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Smart Battery Management System for Electric Vehicles using IoT Technology

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ABSTRACT:

The use of electric vehicles (EVs) has been increasing due to the need for sustainable transportation. However, the main challenge of EVs is the limited range of travel, which depends on the capacity of the battery. In order to ensure reliable and efficient use of EVs, it is necessary to monitor the state of the battery. Therefore, an IoT-based battery monitoring system can be used to track the health of the battery. The proposed IoT-based battery monitoring system for electric vehicles comprises of battery sensors, microcontroller, wireless communication module, and cloud server. The battery sensors measure the voltage, current, and temperature of the battery and send the data to the microcontroller. The microcontroller processes the data and transmits it to the cloud server through the wireless communication module. The cloud server stores the data and analyzes it to generate insights about the battery's health. The IoT-based battery monitoring system provides real-time monitoring of the battery's state, including its voltage, current, and temperature. This information can be used to optimize the performance of the battery and prolong its lifespan. The data generated by the system can also be used to predict the remaining range of the EV, which can help the driver plan the journey more efficiently.

Electric vehicles are popular for transportation in the current world and are taking the place of conventional vehicles since they provide a pollution-free environment. Several battery types, including lithium batteries, lead-acid batteries, nickel-metal batteries, and solid-state batteries, are utilized in electric cars. The Lithium battery is the most recommended of these battery kinds. Since it is more efficient than conventional batteries and has a high energy content per unit of mass. It can also be recycled. In this study, an Internet of Things-based battery management system is suggested.

This this project, observing the display of the car utilizing IoT approaches is proposed in this study, thus the testing should be apparent. The design and development of an IoT-enabled battery monitoring system. Monitoring entails keeping an eye on critical operating factors like as voltage, smoke, and temperature during charging and discharging. This is a hardware-timed sensor system that monitors and reports different variables such as temperature, voltage, and smoke on IOT so you can see when everything has achieved the correct value.

Keywords—ARDUINO UNO, MOTOR, IOT, SENSORS

1.INTRODUCTION

In today's hectic environment, electric vehicles play an important role in mobility. Electric vehicles (EVs) produce no emissions and help to keep our environment clean. To help the global environment grow green, the Indian government has tackled and launched the upgrading and manufacture of electric cars in the country. Electric vehicles improve power efficiency and provide fuel alternatives. EVs are battery electric vehicles that run entirely on energy and are more efficient than others. A hybrid electric vehicle is one that uses both an engine and a battery. A fuel cell electric car is one that operates on electricity generated by chemical energy**.**

Electric vehicles (EVs) have emerged as a promising solution for sustainable transportation. However, one of the major challenges in EVs is the limited range of travel, which is dependent on the capacity and health of the battery. Therefore, it is crucial to monitor the state of the battery to ensure the reliable and efficient use of EVs. In recent years, the Internet of Things (IoT) has gained significant attention in various industries, including automotive, due to its potential to provide real-time monitoring and control of devices remotely. The application of IoT in EVs can improve the performance and efficiency of the battery, as well as enhance the driving experience of the users. This paper proposes an IoT-based battery monitoring system for electric vehicles. The system consists of battery sensors, microcontroller, wireless communication module, and cloud server. The battery sensors measure the voltage, current, and temperature of the battery and send the data to the microcontroller. The microcontroller processes the data and transmits it to the cloud server through the wireless communication module. The cloud server stores the data and analyzes it to generate insights about the battery's health. The proposed system provides real-time monitoring of the battery's state, enabling the optimization of the battery's performance and prolonging its lifespan. Moreover, the data generated by the system can be used to predict the remaining range of the EV, which can help the driver plan the journey more efficiently.

2.LITERATURE SURVEY:

[1] In this study, an alternative method to the currently used methods for categorizing batteries according to their chemistry is discussed. Brand new and aged batteries are used in experimental setup that is consist of a programmable electronic DC load and a software developed to run the algorithm on it.

