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CLOUD BASED BATEERY MANAGEMENT SYSETM

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Abstract : This project mainly aims on the safe and effective operation of rechargeable batteries. With the increased usage of renewable energy sources such as solar panels and the proliferation of Internet of Things (IoT) devices, the need for cloud-based BMS has grown. This study presents a cloud-based BMS system based on IoT, Arduino, ESP 8266 module, current sensor, on-off switch, battery, solar panel, LED, and LCD display. The suggested solution uses an ESP 8266 module to link the BMS to the internet, allowing it to interface with cloud services. The BMS will use a current sensor to monitor the battery voltage and current and adjust the charging and discharging rates as needed to optimise battery performance. The system also contains an on/off switch to manage the flow of electricity to the battery, a solar panel to replenish the battery, and an LED to display battery condition. The LCD display will show the battery's current state of charge, and the cloud-based interface will allow the user to remotely monitor and operate the BMS. The suggested system's main advantage is that it allows for remote access to battery status and control, making it perfect for remote sites or IoT devices that require ongoing monitoring and control. Finally, the suggested cloud-based BMS system provides an efficient and effective solution to manage batteries and renewable energy sources. Its usage of IoT, Arduino, ESP 8266 module, current sensor, on-off switch, battery, solar panel, LED, and LCD display makes it very adaptable and configurable to fulfil a wide range of application needs.

INTRODUCTION

Battery Management Systems (BMS) are critical for maintaining the safe and efficient functioning of rechargeable batteries. BMS systems can assist optimize battery performance, increase battery life, and avoid damage or failures. With the increased usage of renewable energy sources such as solar panels and the proliferation of Internet of Things (IoT) devices, the demand for efficient and effective BMS systems has grown. at recent years, cloud-based BMS solutions have arisen as a solution to the issues of managing batteries at remote places or IoT devices that demand ongoing monitoring and management. Cloud-based BMS systems can allow remote access to battery status and control, making them perfect for situations where human monitoring and control are not practicable or practical.In this study, we present a cloud-based BMS system based on IoT, Arduino, ESP 8266 module, current sensor, on-off switch, battery, solar panel, LED, and LCD display. This suggested method has the potential to improve battery performance, increase battery life, and minimize maintenance costs. It can also enable remote access to battery status and control, making it suitable for remote sites or IoT devices that require ongoing monitoring and management. Overall, the suggested system provides an efficient and effective method of managing batteries and renewable energy sources.

EXISTING SYSTEM

Existing battery management systems (BMS) primarily rely on wired or wireless connections to send data between the battery and a control device. These systems frequently employ microcontrollers or specialized chips to monitor battery properties such as voltage, current, and temperature. They may also have overcharge and over-discharge prevention to prevent battery damage or failure. However, standard BMS systems have limits, particularly when it comes to remote monitoring and control. Wired connections may not be viable or practicable in distant areas or IoT devices, while wireless connectivity may have limited range or dependability. Furthermore, the cost and complexity of standard BMS systems might be prohibitive for small-scale applications or DIY projects.To solve these restrictions, cloud-based BMS systems have evolved as a solution that may give remote access to battery status and control. These systems often rely on IoT devices to link the BMS to the internet, allowing it to communicate with cloud services. The cloud-based interface can allow real-time monitoring and management of the battery, making it perfect for remote sites or IoT devices that require continual monitoring and control. In summary, while traditional BMS systems have been efficient in controlling batteries, they have limits, particularly when it comes to remote monitoring and management. Cloud-based BMS systems have evolved as a solution that may enable remote access to battery status and control, making them perfect for remote sites or IoT devices.

DISADVANTAGE

- One of the primary downsides of cloud-based BMS systems is their dependency on internet access. The system requires a robust and dependable internet connection to work properly, which might be difficult in isolated or rural places. A lack of internet access can result in a loss of monitoring and control capabilities, which can be damaging to battery performance and maintenance.

- Another drawback is the possibility of security breaches or hacking. Because cloud-based BMS systems save data on distant servers, there is a danger that critical information about the battery or the system may be accessed by unauthorized persons. It is critical to deploy suitable security measures to avoid data breaches or unauthorized access.

