IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

BATTERY MANAGEMENT SYSTEM USING IOT TECHNOLOGY

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Abstract: Due to the future scarcity of fossil fuels and their harmful environmental effects, alternative energy sources must be explored. Wind power, a clean and sustainable natural resource, has not yet been fully harnessed in the automotive industry. Additionally, solar energy is one of the most important renewable energy sources available today. This proposed system focuses on using the Internet of Things (IoT) to monitor the performance of electric vehicle batteries. Electric vehicles rely entirely on battery energy, but the energy supplied by the battery gradually decreases, leading to performance degradation, a significant concern for battery manufacturers. Our proposed system introduces the concept of using IoT techniques to directly monitor vehicle performance. Experimental results demonstrate the system's ability to detect battery degradation. The proposed system provides an indication of the battery's voltage. To monitor these battery parameters, we have developed a data acquisition system using an Arduino-based setup. If the temperature or gas levels in the battery change, alerts will be sent to an IoT server, which will manage the operation of the electric vehicle.

Keywords: *Temperature, Battery, Parameter, Monitor, Gas level, Dc Motor*.

I. *INTRODUCTION*

In the contemporary landscape of mining operations, the increasing depletion of fossil fuel reserves and their adverse environmental impact have necessitated the search for alternative energy sources. Among the promising options, wind power stands out as a clean and sustainable resource that remains underutilized in the automotive sector. Alongside wind power, solar energy has emerged as one of the most critical renewable energy sources available today. The transition to these renewable energy sources is essential for creating a more sustainable and environmentally friendly automotive industry.

In the realm of electric vehicles (EVs), the efficient management of battery performance is crucial, as EVs rely entirely on battery energy. Over time, the energy capacity of batteries diminishes, leading to a decline in vehicle performance, which poses a significant challenge for manufacturers. This paper introduces a novel system that leverages the Internet of Things (IoT) to monitor and manage electric vehicle battery performance in real-time. By utilizing IoT techniques, our system can detect battery degradation early, providing valuable insights and alerts to improve battery maintenance and vehicle operation. The system incorporates an Arduino-based data acquisition setup to monitor key battery parameters such as voltage, temperature, and gas levels, with alerts sent to an IoT server for efficient vehicle management.

The proposed IoT-based battery management system offers a comprehensive solution to the challenges faced by electric vehicle manufacturers and users. By integrating IoT technologies, the system ensures continuous monitoring and real-time data acquisition, allowing for immediate response to any irregularities in battery performance. This proactive approach helps in extending the lifespan of batteries, reducing maintenance costs, and enhancing the overall reliability of electric vehicles. Furthermore, the ability to monitor temperature and gas levels within the battery provides an added layer of safety, preventing potential hazards that could arise from battery malfunctions.

In addition to improving battery management, the adoption of IoT in electric vehicles represents a significant step towards smarter and more connected transportation systems. The data collected through the IoT-based system can be analyzed to identify patterns and trends, leading to better understanding and optimization of battery usage. This information can also be used to inform future research and development efforts in battery technology and electric vehicle design. By harnessing the power of IoT, the proposed system not only addresses current challenges but also paves the way for advancements in the field, contributing to the broader goal of sustainable and efficient energy use in the automotive industry.

II. *RELATED WORKS:*

"Internet of Things (IoT) Enabled Battery Management System" Authors: Dnyaneshwar V Kale, Sonal B Thombre, Nitin M Mane - VPKBIET College of Engineering, Department of Electronics and Telecommunication, Baramati, India. Professor Rohit S Piske - VPKBIET College of Engineering, Department of Electronics and Telecommunication, Baramati, Maharashtra, India., IoT technology to oversee and regulate batteries across various applications. Comprising sensors, microcontrollers, communication modules, and cloud-based servers, the BMS collaborates to gather, analyze, and enhance battery data. This enables real-time monitoring of critical parameters such as voltage, current, temperature, and state of charge, facilitating early detection of potential battery issues. Through the insights derived from this data, the system optimizes battery charging and discharging processes, prolongs battery lifespan, and lowers maintenance expenses. This summary outlines the IoT-based BMS technology and its advantages, including enhanced battery efficiency, heightened reliability, and minimized environmental footprint.