[2] The Battery Management System of an Electric Vehicle is a system designed to ensure safe operation of the battery pack, and report its state to other systems. It is a distributed system, and the communication between its sub-modules is performed through wired buses.

[3] 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.

[4] This paper proposes a real-time Battery Monitoring System (BMS) using the coulomb counting method for SOC estimation and messaging-based MQTT as the communication protocol, based on ease of implementation and less overall complexity. The proposed BMS is implemented using sufficient sensing technology, central processor, interfacing devices, and Node-RED environments on the hardware platform.

[5] States estimation of lithium-ion batteries is an essential element of Battery Management Systems (BMS) to meet the safety and performance requirements of electric and hybrid vehicles. Accurate estimations of the battery's State of Charge (SoC), State of Health (SoH), and State of Power (SoP) are essential for safe and effective operation of the vehicle.

[6] 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.

[7] This paper not only provides insights in the latest knowledge and developments of electric vehicles (EVs), but also the new promising and novel EV technologies based on scientific facts and figures—which could be from a technological point of view feasible by 2030.

[8 This paper deals with monitoring the state of charge of the battery along with temperature, current for Solar panel fitted with battery for residential application

[9] Hence the energy demand will be higher when EVs are brought into the public transportation system. In this review paper, the solar-powered charging station for an electric vehicle is evaluated by tilting the solar panel at a different angle, then the maximum efficiency and power that can be obtained from the solar light depending on the wavelength of the sunlight are analyzed. Photovoltaic (PV) panels can be able to charge electric vehicles (EVs) sustainably.

[10] This paper aims to boost the performance of a photovoltaic system by employing a suitable algorithm to control the power interface. The main goal is to find an effective and optimal control law that will enable the photovoltaic generator (GPV) to generate the maximum amount of power possible.

3.PROPOSED METHOD

The system would include battery sensors that measure the voltage, current, temperature, and other relevant parameters of the battery. The sensors would transmit the data wirelessly to a central hub. Wireless network: The system would rely on a wireless network, such as Wi-Fi or cellular, to transmit the data from the sensors to the central hub. The central hub would receive and process the data from the battery sensors, using analytics and algorithms to identify any abnormalities or faults in the battery. The hub would also provide a user interface for the driver or user to monitor the battery's state and receive alerts or notifications. The system could also include a cloud-based platform that stores and analyzes the data generated by the battery sensors. The platform could provide additional analytics and insights into the battery's performance, as well as enable remote monitoring and control of the battery. Machine learning and artificial intelligence: The system could also incorporate machine learning and artificial intelligence (AI) algorithms to analyze the data from the battery sensors and identify patterns and anomalies that might indicate potential issues with the battery. The AI algorithms could also be used to predict the battery's remaining lifespan and optimize its performance. Mobile application: The system could also include a mobile application that provides a user interface for the driver or user to access the battery's data and receive alerts or notifications on their smartphone.

The suggested IOT-based battery management solution for electric vehicles. This system includes a voltage sensor that detects voltage and updates the IOT. The temperature sensor is used to detect the temperature of the battery; if the temperature rises, a buzzer alarm is sent and shown on the LCD. To ensure safety, the system is linked to a smoke sensor, which detects smoke in the battery and sounds an alert. When the voltage surpasses a specific level,

the overvoltage button illuminates. The measured parameters are updated in the IOT and shown on the LCD display.

