EFFICIENT HYBRID DUAL AXIS SOLAR TRACKING SYSTEM

G. Naga Lakshmi, S. Keerthi, D. Yegnitha, J. Gopichand, K. Naveen

Abstract — Environmental catastrophe is one of the most important issues facing in growing economies. This issue can only be solved with renewable energy. Solar radiation is one of the most efficient renewable energy sources, and it has the ability to help solve the problem. Renewable solar energy is energy that can be regenerated. As a source of power, it is becoming progressively crucial. Tracking the sun allows humans to spend a lot more time outside. The sun provides enough energy for a solar panel. It generates the maximum energy when the photovoltaic system is aligned with the sun's rays. The sun's passes through the sky is tracked using this system. This system is designed to follow the path of the sun through the sky. Using a Motor driver, the photovoltaic system will change due to the DC motor's control movement. Employing four light-dependent resistors, the solar panel detects daylight based on their orientation (LDRs).

The goal is to create and construct an autonomous solar-tracking mechanism with a low-cost, reliable structure using an embedded design. The performance of a dual-axis sun tracking system utilizing Arduino is examined in this study. The goal of this study is to see if a stationary photovoltaic system is better than a solar tracker. The performance is outstanding. The system is separated into two parts: hardware and software. Four light-dependent components are included in the hardware. LDR resistors are being used to identify the sun's brightest light source. There are two dc motors in this set used to shift the photovoltaic panels to the illumination source location as perceived by the solar panel. The solar tracker system's result has been compared to permanent or static solar panels, the performance of the mobile solar panel was shown to be superior. As a result, the solar tracker has shown to be more useful.

Index Terms — Solar Cell, Advance Solar tracking, Single axis, Dual axis, Self-Cleaning, LDR, DC Motors, Wi-Fi module, LCD display.

1 INTRODUCTION

The solar tracking system plays a major role in which it is used to capture the maximum power from the sunlight. During those days, the power generation method is not great as now because there are many types of power generation system like Nuclear power plant, hydroelectric power plants, geo thermal power plants, other non-renewable and also renewable energy source power generation methods. In this paper, the solar power generation is one of the pollution free and zero emission process rather than non-renewable energy source. In these trackers allow photovoltaic systems to decrease the angle of incidence between the incoming sunlight and the sensor in the solar tracking device, decreasing the amount of electricity. All focused solar systems have trackers in an effort to produce energy from direct sunlight into solar panels. These solar trackers have been shown to have dual axis tracking technology designed to combine solar modules and reduce the cost of devices. These kinds of solar tracking systems is also ideal in rural areas where electricity production is inadequate. The solar panel, which transforms solar energy directly into electricity, is one of the key components. Here the Solar panel, which is used is made up of semiconductors material. The solar panel placed in one direction does not get maximum power due to climate change. So, the Maximum Power Point Tracking (MPPT) is a technique for maximizing the generation of power from solar panels by maintaining the working of P-V solar panels.

2 BLOCK DIAGRAM AND EXPLANATION

2.1 BLOCK DIAGRAM

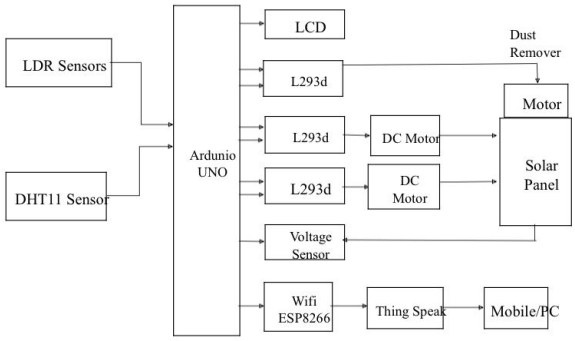

Fig. 1 Block Diagram

2.2 EXPLANATION

2.2.1 Power Supply

The solar tracking system plays a major role in which it is used to capture the maximum power from the sunlight. During those days, the power generation method is not great as now

because there are many types of power generation system like Nuclear power plant, hydroelectric power plants, geo thermal power plants, other non-renewable and also renewable energy source power generation methods. In this paper, the solar power generation is one of the pollution free and zero emission process rather than non-renewable energy source. In these trackers allow photovoltaic systems to decrease the angle of incidence between the incoming sunlight and the sensor in the solar tracking device, decreasing the amount of electricity. All focused solar systems have trackers in an effort to produce energy from direct sunlight into solar panels. These solar trackers have been shown to have dual axis tracking technology designed to combine solar modules and reduce the cost of devices. These kinds of solar tracking systems is also ideal in rural areas where electricity production is inadequate. The solar panel, which transforms solar energy directly into electricity, is one of the key components. Here the Solar panel, which is used is made up of semiconductors material. The solar panel placed in one direction does not get maximum power due to climate change. So, the Maximum Power Point Tracking (MPPT) is a technique for maximizing the generation of power from solar panels by maintaining the working of P-V solar panels.

