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IoT Based Solar Tracking and Monitoring System

Yousha Hussain[1], Ratnakar Tripathi[2], Satya Prakash Singh[3]

UG[1,2], Assistant Professor[3]

Department of Electronics and Communication Engineering

United College of Engineering & Research, Prayagraj, India.

Abstract: In today's era, our life is dependent on energy. The development of the Nation is somehow associated with the availability of energy. So, the use of renewable energy is the only way to fulfil the demands of people. Solar energy is the most eminent and renewable & cleanest source of energy. It can easily be harnessed with the help of solar photovoltaic (PV) panels. But, most of the solar panels are positioned at fixed angles. To maximize the amount of solar radiation collected by a solar panel, we use a solar tracking device whose function is to follow the sun orthogonally throughout the day. This project is based on the tracking of the sun with the help of light dependent resistor (LDR). The tracking mechanism of the sun requires LDR as a sensor to sense the maximum light availability & two DC servo motor for two-axis movement (i.e., vertical and horizontal) to direct the position of the solar panel. The software part is done with the help of written code using a Node MCU (ESP8266) Wi-Fi Development Board controller. This paper proposed a model of a dual-axis solar tracker with minimum complexities & more feasible in terms of cost and operation.

Index Terms: **Dual Axis, Solar Tracker, IOT, WIFI ESP8266, BH1750 Light sensor.**

I. Introduction

In the present scenario dependency on energy is increasing day by day, which leads to an increase in demand for energy resources mainly fossil fuels (coal, oil, and gas). The crisis of energy and environmental degradation are the main causes of increasing concern. The key solution to these problems is the utilization of sustainable and renewable energy sources. One of the everlasting renewable sources of energy is Solar Energy with no damage to the environment. The power received by the earth through the sun is nearly a thousand times greater than the current power consumption from all sources.

A solar tracker is a device for orienting a solar photovoltaic panel, day lighting reflector, or concentrating solar reflector or lens toward the sun. Solar power generation works best when pointed directly at the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position. As compared to fixed-position PV panels, a movable PV panel is better result oriented as it gains maximum solar energy. The conversion of solar energy into electrical energy takes place by photovoltaic (PV) cells using photovoltaic effects. The solar panels must be perpendicular to the sun's rays for maximum energy generation. Deviating from this optimum angle will decrease the efficiency of energy generation from the panels. A few degrees of misalignment will only cause 2% to 7% of energy loss, while larger angles of 15° to 20° will decrease the energy generation by up to 36% significantly. An active tracker uses motors to direct the panel toward the sun by relying on a sensing circuit to detect light intensity. In a dual-axis mount where one axis is a vertical pivot and the second axis is horizontal. By using a combination of the two axes, the panel can always be pointed directly at the sun. This method increases the output by approximately 36% compared to stationary panels. Despite solar energy being a good source of energy, it is needed to improve the methods to harness the energy. This can be achieved by using a dual solar tracking system that has two degrees of freedom that act as axes of rotation.

II. Overview

Before diving deep into the concept of what a dual-axis solar tracking system is., We will help you understand what solar trackers are & also their types. Solar tracker helps the panels track the solar energy and draw the maximum power

required to power up electronic appliances.

Generally, solar trackers are of two types: a single-axis tracker and a dual-axis solar tracker. Single-axis tracker tracks the sun's rays from east to west or north to south whereas Dual-axis solar tracker tracks the Sun from all directions: East to West as well as North to South. Besides, due to its movement in all directions, a dual-axis tracker is quite flexible. In terms of efficiency and precision, dual-axis trackers are better than single-axis solar trackers. But, at the same time, they are more expensive than the single-axis ones. Well, both models have their advantages and disadvantages. With solar tracking systems being the best option to collect more sunlight, a dual-axis solar tracking system is expected to dominate the market in the future due to its high energy output.

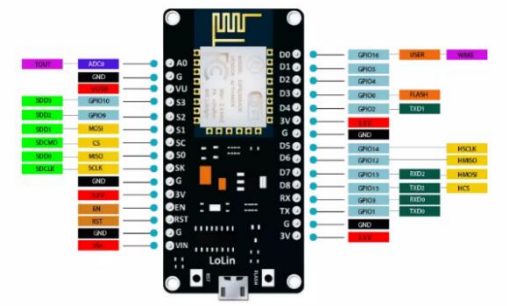
The main objective of this project is to absorb maximum sunlight by tracking the sun's position with the help of a dual-axis solar tracker and hence it increases the efficiency of the system.

III. Hardware Design

This section describes the entire electronics and hardware components that are part of the system and how they are interfaced.

