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DUAL AXIS SOLAR TRACKING SYSTEM WITH WEATHER SENSOR

H Venkatesh
Assistant Professor dept. ECE
St. Johns College of Engineering and Technology
(JNTUA)
Gonegandla, India
sudhakerjohn@gmail.com

Boya Anil Kumar
dept. ECE
St. Johns College of Engineering and Technology
(JNTUA)
Peddakadaburu, India
boyaanilkumar2003@gmail.com

Kadapa Naveen kumar
dept. ECE
St. Johns College of Engineering and Technology
(JNTUA)
Kodumur, India
nk0637119@gmail.com

Kare Chandu
dept. ECE
St. Johns College of Engineering and Technology
(JNTUA)
Yemmiganur, India
Karechandu914@gmail.com

Golla Chandra
dept. ECE
St. Johns College of Engineering and Technology
(JNTUA)
Yemmiganur, India
Gollachandra7671@gmail.com

Kuruva Kishore
dept. ECE
St. Johns College of Engineering and Technology
(JNTUA)
Adoni, India
kuruvakishore23@gmail.com

***Abstract*— Renewable energy sources, particularly solar power, have gained significant importance in the quest for sustainable and clean energy solutions. Maximizing the efficiency of solar panels is crucial to harness the full potential of solar energy. This project presents the design and implementation of an Arduino- based dual-axis smart solar tracking system aimed at enhancing the energy output of photovoltaic panels. Despite the fact that solar energy is infinite, harvesting it is challenging owing to panel inefficiency. In many years, the old solar tracking method was normally set where the solar panel does not shift orientation towards the sun. Since the sun change its position with time, hence dynamic tracking system is needed. The aim of this project, to develop a dual solar tracker that can absorb more lights and real-time monitor its performances. The proposed system employs two 360 degrees Servo motors to control the orientation of the solar panel in different axes, ensuring that it continuously faces the sun throughout the day. An array of 4 light-dependent resistors (LDRs) is used to detect the sun's position. The DHT11 also added to monitor temperature and Humidity of the environment. The Arduino microcontroller processes the data from the LDRs and adjusts the panel's position accordingly, ensuring that it maintains its optimal alignment with the sun. Additionally,the system incorporates real-time data monitoring and control through a user-friendly interface. The dual-axis smart solar tracking system not only enhances energy generation but also contributes to reducing the overall cost of solar power installations by increasing their efficiency. By use of light dependent resistor sensors, the sun position is tracked, and the Arduino microcontroller controls the servo motors to align the solar panel perpendicular to the sun. As a result, the dual solar axis tracker can capture 27.4% more solar power compared to fixed tilted axis.**

Keywords*—ESP32 Microcontroller, 4 LDR (LIght dependent resistor), 4- 10K Ohm Resistor, 2- servo motors, 1-Solar Panels, Jumper wire, Breadboard, Voltage sensor, Amptex 6v/12v battery, LCD display, I2C module, Voltage regulator, DHT11 Temperature and humidity sensor, Switch, Arduino IDE, Embedded C.

I. INTRODUCTION

Solar energy is emerged as a possible source of renewable energy over the past two to three decades. This solar energy is

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converted into electrical energy by using solar panel according to the principle of photovoltaic effect. Out of various renewable energy sources solar energy is widely used. Because it is simple and it is easy to use in household too. Solar Trackers is a device used for the rotation of solar panel according to the sun's rays. To utilize this renewable solar energy solar trackers are employed. For static solar panel, there is no movement in the panel. But the position of the sun changes during rising and setting (sun rises in the east and sets in the west).

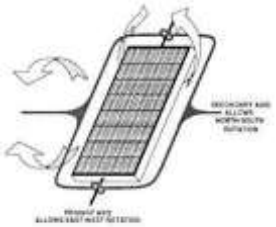

Figure.1 Mechanism of dual axis tracker

II. LITERATUE REVIEW

In paper [1] This article's major focus is on how a dual axis tracking system performs in contrast to a single axis tracker and a stationary solar system. The suggested technology has been demonstrated to be cost-effective as a stroke adjustment in single-axis trackers and offers double the power output of a singleaxis tracker. This essay also shows how renewable energy may be used to real-world products like point in time relative to another point in time; harmonic disturbance is also known as harmonics. thermoelectric modules, light sensors, and energy storage. We'll wrap off with some advice on how to boost the efficiency of these solutions. However, they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels.