- The expense of adopting a cloud-based BMS system might also be an issue. The cost of components and software might be high depending on the complexity and features of the system. This cost may be prohibitive for small-scale applications or DIY projects.

- Finally, the complexity of a cloud-based BMS system might be a disadvantage for individuals who are unfamiliar with the essential technologies, such as IoT devices, programming, and cloud computing. It may be necessary to have particular knowledge and abilities in order to efficiently develop, deploy, and maintain the system.

- While cloud-based BMS systems have numerous advantages, such as remote monitoring and control capabilities, they also have drawbacks, such as dependency on internet access, security threats, high cost, and complexity. These aspects must be addressed when determining if a cloud-based BMS system is the best answer for a certain application.

PROPOSED SYSTEM:

The suggested system is a cloud-based BMS system that makes use of IoT, Arduino, ESP 8266 module, current sensor, on-off switch, battery, solar panel, LED, and LCD display. The technology seeks to improve battery performance, prolong their longevity, and save maintenance costs while allowing remote access to battery monitoring and control.
The system's major components are an IoT device (in this example, an ESP 8266 module), an Arduino micro controller, and a cloud-based interface. The ESP 8266 module links the BMS system to the internet, allowing it to communicate with cloud services. The Arduino micro controller monitors battery characteristics such as voltage and current using a current sensor and offers overcharge and over-discharge prevention. The system can additionally contain an on/off switch to manage the charging and draining of the battery.The cloud-based interface allows for real-time monitoring and control of the battery. It may show battery metrics such as voltage, current, and temperature, as well as give alarms when the battery is running outside of safe operating norms. The cloud-based interface may also handle the on-off switch, allowing for remote management of the battery's charging and draining. The system may include a solar panel to charge the battery, making it perfect for remote sites or IoT devices that require ongoing monitoring and management. An LED or LCD display can offer visual feedback on battery status, such as charging or discharging status, remaining battery life, and other information.The suggested system provides an efficient and effective solution to manage batteries and renewable energy sources, allowing for remote monitoring and management while maximizing battery performance and lowering maintenance costs. The system may be changed and scaled based on the unique application and requirements.

ADVANTAGE:

- Remote monitoring and control: The system enables for real-time monitoring and control of battery state and performance, making it perfect for remote sites or IoT devices that require continual monitoring and management.

- Battery performance optimization: The system may enhance battery performance by monitoring battery parameters such as voltage and current and offering overcharge and over-discharge protection, prolonging the battery's lifespan and lowering maintenance costs.

- Renewable energy source: The system can contain a solar panel to charge the battery, making it a perfect alternative for applications that demand a renewable energy source.

- Customizability: The system may be adjusted and scaled based on the unique application and requirements, making it a versatile solution for a variety of applications.

- Cost-effective: The system may be created with relatively modest components, giving it a cost-effective alternative when compared to standard BMS systems
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- User-friendly: The system can feature an LED and LCD display to offer visual input on battery state, making it simple to operate and comprehend.

HARDWARE USED:

ARDUINO UNO:

The Arduino Uno is a micro controller board based on the 8-bit ATmega328P microprocessor. It includes auxiliary components to assist the micro controller, such as a crystal oscillator, serial communication, a voltage regulator, and so on, in addition to the ATmega328P. The Arduino Uno contains 14 digital input/output pins (of which 6 may be used as PWM outputs), 6 analog input pins, a USB connection, a power barrel connector, an ICSP header, and a reset button

HOW TO USE ARDUINO:

In Arduino programming, the 14 digital input/output pins may be utilized as input or output pins by utilizing the pin Mode(), digital Read(), and digital Write() methods.
Each pin operates at 5V and contains an inbuilt pull-up resistor of 20-50 K Ohms that is unconnected by default. Some of he 14 pins have special roles, which are detailed below:
• Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are linked to the matching ATmega328P USB to TTL serial chip.
•External Interrupt Pins 2 and 3: These pins can be set to cause an interrupt on a low value, a rising or falling edge, or a value change.

• PWM Pins 3, 5, 6, 9, and 11: Using the analog Write() method, these pins give an 8-bit PWM output.

