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Automatic Solar Optimizer: Dual Axis Solar Tracker

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Abstract

Power generation have gained attention to the tremendous demand of electricity, that led some harmful effects to environment and also sometimes not sufficient to provide in excessive. The problem of controlling the power generation has become the focus of tremendous amount of research over the years using natural resources, and one out of many is solar power. As an average entire earth receives 84TW of power from sun and the consumption is approximately 12TW [2]. In last few years various algorithms were developed for optimizing the sun's efficiency. This project aims to extract more power from the same solar panels. This can be improve by using solar tracker (dual- axis mechanism) with the well known controller board (Arduino) using the LDR circuitry method. Further analysis of the performance of dual- axis tracker with the normal solar panels in the MATLAB is done. The result shows that –"dual- axis trackers" have best performance than other conventional methods of harvesting the solar energy but at the cost of some complexity and money requirement.

Keywords: Automatic Solar Optimizer, Dual Axis Solar Tracker

1. Introduction

In the last few decades world has seen a boom in renewable energy systems because of depleting resources of fossil fuels. The depleting sources of fossil fuels have caused world to pay attention to renewable energy systems. Global energy demand will almost triple in next three decades.

Depleting fossil fuels will be able to provide energy only for next two centuries. Solar energy is one of promising resource for tomorrow's energy. Fortunately, INDIA is in region of world where solar energy and sun light is present almost thought the year [1]. The world population is increasing day by day and the demand for energy is increasing accordingly. Oil and coal as the main source of energy nowadays, is expected to end up from the world during the recent century which explores a serious problem in providing the humanity with an affordable and reliable source of energy. The need of the hour is renewable energy resources with cheap running costs. Solar energy is considered as one of the main energy resources in warm countries.

In general, India has a relatively long sunny day for more than ten months and partly cloudy sky for most of the days of the rest two months. This makes our country, especially the desert sides in the west, which include Rajasthan, Gujarat, Madhya Pradesh etc. very rich is solar energy [3]. Many projects have been done on using photovoltaic cells in collecting solar radiation and converting it into electrical energy but most of these projects did not take into account the difference of the sun angle of incidence by installing the panels in a fixed orientation which influences very highly the solar energy collected by the panel.

Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received [5]. At night or during heavy cloud cover, for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container.

There are two possible ways to enhance output power from solar energy based systems. One of them is to use different efficient materials in manufacturing Photo voltaic (PV) cells or to use a solar tracker to follow the sun [4]. To use a fixed PV array system is not a suitable method as sun keep on changing its position and trajectory during a day. A Solar tracker is an automated solar panel which actually follows the sun to get maximum power. The tracking system has disadvantage of tracking in one axis only as sun varies its position in sky both with seasons (elevation) and time of the day as sun moves across the sky. Although single axis solar tracker enjoys superiority over fixed PV array for solar energy conversion but it does not perfectly aligns the sun's path in an accurate way [7] .To improve the solar conversion dual axis solar tracker is used.

1. Project Overview :

In dual-axis tracking system the sun rays are captured to the maximum by tracking the movement of the sun in four different directions [6]. The dual-axis solar tracker follows the angular height position of the sun in the sky in addition to following the sun's east-west movement. The dual-axis works in the same way as the single-axis but measures the horizontal as well as the vertical axis. The dual axis tracker consists of Arduino microcontroller, LDR (light dependent resistor) sensors, two Servo motors and Solar panel (5 watt).

