Arduino based Dual Axis Smart Solar Tracker

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ABSTRACT

The world is now moving towards the renewable energy source due to various factors like pollution and cost of non-renewable energy sources. One of the major renewable energy sources is Sun. In this project Arduino based Dual-axis solar tracking system proposed in order to get maximum solar energy. The Arduino is used to give command to rotate the solar panel. Solar trackers are used to improve the power gain from solar energy. Solar power is changes due to the seasonal variation and tilting of earth which changes the position of the sun in the sky. In this regard dual axis solar tracking is practically implemented and performance is compared with fixed mount and single axis solar tracking system. Finally, experimental result clearly evident that proposed method gives better efficiency compared to fixed mount and single axis solar tracking system.

Keyword : - *Renewable energy, Arduino, Solar trackers, Seasonal variation, Tilting, Practicality, efficiency.*

1. INTRODUCTION

The quality and availability of conventional energy sources are insufficient to meet the growing demand for power in the modern world, making renewable resources a serious problem. Energy is a crucial component for any country's progress worldwide. Fossil fuels are used to produce most energy. The need for energy from renewable resources like solar, geothermal, and ocean tidal waves is rising as a result of the finite supply of fossil fuels. The photovoltaic system is the most likely to eventually replace conventional energy sources among all renewable energy sources. The only method to improve a solar panel's performance is to increase the amount of light that strikes it.

The greatest technique for boosting solar panel efficiency is a solar tracker, which keeps the panels oriented toward the sun. The likelihood of solar power makes it a great option for tiny power generation since it may be used anytime and anywhere small power generation is needed. Models of Deployment. This study presents an automatic solar tracker that is simple to operate and can be simply programmed using a microcontroller. This article discusses

the design and building of a prototype solar tracking system that uses light-dependent resistors (LDR) to detect sunlight.

The Arduino Uno serves as the foundation for the solar tracking system's control circuit. The solar panel is positioned where it receives the most sunshine by using the stepper motor, which is activated by a programming that detects sunlight through the LDRs. In comparison to other motor types, stepper motors provide superior controllability, energy efficiency, stability, high tracking precision, and minimal environmental impact.

Technology development has also made it possible to find ways to put this energy to good use. such as the creation of fuel, electricity, heat energy, and many more. The purpose of photovoltaic or concentrated solar power (CSP) systems is to convert solar energy that the earth has appropriated into electrical power. Through the channel of photovoltaic arrays, an oriented scaffolding of photovoltaic/solar cells, a solar tracking device uses this stolen solar power. Photovoltaic cells, another name for solar cells, are devices that use light energy to generate electricity. The photovoltaic effect, which is comparable to the photoelectric effect, provides the basis for how solar cells operate. The distinction is that photovoltaic systems use electrons that are contained in the material around the surface rather than emitting them, which results in a voltage differential. Silicon crystal is used to create solar cells. It is the component of a solar cell that is most frequently employed. Silicon has been used in solar cells with great efficiency and at a very low cost. To create solar cells, two types of crystalline silicon can be utilized. In addition to silicon, other materials such as cadmium telluride (CdTe), copper indium gallium (di)selenide (CIGS), etc. can be used to create solar cells. Silicon is the ideal material to utilize in solar tracking systems because it is slightly more expensive to fabricate solar cells using other materials.

1.1 Existing System

In a one-axis tracking system, the surface is adjusted along a single axis. Additionally, the dual-axis tracking system rotates the surface by concurrently rotating it across two axis.

1.2 Disadvantages of Existing Systems

Limited Sunlight Capture: Single-axis trackers only have the ability to track the sun's east-west movement; they are unable to capture the sun's elevation changes during the day, which reduces their energy production.

2. BLOCK DIAGRAM

Dual-axis systems capture more sunlight, resulting in higher energy output compared to single-axis trackers Figure 1 shows the block diagram of the created closed-loop solar tracking system, which details the system's components and connections. How to get the PV panel location (output) to as closely follow the sunlight location (input) as possible is the solar tracking problem for the closed-loop tracking strategy. The LDR sensor, differential amplifier, and comparator make up the sensor-based feedback controller. The LDR sensor uses the amount of sunlight as a reference input signal throughout the tracking process. A feedback error voltage is produced by amplifying the voltage imbalance that the LDR sensor senses. The discrepancy between the PV panel's location and the direction of sunlight determines the error voltage.

Currently, the comparator evaluates the incorrect voltage against a tolerance threshold. The dual-axis tracking motor (which rotates both elevation and azimuth) and raises the PV panel to face the sun is triggered by a relay and the motor driver if the comparator output changes to the high state. Consequently, the feedback controller carries out the following crucial tasks: PV panel and sunlight are continuously monitored, and when the error voltage falls below a certain level, a differential control signal is sent to drive the PV panel.

