SINGLE AXIS SOLAR TRACKER USING SERVO MOTOR

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Abstract

With the increasing population, the energy demand also increases which cannot be fulfilled by non-renewable resources that are getting exhausted at an alarming rate. So, the race for utilizing renewable energy sources is booming day by day and among them, solar energy stands atop all. Harvesting solar energy with fixed solar panels proves to be efficient but not enough to meet the current demands. So, to increase the efficiency single Axis Solar trackers have been developed which can gather as much energy as they could throughout the day. The solar panels' movements have been controlled by a servo motor which works on the command given by it through a microcontroller AT-MEGA328. As this consumed is less for its working. It is more efficient than fixed-axis solar panel.

Keywords: Servo motor, Solar panel, LDR, Single axis, Light intensity

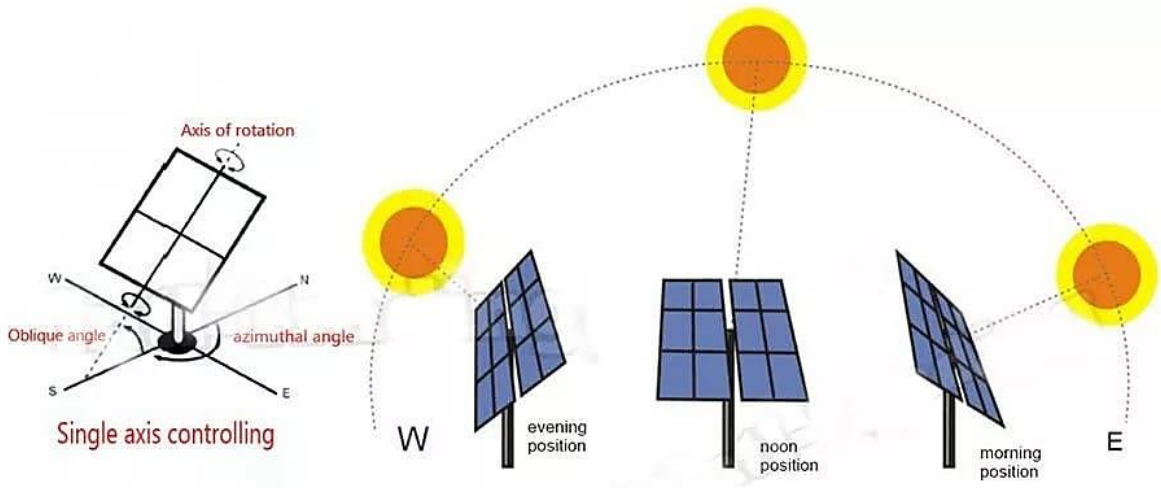
1.Introduction

Coal is a reactionary energy that's non-renewable and it's consumed at a radical speed. Coal is burned in the furnace to induce thermal energy which is converted into electrical energy. As coal contains a lot of carbon patches in it when it's burned to get thermal- the energy releases a lot of carbon patches into the atmosphere. The carbon patches reply with the atmosphere to produce GREENHOUSE feasts like carbon- dioxide, and carbon mono oxide. These feasts beget reduction in the ozone subcaste and beget GLOBAL WARMING so, a volition for coal are considered as the new source of electricity. As solar radiation is indefatigable, we work on optimizing solar power generation. At present Silicon is the most used semiconductor material in the construction of solar panels, almost 95% of the panels constructed now are made of this silicon material as a base [1]. The Average efficiency of the solar panel is generally around15%-20%, but in some cases the efficiency of the solar panel can reach up to a maximum of 42%[2]. A solar panel can produce further energy when the further intensity of solar shafts falls on it. The end is to produce a solar tracker that's suitable to track the sun's movement precisely and in a cost-effective way on a single axis using Arduino, Light detectors, a Servo motor, and Pan-tilt.

2.Related Work:

This paper deals with the construction of a single axis solar tracker. Here solar tracker was constructed by using solar panel, dc motors, sensors, IC and Arduino as control unit. The drawback in this work is DC motor to change the axis of the solar panel. When there is increase in voltage through the DC motor,it increases its torque and velocity so there is an additional need of voltage regulator and speed control gears to maintain the rpm of the motor to avoid the wear and tear of the system[3].

Single axis solar tracker's basic need is the movement of solar panel towards the direction of sun. This can be done with the help of stepper motor as mentioned in this paper written by Mohammed Ben OUMAROU,et al. But the major drawback in this system is that the energy consumption for the working of stepper motor is very high, when compared to the solar energy produced from the same solar panel. Also, the development of the prototype is complex which makes it difficult to implement in the commercial power generation sector [4].



