Automatic Charging Design on Single Axis Solar Tracking Based on IoT

Ali Nurdin, Ade Silvia Handayani(✉), M. Zakuan Agung, Hairul Hairul, Nyayu Latifah Husni, Ciksadan, Rahma Alya Balqis, and Jihan Chairani

Politeknik Negeri Sriwijaya, Palembang, Indonesia
ade_silvia@polsri.ac.id

Abstract. Solar energy is one of the most popular renewable green energies since it produces less pollution than conventional sources. This paper describes the design and testing of an active solar tracker with a single axis. The term "solar tracker" refers to devices that can track the sun's movement and direction. It is converted to power to produce a solar panel with the highest light output for the benefit of the area. Automatic charging prevents the battery from overcharging when the solar panel has energy. Based on the internet of things, the charging process of a battery can be remotely monitored using a smartphone (IoT). Based on the results, the system can track the charging parameters of the solar tracker's batteries and other environmental factors, such as ambient light and temperature. The data is uploaded to a cloud database to be viewed on a mobile device over the internet.

Keywords: Automatic Charging · Solar Tracking · IoT

1 Introduction

The control system is essential for facilitating human work in daily life. Control system technology is advancing quickly, so individuals can reduce their workload by employing innovations. The control system is divided into two categories based on general grouping: manual and automatic control. Manual control is control carried out directly by humans. Simultaneously, automatic control is performed by machines or equipment that operate automatically under human observation. Automated tracking of the sun is one of them.

This solar-powered electricity generation technology is quickly gaining popularity as it is simpler, more practical, less damaging, and cheaper than competing renewable energy options [1]. While the sun provides an accessible and abundant energy source, solar cells only convert about 20% of that into electricity [2]. Because of this need for maximum efficiency, solar tracking technologies have developed.

Tracking the sun during the day ensures that the panels receive sunlight perpendicular to their orientation, increasing efficiency. Numerous research on solar tracking system advancements has been conducted in recent years [3]. To ensure that panels receive sunlight at a perpendicular angle, researchers are exploring different control

N. L. Husni et al. (Eds.): FIRST-ESCSI 2022, AHE 14, pp. 466–472, 2023.
https://doi.org/10.2991/978-94-6463-118-0_48

methods [4, 5]. The research shows that new materials and techniques are being developed for solar energy rapidly.

A solar cell is a device that can be used to collect energy from the sun. The installation of solar cells is predominantly motionless or silent. This decreases the efficiency of solar energy absorption. With this in mind, an instrument known as automatic solar tracking is developed. Solar tracking is a device meant to enhance solar energy absorption by automatically following the direction of the sun's beams as the solar panels rotate. Thus, the amount of photon energy absorbed from the sun can be maximized. An LDR sensor is fitted during solar tracking. This intensity input will eventually be utilized as a reference for solar tracking to move toward the sun's axis. The Light Dependent Resistor (LDR) or Photo resistor performs an essential function in this sun-tracking system [6]. It is helpful in light or dark detector circuits due to its sensitivity to light. An LDR is set up, and a servo motor points the system toward solar energy.

In this research, the stepper motor continues to follow the sun's commands as it advances toward the LDR, the point at which the resistance becomes strong. The stepper motor will not turn if the light falling on the LDR remains constant. The Arduino microcontroller is used to communicate with many other parts [7, 8]. Typical battery charging still uses conventional methods, whereby the continuous passage of electric current to the battery causes overcharging or overcharging of the storm. To avoid this, this research aims to design a tool that automatically creates a battery charging system to limit the danger of battery damage.

2 Proposed Method

Solar energy is advancing to satisfy future energy demands as an endless and non-polluting energy source. The Arduino-based solar tracking system consists primarily of an Arduino Microcontroller, an LDR sensor, a voltage sensor, a drive motor, a solar panel, and a battery. Four-light-based resistors (LDR) are used in production hardware to collect the maximum incident light. A stepper motor is utilized to move the solar panels in response to the incident light, which the LDR controls. This program regulates the solar panel's horizontal rotation and vertical tilt angle. Consequently, the solar panel can rotate vertically and horizontally by the direction of the Sun, based on the incident sunlight. These devices can also achieve ideal lighting and lower the cost of energy generation by requiring a minimal amount of solar panels.

2.1 The Hardware Design

The hardware design and software for the monitoring system comprise the two halves of this overall design. Figure 1 displays the circuit schematic related to this. Figure 1 shows a block diagram of the solar tracking system design. The hardware design, the control system has three components: an LDR sensor, nodeMCU ESP8266, and a 12V battery. The LDR sensor functions to read the movement of the direction of sunlight. Solar tracking is a set of systems that can follow the movement of the direction of the sun's light source. To get the maximum light intensity, the energy produced by the solar panels is converted into power and goes to the battery.

