT devices rely on connectivity to transmit data and communicate with other devices. However, in some areas where battery management system is a problem, the connectivity infrastructure may not be well developed, making it difficult to implement IoT-based solutions.

Power supply: IoT devices need a reliable power supply to function. However, in areas where battery management system is common, the power supply may be unstable, making it difficult to maintain a reliable connection to IoT devices.

Data privacy and security: IoT devices collect and transmit sensitive data related to electricity consumption, which can be vulnerable to cyber-attacks and data breaches. Ensuring the privacy and security of such data can be a challenge.

Regulatory constraints: Some countries or regions may have regulations that limit the deployment of IoT devices or the collection of certain types of data, which can make it difficult to implement IoT-based solutions for battery management system.

Limited awareness: In some areas, there may be limited awareness or understanding of the benefits of IoT-based solutions for battery management system, which can make it challenging to gain support and adoption for such solutions.

Internet connection: Require a constant internet connection.

Inoperability: May become inoperable due to internet or power outages.

Custom development: Need custom development or integration to adapt to changes in fleet size or configuration.

2.1 TRADEOFF

Cost vs. benefits: The cost of implementing IoT-based solutions for battery management system may be high, but the benefits of reducing theft can be significant in terms of cost savings, improved revenue collection, and improved grid stability.

Privacy vs. security: IoT devices collect sensitive data related to electricity consumption, which can be vulnerable to cyber-attacks and data breaches. Balancing the need for data privacy and security is a critical tradeoff in implementing such solutions.

Coverage vs. granularity: IoT devices can provide granular data on electricity consumption, but the coverage area of such devices may be limited. Balancing the need for broad coverage and granular data is an important tradeoff in implementing IoT-based solutions for battery management system.

Reliability vs. complexity: IoT devices can provide reliable data on electricity consumption, but the complexity of such devices and the associated software can make them more challenging to implement and maintain.

Energy consumption vs. functionality: IoT devices need a reliable power supply to function, but the energy consumption of such devices can be significant, which can impact their functionality and deployment.

Battery management systems keep the battery safe, reliable, and increase the senility without entering a damaging state. Different monitoring techniques are used to maintain the state of the battery, voltage, current, and ambient temperature. The BMS communicates with the onboard charger to monitor and control the charging of the battery pack. It also helpsmaximize the range of the vehicle by optimally using the amount of energy stored in it. It is a crucial component in electric vehicles to ensure that batteries do not get overcharged or over discharged, thus avoiding damage to the battery.

2.1 PREREQUISITES

IoT infrastructure: A reliable and robust IoT infrastructure is needed to support the deployment of IoT devices and sensors for battery management system.

This includes a network architecture that can support the collection, transmission, and processingof data from these devices.

Data management: An effective data management strategy is critical for IoT-based solutions for battery management system.

This includes data collection, storage, analysis, and visualization to help identify patterns of battery management and enable real-time response.

Analytics and machine learning: Advanced analytics and machine learning algorithms are needed to analyze the large volumes of data generated by IoT devices and sensors for battery management system accident detection and prevention.

These algorithms can help identify anomalies, patterns, and trends that may indicate no errors.

Regulatory compliance: IoT-based solutions for must comply with relevant regulations and laws, including data privacy and security regulations.

Stakeholder buy-in: Successful implementation of IoT-based solutions for battery managementsystem requires stakeholder buy-in from both utilities and customers. This includes educating customers about the benefits of such solutions and ensuring that utilities have the necessary resources and support to deploy and maintain these solutions.

Technical expertise: IoT-based solutions for battery management system require technical expertise in areas such as IoT device design, data analytics, cyber security, and network infrastructure.

Ensuring that the necessary technical expertise is available is critical for successful Implementation

