iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.52007

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Solar Tracking System with Dual Axis

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Abstract: The world economies are starting to move towards solutions that address both the global energy dilemma and the mounting evidence of climate change. One of the most well-known and widely used renewable energy sources to date is solar electricity. This study illustrates the performance advantages of a dual-axis solar tracker in contrast to other photovoltaic systems. A dual axis solar tracker can simultaneously measure the sun's radiation in the horizontal and vertical axis. For maximum effectiveness, the gadget monitors both daily tilt and seasonal variations. The study focuses on the design and development of an autonomous dual axis solar tracker prototype using Arduino code written for microcontrollers, as well as the fundamental properties of solar panels and their applications.
Keywords: MPPT, PV array, Dual-axis Solar Tracking System.

I. INTRODUCTION

One of the most efficient, affordable, safe, and minimally harmful renewable energy sources is solar energy. Solar heating and cooling and solar electricity are two subcategories of solar energy use. Through the use of a photovoltaic array, this energy can be transformed into electrical energy. Recent years have seen a rise in the popularity and utilisation of photovoltaic (PV) systems in electric power technology. In relation to this technology, numerous applications have been created, including solar power generation, battery charging, water pumping, so on.

Electricity might become the primary energy source by combining concentrated solar power and photovoltaic technology.Indiaobtains solar energy every year that is equal to approximately 5,000 trillion kWh. Depending on the area, the average daily solar energy incidence over India ranges from 4 to 7 kWh per square metre per day. The fact that solar photovoltaic (PV) energy is free, abundant, pollution-free, and available everywhere makes it one of the most significant resources today. PV production systems, however, suffer from too main issues: the conversion efficiency of electric power generation is low. The solar cell V-I characteristic is also nonlinear and varies with temperature and radiation. Generally speaking, the complete PV system functions at its peak efficiency and generates its highest output power at a certain point on the V-I or V-P curve known as maximum power point. Although the MPP's position is unknown, it can be found using search algorithms or calculating models. As a result, methods such as (MPPT) are required to keep the PV array's operating point at its MPPT.

II. DIRECT AND INDIRECT METHODS FOR MPPT IN THE PV PANELS

A. Direct Methods

To maximise system power, direct methods employ measurement data and computing strategies. The following is a survey of the most well-known techniques in this category:

1) Perturb and Observe method

With this technique, the PV panel's voltage and current are measured. The outcome is then contrasted with the prior power. The controller then modifies the pulse width modulation's duty cycle to increase the system's power. The process of designing is simple.

If the computed power is more than the previous one, the controller keeps the duty cycle moving in the same direction. But if the power goes out, the controller reverses the duty cycle. The perturb and observe approach is sometimes referred to as the hill climbing (HC) algorithm in various research studies. It should be observed that in a disturbance-free environment, the perturb and observe controller performs quite well.

In contrast, the controller's sluggish tracking is useless when the environment is rapidly changing.

In order to increase the approach's effectiveness in the presence of the disturbance and varied surroundings, the perturb and observe method is usually used in conjunction with other strategies.To eliminate the steady-state oscillations in the power response and maximize the power, a new start-stop mechanism built on the perturb and observe method is presented. The major goal is to decrease the perturbation magnitude in order to increase power performance. This approach, however, slows down the system under fast irradiation circumstances. As a result, the system makes a trade-off between speed and steady-state oscillation.

The performance of the suggested technique is demonstrated in experimental test settings are used in PV system. The suggested approach performs well under various irradiation circumstances. To address the issue of the local maximum for the MPPT, a modified perturb and observe approach is provided. The proposed approach augments the traditional perturb and observe method with a checking algorithm to keep track of all current maximum powers before deciding how to adjust the controller to increase the system's power. The suggested approach is tested in two situations with varied and constant irradiation levels.