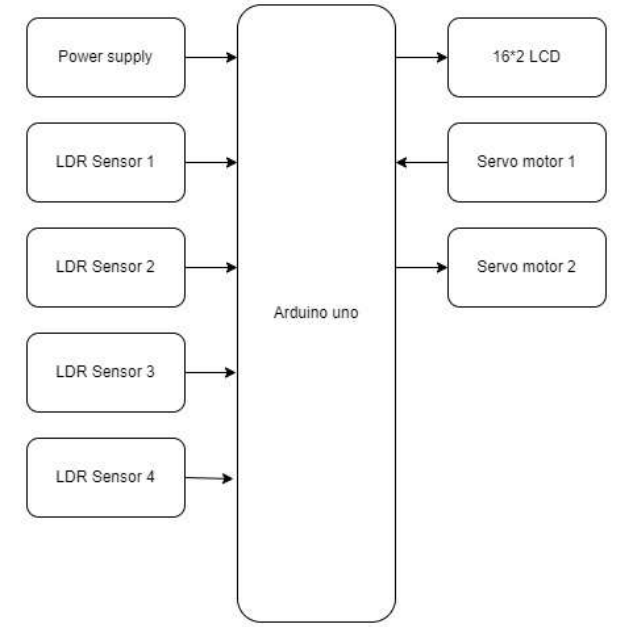


Fig-1: Block diagram of automatic Solar tracking

3. LIST OF COMPONENTS AND OVERVIEW

The list of elements that are required to develop automatic water level controller circuit as shown in the below table[1].

Table -1: Table Of Components required

Component	Specification	Quantity
Arduino-Uno	ATmega328,5V	1
LCD	16x2pin,4.7V-5.3V	1
Servo Motor	SG90, +5V	2
Voltage Regulator	LM7812,12V	1
DC voltage sensor	0-25V	1
Charge controller	TP4056,5V	1
Photo Sensor	LDR 5528,5mm	4

Some components like Transformer, Resistor, Capacitor ,Voltage Regulator, Bridge Rectifier, temperature sensor are'nt mentioned in the table.

3.1 Description of Each Component

The description of each Component is given below:

- Arduino-Uno:
  Arduino is open source physical processing which is base on a microcontroller board and an incorporated development environment for the board to be programmed. Arduino gains a few inputs, for example, switches or sensors and control a few multiple outputs, for example, lights, engine and others. Arduino program can run on Windows, Macintosh and Linux operating systems (OS) opposite to most microcontrollers' frameworks which run only on Windows. Arduino programming is easy to learn and apply to beginners and amateurs. Arduino is an instrument used to build a better version of a computer which can control, interact and sense more than a normal desktop computer.

Fig-2: Arduino Uno

- LCD Display:
  The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

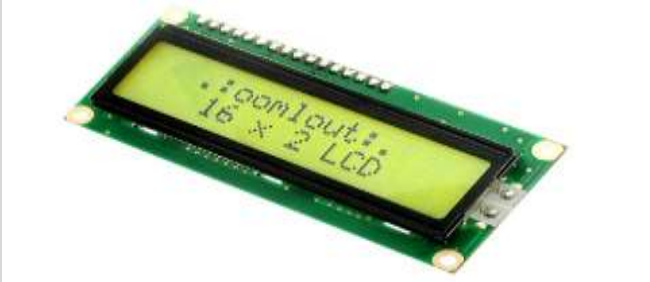


Fig-3: LCD Display

- Voltage Regulator:
  A voltage regulator is an integrated circuit (IC) that maintains a constant fixed output voltage regardless of load or input voltage changes. It can do this in a variety of ways depending on the topology of the circuit in them, but for the sake of keeping this project simple, we will focus mostly on the linear regulator. A linear voltage regulator operates by automatically changing the resistance through a feedback loop, allowing for variations in both load and input while maintaining a constant output voltage.

Fig-4: Voltage Regulator

- SG-90 Servo Motor :
  A DC servo motor consists of a small DC motor, feedback potentiometer, gearbox, motor drive electronic circuit and electronic feedback control loop. It is more or less similar to the normal DC motor. The stator of the motor consists of a cylindrical frame and the magnet is attached to the inside of the frame. A brush is built with an armature coil that supplies the current to the commutator. At the back of the shaft, a detector is built into the rotor in order to detect the rotation speed. With this construction, it is simple to design a controller using simple circuitry because the torque is proportional to the amount of current flow through the armature.

Fig-5: SG-90 Servo Motor

- DC voltage sensor:
  This is a simple but very useful module which uses a potential divider to reduce an input voltage by a factor of 5. The Voltage Detection Sensor Module 25V allows you to use the analog input of a microcontroller to monitor voltages much higher than it capable of sensing.

Fig-6: DC voltage sensor

- Charge Controller:
  To prevent electrical overload, overcharging, and perhaps overvoltage, a charge controller, charge regulator, or battery regulator restricts the rate at which electric current is supplied to or taken out of electric batteries. This avoids situations that could endanger safety and lower battery performance or lifespan. In order to save battery life, it may also prevent a battery from being fully depleted (also known as "deep discharging") or carry out controlled discharges, depending on the battery technology. The words "charge regulator" and "charge controller" can apply to integrated control circuitry found in battery chargers, battery packs, and other battery-powered devices, as well as stand-alone devices.