1. Figure 1: Image of single axis solar tracker [3]

This proposed work by MstJesmin Nahar, et al. consists of LDR to calculate the intensity of the sun and move the solar panel in that direction where intensity is high and for the movementdc geared motor is used, which is one of the major disadvantage dc geared motorsarecostly. The DC motorcontains commutator and brush gear which make the cost high. If there is a commutator failure it leads to a spark in the motor which may lead the system into fire.[5]

In this project work, The Solar Panel Can be moved efficiently in single axis with the maximum power point methodology. With this method the axis can be determined quicklyHere Bi-directional DC is used which makes the movement of solar panel at ease and the control unit

comprises of microcontroller which is ATMEGA328P.Its axis speed is independent of motor speed.It is 38% more efficient than fixed solar panels which has paved way for getting more energy at the least amount of time when compared to fixed solar panels. Due to the increased efficiency and the simplified mechanism made it easy to use.[6]

In this proposed work the movement of single axis is performed by a microcontroller, that comprises of fuzzy logic circuits that has been used which in turn comprises of IF-THEN rules and aligns the solar panel in the direction of sun with the help of photo sensitive resistor i.e., LDR and the movement is done with DC motor. Here the intensity of solar energy determines the speed at which thesolar panel must move in order to obtain maximum energy.The Energy consumed by this whole system is way less that also improvises the energy produced.[7]

In this tracker the construction is too complex for single axis solar tracker.They are using the components such as Voltage Regulator IC 7805, Motor driver IC L293D,Stopper,Caster wheel which will make the system construction complex and also the cost will be effectively high if we use these components to built the tracking system.[8]

This single axis solar tracker system is constructed using LDR, Microcontroller, Motor driver, Two DC motors. This system contains DC motors and motor controller. The micro controller used in this system in PIC16F877A which is not suitable for high scale production on the other hand if use Arduino which can be used for high scale production and easy to program.[9]

In this system they are using the stepper motor for rotation and gear box to control the stepper motor but, as the sun moves at a slow rate of speed, we don't need the use of a gear box to increase or decrease the speed of the stepper motor.[10]

With the help of an open loop control system single axis solar tracking system can be achieved.The Output which is derived from light sensitive device is given as input to the servo motor which then rotates the bike gear that helps greatly in reducing torque on servo motors and also enhances the ease of movement in solar panel more precisely and maximum output is obtained through-out the day.[11]

3.EXISTING WORK:

The recent research work that has been done on the topic single axis solar tracking system was published in the year 2022. In this existing work the single axis solar tracking system was developed with SIMULINK as a software base. The hardware components used were LDR's, an Arduino microcontroller with WIFI, a servo motor and a current sensor. This model has been made fully automated and the tracking is managed by a PC software application with a user-friendly graphical interface. Here two types of algorithms are used, they are chronological and active algorithm. The active algorithm is a closed loop tracking system that analyzes the value obtained from the sensor with the help of microcontroller, this in turn controls the motor motion. Moreover, this active algorithm works on practical values obtained, whereas the chronological algorithm works on the basis of mathematical models derived for tracking sun's direction. So, we can say that this algorithm works on theoretical values. With the hybrid of the values obtained from these algorithms the solar panel tracks the sun's direction more efficiently.[12]

4.PROPOSED SYSTEM:

This paper deals with the construction of a single-axis solar tracker that can generate more solar power and is constructed in a cost-efficient way. This solar tracker consists of two LDR, Servo motor, Panel carrier, Pan tilt, Arduino Uno R3 as its microcontroller. When high intensity of sun rays falls on the LDR they give analog signals as an input to the Arduino microcontroller and the control measures which direction has the high intensity of light using the formula coded in it and gives digital signal as command to the Servo motor that makes the Servo motor to tilt on that direction that has high intensity of light. The Resistance of the LDR varies with respect to the formula mentioned below,

$$Vout = \left(\frac{R2}{R1+R2}\right) * Vcc \quad (1)$$

Where R1 and R2 denote the resistances of LDR respectively.

The working proposal of the system is given below in fig.2 below. By this method we can precisely calculate the direction of the sun and track it down easily as there are no pre-recorded angles to the Servo motor except for the maximum and minimum angles set for the Servo motor. This is the most efficient and cost-effective way of constructing a single-axis solar tracker.

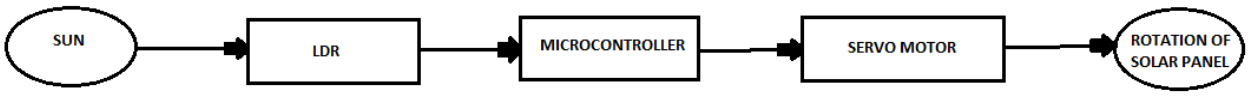


Figure 2: Block diagram of the proposed work

5. FLOW CHART OF THE WORKING MODEL:

The flow of the commands given to the microcontroller is given as a flow chart in the below Figure 3