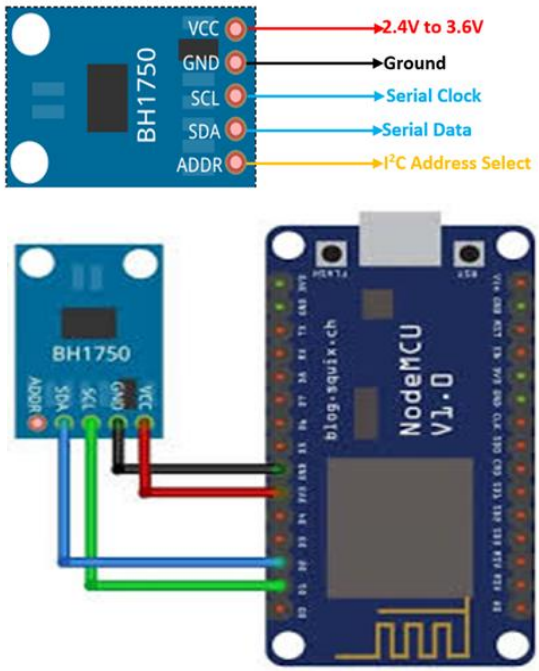
A. ESP8266 Wi-Fi Node MCU

ESP8266 offers a complete and self-contained Wi-Fi networking solution, which allows it to either host the application or offloading all Wi-Fi networking functions. When it is the only application processor in the device, it can boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements.



B. BH1750 Light Sensor

BH1750 is a digital ambient light sensor that is used commonly used in mobile phones to manipulate the screen brightness based on the environment lightning. This sensor can accurately measure the LUX value of light up to 6553lx.



C. SG90 Servo motor

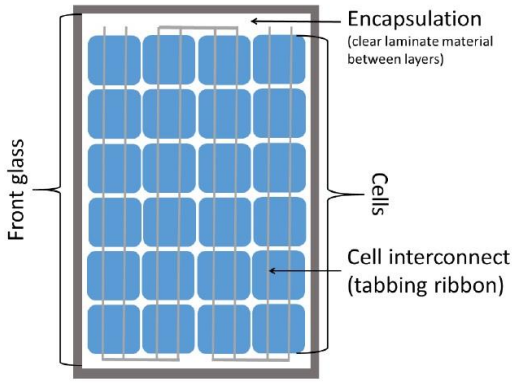
SG90 is a tiny, cheap servo motor that can rotate with great precision i.e., 180 degrees with a maximum torque of 1.8kg-cm. It consists of three parts :-

1: Controlled device 2: Output sensor 3: Feedback system

Interfacing hobby Servo motors like the S90 servo motor with MCU is very easy. Servos have three wires coming out of them. Out of which two will be used for Supply (positive and negative) and one will be used for the signal that is sent from the MCU. Servo motors are controlled by sending **PWM** signals.

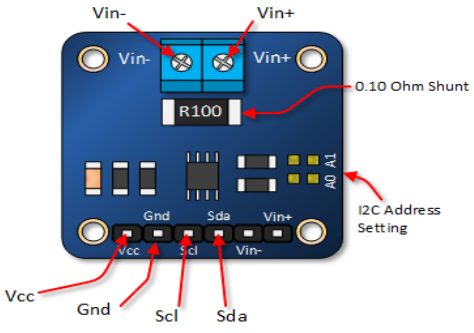
D. Solar Panel

Solar panels are comprised of many small photovoltaic cells. A solar cell is a device that converts light into electricity via a 'photovoltaic effect'. The PV cell is composed of semiconductor material. There are several different semiconductor materials used in PV cells. Silicon is, by far, the most common semiconductor material used in solar cells, representing approximately 95% of the modules sold today. When the semiconductor is exposed to light, it absorbs the light's energy and transfers it to negatively charged particles in the material called electrons. This extra energy allows the electrons to flow through the materials as an electrical current.



E. INA219 Current Sensor

The INA219 Current Sensor is a 12C supported interface-based zero drift and bi-directional current/power monitoring module. The INA219 Current Sensor can be easily used with Node-MCU to measure current, and power, and it can also sense shunt voltage.

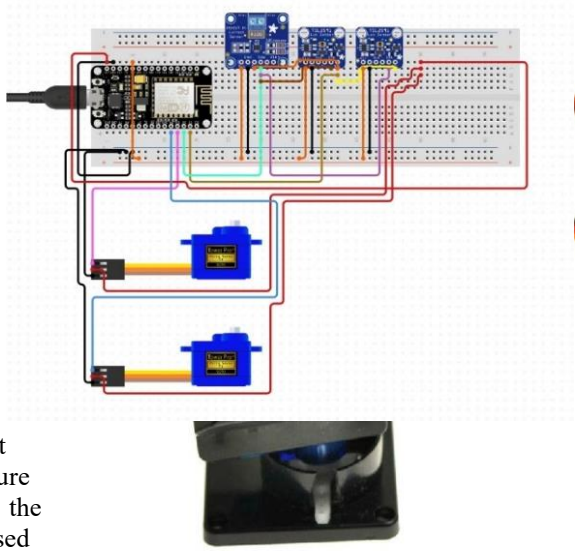


F. Servo Bracket Pan Tilt camera

These are 2 Axis Pan Tilt brackets for the camera/sensors for servo SG90 MG90 which is based on 2 axes pan and tilt mechanism for mounting wireless/ wired camera and sensors on robot assembly. Panning, rolling, and tilting is achieved by controlling Servo motors using PPM pulses.