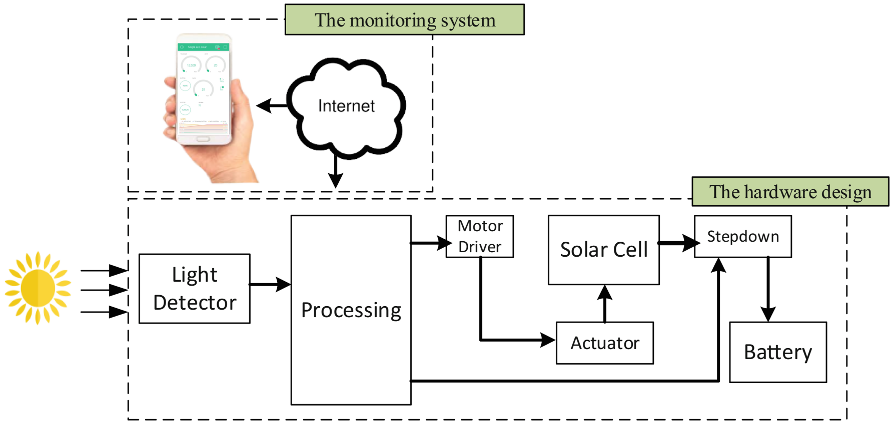

Fig. 1. Block diagram of solar tracking system

Charging with an automatic method to avoid overcharging can damage the battery, and the charging process can be monitored remotely. This is without looking at the location based on the internet of things (IoT). The signal will be sent by the LDR sensor circuit and received by the NodeMCU ESP8266 module. Then the data will be forwarded to Arduino Uno, which processes data received from the LDR sensor as data. 2 buttons move the tool up and down; by pressing the gp32 and gp33 buttons, the device will move according to the commands specified in the application. Solar panels will absorb solar energy. The current will go through the solar charging controller and be converted into electrical energy, as well as monitored through the blynk application on Android.

2.2 The Monitoring System

In designing software for automatic battery monitoring using the blynk application. A program or code is a collection of instructions that enables the synchronized operation of the sun tracking system's hardware components. The blynk application serves to monitor automatic solar battery charging devices via Android. The data can be seen in the blynk application and can control the movement of the solar panel actuators to detect sunlight. The Blynk graphical user interface (GUI) for both manual and automatic control is displayed in Fig. 2. In manual mode, the user can independently set the panel's speed and direction of movement.

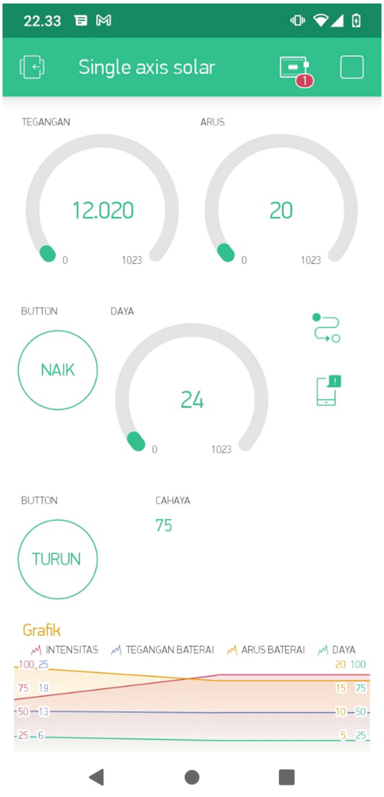

Fig. 2. Display the Blynk graphical user interface

3 Result and Discussion

After the device was designed and built, we installed it on the roof and connected it to a stationary solar panel perpendicular to the ground. Wiring was completed so that we could monitor and record the voltage and current output by the product and the fixed solar panel. The solar panel shifts in response to changes in the light intensity detected by an LDR, which can occur in the horizontal or vertical plane, at various orientations, and in a wide range of durations. A prototype of a sun-tracking solar system with a single axis is shown in Fig. 3.

The functional criteria are met by the developed system, as evidenced by the results of the blynk application testing. All experiments are successful by the test results, and the blynk application command and NodeMCU are both working as expected. The experiment was carried out from 9 am to 18 pm. The measurement results are shown in Table 1.

