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A REVIEW ON EFFICIENT DUAL AXIS SOLAR TRACKER

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Abstract: The proliferation of renewable energy sources such as solar, wind and hydroelectricity requires a large population to be able to access these resources. In order to meet this goal, it is important to move towards efficient and renewable energy sources such as solar panels that are more abundant in origin. This paper focuses on the performance analysis of solar power panels with dual-axis tracking and cleaning systems. By improving the efficiency of these panels from 3 watts (according to prototype model) to 5-10%, we can increase the number of people who are able to use renewable energy. In addition, this model promotes the design of a cleaning system with a wiper that is arranged on the side of the panel to clean off dirt and dust from its surface. The results show that after using these three methods, performance indicators for this panel have been greatly improved as compared to an unmodified panel.

Key Words **- Solar energy, Tracking, Cooling, Cleaning, Solar panel, Renewable energy.**

I. INTRODUCTION

Over the last few years, fossil fuels have been supplanted by renewable energy sources as the world seeks to reduce its dependence on fossil fuels. With the integration of renewable energy resources into power systems, various issues arise that lead to power losses in the power system--is followed as: power quality issue, availability of conventional energy sources issue and power theft issue.[16] Power quality is a crucial component in integrating renewable energy sources; key power quality problems caused by the uncontrollable fluctuation of renewable energy sources include voltage sag, voltage flicker, and distortion. voltage sag is defined as the reduction in system voltage between two or more phases; frequency fluctuation is defined as fluctuations within a range of frequencies; distortion is defined as an increase in DC voltage at one According to IEEE std 929-2000 standards for PV systems: Voltage sag occurs when there is low voltage on a PV cell due to excessive shading or physical obstruction on its surface; voltage flicker occurs when PV cells are in direct sunlight which causes them to produce high voltages which cause them to turn on and off rapidly with each cycle; frequency fluctuation occurs when each cell produces its own frequency. The renewable energy sector has seen significant growth in recent years both because of the rise in popularity of solar power as well as technological advancements. These advancements have led to greater integration of renewable energy into smart grids, which make renewable energy more suitable for power system planning and expansion.[9] To expand existing power systems with less negative environmental impacts, integrating renewable energy with power planning can be a common remedy. India is a tropical nation with a lot of solar radiation all year long; as a result, it receives solar radiation virtually all year long, or around 3000 hours of sunshine. Since most people live in rural regions, solar energy has a lot of potential to minimise the amount of non-renewable resources that these families utilize.[10]

II. RELATED WORK

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 single-axis tracker.[11] 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.

In paper [2] In this research, they provide a sun follower platform solar tracking technique. Water and air are used in the proposed system to power thermal systems. Online visualization of the saved data is possible with the aid of an application created specifically for this function. The system's hardware component has been programmed to function precisely.[12] For experimental sun follower platforms, a solar-tracking approach design and implementation are presented in this study Solar tracking is one of the finest techniques to increase the efficiency of energy generation. The microcontroller is utilized to figure out the exact position of the sun. However, they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels.

In paper [3] The research presents a dual-axis solar tracking system simulation model in MATLAB. To track the sun's movement from north to south as well as from east to west with this system, the PV panel may be moved in two axes. The technique was developed to enhance the solar panel output power, however when the discrepancy between the set normal angles grows, the output power decreases. According to the findings of this study, the electricity generated by a dual-axis solar tracking system (DASTS) during the course of the observation period was 26.72% more than that generated by a stationary solar panel.[13] However, they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels.

In paper [4] In this work, the performance of a dual-axis sun tracking system using Arduino was assessed. The main goal was to establish if a static solar panel with a dual-axis tracking system is more efficient than one without one. The LDR sensors were the main focus of the article since they can detect when the Sun's position has changed and can then transmit that information to an Arduino microcontroller for additional processing.[14] Instead of investing money on monitoring structures, more panels were added to the system to make it more cost-effective. However, they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels.

In paper [5] The development of an affordable active dual-axis solar tracking system that follows the sun's path to maximise the amount of power generated by solar panels as they follow the sun. The controlling device is a low-cost Arduino Uno, a single-board microcontroller and open source electronics platform constructed on user-friendly hardware and software. Other important parts include a solar panel, Light Dependent Resistors (LDRs), and servo motors that may be controlled by an Arduino.[15] The Light Dependant Resistor operates the solar tracking system (LDR). However, they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels.

In paper [6] By combining a dual-axis solar tracker with LDRs as the primary sensor input, an Arduino Uno microcontroller as the processing unit, and two servomotors, the researchers are attempting to increase the efficiency of the old static solar panel. They said that they improved the solar panel's efficiency by 37.76% by changing the static solar tracker into a dual axis solar tracker. But this paper's weakness is that it did not take into account all of the elements that reduce the solar panel's total performance, including temperature increases and the buildup of dust particles on the panel. When the temperature rises by 1.8 degrees Celsius, the efficiency is decreased by 0.5% and the dust accumulation is also decrease the efficiency of the solar panel.

