Internet Of Things (IoT) For Electric Car Battery Capacity Controller

Jefri Lianda[1,1)] Muhammad Afridon[1, b)], Zamhuri[1, c)], Dea Fitriana[1)], Gusti Eviani[1,d)]

[1]*Department of Electrical Engineering. Bengkalis State Polytechnic, Bengkalis, Riau, Indonesia, 28711*

[a)] *Corresponding author: jefri@polbeng.ac.id*
[b)] *afridon@polbeng.ac.id*
[c)]*zamhuri@polbeng.ac.id*
[d)] *fitrianaadea24@gmail.com*
[e)]*gustieviani@gmail.com*

Abstract. This paper discusses a 58 volt battery voltage control system for electric vehicles using the Blynk application. The research successfully monitors the amplitude of the battery voltage. Additionally, it includes the capability to control the battery via an SSR relay, which is connected to the NodeMCU ESP8266. The Blynk application displays both the amplitude and the percentage of the battery voltage. The NodeMCU ESP8266 has demonstrated reliable performance, maintaining a stable connection as long as it is connected to the internet. The average voltage discrepancy shown on the Blynk application is 0.74%. The SSR relay disconnects the power supply to the electric vehicle when the battery voltage approaches 46.3 volts or when the battery capacity percentage drops to 0.16%. This system ensures that the battery is managed effectively, preventing over-discharge and potential damage by disconnecting the load at critical voltage levels

Keywords: battery, blink, SSR relay

INTRODUCTION

Cars are a common means of transportation used in daily life, prized for their practicality and comfort. However, with growing concerns about air pollution, rising fuel prices, and diminishing fuel resources, people are seeking alternative energy sources for vehicles, with electric cars emerging as a prominent solution. In Indonesia, the development of electric cars is a hot topic, with numerous researchers striving to design vehicles that offer a variety of features and innovative designs. Yet, a central challenge remains: battery capacity, which is a key focus in the discussion about electric vehicles. This system utilizes the STM32F103 chip as the primary control unit to oversee all system operations. The BQ76930 chip is employed to gather critical battery data, including voltage, current, and temperature, ensuring precise monitoring. The gathered information is transmitted to Alibaba Cloud servers through the NB-IoT module, facilitating efficient data transfer and real-time connectivity. The server handles state of charge (SOC) estimation and storage of battery data, offering comprehensive analysis and monitoring. Finally, battery information is visually presented through a PC interface and mobile terminal, enabling users to directly monitor battery status from various devices [1].

In the research conducted by Jefri Lianda and colleagues, titled "IoT-Based Battery Capacity Monitoring System on Solar Panels in Electric Vehicles," it was discovered that the capacity of a 12-volt DC battery can be monitored using IoT technology. The study utilized a solar panel with a capacity of 50 WP along with a 12-volt, 7 Ah battery. This battery is employed for powering the lighting system in an electric vehicle. Additionally, the battery can be deactivated by pressing the Off button in the Blynk application [2].

Electric cars utilize various types of batteries, including Lead Acid and Lithium-Ion batteries, each with distinct characteristics that can significantly impact vehicle performance. For optimal operation, batteries require careful monitoring of several parameters, such as voltage, current, temperature, specific gravity, and reactivity. By analyzing these parameters, we can assess the battery capacity more accurately. Effective control and monitoring are essential to ensure that electric cars operate efficiently with proper battery management. [3]- [5] .

Model A employs a USB serial connection as the transmission medium to link devices within the system, providing direct and reliable data communication. In contrast, Model B utilizes the Message Queuing Telemetry Transport (MQTT) Protocol in conjunction with the ESP8266-12 Wi-Fi module to connect the system to the internet. This method offers more flexibility and efficiency for data exchange over wireless networks, supporting extensive and scalable communication within the IoT ecosystem and enabling real-time interactions between various devices. [6]

To advance the development of electric cars at Bengkalis State Polytechnic, an IoT application is essential for monitoring and controlling battery capacity. This will enable users to estimate the remaining travel distance based on the current battery status. The electric cars currently being developed in 2023 lack a monitoring and battery control system, leading to frequent instances of the vehicles abruptly stopping on the road due to depleted battery energy. Therefore, the author will research "Application of the Internet of Things (IoT) to control electric car battery capacity". Then this tool will notify you of the percentage and how long the battery will last, and can monitor and control the battery while charging using your cellphone. In this research, a monitoring system will be created that can classify the monitoring results of electric car batteries based on the voltage of the battery being used and being charged using the charging system. The following monitoring system uses a DC voltage sensor. Apart from that, the NodeMCU ESP32 will be used as a microcontroller and a medium to connect to the internet. This research is equipped with a control system that can control the battery so that it can turn off some loads if the battery condition approaches the minimum level. In addition, it will be able to disconnect the battery from the main load in case of theft so that the electric car cannot be operated.