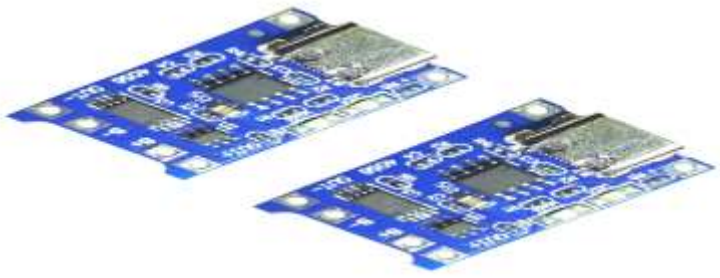


Fig-7: Charge Controller

- Photo Sensor:
  Photodetectors, which are sometimes known as photosensors, are devices that measure electromagnetic radiation, such as light.Numerous types of photodetectors exist, and they can be categorized based on different performance metrics like spectral response or by the process of detection, like photoelectric or photochemical effects. A p–n junction is commonly used in semiconductor-based photodetectors to transform photons into charge. In the depletion area, the absorbed photons form electron–hole pairs. Among the several types of photo detectors are photodiodes and photo transistors. A portion of the light energy absorbed is converted into electrical energy by solar cells.

Fig-8: Photo Sensor

4. RESULT AND DISCUSSIONS

The project's goal has been accomplished. This was made possible by the use of light sensors, which can gauge how much sunshine reaches the solar panel. The panel is activated when the values produced by the LDRs are compared and there is a discernible difference .increasing the servo motor's speed until it nearly parallels the sun's rays.

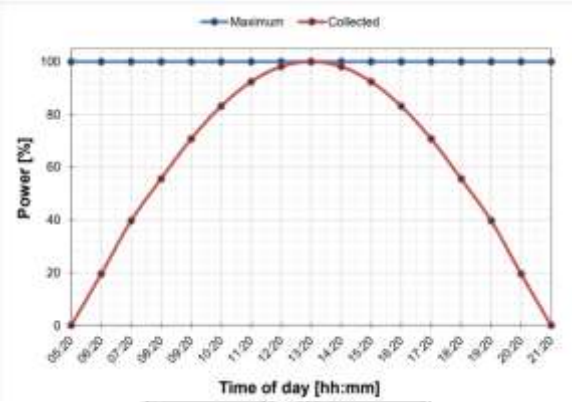
A three-stage or subsystem system was used to accomplish this. Every stage plays a certain role. The phases were

- An input stage was in charge of creating a voltage from incident light.
- a control phase in charge of managing decision-making and actuation
- a driver stage that includes a servo motor. It was in charge of the panel's actual movement.

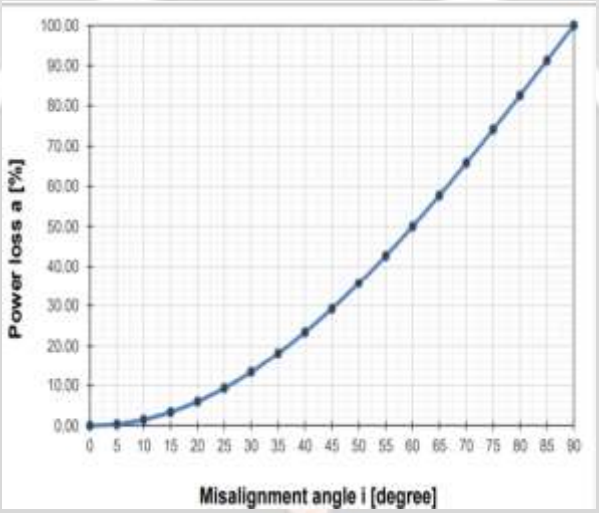
Chart -2: implementation of rotation of solar panel based on light direction

3.1 Graphs

The graphs of power to time of day, misalignment and power loss are given below.



Graph -1: Approximation of power output (red line) compared to maximum output (blue line) for a fix mounted solar module



Graph -2: Relation between solar panel misalignment and direct power loss

5. CONCLUSIONS

The dual axis solar tracking based solar panel using Arduino technology was created and successfully put into use to boost solar panel efficiency. Compared to the current single axis solar tracker and fixed mount, the suggested two axis solar tracker is more efficient. With the aid of an Arduino board, the suggested solar tracker that tracks the sun automatically in order to harvest the most solar power was successfully realized. The Arduino board is an inexpensive and easy-to-implement tool for tracking solar power. Lastly, the experimental system unequivocally shows that the suggested method follows the sun in both favorable and unfavorable weather circumstances. When compared to the current system during different times of the day, the solar panel's efficiency is significantly increased.

6. ACKNOWLEDGEMENT

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