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III. PROPOSED SYSTEM

This project has monitored the performance of solar tracker system by using internet of things. In this project also divide into two parts, Firstly, the software development and secondly is the hardware development. When sunlight incident on the solar tracker. it starts calculating and comparing that from which direction the maximum intensity sunlight is coming. ESP32 Microcontroller control the 2 servo motors to either rotate in clockwise or counterclockwise rotation. The controller calculates the average value of each of four LDR sensors (top, bottom, left and right) to determine the position of solar panel module to perpendicular to the sun ray. If the analog value top is less than bottom, the controller send signal to Servo motor 1 (vertical) to move northwest and if analog value (top) is more than bottom, the controller send signal to Servo motor 1 to move southwest. Next, for left and right use same operation as before but Servo motor 2 (horizontal) will move east west and southwest depends on analog value from left and right. If all voltages are equal, then Servo motor will be in stop position. The sun position and send the data to an ESP32 controller. After that the Arduino process the information from the sensor to command the 180-degree RPM DC motor that hold the photovoltaic to move toward the sun. Next, the photovoltaic gather the energy from the sun and charges the battery and send the value to the Arduino.

Block diagram:

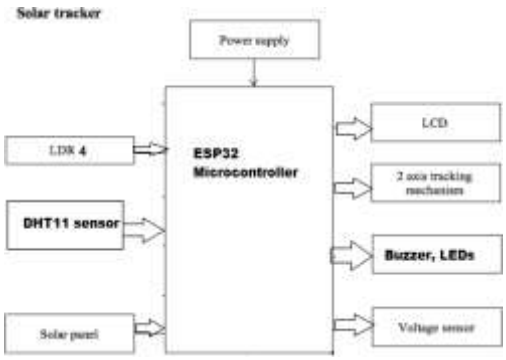

Fig.1. Block diagram of proposed system

IV. WORKING PROCESS

The development of this project is divided into two parts. The first part is software development, and the second part is hardware development. Figure 1 shows the block diagram of the proposed system. The system starts with the four LDR sensors mounted on PV module detect the sun position and then send analog signal to the microcontroller. The microcontroller processes the information and command the 2 Servo motors to position the

Flow chart:

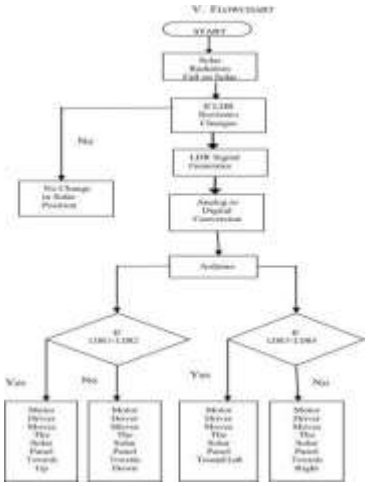

Fig:2. Flow chart

PV module perpendicularly to the sun. The data information such as voltage are sensed by Voltage sensor.

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5. Hardware Description:

5.1. Hardware description:

ESP32 is a chip that provides Wi-Fi and (in some models) Bluetooth connectivity for embedded devices – in other words, for IoT devices. While ESP32 is technically just the chip, the modules and development boards that contain this chip are often also referred to as “ESP32” by the manufacturer. The original ESP32 chip had a single core Tensilica Xtensa LX6 microprocessor. The processor had a clock rate of over 240 MHz, which made for a relatively high data processing speed.

Fig:5.1. Hardware description

3.2.Solar Panel:

The solar panel function to converts the sunlight to electricity and then store it into rechargeable battery 12V. This project had been used the solar panel from SOLARLAND brand. The types of solar panel are SLP005-12 polycrystalline silicon cell. As shows the solar panel that had been used in this project.

Fig:5.2.Solar Panel

5.3. Wires:

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them) is an electrical wire or group of them in a

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cable with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

Fig:5.3.Wires

5.4. PCB:

A printed circuit board (PCB) mechanically supports and electrically connects electrical or electronic components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate. Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it.

Fig:5.4.PCB

5.5. Resistor:

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law: V=IR (4.1)

Fig.5.5.Resistor

5.6. PV CELL :

The cells must be connected electrically to one another and to the rest of the system. Cells must also be protected from mechanical damage and moisture. Most solar panels are rigid, but semi-flexible ones are available, based on thin-film cells. Electrical connections are made in series to achieve a desired output voltage and/or in parallel to provide a desired current capability.

Fig.5.6.PV Cell

5.7. LDR:

It is a photo-resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance.

Fig.5.7.LDR

5.8. TowerPro SG90 Continuous Rotation 360 Degree Servo Motor:

This TowerPro SG90 Continuous Rotation 360 Degree Servo Motor is special among all the available servo motors because its operation is very different from that of a standard servo. As instead of going to a specified angle, this servo will be static at a 1.5ms pulse, a longer pulse gives forward rotation and a shorter pulse give backward rotation.

Fig.5.8.TowerPro SG90 Continuous Rotation 360 Degree Servo Motor

5.9. Humidity and temperature DHT 11:

This DFRobot DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit ARM Processor, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

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Fig.5.9. Humidity and temperature DHT 11

5.10. AMPTEK AT-6-1.3 (6V1.3AH) 20Hr Lithium Solar Battery (6 V):

Sealed Lead-Acid Rechargeable Battery 6V 1.3AH for UPS, Toys, Solar, Emergency lights, security device etc. Strong ABS and Sealed Maintenance Free. Sealed Construction and Leak Proof. Safety Valve Regulated System Deep Discharge Recovery. Wide Operating Temperature Range 100% Brand New Suggested to charge initial 8 hours for better life.