METHODS

In the application of the Internet of Things (IoT) for managing electric car battery capacity, several critical components are essential throughout the tool's operational process. The primary component is the battery, which is crucial for the power and electrical system of electric cars, as it stores electrical energy generated through charging from the PLN source. In this electric car battery capacity management system, a Lithium-Ion (LiFePO4) battery is employed as the power source, which will be monitored during both charging and discharging phases.

This electric car battery capacity control system utilizes a NodeMCU ESP8266 microcontroller, which features an integrated WiFi module to enable remote access via the internet. The system design incorporates an INA219 sensor connected to the NodeMCU ESP8266 microcontroller, allowing users to monitor voltage flow values through both an OLED display and a smartphone. The smartphone monitoring is facilitated by the Blynk application, which receives data from the NodeMCU. Additionally, the tool includes an OLED display to show the battery charge percentage. The system design also features a control mechanism that allows the user to manage battery charging via a smartphone. When the battery is depleted due to load, the system can control the charging process and also stop charging when the battery reaches full capacity.

The block diagram for the IoT-based electric car battery capacity controller is illustrated in Figure 1.

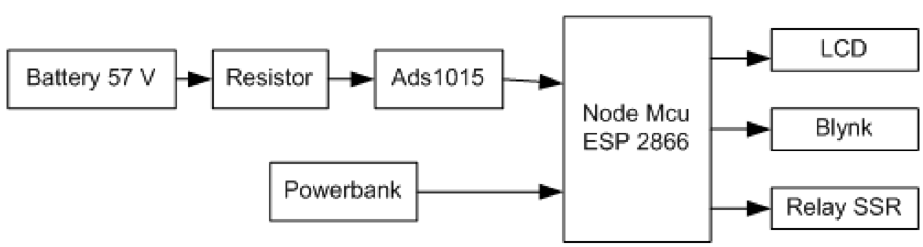

FIGURE 1. Research Block Diagram

Hardware is a crucial element in the tool manufacturing system. The purpose of this design is to plan and develop hardware in accordance with the specifications and operational requirements of the control system, which aims to monitor the battery condition in a solar panel system using the IoT-based NodeMCU ESP8266. This involves selecting compatible components and creating an effective integration scheme to ensure the system operates optimally, providing real-time monitoring and reporting of battery status over the internet. The hardware design is illustrated in Figure 2.

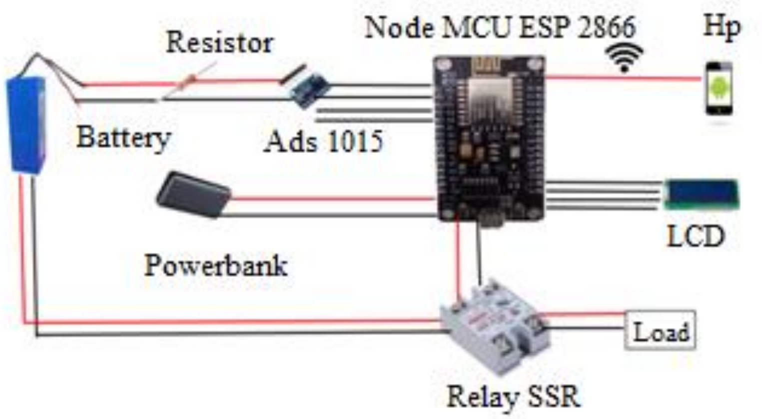

FIGURE 2.. Hardware Design

A battery serves as the power source for an electric vehicle. A voltage divider resistor splits the voltage so that it can be read by the ADC module (ADS1015). The ADC module (ADS1015) converts the analog voltage value into a digital value that can be read by the NodeMcu ESP8266. A power bank supplies power to the NodeMcu ESP8266. The NodeMcu ESP8266 sends commands to the SSR relay, LCD, and Blynk. The SSR relay acts as a switch that connects or disconnects the battery from the load. The LCD and Blynk display the battery voltage and percentage

Software design involves developing an application for managing and monitoring battery capacity in electric vehicles using the IoT-based NodeMCU ESP8266. This process includes creating algorithms and user interfaces to facilitate effective system monitoring and control over the internet. The detailed design of the software is illustrated in Figure 3, which includes the workflow scheme, module structure, and user interface used in the system. This figure provides a clear overview of how the software operates and integrates into the overall system for control and monitoring.