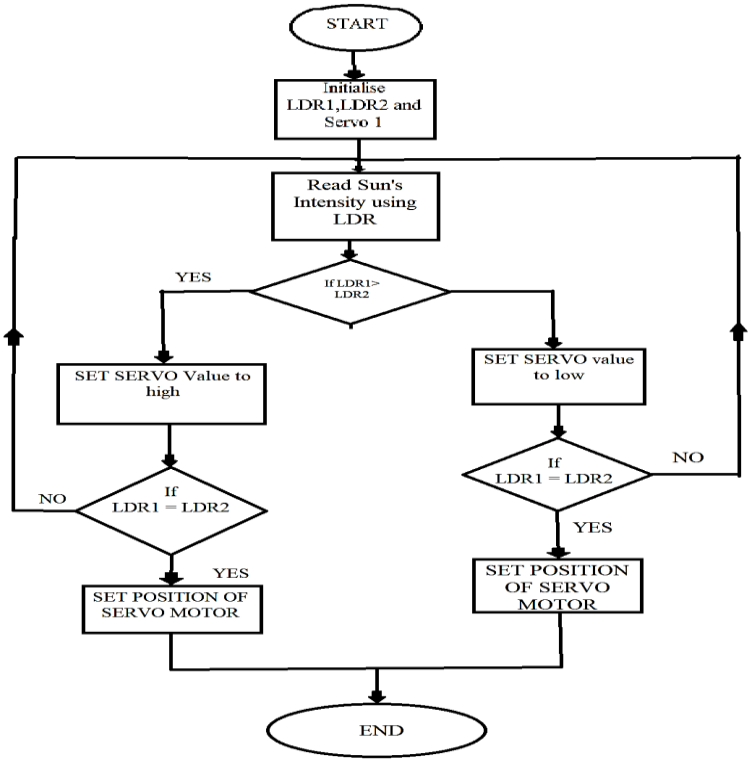


Figure 3: Flowchart of command flow of the proposed work

6. RESULTS AND DISCUSSION:

The observation is done by using a fixed axis solar panel and a single axis solar tracker as per our proposal. Each reading has been taken on a regular interval of one hour. Both of the panels were placed in the same area. The output voltage generated in each of the solar panel is noted and displayed in the Figure 3 in the form of both graph and in the form of tabulation. The results show that there is a drastic change in the output in the output voltage generated.

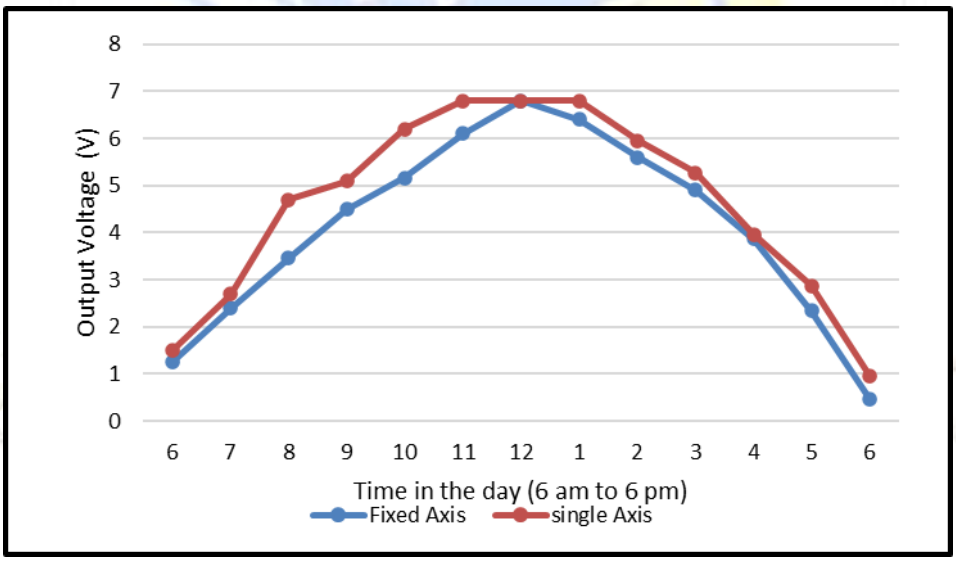


Figure 4: Comparison graph between the voltage output of single axis and fixed solar panel

Tabulation 1: Shows the difference in the output voltages between fixed and single axis solar tracker

TIME	FIXED AXIS (V)	SINGLE AXIS SOLAR TRACKER (V)
6	1.25	1.5
7	2.4	2.7
8	3.46	4.7
9	4.5	5.1
10	5.17	6.2
11	6.1	6.8
12	6.8	6.8
1	6.4	6.8
2	5.6	5.96
3	4.9	5.28
4	3.87	3.97
5	2.34	2.87
6	0.46	0.95

7.CONCLUSION:

The Single axis solar tracker on our proposal is constructed by using LDR through which we can identify the direction which has high intensity of sunlight. The Tracker system takes the LDRs output as input to the control system which is a microprocessor that has already coded to find the direction that has high intensity of sunlight. Then the microprocessor sends a command to the servo motor which then rotates in the direction that has maximum sunlight. The total power generated in the fixed solar panel in terms of voltage is 54.78V and the total power generated in terms of voltage by using single axis solar tracker is 59.7V. The total efficiency of a fixed solar panel is 64.2% and the efficiency of a single-axis solar tracker is 68.9%. This proves that the single-axis solar tracker constructed by our proposal produced 4.7% of output more than the fixed-axis solar panel. This can be implemented in the domains such as agricultural areas as a source of power in water irrigation, residential areas for using the low power consuming appliances.

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