CHAPTER- 3 HARDWARE DESCRIPTION

3.1 NODE MCU

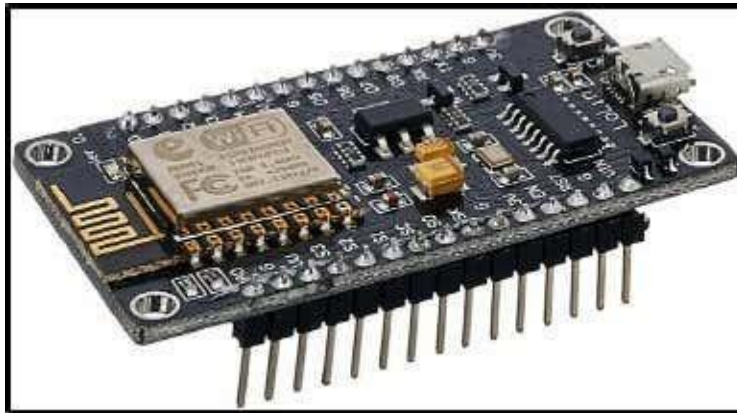


Fig.3.1: Node MCU microprocessor

The Node MCU is an open-source platform that combines software and hardware. It's built around an affordable microprocessor called the ESP8266. This small and powerful chip allows developers to create a wide range of connected devices and applications. The Node MCU provides an easy-to-use development environment, making it accessible for both beginners and experienced programmers. The Node MCU is a Wi-Fi-enabled microcontroller used in Internet of Things (IoT) projects. It allows you to control the entire circuit by accessing the Wi-Fi network. This compact device makes it easy to incorporate wireless connectivity into IoT projects. The device is a combination of a microcontroller and a Wi-Fi module, which are connected to control an RFID module. This integrated system allows for wireless communication and control of the RFID module. The Node MCU allows you to work in different programming environments, including the popular Arduino software. This makes it easy for developers to get started with the Node MCU, as they can use the familiar Arduino tools they're already comfortable with. The Node MCU/ESP8266 community expanded the IDE options by creating an add-on for the Arduino platform. This allowed users to easily program and work with the Node MCU and ESP8266 boards using the familiar Arduino IDE.

Specification

Operating Voltage: 3.3V • Input Voltage: 7-12V • Digital I/O Pins (DIO): 16

Analog Input Pins(ADC): 1 • Flash Memory: 4 MB • SRA M: 64 KB • Clock Speed:

3.2 LCD DISPLAY

The term LCD stands for liquid crystal display.

An electronic display module is a type of screen used in a wide range of devices, such as mobile phones, calculators, computers, and televisions. These modules serve as the visual output for various electronic circuits and gadgets. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations.

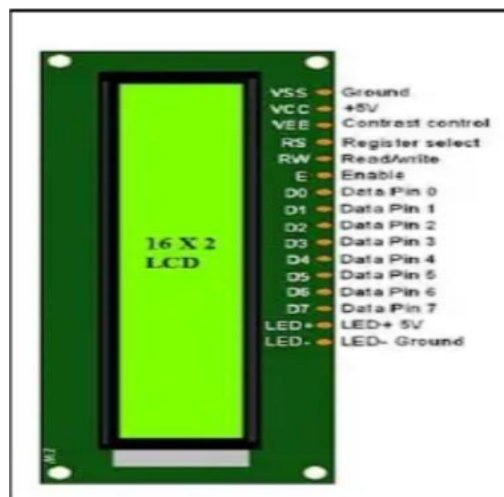


Fig.3.2: LCD Display

The operating voltage of this LCD is 4.7V-5.3V. It includes two rows where each row can produce 16-characters. The utilization of current is 1mA with no backlight. Every character can be built with a 5×8-pixel box. The alphanumeric LCD display can work on two modes like 4-bit & 8-bit. These are obtainable in Blue & Green Backlight. It displays a few custom generated characters.

The main advantages of this LCD device include power consumption is less and low cost. The main disadvantages of this LCD device include it occupies a large area, slow devices and also lifespan of these devices will be reduced due to DC. So these LCD's use AC supply with less than 500Hz frequency.

3.3 DC MOTOR



Fig.3.3: DC motor

The term 'DC motor' refers to any rotary electrical machine that turns DC electrical energy into mechanical energy. DC motors come in a wide range of sizes and power levels - from small motors in toys and appliances to large mechanisms that power vehicles, operate elevators and hoists, and drive steel rolling mills.

DC motors consist of two main parts: the stationary stator and the rotating armature. The stator generates a spinning magnetic field that causes the armature to spin. This interaction between the stator's magnetic field and the armature's rotation is what drives the motor.

A basic DC motor uses fixed magnets in the outer part, and a coil of wire that carries electric current to create a magnetic field in the center. The coil is wrapped around the motor's core to focus the magnetic field. When the coils are turned on and off in sequence, a rotating magnetic field is created that interacts with the differing fields of the stationary magnets in the stator to create torque, which causes it to rotate. These key operating principles of DC motors allow them to convert the electrical energy from DC into mechanical energy through the rotating movement, which can then be used for the propulsion of objects.

