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TIME AND INTENSITY BASED SOLAR TRACKER USING ARDUINO WITH SERVO MOTORS

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ABSTRACT

Our project aims to enhance the efficiency of solar panels by utilizing a solar tracker that increases efficiency by 10-15% compared to standard solar panels. This model proposes a dual approach, incorporating both sunlight intensity tracking and time-based adjustments. The system employs Light Dependent Resistors (LDRs) to monitor the intensity of sunlight, allowing the solar panel to adjust its position accordingly. Additionally, the panel can be manually adjusted to a specific angle based on the time of day, enhancing its ability to capture maximum sunlight. The proposed methodology involves using two LDR sensors to track sunlight intensity and a time-based mechanism to control the panel's orientation. For example, by setting a timer to 30 seconds, the panel can rotate by 0.5 degrees, enabling manual adjustments. Servo motors are utilized to control the horizontal and vertical movements of the solar panel, ensuring precise positioning. A pre-set time-based algorithm directs the servo motors, combining time-based and intensity-based tracking to provide a robust solution that addresses the limitations of using either method alone. This hybrid approach optimizes the solar power generation compared to conventional panels.[1]

Keywords: Solar Tracker, Efficiency Enhancement, Sunlight Intensity Tracking, Time-Based Adjustments, Light Dependent Resistors (Ldrs), Servo Motors, Solar Panel Orientation, Power Generation, Hybrid Approach, Time-Based Algorithm.

I. INTRODUCTION

The effective utilization of solar energy is very important to ensure the renewable energy sources are used to the maximum extent. The usual solar panel statics are fixed and cannot catch the sun's energy optimally all day long as the sun changes the position. The "Time and Intensity Based Solar Tracker Using Arduino with Servo Motors. The project includes the integration of time-based and intensity-based tracking mechanisms. Time-based tracking is made possible through the Arduino microcontroller, which is programmed with an algorithm that predicts the sun's trajectory according to time and place. The light-dependent resistors (LDRs) used for the intensity-based tracking measure the sunlight intensity in real time and provide the panel with proper adjustments to its position.

Solar energy is one of the most efficient and sustainable sources of renewable energy. However, maximizing solar panel efficiency requires optimal alignment with the sun throughout the day. A time and intensity-based solar tracker using Arduino with a servo motor aims to address this challenge by automatically adjusting the solar panel's orientation based on both the time.

This project demonstrates a practical and innovative application of microcontrollers in renewable energy systems, providing a significant boost to solar power output. This system contributes to maximizing solar power output, making it a practical, cost-effective approach to renewable energy generation. This system contributes to maximizing solar power output, making it a practical, cost-effective approach to renewable energy generation.

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II. LITERATURE REVIEW

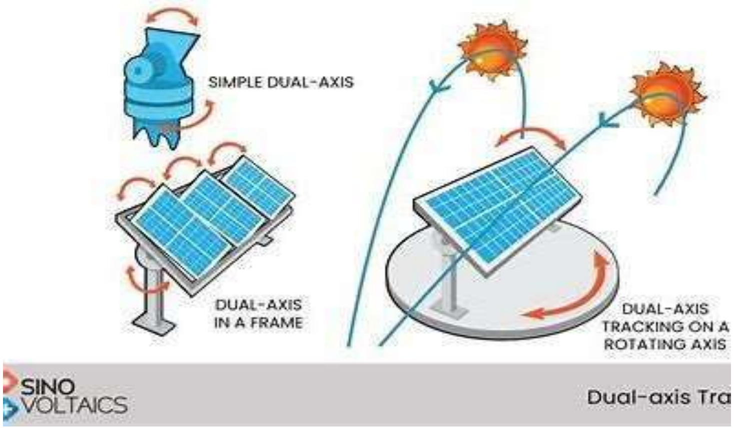

Fig 1: Dual axis Solar Panel

As solar power production is used in large scale worldwide so, even an increment in efficiency by 1% than stationery plane will increase the net power production by large amount. Hence, no matter by how much tracker increases efficiency it is always welcome.

