DUAL AXIS SOLAR TRACKER SYSTEM WITH BLYNK MONITORING AND CONTROLLING

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Abstract

The performance of a solar power system depends mainly on how effectively the panel receives sunlight during different times of the day. In most practical installations, solar panels are fixed in a single position, which limits their ability to capture maximum energy as the sun moves. To address this issue, a dual axis solar tracking system with IoT-based monitoring is developed in this work. The system is designed to automatically adjust the position of the panel in both horizontal and vertical directions based on the availability of sunlight. In this setup, Light Dependent Resistors (LDRs) are used to sense the intensity of light from different directions. The sensed values are processed by an Arduino Nano controller, which then controls DC motors through an L293D driver to rotate the panel accordingly. An ESP8266 module is used to transmit the output voltage to the Blynk mobile application, allowing the user to monitor the system and control connected loads remotely. From the testing results, it was observed that the system is able to track the sunlight effectively and maintain better alignment compared to fixed panels. The overall design is simple, low-cost, and suitable for small-scale applications where improved solar energy utilization is required.

Keywords: Dual axis solar tracking, Arduino Nano, LDR sensor, ESP8266 Wi-Fi module, Blynk application, solar energy utilization, IoT monitoring, DC motor control.

1. INTRODUCTION

In recent years, the demand for renewable energy has increased due to the depletion of conventional energy sources and growing environmental concerns. Among the available options, solar energy is widely used because it is clean, easily available, and suitable for small as well as large-scale applications. Solar panels are commonly used to convert sunlight into electrical energy, but their performance mainly depends on how much sunlight they receive. In most cases, solar panels are fixed in a single position, which means they cannot follow the movement of the sun throughout the day. Because of this, the amount of energy generated is not always maximum. To overcome this limitation, solar tracking systems are used, which help the panel to align with the direction of sunlight automatically. A dual axis tracking system is more effective than a single axis system because it allows movement in both horizontal and vertical directions.

In this project, a dual axis solar tracking system is developed using simple electronic components and a microcontroller. Light Dependent Resistors (LDRs) are used to detect the direction of sunlight, and an Arduino Nano is used to control the movement of the panel. The system is also integrated with an ESP8266 Wi-Fi module, which enables monitoring through the Blynk mobile application. This makes the system more flexible and easy to use. The main aim of this work is to improve the efficiency of solar energy utilization using a low-cost and practical approach.

2. LITERATURE SURVEY

Over the past few years, different types of solar tracking systems have been developed to improve the efficiency of photovoltaic panels. In the early stages, most systems used fixed solar panels because of their simple design and low cost. However, it was observed that fixed panels are not able to capture maximum sunlight throughout the day, as the position of the sun changes continuously. To overcome this issue, single axis solar tracking systems were introduced. These systems allow the panel to move in one direction, usually from east to west, which helps in improving energy collection to some extent. Even though single axis trackers perform better than fixed panels, they still have limitations, especially when there are seasonal changes in the sun's position. Later, dual axis tracking systems were developed to provide better alignment with sunlight. These systems can move in both horizontal and vertical directions, making them more effective in capturing solar energy at different times of the day and during different seasons. Many researchers have used simple sensors such as LDRs to detect light intensity because they are easy to use and cost-effective. In recent developments, microcontrollers like Arduino have been widely used to control solar tracking systems. These controllers make it easier to process sensor data and control motor movement accurately. At the same time, the use of wireless communication modules has increased, allowing users to monitor system performance remotely. With the growth of IoT technology, several systems have been designed to provide real-time monitoring using mobile applications. These systems improve user interaction by allowing control and observation from any location. However, there is still a need for simple and low-cost solutions that can be easily implemented for small-scale applications. The present work focuses on developing a dual axis solar tracking system with IoT-based monitoring using easily available components. The aim is to improve energy utilization while keeping the system simple and economical.

3. WORKING METHODOLOGY AND PROPOSED SYSTEM

The working of the proposed system is mainly based on detecting sunlight intensity and adjusting the position of the solar panel accordingly. In this setup, four LDR sensors are placed around the panel to sense light from different directions. These sensors continuously measure the intensity of sunlight falling on them. The output from each LDR is given to the Arduino Nano controller. The controller compares the values obtained from the sensors to identify which side is receiving more light. If there is a difference in light intensity, the controller generates control signals to rotate the panel in that particular direction. Two DC geared motors are used to achieve movement in both axes. One motor is responsible for horizontal rotation, while the other controls vertical movement. The motors are driven through an L293D motor driver, which provides the required current and allows proper control of direction. As the panel starts moving, the system continuously checks the LDR values.

Figure 1

The movement stops when all the sensors receive nearly equal light intensity, which indicates that the panel is properly aligned with the sun. Limit switches are also used in the system to prevent the panel from rotating beyond its mechanical limits. At the same time, the output voltage of the solar panel is monitored using a voltage sensing circuit. This data is transmitted to the Blynk mobile application through the ESP8266 Wi-Fi module. The user can view the voltage levels in real time and can also control connected loads through the application. Overall, the system works in a continuous loop, adjusting the panel position based on sunlight conditions and providing real-time monitoring through IoT.

