IoT Based Battery Capacity Monitoring System on Solar Panels in Electric Vehicle

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Abstract. This paper studies the battery capacity monitoring system on solar panels in electric cars using the IoT-based NodeMCU ESP8266. All of these systems were built with the aim of making it easier for workers to manage incoming power consumption when charging the battery while preventing battery damage so that battery life can last longer and the use of battery becomes more optimal. This study uses blynk via smartphone and Oled 128 x 64 to see the percentage of battery capacity. After testing the monitoring accuracy, an average error value of 0.97% was obtained. In testing a 12 V / 7 Ah battery using a solar panel with a capacity of 50 WP, it takes 4.5 hours to charge the battery with an average current of 1.74 Amperes. Battery charging can also be controlled via a smartphone by pressing the OFF button on the blynk application.

Keywords: Battery, Monitoring, NodeMCU, Solar Panel, Blynk.

1 Introduction

Solar power plants require maintenance or checking of the battery electrical system to see the condition of the battery so that the quality and quality of the battery are continuously maintained. This maintenance is still done manually by the officer in charge. Manual performance by officers can actually be made easier if there is a special monitoring control made for the observation system, especially the battery at the solar power plant center. This can be overcome by using a microcontroller because of its association with low voltage and direct current. Its use can be done directly and it will be easy if later remote observation is needed because it can also be displayed on a smartphone[1].

In solar power generation systems, batteries are used as power storage, the power stored in the battery will be used during periods of low solar radiation or at night, for this reason the battery must remain in good condition so that its use can run smoothly[2]–[4].

Monitoring the state of charge (SOC) is tricky because it reflects the internal state of the battery[5], [6]. There are no instruments or sensors that can directly measure SOC. It must be removed from the battery current or voltage. Thus, the term SOC estimate is used instead of SOC measurement. There are many approaches to determining battery

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SOC parameters[7]. Each of these actions has its own weaknesses. There will be no risk of overcharging the battery if the percentage is calculated correctly.

This study designed an IoT-based monitoring control system for battery conditions using the NodeMCU microcontroller as a controller for observations to be carried out by smartphone.

Blynk is a server service used to support Internet of Things projects. This server service has a mobile user environment for both Android and IOS. The Blynk application as an IoT supporter can be downloaded through Google Play for Android users and through the App Store for iOS users. Blynk supports a wide variety of hardware that can be used for Internet of Things projects. Blynk is a digital dashboard with a graphical interface for project creation.

NodeMCU is a microcontroller similar to Arduino[8], [9]. NodeMCU has an advantage over Arduino, namely that there is an ESP8266 system on chip that has been embedded in the nodeMCU, while Arduino is that nodeMCU does not have I/O pins like Arduino. ESP8266 works for Wifi network connectivity. NodeMCU is based on a wide range of programming languages but can also use the Arduino IDE for programming[10].

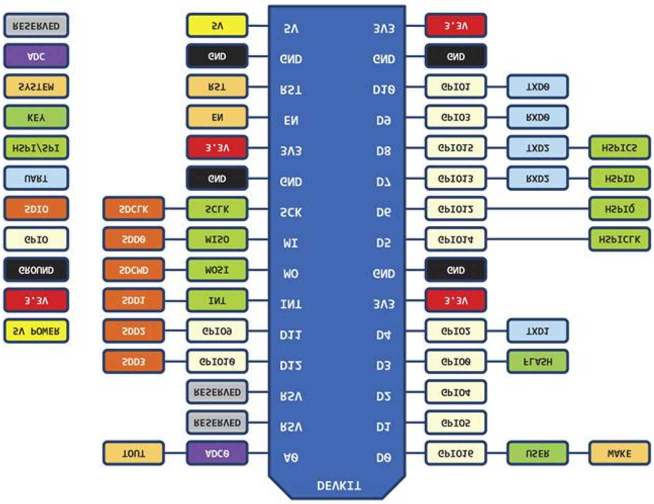

Fig.1. Block I/O pins on NodeMCU

The INA219 sensor is used to measure electric current[11]. The INA219 Sensor Module is a module that is supported by measuring capabilities that are capable of measuring load sources up to 26 VDC and 3.2 amperes of current. This is a small but cool sensor module because it not only measures current, but can also measure voltage via I2c communication with a precision level of 1% by utilizing ohm's law multiplication and can also calculate the wattage, the amount of power that can be measured using this module is can reach more than 75 watts of power.

