Progress in Engineering Application and Technology Vol. 3 No. 1 (2022) 411-418
© Universiti Tun Hussein Onn Malaysia Publisher's Office

PEAT

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-5303

IoT Solar Panel Tracking For I-V and P-V Characteristic

Nor Arina Gimin[1], Nor Aira Zambri[1], Sim Sy Yi[1], Farahiyah Mustafa[1]*

[1]Department of Electrical Engineering Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/peat.2022.03.01.042
Received 17 January 2022; Accepted 11 April 2022; Available online 25 June 2022

Abstract: This project presents and discusses techniques in monitoring and processing of I-V and P-V curves of photovoltaic modules. Usually, this problem occurs at all solar sites where collecting information or data on each solar panel become difficult due to its. The huge region and acreage of solar sites. Furthermore, some equipment has restricted or incorrect specifications, which might be compromised during data collecting. It is conceivable that the data collected is inaccurate. Therefore, this project aims to analyze, collect, and store I-V and P-V data on the solar panels at solar sites. This project combines an IoT system that consists of an Arduino systems and Wi- Fi module that allows, to analyze, collect and also store the voltage, current and power data from each solar panel. The Blynk system will serve as a medium for IoT systems to connect information to the users. Then, all the data from each solar panel can be displayed via phone and the data can be transferred through email. With this feature, all the data from the solar panel's voltage, current and power can be displayed quickly and easily. Using this system, a lot of time can be saved compared to the one using data logger. In conclusion, this project can provide improvements to existing systems by notifying to the users about the required voltage, current and power data.

Keywords: Solar Tracking, Internet of Thing (IoT), Blynk

1. Introduction

Nowadays, solar photovoltaic systems are one of the major contributors of a clean energy in most country. The most important thing to be concentrated is the electricity generation potential from the photovoltaic system. To obtain a high efficiency system, the installation of photovoltaic system shall be in accordance with the specified specifications to prevent the photovoltaic system from any problems or damage, regular monitoring is required in order to endure no damage to the system.

*Corresponding author: farahiyah@uthm.edu.my

The main problem encountered in the photovoltaic monitoring is the manpower for maintenance purpose. Energy detail of the monitoring on the system are crucial and full intentions are needed so that all regulations in taking data from I-V and P-V curve are fulfil. In addition, the problem in identifying the source of the problem on the systems is the monitoring method using the "Internet of Things" (IoT). Inside the IoT, there are all kinds of information and communication technologies. It is also an object that connected to the internet that can transfer and collect the data over a wireless network and without human intervention. With help of IoT information/ data on the photovoltaic system are automatically gathered and displayed. The IoT has a variety of application such as in renewable energy system, machine maintenance in industry and other applications.

Besides that, the I-V and P-V curve trails is also important in PV system maintenance and performing. With the existence of this IoT technology, I-V and P-V features of PV modules can be monitored easily and efficiently. In addition, data storage can also be used in its IoT system. In the event of a failure on the photovoltaic system, the IoT can detect the problem earlier so that action, as well as measures can be taken immediately.

Furthermore, the performance of the modules in each PV modules has information's that will be shown on the rating plate, such as the value of short circuit current (I_s), open circuit voltage (V_o), maximum power (P_{max}) as well as the value of voltage and current at the maximum power point (V_{mpp} and I_{mpp}) [1]. The manufacturer will check the performance and determine the value of the rating plate when the PV module is produced by plotting the I-V and P-V curves. The voltage and current output by the PV module depend on the module temperature, the content level of the irradiation spectrum and also the irradiation level. The standard test condition (STC) is an industry-wide standard for demonstrating performance on PV modules by specifying a radiation of $1000W/m^2$, a cell temperature of 25°C and an air mass spectrum of 1.5 (AM1.5) [2].

Moreover, a photovoltaic device's efficiency is defined as the maximum power output (Pm) divided by the product of input irradiation and area. This efficiency is affected by a variety of parameters, including irradiation and temperature. Among even cells of the same kind, changes in electrical characteristics are common due to manufacturing methods. However, when the losses caused by cell connections in modules are considered it is impossible to locate two sets solar modules. As a result, only experimental data of the I-V curve allow to precisely determine the electrical properties of a solar device [2]. On PV panels, the cables can be connected in series or parallel or even connected both at once to increase the voltage value o current capacity on the PV module [3]. If the PV panel modules are connected in series state, then the voltage value will increase and if the PV modules are connected in parallel then the current value will increase as well. Therefore, PV arrays are connected in series and parallel to increase the voltage and current simultaneously. The power produced by a combination of cables will remain the results of the voltages times current.

