RESEARCH ARTICLE OPEN ACCESS

A Review on Battery Health Monitoring System

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ABSTRACT:
As people become more aware of global warming, the need for clean fuel and energy is increasing, and as a result, there is a steady trend toward electric automobiles and hybrid electric vehicles. The depth of discharge (DOD), temperature, and charging algorithm all have an impact on battery performance. Using the internet of things, this study seeks to offer a measurement of the battery's voltage and current level. Lead-acid batteries are capable of powering a wide range of applications. They're simple to find, affordable, and deliver a lot of power to anything they're connected to. Unfortunately, if the charge is not monitored, the battery will ultimately run out of power. current and voltage of battery is required in extra to finding the charge of the battery. The approximate charge of the battery may be determined based on the battery's output voltage. This paper summarizes a number of studies on battery health monitoring systems.

Keywords: Review, battery, monitoring system, battery performance

Date of Submission: 08-12-2023 Date of acceptance: 23-12-2023

I. INTRODUCTION

As people become more aware of global warming, the need for clean fuel/energy is increasing, and as a result, there is a steady trend toward electric automobiles and hybrid electric vehicles. The depth of discharge (DOD), temperature, and charging algorithm all have an impact on battery performance. Using the internet of things, this study seeks to offer a measurement of the battery's voltage and current level. Lead acid batteries are capable of powering a wide range of applications. They're simple to find, affordable, and deliver a lot of power to anything they're connected to. Unfortunately, if the charge is not being monitored, the battery will ultimately run out of power. current and voltage in battery is needed in extra to finding the charge of the battery. The approximate charge of the battery may be finding based on the battery output voltage. The degree of hotness, voltage, current, and state of charge (SoC) of battery are the most commonly observed metrics. The battery system's operating levels and conditions are maintained by monitoring each battery in the battery bank [2]. If here unavailable of our ac input power, battery shall gives output, there no need to stopping system's functions. In order to give power to the systems when there is no ac input, the battery must be in excellent working order to supply enough energy to the gadgets without any problem. next determine the battery's state, every battery of the battery system must be monitored in real time on a regular basis. The major purpose of this system is to keep users informed about the current state situation of every battery in the battery bank on a regular basis, and to communicate the alarm information to authorized people via the IoT module. Some critical metrics of the battery should be measured at regular intervals to finding current situation in battery. The terminal voltage, load current, capacity, discharge current, and room temperature of every battery are important factors [10].

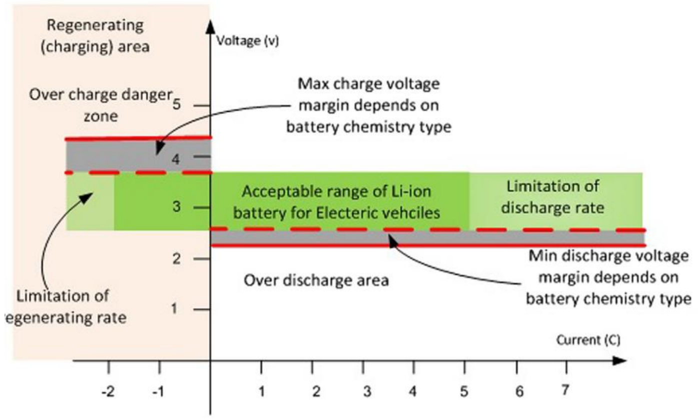

Fig. 1. Discharge and charge rate stress factors on Li-ion batteries

TABLE 1: Parameter of Exciting System

Parameter	Unit	Lower limit	Upper limit	Resolution
SoH	%	0	100	1
SoC	Wh	0	24,000	1
ϑ_{amb}	°C	-25	50	0.5