.

FIGURE 3. Software Design

RESULTS AND DISCUSSION

This monitoring tool is enclosed in a compact acrylic box with dimensions of 11 x 7.5 x 4 cm. The box is designed to house essential components and features a power button for easy operation. Additionally, it includes a 6-terminal block specifically for connecting the battery and solar panel, ensuring secure and organized connections. This setup facilitates the efficient monitoring of battery and solar panel performance. For a detailed view of the tool's design and configuration, refer to Figure 4, which illustrates the layout and components of the acrylic enclosure, highlighting its practical design and functional features.

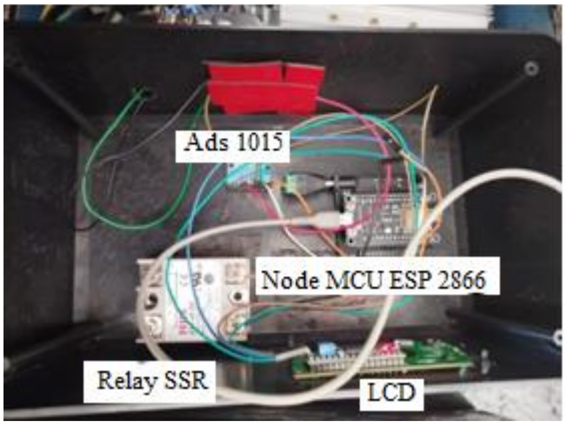

FIGURE 4. The results of the device design

This device is used for monitoring a 58 Volt DC battery. The voltage is reduced using a resistor to 5 V DC in order to convert the analog value to digital so it can be read by the NodeMCU ESP8266. Meanwhile, the 5 V DC power for the ADS1015 module, SSR relay module, and 16x2 LCD can be taken from the NodeMCU ESP8266. The BLYNK application is used to display the data read by the ADS1015 module, allowing the battery condition to be monitored from a smartphone. The pin configuration between the INA219 sensor module and NodeMCU ESP8266 can be seen in table 1 and is described as follows:

a. Connect the 5 V pin of the NodeMCU ESP8266 to the VCC pin of the ADS1015.
b. Connect the GND pin of the NodeMCU ESP8266 to the GND pin of the ADS1015.
c. Connect the D1 pin of the NodeMCU ESP8266 to the SCL pin of the ADS1015.
d. Connect the D2 pin of the NodeMCU ESP8266 to the SDA pin of the ADS1015.

This device uses an SSR relay to switch between the battery and the load, controlled by a program from the NodeMCU ESP8266. The pin configuration between the NodeMCU ESP8266 and the SSR relay is detailed in Table 1 and is described as follows :

a. Connect the D5 pin of the NodeMCU ESP8266 to the VCC pin of the relay.
b. Connect the GND pin of the NodeMCU ESP8266 to the GND pin of the relay

TABLE 1. CONFIGURE PIN

NodeMCU ESP8266	Relay
5 V	VCC
GND	GND

Monitoring with Blynk can be carried out by installing the Blynk application from the Play Store for Android users or from the App Store for iOS users. In addition to mobile devices, Blynk is also accessible via desktop computers by visiting the Blynk website through a web browser. This flexibility allows users to monitor their systems effectively across different platforms. For a visual reference, the Blynk display on a smartphone is shown in Figure 5. This setup provides convenient and versatile access to real-time monitoring and control features provided by Blynk.

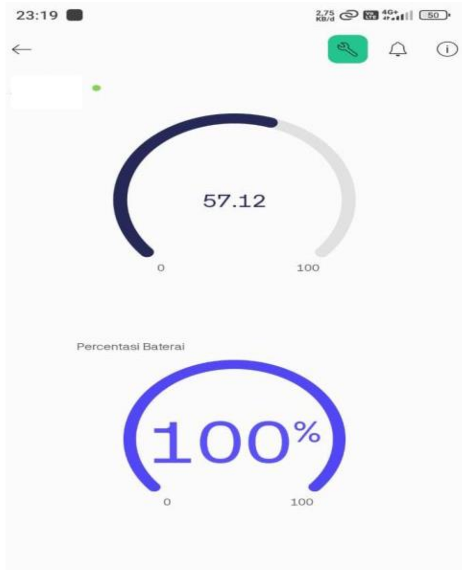

FIGURE 5..Display of data on the blynk application

In this study, the blink display presents both voltage values and battery capacity percentages. Specifically, when the voltage is at 57.12 volts, the display indicates that the battery capacity is at 100%. This correlation allows for a straightforward interpretation of the battery's charge status based on its voltage level. The display is designed to provide clear and immediate feedback on the battery's health, ensuring that users can easily monitor the battery's condition and manage its usage effectively. The system aims to enhance user experience by offering accurate and real-time information about battery performance.