Characteristic of a PV module such as the optimum current, optimum voltage and optimum power that can be extracted from the curve. For the I-V curve in Figure 1, the graph depicts the connection between PV voltage and current. The relationship output power and voltage of PV module is known by the P-V curve.

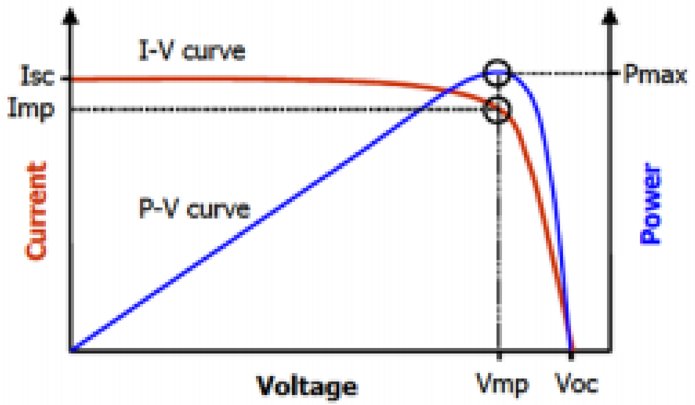

Figure 1: I-V and P-V curves of PV module [4]

2. Methodology

A block diagram is used to illustrate the layout and structure of the system in consideration. The project's design will be highlighted in Figure 2.

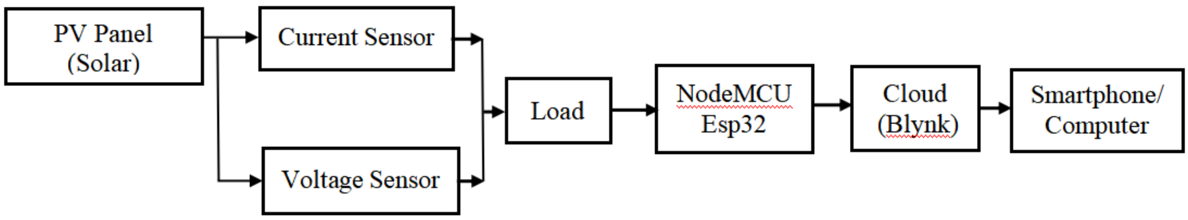

Figure 2: Block diagram of the proposed project

This block diagram is used to achieve the goals for developing Internet of Things (IoT) in Blynk system to trace I-V and P-V data and curve of PV system. This project is also developed by both simulation prototype.

2.1 Flow Chart

Figure 3 shows the overall step in acting objectives. The system starts by identifying whether Arduino functions, whether the coding is successful to send the data to the microcontroller. If there is an error in the coding, then the system cannot be continued. If the coding is successful without any problems, then the microcontroller i.e., NodeMCU ESP32 will receive data from Arduino. At the same time, the microcontroller must be connected to Wi-Fi so that the data can be read by the microcontroller. If the three components can be connected, the data of voltage, current and power can be displayed on the serial monitor and connected to the Blynk systems as well. On the Blynk system, all data and graphs of voltage, current and power are also displayed. Table 1 shows the list of the component for this project.

Table 1: List of components

Quantity	Item	Description
1	Solar Panel	12V-10W
1	NodeMCU ESP32	38 pins out &2 pins GPIO
1	Voltage Sensor	Dc load input: 0-25V
1	Current Sensor	ACS-712-30A
1	DC Motor	Operating Voltage: 5V-9V