II. LITERATURE REVIEW:

S. Gopiya Naik et.al (2022) An electric car will have a system called a Battery Monitoring and Control system placed in it. This system will tell about voltage and current and degree of hotness of battery, as well as look for any indicators of a potential fire. This system is made up of both its hardware and its software. In hardware present a smartphone running Android, as well as several sensors, a microprocessor, and a Bluetooth module. The building of it (Arduino UNO) makes use of an ATMEGA 328, which is a microcontroller that has a relatively low cost. The microcontroller receives the information on the temperature, as well as the voltage and the current. After then, the information regarding the battery is communicated to the Android application through the Bluetooth connection. It is proposed here to monitor the vehicle's calculation using an Android system from that the working may be carried out instantly. This would make it possible to have more accessibility. The key elements that constitute the battery monitoring system that is the subject of this discussion are the monitoring device itself as well as the user interface that is provided for the system. The system that is being presented monitors in real time an indicator of the battery's voltage, current, and remaining charge capacity. Appropriate management actions are triggered as a result of this monitoring, which ensures that the battery is maintained in optimal condition. We were able to design a data collecting system to monitor the battery metrics previously mentioned by basing our system on the PIC microcontroller and building it from the ground up. In addition, the data are stored in a database that is housed on a server and are shown on a mobile device that operates on the Android operating system. During this stage of the process, a detailed model is constructed so that an accurate representation of the final product may be produced for the proposed system.

Ksung-Sung Lee et al. (2012) studied a situation of installing a group of a battery for the new creativity in electric vehicle, this is important to have a system to keep the better situation of a battery and operate the charging of power. This article discusses the measurement module for the status information of a battery as well as the construction of a battery management system to manage individual batteries inside a room containing batteries with a level of 120 kWh. Additionally, the paper addresses the creation of a battery management system. It was developed to measure a maximum voltage of 400V for a battery, as well as a current of 300A and a temperature of (up to -50) °C. These are the parameters for the electric current. The voltage, current and degree of hotness of a nickel-metal hydride battery were monitored using measurement module that was manufactured, and a system that manages the recharge and discharge of electricity from a battery in real time was constructed using the LabVIEW programme.

D. S. Suresh and colleagues (2014) showed that batteries are the most important for UPS system, and its requirement are useful in all the fields for electrical system. In order for battery to supply uninterrupted power to the load without requiring any periodic monitoring or observations, the situation must be monitored on a regular basis. For the most part, crucial monitoring is required whenever the batteries are arranged in like an online or no-break UPS system. It is because it's important to supply quality power for providing better work of the load. This time or previous design set up to monitor the line voltage and load current of the battery system . Because of this configuration, performance of every cells or batteries as well as their status cannot be checked. All of the aforementioned issues are remedied by the new PLC-based battery health monitoring system that has been presented. SCADA is utilised by this system to maintain electrical properties of every battery. This device is equipped with a GSM module, and it can also measure the temperature in the room. When the battery's state becomes critical and the room temperature rises over the value that has been specified, the GSM module will send an alarm message to a person who has been given permission to receive it.

The researchers Ross Kerley and colleagues (2015) proposed the way for calculating the performance of a lead-acid car battery and alerts car owner for suddenly problem on it. The majority of the currently available technologies for estimating the state of health (SOH) of lead-acid batteries estimate battery impedance by calculating battery voltage and current. So, sensing about current can be somewhat expensive due to the parts and/or labour involved. It was claimed that a technique may be used to calculate SOH through calculating potential of the battery while it was being cranked. Our approach is meant to be an advancement on an earlier method. It does this by measuring the voltage of the battery while the engine is cranking, calculating the state of health of the battery based on certain crucial voltage points, and alerting the driver of a possible impending failure.