2.2.2 LDR (Light Dependent Resistor)

Light Dependent Resistor an LDR is a component that has a (variable) resistance that variations with the light intensity that bouquets upon it. This allows them to be used in light detecting courses. They are made of high struggle semiconductor material. When light hits the expedient, the photons give electrons energy. This makes them jump into the conductive band and in that way behavior current. A Light Sensor is approximately that a robot can use to detect the current ambient light level - i.e., how optimistic/shadowy it is. There are a range of different categories of light sensors, collected with 'Photo resistors', 'Photodiodes', and 'Phototransistors'. Light dependent resistors, LDRs or photo resistors are often used in circuits where it is compulsory to detect the incidence or the level of light. They can be designated by a variation of names from light dependent resistor, LDR, photo resistor, or even photo cell, photocell or photoconductor.

2.2.3 Arduino UNO

The Arduino Uno microcontroller board that uses the ATmega328 microcontroller (datasheet). There are digital pins input/output pins (six of which can be used as Output pin), six analogue input, a 16 MHz digital oscilloscope, an USB interface, a headphone jack, and ICSP, and a reset button on this circuit. It comes with everything you'll need to get started with the microcontroller; simply plug it into a pc with a USB link or USB cable or power adapter or battery.

2.2.4 Solar Panel

A photovoltaic panel, photovoltaic solar panel, photovoltaic (PV) module, or solar array is a collection of photovoltaic cells installed in a framework. Solar cells generate dc electricity using sun as a type of power. A PV panel is a group of PV modules, while an array is a group of PV panels. A photovoltaic system's arrays provide solar energy to electrical equipment. Solar panels, also known as photovoltaic, are made up of individual solar panels, also known as photovoltaic cells. The solar panel's functionality improves as the number of power cells increases. The most important thing to understand about solar cells is that they collect sunlight and turn it into electricity.

2.2.5 L293D (Motor Driver)

L293D is a typical Motor driver or Motor Car driver IC which allows DC motor to initiative on whichever path. L293D is a 16-pin IC which can control a conventional of two DC motors concurrently in any track. It means that you can regulator two DC motor with a solo L293D IC.

It works on the believed of H-bridge. H-bridge is a route which allows the current to be flown in what's more direction. As you know current need to revolution its direction for being able to interchange the motor in circular or counterclockwise path, Hence H-bridge IC are ideal for powerful a DC motor.

In a single L293D chip there are two h-Bridge circuit inside the IC which can interchange two dc motor autonomously. Due its size it is very considerable used in robotic submission for monitoring DC internal combustion engine

2.2.6 DHT11 (Temperature Sensor)

A temperature and humidity sensor complicated with such a calibrated digital input output is included in the DHT11 Temperature and

Humidity Sensor. It offers high dependability and outstanding long-term stability by employing an innovative digital-signal-acquisition technique as well as temperature and humidity sensing technologies. This sensor links to a high-performance 8-bit microcontroller and combines a resistor measuring component as well as an NTC temperature measuring component, providing great quality, quick reaction, anti-interference ability, and cost-effectiveness.

2.2.7 DC Motor

An electric motor is an electric machine that converts electric energy into power-driven energy. Most electric motors activate through the collaboration between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque functional on the electric mechanical shaft. An electric originator is unhappily matching to a rechargeable motor, but activates with an inverted flow of power, converting mechanical energy into electrical energy. Electric motors can be powered by unswerving current (DC) sources, such as beginning batteries, or rectifiers, or by blinking current (AC) fundamentals, such as a power grid, inverters or electric manufacturers. Electric motor may be off the record by considerations such as rule foundation type, structure, submission and type of motion output. They can be power-driven by AC or DC, be cleared or brushless, single-phase, two-phase, or three-phase, axial or radiated flux, and might be air-cooled or liquid-cooled. Applications embrace industrial fans, lines and pumps, machine tools, household appliances, power tools, vehicles, and disk drives. Small motors may be create in electric watches. In certain applications, such as in recovering braking with traction internal ignition engine, electric motors can be used in reverse as originators to improve energy that might otherwise be missing as heat and roughness.