4.SOFTWARE DESCRIPTION:

4.1.ARDUINO IDE

An Arduino program may be written in any programming language and processed via a compiler to create binary machine code for the target processor. AVR Studio and the upgraded Atmel Studio are Atmel microcontroller development environments. The Arduino project comprises the Arduino integrated development environment (IDE), a cross-platform Java program. It grew from the IDE for the Processing and Wiring programming languages. It includes a code editor with text cutting and copying, text finding and replacing, automatic indenting, brace matching, and syntax highlighting, as well as one-click compilation and uploading methods for Arduino boards. It also has a message area, a text terminal, a toolbar with buttons for common operations, and a hierarchy of operating menus. A sketch is a program that was generated using the Arduino IDE. Sketches are saved in the form of text files with the file extension. Arduino software (ide) pre-1.0 stored drawings with the extension, whereas ino on the development machine. pde. By utilizing unique code organization rules, the Arduino IDE supports the programming languages C and C++. The arduino ide includes the wiring project's software library, which covers many common input and output activities. User-written code only requires two basic functions, which are compiled and linked into an executable cyclic executive program with the GNU tool chain, which is also provided with the IDE version. The Arduino IDE employs avrdude to convert executable code into a hexadecimal-encoded text file, which is subsequently loaded into the Arduino board through a loader program in the board's firmware. A simple Arduino C/C++ sketch, as seen by the Arduino IDE programmer, consists of only two functions: setup: This function is called once when a sketch starts after a power-up or reset. It is used to configure variables, input and output pin modes, and other libraries that the sketch requires.

4.2.PROTEUS

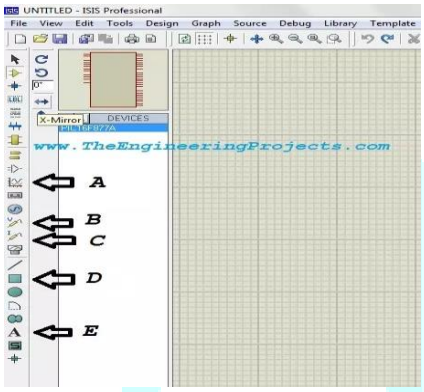
Proteus is an electronic circuit design, simulation, and PCB layout design software application. Electronic engineers, amateurs, and students frequently use it to create and simulate electronic circuits and devices. Proteus' major characteristics include:

Capabilities for simulation and design: Proteus allows users to create and model electronic circuits and devices such as microcontrollers, power supplies, and sensors. Proteus offers mixed-mode simulation, which allows for the modeling of analog, digital, and mixed-signal circuits.

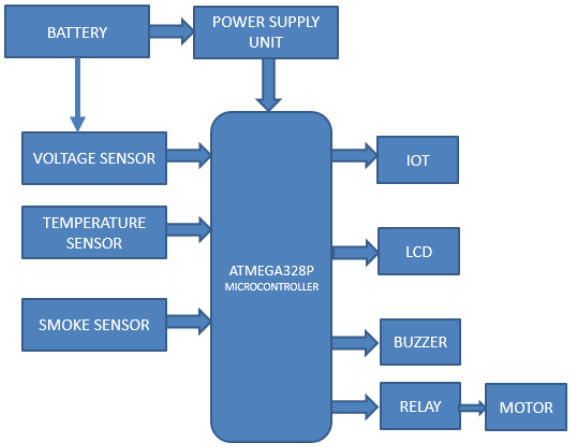
Virtual instrumentation: Proteus contains a number of virtual instruments for testing and debugging circuits, like as oscilloscopes, logic analyzers, and waveform generators.

PCB layout design: Proteus comes with a tool that lets users design PCB layouts, tweak them, and produce manufacturing files. Microcontrollers, sensors, and integrated circuits are just a few of the electronic parts that may be found in Proteus' extensive library and employed in circuit design.

Real-time simulation: Proteus can simulate circuits in real-time, enabling users to watch a circuit's operation in action. Interactive debugging: Proteus has a capability for interactive debugging that lets users find and correct mistakes in their circuit designs. The electronics industry, academia, and research all rely heavily on Proteus, a potent tool for electrical circuit design and modeling.



5.HARDWARE BLOCK DIAGRAM:



HARDWARE BLOCK DIAGRAM

5.1.HARDWARE EXPLANATION:

This project discribe the electric vehicle setting.we are used in temperature sensor,voltage sensor,smoke sensor.the voltage sensor sense the battery voltage,because battery condition monitor to the voltage sensor.the temperature sensor,sense the vehicle temperature condition and the smoke sensor sense the,if any person to drive the vehicle will stop automatically.the sensors winformation share to the LCD and IOT.the IOT monitor the vehicle condition in anywhere.if any sensor value are high the buzzer will be on to indimate the driving person.