So now for advance in technology of integrated power supplies in power systems, Aixiang Zhang and colleagues (2017) studied two level for control structure, which is composed of a battery management unit and a central management unit. In this study, we offer a design strategy for a battery management system, often known as a BMS. We created the hardware circuit for it and tested it under controlled settings in the lab. According to the findings, the component is able to carry out precise monitoring of the battery's status in real time, which includes measuring the battery's charge and discharge current, voltage, temperature, and overall state of charge. It is also able to notify the user in a timely manner and take protective measures in the event that the battery group is in an abnormal state. The results of this investigation will assure the safety of batteries and increase the battery group's lifespan.According to the findings that Atzori L et al. (2017) provided, the demand for electric power to be used in industrial settings is quickly increasing. Electricity is necessary for the proper functioning of a great number of the transportation vehicles and uninterruptible power supply (UPS) systems that are utilised in the manufacturing of heavy goods. These cars and UPS systems all have lead-acid batteries installed in them so that they may use them as a backup source of electric power. In addition, plans to conserve gasoline by actively using the electricity from these batteries are now under consideration as potential solutions. As a result, a dependable battery system is essential to the efficient running of a business in the industrial sector. However, it is important to remember that these batteries are significantly more expensive, and it is possible that overusing them will cause them to malfunction. During the recycling process, damaged lead-acid batteries may have a harmful effect on the surrounding environment. Because of this, it is of the utmost importance to consistently monitor the growth and management of these batteries in order to protect them from unneeded harm and increase the length of their lifespan. In this article, an attempt is made to offer a measurement of the temperature of the electrolyte as well as the number of backup hours for lead-acid batteries. This approach allows for the monitoring of a variety of parameters, including temperature, humidity, remaining capacity, full charge capacity, voltage, and average current. There is a high reading for the monitoring parameters. There will be a longer life for the battery. Monitoring in real time utilising interference from the Internet of Things. We are going to use a current sensor and a voltage sensor for this project so that we can keep track of the amount of charge in the battery. It will also be shown on the LCD, and a notification will be sent to the specific individual over the internet of things when the battery level is approaching dangerously low.

In their 2017 study, Nicholas J. Watkins and colleagues described the problem of computing the minimum battery capacity required to stabilise a scalar plant communicating with an energy harvesting sensor over a wireless communication channel. We provide evidence that a certain greedy battery management strategy is all that is necessary to maintain the plant's stability, and we show that the linear programme can be used to determine whether or not the system is stable under the greedy policy. In addition, we demonstrate that there is a minimum battery capacity below which no policy can stabilise the system. This minimum capacity, which can be determined by resolving a series of linear programmes whose difficulty rises logarithmically with regard to the maximum storage capacity that is permitted, is called the critical battery capacity. The first of these solutions solves a mystery about the steadiness of control systems for energy harvesting, which was one of the unresolved questions. This last one enables us to easily compute the minimal battery capacity necessary to stabilise a particular system. This solves a challenge that is important to address when device size or cost are key considerations.

M. Ramesh Kumar et al. (2018) the suggested and analysed real-time monitoring of lead acid batteries based on the internet of things is described. The characteristics that offer an indicator of the lead acid battery's acid level, state of charge, voltage, current, and the remaining charge capacity are monitored and stored by the system that we have presented. This monitoring and storage takes place in real time. The backbone of the network is comprised of the wireless local area network. An asynchronous transmission control protocol/user datagram protocol based C server programme is executed on a personal computer in order to identify critical parameters using the data that is collected from all of the related battery clients in the system.

presented Battery Management System by William Kevin Siagian et al. (2018) is an electrical system that manages a rechargeable battery cell or battery pack. Monitoring the battery's condition, computing secondary data, reporting the data, managing the battery's environment, authenticating or balancing it, and preventing the battery from running outside of its safe operating region are the primary responsibilities of a battery management system (BMS). Within the scope of this study, the authors want to develop a prototype for a battery management system that would monitor the charging of batteries by means of solar panels. The voltage, current, and temperature are some of the parameters that are monitored by the BMS. The BMS also comes equipped with an extra function known as the on-grid system. Because of this function, the BMS is able to make the most efficient use of the energy that is generated by the solar panels. Microcontroller, sensors, and other components such as Arduino Mega, a temperature sensor, voltage sensor, current sensor, real time clock, relay, multiplexer, and dc fan are used in the construction of the BMS. Every day from six in the morning to six in the evening, the BMS is used to illuminate street lamps. This battery management system (BMS) is equipped with three modes: charging, discharging, and on-grid mode. During the charging mode, the battery management system (BMS) is utilised to monitor the process of charging the battery. This mode lasts for five hours from 10:00 am to 3:00 pm. In the discharging mode, the batteries are utilised to power the lighting of the street lights. When a solar panel is in Ongrid mode, it means that it may continue to produce electricity even when it is not being charged or discharged.