2) Incremental Conductance Method

The perturb and observe approach's weakness is addressed by the incremental conductance method. The technique shortens the tracking time and boosts the power in various settings. To modify the controller and generate the most power, the IC approach takes into account the relationship between current and voltage. The controller is thought to be modified using a fixed step mechanism, which could take a while to achieve its full power. As a result, in different circumstances, the performance is still slow.

For nonlinear load, a brand-new IC technique is suggested in. To address the nonlinearity of the load, the suggested IC approach takes into account both conductance and the rate of conductance. The recommended approach can readily deliver the MPPT while coping with voltage ripple. The suggested solution increases the maximum power, according to simulation results. In, For the purpose of maximising power in the PV panel, an IC technique utilising a PI controller is devised. In contrast to other traditional converters, the technique generates a larger voltage by using a converter. Three instances are taken into consideration for the test study, including varying temperatures, shifting light intensities, and unclear loads. The test results show that the PV panel always responds correctly.

3) Fuzzy Logic Method

By utilising membership functions to define a system with linguistic rules, fuzzy logic is a clever technique. PV panels can use fuzzy logic to frame the MPPT issue and describe the system's nonlinearity and uncertainty.

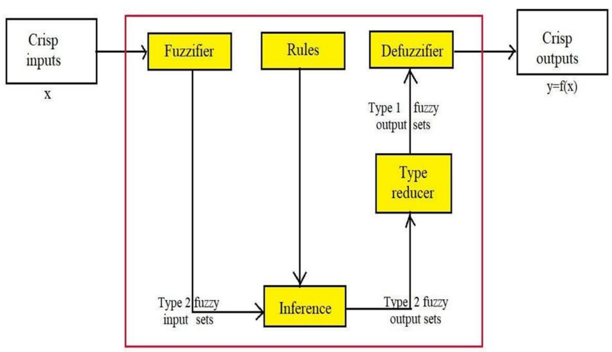

Fig 1: fuzzy logic structure.

Create the MPPT issue and consider the linearity of the system. Fuzzy logic technologies, as well as the perturb and observe approach, are utilised to improve the maximum power of PV panels. The proposed method uses power variation and voltage variation as input to the fuzzy system rather than error and its variations, which improves the method's performance. The design is then implemented using the ds PIC digital signal controller. The results of the experimental testing demonstrate the procedure's effectiveness. of the proposed technology under various weather.

4) Artificial Neural Network Method

These are intelligent techniques that, without being aware of the system's physics, can simulate a system using input-output data that is already available. As a result, the neural networks are referred to as "block box systems."

To anticipate the PV panel powers, an intelligent method utilising Elman neural networks is given. The suggested approach is trained and tested using two years' worth of PV panel data. In consideration of the data's nature, the network's structure must be chosen. To increase the system's accuracy, the suggested solution combines the ANN and FL's learning capabilities. Therefore, the suggested system is capable of handling a nonlinear load or altering circumstances. Numerous simulation studies demonstrate that the ANFIS technique operates more accurately than fuzzy logic.

B. Indirect methods

To maximise the power, the indirect method needs prior understanding of the PV system. A survey of the techniques in this group is shown in the sentences that follow:

1) Short Circuits PV Current Method

The maximal power and cells in short circuit current are linearly connected in this method. Nearly 90% of the short-circuit current is produced by the highest power. In, a brand-new PV panel modelling technique is proposed that incorporates short-circuit current (Isc). At short time scales, the recommended technique provides more accurate PV panel prediction. The test's findings demonstrate that variations in module tolerances can result in inaccurate model estimate.

2) Open-circuit PV Voltage Method

For the PV panel, an indirect approach utilising open circuit voltage is advised. The results of the simulation demonstrate the suggested system's dependability under various operational circumstances. The power of the PV system may be improved by utilising a novel combination method based on fractional open circuit voltage, short circuit current, and incremental conductance. The suggested approach does this by calculating the open circuit voltage or short circuit current.

