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A Study on Automatic Solar Tracker

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Abstract: Solar tracking systems that can track the Sun's movement can boost power generation by increasing the surface area of solar panels exposed to sunlight. Using a solar tracker reduces the number of solar panels required to generate the same amount of electrical energy. Solar tracking systems are divided into two types: single-axis solar tracking systems and dual-axis solar tracking systems. Several researchers conducted simulation and experimental work to compare and evaluate the performance of solar tracking systems versus static solar panel systems, as well as the performance of different solar tracking system mechanisms.

Solar energy is a non-traditional energy source. In light of this, a solar panel for electricity generation has been developed. The amount of electricity produced is determined by the amount of sunlight that falls directly on the solar panel. Solar panels are typically stationary. Because of the earth's revolution, the position of the sun changes, and as a result, the solar panel does not always align with the sun, producing less electricity. A solar tracker system can help to solve this problem. The solar tracker automatically adjusts the position of the solar panel and tracks the sun to maximize power output.

Keywords: Solar Tracker, Tracking System, Solar Tracking System Performances

I. INTRODUCTION

recent years, several issues remain that must be addressed in order to fully utilize these energy resources. Solar photovoltaic panels, for example, are commonly available on the market and are fixed at a specific inclination angle, thus only facing one direction. When the Sun is perpendicular to the surface of the solar panel, it produces the most power. Throughout the day, the sun rotates from east to west, and it is not always perpendicular to the solar panel, resulting in low power generation. For a large household with high energy consumption, the number of static photovoltaic solar panels that must be installed to meet the energy demand is relatively high, resulting in higher start-up costs, which in turn increase the payment period and total cost of electricity, making photovoltaic solar energy unappealing and uneconomic. Solar tracking systems that can track the sunlight from east to west are proposed to solve this problem because they can increase power generation rate by maximizing the surface area of solar panels exposed to sunlight. The number of solar panels required to generate the same amount of electrical energy will be significantly reduced by using a solar tracker due to the increased efficiency of the solar tracking systems, lowering the overall performance of the solar photovoltaic system, both technically and economically. [1]

Solar Tracking Systems

In general, solar tracking systems can be divided into two categories based on their ability to tilt and rotate. A single-axis solar tracking system and a dual-axis solar tracking system are the two classifications.

The single Axis Solar Tracking System is used to track the angle of tilt of the sun along a single axis. It is commonly used in the tropical region because the position of the Sun does not vary much throughout the year. This system is made up of one linear actuator and a motor that rotates the panel in response to the movement of the Sun [2]. A pair of light-dependent resistors (LDRs) are typically used and placed on opposite sides of a solar panel. Its function is to calculate the voltage drop across them to determine the intensity of light. When the voltage

Despite the significant shift toward renewable energy in dropis equal, the panel will continue to rotate until it stops. As a result, the solar panel will always be perpendicular to the sun's rays.

The sun provides the earth with 16x1018 units of energy per year, which is 20,000 times the amount required by humanity. On a sunny day, the sun's radiated energy is approximately 1 kW/m2. According to, "the International Energy Agency predicts that roughly one-quarter of renewable energy, or 11% of global electricity, could be supplied by solar energy in 2050." As a result, the purpose of this paper is to optimize solar energy utilization by designing and developing an automatic microcontroller-based solar tracker with a hybrid algorithm that can precisely locate the sun's position. Experiments were carried out to assess the performance of the proposed solar tracker in the local climate. A webpage was also created to help with the timely monitoring of solar data. [3]

Figure 1 Single Axis Solar Tracking system

The Dual Axis Solar Tracking System has two axes of rotation, allowing it to always track the movement of sunlight, and it is primarily intended for use outside of the tropical region, beyond latitudes of 10°N and 10°S from the

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Equator [4]. This system consists of two actuators, each with a motor that rotates the panel in response to a voltage control signal received from four LDRs located on all four corners of the solar panel. A dual-axis

solar tracking system's mechanism is more complex, and its overall cost is higher than that of a single-axis solar tracking system. When the solar panel receives maximum irradiation, the voltage drops across the four LDRs are equal, and the panel stops moving. This system allows the solar panel to face perpendicular to the sun for the majority of the time. [5]

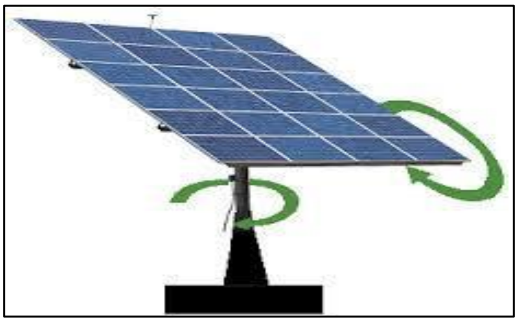


Figure 2 Dual Axis Solar Tracking system

II. REVIEW OF LITERATURE

Horizontal single-axis tracked solar panels were investigated by Guiha Li, Runsheng Tang, and Hao Zhong [6]. They discovered that tracking the sun about south-north was the best way to improve energy while tracking the sun about east-west was the worst. The east-west axis efficiency increased by less than 8%, while the south-north axis efficiency increased by 10-24%.