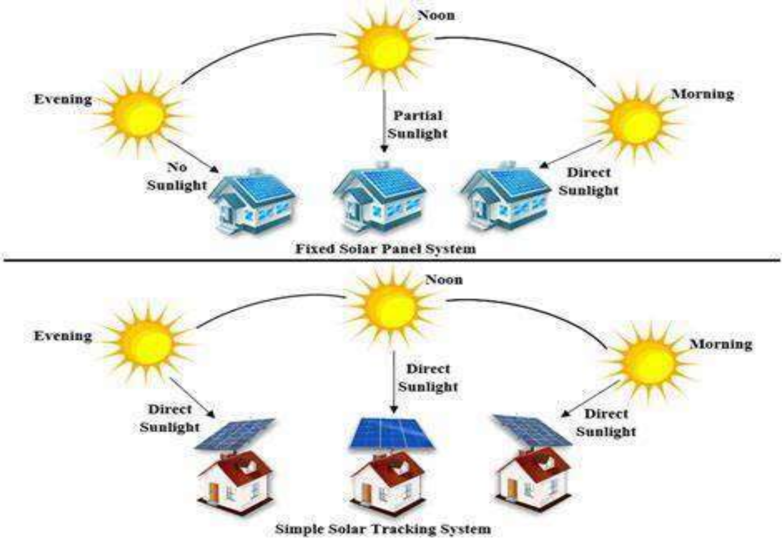

Fig 2: Time Bas Solar Photovoltaic Tracking

Time-based solar photovoltaic (PV) tracking systems are designed to enhance the energy absorption efficiency of solar panels by optimizing their orientation relative to the sun throughout the day. Here's an overview of how these systems work and their benefits:

Fig 3: Future based solar panels

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Renewable power generation by significantly imp this research work is to design and develop an IoT-based automated solar panel cleaning and real-time monitoring system using a microcontroller to improve the output and efficiency of a solar module.

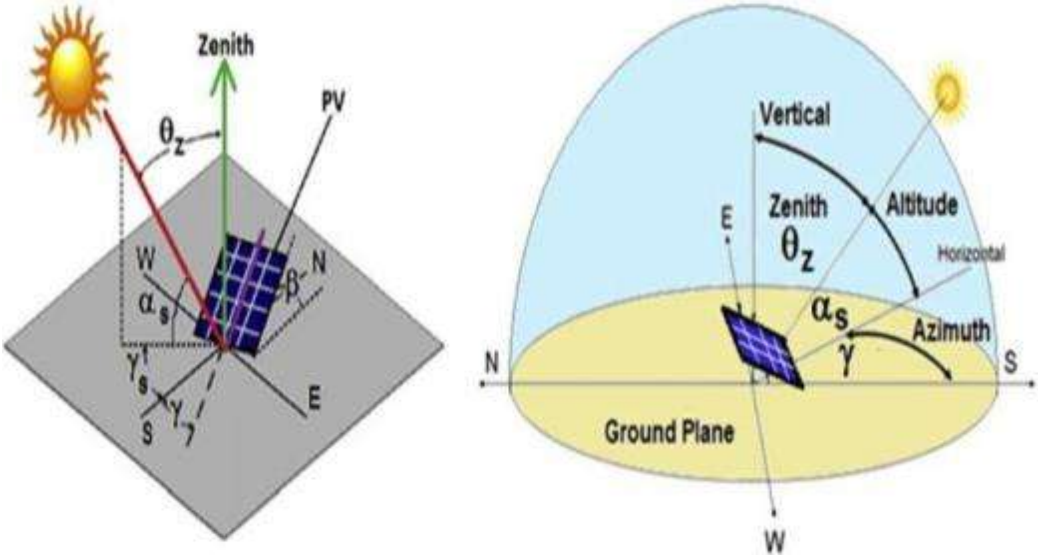

Fig 4: Future SOLAR TRACKING SYSTEMS

- Passive solar trackers have capability to orient their sensing units towards the direction of the solar
- Radiation beam without using any mechanical drives.
- Passive solar trackers have capability to orient their sensing units towards the direction of the solar radiation beam without using any mechanical drive[3]

III. PROPOSED SYSTEM

SOLAR TRACKER BASED ON TIME AND INTENSITY USING ARDUINO AND SERVO MOTORS

Our goals are to develop an efficient solar panel that will boost production and a tracking solar panel that will track the sun's movement throughout the day. The suggested model uses two strategies: time-based modifications and tracking of sunshine intensity.

1. **Tracking Sunlight Intensity:**

LDRs, or light-dependent resistors, are incorporated into the system to measure solar light levels. By using these sensors, the solar panel is able to "move" and "dance" with the sun as it moves across the sky in order to "catch" as much solar energy as possible. The panel is always in the ideal position with the sun's rays because two LDR sensors are positioned in two distinct positions to monitor the sun's intensity.2. Time-Based Adjustments:

2. Monitoring intensity is not the only way that the system may be adjusted. Depending on the time of day, the solar panel can also be angled at fixed angles. Consequently, the panel can move by 0.5 degrees, for instance, if we set the timer for 30 seconds. This time-based control works best when the sun is not shining or when only minor adjustments are needed.
3. **Servo Motor Control:** The solar panel's horizontal and vertical movements are controlled by servo motors. With the help of these motors, exact alignment is ensured, allowing the panel to precisely adapt in response to the time-based algorithm and the input from the LDR sensors.
4. **Pre-Set Time-Based Algorithm**

The Pre-Set Time-Based Algorithm is a feature of the system that combines time-based and intensity-based tracking. It is in charge of managing the servo motors.