K.Abdul Kader Jilani et al. (2020) studied In a variety of applications, including electric cars (EV), hybrid electric vehicles (HEV), and uninterrupted power supply (UPS), as well as telecommunications, and so on, a battery management system (BMS) serves as an essential component of the system. The correctness of these systems has never been settled, despite the fact that they often provide an error of no more than 10 percent when all of the criteria are taken into consideration combined. Batteries are the fundamental component of every automation system, and their use is becoming increasingly widespread across all industries where there is a demand for electrical power. In order for the battery source to supply uninterrupted power to the load at all times and without interruption, periodic monitoring and observations are necessary. The characteristics that offer an indicator of the lead acid battery acid level, state of charge, voltage, current, and the remaining charge capacity are monitored and stored by the system that we have presented. This monitoring and storage takes place in real time. The information that is collected from all of the linked battery clients in the system is analysed, and the backbone network that supports the system is a wireless local area network. On the basis of rapid changes, the state of the battery is continually examined for any signs of malfunction. With the aid of an Internet of Things module, the charge discharge voltage of a battery bank and the battery conditions may be seen in the cloud.

Proposed a straightforward approach towards existing battery monitoring systems with solar input which use a series of batteries, Saurav Malve et al. (2020) wrote. The monitoring is reduced with this system to the point that it just requires a single battery. The voltage of the battery and the charging current are the two parameters that are being monitored. Based on these two measurements, a number of additional properties, such as the depth of discharge, state of charge, and condition of health of the battery, may be estimated. This system displays the readings and plots the characteristics on an easy to use Graphical User Interface (GUI) that was made using Python. The system employs a simple mechanism for design in which an Arduino UNO board is interfaced with easily available and inexpensive voltage and current sensors for reading data. The solution that has been shown includes a mechanism for voltage cutoff, which prevents the battery from being overcharged. The data collecting from the battery is done in real time, and the results are shown with all of the minute fluctuations in the output characteristics that occur as a result of changes in the weather at the input provided by the solar panel. In addition to this, the data is sent to an

Excel spreadsheet in order to facilitate recording and additional technical analysis .

III. MOTIVATION AND AIM:

The state of health (SOH) estimate methods presented in article [8] tells about impedance of battery by measuring batteries voltage and current. sensing of current work is expensive in terms of both parts and labour. The algorithm is inefficient and offers timely warnings. In paper [1,] two-level control is compromised by battery management and central management gives control structure that forms the battery management system device. Hardware module was installed to guarantee that the BMS continued to function after the MCU failed. This design, on the other hand, employs an equilibrium dissipative system. Consumption rate of energy is disadvantage when compared to the non-dissipative system, so equality treatment rule is explored and got good result. Paper [9] refined work through using an Arduino to monitor the voltage of a single battery in real time.

This inspires us to create a real-time Bms with Arduino and LABVIEW. The whole health of the battery will be checked, including voltage, current, and temperature. This would provide us with previous knowledge of the batter damage in any aspect.

IV. SYSTEM ANALYSIS

The various literature studies that were done helped in developing a new technique for controlling and monitoring the battery health.

4.1. ISSUES IN THE EXISTING

As a result, lead acid batteries are employed in IC engine ignition. This concept has been employed in a single battery for the ignition process on an IC engine, therefore it is only a tiny part of the operation that has worked. Typically, batteries are monitored on an individual basis, so they do not detect (such as current, voltage, or temperature) during operation. It's mostly a monitoring system flaw.

$$\mathrm{SoC} = \mathrm{SoC}_0 + \frac{1}{C_n} \cdot \int_{t_0}^{t} |I| \cdot dt \quad \text{Charge}$$

$$\mathrm{SoC} = \mathrm{SoC}_0 - \frac{1}{C_n} \cdot \int_{t_0}^{t} |I| \cdot dt \quad \text{Discharge}$$

4.2. PROPOSED SYSTEM

This paper explains about non operating time disadvantage of monitoring. The issue was minimized by analyzing the voltage, current, and temperatures since the battery bank was linked in series. Using IoT and Arduino/ATMEGA 2560, an effective energy-management system for Lead Acid Batteries is being developed. The system detects current and voltage in the circuit with an ACS712 sensor, while the temperature is detected with an LM35 Thermistor. The LM35 is a temperature sensor that outputs voltages proportional to the temperature measured in degrees Celsius. In comparison to linear temperature sensors calibrated in Kelvin, the LM35 gadget offers one advantage. Arduino is used to store and handle the data generated by these sensors (microcontroller). The battery's state of charge (SOC) is an index that indicates how much charge is in the battery. The SOC is affected by a number of factors, including current, voltage, temperature, and pressure. The temperature, current, and voltage are all taken into account while calculating the SOC in our system.