In paper [7] The researchers built the model based on the maximum power point tracking and they convert the fixed solar module into dual axis solar which consist of light sensors and Aurdino program which controls the solar tracker and by the maximum power point tracking which track the maximum power they tried to increase the efficiency of the solar panel and their model efficiency is increased and has high reliability. But the limitation of there is that they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels.

In paper [8] The main goal of the researcher is to increases the efficiency of fixed solar panel by the designing of a solar module with two axis (azimuth angle and altitude angle) which tracks the exact position of the sun and this research is performed for the Baghdad city. Their module is divided two in two part one is hardware which consist solar panel, Dc motor with gearbox and another one is the electronics part which consist sensor that are used to sense the position of the sun. By this research they claimed that they increased the efficiency of fixed solar panel by 35% . But the limitation of this is that they overlook elements that impact solar panel efficiency, such as the temperature rise of the panels and dust buildup on the panels. By considering these factor they can increase more efficiency of the solar panel.

Fig.1 (Solar tracker with two axes)

III. FACTORS AFFECTING THE EFFICIENCY OF SOLAR PANEL

POWER TOLERANCE

Power tolerance measures the ability of a solar panel to produce electrical power under real-world conditions, such as when it is exposed to weather conditions or other factors that might affect its performance. Power tolerance levels are typically expressed in percent, with a value of zero meaning the panel can produce no power at all.

A. TEMPERATURE

When all factors are the same, the lower the voltage is, the more high temperature there is. This means that power is lost. However, when PV output increases for a decrease in temperature, it shows that power is gained.[17]

METHOD I

Temperature Coefficient -The rate at which a parameter relating to temperature change changes is known as a temperature coefficient. It might be the power temperature coefficient, voltage, or current. Under the STC condition, the coefficients for power, open-circuit voltage, and short circuit current in common commercial solar modules are calculated. Usually, these coefficients are given as a percentage per degree change (%°C).[18]

Effect of Temperature Change on Module's Parameters-

The following two equations can be used to determine or define the numerical impact of temperature on the PV module.[19]

$$V = VSTC + VT\ Coeff \times (Tcell - 25)°C$$

$$P = PSTC + PTCoeff \times (Tcell - 25)°C$$

VSTC = Voltage at STC
PSTC =Current at STC
VTcoeff = Temperature coefficient of voltage
PTcoeff = Temperature coefficient of current

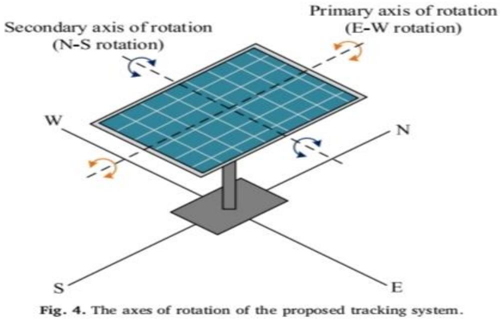

Fig. 2 (Axes of rotation)

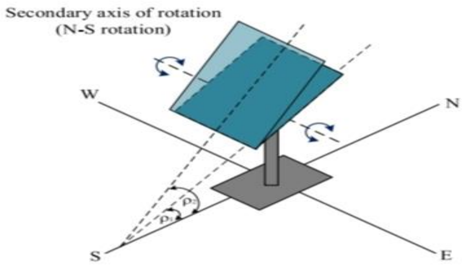

Fig. 2(a) (Secondary axes rotation)

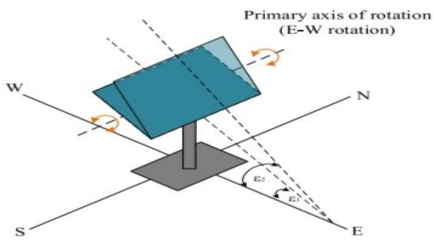

Fig. 2(b) (Primary axes rotation)

METHOD II The module estimates the temperature based on ambient temperature.

NOCT Module:- The NOCT module may be used to determine a PV module's temperature as a function of the ambient temperature. The name of the module is derived from the Notional Operating Cell Temperature (NOCT), which is established for a particular PV cell and obtained by the cell at an ambient temperature of 20 °C, a nominal wind speed of 1 m/s, and an irradiation of 800 W/m2.[20]

$$T_{cell} = T_{ambient} + G \times \frac{(NOCT - 20°C)}{800\ w/m2}$$

G = irradiance at instant

Tambient = ambient temperature

B. EFFECT OF DUST AND DIRT

Light-obstructing materials are an issue since they reduce the efficiency of PV panels. Dust contamination and buildup can block the solar cell from receiving light energy. Both the amount of dust that collects on a solar panel's surface and the amount of light that is blocked by dust particles may be used to examine how PV panel performance is impacted by dust collection.[21- 22]

DUST ACCUMULATION

When dust builds up on the solar panels' surface, the amount of incoming photons is reduced. The efficiency of PV cells falls as a result of the increased number of dust particles reducing the surface area of solar panels. According to studies, when dust builds up on a solar panel's surface, the amount of incoming light is reduced, which results in power loss. These studies suggest that in places with little moisture, power losses may be as high as 15%.[23]
Cleaning solar panels is a frequent practise in these situations to preserve efficiency.[24]

Some of the cleaning techniques are-

1. Forced-flow- In addition to being utilised extensively in the United Arab Emirates (UAE), forced-flow air conditioning is also employed in other industrialised nations. This method uses forced air to blow dust off solar panels.

