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Solar Tracking System based on Arduino for improving the efficiency of photovoltaic solar panels

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Abstract - Nature provides a plethora of clean, easily accessible, and plentiful sources of alternative energy in the form of solar power. It's helpful to produce power using solar energy. In Nigeria, a constant power output is produced between 12 pm and 2 pm due to the constant movement of the sun in the sky. The need of establishing a solar tracking system to improve PV solar panel energy efficiency can't be over emphasised. The most power is produced when panels face the sun directly. A Solar Tracking System That Uses an Arduino Has Been Implemented Using This Work's Methodology. A photovoltaic panel (PV) adjusts its position depending on the light intensity sensed by Light Dependent Resistors (LDRs). A servo motor controls the movement of the solar panel in the device. The servo motor is being controlled by the microcontroller, which is interpreting signals sent by the LDRs. The conclusion is that tracking panels generate more energy than stationary panels.

Keywords - tracking, microcontrollers, and solar energy

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GENERAL PROLOGUE

Nigeria lies in the sunny tropical zone with 6.25 hours of sunlight per day. The country's location puts it among the group of 4°-13° (degrees) countries that receive everyday sunshine. Currently, 40% of Nigerian homes have access to public power, although that access is not constant. To compensate for inconsistent electrical supplies in Nigeria, residents have begun cultivating their own sources of power. Electricity produced with fossil fuels has grown expensive, causing the cost of living to rise greatly in rural areas. Fuel combustion has caused pollution, and this, in turn, isn't healthy for humans. Carbon dioxide is released, causing the greenhouse effect. This results in the clear cutting of forests and contamination of the water and air. Because it only derives from the sun, solar energy does not release carbon dioxide, which helps reduce the risk of the green-house effect. Nigeria's expansion of solar energy has the potential to produce employment. People who work in the renewable energy industry are less likely to face occupational dangers, as this industry employs fewer people than coal mining and oil extraction.

Scanlon (2012) conducted research of 40% more solar electricity could be generated by utilising the dual axis tracking method in comparison to a single axis solar tracker. Because of their ability to follow the Sun light vertically and horizontally, the tracking system with dual axis are able to take advantage of a solar panel's energy capabilities and deliver more power, compared to single axis solar trackers. Previous study has been performed using single axis solar trackers, which leads to solar energy being squandered and not precisely tracking the sunshine to produce the most amount of electricity. The energy efficiency of the dual-axis tracking system **Catarius (2010)** rise 36.504% in one year over the previous model. According to **Tudorache et al. (2012),** who used a bi-directional DC motor to turn a rotating panel so that the direction of the motor could be controlled using light intensity sensors, a single-axis design, which is dependent on solar light for operation, was developed to track the position of the sun. The two LDRs (one on each side of the solar panel, on opposite sides of a black card box) comprise the light sensors. The one LDR will be under darkness, and the other will be lighted based on the sun's strength.

Ghassoul (2018) has already come to the conclusion that the strategy helps to improve solar energy extraction. By examining comparisons and how extraction can be 40% better than standard installations.Awasthi et al. (2020) highlighted the most current developments in solar tracking systems worldwide, which stress the recent breakthroughs in the use of dual axis sun tracking systems with varied designs and approaches. The voltage, electrical current, power and performance of the solar tracking system were compared to that of Manosroi (2020), employing two and four-sided flat-panel mirror reflectors with angles of 90◦, 120◦, and 150◦ between solar panel and flat-Panel reflectors. Ghassoul (2021) notes that single axis tracking is almost universally preferred over stationary panels. But dual axes tracking is better than single axis tracking or a fixed unit.