The LM2596 module has 4 pins, 2 left DC input pins and 2 right DC output pins. This module is used to lower the dc voltage as needed[12]. To reduce the voltage from the step down module, this can be done by changing the position of the potentiometer and measuring the output voltage with a multimeter.

2 Experimental Setup

In the control system for observing battery conditions in solar panel systems using NodeMCU based on IoT, there are several components that play a very important role in the initial to the final process of the tool's work system, including there is a very important main component, namely the battery which plays an important role in the power generation system. Solar cells are used to store the electrical power generated by solar cells. In addition, the designer also uses a solar charger controller which functions to regulate the direct current that enters the battery because the solar charge controller regulates overcharging (overcharging - because the battery is full and the excess voltage from the solar panel / solar cell. Excess voltage and charging will reduce battery life.

In the design of the battery condition observation control system using the NodeMCU ESP8266 microcontroller which has a wifi module that has been provided on the microcontroller so that observations can be accessed via the internet[13]–[15]. In the design of the tool to be made, it requires the INA219 sensor which will be connected to the NodeMCU ESP8266 microcontroller so that users can monitor the value of the voltage flow through OLED and smartphones, monitoring using the smartphone in question is by using the application that has been provided, namely the Blynk application which has received data from NodeMCU. The design of this tool also uses an OLED display to see the percentage of the accumulator battery. Apart from that, in designing this tool, the author will create a control system for the battery where when the battery is in a reduced condition due to a load, the tool can control battery charging via a smartphone and can also disconnect charging when the battery is fully charged.

The block diagram of the battery condition monitoring control system in a power generation system using Arduino-based IoT can be seen in Figure 2.

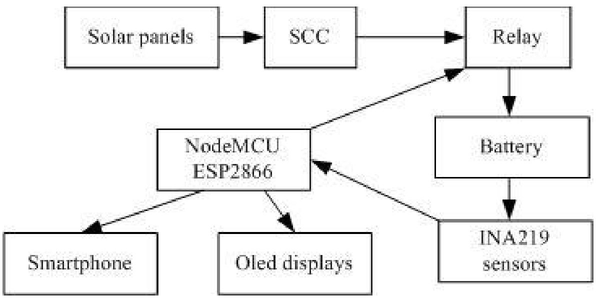

Fig.2. Research Block Diagram

Hardware is the device that will be used in the tool making system. The purpose of this design is to plan or design hardware according to the specifications and work systems of the control system for observing battery conditions in solar panel systems using the IoT-based NodeMCU ESP8266. The hardware design can be seen in Figure 3.

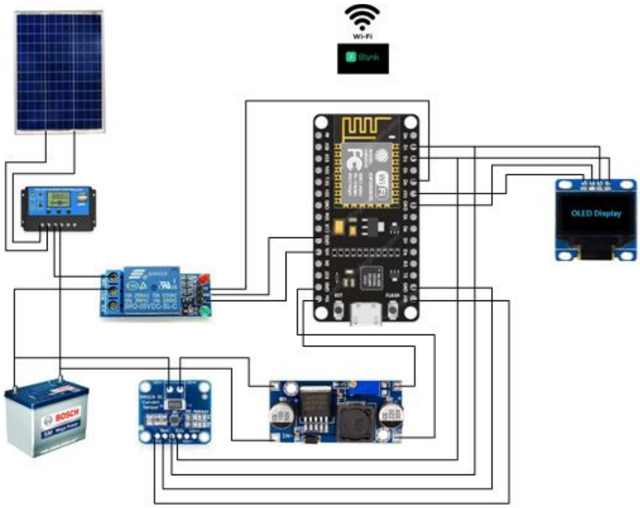

Fig. 3. Hardware Design

Software design is software used in programming a control system for observing battery conditions in a solar power generation system using the IoT-based NodeMCU ESP8266. The software design can be seen in Figure 4.