2.2.8 Voltage Sensor

The Volt Detect Sensor is a simple and handy module that reduces any voltage level by a factor of 5 using a potential divider. This enables us to use a microcontroller's Analog input pin to monitor voltages greater than it is capable of sensing. You may detect a voltage up to 25V with a 0V - 5 volt Analog input range, for example. This module also incorporates handy screw terminals for quick and secure wire connections.

2.2.9 LCD Display

LCD (Liquid crystal) is indeed a flat panel display that operates primarily with liquid crystals. LEDs are widely used in cellphones, televisions, computer monitors, and instrument panels, and they have a wide range of applications for consumers and enterprises.

In comparison to the technologies they replaced, such as led diodes (LED) and gas-plasma displays, LCDs were a huge step forward. LCD technology allowed for significantly thinner displays than ray tube (CRT tube) technology. Because LCDs block rather than transmit light, they require far less energy than LED or gas-display displays. In which an LED emits, those crystals inside an LCD use a backlight to create an image.

2.2.10 Dust Remover

An automatic rubber scrubbing system, which is an eraser system self-possessed of brushes arranged on a flat solar panel. The direct up-to-date must be triggered by the rubber brush system, power-driven by the solar panel itself finished batteries. Consequently, the cleaning system can work when dust accumulates in the air.

2.2.11 Wi-Fi Module

The Hardware is a complete Wireless system on a chip that includes a 32-bit processor, significant RAM, and also between 512Kilobases and 4MB of flash memory, depending on the vendor. As a wireless adapter, it may extend Wireless capabilities to other systems, or as a standalone machine, it can run simple apps on its own. In addition to the Rx and TX pins of the UART, depending on the exact module model (ESP-1 through ESP-12 at the date of this thesis), the module with between 0 to 7 Generic Purpose Input/output (GPIO) pins, making it ideal for IOT systems.

3 WORKING PRINCIPLE

The proposed real-time tracking system allows you to monitor a lot of sunlight by rotating the photovoltaic panels on different axes. In this dual-axis system, solar tracking tasks can be performed from four directions to get more energy from solar panels. Figure 3 clearly illustrates the movement along two axes. A two-axis two-servo motor system is inserted into a single-axis because it can

efficiently obtain solar energy by rotating horizontally. The vertical axis structure design of the applicable dual-axis tracker is illustrated in Fig. 4. This study uses 4 LDR systems, with 2 Arduino DC motors and microcontrollers to form a complete function. The sensors and motors are designed to track obliquely in the east-west direction of the sun, while other sensors and motors mounted on the frequency converter use a north-oriented sun track.

Running DC motors run on the solar path. Two DC motors and four LDR sensors are connected to the microcontroller, which designs the DC motor at the sensor input base. The light direction and intensity strongly affect the LDR sensor, and can send the signal we set to the Arduino microcontroller. At this moment, the microcontroller will confirm the rotation direction of the DC motor and control it accordingly.

The LDR sensor sends a signal to the microcontroller when it detects sunlight. The microcontroller selected in this study is a logic device that can perform useful processing based on the sensor input signals and use the output signals to excite the motor driver for tracking actions. Suppose that if the sun changes a person's terrain and goes from east to west, this will result in a change in the absorption of light on one sensor associated with another. This system works according to the effect of light on the sensor. The controller will start the control loop and automatically move the DC motor to a new position when the light is on the same pair of sensors. The same method can support it by changing the position of the sun, which is surrounded by the sky. Consequently, the proposed model is capable of capturing additional sunlight and the system's ability to convert solar energy is very high. How the control algorithm performs motion estimation and is the main key. When collecting data from the LDR sensor, the main algorithm is started. The sensor uses an ADC (analog-to-digital converter) to perform our set tasks. The main purpose is to perform performance simulation with digital signals. The digital signals will be transmitted to the Arduino microcontroller. After collecting the digital signal, he decided it was connected to the direction of movement and the steep angle of the DC motor. The control algorithm determines that the Arduino microcontroller drives the DC motor if the light sensors do not match and if the sensor signals match. Start with the algorithm. This methodology is infinite as long as the light incident on a pair of detectors is the same and the photovoltaic panel is regulated for optimal power.