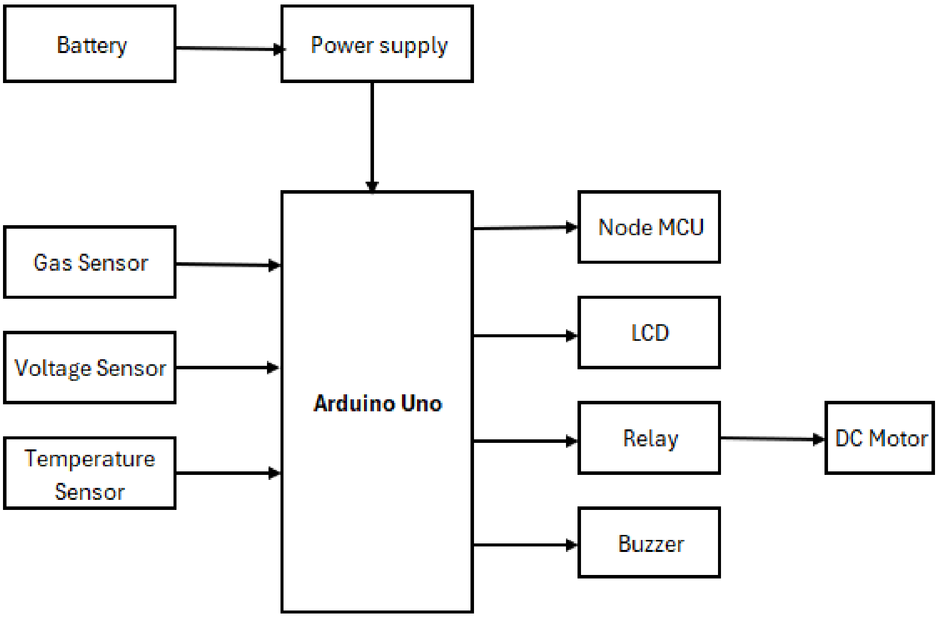
To ensure efficient monitoring under various conditions, a systematic battery management system (BMS) is necessary. This system focuses on key parameters such as the State of Charge (SoC) and State of Health (SoH), although these can be affected by factors like battery materials, environment, and load. Overcharging can lead to the emission of gases such as hydrogen and oxygen. The BMS aims to detect these emissions and monitor voltage, current, and temperature using an STM controller and sensors. It also includes a GPS module for vehicle tracking and displays data on the cloud, integrating IoT for comprehensive and real-time battery management

III. *PROPOSED METHOD:*

In the proposed method, we are implementing wireless power transmission for charging purposes. The system utilizes two power sources: a diesel generator and solar power, allowing for flexibility based on availability and requirement. The solar panels convert solar energy into electrical energy, contributing to the system's sustainability. Our proposed system introduces the concept of monitoring vehicle performance using IoT techniques, enabling direct and continuous monitoring. Experimental results have shown that the system can detect battery degradation effectively.

To monitor the battery parameters, we have developed a data acquisition system using an Arduino-based setup. This system provides real-time indications of the battery's voltage. Additionally, it monitors temperature and gas levels within the battery, alerting the user if any irregularities are detected. The collected data is then sent to an IoT server, which manages the operation of the electric vehicle. This integration of IoT ensures comprehensive monitoring and management, enhancing the reliability and efficiency of the battery system.