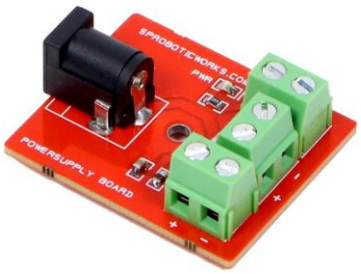
METHODS

MODULE LIST

- POWER SUPPLY
- ATMEGA328P MICROCONTROLLER
- BATTERY
- VOLTAGE SENSOR
- TEMPERATURE SENSOR
- SMOKE SENSOR
- NODEMCU
- RELAY
- DC MOTOR
- LCD
- BUZZER

5.2.MODULE DESCRIPTION:

POWER SUPPLY



Electricity is the lifeblood of any electronic system, and the power supply is what keeps it running. Selecting the correct power source might be the difference between a gadget that performs optimally and one that produces inconsistent results. DC to DC converters are available in addition to alternating current (AC) to direct current (DC) power sources. If your system already has DC, a DC to DC converter may be a better design choice than the AC mentioned below. Unregulated or regulated direct current power supply are available. Regulated supplies are available in a variety of configurations, including linear, switching, and battery-based.

A power supply takes alternating current from a wall outlet, transforms it to unregulated direct current, and then steps it down to the voltage required by the load using an input power transformer. The transformer also isolates the output power supply from the mains input for safety reasons. There are two types of AC power supplies: uncontrolled and regulated. Unregulated power supplies are the most basic sort of power supply and cannot provide a stable voltage to a load, whereas regulated power supplies can and have many other design possibilities. Linear converters are the simplest but produce the greatest heat, whereas switched converters are more involved and produce less noise. Typically, batteries are switched converters.

5.3.ATMEGA328P MICROCONTROLLER

Arduino has been utilized in hundreds of different projects and applications. The Arduino software is simple to use for novices while yet being versatile enough for expert users. It is compatible with Mac, Windows, and Linux. Instructors and students use it to create low cost scientific equipment, to verify chemistry and physics principles, or to get started with programming and robotics. Designers and architects develop interactive prototypes, musicians and artists utilize it for installations and to experiment with new musical instruments. Makers, of course, utilize it to create many of the creations presented at the Maker Faire, for example. Arduino is an essential tool to learn new things. . Everyone - youngsters, amateurs, artists, and programmers - may begin tinkering by simply following the step-by-step instructions of a kit or by exchanging ideas online with other members of the Arduino community.

For physical computing, there are several additional microcontrollers and microcontroller platforms available. Similar capability is provided by Parallax Basic Stamp, Netmedia's BX-24, Phi gets, MIT's Handy board, and many more programs. All of these tools take the tangled nuances of microcontroller programming and package them in a user-friendly format. Although alternative systems simplify working with microcontrollers, Arduino has some advantages for instructors, students, and curious.

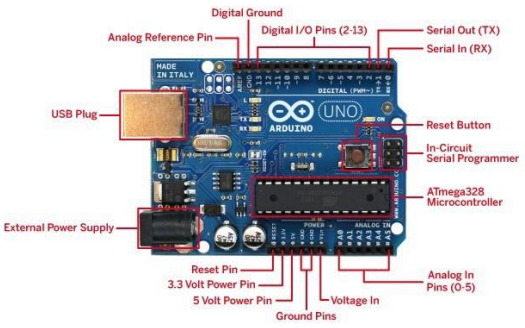
Amateurs: In comparison to other microcontroller systems, Arduino boards are comparatively affordable. Cross-platform - The Arduino Software (IDE) is available for Windows, Macintosh OSX, and Linux. Most microcontroller systems are only compatible with Windows. Easy, straightforward Programming environment - The Arduino Software (IDE) is simple enough for novices to use while yet being versatile enough for expert users to benefit from. It's built on the Processing programming environment, which is useful for teachers because students learning to code in that environment will be familiar with how the Arduino IDE works.