• SPI Pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK): These are the SPI communication pins.
• In-built LED Pin 13: This pin is linked to an in-built LED; when pin 13 is HIGH, the LED is turned on; when pin 13 is LOW, the LED is turned off.
In addition to the 14 digital pins, there are 6 analog input pins, each of which has a resolution of 10 bits, or 1024 possible values. They measure between 0 and 5 volts, although this limit may be raised by utilizing the AREF pin with the analog Reference() function. Analog pins 4 and 5 (SDA and SCA) are also utilized for TWI communication with the Wire library.
Other pins on the Arduino Uno are described below:
• AREF: Used in the analogReference() function to give a reference voltage for analog inputs.
• Reset Pin: By setting this pin to LOW, the microcontroller is reset.

COMMUNICATION:

Arduino can connect with a computer, another Arduino board, or other micro controllers. The ATmega328P micro controller supports UART TTL (5V) serial communication through digital pins 0 (Rx) and 1 (Tx).
An ATmega16U2 on the board routes serial communication over USB and appears as a virtual com port to computer applications. The ATmega16U2 firmware makes use of conventional USB COM drivers, therefore no additional drivers are required. However, a.inf file is required on Windows.
The Arduino software features a serial monitor that allows basic textual data to be transferred to and from the Arduino device. The Arduino board has two RX and TX LED's that blink when data is delivered via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1).
A Software Serial library enables serial communication on any of the Uno's digital pins. The ATmega328P additionally supports I2C (TWI) and SPI communication. The Arduino software contains a Wire library that simplifies the usage of the I2C bus.

LCD:

- LCD (Liquid Crystal Display) is a type of flat panel display that employs liquid crystals as its principal mode of operation.LCD is defined by its name. It is a mixture of two states of matter, solid and liquid. A liquid crystal is used to generate a viewable image on an LCD. LCD technologies enable screens to be substantially thinner than cathode ray tube (CRT) technology.

- In an LCD display, pixels are turned on and off electrically utilizing liquid crystals to spin polarized light.
- LCD's are utilized in a variety of applications, including LCD televisions, computer monitors, instrument panels, aviation cockpit displays, and indoor and outdoor signs.
- LCD's (Liquid Crystal Displays) are used in embedded system applications to show system parameters and status.
- LCD 16x2 is a 16-pin device with two rows of 16 characters each.
- LCD 16x2 can be utilized in 4-bit or 8-bit mode.
- Custom characters can also be created.
- It contains 8 data lines and 3 control lines that may be utilized for control.

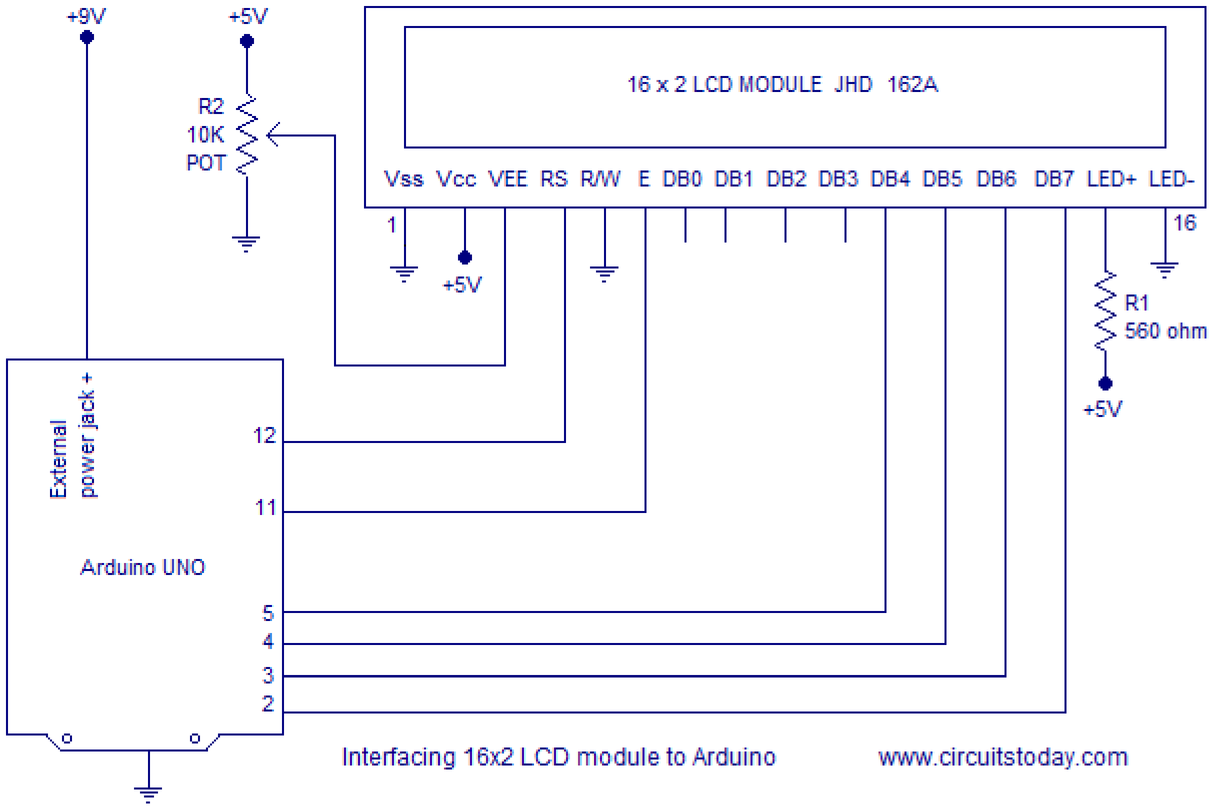
INTERFACING 16×2 LCD TO ARDUINO:

