Generation of Energy through Solar Plant Using Tracking System

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Abstract— Solar energy is rapidly becoming an alternative means of electricity source. Fossil fuels are seriously depleting, thus the need for alternative energy source is a necessity. To make effective use of solar energy, its efficiency must be maximized. A feasible approach to maximizing the power output of solar array is by sun tracking. This paper therefore presents the design and construction of a solar tracking system that position the solar PV panel in proper orientation with the sun so as to always receive direct radiation. The prototype is designed around a programmed microcontroller which controls the system by communicating with the sensors and motor driver based on the movement of the sun.

Keywords: Fossil Fuels, Sun Tracking, Microcontroller, Motor Driver

I. INTRODUCTION

Over the years, researches and development of solar energy is rapidly gaining importance and attention especially in tropical areas of the globe. It is recognized as a bold step towards exploiting the providence of natural resources for the benefit of mankind and is continually harnessed as much as could be made possible by technological discoveries. Before now, non-renewable energy source such as fossil fuel had been the major means of generating electricity. The high dependence on it has resulted in consequential implications like fuel price fluctuation environmental hazard and global warming. Again studies suggest that the increasing rate at which fossil fuels are consumed might lead to their depletion by the end of this century. Hence, there is great need for other means of electricity generation as an alternative. Renewable energy systems are presently becoming very popular. They are energy source gotten from natural resources such as wind, sunlight, water and thermal heat which can be renewed after use. Solar energy is one gotten from sunlight and is called photovoltaic system. Photovoltaic energy is the process of converting the sunlight directly to electricity, using solar cells. It is clean, non-polluting, sustainable resource that requires easy installation and little maintenance. Most solar panels are statically aligned, that is they are placed at a fixed position towards the sky. As the sun moves across the sky throughout the day, the angle of incendence of the sun rays to the panel keeps on changing thereby resulting to low power output from the solar cells. Maximum energy is collected by the solar panel when the orientation is such that the sun rays fall directly on it. This means that the sunlight's angle of incidence has to be constantly perpendicular to the solar panel. Thus, a system which can continuously track the sun's radiation as it changes position in its motion during the day is the interest of this project. The initial deployment of solar energy is very costly. More capacity electricity generation requires more solar panels (solar cells) which are rather expensive. Apart from cost, the conversion efficiency is low. Hence, there is need to improve the efficiency of solar system.

The aim and objective of this project is to design a solar tracker system that can continuously track sunlight to optimize energy produced from photovoltaic cells for maximum power generation.

The scope and limitation of this work involves the processes in successful development of an automatic solar tracking system which include researches and study of solar energy concepts as well as selection of appropriate components to achieve the design. The approach employed in the design mechanism of the system entails

1) Selection of components that constitutes the system design.
2) Development and simulation of the circuit design.
3) Assembly of components considering design parameters.
4) Integration of the parts to develop the whole system.
5) Testing to ascertain overall functionality. This work incorporates latest technology and inexpensive electronic components to achieve maximum energy absorption, thereby making the system efficient and cost effective.

II. COMPONENTS:

In the design for the automatic solar tracking system, a modular approach was used to break the project into separate tasks. Considering the project as a whole, it has a fixed vertical axis and a motor controlled horizontal axis as shown in figure 1. The signal from the light sensor is used to determine the direction of movement to align the array with the sun. a motor circuit is used to perform this movement based on the signal received from the controller.