3.4 MOTOR DRIVERS

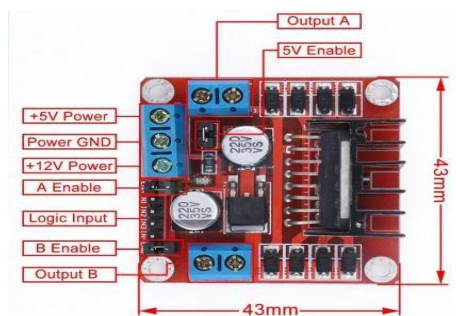


Fig.3.4: Motor Driver

This 16 pin Motor Driver is designed and developed based on L293DIC to provide bidirectional drive currents at voltages from 5V to 36 V.

The DC motor speed in general is directly proportional to the supply voltage, so if the voltage is reduced from 9 volts to 4.5 volts, then speed become half of what it originally had. But in practice, for changing the speed of a DC motor supply voltage cannot be changed beyond a limit. The speed controller PWM for a DC motor is utilized for this purpose. It works by varying the average voltage supplied to the motor and the input signals to PWM controller might be an analog or digital signal according to the design of the PWM controller. The PWM controller accepts the control signal and adjusts the duty cycle of the PWM signal according to the requirements Fig-: 4.6 Pin Diagram of L239D MOTOR DRIVER Pin 1: When Enable1/2 is HIGH, left part of IC will work,

i.e motor connected with pin 3 and pin 6 will rotate Pin 2: Input 1, when this pin is HIGH the current will flow though output 1. Pin 3: Output 1, this pin is connected with one terminal of motor. Pin 4/5: GND pins Pin 6: Output 2, this pin is connected with one terminal of motor. Pin 7: Input 2, when this pin is HIGH the current will flow though output 2. Pin 8: VSS, this pin is used to give power supply to connected motors from 5V to 36V maximum depends on Motor connected. Pin 9: When Enable 3/4 is HIGH, Right part of IC will work, i.e motor connected with pin 11 and pin 14 will rotate. Pin 10: Input 4, when this pin is HIGH the current will flow though output 4. Pin 11: Output 4, this pin is connected with one terminal of motor. Pin 12/13: GND pins. Pin 14: Output 3, this pin is connected with one terminal of motor. Pin 15: Input 3, when this pin is HIGH the current will flow though output 3. Pin 16: VCC, for supply power to IC i.e. 5V.

3.5 Arduino UNO

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them

independently and eventually adapt them to their particular needs. The software, too, is open- source, and it is growing through the contributions of users worldwide.

Input and Output

Arduino - Arduino Board Uno Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

The Uno is one of the more popular boards in the Arduino family and a great choice for beginners.

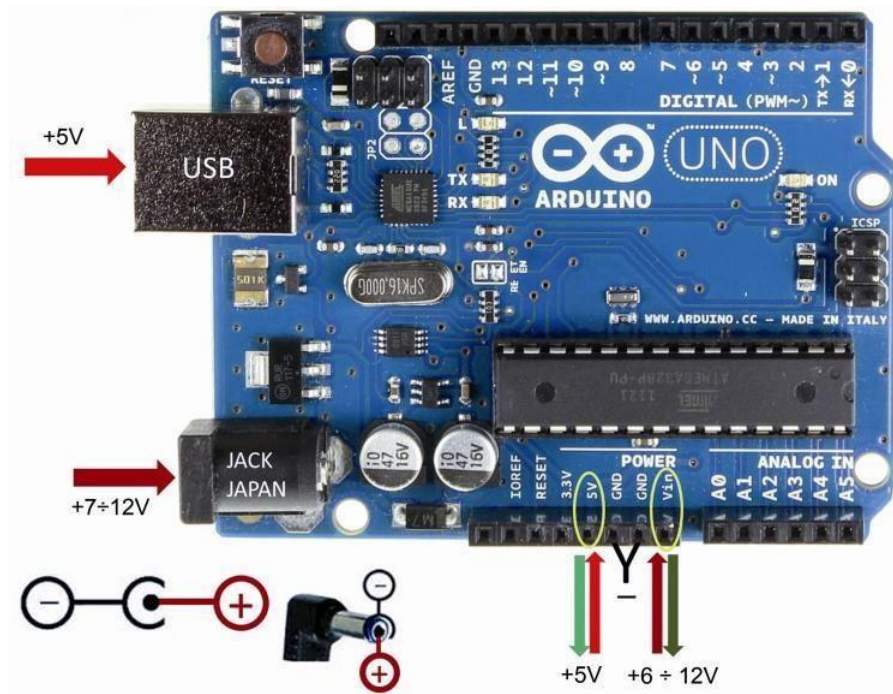


Fig.3.5: Arduino UNO Board

TABLE NO.1: Arduino UNO specifications

Microcontroller	ATmega328P – 8bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Boot loader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