This algorithm works in tandem with the intensity-based tracking system to ensure that the solar panel is consistently positioned for maximum sunlight exposure. [4]

Fig 5: Demonstration Image

The above image is the demonstration of time and intensity based solar tracker, which helps for the producing electrical energy efficiently schedule that reflects the sun's position throughout the day. Here's a quick rundown: Fixed Schedule: The tracker estimates the sun's position using preset algorithms or schedules dependent on the day and time of day. This usually entails figuring out the best angle for the solar panels using the time, latitude, and longitude of the installation site

Fig 6: Time-based solar tracker

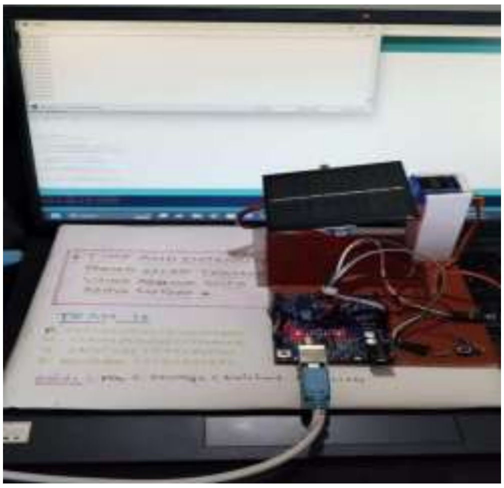

Fig 7: Intensity-based solar tracker

Solar panel positions are modified by an intensity-based solar tracker using current sunshine intensity observations. Here's a quick rundown:

Adjustment in real time: In contrast to time-based trackers, intensity-based trackers utilize sensors to determine how much sunshine is actually reaching the panels at any given time. Based on these readings, the tracker then modifies the panel position to maximize sun exposure.[5]

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Block Diagram:

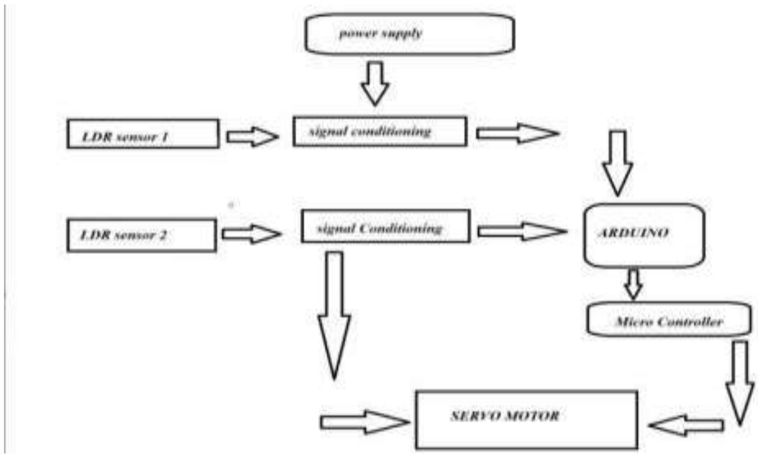

Fig 8: Block Diagram

Power Supply: Gives the system the electrical power it needs.

LDR Sensors 1 and 2 are light-dependent resistors, meaning that their resistance varies in response to the amount of light that strikes them. They're employed for light intensity detection.

Signal conditioning is the step that prepares the signals coming from the LDR sensors for the Arduino to receive them. Filtering, amplification, and analog-to-digital conversion are some examples of this.

The system's main control unit is the Arduino microcontroller. After processing the conditioned signals from the LDR sensors, it applies the preprogrammed logic to make judgments.