Open source and extendable software - The Arduino software is accessible as open source tools for skilled programmers to extend. The language may be expanded using C++ libraries, and those interested in the technical intricacies can switch from Arduino to the AVR C programming language on which it is based.

Similar to that, if you choose, you may directly include AVR-C code into your Arduino applications.

Hardware that is open source and extendable - The Arduino boards' blueprints are made available under a Creative Commons license, allowing qualified circuit designers to create their own version of the module while modifying and expanding it.

The breadboard version of the module may be constructed by even relatively unskilled users in order to comprehend its operation and save money.



6.BATTERY:

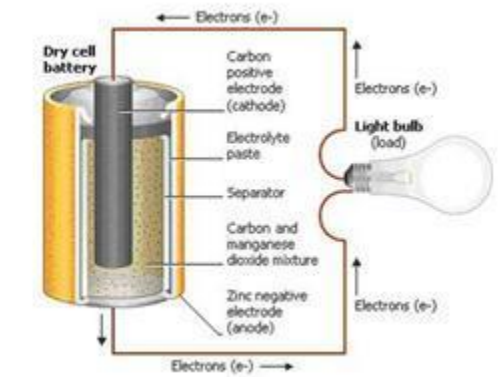
A battery is an electronic device that turns chemical energy into electrical energy. The chemical processes of a battery include the transfer of electrons from one substance (electrode) to another via an external circuit. The movement of electrons produces an electric current, which may be employed to do work. To balance the flow of electrons, charged ions pass through an electrolyte solution in contact with both electrodes. Various electrodes and electrolytes induce different chemical reactions, which influence how the battery operates, how much energy it can store, and how much voltage it can produce. A battery is defined as a collection of one or more electrochemical cells that are capable of turning stored chemical energy into electrical energy.

A useful battery must have the following characteristics:

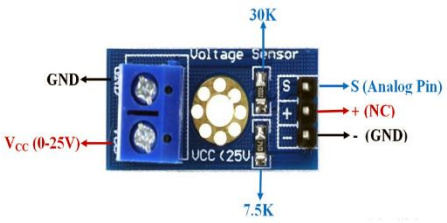
It should be light and compact in size

The cell or battery must have the ability to provide a steady voltage. Also, the battery or cell's voltage must not alter while in operation. A battery is a device composed of voltaic cells. Each voltaic cell consists of two half cells connected in series by a conductive electrolyte containing anions and cations.

The electrolyte and the electrode to which anions migrate, known as the anode or negative electrode, are located in one half of the cell; the electrolyte and the electrode to which cations move, known as the cathode or positive electrode, are located in the other half of the cell.



6.1.VOLTAGE SENSOR

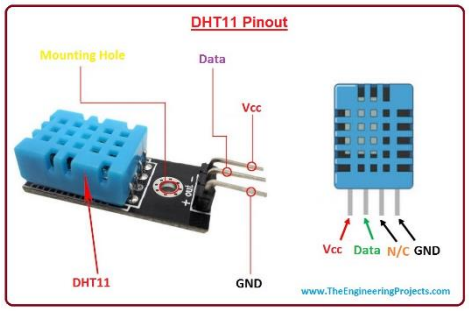


This sensor measures, calculates, and determines the voltage supply. This sensor can detect the amount of AC or DC voltage. This sensor's input can be voltage, and its output can be switches, analog voltage signals, current signals, audio signals, and so on. Some sensors produce sine waveforms or pulse waveforms, while others can produce AM (Amplitude Modulation), PWM (Pulse Width Modulation), or FM waveforms (Frequency Modulation). The voltage divider can affect the measurement of these sensors. This sensor has both input and output. The input side consists mostly of two pins, positive and negative. The device's two pins can be linked to the sensor's positive and negative pins.