Testing the NodeMCU ESP8266 Wifi on the blynk application which is used as a remote communication link or so-called Internet of Things (IoT) based, this test is carried out to find out how far the wifi connection on NodeMCU can be connected. The NodeMCU ESP8266 Wifi test on the blynk application can be seen in Table 2.

TABLE 2. TESTING THE NODEMCU ESP8266 WIFI ON THE BLYNK APPLICATION

No.	Distance (meters)	Description
1	0	Connect
2	20	Connect
3	500	Connect
4	1000	Connect
5	1500	Connect
6	2000	Connect
7	4000	Connect
8	10000	Connect

Testing the NodeMCU ESP8266 WiFi connection with the Blynk application for the battery condition monitoring and control system involves using a smartphone to remotely control and observe the system. The Blynk application, available for download on the Play Store and App Store, includes features for both battery charging control and voltage monitoring. Even at a distance of 10,000 meters, the connection remains stable as long as there is an active internet network.

This testing aims to determine the voltage value and battery percentage while the vehicle is in motion. The tests are carried out on the campus of Bengkalis State Polytechnic. By measuring these parameters during operation, the objective is to assess the performance and efficiency of the battery in real-world driving conditions. The results will help evaluate the accuracy of the monitoring system and ensure that it provides reliable data for managing battery performance. This process is essential for verifying that the system functions correctly and meets the requirements for effective battery management in an operational environment. The voltage percentage testing table can be found in Table 3.

TABLE 3. ADS1015 SENSOR VOLTAGE BATTERY

No.	Voltage at the ADS1015 Sensor (Volt)	Voltage on Voltmeter (Volt)
1	57,12	57,14
2	55,1	54,4
3	54,27	52,5
4	54,06	52,4
5	53,89	52,3
6	53,64	52,1
7	53,08	52,1
8	52,68	51,2
9	50,82	49,22
10	49,16	48,48
11	47,83	47,04
12	46,8	46,3

The testing of voltage percentage displayed on the Blynk application is detailed in Table 4. This table provides a comprehensive overview of how the voltage percentage is monitored and recorded through the Blynk application. It includes various data points collected during the testing process, showcasing how the application tracks and displays battery voltage levels in real-time. The table is crucial for evaluating the performance of the monitoring system, ensuring that the Blynk application accurately reflects the current battery status. By reviewing Table 4, users can assess the effectiveness and reliability of the voltage percentage monitoring feature within the Blynk application.

TABLE 4. VOLTAGE PERCENTAGE BATTERY

No	**Voltage (Volt)**	**Battery Capacity LCD (%)**	**Battery Capacity Blink (%)**
1	57,12	100	100
2	55,1	90	90
3	54,27	82,66	83,35
4	54,06	80,19	80,19
5	53,94	79,98	79,24
6	53,64	76,35	76,35
7	53,08	70,78	69,31
8	52,68	66,81	64,17
9	50,82	50,62	49,84
10	49,16	32,65	32,08
11	47,83	19,27	18,26
12	46,8	0,42	0,16

From Table 5, it is evident that the battery capacity percentage displayed on the Blynk application is nearly the same as that shown on the LCD. The average difference between the LCD and Blynk readings is just 0.74%. This small discrepancy indicates a high level of accuracy and consistency between the two monitoring systems. Such minimal variation suggests that both the Blynk application and the LCD are effectively providing reliable battery capacity information, which is crucial for precise battery management and ensuring users receive accurate and trustworthy data about the battery's charge level.