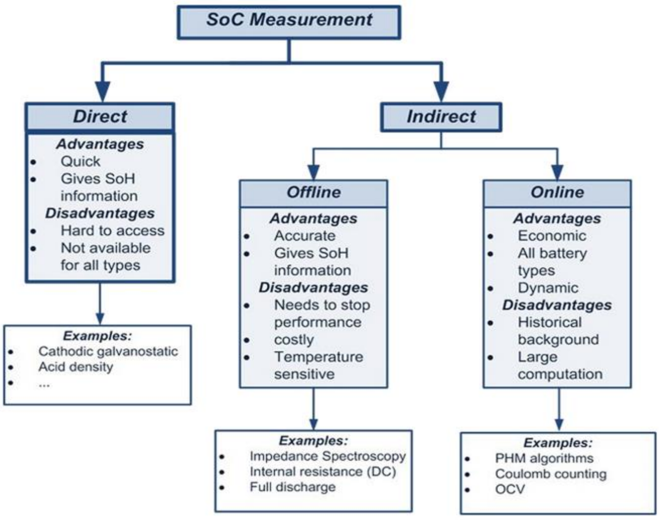

Fig. 2. The most important SoC estimation methods

4.3 Proposed Expected Outcome:

It is possible for a battery monitoring system built with Arduino and LabVIEW to produce different predicted results based on the particular design and implementation chosen. Having said that, the following are some general expectations:

Real-time Monitoring: Bms needs to be able to give real-time data on important characteristics such as the battery's voltage, current, temperature, Soc. This information ought to be regularly updated and displayed by it.

LabVIEW may be used to develop a graphical user interface (GUI) that enables users to visualize and interact with a battery monitoring system. This GUI can be used to create a user interface. The graphical user interface could contain functions like data logging and trend analysis, in addition to alarms for dangerous battery conditions.

Data Acquisition and Processing: An Arduino can serve as an interface between the battery and LabVIEW if it is utilized in this capacity. LabVIEW may further process and analyses the data after it has been sent to Arduino, which can acquire analogue or digital signals from the battery, turn them into usable data, and send it to LabVIEW.

Alarms and Notifications: The system should be able to detect abnormal battery conditions, such as low voltage, high temperature, or rapid discharge, and generate appropriate alarms or notifications to alert the user. These abnormal battery conditions include: rapid discharge, low voltage, and high temperature. This reduces the likelihood of the battery failing or being damaged in the future.

Data Logging and Analysis The battery monitoring system has the capability to log data over time, providing users with the ability to evaluate past trends and patterns. LabVIEW is capable of providing tools for data analysis, which enables users to discover performance decline in batteries, optimize charging and discharging procedures, and make decisions based on accurate information.

Modifiability and Expandability: The system ought to be adaptable and modifiable so that it can fulfil the needs of users with a wide variety of battery kinds, setups, and preferences. In addition to that, it ought to contain facilities for future development, such as the addition of more sensors or the integration with other systems.