Servo Motor: The system's output actuator, which the Arduino regulates using data from the LDR sensors. It shifts or modifies based on the processed signalsThe flow can be summarized as follows:

The power supply energizes the entire system. The LDR sensors detect light intensity and send analog signals to the signal conditioning circuits. The conditioned signals are sent to the Arduino, which processes them.[6]

IV. RESULT AND DISCUSSION

The implementation of time and intensity-based sun tracking systems for solar panels led to a significant increase in energy yield compared to fixed-angle panels, capturing more sunlight throughout the day. This dynamic adjustment also improved efficiency across different seasons by adapting to changes in the sun's path, ensuring optimal energy capture year-round. The system demonstrated robust performance under varying weather conditions, including cloudy days, by maintaining higher energy output through real- time sunlight intensity adjustments. Environmentally, it contributed to reducing carbon emissions and promoting sustainable energy practices. Operationally, the system required minimal maintenance, with technological advancements reducing upkeep needs. Future research should focus on optimizing tracking algorithms, enhancing durability, and lowering installation costs to further improve efficiency and affordability.[7]

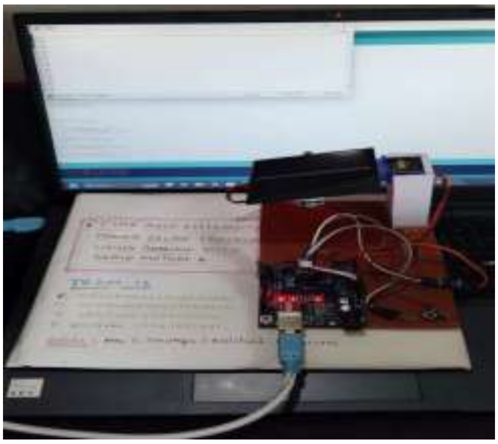

Fig 9: Final execution image

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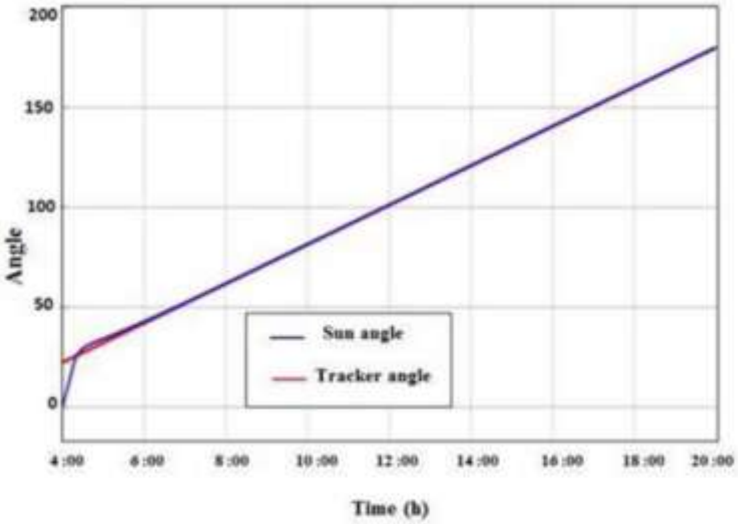
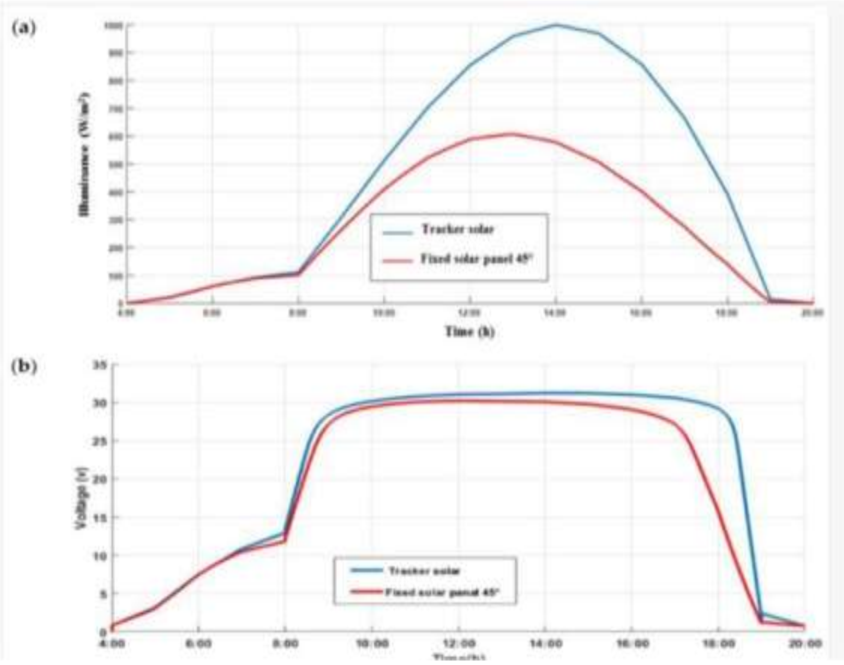
Graphs:



Above shows that the solar tracker device maximizes the sun's irradiance by keeping the solar module's active surface vertical at the sun's angle. From noon until sunset, we find that the fixed panel loses a large amount of solar radiation during the day.