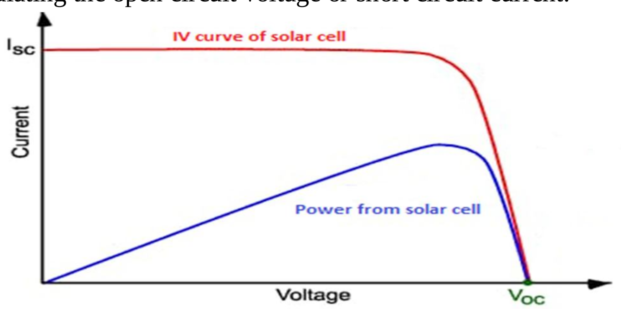

Fig 2: IV curve of solar cell

III. PHOTOVOLTAIC MODULE

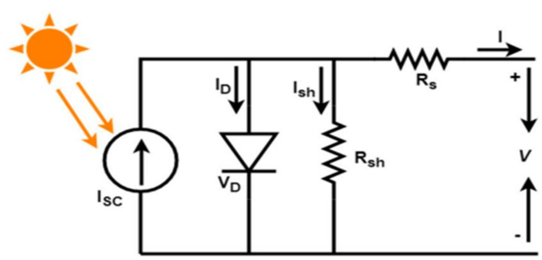

Fig3: Circuit of single diode Solar Cell

In order to study the I-V characteristics of a PV array and the position of the maximum power point for a specific parameter modification, a simplified electrical model for PV modules is developed based on the Shockley diode equation.
To design a single diode model-based PV module that accounts for continuous insolation and temperature, Simulink was utilised. The maximum power point tracker system draws its electricity from this module. Simulink has been used to model and simulate the proposed solar panel.

IV. FLOWCHART OF PROCESS

As indicated in the flowchart, the initial setup of both motor positions is followed by a voltage check of the LDR. The estimated sun orientation is obtained after this method, which impacts how much sunshine the LDR gets. Four LDRs are employed on the four sides of the solar panel where the sun shines; two of these LDRs work for horizontal panel movement and two for vertical panel movement. The panel travels clockwise or anticlockwise, upward or downward, as a result of comparing the voltages of the x and y axis sensors. The panel always goes in the direction of the most sunshine. As a result, the solar tracker has improved in efficiency.

