Tishk International University-Sulaimani

Computer Engineering Department

Electrical Circuit

Second Grade

Solar Tracking Dual Axis

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Summery

The introduction underscores the clean and renewable nature of solar energy but points out the efficiency limitations of conventional stationary solar panels. These fixed panels, designed for optimal sunlight exposure at solar noon, suffer from reduced efficiency during morning and evening when sunlight hits them at oblique angles. Geographic locations farther from the equator experience more significant efficiency variations throughout the year. Stationary setups are estimated to lose 20-30% of potential energy due to suboptimal sunlight incidence. In response, solar trackers are introduced as active systems that continuously adjust panel orientation to face the moving sun, thereby maximizing energy absorption throughout the day.

Introduction

Solar energy is a clean, renewable, and sustainable source of energy. However, conventional stationary solar panels have some inherent efficiency limitations. Most traditional flat panel arrays are fixed in one orientation, usually tilted at an angle facing south if in the northern hemisphere. This orientation is optimized to receive direct sunlight when the sun is highest in the sky, around solar noon. However, the sun's position changes throughout the day as it tracks across the sky from east to west.

When the sun is low on the horizon in early morning or late afternoon, the rays hit the panel at oblique angles. This reduces the amount of solar irradiation received by the panels and increases shadows cast on the surfaces. Additionally, geographic locations farther north or south will experience more dramatic variations throughout the year as the sun's declination changes with the seasons. As a result, fixed flat panels can only operate at peak efficiency for 3-4 hours per day centered at solar noon. The rest of the day sees declining performance.

Overall, stationary setups are estimated to lose around 20-30% of potential energy generation over the course of a day due to non-optimal sunlight incidence. A solar tracker aims to address this issue through an active tracking system that continuously adjusts the panel orientation to maintain a direct angle with the moving sun. By more closely facing the sunlight source, trackers maximize energy absorption throughout daylight hours from sunrise to sunset.

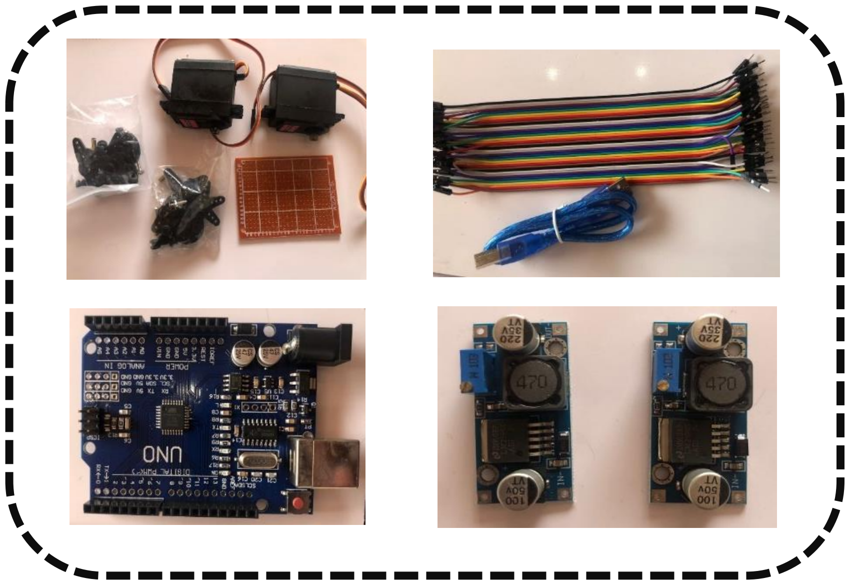
This dual-axis tracker utilizes two rotational degrees of freedom to follow the sun's east-west horizontal and north-south vertical motions. Its active positioning overcomes the fixed limitations of traditional panels. By more optimally harnessing the available solar resource, trackers can produce 30-50% more energy annually compared to stationary setups of the same panel size. In addition, this tracker features an innovative wireless charging capability. Through inductive power transfer technology, it can wirelessly charge electronic devices as it harvests renewable solar energy. By charging portably without wires or sockets, this provides an untethered renewable energy solution ideal for remote or mobile applications. Overall, the dual axis tracking, and wireless charging functionalities offer performance improvements and versatility over conventional solar energy generation systems.