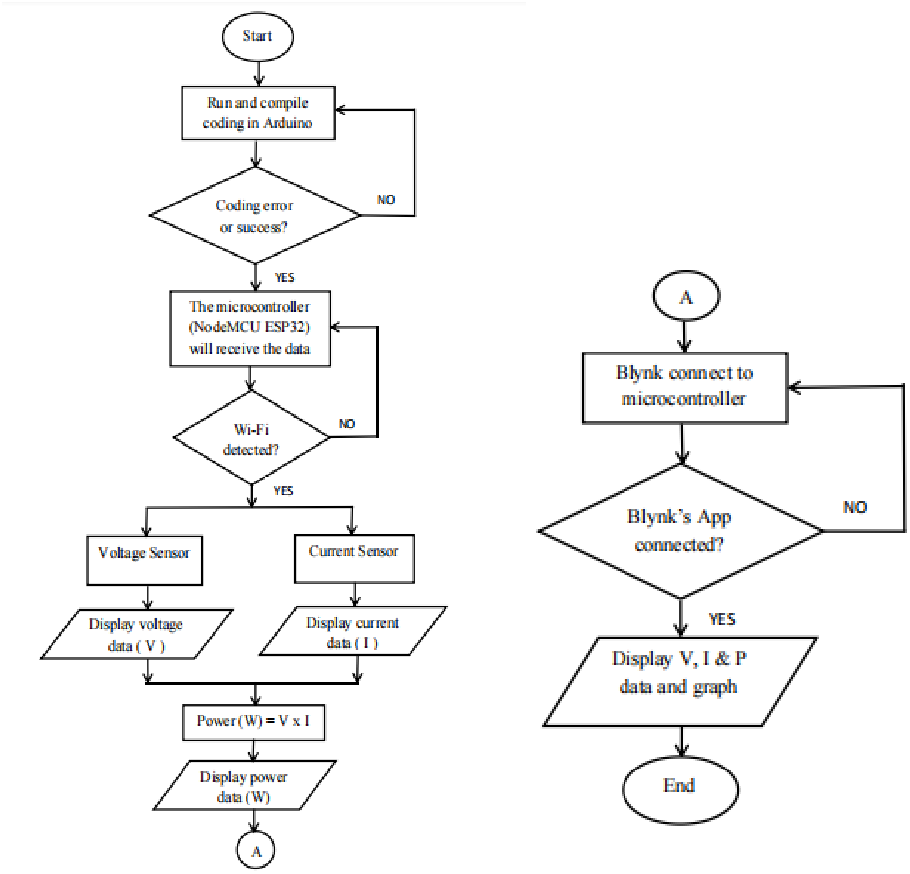

Figure 3: Project flowchart

2.3 Schematic Diagram

This project will be developed as shown in the Figure 4. The purpose of a current sensor is to detect and compute the current flowing through a conductor without interfering with the systems performance. In direct sensing, it is also measured by calculating the magnetic field. Furthermore, the voltage sensor's technique of usage is similar to that of the current sensor in that it just measures and calculates the amount of voltage in an object. Furthermore, this voltage sensor can detect both DC and AC voltage levels. Microcontroller in this project is NodeMCU ESP32, which combines two types of modules namely Wi-Fi module and also Bluetooth module. This is due to fact that this component is quite common and also pertains to the Internet of Things application.

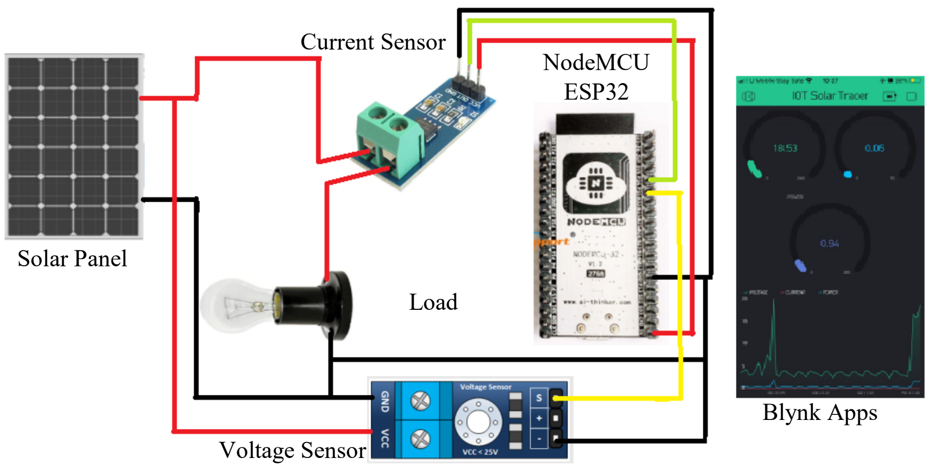

Figure 4: Schematic diagram of project

2.4 Software Development

Software development is required as part of the data and information collection for this project. The Arduino software (IDE) and Blynk software are applied in this project. The Arduino IDE is used to build and create the programming code, while Blynk system is to display the data/ curve of voltage, current and power from the solar panel.

2.4.1 Arduino IDE

This project's programming code was crated using this software for Arduino Uno controller. The program may simulate the coding before uploading it to the Arduino controller board. This program's working platforms are Windows, Linux and macOS. It is because the software is open source, it is simple to develop code and upload it to Arduino compatible devices.