Block Diagram:



IV. *METHODOLOGY*

Hardware Required for this project:

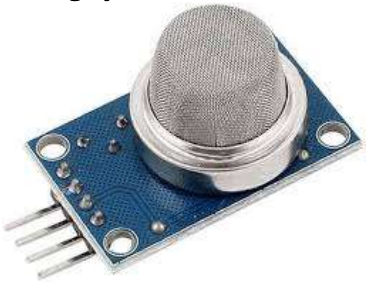
Arduino Uno:

The Arduino Uno plays a pivotal role in the proposed method as the core component of the data acquisition system. Known for its simplicity and versatility, the Arduino Uno serves as the central microcontroller, interfacing with sensors to monitor critical battery parameters such as voltage, temperature, and gas levels. Its ATmega328P microcontroller ensures efficient processing and communication with connected components, making it well-suited for real-time monitoring applications. The Uno's digital and analog input/output pins allow seamless integration with the various sensors, enabling precise data collection from the battery. This collected data is processed and used to trigger alerts when abnormal conditions, such as overheating or gas emissions, are detected, ensuring user safety and battery reliability.

Additionally, the Arduino Uno supports efficient communication with IoT platforms via wired or wireless modules. In this system, it transmits the monitored data to an IoT server for centralized management and analysis, enhancing the system's overall functionality. The Uno's open-source nature and compatibility with a wide range of libraries make it easy to program and adapt for customized applications like this. Its compact size and low power consumption further contribute to its suitability for integration into electric vehicle monitoring systems. By leveraging the Arduino Uno, the proposed method achieves cost-effective, real-time monitoring that enhances the performance and safety of the wireless charging system.

Gas Sensor:

The gas sensor used in this project plays a crucial role in ensuring the safety and efficiency of the battery management system. This sensor is designed to detect the presence of gases such as hydrogen and oxygen, which can be emitted from the battery during overcharging or malfunction. By accurately sensing these gases, the system can provide timely alerts, preventing potential hazards such as fires or explosions. The gas sensor operates by measuring changes in the concentration of specific gases in the battery environment and transmitting this data to the central monitoring system.



Incorporating the gas sensor into the IoT-based battery management system enhances the overall safety and performance of electric vehicles. The sensor's real-time data is sent to an IoT server, where it can be analyzed and used to make informed decisions about battery maintenance and operation. This proactive approach allows for immediate response to any detected gas emissions, thereby extending the battery's lifespan and ensuring the vehicle operates safely. By integrating this technology, the system not only monitors traditional parameters like voltage and temperature but also adds an essential layer of protection against gas-related risks.

Dallas Temperature Sensor:

The Dallas sensor, also known as the DS18B20 temperature sensor, plays a crucial role in the proposed battery management system. This sensor is utilized to monitor and track the temperature of the battery in real-time. The DS18B20 sensor is known for its accuracy and digital output, making it suitable for precise temperature measurements in various applications, including automotive and IoT systems. Its waterproof capabilities further enhance its utility, allowing for reliable operation even in challenging environmental conditions.

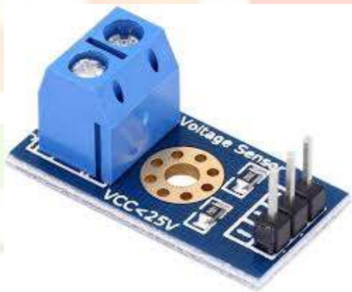
In the context of this project, the Dallas sensor is integrated into the Arduino-based data acquisition system. It continuously monitors the temperature of the battery, providing essential data points that are crucial for assessing battery health and performance. The sensor's digital output simplifies the integration process, ensuring seamless communication with the microcontroller and other components of the system. By accurately monitoring temperature fluctuations, the Dallas sensor enables early detection of overheating or abnormal temperature variations, which can help prevent potential battery damage and optimize operational efficiency in electric vehicles. Its reliability and precision make the Dallas sensor a valuable component in ensuring the robustness and effectiveness of the battery management system.

Relay:

In this project, relays play a crucial role in controlling the power distribution and management within the system. Relays are electromechanical switches that are operated by an electric current. They allow low-power control signals to switch high-power circuits or devices, making them essential for handling the switching between different power sources such as the diesel generator and solar panels.