3.6 VOLTAGE SENSOR

A voltage sensor is an electronic device that measures and monitors the electrical potential difference, or voltage, between two points in an electrical circuit. It is commonly used in various applications, including power systems, industrial processes, consumer electronics, and automotive systems. The voltage sensor plays a critical role in ensuring the safe and efficient operation of electrical equipment by providing accurate voltage measurements and transmitting the information to other devices or systems for further

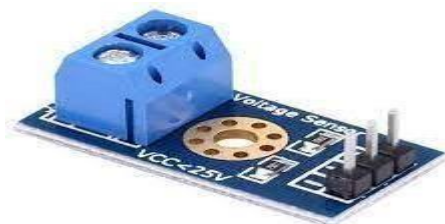


Fig:3.6: Voltage Sensor

A typical voltage sensor consists of several key components, including a sensing element, signal conditioning circuitry, and an output interface. The sensing element is the part of the voltage sensor that comes into contact with the electrical circuit and converts the electrical voltage into a measurable signal, which is then processed by the signal conditioning circuitry. The signal conditioning circuitry amplifies, filters, and isolates the signal to ensure accurate and reliable measurements. The output interface provides the means for transmitting the processed voltage measurement to other devices or systems, such as analog or digital output signals, communication protocols, or display interfaces.

3.7 CURRENT SENSOR

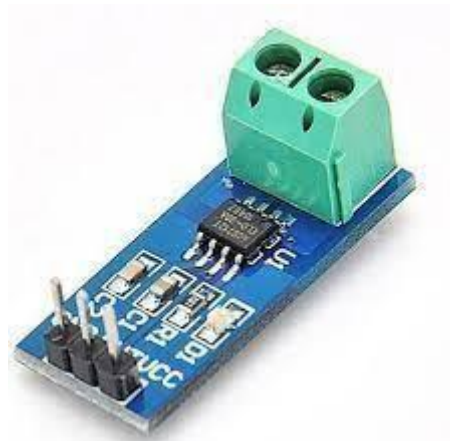


Fig.3.7: Current Sensor

electric current in a circuit. It is widely used in various applications, including power systems, motor control, battery management, renewable energy systems, and industrial processes. Current sensors play a crucial role in providing accurate current measurements, which are essential for monitoring and controlling electrical systems, ensuring safety, efficiency, and performance.

A typical current sensor consists of several key components, including a sensing element, signal conditioning circuitry, and an output interface. The sensing element is the part of the current sensor that comes into contact with the electrical current-carrying conductor and generates a measurable signal proportional to the current. The signal conditioning circuitry processes the signal, providing amplification, filtering, and isolation to ensure accurate and reliable measurements. The output interface provides the means for transmitting the processed current measurement to other devices or systems, such as analog or digital output signals, communication protocols, or display interface.



.3.8 :12V Fig Rechargeable Lead Acid Battery

A typical 12V battery is composed of one or more electrochemical cells connected in series to produce a total voltage of 12 volts. The cells are usually enclosed in a durable plastic or metal case and contain an electrolyte and one or more electrodes that undergo chemical reactions to generate electrical energy. The most common types of batteries used to produce 12V output are lead-acid batteries and lithium-ion batteries.

Lead-acid batteries are a type of rechargeable battery that uses lead plates and sulfuric acid as the electrolyte. They are widely used in automotive applications and other high-current applications due to their ability to deliver high power outputs. Lead- acid batteries are relatively inexpensive and have a long history of reliable performance, although they are relatively heavy and require periodic maintenance.

In conclusion, a 12V battery is a common type of rechargeable battery that provides a nominal voltage of 12 volts. It is widely used in various applications due to its versatility, including automotive, marine, recreational vehicles, UPS systems, solar power systems, and portable electronics. Whether it's a lead-acid or lithium-ion battery, proper handling, charging, and maintenance are essential to ensure its safe and reliable operation. The selection of the appropriate type of 12V battery depends on the specific requirements of the application in terms of power output, energy density, weight, and cost considerations.