4. HARDWARE USED

A) SOLAR PANEL

In this project, the solar panel is used as the primary source of energy for the system. It converts sunlight into electrical energy, and the output mainly depends on the amount of light falling on its surface. As the sunlight changes during the day, the panel output also changes.In the prototype, the solar panel is fixed on a movable frame so that it can rotate along with the tracking system. This allows the panel to face the direction where sunlight is stronger. By doing this, the system is able to receive better light compared to a fixed position. The voltage produced by the panel is used for observing the system performance and is also displayed through the IoT monitoring setup. The main aim of using the solar panel in this model is to show how automatic tracking can help in improving the utilization of solar energy in a simple way.

B) NANO AURDINO

In this project, Arduino Nano is used as the main controller of the system. It is responsible for reading the signals from the LDR sensors and making decisions based on the light intensity. According to these inputs, it controls the movement of the motors to adjust the position of the solar panel. The Arduino Nano is small in size and easy to use, which makes it suitable for prototype development.

Figure 2. Arduino uno

It also provides enough input and output pins to connect sensors, motor driver, and the Wi-Fi module In this setup, the controller continuously checks the sensor values and sends signals to the motor driver to rotate the panel in the required direction. It also helps in sending data to the IoT module for monitoring. Overall, Arduino Nano acts as the central unit that controls the entire working of the system.

C) LDR SENSORS

In this project, LDR sensors are used to detect the intensity of sunlight from different directions. The resistance of an LDR changes depending on the amount of light falling on it. When the light is strong, the resistance decreases, and when the light is low, the resistance increases. Four LDR sensors are placed around the solar panel to compare the light levels from different sides.

Figure 3. LDR Sensor

The Arduino Nano reads these values and identifies the direction where the light is higher. Based on this information, the system moves the panel toward the direction of maximum sunlight. In this way, the LDR sensors help the system to track the sun automatically.

D) WI-FI MODULE

In this project, a Wi-Fi module (ESP8266) is used to send data from the system to a mobile application. It helps in connecting the hardware setup to the internet so that the output can be monitored remotely.

Figure 4. WI-FI Module

The module receives information from the Arduino Nano and transfers it to the Blynk application through a wireless network. This allows the user to check voltage values and control basic functions using a smartphone. The Wi-Fi module is small in size and easy to connect with other components. Its use in this project makes the system more convenient, as there is no need to be physically near the setup for monitoring.

E) MOTOR DRIVER

In this project, a motor driver is used to operate the DC motors that move the solar panel. Since the Arduino Nano cannot provide enough current to run the motors directly, a motor driver is used in between the controller and the motors. The motor driver takes signals from the Arduino and supplies the required power to the motors. It also helps in changing the direction of motor rotation, which is necessary for moving the panel in different directions

Figure 5. Motor Driver

By using the motor driver, the motors can work properly without putting load on the controller. This improves the overall performance and ensures smooth movement of the system.

F) DC MOTOR

In this project, DC motors are used to rotate the solar panel in different directions. Two motors are used in the system, where one motor controls horizontal movement and the other controls vertical movement of the panel. The motors receive signals from the Arduino Nano through the motor driver and rotate accordingly. When there is a difference in sunlight detected by the sensors, the motors move the panel toward the direction of higher light intensity. DC motors are used because they are simple, easy to control, and suitable for small prototype applications. They provide enough movement for adjusting the panel position and help the system track sunlight effectively.

G) LIMIT SWITCH

In this project, limit switches are used to control the movement range of the solar panel. They are placed at the ends of the mechanical structure to stop the panel from moving beyond a certain position. When the panel reaches its maximum limit in any direction, the limit switch gets activated and sends a signal to stop the motor. This prevents unnecessary rotation and protects the system from possible damage.

Figure 6. Limit Switch

The use of limit switches helps in maintaining safe operation and ensures that the panel moves only within the required range. It also improves the reliability of the overall system.

H) BATTERY

In this project, a rechargeable battery is used to store the energy produced by the solar panel. This stored energy can be used when the sunlight is not available or when the panel output is low. The battery provides power to the main components of the system, such as the controller and other connected parts. This helps the system to work continuously without stopping.

