Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 09, September - 2025

Enhancement on IOT Based Battery Management System for Electric Vehicles

N Jagadeesh
Associate Professor, Department of Automobile Engineering, PESCE, Mandya

Suyog Cariappa P C
UG Scholar, Department of Automobile Engineering, PESCE, Mandya

***Abstract*—The most crucial component of any Electric Vehicle (EV) is its battery storage, which stores the energy needed for the vehicle to function. So, an effective battery management system is required in order to get the most out of a battery while also ensuring its safe operation. With the rapid growth of Internet of Things (IoT) technology, various applications have emerged to optimize energy consumption and expand the performance of devices. The cloud-based platform analyzes the State of Charge and State of Health data using advanced algorithms. It identifies abnormalities in battery behavior and enables early fault detection. The suggested IoT-based battery management system consists of two major parts that is management system and user interface. IoT-based battery management system is designed to address the limitations of conventional BMSs. Overcharging of the battery leads to emission of gases like Hydrogen, Oxygen etc. By leveraging IoT connectivity and data analytics, it enables efficient battery monitoring, prevents overcharging and motor cut-off with respect to the abnormalities found in the battery, based on experimental results.**

***Keywords*— EV, IoT, SOC, NodeMCU, Overcharging**

I. INTRODUCTION

Electric vehicles (EVs) have emerged as a revolutionary alternative to traditional combustion engine vehicles, offering a sustainable and eco-friendly solution to the transportation sector. The electric vehicles offer numerous advantages, including lower operating costs, quieter operation, and the potential for vehicle-to-grid integration, enabling them to provide energy back to the grid during peak demand. A battery management system (BMS) in any electronic system that manages a rechargeable battery (cell or battery pack), such as by protecting the battery from operating outside its safe operating area based on the battery charging and discharging rates, state of charge estimation, battery voltage, temperature, current etc. The integration of the Internet of Things (IoT) into battery management systems (BMS) has revolutionized the way batteries are monitored, controlled, and optimized.

IoT-enabled BMS utilizes a network of interconnected sensors and devices to gather real-time data on various parameters of the battery system. With IoT in BMS, battery performance can be optimized through continuous monitoring and analysis. This allows for early detection of potential issues or abnormalities in the battery system, such as overcharging, undercharging, excessive temperature, or cell imbalance. By identifying these problems in real-time, proactive measures can be taken to prevent damage, improve safety and maximize the battery's efficiency. Through a web-based interface or a mobile application, users can access real-time data, receive alerts and remotely check the charging and discharging parameters of the batteries.

II. RELATED WORKS

1) Technology Based on Wireless Battery Management System:

Reliable battery management is obligatory for safety purposes. There have been several reasons that can cause battery breakdown such as deterioration of battery and design defects. Manual battery monitoring system which means that it does not save the data into the database but only show the data collected in real time. Therefore, it is crucial to remotely monitor battery systems using wireless technology.

Suresh et al. proposed a PLC-based battery health monitoring system for an UPS using GSM modules and SCADA by providing alert messages when the batteries are in abnormal conditions [1]. Dhotre et al. developed an automatic battery charging and engine control system for EV using GSM module [2].There are also several studies related to the progress of battery monitoring system for EV using wireless communication.

The lithium-ion batteries or Lead acid battery monitoring system using WIFI communication for EVs that collects and displays voltage, current, temperature and other parameters of batteries on a smartphone is also based on different studies. Based on the described previous work, it shows that there is no automatic monitoring system available to notify the user and also system that can ensure power cutoff from battery to the EV vehicle motor with regard to the performance of the battery. Therefore, IoT technology that integrates together within the management system can help in improving the preventive maintenance in ensuring the battery quality and increase the safety of the user.

III. METHODOLOGY

A) System Overview:

The proposed structure is depicted in figure1. It consists of EV Battery, Voltage sensor, Current sensor, Temperature sensor, 2 module relay, EV Motor, Node MCU Board with integrated WIFI Module, Wireless Monitoring Device, Power supply, and charge control unit. Voltage sensor reads the voltage rating, the current sensor reads the battery current rating, and the temperature sensor is used to read the temperature rating of the battery. All the parameters are given to the Node MCU Board unit where the information is transferred to the wireless monitoring unit through the IOT (Internet of Things) module and IOT protocol networks which performs different tasks based on the given instructions. On the remote monitoring side, IOT based Wireless smart device will be used to monitor the parameters of the battery efficiently. Smartphones is used for wireless remote monitoring applications.