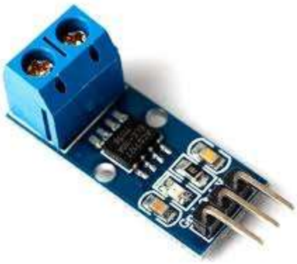
Specifically, relays are used to manage the selection between these two power sources based on system requirements or conditions. For instance, when solar power generation is optimal, the relay can be used to connect the solar panels to the charging system. Conversely, if solar power is insufficient or unavailable, the relay can switch to activate the diesel generator, ensuring continuous charging capability for the batteries. Moreover, relays in this project are integrated with the Arduino-based control system to automate these switching operations based on real-time data and predefined conditions. This automation not only optimizes energy efficiency but also enhances the overall reliability and performance of the charging system, ensuring seamless operation of the electric vehicle under varying environmental and operational conditions.

Voltage Sensor:
In this project, a voltage sensor plays a crucial role in monitori ng the performance of the electric vehicle battery system. The voltage sensor is designed to accurately measure the electrical potential difference across the battery terminals. This measurement is essential as it provides real-time data on the battery's voltage level, which directly correlates with its state of charge (SoC) and overall health (SoH). By continuously monitoring the voltage, the system can detect fluctuations that may indicate battery degradation or irregularities in charging and discharging processes.



The voltage sensor used in this project is integrated into the Arduino-based data acquisition system. It interfaces directly with the battery terminals to capture voltage readings with high precision and reliability. These readings are then processed and transmitted to the IoT server for further analysis and monitoring. The sensor's ability to provide accurate voltage measurements in real-time enables proactive maintenance and optimization of battery performance. By leveraging this sensor technology, the project aims to enhance the efficiency, lifespan, and safety of electric vehicle batteries, contributing to sustainable transportation solutions.

Current Sensor:
In this project, a current sensor plays a critical role in monitoring the electrical current flowing through various components, particularly the battery and charging system of the electric vehicle. The sensor is essential for accurately measuring the amount of current drawn from the battery during charging and discharging cycles. This data is crucial for assessing the health and performance of the battery, as well as for ensuring safe operation within specified limits.



Typically, the current sensor used in such applications employs Hall Effect technology, which is known for its ability to measure direct and alternating currents with high precision. Hall Effect sensors detect the magnetic field generated by current flow through a conductor, converting this magnetic field into a voltage signal proportional to the current intensity. This signal is then processed by the system to provide real-time current measurements. The sensor's output is integrated into the overall data acquisition system, which includes an Arduino-based controller and IoT connectivity. By accurately monitoring current levels, the sensor helps in Unoptimizing charging efficiency, preventing overcurrent situations that could damage the battery, and ensuring the overall safety and longevity of the electric vehicle's power system.

DC Motor:

The DC motor employed in this project plays a crucial role in the overall functionality of the electric vehicle system. Direct current (DC) motors are chosen for their efficiency and suitability in electric vehicles due to their ability to convert electrical energy directly into mechanical motion. They operate on the principle of electromagnetic induction, where a current-carrying conductor in a magnetic field experiences a force, resulting in rotational movement.

In this specific application, the DC motor drives the vehicle's propulsion system, providing the necessary torque and rotational speed to propel the vehicle forward. It is integrated with the battery management system (BMS) and controlled through electronic motor controllers, ensuring precise management of power delivery based on the vehicle's operational requirements. The use of DC motors in electric vehicles contributes to reduced emissions, improved energy efficiency, and quieter operation compared to internal combustion engines. Furthermore, advancements in motor design and control technologies continue to enhance the performance and reliability of DC motors in electric vehicle applications, making them a cornerstone of modern electric transportation systems.

Nodemcu (ESP8266):

In this project, the NodeMCU plays a pivotal role in facilitating the Internet of Things (IoT) capabilities of the battery management system. NodeMCU is a low-cost open-source IoT platform based on the ESP8266 Wi-Fi module, which integrates a microcontroller unit (MCU) and Wi-Fi capabilities into a single board. Its compact size and built-in Wi-Fi functionality make it ideal for connecting devices and sensors to the internet, enabling remote monitoring and control.