Fig.4. Software Design

3 Results and Discussions

This monitoring tool is packaged in an acrylic box with a size of 11 x 7.5 x 4 cm, equipped with 1 power button, 1 terminal 6 block for the battery and solar panel, as shown in Figure 5.

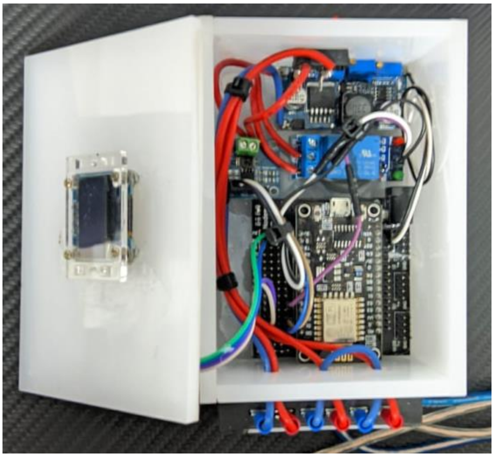

Fig. 5. The results of the devicedesign

The pin configuration between the INA219 sensor module and NodeMCU ESP8266 can be seen in table 1 and is described as follows:

a. 3V NodeMCU ESP8266 is connected to the VCC sensor INA219
b. GND NodeMCU ESP8266 is connected to GND sensor INA219
c. D1 NodeMCU ESP8266 is connected to SCL sensor INA219
d. D2 NodeMCU ESP8266 is connected to SDA sensor INA219

Table1. Configure INA219 sensor to NodeMCU ESP8266

NodeMCU ESP8266	INA219
3 V	VCC
GND	GND
D1	SCL
D2	SDA

This system uses a 128x64 OLED which is used to display data that has been read by the INA219 sensor on an OLED screen placed above this tool. The pin configuration between OLED 128x64 to NodeMCU ESP8266 can be seen in table 2 and is described as follows:

a. 3V NodeMCU ESP8266 connected to VCC OLED 128x64
b. The GND of the NodeMCU ESP8266 is connected to the GND of the 128x64 OLED
c. D1 NodeMCU ESP8266 is connected to SCL OLED 128x64
d. D2 NodeMCU ESP8266 connected to SDA OLED 128x64

Table2. Configure Oled 128x64 to NodeMCU ESP8266

NodeMCU ESP8266	Oled 128x64
3 V	VCC
GND	GND
D1	SCL
D2	SDA

Monitoring on blynk can be done by installing the blynk application via playsote for Android users or the App Store for IOS users. Apart from using a smartphone, blynk can also be accessed using a desktop by opening the blynk website in a browser. The blynk display on a smartphone can be seen in Figure 6.

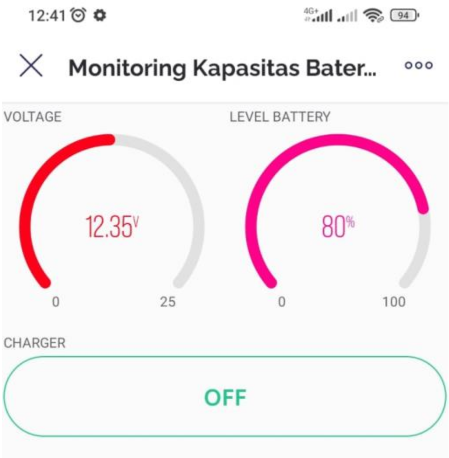

Fig.6. Display of data on the blynk application

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 3.

Table 3. Testing the NodeMCU ESP8266 Wifi on the blynk application

No.	Distance (meters)	Description
1	0	Connect
2	20	Connect
3	100	Connect
4	200	Connect
5	500	Connect
6	1000	Connect
7	1200	Connect
8	1400	Connect

Testing the NodeMCU ESP8266 Wifi to the blynk application on the battery condition observation control system using remote control via a smartphone using the blynk application which can be installed via the play store and app store, in testing the blynk application it includes a battery charging control button and there is also voltage monitoring that's in the battery. With a distance of 1400 meters it is still connected while there is still an internet network.