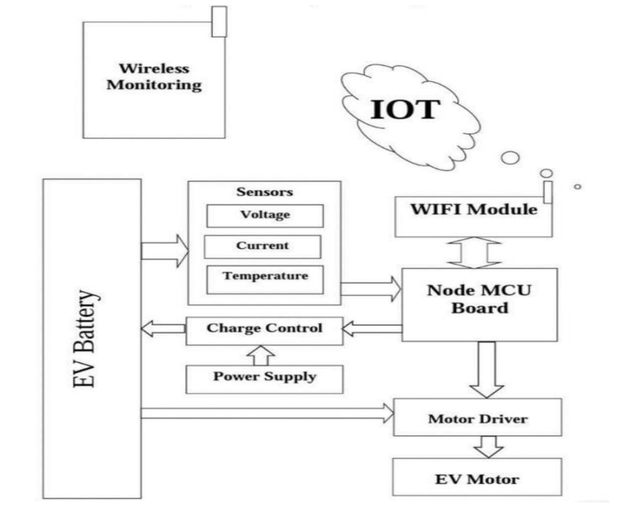

Figure 1: Overview of proposed system

.

B) System Flowchart:

Figure 2 displays the source code flow the Battery management system. Once the BMS system is switched ON, it will starts to initialize. Next it includes all the Blynk library data that is required for the functioning of the Battery Management system followed by the speed at which the information is to be sent from Node MCU board to the Blynk IoT mobile application following the setting up of Input and Output port of the Node MCU with gathering all the data from the libraries for the functioning of the BMS device and with all the above functions in normal state the condition is sent as TRUE and the Blynk IoT starts its function along with BMS device.

After all the above functions, conditional statements are applied in order to find the data whether it is TRUE or FALSE.

Here in the Algorithm flow chart it defines the complete structure of the codes that is used in the Battery Management System that is from the pre-defined variables related to the Blynk application and Node MCU Board and then the user defined variables that is the values of the parameters and then the conditional statement in the form of else if in order to define the each conditions whether it is TRUE or FALSE and give the information to Node MCU to perform different with respect to the conditions that is defined.

Based on the received data of Voltage, Current and Temperature, the source will verify the battery condition. If the conditions are normal, it will continue to read the parameters and if abnormal parameters are noticed then power cutoff to motor or charge cutoff during overcharging is been administrated to the system by the NodeMCU.

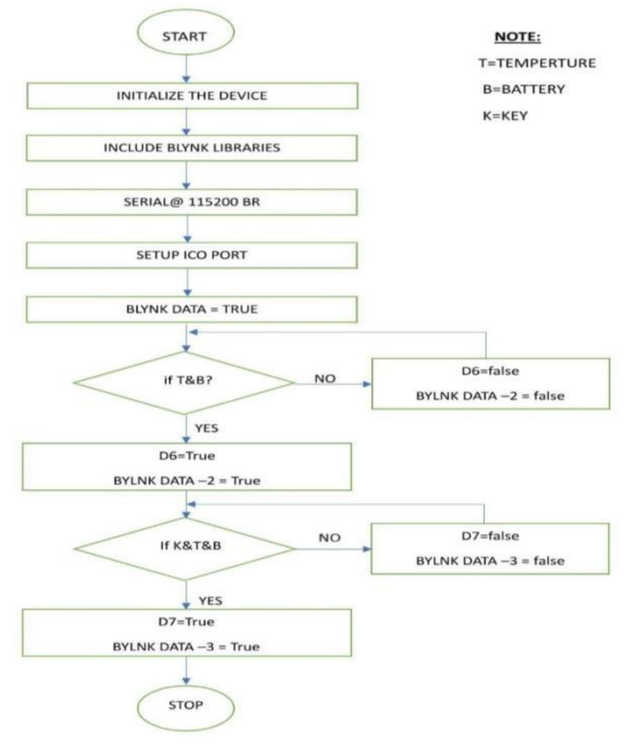

Figure 2: System Flowchart

C) Hardware Design:

Initially, in order to verify the suitability of the hardware parts, the design of the system was developed. Figure 3 illustrates the circuit design of the system which consists of a voltage sensor, temperature sensor, current sensor, NodeMCU board, 2 module relay, motor driver, resistors, diodes and battery.