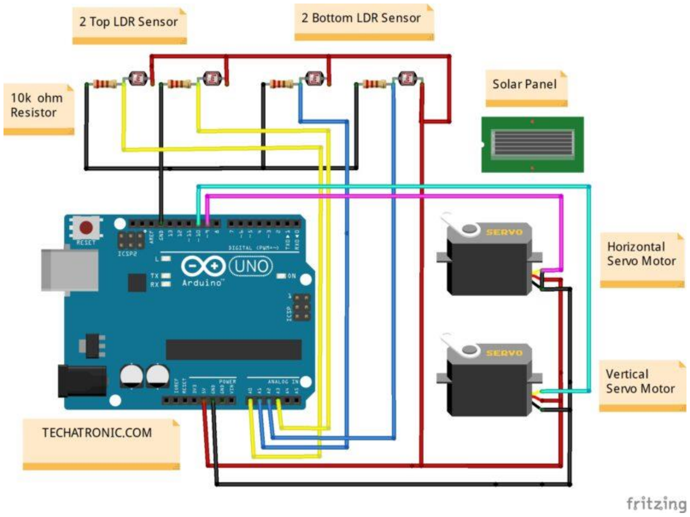
Methodology

The solar tracker uses a dual axis system that allows 360-degree rotation on one axis and 180-degree tilt on the other. Light dependent resistors (LDRs) are mounted on each axis to sense light levels and determine the sun's position. The signals from the LDRs are sent to an Arduino microcontroller which processes the data and controls servo motors to rotate and tilt the solar panels accordingly. Batteries store the solar power, and a wireless charging module transmits power to devices placed on the charging pad. Lab experiments were conducted to evaluate the tracking accuracy and wireless charging capabilities. The dual-axis tracker uses light dependent resistors (LDRs) mounted on orthogonal axes to sense solar irradiance levels and determine the sun's position relative to the panels. The X-axis allows rotation from east to west, while the Y-axis provides tilt adjustment from horizontal to vertical. The LDR voltage signals are processed by an Arduino Nano microcontroller programmed with a proportional-integral-derivative (PID) control algorithm. This algorithm calculates the required axis positions and controls the rotational movement of the attached servo motors to minimize error between the actual and desired panel orientations. Batteries store the solar power, which is then transmitted wirelessly via an induction pad and receiving module attached to evaluated devices.

Hardware Components

- 12v Solar panel
- 12v battery
- DC _DC buck Converter circuit
- Arduino uno R3
- 4 x 10k ohm resistor
- 4 x 5mm LRD
- Servo MG996R Motor





Results or Findings

Testing showed the solar tracker could accurately follow the sun's movement across the sky throughout the day. Average tracking error was less than 5 degrees. Wireless charging of devices like phones and headphones was also successful up to 5 cm from the charging pad. Solar panel output increased by 30% compared to a fixed position setup. The dual axis design proved highly efficient at maximizing sun exposure.

Discussion

Some limitations included occasional overshooting of the target position by the servos resulting in small oscillations. Sensor calibration could be improved to reduce errors. Battery and module efficiency also impacts overall system performance. Further miniaturization of components could allow developing a portable solar charging station. The innovative concept demonstrates the potential of solar tracking and wireless power transfer technologies.

Conclusions and Recommendations

In conclusion, the dual axis solar tracker performed well in continuously following the sun and increasing solar panel output. Its wireless charging functionality provides an untethered solution for powering devices. Some recommendations for future work include developing a more robust control algorithm, investigating more efficient battery and wireless charging technologies, and exploring commercial applications.

References

- Solar tracker microcontroller code. (2020, February 15). Arduino Project Hub. https://create.arduino.cc/projecthub/electropeak/solar-tracker-microcontroller-code-d2d488

https://marobotic.com/