TABLE 5. RELAY SSR CONDITION

No	Voltage (Volt)	Battery Capacity LCD (%)	Battery Capacity Blink (%)	Relay SSR Condition
1	57,14	100	100	On
2	54,4	90	90	On
3	52,5	82,66	83,35	On
4	52,4	80,19	80,19	On
5	52,3	78,35	78,25	On
6	52,1	76,35	76,35	On
7	52,1	70,78	69,31	On
8	51,2	66,81	64,17	On
9	49,22	50,62	49,84	On
10	48,48	32,65	32,08	On
11	47,04	19,27	18,26	Off
12	46,3	0,42	0,16	Off

When the battery voltage drops to 46.3 volts, the SSR relay will disconnect the power supply to the load. This is also supported by the battery capacity percentage, which ranges from 0% to 16% and is indicated through Blynk application as shown in Table 5. The blinking lights serve as a visual confirmation of the battery's low capacity, ensuring that the relay acts to prevent further discharge and potential damage. This integrated approach helps in maintaining battery health and system reliability.

CONCLUSIONS

This research successfully monitored and controlled a 58-volt battery voltage using the Blynk application. Blynk provides real-time data on both the amplitude and percentage of the battery voltage. The NodeMCU ESP8266 has demonstrated reliable performance, maintaining a stable connection as long as it is connected to the internet. Throughout the study, the average voltage discrepancy displayed on the Blynk application was just 0.74%, indicating a high degree of accuracy in the voltage readings. The SSR relay disconnects the power supply to the electric vehicle when the battery voltage approaches 46.3 volts or when the battery capacity percentage drops to 0.16%. This level of precision ensures that the battery's performance and status are closely monitored, providing valuable insights for effective battery management. The integration of NodeMCU ESP8266 with Blynk not only facilitates real-time monitoring but also enables precise control over the battery system, contributing to improved reliability and efficiency in battery management applications.

ACKNOWLEDGMENTS

This research was carried out thanks to the support of the Bengkalis State Polytechnic.

REFERENCES

[1] X. Wang, X. Yi, and H. Ding, "Battery Monitoring System Design Based on NB- IoT," in *2022 First International Conference on Cyber-Energy Systems and Intelligent Energy (ICCSIE)*, 2022, pp. 1–5. doi: 10.1109/ICCSIE55183.2023.10189334.

[2] J. Lianda, A. Hadi, Adam, H. Amri, and G. Eviani, "IoT Based Battery Capacity Monitoring System on Solar Panels in Electric Vehicle", 2023 Proceedings of the International Conference on Applied Science and

Technology on Engineering Science 2023 (iCAST-ES 2023), pp. 484-292. doi: 10.2991/978-94-6463-364-1_45.

[3] G. G. Vijaya, N. Aruna, S. Janadharani, and N. D. Varshini, "IoT based Lithium-Ion Battery Monitoring System in Electric Vehicle," in 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS), 2023, pp. 1092–1096. doi: 10.1109/ICAIS56108.2023.10073696

[4] S. Kale and B. N. Chaudhari, "IoT Based Battery Monitoring System," in 2022 International Conference on Advances in Computing, Communicati*on and Materials (ICACCM),* 2022, pp. 1–5. doi: 10.1109/ICACCM56405.2022.10009576.

[5] Y. Hu, "Research on Battery Monitoring Technology Based on Internet of Things," in 2021 International Conference on Signal Processing and Machine Learning (CONF-SPML), 2021, pp. 150–153. doi: 10.1109/CONF-SPML54095.2021.00037.

[6] M. Kashyap, V. Sharma, and N. Gupta, "Taking MQTT and NodeMcu to IOT: Communication in Internet of Things," Procedia Comput. Sci., vol. 132, no. Iccids, pp. 1611–1618, 2018, doi: 10.1016/j.procs.2018.05.126.

[7] D. H. de la Iglesia, F. L. Alejano, A. H. de la Iglesia, H. S. S. Blas, L. A. Silva, and J. L. Alfonso, "Design of a low-cost IoT device for the estimation of the state-of-health (SOH) of reused lithium batteries," in 2023 6th Conference on Cloud and Internet of Things (CIoT), 2023, pp. 171–175. doi: 10.1109/CIoT57267.2023.10084881.

[8] Nikhil, K. Sharma, S. Khubalkar, P. Daigavane, and P. Vaidya, "IoT-Enabled Battery Monitoring System for Enhanced Electric Vehicle Performance," in 2023 3rd International Conference on Intelligent Technologies (CONIT), 2023, pp. 1–6. doi: 10.1109/CONIT59222.2023.10205665.

[9] N. Nadhiroh and R. Fierdaus, "IoT based Battery Storage Temperature Monitoring System," 2022 5th Int. Conf. Comput. Informatics Eng., pp. 258–261, 2022, doi: 10.1109/IC2IE56416.2022.9970080.