Values of (a) solar radiation, (b) voltage, (c) current, and (d) power produced by a PV panel bound with a solar tracker compared to a fixed PV panel.



Graph (a): Illuminance (W/m^2) vs. Time (h)

The blue line represents the illuminance on the tracker solar panel, which peaks higher and remains elevated for a longer period compared to the fixed solar panel (red line).[8]

Graph (b): Voltage (V) vs. Time (h)

The blue line shows the voltage output of the tracker solar panel, which is higher and more consistent throughout the day than the fixed solar panel (red line).

The tracker solar panel maintains a higher voltage output for a longer period, indicating energy[9]

Current (Graph c):

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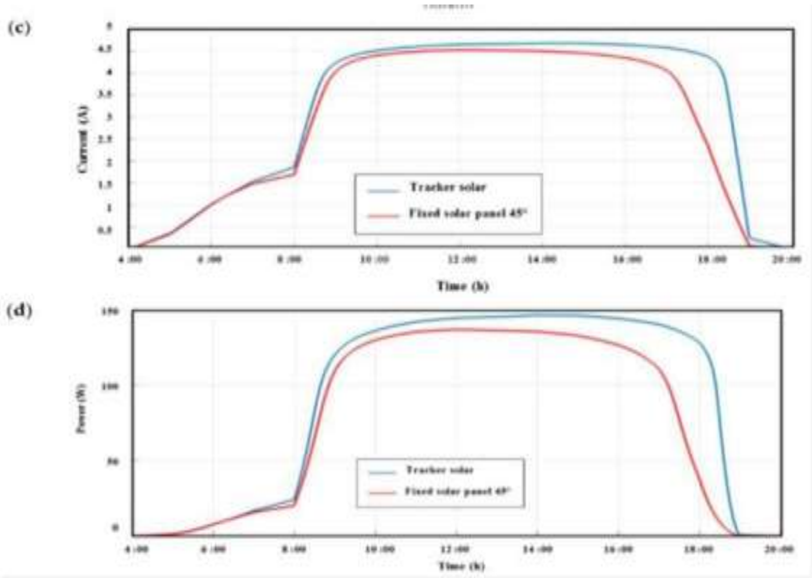

The x-axis represents time (from 4:00 to 20:00 hours).

The y-axis represents current (in Amperes).

The blue line represents the current output of the tracker solar panel.

The red line represents the current output of the fixed solar panel.

The tracker solar panel consistently generates more current throughout the day compared to the fixed solar panel, especially during the peak sunlight hours.

Power (Graph d): In the image shows a comparison of power output (in watts) over time (in hours) between two types of solar panel setups:

1. **Tracker Solar (Blue Line)**: This line represents the power output of a solar panel equipped with a tracking system that adjusts its angle to follow the sun's path throughout the day.
2. **Fixed Solar Panel at 45° (Red Line)**: This line represents the power output of a solar panel fixed at a 45-degree angle.

V. CONCLUSION

Our dual-method solar tracker marks a significant advance in boosting solar energy output. By merging sunlight intensity tracking with time- based adjustments, our system makes sure solar panels catch the most sunlight at all times. Light Dependent Resistors (LDRs) allow the panels to adapt on the spot to sun brightness guaranteeing they stay in the ideal position. Time-based tweaks let us angle the panels according to the hour, which proves valuable in various light settings.

The combination of these two approaches helps us beat the drawbacks of relying on just one. This strategy boosts solar panel efficiency by 10-15% when compared to stationary panels. The setup also employs servo motors for exact movements and a preset algorithm to keep performance at its peak.

On the whole, our solar tracker blends intelligent tech with hands-on engineering to boost the output and dependability of solar panels aiding in the creation of more green energy.

By integrating these two approaches, we overcome the limitations of relying on a single tracking method. This combined strategy increases solar panel efficiency by 10-15% compared to fixed, stationary panels. The system employs servo motors to ensure precise and smooth movements, while a pre-set algorithm optimizes panel positioning, ensuring that the system is always working at peak performance.

Overall, our solar tracker merges intelligent sensor technology with practical engineering to create a reliable and efficient solution for boosting solar energy output. This not only enhances solar panel performance but also contributes to the broader goal of green energy production, making renewable solar power more accessible and effective for a sustainable future.

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