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Comparison of Efficiencies of Single-Axis Tracking System and Dual-Axis Tracking System with Fixed Mount

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Abstract*— Electric power has become a basic need in today's life. Due to the usage of abundant power, there is a need to search for an alternate energy source. Solar energy is one such reliable source. Photovoltaic panels are used to collect solar energy and convert it into electrical energy. But these photovoltaic panels are inefficient as they are fixed only at a particular angle. This inefficiency can be decreased by designing a solar tracker system which changes its position automatically in accordance with the sun's movement. This paper presents the comparison of single axis solar tracking system and dual axis solar tracking system with the fixed mount solar system.

***Index Terms*—Dual-axis solar tracker, Efficiency, Fixed mount solar system, , Solar energy, Single-axis solar tracker.**

I. INTRODUCTION

During recent times due to the shortage of electricity, the search for an alternate source of power has been increasing. Solar power has proved to be one of the best alternative power sources since it is abundant in nature. It is also a renewable form of energy. A photovoltaic panel is a device used to capture the sun's radiation. These panels consist of an array of solar cells. The solar cells are made up of silicon (sand). They are then connected to complete a photovoltaic (solar) panel. When the sun rays are incident on the solar cell, due to the photovoltaic effect, light energy from the sun is used to convert it to electrical energy. The solar panels can be mounted as a fixed type or used as a tracker type. In the fixed type, the solar panel is mounted on the surface of the roof or ground irrespective of sun's direction at a particular angle. In single and dual axis solar tracking type the solar panel moves according to the movement of the sun. In the first paper, Asmarashid Ponniran[1] experimentally verifies the efficiency and electrical energy output of single axis solar tracking panel with fixed mount. In the second paper, M. Serhan [2] proves that dual axis tracking system has higher efficiency when compared to the fixed mount.

II. SINGLE-AXIS TRACKING SYSTEM

The single-axis solar tracking system analyzed in the paper consist of a PV panel rotating around a tilted shaft under the action of a Bidirectional-DC Motor controlled according to the real sun position estimated by means of two light intensity sensors [3]. The light sensor's consists of two LDR's placed on either side of the panel separated by an opaque plate. Depending on the intensity of the sun rays one of the two LDR's will be shadowed and the other will be illuminated.

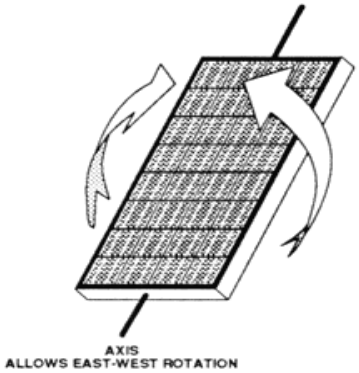

Fig. 1 Single-Axis Tracker

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The LDR present in the side, in which the intensity of the sun rays is higher, will generate a stronger signal and the other will generate a weaker signal. The difference in the output voltage between the two LDR's will help in the movement of the PV panel in the direction in which the intensity of the sun rays is maximum. In this paper [1], PIC18F877A micro controller is used to command the DC motor by giving pulse signal to it. Relay controls the rotation of the motor either to rotate clockwise or anticlockwise [1].

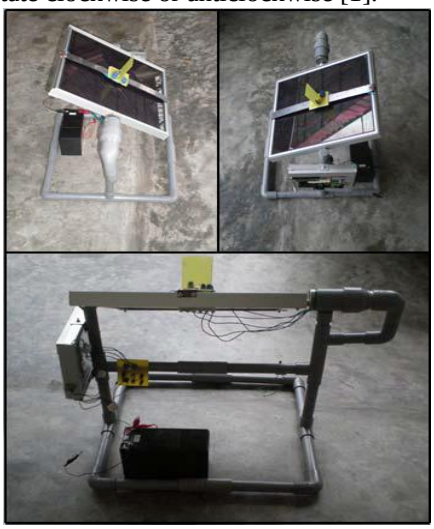

Fig. 2 Overall Setup of Single Axis Tracker [1]

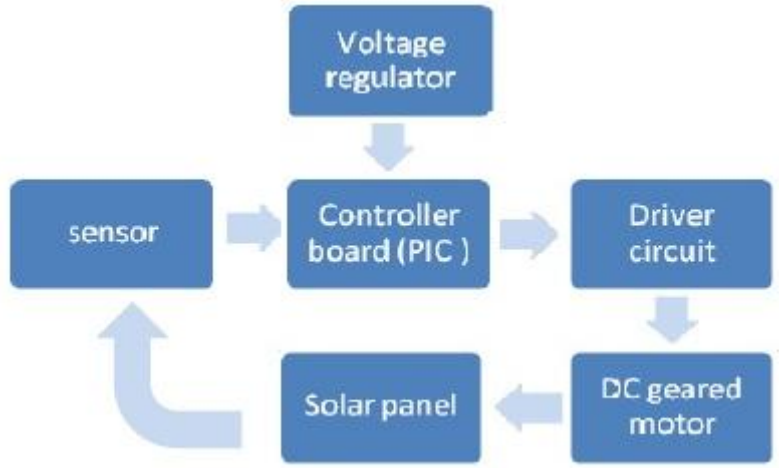

Fig. 3 Block Diagram of Single Axis Tracker System [1]

A. Efficiency Of Single-Axis Tracking System over Fixed Mount

The power output for the single-axis and fixed mount panel are tabulated for a single day. The average power values prove that the single-axis panel produces more power than that of the fixed mount. The power efficiency calculated for the singe-axis solar tracker is said to be 13% more than that of the fixed mount. The tabulated values are simulated and the graph is obtained using MATLAB.