In this test it was carried out to find out the sensor output results that the INA219 sensor had read. The following is the result data from the INA219 sensor test which can be seen in table 4.

Table 4. INA219 Sensor Testing

No.	Input Voltage (Volt)	Voltage at the INA219 Sensor (Volt)	Voltage on Voltmeter (Volt)
1	5	5,27	5,35
2	6	6,41	6,51
3	7	7,19	7,28
4	8	8,14	8,22
5	9	9,07	9,15
6	10	10,23	10,30
7	11	11,16	11,25
8	12	12,31	12,40
9	13	13,11	13,19
10	14	14,30	14,39

The data obtained in Table 4 is the result of testing the tool using a power supply with a voltage regulator potentiometer. The test is carried out by adjusting the potential on the power supply that is used as the input voltage, starting from 5 V DC to 14 V DC on the power supply connected to the device.

This test is carried out to determine the comparison between the battery charging time using calculations and during testing. The battery that will be charging is a battery with a capacity of 12 V / 7 Ah. The length of time it takes to charge a battery is influenced by various factors, one of which is the charging current, the battery is said to be full when the battery voltage has reached 12.8 V. The following is a battery charging test using a solar panel with a capacity of 50 Wp and a battery of 12 V / 7 Ah can be seen in Table5.

Table 5. Battery Charging Test

No	Time	Voltage (Volt)	Current (Ampere)	Power (Watt)	Battery capacity (%)
1	10.00	14,58	1,9	27,702	30 %
2	10.30	14,35	1,8	25,83	36 %
3	11.00	14,52	1,9	27,588	45 %
4	11.30	14,55	1,9	27,645	49
5	12.00	14,88	2,1	31,248	53
6	12.30	14,22	1,7	24,174	65
7	13.00	14,13	1,7	24,021	78
8	13.30	13,98	1,5	20,97	84
9	14.00	13,84	1,5	20,76	93
10	14.30	13,55	1,4	18,97	100

From the data obtained after carrying out the battery charging test, it is known that the time needed to charge the battery from a battery percentage position of 30% to 100% takes 4.5 hours, using a 50 WP solar panel and a 12 V / 7 Ah battery. In the process of charging the battery that affects the charging time of the battery is the charging current, the greater the charging current, the faster the charging time.

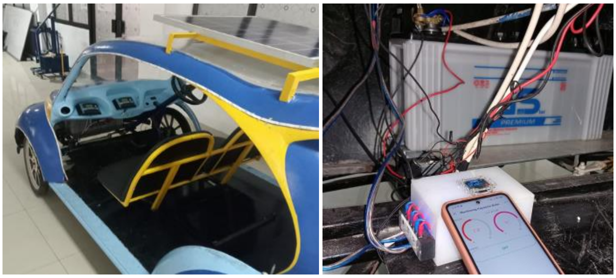

Fig. 7. Overall testing

Overall testing in this study was carried out on a battery and solar panels to monitor battery charge. The test was carried out using a 12 VDC battery as a battery charging experiment. The testing process using solar panels and batteries can be seen in Figure 7.

4 Conclusion

This research has succeeded in monitoring the capacity of IoT-based batteries through the blynk application. Display on the blynk in the form of voltage and voltage level. The NodeMCU ESP8266 test is still connected at a distance of 1400 meters. The average percentage of error in the value of the voltage reading on the sensor and measuring instrument after conducting 10 trials is 0.97%. The highest percentage of voltage error when the sensor is working is 1.5% while the lowest percentage of voltage error is 0.62%. These results show that the INA219 sensor is feasible. The time needed to charge the 12 V / 7 Ah battery on this tool using a solar panel with a capacity of 50 Wp with an average charging current of 1.74 A, which is 4.5 hours.

5 Acknowledgment

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