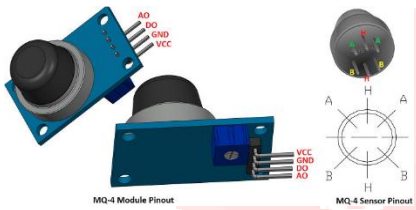
This sensor's output primarily contains supply voltage (Vcc), ground (GND), and analog o/p data. Voltage Sensor Types These sensors are divided into two types: resistive sensors and capacitive sensors.

6.2.TEMPERATURE SENSOR

The temperature sensor is a sensor that detects temperature and converts it into a useful output signal, and it is the main component of a temperature measurement device. It is classified into five categories, each with its own set of operating principles. Also, several considerations must be made throughout the installation and use processes. Because temperature sensors correctly monitor ambient temperature, they are extensively employed in a variety of areas and provide convenience for people's production and daily lives. One of the most common sensors is the temperature sensor, which is found in computers, autos, kitchen appliances, air conditioners, and residential thermostats. The thermocouples, Thermistors, RTDs (Resistance Temperature Detectors), analog thermometer IC, and digital thermometer IC are the five most popular forms of temperature sensors.



6.3.SMOKE SENSOR



A smoke sensor is a device that detects the presence or concentration of gases in the surrounding environment. The sensor generates a corresponding potential difference based on the concentration of the gas by altering the resistance of the material inside the sensor, which may be detected as output voltage. The nature and concentration of the gas may be calculated using this voltage value. The sort of smoke that the sensor can detect is determined by the detecting material used inside the sensor. These sensors are often supplied as modules with comparators, as indicated above. These comparators may be configured for a certain threshold value of smoke concentration. When the gas concentration surpasses this level, the digital pin swings high.

A simple smoke sensor contains six terminals, four of which are input or output (A, A, B, B) and two of which are for heating the coil (H, H). Two terminals on each side can be used as either input or output (as illustrated in the circuit design), while the other two can be used as both.

Pinout of smoke Sensor these sensors are often offered as modules, which include the smoke sensor and a comparator IC. At the pin out of the smoke sensor module, which we'll be using with an Arduino in most cases. The smoke sensor module is made up of four terminals.

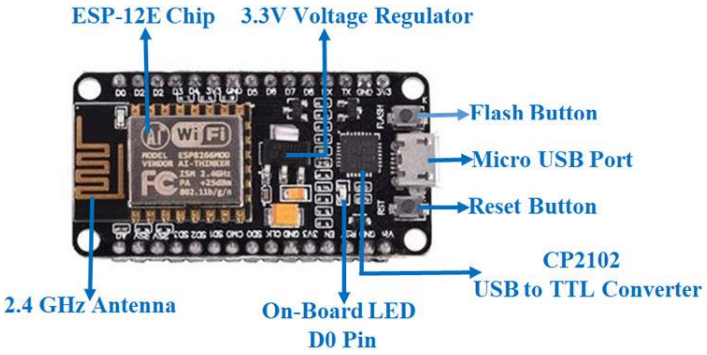
Power supply (Vcc)

GND - Power source

. Digital output - This pin provides a logical high or logical low (0 or 1) output, indicating the presence of hazardous or combustible gases near the sensor.

Analog output - This pin provides a continuous in voltage output that fluctuates with the concentration of gas delivered to the gas sensor.

7.NODEMCU:



The NodeMCU (Node Microcontroller Unit) is an open source software and hardware development environment based on the ESP8266, a low-cost System-on-a-Chip (SoC). The Espressif Systems ESP8266 has all critical parts of a contemporary computer: CPU, Memory, networking (wifi), and even a current operating system and SDK. The ESP8266 chip is only $2 USD per piece when purchased in bulk. As a result, it is a fantastic alternative for all types of IoT projects. We can read inputs - a light on a sensor, a finger on a button, or a Twitter post - and transform them into outputs - actuating a motor, turning on an LED, or publishing anything online - using its pins. It also has WiFi capabilities, allowing us to control it electronically.