4 HARDWARE AND SOFTWARE REQUIREMENTS

4.1 Hardware Requirements

1. Power supply
2. Light dependent resistor
3. DHT11 sensor
4. Arduino UNO
5. L293D
6. DC motors
7. Dust remover
8. Solar panel
9. Voltage sensor
10. LCD display
11. ESP8266 Wi-Fi Module

4.2 Software Requirements

1. Arduino IDE
2. Thing Speak Cloud
3. Windows Environment
4. Embedded C language

5. EQUATIONS

The performance can be evaluated according to equations (1) and (2) to obtain the device fill factor (FF) and conversion efficiency (η)

$$F.F = VmIm/VocIsc \quad (1)$$

$$\eta = [VocIscFF/AG]*100\% \quad (2)$$

In equations (1) and (2), A is the area of the panel, and G is the radiation falling from the surface of the panel. For the performance of the test panel, this study is calculated based on the energy generated per unit time (kWh), which is expressed by the efficiency coefficient energy (Ys) (kWh / Kw • h), as shown in formula (3)

Shown = EtotalP

6 FIGURES AND TABLES

6.1 Figure

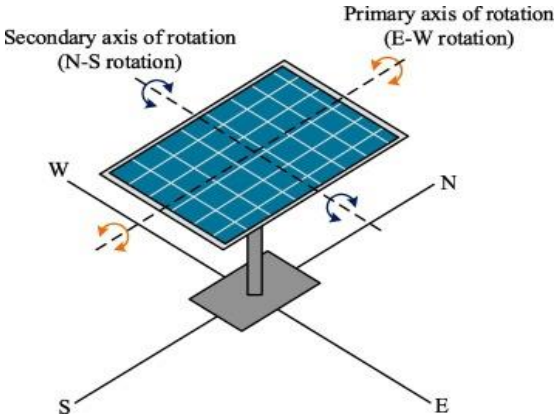

Fig.2 Dual Axis Rotation

6.2 Table

The table shows how much power is generated by fixed axis, single axis, and dual axis solar tracking at different time intervals. We can clearly see that the dual axis solar tracker produces the most power when compared to the other systems. As a result, a dual axis/two axis solar tracking system can be utilised to get most electricity.

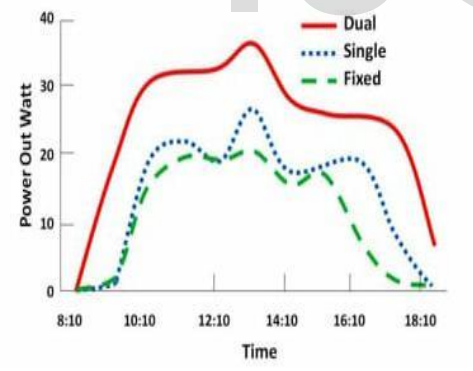

Fig 3. Graphical comparison of experimental data

7 END SECTIONS

7.1 Appendix A

Appendix A includes the Arduino IDE source code, which is based on the C programming language and utilizes the Microsoft environment to build the Arduino IDE software. The code must be dump into that software, then uploaded, and the results must be checked.

7.2 Appendix B

The azimuth and elevation axes are the two axes that make up solar tracking. The daylight is absorbed by the LDR sensor, and the panels are rotated in response to the strength of the light. The panel is rotated horizontally and vertically depending on the strength of the light.

The East-West direction is the primary axis, and the North-South direction is the secondary axis.

Time	Fixed Axis(W)	Single Axis(W)	Dual Axis(W)
8:10	0.16	0.0046	0.95
10:10	16.91	20.19	30.67
12:10	19.31	19.72	33.69
14:10	14.68	17.71	29.60
16:10	8.42	18.82	26.39
18:10	0.72	1.025	7.49

Appendix B includes references, as well as research papers from which we derived the foundational research for this project.

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8 CONCLUSION

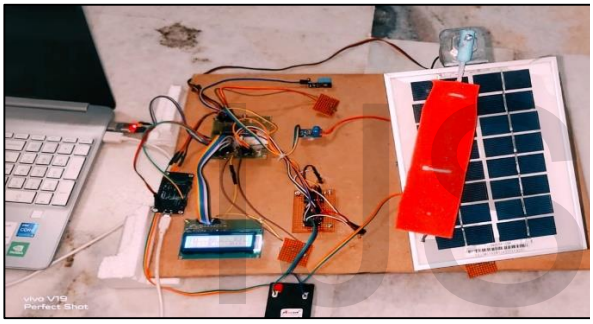

Fig 4. Result

We have concluded in this research that a dual-axis solar tracking system is more effective in terms of electrical energy output than a single-axis tracker or a stationary system. When compared to the fixed system, the dual-axis tracking system gains roughly 40%. Also, because the tracking mechanism employed in a dual axis tracking system is more sophisticated, it'll be pricier and less dependable than a fixed system. When compared to a static system, the gain of single-axis tracker systems is roughly 28%, resulting in a trade-off between maximum power collection and system simplicity. When the light intensity is extremely low or extremely high, the dirt remover needs to clean the solar panel automatically.

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