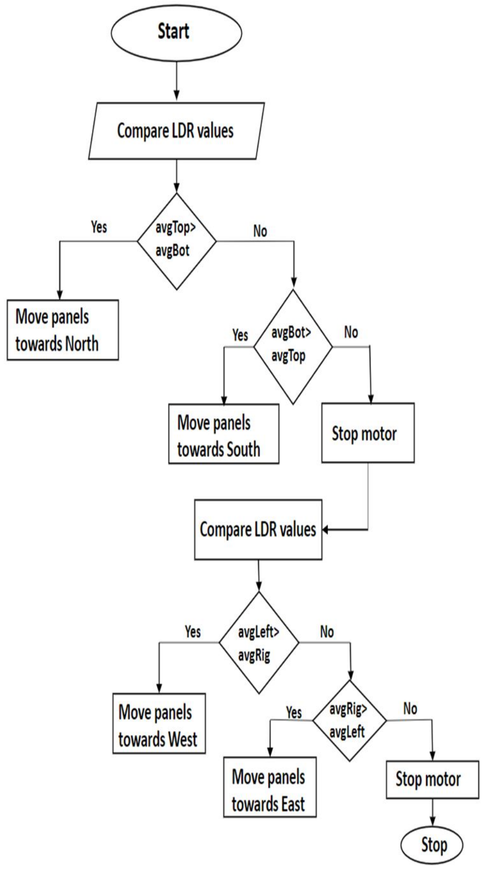

Fig 4: Flowchart of Process

V. BLOCK DIAGRAM DESCRIPTION

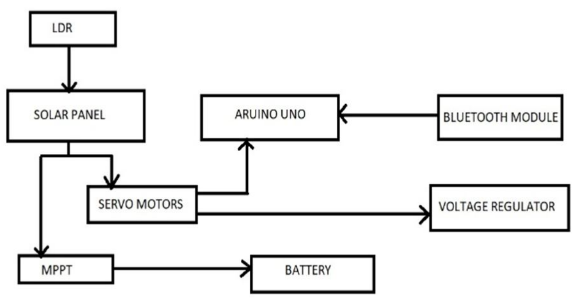

Fig 5: Block diagram

Solar panels are typically made of semiconductor materials. With a maximum efficiency of 24.5%, Si is a key component of solar panels. Unless extremely efficient solar panels are developed, the only way to improve a solar panel's performance is to increase the intensity of light falling on it. Increasing cell efficiency, increasing power output, and utilising a tracking system are three methods for increasing the efficacy of solar panels. At any one time, only stationary solar panel arrays can generate the most electricity with MPPT technology. However, when the sun is not in alignment with the system, the technology is unable to generate more power. Because the position of the sun varies throughout the year depending on the season and day of the week. As a result, using a solar tracker is the greatest strategy to improve energy output. Solar tracking systems follow the sun's position and align perpendicularly to increase power production by 30% to 60% over fixed systems.

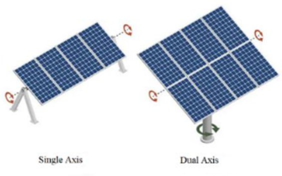

Fig 6: SAST and DAST

VI. HARDWARE IMPEMENTATION

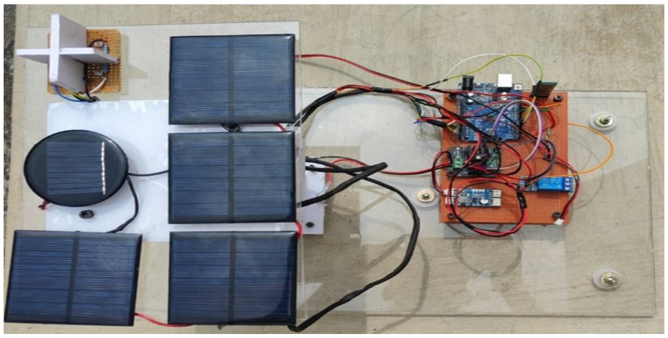

Fig 7: Hardware Module

Two servo motors, a solar panel, four LDR sensors mounted on the solar panel, voltage divider circuitry, an Arduino UNO board, and an HC05 Bluetooth module make up the system. In this project, the brain of the system is Arduino uno and the components used in this project are LDR sensor for detecting the light and servo motor for rotating the solar panel towards the light voltage sensor is used to detect the voltage and current in the battery. The LDR is connected to the analog pin of the Arduino microcontroller, when the light particle is present the LDR sensor will detect the Light and send the value to Arduino, then Arduino microcontroller will rotate the servo motor attached with solar panel, by this method the energy is stored in the battery, and voltage sensor is used to measure the voltage and current of the battery provided

VII. RESULTS

The system is tested throughout the day under various sun orientations to see how well it can recognise incident light under various circumstances. With the aid of panel movement, the output is obtained in accordance with maximum efficiency.

TIME	SOLAR PANEL VOLTAGE	
	WITHOUT TRACKING	WITH TRACKING
08:00 am	3.2 V	4.3 V
10:00 am	5.3 V	6.1 V
12:00 pm	7.6 V	8.2 V
02:00 pm	9.1 V	9.6 V
04:00 pm	7.9 V	8.3 V
06:00 pm	5.6 V	6.0 V

Table.1 : Comparison of Panel Voltage with and without Tracking

VIII. CONCLUSION

Solar tracking system with dual axis was designed and implemented. The partitioning of LDRs and arrangement of LDRs improves solar tracking precision, enhancing the effectiveness of solar panels. Users can monitor the entire system from any location in the world by connecting this system to the internet. Overall system efficiency is improved in this way.