Fig.5.10.AMPTEK AT-6-1.3 (6V1.3AH) 20Hr Lithium Solar Battery (6 V)

5.11. LCD (Liquid Crystal Display):

This LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

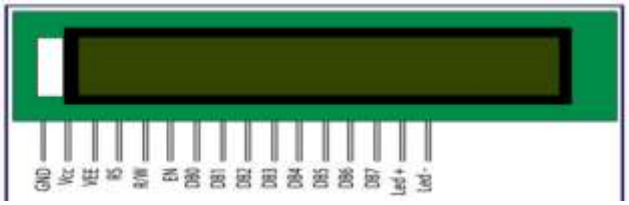

Fig:5.11.LCD

V. RESULTS AND DISCUSSION

In this hardware model, a dual axis solar tracker is implemented with the help of motor driver and ESP32 controller. It is more efficient than fixed system. It tracks the sunrays by moving the solar panel with the help of dc gear motor which is controlled by a motor driver circuit. The input pulse to the motor driver circuit is provided by ESP32. LDR first senses the light intensity and produced signal according to its resistance value which goes to the ESP32 controller through ADC. The ADC converts the analog value of signal into digital. Then, ESP32 controller gives this signal to motor driver circuit and thus the motor driver circuit produces the signal which control the position of solar panel through dc motor. In this way the circuit works. It is very inexpensive and easy to implement. It operates automatically. There is also a temperature sensor which is used to sense the temperature. The experimental

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results are obtained. This model is also friendly in nature and are widely used.

Fig:3. Dual Axis Solor Tracking System With Weather Sensor

Fig:4. Dual Axis Solor Tracking System With Weather Sensor

Fig:5. LCD Dispaly

7. Advantages of dual axis trackers include:

- Can give 40% more electricity than a non moving solar panel.
- Higher degree of flexibility, allowing for a higher energy output on sunny days.
- Higher degree of accuracy in directional pointing.
- More efficient.
- Less maintenance.
- Less complexity.

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- More economical.
- Increased output.
- More accurate.

8. The applications of solar tracking system:

- Solar tracker, a system that positions an object at an angle relative to the Sun. The most-common applications for solar trackers are positioningphotovoltaic (PV) panels (solar panels) so that they remain perpendicular to the Sun's rays and positioning space telescopes so that they can determine the Sun's direction.
- The biggest advantage to installing a solar tracker comes in the form of improved energy output. By some estimates, adding a tracker to your panels could improve their productivity by 10 to 25 percent, depending on where your home is located.

APPLICATION ➢ Used for solar power towers ➢ Used to improve solar pumping system ➢ Used for street lightning system ➢ Used to provide electricity in remote areas.

VI. CONCLUSION

The dual solar tracker was developed and able to increase the solar still capability to capture more solar radiation with the use of a microcontroller and LDR sensors, this dual solar tracking system project has demonstrated a method of tracking the sun's location which allow the solar panel always to be positioned perpendicular to the sun. Therefore, the system tracking become more robust and accurate with applied calibration of LDR sensor. The benefit of having this system is that the measured solar panel parameter data can be monitored real-time where it is accessible from anyplace with an internet connection. Finally, the performance of a fixed tilted solar panel and a dual-axis solar panel was compared, and it was determined that the dual solar panel tracker can capture more solar radiation and thus produce higher solar power than the fixed solar panel. The proposed dual axis solar tracker is more effective than the existing single axis solar tracker and fixed mount. The proposed solar tracker which automatically tracks the sun to grab maximum solar power with the help of ESP32 board was effectively achieved. The implementation cost of Controller board for tracking solar power is low and it is implementation is simple. Finally, experimental system clearly reveals that proposed system effectively tracks the sun in both good and bad weather conditions. This weather conditions are monitored by using DHT11 sensor. During different time periods

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in a day compared with the existing system and efficiency of solar panel is effectively improved.

10.Future scope :

Air must flow over the solar panels in order to remove their heat in order for the systems to be cooled. Convection is the ideal method for doing this since it is more efficient than air movement beneath the panels. Active air-cooling is one of the most fundamental methods of cooling. Pumps powered by solar energy are used in active air-cooling to move water through a system. Active cooling technology uses solarpowered D.C. pumps to operate water circulation in each of these systems. Artificial intelligence (AI) methods follow the Sun at the right angles while enabling your gadget to collect the most energy possible from solar cells. This approach is excellent for remotely controlled solar power installations. The PV panel's azimuth and elevation angles are held constant at noon while the tilt angle is changed to follow the Sun using a Direct Current (DC) motor, an H-bridge motor driver circuit, and an Arduino.

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