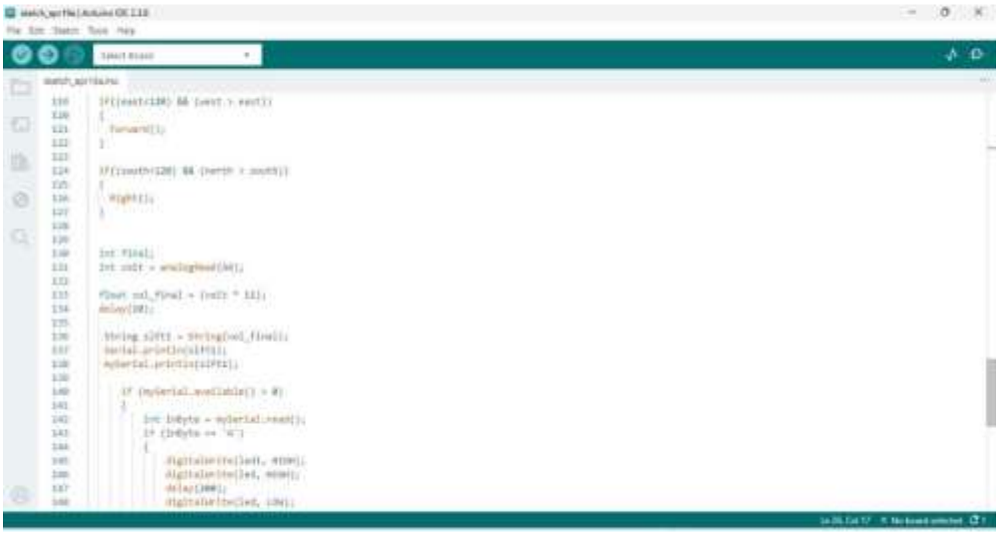
Figure7. Lead Acid Battery

By using a battery, the prototype also shows how solar energy can be saved and used later when needed. This makes the system more useful for practical applications.

5.SOFTWARE USED

A) ARDUINO IDE

Arduino Integrated Development Environment (IDE) was used to write and upload the program to the Arduino Nano microcontroller. This software provides a simple platform for creating programs using embedded C language. In this project, the code was developed to read the values from the LDR sensors, compare the light intensity levels, and control the movement of the motors accordingly. The Arduino IDE was also used to verify the code and correct errors during testing.



B) BLYNK IOT APPLICATION

The Blynk mobile application was used for real-time monitoring and basic control of the system. This application allows the user to observe output voltage values from the solar panel through a smartphone. Display widgets were arranged in the application to show readings in a clear manner. The data transfer between the hardware and the mobile application was carried out using the Wi-Fi module connected to the system.

From the experimental setup shown in the above figures, the system performance was observed under different lighting conditions. The mobile application displays the solar voltage and power values, which change according to the availability of light on the panel. When the panel is exposed to sufficient light, the voltage reading shown in the application increases, and the connected LED load glows properly.

This indicates that the panel is receiving enough energy and the system is functioning as expected. In some of the observed cases, higher voltage values are seen along with proper load operation.

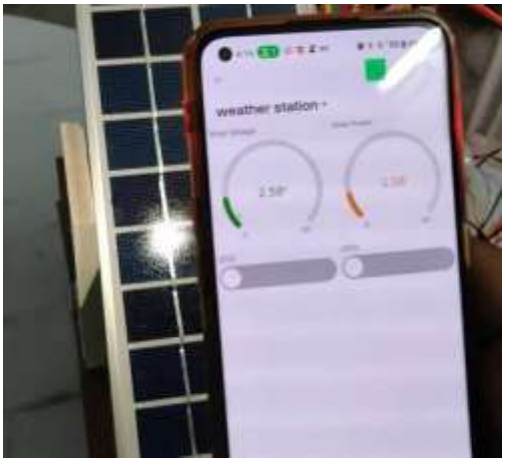


Figure.8

When the panel is exposed to sufficient light, the voltage reading shown in the application increases, and the connected LED load glows properly. This indicates that the panel is receiving enough energy and the system is functioning as expected. In some of the observed cases, higher voltage values are seen along with proper load operation.

Figure.9

When the light intensity is reduced or partially blocked, a decrease in voltage can be noticed in the application. At the same time, the brightness of the LED also reduces. This shows that the system is responding correctly to changes in sunlight conditions.

Figure.10

The control of loads through the mobile application is also working properly. The ON and OFF operations are reflected immediately in the hardware setup, which confirms proper communication between the controller and the IoT module. Overall, the results indicate that the system is able to monitor solar output, respond to light variations, and control loads through a wireless interface. The observed behaviour confirms that the prototype is working effectively and meets the intended objective.

6. FUTURE SCOPE

In future work, additional sensing elements such as current sensors can be included along with voltage measurement. This will help in calculating the actual power output and give a better idea about the system performance under different conditions. The tracking method used in this project is based on LDR sensors, which are simple and low cost. However, the accuracy of tracking can be improved by using more reliable sensing techniques or improved control methods, especially during cloudy weather. The movement of the panel can also be made smoother by using efficient motors or servo-based mechanisms. This may reduce unnecessary power consumption and improve overall system operation. In addition, the mechanical structure can be strengthened for handling larger solar panels.

7. CONCLUSION

In this work, a dual axis solar tracking system with IoT-based monitoring has been designed and implemented. The system is capable of adjusting the position of the solar panel automatically by sensing the direction of sunlight. This is achieved using LDR sensors along with an Arduino Nano controller, which controls the movement of the panel in both horizontal and vertical directions. The use of DC motors with a motor driver helps in smooth operation, and the ESP8266 module enables basic monitoring through the Blynk mobile application. From the testing results, it was observed that the system responds well to changes in light intensity and maintains proper alignment with the sun. Overall, the developed model is simple, economical, and easy to implement. It provides an effective method for improving the utilization of solar energy and can be used for small-scale applications as well as educational purposes.

8. REFERNCES

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