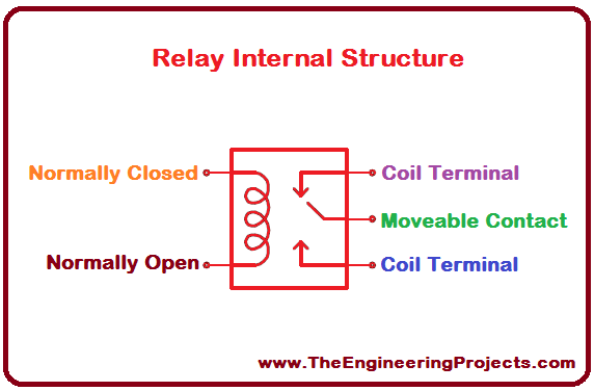
We can read inputs - a light on a sensor, a finger on a button, or a Twitter post - and transform them into outputs - actuating a motor, turning on an LED, or publishing anything online - using its pins. It also has WiFi capabilities, allowing us to operate it electronically and quickly make it function on a remote installation! We may direct our board by delivering a series of instructions to the board's microcontroller. We can accomplish this by utilizing the Arduino Software (IDE). We can read inputs - a light on a sensor, a finger on a button, or a Twitter post - and transform them into outputs - actuating a motor, turning on an LED, or publishing anything online - using its pins. It also has WiFi capabilities, allowing us to operate it electronically and quickly make it function on a remote installation! We may direct our board by delivering a series of instructions to the board's microcontroller. We can accomplish this by utilizing the Arduino Software (IDE).

Applications IoT device prototyping Battery-powered apps with low power consumption Projects involving networks Projects that need various I/O interfaces with Wi-Fi and Bluetooth capabilities

7.1.RELAY

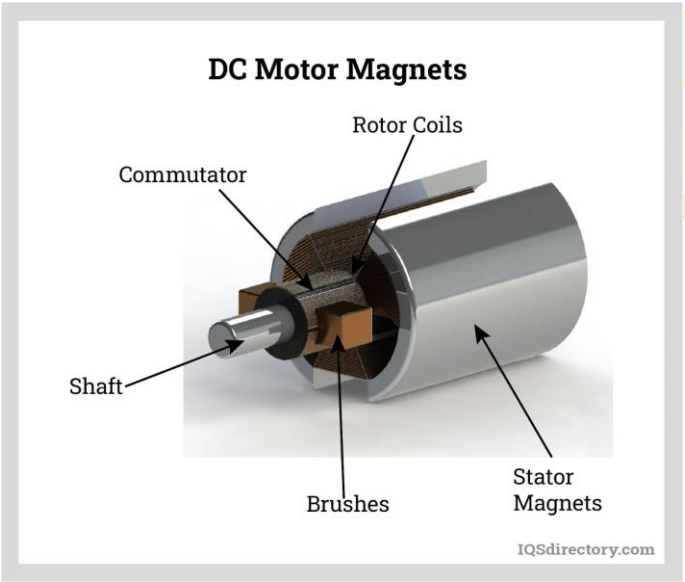
A relay is an electromagnetic switch that can turn on or off a substantially greater electric current using a very tiny electric current. An electromagnet is at the core of a relay (a coil of wire that becomes a temporary magnet when electricity flows through it). Consider a relay to be an electric lever: turn it on with a little current, and it turns on (or "levers") another device with a much larger current. A relay, on the other hand, utilizes an electrical signal to drive an electromagnet, which in turn connects or disconnects another circuit, rather than a manual process. Several types of relays exist, such as electromechanical and solid state. Electromechanical relays are commonly employed. Let us first examine the internal components of this relay before learning how it works. Despite the presence of several types of relays, their operation is the same. Every electromechanical relay is made

up of an electromagnet. Contact that can be moved mechanically spring and switching points an electromagnet is made by winding a copper coil around a metal core. The coil's two ends are attached to the relay's two pins as illustrated. These two serve as DC power supply pins.