LCD modules form a very important part in many Arduino based embedded system designs. So the knowledge on interfacing LCD module to Arduino is very essential in designing embedded systems. This section of the article is about interfacing an Arduino to 16×2 LCD. JHD162A is the LCD module used here. JHD162A is a 16×2 LCD module based on the HD44780 driver from Hitachi. The JHD162A has 16 pins and can be operated in 4-bit mode (using only 4 data lines) or 8-bit mode (using all 8 data lines). Here we are using the LCD module in 4-bit mode. The JHD162A lcd module has 16 pins and can be operated in 4-bit mode or 8-bit mode. Here we are using the LCD module in 4-bit mode. Before going in to the details of the project, let’s have a look at the JHD162A LCD module.

16×2 LCD TO ARDUINO CIRCUIT DIAGRAM

RS pin of the LCD module is connected to digital pin 12 of the Arduino. R/W pin of the LCD is grounded. Enable pin of the LCD module is connected to digital pin 11 of the Arduino. In this project, the LCD module and Arduino are interfaced in the 4-bit mode. This means only four of the digital input lines(DB4 to DB7) of the LCD are used. This method is very simple, requires less connections and you can almost utilize the full potential of the LCD module. Digital lines DB4, DB5, DB6 and DB7 are interfaced to digital pins 5, 4, 3 and 2 of the Arduino.

The 10K potentiometer is used for adjusting the contrast of the display. 560 ohm resistor R1 limits the current through the back light LED. The Arduino can be powered through the external power jack provided on the board. +5V required in some other parts of the circuit can be tapped from the 5V source on the arduino board. The arduino can be also powered from the PC through the USB port.



CURRENT SENSORS:
A current sensor is a device that detects and converts current to produce an output voltage that is proportionate to the current in the intended route. When current flows across a circuit, a voltage drop occurs across the path of the current. A magnetic field is also produced around the current-carrying conductor.

CURRENT SENSING ELEMENT:
Current sensing is the creation of a voltage signal that is proportional to the current flowing in the circuit. To be sensitive, a resistor is placed in the path of current. The detected resistor can then be placed anywhere in series with the circuit, possibly as a load or switch. As a result, current sensing devices should be regarded as current to voltage converters.

SOLAR PANEL:

- USB port charging for a 1.12 volt polycrystalline solar panel.
- .High conversion speed, high output efficiency.
- .Tempered glass with a high transmittance.
- A novel method of preventing water from freezing within the deforming structure.
- The 10W 12Volts 36-cell Solar Panel (41 x 30 cm) for DIY Projects is ready to use and does not require a frame or other extra adjustments. We selected to sell these Polycrystalline solar cells because they are laser cut to the correct size and encased in specific sun and weather-resistant materials that give them distinctive qualities.
- Polycrystalline solar cells are housed and protected by a sturdy outer poly frame in the 12v 10W small Solar Panel. This 3v 150mA small Solar Panel for DIY Projects is made of light weight, highly sturdy, and weather-resistant substrates or injection molded trays that have been custom-designed for the target product. These Small Epoxy Solar Panels are easy to install or add to your existing product, and they don't require a frame or other specific adjustments. Polycrystalline solar cells produce two to three times the energy of amorphous thin-film solar panels.