IV. EXPERIMENTATION

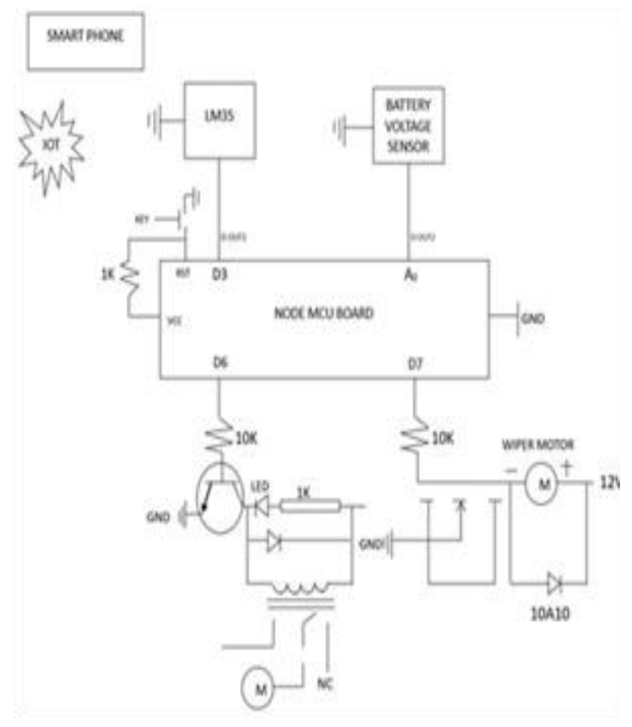

Figure 3: The design of circuit

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 09, September - 2025

This work reports the tests and analysis of the Battery Management System. First trial steps and results on the characteristics of Voltage sensor have been described. This is also to make sure the circuits are in good condition. It also ensures the measurements of basic parameters of the battery.

A) Voltage Sensor Test:

In this test, the values of the battery were measured by means of a multimeter. These values were then compared with the values of the same battery that is connected to the voltage sensor circuit. The purpose is to display the differences and also the accuracy between both values in percentage. The selected battery was varied in voltage values. The results of measurement of battery will show these differences.

TABLE I. VOLTAGE MEASUREMENT RESULTS

Sl No	***Voltage Measurement result***		***Accuracy percentage(%)***
	Voltage Sensor	***Multimeter***	
1	10.4	10.38	99.80
2	12.6	12.59	99.92

B) Measurement of Basic Parameters of Batteries:

When it comes to Battery Management system, monitoring the basic parameters of the battery is very much essential. The basic parameters of the battery include voltage, current and temperature of the battery. These parameters are very important and needs to be measured continuously

1) Measurement of Voltage and Current:

As the battery is charging, the voltage of the battery by any means will not provide the charging status or charging voltage of the battery. The charging voltage and the voltage measured across the terminals of the battery need not be the same. A dead battery which is not connected to any load can show an approximate voltage of 10.5 Volts (in case of Lithium Ion Batteries). This needs some complex circuitry to measure the charging voltage, or can use any voltage detection module to measure the voltage across the terminals of the battery.

Battery voltage sensor circuit is designed using voltage divider circuit and calculates the output voltage using voltage divider calculator according to the following voltage divider formula:

$$V_{out} = (V_{in} \times R2) / (R1 + R2)$$

Now:

- V_{in} --is the input voltage
- R1 --is the resistance of the 1st resistor,
- R2 --is the resistance of the 2nd resistor
- V_{out} --is the output voltage.

A potential divider circuit is presented in figure 4 is a very common circuit used in electronics where an input voltage has to be converted to another voltage less than it. A voltage divider circuit is very simple circuit consisting of only two resistors (R1 and R2) as shown above. The required output voltage (Vout) can be obtained across the resistor R2.