2.4.2 Blynk

The Blynk apps was developed for the IoT and it can be use with the various widgets for providing a great interface for the project as shown in Figure 5. Blynk server responsible for all communication between the smartphone and the prototype of the project. The Blynk cloud can run the private Blynk serve locally. Its's open source and easily handle thousands of devices. Blynk library for all popular hardware platform allows communication with the server and handles all incoming and outgoing commands.

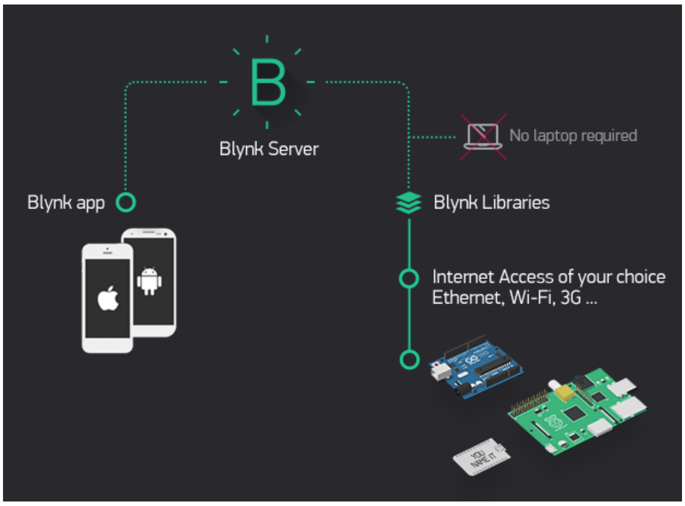

Figure 5: Blynk's architecture

3. Results and Discussion

The IoT Solar Panel Tracking for I-V and P-V characteristics hardware that has been developed is shown in Figure 6. Its functionality has been tested extensively in attempt to reach the project's ultimate objectives. The data and curve for this project were collected over three consecutive days, beginning on 05th January, and ending on 07th January. The time taken collecting the data was from 2.00 pm until 4.00 pm, since the sunlight was quite hot during this time compared to 11.00a m to 12.00 noon.

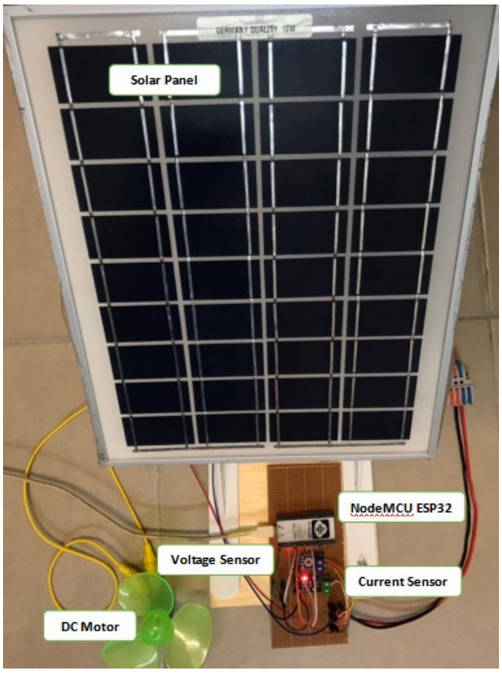

Figure 6: Prototype for the project

The data collected are tabulated in Table 2 and it shows that the voltage and current data taken every 10 minutes Graph related to Table 2 is shown in Figure 7. The data taken on the first day is quite high for voltage and current. i.e., 16.80 V and 2 A.

Table 2: Data I-V and P-V on the first day

Voltage (V)	Current (A)	Power (W)	Time (PM)
8.55	0.27	2.32	14:00
12.84	1.55	19.96	14:10
16.80	2.00	33.66	14:20
8.55	0.54	4.65	14:30
12.65	0.99	12.55	14:40
12.61	0.26	3.30	14:50
8.80	0.13	1.12	15:00
13.85	0.12	1.61	15:10
8.59	0.15	1.33	15:20
15.19	0.12	3.75	15:30
7.71	0.11	0.81	15:40
4.96	0.06	0.31	15:50
10.12	0.18	1.84	16:00