BATTERY:
A twelve-volt battery contains six single cells connected in series, yielding a fully charged output voltage of 12.6 volts. A battery cell is made up of two lead plates: a positive plate coated with lead dioxide paste and a negative plate composed of sponge lead, with an insulating substance (separator) in between. This is a rechargeable 12V 1.2AH Sealed Lead Acid Battery. Our Power-Sonic or equivalent valve regulated sealed lead acid batteries are maintenance free, easy to handle, durable, and cost effective. It boasts a high discharge rate, a wide working temperature range, a long service life, and a deep discharge recovery. This product uses Absorbent Glass Mat (AGM) technology for enhanced performance.This product's valve-regulated and spill-proof structure allows for safe operation in any position, and the power/volume ratio delivers unequaled energy density. This product is suitable for air shipping.
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ESP8266 MOODULE: The ESP8266 is a very user-friendly and low-cost gadget for providing internet access to your projects. The module may function as both an access point (which can establish a hotpot) and a station (which can connect to Wi-Fi), allowing it to simply retrieve data and publish it to the internet, making Internet of Things as simple as feasible. It can also retrieve data from the internet via APIs, allowing your project to access any information accessible on the internet, making it smarter. Another fascinating aspect of this module is that it can be programmed using the Arduino IDE, making it much more user friendly.

ON/OFF SWITCH:

A switch is an electrical component that may detach or join the conducting channel in an electrical circuit, halting the electric current or directing it from one conductor to another.The most common sort of switch is an electromechanical device composed of one or more sets of moveable electrical contacts coupled to external circuits. When two contacts are touching, current can flow between them; when the contacts are separated, no current can flow.

Switches come in a variety of forms; they can have numerous sets of contacts operated by the same knob or actuator, and the contacts can work simultaneously, sequentially, or alternately. A switch can be actuated manually, such as a light switch or a keyboard button, or it can serve as a sensor device to detect the location of a machine part, liquid level, pressure, or temperature, such as a thermostat. Toggle switches, rotary switches, mercury switches, push button switches, reversing switches, relays, and circuit breakers are just a few examples. Lighting control is a frequent application, where many switches are linked into one circuit to provide simple control of light fixtures.

Electrical circuits only operate when electricity is free to flow in a continuous loop. When that loop is broken, the electricity is turned off. This is where the switch comes in. When in the "off" state, an on/off toggle circuit cuts the current. The power-off sign (circle) on a button or toggle shows that activating the control would disconnect power to the device. IEC 60417-5010, the power on-off sign (line within a circle), is used on buttons that switch a device between on and entirely off states.

LED:

When current travels through a light-emitting diode (LED), it emits light.Electrons recombine with electron holes in the semiconductor, producing energy in the form of photons. The energy required for electrons to pass the band gap of the semiconductor determines the hue of the light (matching to the energy of the photons).[5] Multiple semiconductors or a coating of light-emitting phosphor on a semiconductor device are used to generate white light.

LEDs provide various advantages over incandescent light sources, including reduced power consumption, longer lifetime, increased physical resilience, smaller size, and quicker switching. LEDs' disadvantages include electrical limitations to low voltage and generally to DC (not AC) power, inability to provide steady illumination from a pulsing DC or an AC electrical supply source, and lower maximum operating and storage temperatures. In contrast to LEDs, incandescent lamps can be engineered to work at nearly any source voltage, can use either AC or DC current interchangeably, and will give constant light when driven by AC or pulsating DC at frequencies as low as 50 Hz.

IOT:

The internet of things, or IoT, is a network of interconnected computing devices, mechanical and digital machines, objects, animals, or people with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a bio chip transponder, a car with built-in sensors to alert the driver when tire pressure is low, or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and can transfer data over a network.Organizations in a range of sectors are increasingly utilizing IoT to run more effectively, better understand consumers in order to provide enhanced customer care, improve decision-making, and create corporate value.