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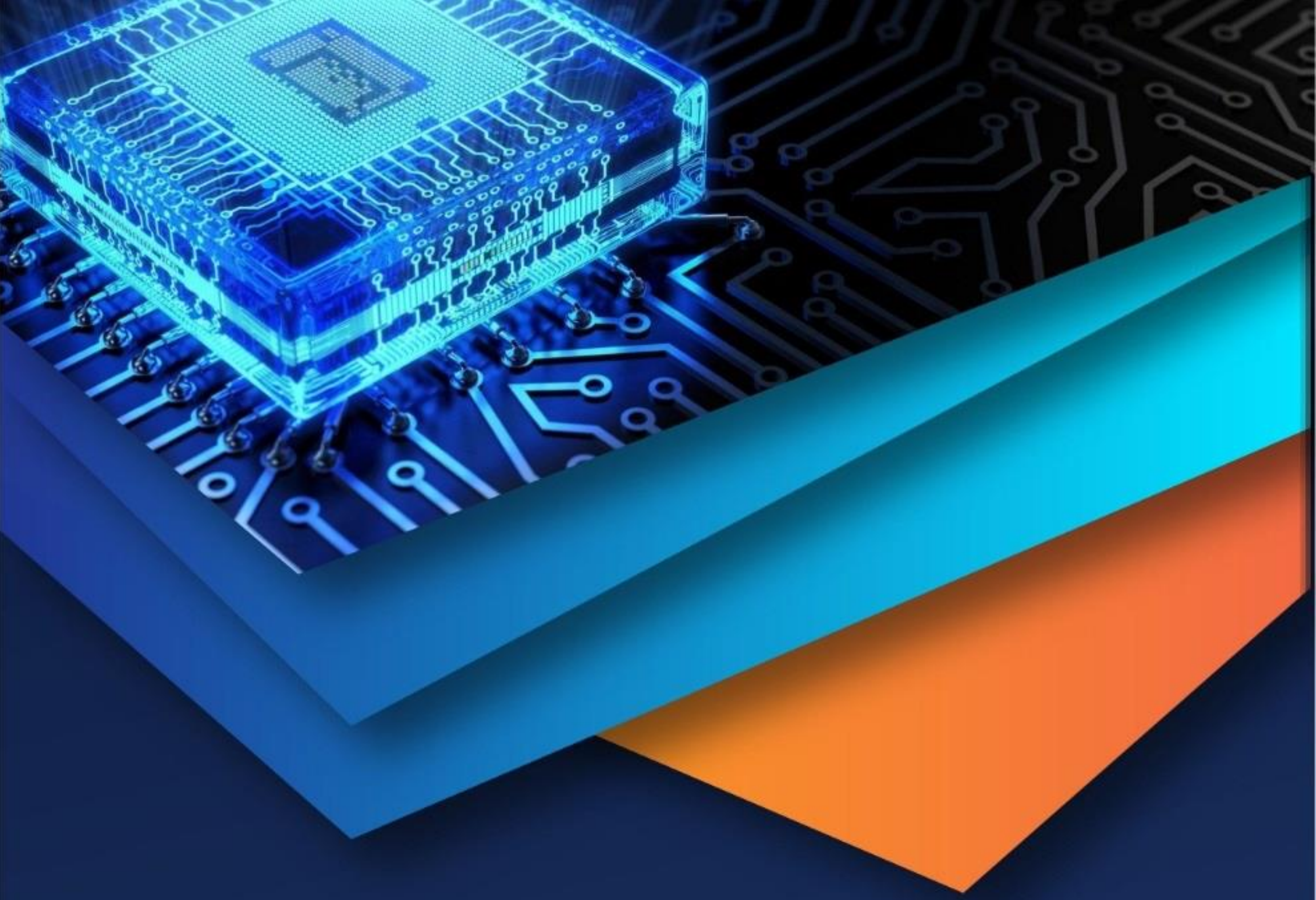

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