7.2.DC MOTOR

Continuous actuators that transform electrical energy into mechanical energy are known as direct current motors. The DC motor does this by providing a constant angular rotation, which may be used to rotate pumps, fans, compressors, wheels, and other similar devices. In addition to traditional rotary DC motors, linear motors capable of providing continuous liner movement are provided. A direct current motor is made up of two parts: a "Stator," which is stationary, and a "Rotor," which rotates. As a result, there are three primary types of DC motors available. Motor with a brushed finish the brushless motor the servo motor the gear motor.



7.3.LCD

A liquid-crystal display (LCD) is a flat-panel display or other electronic visual display that makes advantage of liquid crystals' light-modulating characteristics. Liquid crystals do not directly emit light. The command register holds the LCD's command instructions. A command is an order issued to an LCD to do a specific action such as initializing it, clearing its screen, setting the cursor location, managing the display, and so on. The data register saves the information that will be presented on the LCD. Computer monitors, TVs, instrument panels, aircraft cockpit displays, and signs are all examples of electronic displays. They are widespread in consumer gadgets such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have virtually completely replaced cathode ray tube (CRT) displays.

7.4.BUZZER

A buzzer, often known as a beeper, is a sound-producing signaling device. It might be mechanical, electromechanical, or piezoelectric in nature.

This Piezo buzzer is 23 mm in diameter and has mounting holes spaced 30 mm apart. It comes with a 100 mm lead and is suited for 3 - 20V. At 3Com, it generates a kHz tone at an 85 dB level. Specifications:

- Voltage of operation: 3-20V DC
- Current: 15 mA
- SPL: 85dBA/10cm
- Frequency: 3,300Hz
- Color: black
- Operating Temperature: -20° to +60° C.

Buzzers are available in a range of construction, size, and specification options. Buzzers of various shapes and sizes are used for a variety of purposes. Buzzers are classified into the following categories based on their construction:

- Piezoelectric buzzers.
- Magnetic buzzers.
- Electromagnetic buzzers.
- Mechanical buzzers.
- Electromechanical buzzers.

Conclusion:

An IoT-based battery monitoring system in electric vehicles can provide numerous benefits, such as real-time monitoring, predictive maintenance, improved battery performance and longevity, enhanced user experience, and optimized charging patterns. The system can also enable remote monitoring and control of the battery, which is especially beneficial for fleet management. However, there are also potential demerits to consider, such as cost, data privacy and security, connectivity issues, false alerts, and integration with existing systems. It is important to carefully evaluate the feasibility and effectiveness of the system, and to implement appropriate security measures to protect the data transmitted wirelessly.

The study detailed the design and development of an IoT-based battery monitoring system for electric vehicles in order to monitor battery performance deterioration online. The goal is to demonstrate that the notion of the idea can be implemented. The system's development includes the creation of hardware for the battery monitoring device as well as a web-based battery monitoring user interface. A hardware event for the battery monitor and a web-based battery monitoring interface comprise the system's event. The system is capable of communicating information such as position, battery condition, and time through the internet by integrating an IOT system to identify the coordinate and display it on the mobile application.

8.ADVANTAGES AND DISADVANTAGES:

8.1.ADVANTAGES

- Real-time monitoring
- Improved battery performance
- Longer battery lifespan
- Enhanced safety
- Efficient journey planning
- Remote monitoring and
- Control

8.2.DISADVANTAGES

- Cost
- Data privacy and
- Security
- Connectivity issues
- False alerts
- Integration with existing systems

9.APPLICATION :

- Fleet management
- Predictive maintenance
- Charging optimization
- User interface
- Environmental monitoring
- Warranty tracking

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