SOFTWARE REQUIRED:

Arduino IDE:

Arduino IDE stands for "Integrated Development Environment": it is an official program introduced by Arduino.cc that is mostly used for editing, compiling, and uploading code to the Arduino Device. Almost all Arduino modules are compatible with this open source software, which is simple to install and use to compile code on the fly. In this post, we will present the Software, show how to install it, and get it ready for building apps using Arduino modules.

Arduino IDE Definition:

1. The Arduino IDE is an open source program that is primarily used for authoring and compiling code for the Arduino Module.
2. It is an official Arduino program, making code compilation so simple that even a layperson with no prior technical expertise may get their feet wet with the learning process.
3. It is easily available for operating systems such as MAC, Windows, and Linux, and it operates on the Java Platform, which has built-in functions and commands for debugging, editing, and compiling code in the environment.
4. A variety of Arduino modules are available, including the Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro, and many more.
5. Each of them has a micro controller on the board that is programmed and takes input in the form of code.
6. The primary code, also known as a sketch, written on the IDE platform will eventually generate a Hex File, which is then transmitted and posted in the controller on the board.
7. The IDE environment is comprised of two fundamental components: the Editor and the Compiler, the former of which is used for creating the needed code and the latter for compiling and uploading the code into the supplied Arduino Module.
8. This environment supports both the C and C++ programming languages.

PROGRAM STRUCTURE :

Declarations

Variables

When working with Arduino, you must define global variables and instances that will be utilized later. A variable, in a nutshell, allows you to name and save a value that will be utilized in the future. For example, you may save sensor data to use later. Simply describe the type, name, and initial value of a variable to declare it. It's important to note that defining global variables isn't required. However, it is recommended that you define your variables in order to make it easier to use your values later on.

Instances

A class is a grouping of functions and variables in software development. Each class contains a particular method known as a constructor that is used to create an instance of the class. To utilize the class's functions, we must first create an instance of it.

Setup()

Every Arduino sketch must have a setup function. This function only runs once and defines the initial state of the Arduino at boot. We will define the following terms here:

1. Pin functionality through the pin Mode function
2. Pins' initial condition
3. Initialize classes
4. Initialize variables
5. Code logic Loop() The loop function is also required for every Arduino sketch and is executed once setup() is complete. It is the primary function, and as the name implies, it runs in a loop over and over again. The loop describes the core logic of your circuit.

SYSTEM TESTING AND IMPLEMENDATION:

Unit testing: Each component of the system should be tested separately to verify proper operation. This covers testing the ESP8266 module, the Arduino micro controller, the current sensor, the on/off switch, the battery, the solar panel, the LED, and the LCD display. After each component has been separately tested, they should be incorporated into the system and tested as a whole. This involves evaluating the system's monitoring and control capabilities, as well as the connectivity between the ESP 8266 module and cloud servers.

End-user testing: End-users should test the system to ensure that it is user-friendly and fits their needs.

Implementation: After the system has been thoroughly tested and any difficulties have been resolved, it may be put into action in the desired application.

During the implementation phase, it is critical to ensure that the system is correctly installed and that all components are properly linked. End-users may require training on how to utilize the system and analyze the data offered via the cloud-based interface. Regular maintenance and upgrades should also be undertaken to ensure that the system continues to work properly and is kept up to date with any changes in technology or needs. The testing and implementation phase is critical to ensuring that the proposed cloud-based BMS system is functional, effective, and satisfies the project's goals and criteria.

4.2 CONCLUSION:

Finally, a cloud-based BMS system employing IoT, Arduino, ESP 8266 module, current sensor, on-off switch, battery, solar panel, LED, and LCD display provides an efficient and effective approach to manage batteries and renewable energy sources. The solution enables remote monitoring and control, improves battery performance, and lowers maintenance expenses. It is also adaptable, cost-effective, and user-friendly. The suggested system may be used in a variety of applications, including remote monitoring of renewable energy systems, IoT devices, and other battery-powered devices. The testing and implementation phase is critical to ensuring that the system performs well, satisfies the project's goals and criteria, and remains current with any changes in technology or needs.

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