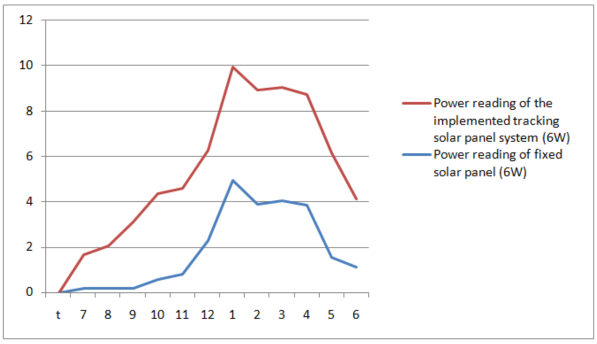
METHODOLOGY

The sensors used in the solar tracking system are composed of a solar panel, microprocessor, and various other devices. This system needs the sun to emit light to function. The LDRs function as the sensors for the solar panels, detecting how much light is coming in. Then, the LDR communicates with the Arduino microcontroller, which in turn transmits data. After that, the servo motor circuit is built. The servo is connected to the microcontroller via a positive connection to the 5V line. The servo's ground wire is attached to the negative. The servo's data wire is attached to the microcontroller's analogue pin. A potentiometer is linked to the servo motor to regulate its speed.

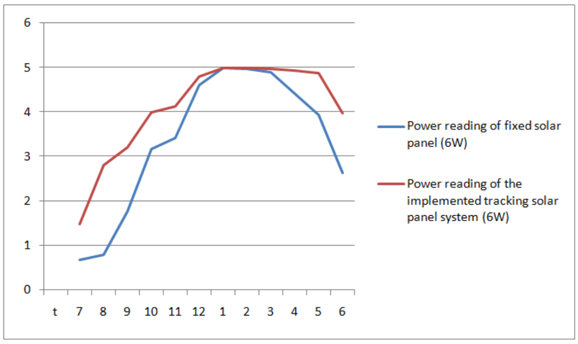
The simulation of this solar panel tracking system was carried out using Proteus software. The system was tested using a simulation to see if it would meet our expectations. Simulation reveals all of the system's components and interconnections. Figure 3 depicts the simulation carried conducted, which was a success. We then tested and compared fixed solar panels and the new tracking ones. We had an identical 6W solar panel constructed from the same material and from the same company.

RESULTS ANALYSIS

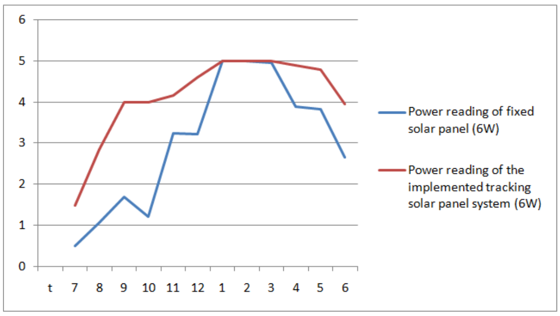
The power readings of the fixed solar panel and the tracking solar panel that was installed were taken hourly for three days in the year 2021 and recorded as shown in graphs 1, 2, and 3 of the following pages. The results obtained on different days demonstrate the difference in efficiency between the fixed solar panel and the solar tracker that was deployed. On the basis of the graphs above, it can be concluded that the most sunshine is received around midday, with the highest values occurring between 1200 and 1500 hours. The intensity of sunlight diminishes in the early morning and late evening, and the values obtained are lower than those obtained during the day. The tracking system is turned off after sundown in order to conserve energy. The device is then turned back on in the morning to continue tracking the information collected. When the numbers are the same, the panel's motion is stopped, indicating that the LDRs are receiving the same amount of solar radiation.



Graph 1: 23rd of March, 2021, power readings for an overcast morning and a sunny afternoon.



Graph 2: A bright and sunny day on March 24, 2021, with high power measurements



Graph 3: Power readings for a bright and sunny day on the 25th of March in 2021.

CLOSING COMMENTS

A tracking system for solar panels was created and put into action. The experimental results demonstrate that the goal of the solar panel tracking system is to follow the position of the sun in order to improve the efficiency of the solar panel. Developing countries such as Nigeria and Sub-Saharan African countries will benefit from the completion of this work on an industrial scale. Our advice for future work is to take into consideration the use of more sensitive and efficient sensors that consume less power and are also more cost-effective to produce. When combined with cost savings, this would boost efficiency.

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