Chaiko and Rizk [7] created an efficient tracking system using solar panels. They created a simple one-axis tracking system with a stepper motor and a light sensor. They discovered that by keeping a solar panel perpendicular to the sun's rays, this system increases the efficiency of power collection. They also discovered that the power gain was increased by 30% when compared to a static PV system.

Ashwin R, Varun A.K, and colleagues [8] presented a sensor-based single axis solar tracker for maximizing energy output from a solar panel. It continuously tracks for the maximum amount of light. When the sun moves, this system automatically changes its direction to capture the most light energy. As a result, the experimental result demonstrates the robustness and productivity of the proposed method.

Gamal M DOSOUKY, Abou-Hashema, and colleagues [9] presented an improved orientation design for increased energy productivity in PV panels. The panels are pitched with a monthly-based angle to maximize incident radiation. They investigate the proposed strategy in two cities: Fukuoka, Japan, and Cairo, Egypt (AI-Kharijah). The findings revealed that the proposed design resulted in an increase in energy building in both cities.

Sundara V Siva Kumar and S Suryanarayana [10] proposed a dual axis tracking system for implementing and developing a simple and efficient control scheme using a single tracking motor. Their main goal is to increase power gain by accurately tracking the sun. They successfully designed, built, and tested a dual axis sun tracking system in this paper and received the best results. They concluded that this tracking technology is simple in design, precise in tracking, and affordable.

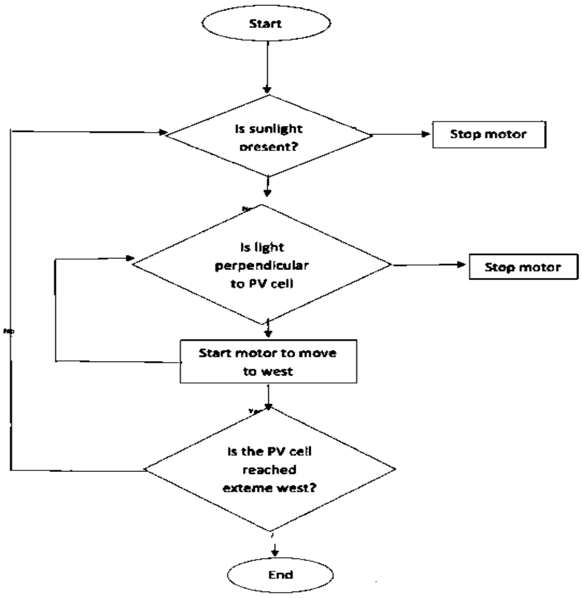
M.Kacira [11] overlooked the cause of a dual axis solar tracking with power energy development versus a fixed PV panel in Sanliurfa, Turkey. They discovered that for a specific day in July, the daily power gain is 29.3% in solar radiation and 34.6% in power generation.

S.B. Elagib and N.H. Osman [12] describe the development of a solar tracking system based on solar maps that uses a microcontroller to forecast the real detectable position of the sun based on latitude location for maximize the energy efficiency. The main goal of this design was to work with minimal operator interaction in remote areas where network coverage is limited.

III. OBJECTIVES

The goal of this research is to provide a constant rotational speed to a rotatable platform carrying a solar device, in this case a domestic solar oven. It entails the design, development, and testing of a simple all hydraulic/mechanical solar tracking system as an alternative to expensive electrical or electronic control systems for use in homes or small communities. The research studies intend to develop an affordable, effective, and convenient sun tracker for small solar thermal energy devices in order to promote their large-scale applications, including among the poorer sections of society, in order to improve energy and environmental conservation. Another goal of this work is to apply the proposed one axis hydro mechanical tracker to a solar cooker, which is an example of a small solar device.

IV. RESEARCH METHODOLOGY



A solar cell is an electronic device that converts light energy into electrical energy. Because a single solar cell produces a small amount of energy (around.6 volts DC), they are typically assembled together in a coordinated electrical

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board known as a sun based board. Daylight is made up of bundles of subatomic particles known as photons. When photons strike the semi-conductor layer (typically silicon) of a solar cell, a portion of the photons are retained rather than reflected. When a photon is consumed, its vitality is exchanged to an electron in a small amount to the cell, causing the electron to escape from its normal position. This creates a void in the molecule. This opening attracts an alternate electron from a nearby particle, converting it to an alternate, which is then filled by an electron from an alternate molecule. The issue with solar energy is that the panel's output is variable. These solar systems are intended to extract as much power as possible from the solar panels and store it in the battery. After the sun goes down, these controllers prevent the panels from discharging. The solar panels used to convert solar energy into electrons are available in a variety of volts; a solar panel battery charger ranges from 2watt to 30watt.