NodeMCU interfaces with various sensors and components within the battery management system, such as voltage and temperature sensors, through its GPIO pins. It communicates data wirelessly to an IoT server, where the information is processed, analyzed, and made accessible for real-time monitoring and historical analysis. The versatility of NodeMCU allows for seamless integration with other IoT devices and platforms, enhancing the system's scalability and flexibility. By leveraging NodeMCU's capabilities, this project not only monitors critical parameters of the battery system but also enables efficient management and proactive maintenance, contributing to enhanced reliability and performance of electric vehicles.

LCD:

Liquid Crystal Displays (LCDs) represent a ubiquitous technology employed across a multitude of electronic devices, renowned for their versatility and efficiency in visual data representation. Functioning on the principle of modulating light through liquid crystal molecules, LCDs offer distinct advantages such as low power consumption, lightweight construction, and compact form factor. These characteristics render LCDs particularly suitable for applications where energy efficiency and portability are paramount considerations. Furthermore, LCDs boast a wide range of display resolutions, enabling high-definition rendering of text, images, and graphics with remarkable clarity and precision.

In addition to their technical prowess, LCDs offer unparalleled flexibility in terms of display customization and integration into various electronic systems. Whether utilized in consumer electronics such as smartphones, tablets, and laptops, or embedded within industrial equipment, medical devices, and automotive dashboards, LCDs can be tailored to meet specific requirements and design aesthetics. Moreover, advancements in LCD technology have led to the development of specialized variants such as touchscreen displays, curved displays, and transparent displays, expanding their applicability across diverse industries and enhancing user interaction and experience. With ongoing research and innovation driving continuous improvements in performance, durability, and cost-effectiveness, LCDs remain at the forefront of visual display technology, poised to shape the future of human-computer interaction and information dissemination.

Buzzer:

The incorporation of a buzzer within the proposed system serves as a vital component in ensuring prompt communication of potential safety hazards or critical events. Positioned as an audible alert mechanism, the buzzer is strategically designed to activate in response to predefined triggers derived from the monitored data. This proactive approach enables swift notification to both the worker and supervisory personnel, facilitating immediate intervention in the event of an emergency. For instance, if the system detects a sudden impact or fall through MEMS accelerometers, indicative of a potential accident, the buzzer is triggered to alert nearby workers and supervisors, prompting rapid response measures to mitigate risks and ensure the safety of the affected individual.

Moreover, the versatility of the buzzer extends beyond emergency situations to encompass various operational scenarios within construction environments. For instance, the system can be programmed to emit different tones or patterns to signify specific alerts, such as exceeding predefined temperature thresholds or prolonged periods of inactivity indicating potential health concerns. This multi-functional aspect of the buzzer enhances its utility as a proactive safety tool, enabling it to cater to a diverse range of monitoring needs and operational requirements. By leveraging the audible cues provided by the buzzer, construction workers and supervisors can maintain heightened awareness of potential hazards, fostering a culture of safety and vigilance within the workplace.

Power supply:

The power supply board in this project serves a critical role in regulating and distributing power effectively. Designed to take a 12-volt input, the board incorporates both a 12-volt voltage regulator and a 5-volt voltage regulator. The 12-volt regulator ensures a stable output voltage of 12 volts, which is crucial for powering components and systems that require higher voltage levels. Simultaneously, the 5-volt regulator provides a steady 5-volt output, essential for powering microcontrollers, sensors, and other low-voltage devices used in the project.

By efficiently managing these voltage levels, the power supply board ensures consistent and reliable operation of the entire system. It facilitates the seamless integration and functioning of various electronic components, allowing them to operate within their specified voltage requirements. This capability is essential for maintaining the performance and longevity of critical components like the Arduino-based control system, sensors, and communication modules, thereby contributing to the overall reliability and functionality of the electric vehicle charging and monitoring system.