Using these two resistors can convert an input voltage to any required output voltage; this output voltage is decided by the value of the resistance R1 and R2.

2) Temperature Sensor:

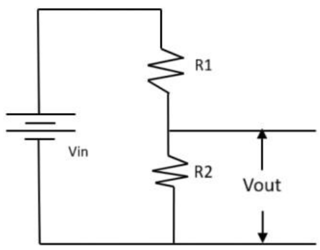

Figure 4: Battery Voltage Sensor

The temperature of the battery is a very significant parameter, as it decides the current state of the battery. If the temperature of the battery is high, it is a clear indication of the instability of the battery or to be more precise, it depicts the behavior the battery under abnormal conditions. The LM35 temperature sensor uses the basic principle of a diode to measure known temperature value as depicted in figure 5. As all of us know from semiconductor physics, as the temperature increases the voltage across a diode increases at a known rate. By accurately amplifying the voltage change, can easily generate a voltage signal that is directly proportional to the surrounding temperature.

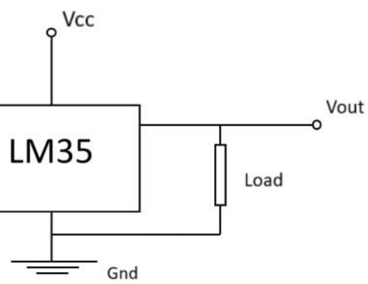

Figure 5: LM35 Temperature Sensor

By connecting the LM35 sensor to the NodeMCU is really modest. The sensor is to be connected to 5V for power supply and the output pin of the sensor is connected to the temperature digital convertor which is in turn connected to the D3 pin of the NodeMCU board. Once the connection is done, it is important to write the code to convert the output voltage of the sensor to temperature data. This is given as input to the Analog to Digital converter of the Microcontroller.

C) Battery Management using NodeMCU:

The code is been feed to the NodeMCU board which controls different aspects such as charge control, temperature sensing, current voltage sensing and automatic motor cutoff due to the abnormal behavior of the battery parameters. It ensures the health of battery and also the safety of the electric vehicles and driver with different safety measurements mainly the power cutoff to the motor.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 09, September - 2025

The NodeMCU's capability to connect to Wi-Fi or other IoT protocols enables the BMS to provide remote monitoring and control. By integrating the NodeMCU with appropriate communication protocols, the BMS can transmit crucial battery information to a centralized monitoring system or trigger actions based on specific battery conditions.

The developed hardware circuit of the battery management system is indicated in figure 6. In this image, the voltage, current and temperature sensor is connected to NodeMCU board. The system is also connected to the relay and motor driver.

The relay and motor driver works on the basis of input from the NodeMCU which makes sure that charge cutoff takes place with the help of relay to counter overcharging and power cutoff to motor with the help of motor driver when there are abnormalities found in battery parameters.

When the abnormalities is found, a beep alarm is used to alert the driver and there is a delay of 5 to 15 seconds which can be varied by the changes in codes in order to allow the driver to control the steering wheel before the power cutoff to the motor.

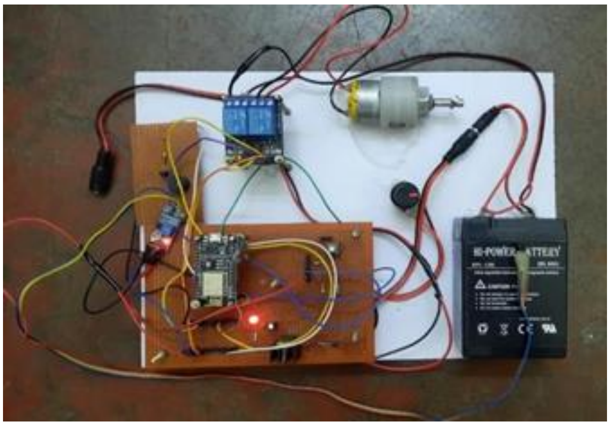

Figure 6: Hardware for the developed Battery management system

D) Battery Monitoring system User Interface:

The advanced battery monitoring system also consists of a web-based user interface in smartphone. The user interface is capable to the conditions of batteries. Therefore, the idea of the user interface has been taken into consideration where there is a need to monitor multiple batteries conditions. Figure 7 displays the main page for the web-based user interface Blynk IoT application. A user needs to login prior to use the interface. The login page is built for a secure data handling, where user is required to key-in username and password.