2. Rainfall cleaning- This method uses a tilted solar panel. It is a natural cleaning method, where rainwater falls on the panel and maintains its tilted shape.

3. Water-based cleaning uses large amounts of water and high pressure to remove dirt. The results are less than adequate.

4. Manual cleaning- This method is used in cleaning solar panels. Special brushes scrub particles from the surface of the panels.

5. Mechanized cleaning- This method uses organized sets of mechanical apparatus (robots) to operate brushes, reducing the labour necessary for cleaning panel surfaces.

Fig 3 (Mechanized Cleaning)

6. Electro Dynamic Screen (EDS)- This method utilizes high-voltage supplies to power the electrode, which ensures that electrical field is generated and dust particles are removed.

7. Super hydrophobic plane (SHOP)- It is a passive cleaning method. It requires a hydrophobic surface or chemical coating to be applied to the surface.

8. Super hydrophilic plane (SHIP) - This method is operated by using titanium oxide nanoparticles, nanofabrication techniques, and a chemical coating. Here, a hydrophilic surface or chemical coating/screen layer is used to reduce soiling. The basic cleaning method uses an Arduino-based automatic solar panel cleaning device for dust removal.

IV. ARCHITECTURE DESIGN OF EFFICIENT SOLAR POWER GENERATION MODULE

The necessary components are the LDR sensor, Arduino, motor driver, dc gear motor, LCD, and temperature sensor, to name just a few[24]

Solar Cell - A non-mechanical silicon amalgam device called a photovoltaic cell uses light energy from the sun to create electricity. It works between 10 and 20 percent efficiently. Its rated voltage and current are 16.4 volts and 10 watts, respectively.

Fig.3 (Solar Panel)

LDR (Light Dependent Resistor) - In order to provide an analogue signal to Arduino, LDR is utilized to detect light. It is constructed of increased resistance semiconductor that may be manipulated by variations in the surrounding light.

Aurdino Nano - Based on the ATmega328, the Arduino Uno microcontroller was created. The microcontroller was created by Arduino and has an input voltage range of 7 to 12 volts. It has 2296 digital I/O pins and two pin headers on either side of the main chip, which may be used to connect other parts to the main board, such as sensors or motors.

The advantages of Arduino are their inexpensive cost, reliable design, and autonomous board. It operates at a 16 MHz clock rate.

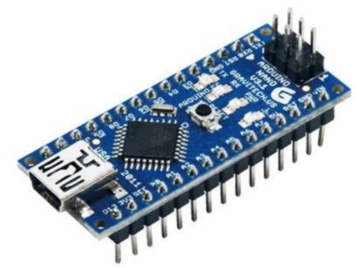

Fig. 4 (Aurdino Nano)

Motor Driver - The devices L293 and L293D are twice as tall. The circuits they are made of are H-bridges, which are widely utilised in robotics. H-bridge circuits may switch the polarity and direction of the voltage, allowing a motor to run in either way. Due to their ability to deliver high voltages and currents on demand, these devices are frequently utilised in robotics.

DC gear motor- It is a plastic dual-shift gear motor. It has a 4 kg cm output torque capacity. It operates at speeds and voltages ranging from 3V to 12V.

LCD - Computers and other electrical equipment employ electronic modules called Liquid Crystal Displays (LCDs). It is extremely thin and has numerous layers. 16 pins make up the JHD162A LCD device, which can show 16x2 monochrome characters. The display's two lines, which each carry 16 characters, may be interfaced in either an 8-bit or a 4-bit manner. The data shown on an LCD is in ASCII format.

Temperature Sensor - A LM35 temperature sensor is used in this hardware model. It is a very low-cost, simple-to-use temperature sensor that produces an output voltage proportional to the ambient temperature. The device has a maximum current of approximately 2.5 mA and can sample at a rate of up to 1 Hz. Its precision is ±2 degrees Celsius.

V. CONCLUSION

An effective dual-axis solar tracker system's design and execution are discussed in this study. An AT mega 328 microcontroller is used to construct this system. Four light-dependent resistors (LDRs) are used to measure the intensity of sunlight for solar tracking. The solar panel is stabilized using a DC motor with a gear configuration. A wiper-like structure is utilized for cleaning and cooling, and it is powered by a servomotor, a temperature sensor to detect an increase in temperature, and a DC fan.

VI. 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 solar-powered 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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