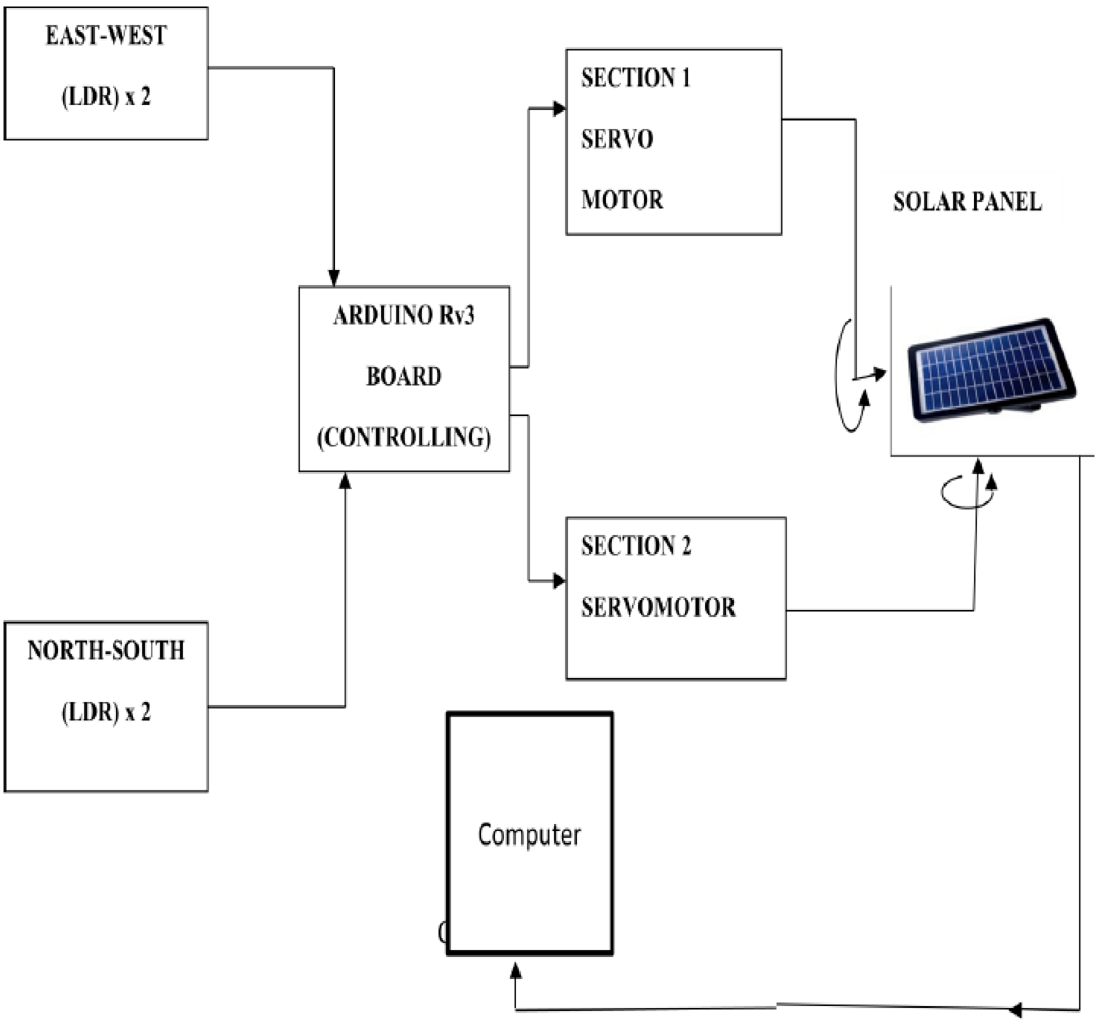
One set of sensors and one motor is used to tilt the tracker in sun's east - west direction and the other set of sensors and the other motor which is fixed at the bottom of the tracker is used to tilt the tracker in the sun's north-south direction. When the sun moves in the northern direction the tracker has to track the path of the sun in anti-clockwise direction along the horizontal axis (east to west). If the sun moves in the southern direction then the tracker has to track the path of the sun in clockwise direction. Sun-synchronous navigation is related to moving the solar powered rover (robot) in such a way that its solar panel always points toward the sun and which results into maximum battery charging. The unique feature of this solar tracking system is that instead of taking the earth as its reference, it takes the sun as a guiding source. Its active sensors constantly monitor the sunlight and rotate the panel towards the direction where the intensity of sunlight is maximum.

The light dependent resistor's job is to sense the change in the position of the sun. The control circuit does the job of fetching the input from the sensor and gives command to the motor to run in order to tackle the change in the position of the sun. By using this system the additional energy generated is around 15% to 25% with very less consumption by the system itself. The tracking system was driven by two Servo motors to provide motion of the PV panels in both horizontal and vertical axis.

The project describes the use of a microcontroller based design methodology of an automatic solar tracker. Light dependent resistors are used as the sensors of the solar tracker. The tracking system maximizes solar cell output by positioning a solar panel at the point of maximum light intensity**.** The Aim of this project is to develop and implement a prototype of two-axis solar tracking system based on arduino microcontroller [8].

This auto-tracking system is controlled with two 5volt servo motors. The four light sensors (LDR) are used to track the sun and to start the operation (Day/Night operation). It is capable of archiving the timeliness, reliability and stability of motor speed control, which is difficult to implement in traditional analog controller. The project concentrates on the design and control of dual axis orientation system for the photovoltaic solar panels.