Once the user has successfully login into the user interface, the battery monitoring parameters is displayed. The parameters such as the Voltage of the battery, Temperature of the battery, Percentage of State of charge and State of Discharge is been determined and displayed to the user with the help of Blynk IoT application. Even the indication of the Charger and motor controller is also displayed in the application as revealed in figure 8 with the charge cutoff which occurs with overcharging is indicated with GREEN and RED lights and in the same way the indication of EV motor power cutoff is also DISPLAYED.

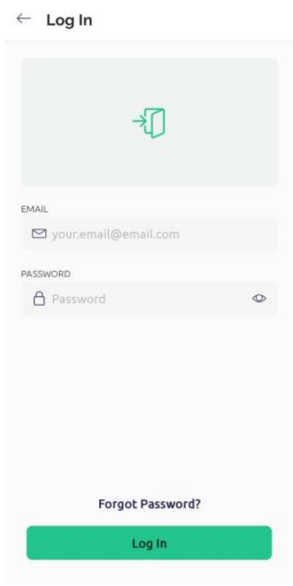

Figure 7: User interface for proposed BMS

Figure 8: Battery Monitoring Interface Blynk IoT showing the details of BMS

BMS enhances safety by continuously monitoring the battery pack for any abnormalities or potential risks. It can detect and respond to conditions like overvoltage, under voltage, overcurrent, and over-temperature, taking appropriate actions to mitigate hazards. By safeguarding against such risks, a BMS helps prevent accidents, damage to the battery, or even potential fire hazards

Furthermore, based on Figure 9, the upper left of the Blynk IoT shows a selection window where the user can Logout, View customer and also add customer. View customer is to view the list of battery monitoring devices that are being monitored. Add customer is used to add new battery monitoring devices to be monitored. The developed battery monitoring device user interface is designed to assist user to monitor condition of batteries so that notification can be sent to the user of a battery monitoring device.

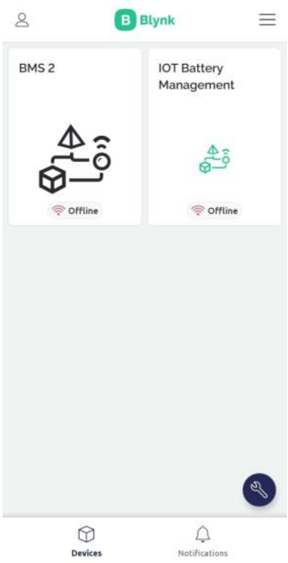

Figure 9: Main page of Blynk IoT application

V. CONCLUSION

This work describes the progress of a loT-based Battery Management System for electric vehicle to ensure the battery performance can be monitored online and also manages the battery with the help of NodeMCU. The progress of this system consists of the development of the hardware for the battery management device and a web-based battery monitoring user interface. The work is capable to show information such as battery condition and also ensures the safety of the battery as well as driver with the automatic cut-off of power to the motor during abnormal conditions. Further modification can be done to improve the system by adding more functions into the system. The Battery monitoring can be examined in smartphones that can help user to monitor battery and as a battery degradation reminder.

REFERENCES

[1] A. Sardar, H. Nascer, E. Qazi, and W. Ali "Smart Grids Wide Area Monitoring System for UPS Batteries Over GSM" 2nd International Multidisplinary Conference For Better Pakistan Vol.1, pp. 159-158, May 2012, 2015.

[2] A. S. Dhotre, S. S. Gavasane, A. R. Patil, and T. Nadu, "Automatic Battery Charging Using Battery Health Detection" International Journal of Engineering & Technology. Innovative science vol. 1, no. 5, pp. 486-490, 2014.

[3] Kamna Singh', Karan Bajaj', Chetan Verma, Mayank Bhardwaj, Rohan Mathpal' "A Review Paper on Sensors and Comparative Study between Node MCU and Arduino UNO", International Journal of Advanced Research in Computer and Communication Engineering , Vol. 11, Issue 4, April 2022

[4] Priyanka, R. Sandeep, V. Ravi, O. Shekar, "Battery Management System in Electric Vehicles", International Journal of Engineering Research & Technology (IJERT), Vol.9 Issue 05, May-2020.