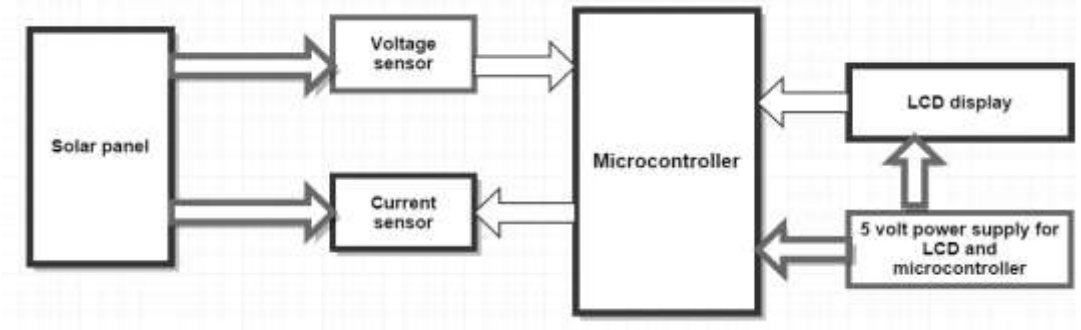

Fig. 1: Circuit Diagram

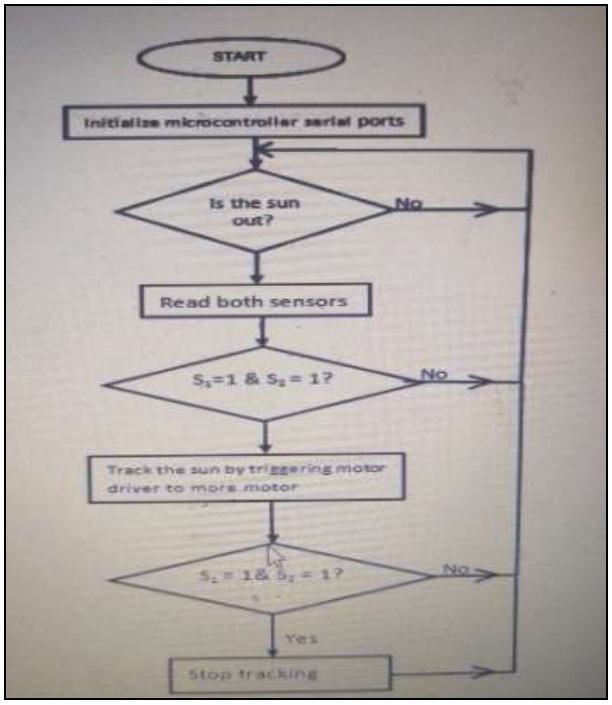

Fig. 2: Flow chart

A. *Microcontroller:*

The AT89S52 microcontroller serves as the brain of the project as shown in flow chart figure 2. It processes all the input signals supplied to the input pins and responds accordingly by giving control signals to the output pins. The input and output ports are configured in the program to specify their functions. It has 40 pins for the various configurations, special function pins inclusive

B. *System operation:*

The operation of the solar tracking system is completely microcontroller based. This makes the operation simple because of the fact that microcontroller understands only two digits, 1and 0. The signals from the two sensor pairs (s1 and s2) are always compared to detect any change in the value. Once the microcontroller detects 0 and 1 at its input ports (pin7and pin8), it sends signal to the motor driver through pin5 and pin6 to move the motor forward and equally send signal to stop the motor when the inputs are 1 and 1.illustrates the operation of the microcontroller with respect to the input signal from the sensors. The system is a single-axis solar tracker in order words, it is programmed to operate in unidirectional mode. Hence, it starts operating only when sensor 1 is 0 and sensor 2 is 1. It was equally programmed to read the generated voltage from the panel through the ADC and compute power for display on the LCD.

III. METHODOLOGY:

A. *Design concept:*

The design of solar tracking system originates from the need to improve the performance of the solar collector. A solar panel receives the morning and evening sunlight at an acute angle, thus reducing the total amount of electricity generated each day. The most attainable method of improving the performance of a solar power collector is to increase the mean intensity of radiation received from the source. This is achieved by tracking the sun.

B. *Fixed and Tracking Collector:*

In an ideal situation where atmospheric influence is negligible, the theoretical calculation of the energy surplus is carried out below. Assuming, the maximum radiation intensity, I=1100w/m2 is falling on the area perpendicular oriented to the direction of radiation and the day length, t=12 hours (43, 200 seconds).

For fixed solar collector,

The projection of the sun bean on the PV cell is given by

S =Socos θ 1.0

Where, So is the collector area (So = 0.15m2)

θ is the angle changing in the interval ($\pi^2 - \pi 2$) during the day.

The angular velocity of the sun moving across the sky,

ω = 727x10-7

rads/sec 2.0

The differential of the falling energy,

dE= ISDt

E= Iso cos$wt\ dt\pi 2{-}\pi$ 2

[ISosin $wtw\pi$ ^{2}

$E = 2ISo$ =

2×1100×0.15

727×10−7

= 4.54 x 106 watt.S

For tracking collector,

E= ISot, since θ = 0

E= 1100 x 0.15 x 43,200

E= 7.13 x 106 Watt.S

Therefore, comparison between the results shows that about 57% energy surplus increase is achieved with the tracking system.

IV. ADVANTAGES:

- Trackers generate more electricity than their stationary counterparts due to increased direct exposure to solar rays. This increase can be as much as 10 to 25% depending on the geographic location of the tracking system.
- Solar trackers generate more electricity in roughly the same amount of space needed for fixed-tilt systems, making them ideal for optimizing land usage.
- In certain states, some utilities offer Time of Use rate plans for solar power, which means the utility will purchase the power generated during the peak time of the day at a higher rate. In this case, it is beneficial to generate a greater amount of electricity during these peak times of the day. Using a tracking system helps maximize the energy gains during these peak time periods.
- Advancements in technology and reliability in electronics and mechanics have drastically reduced long-term maintenance concerns for tracking systems.

V. DISADVANTAGES:

- Even with the advancements in reliability, there is generally more maintenance required than a traditional fixed rack, though the quality of the solar tracker can play

a role in how much and how often this maintenance is needed.

- Trackers are a more complex system than fixed racking. This means that typically more site preparation is needed, including additional trenching for wiring and some additional grading.
- Single-axis tracker projects also require an additional focus on company stability and bankability. When it comes to getting projects financed, these systems are more complex and thus are seen as a higher risk from a financier's viewpoint.
- Solar trackers are generally designed for climates with little to no snow making them a more viable solution in warmer climates. Fixed racking accommodates harsher environmental conditions more easily than tracking systems.

CONCLUSION:

In view of this project report, it has been established that solar tracking system is an efficient and feasible means of obtaining optimal solar energy from the sun. By constantly aligning the photovoltaic panel with the sun, it directly receives sunlight falling on its surface thereby generating more electricity. Different techniques have been adopted in the design of this system but the method implemented in this project is simple, easy to maintain and requires no technical attention for its operation. The software developed for this work can be used outside the mechanical part, thus it is flexible for future modification. The solar module with tracking system as demonstrated in the analysis achieves about 24% efficiency improvement over the static solar module. Hence implementation of this technique in building solar systems will greatly improve utility satisfaction.

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