2.1 Block diagram of Project



3. Results

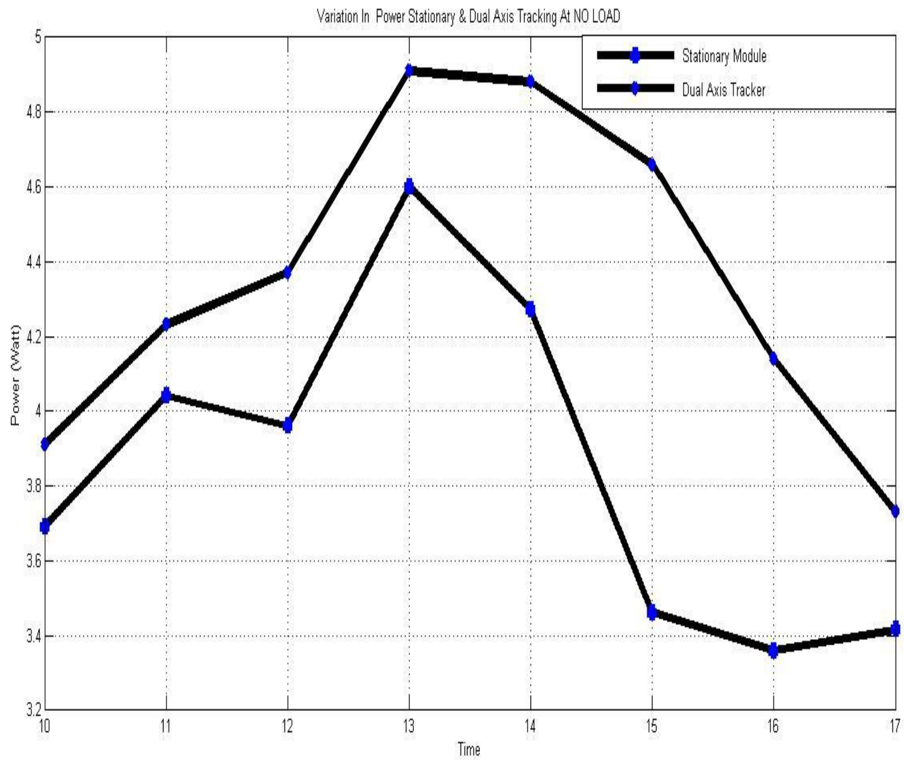
3.1 Stationary module observation

Time	Voltage at no load(volt)	Voltage at load(volt)	Current at no load(ampere)	Current at load(ampere)	Power at no load(watt)	Power at load(watt)
10 am	9.47	8.41	0.39	0.10	3.69	0.841
11 am	9.64	8.63	0.42	0.14	4.04	1.20
12 noon	9.22	8.90	0.43	0.14	3.96	1.25
1 pm	9.80	8.8	0.47	0.14	4.6	1.23
2 pm	8.91	8.89	0.48	0.11	4.27	0.98
3 pm	8.66	8.2	0.40	0.13	3.46	1.06
4 pm	8.21	7.9	0.41	0.10	3.36	0.79
5 pm	7.12	6.6	0.48	0.09	3.417	0.60

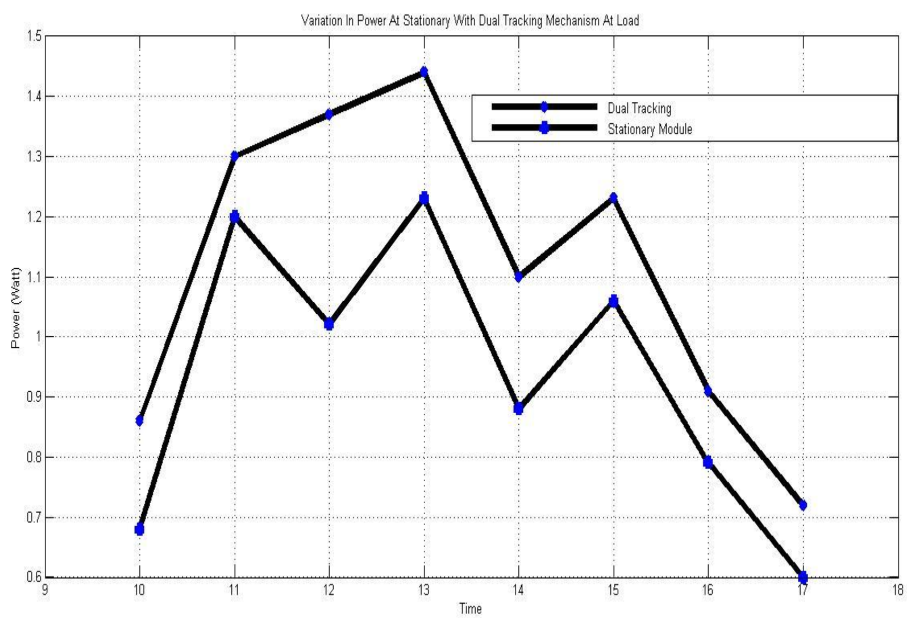
3.2 Dual Axis mode observation

Time	Voltage at no load(volt)	Voltage at load(volt)	Current at no load(ampere)	Current at load(ampere)	Power at no load(watt)	Power at load(watt)
10 am	9.47	8.61	0.41	0.10	3.91	0.861
11 am	9.64	8.7	0.44	0.15	4.23	1.30
12 noon	9.22	8.6	0.45	0.16	4.37	1.37
1 pm	9.80	9.04	0.50	0.16	4.91	1.44
2 pm	8.91	9.1	0.51	0.11	4.88	1.10
3 pm	8.66	8.8	0.49	0.14	4.66	1.23
4 pm	8.21	8.3	0.45	0.11	4.14	0.91
5 pm	7.12	7.2	0.49	0.10	3.73	0.72

3.3 Graph between power readings of stationary Solar Panel and Dual Axis solar Power module at no load



3.4 Graph between power readings of stationary Solar Panel and Dual Axis solar Power module at load



4. Conclusion

The power increase at no load condition attained was 13.09% and at a load of (57 ohm) connected directly to panel terminals was 12.3%.

This project has presented a means of controlling a sun tracking array with a microcontroller system. Specifically, it demonstrates a working software solution for maximizing solar cell output by positioning a solar array at the point of maximum light intensity. This project utilizes a dual-axis design.

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