IV. Circuit and Implementation

Fig.



Circuit Structure of the proposed project

The above figure shows the circuit diagram of the dual-axis solar tracking and monitoring system. This system is based upon IOT Technology to compensate for the existing tracking system and increase the efficiency of the system by proper tracking of the sun's position with the use of a dual-axis solar tracker.

In this technology, we get more power from solar energy and we upload data to the IoT cloud using ESP8266, we used the Blynk cloud to observe the various parameters as output in a graphical as well as numeric manner. The INA219 sensor is also used to measure the parameters like voltage, current, power, energy, etc. values of the solar plant.

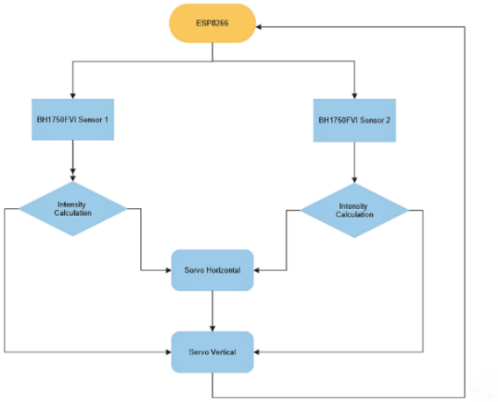
Solar power plants ought to be monitored for optimum power output. This helps retrieve economic power output from power plants.

Therefore, we tend to propose a machine-driven automatic IOT-based Solar tracking system that enables automated solar energy tracking from any place over the web. We tend to use Node MCU-based mostly systems to track solar energy by the use of a BH1750 Light Sensor.

Before there was no technology to monitor solar power energy. We waste solar energy but solar energy is a natural free source. We don't know how to track solar energy and get low-power energy.

In this proposed system, we get more power from solar energy and we can also observe the parameters through the cloud web on our laptops and smartphones.

V. Flowchart



VI. Advantages of Solar Tracker

Looking at the properties and functions of the dual-axis solar tracker, we can say that it is a highly advanced system for increasing the efficiency of solar panels. But what are its varied benefits;

By installing this tracker into your solar system, you get the following benefits:

- They require limited accommodation space. Therefore, you can easily install them if you have a small space for your solar system.
- They are the best solution for generating more electricity throughout the day. The four directional rotations ensure excellent power supply irrespective of the day's timing. Therefore, a high-capacity solar system with a dual-axis tracker is efficient enough to meet your power requirements throughout the day and store extra energy for nighttime utility.
- Since they can rotate both horizontally and vertically, their efficiency is not affected even if the land is uneven.
- The high energy production quickly balances the high investment of solar systems with dual solar trackers.

VII. Drawbacks of Solar Tracker

Merely knowing the benefits is not enough for making a well-informed decision while installing a solar tracker. You must be aware of the limitations of this highly efficient solar system device to handle minute issues that may pop up in the future.

Some limitations of the solar tracker systems are:

- Since the solar tracking device has movable parts, its lifespan may be lesser than that of traditional solar panels.
- The solar tracker may not work accurately when the sky is covered in clouds or smog.
- They require regular maintenance for proper functioning.

VIII. Future Development

Fabrication of Microcontroller: The number of wires can be greatly reduced directly if a customized PCB is made upon which all the resistors can be directly soldered. This also eliminates the use of Breadboard which was used to make all the external connections.

Design improvement: With the current design, it can be seen that the controller circuit rotates along with the panel. This was done to avoid the tangling of wires. A better design may be realized in which only the panel rotates and all other parts are stationary.

Mounting of the panels: In our design, the panels are mounted on a horizontal shaft supported strongly at both ends. We can mount the panels directly onto a motor placed at the center of the Panel-Base to provide East-West movement. This reduces the weight and effective cost of the project.

IX. Conclusion

The increasing popularity and dependency on solar energy have resulted in the invention of the dual-axis solar tracker.

Also, as the area of many new commercial companies is getting smaller day by day, it is not possible to use big solar panels if the energy requirement is more, a dual-axis solar tracker effectively tackles this problem as they are small and provide 40% more output than a fixed axis solar panel.

In addition, the increased output as well as cloud monitoring of the module when dual-axis trackers are used is expected to further draw more people to use them. If you are planning to install a solar system for commercial purposes, do consider investing in the dual solar tracker. Always remember that there's no need for you to install solar trackers for residential installations. Although it's not illegal, installing solar trackers for residential installations isn't required.

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