V. *ADVANTAGES AND APPLICATIONS*

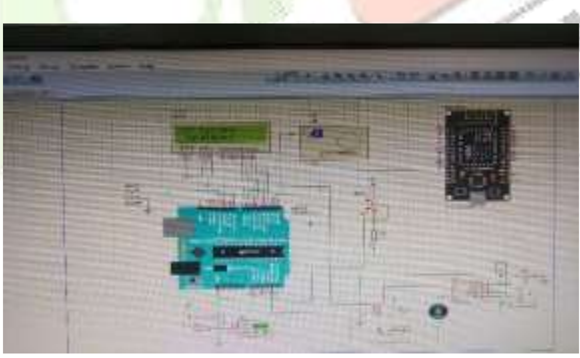
ADVANTAGES

- Reduces the electricity problems
- Proper utilization of natural resources
- Low cost

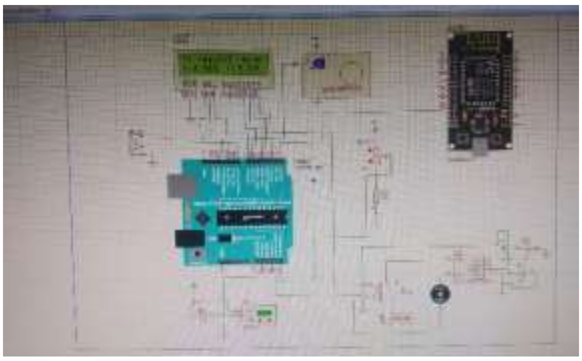
APPLICATIONS

- Houses
- Commercial buildings
- Vehicles
- Offices
- Industries

VI. *RESULTS*

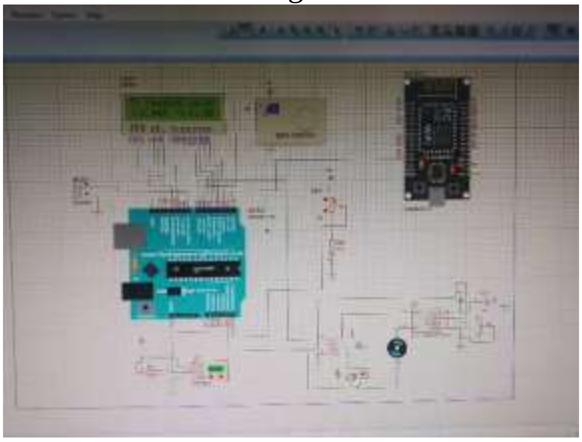


Title displayed IOT battery management
Fig1



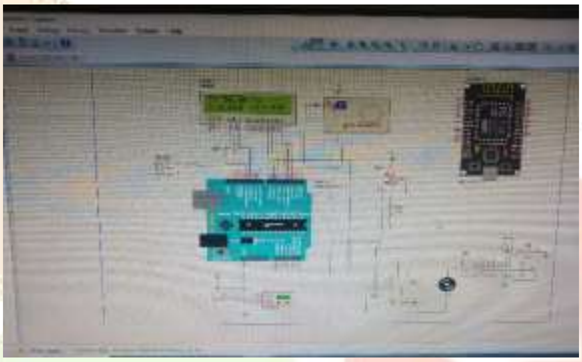
Displaying current and voltage values

Fig2



Values are displaying

Fig3



Showing temperature values through Dallas sensor

Fig4

VII. *CONCLUSION*

In conclusion, this project demonstrates a comprehensive approach to enhancing the efficiency and reliability of electric vehicle battery management through IoT and renewable energy integration. By leveraging wireless power transmission and utilizing both solar and diesel generator sources, the system ensures continuous and sustainable charging capabilities. The implementation of IoT techniques enables real-time monitoring of battery performance, including voltage, temperature, and gas levels, ensuring early detection of issues and proactive maintenance. The integration of a power supply board with 12-volt and 5-volt regulators further enhances system stability and component reliability. Overall, this project not only addresses current challenges in electric vehicle technology but also lays the groundwork for future advancements in sustainable transportation solutions.

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