Figure 4 depicts the output of the Blynk app. An approved user's smartphone, equipped with the Blynk app, receives updates on the tracking status of their solar panels, the voltage of those panels, and the charge of the batteries. This is achieved

(a) (b)

Fig. 3. Solar tracker prototype

Table 1. Measurement the solar panel voltage with tracking

Time	Light Intensity (%)	The Blynk App's Efficiency	
		Current (A)	Voltage (V)
09.00	92	0.14	13.3
10.00	91	0.14	13.3
11.00	84	0.16	13.3
12.00	84	0.16	13.3
13.00	80.6	0.14	13.3
14.00	68.4	0.14	13.4
15.00	56.8	0.14	13
16.00	56.2	0.14	12.9
17.00	25.3	0.14	12.8
18.00	25	0.13	12.8

by the ESP8266 Wi-Fi module, which establishes a network connection between the hardware circuit and the internet, allowing for remote system monitoring by the IoT.

Based on the measurement results, this circuit can work well and function. In the measurement of several series of systems, there are slight differences between the measurement results with what is obtained from the component data. Differences in measurement results occur due to inaccuracy in measurement, or the instrument's accuracy needs to be corrected due to the age factor of the measuring instrument used.

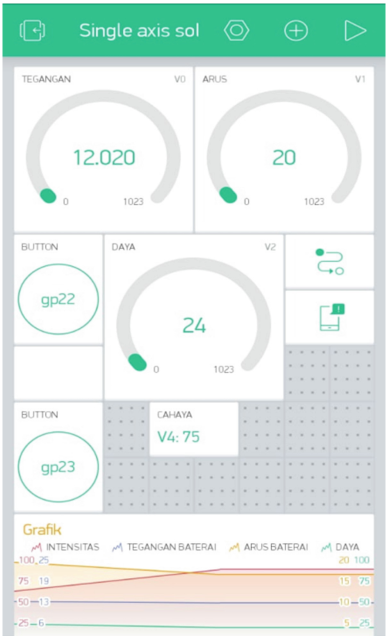

Fig. 4. The output of the Blynk app

4 Conclusion

In this research, the battery was charged using an empty battery with a voltage lower than 12 V for about two hours or until the voltage reached 13.2 V, indicating that the battery was fully charged. Instead of moving automatically to follow the sun's direction like this equipment does, solar cells are often mounted in a static condition. This allows for better solar energy absorption. The blynk app and the Arduino Nano module, which serve as a data translator in this set of tools, automatically monitor the battery level.

References

1. T. Dewi et al., "a Survey on Solar Cell; the Role of Solar Cell in Robotics and Robotics Application in Solar Cell Industry," Proceeding Forum Res., no. November 2017, p. 2016, 2016, [Online]. Available: http://eprints.polsri.ac.id/3576/3/C4.pdf.
2. M. A. Green, K. Emery, Y. Hishikawa, and W. Warta, "Solar cell efficiency tables (version 36)," Prog. Photovoltaics Res. Appl., vol. 18, no. 5, pp. 346–352, 2010, https://doi.org/10.1002/pip.1021.
3. E. Kiyak and G. Gol, "A comparison of fuzzy logic and PID controller for a single-axis solar tracking system," Renewables Wind. Water, Sol., vol. 3, no. 1, 2016, https://doi.org/10.1186/s40807-016-0023-7.
4. A. Soetedjo, A. Lomi, Y. I. Nakhoda, and A. U. Krismanto, "Modeling of Maximum Power Point Tracking Controller for Solar Power System," TELKOMNIKA (Telecommunication Comput. Electron. Control., vol. 10, no. 3, p. 419, 2012, https://doi.org/10.12928/telkomnika.v10i3.819.

5. V. Mohanapriya, V. Manimegalai, V. Praveenkumar, and P. Sakthivel, "Implementation of Dual Axis Solar Tracking System," IOP Conf. Ser. Mater. Sci. Eng., vol. 1084, no. 1, p. 012073, 2021, https://doi.org/10.1088/1757-899x/1084/1/012073.
6. C. Y. Lee, P. C. Chou, C. M. Chiang, and C. F. Lin, "Sun tracking systems: A review," Sensors, vol. 9, no. 5, pp. 3875–3890, 2009, https://doi.org/10.3390/s90503875.
7. Y. Cheddadi, H. Cheddadi, F. Cheddadi, F. Errahimi, and N. Es-sbai, "Design and implementation of an intelligent low-cost IoT solution for energy monitoring of photovoltaic stations," SN Appl. Sci., vol. 2, no. 7, 2020, https://doi.org/10.1007/s42452-020-2997-4.
8. R. Chavan and A. Kolekar, "Solar Rooftop Power Generation System by Using IOT (Arduino & Blynk)," Int. J. Innov. Sci. Res. Technol., vol. 5, no. 9, pp. 759–762, 2020, https://doi.org/10.38124/ijisrt20sep521.