[5] Yogendra Singh Parihar." Internet of Things and Nodemcu", A review of use of Nodemcu ESP8266 in IoT products, 2019 JETIR June 2019, Volume 5, Issue 6

[6] Shabana Urooj , Fadwa Alrowais , Yuvaraja Teekaraman , Hariprasath Manoharan and Ramya Kuppusamy, "IoT Based Electric Vehicle Application Using Boosting Algorithm for Smart Cities", Energies 2021, 14, 1072. https://doi.org/10.3390/en14041072

[7] Shivanand Basgonda Patil, Akshay Sanjay Kamme, Aniket Sunil Patil, Vaibhav Ravso Patil, Apurva A Londhe, "Design of Battery Health Monitoring System Using Arduino Uno", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), Volume 9, Issue 6, June 2020.

[8] Payal Kadu, Tejal Jejurkar, Harshal Patil, Harshvardhan Deshmukh, Monal Gadakh, "Arduino-based battery monitoring system with state of charge and remaining useful time estimation", International Research Journal of Modernization in Engineering Technology and Science, Volume: 04/Issue: 05,May-2022.

[9] Yohanes Calvinus, "Battery Charging Management System Design with Voltage, Current and Temperature Monitoring Features in Electric Vehicles", IOP Conference Series: Materials Science and Engineering, 3rd TICATE 2020.

[10] Ravindra Parab, Smita Prajapathi "IoT Based Relay Operation" International Journal of Engineering and Advanced Technology (IJEAT), Volume-9 Issue-1, October, 2019

[11] S.Anbarasu , K.Hariharan , S.Hariharan , B.Suryakrishnan, "Design of IoT Based Battery Monitoring System for E-Vehicle", International Journal of Innovative Research in Science, Engineering, and Technology (IJIRSET), Volume 10, Issue 12, December 2021.

[12] Nikita Shelke , Chaitali Nilawar, Gajajnan Udas Review of Battery Management Systems(BMS) , International Research journal of Engineering and technology (IRJET), Volume: 10 Issue: 03, Mar 2023

[13] Ashutosh Patel, Shriparno, Akshat, Harris " Battery Management System using Passive Elements and Aurdino", International Journal of Science and Research(IJSR), Volume-10 Issue-2, February 2021

[14] Mya Thandar Phyu, Nan Myint, Nan Sandar Thin " Temperature Monitoring System Using LM35 and PIC Microcontroller", International Research Journal of Modernization in Engineering Technology and Science, Volume-2 Issue-7, July 2020

[15] Deepak S Kumbhar, Harish C Chaudhari, "Comparative Analysis of Temperature Sensors and Selection of Temperature Sensor for Concrete Temperature Monitoring to Study Concrete Maturity in Civil Structure", Journal of Engineering Technologies and Innovative Research, Volume 6 Issue 5, May 2019

[16] E Ramya, "Embedded based Battery Monitoring System", International Journal of Electrical Engineering and Technology(IJEET), Volume-11 Issue-6, August 2020

[17] P Suresh Kumar, Krishnaprasad V, Dijo Joseph, Mohammad Aneesh, Yadhukanan, "Investigation and Safety Measures of Fire Accidents in Electric Vehicles", International Journal of Engineering Research and technology (IJERT), Volume: 11 Issue: 06, June 2022

[18] Yunus Tjandi, Syarifuddin Kasim, " Electric Control Equipment Based on Aurdino Relay", IOP Conference Series: Journal of Physics, 2019

[19] Nabilah Binti Mazalam, "Application of Wireless Internet in Networking using NodeMCU and Blynk App", Seminar LIS 2019, Politeknik Mersing Johor, Malaysia

[20] Shabana Urooj, Fadwa Alrowais, Yuvaraja Teekaraman, Hariprasath Manoharan, Ramya Kuppuswamy " IoT Based Electric Vehicle Application Using Boosting Algorithm for Smart Cities", Energies 2021, 14, 1072