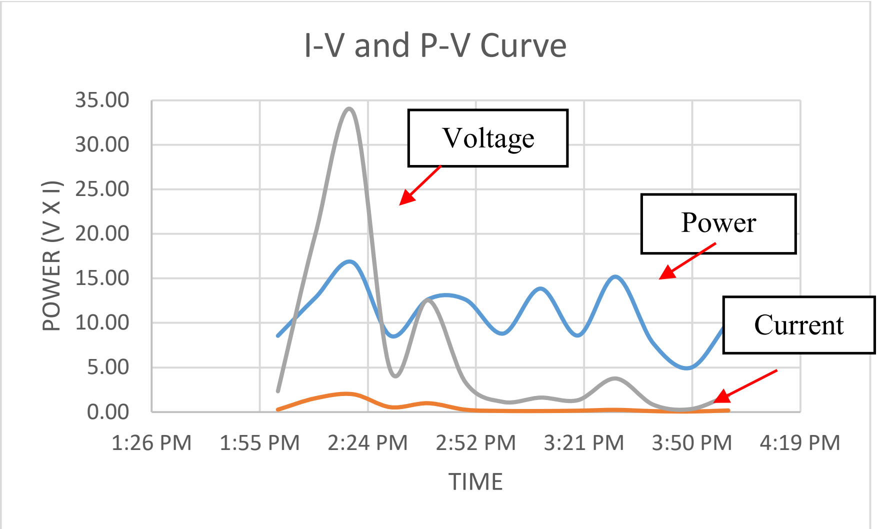

Figure 7: I-V ad P-V curve on 05th January 2022

4. Conclusion

In conclusion, this project is the IoT system in monitoring I-V and P-V curve of PV system is incredibly simple and easy. Because, with the IoT system, it can save time in data collection on each solar panel within the site plan. Additionally, now the era of increasingly sophisticated and versatile technology, all information is at fingertips, like information, searching current info then on. Then during this project, using Blynk system to follow the present circulation and it's also a platform during this IoT system. Blynk's in this project is to display data and curve likewise as voltage, current and power on solar panels. The Blynk server is additionally liable for all communications between the smartphone and also the hardware. Lastly, the objectives for this project were achieved.

Acknowledgement

The author would like to thank the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] Silvano Vergura, Rodolfo Araneo. (2016).'A Complete and Simplified Datasheet – Based Model of PV Cells in Variable and Information Engineering.

[2] H.B. Chi, M. F. N. Tajuddin, N. H. Chazali, A. Azmi, M. U. Maaz. (2019) "Internet of Things (IoT) based I-V curve tracer for photovoltaic monitoring systems". Indonesian Journal of Electrical Engineering and Computer Science. 13(3) pp. 1022-1030.

[3] Dr. Ali N. Hamoodi, Safwan A. Hamoodi, Rasha A. Mohammed. (2018). 'Photovoltaic Modeling and Effecting of Temperature and Irradiation on I-V and P-V Characteristics'.

[4] Navdeep Sigh, Arvind Goswami. (2018). 'Study of P-V and I-V Characteristics of Solar Cell in MATLAB / Simulink'. International Journal of Pure and Applied Mathematics. 118(24).

[5] E. Duran, M. Pilliougine, M. Sidrach -de-Cardona, J. M. Andujar. (2008) 'Differen Methods to Obtain the I-V Curve of PV Modules'. Department of Electronic Engineering, Computer System ad Automatics.

[6] Roberto Francisco Coelho, Denizar Cruz Martins. (2012). 'An Optimized Maximum Power Point Tracking Method Based on PV Surface Temperature Measurement'. International Journal of Applied Engineering Research. 13(5). pp 3123-3127

[7] Dr. D. Venu Madhava Chary, M. V. Subramanyam, P. Kishor. (2017). 'P-V Curve Methods for Voltage Stability and Power Margin Studies'. Department of EEE. 7(5).

[8] Amish Chauhan, Anand Panchbhai, Dr. Hiren Shah. (2016). 'Microcontroller based solar power system with grid synchronization'. [9] Bruce Cross. (2018). 'PV System Monitoring'. Fundamental and Applications, pp. 1183-1191.

[9] Rwan Mahmoud, Tasnem Yousuf, Fadi Aloul, Imran Zualkernan. (2015). 'Internet of Things (IoT) Security: Current Status, Challenges and Prospective Measures. Department of Computer Science & Engineering.

[10] Ali E. Murtaza, Umer Munir, M. Chiaberge. (2018) 'Variable Parameters for a Single Exponential Model of Photovoltaic Modules in Crystalline - Sillicon'. Department of Electronics and Telecommunication.