V. RESULT AND DISCUSSION

The Effects of Weather on Solar Tracking System Performances

Sunlight emits two kinds of radiation: beam radiation and diffuse radiation. Beam radiation is the solar radiation received by the Earth's surface that does not change direction, whereas diffuse radiation is the solar radiation received by the Earth's surface that has been reflected and scattered by the atmosphere. As a result, the weather condition is an important factor that can affect the performance of the solar panel, as clouds easily block the sun's rays, resulting in no beam radiation falling on the solar panel [14].

Lee et al. [14] conducted an outdoor experiment using a low-cost solar tracker to compare the performance of a static solar panel and a solar tracking system in terms of solar irradiance and energy gain over the course of one month. The solar panel's efficiency and energy gained were measured on cloudy and sunny days. The efficiency and energy gained by solar panels on different days are shown in Table 1. According to the findings, efficiency on sunny days increased from 24.91% on a cloudy day to 82.12% on a sunny day, while energy generated increased from 0.108 kWhr/m^2 on a cloudy day to 0.603 kWhr/m^2 on a sunny day. The efficiency and energy generated by the solar panel are influenced by the day's weather.

Table 1 shows the efficiency and energy generated for various weather conditions.

Weather Condition	Efficiency,	Energy Generated (kW m^2)
Cloudy	24.91	0.108
Suuny	195.4	0.603

Figure 3 depicts the six-day average voltage readings for active and chronological algorithms. On cloudy days or when the active output voltage is less than 11 V, the chronological algorithm outperforms the active algorithm. In contrast, the active algorithm can achieve high accuracy on sunny days but not on cloudy days, possibly due to low LDR sensitivity.

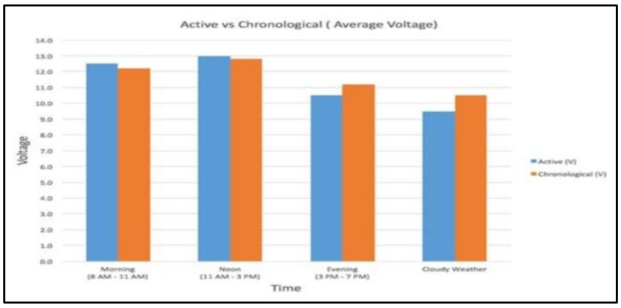

Figure 3: Average voltage readings for active and chronological algorithms.

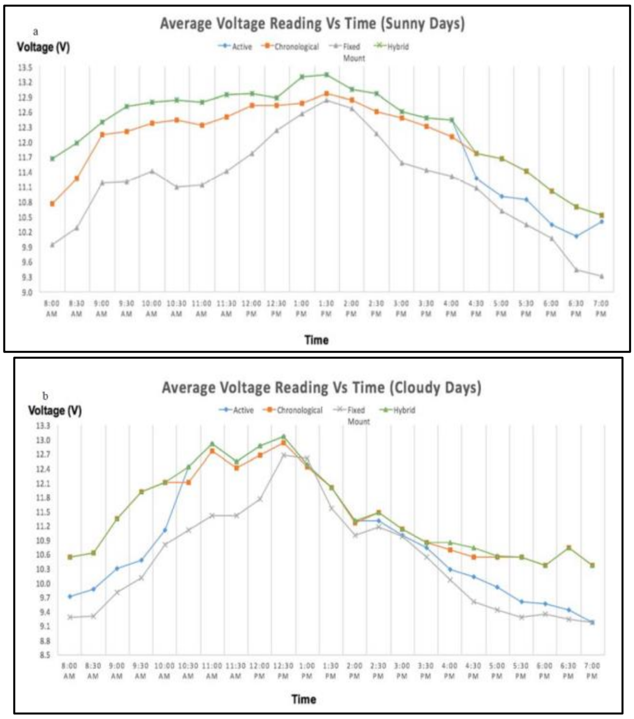

Figure 4: (a) Average voltage readings on sunny days; (b) Average voltage readings on cloudy days.

Figures 4(a) and 4(b) show the average voltage readings for various solar tracking algorithms on sunny and cloudy days, respectively. On cloudy days, the hybrid algorithm consistently produces the highest voltage increment of up to 14%, and on sunny days, it produces the highest voltage increment of up to 13%. The percentage of increased voltage for active, chronological, and hybrid algorithms in comparison to a stationary solar panel is summarised in Table 1. [15]

VI. CONCLUSION

This paper reviews previous work on the simulation and experimental analysis of solar tracking systems, including single-axis and dual-axis systems. These researchers compared and evaluated the performance of solar tracking systems versus static solar panels systems, as well as different solar tracking system mechanisms, and they all agreed that solar tracking systems perform significantly better than static solar panels. In conclusion, with large-scale implementation, the proposed hybrid solar tracker can harness optimal solar energy for all weather conditions, significantly reducing carbon emissions and electricity costs for public and private organizations.

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