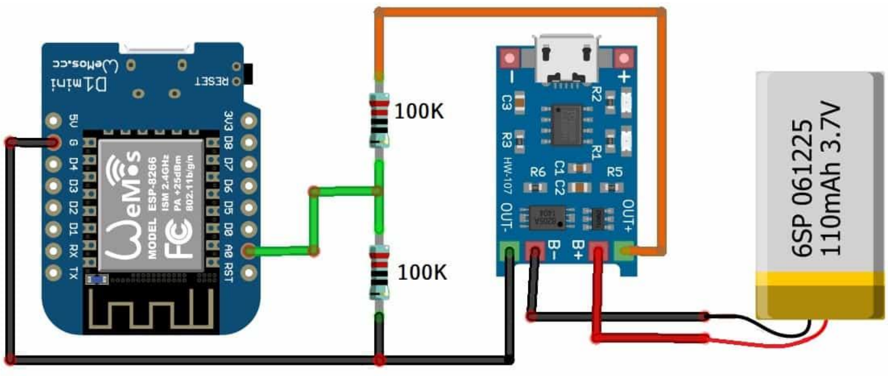

Fig 3: Proposed Circuit Layout

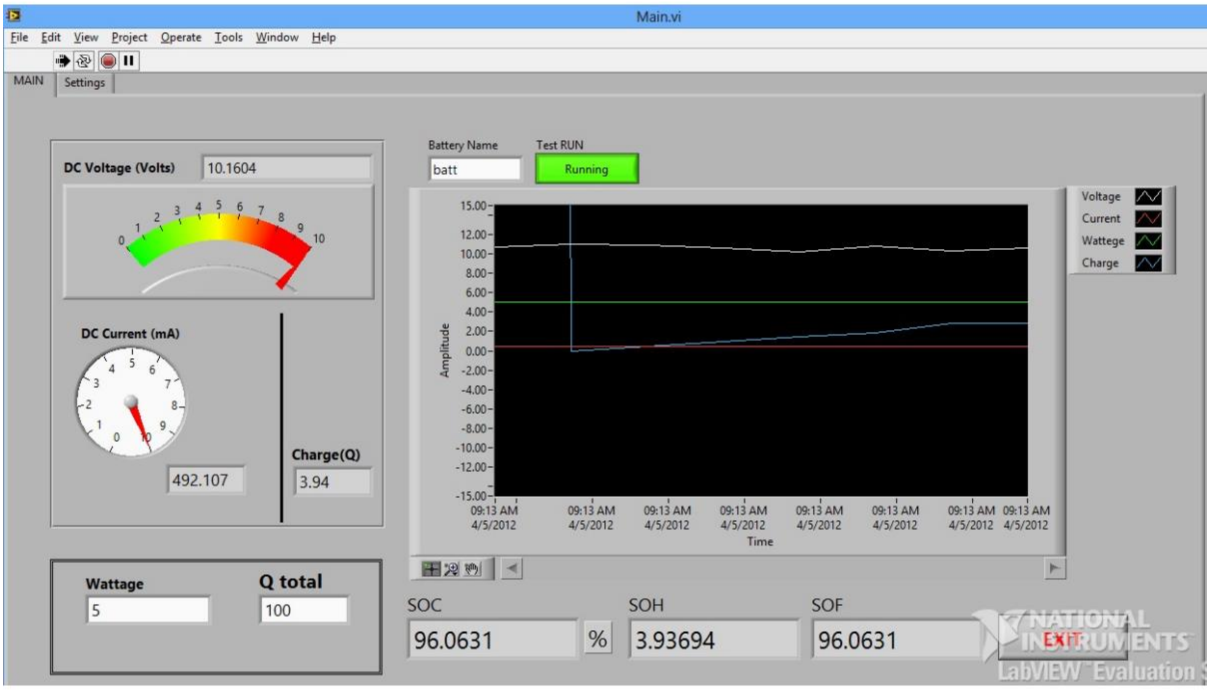

Fig 4: Expected Output show in LabVIEW

V. CONCLUSION:

The construction of recharging infrastructure is required for the widespread use of electric vehicles. In it available charging terminal, management of charge system, power generating also facility of supply reinforcement. There is extra power in a specific region might occur if several electric cars are charged at the same time, it is critical to regulate power based on the conditions. With recent improvements in battery performance for energy storage, the approaches that are employed on the night for high load provide better capacity. Creating room with a high-capacity battery for recharging an automobile necessitates a system to keep the battery in top condition and regulate power recharge and discharge. A good storage battery connecting in parallel and series combination gives required power. Combination of cells can be vary accordingly it's performance, so it regulated separately. The problem in any single cell prevents the entire stored energy from being used. As a result, the implementation system that checks state of every cell in actual time while also automatically managing the stored power is necessary .

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