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TABLE I: FIXED VS SINGLE-AXIS [1].

HOUR	POWER FOR FIXED MOUNT(mW)	POWER FOR SINGLE-AXIS(mW)
0800	20.664	62.403
0900	39.780	67.473
1000	44.176	77.212
1100	70.616	93.772
1200	88.110	110.430
1300	104.960	137.160
1400	125.334	130.754
1500	105.342	120.335
1600	86.172	103.096
1700	70.620	89.910
1800	46.494	65.625

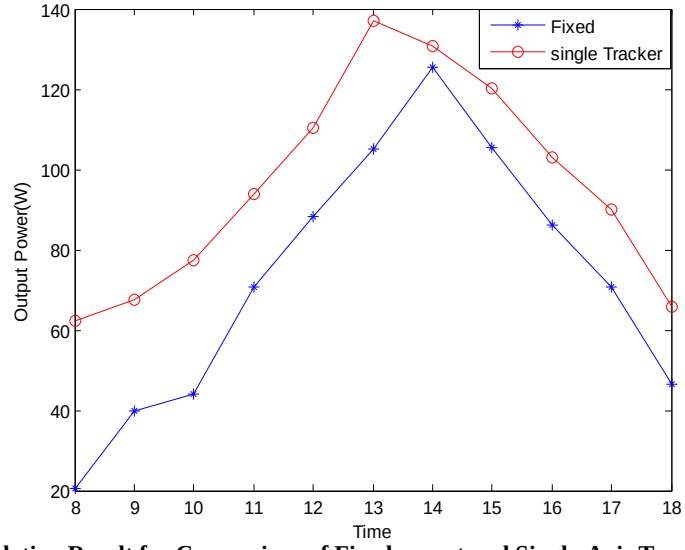

Fig. 4 Simulation Result for Comparison of Fixed mount and Single-Axis Tracker System

B. Disadvantages

This kind of tracker is most effective at equatorial latitudes where the sun is more or less overhead at noon. Due to the annual motion of the earth the sun also moves in the north and south direction depending on the season and due to this the efficiency of single-axis is reduced since the single-axis tracker only tracks the movement of sun from east to west. During cloudy days the efficiency of the single axis tracker is almost close to the fixed panel.

III. DUAL-AXIS SOLAR TRACKING SYSTEM

To overcome the disadvantages in the single-axis tracking system, a dual-axis tracking system was introduced. In dual-axis tracking system the sun rays are captured to the maximum by tracking the movement of the sun in four different directions. 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 [4]. 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 in paper [2] consists of two sets of phototransistor sensors, two AC motors and PIC controller. 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. The sensor senses the light from the sun and sends the signals generated by them to the PIC

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microcontroller. The controller detects the stronger signal and commands the motor to rotate in clockwise or anti-clockwise direction accordingly.

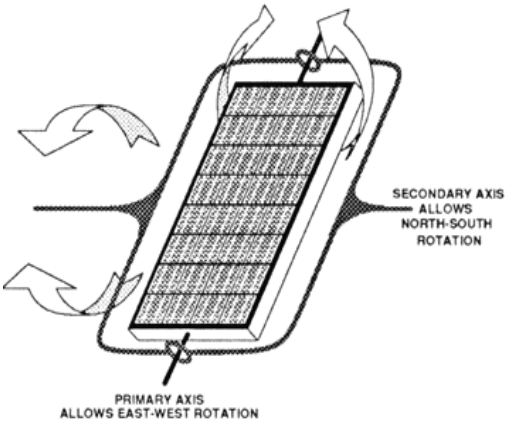

Fig. 5 Dual-Axis Tracker

Fig. 6 Overall Setup of Dual Axis tracker System [2]

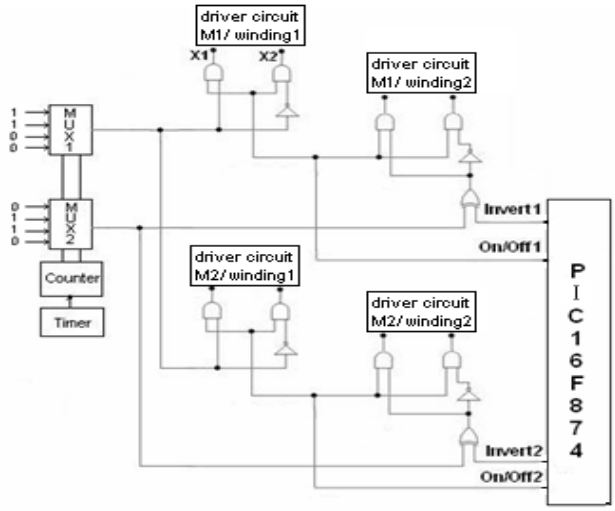

Fig. 7 Logical Diagram for Dual Axis tracker System [2]

Efficiency of Dual-Axis Tracking System over Fixed Mount

The power output for the dual-axis and fixed mount panel are tabulated for a single day. The average power values prove that the dual-axis panel produces more power than that of the fixed mount. The power efficiency calculated for the singe-axis solar tracker is said to be 25% more than that of the fixed mount. The tabulated values are simulated and the graph is generated using MATLAB.

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TABLE 2 .FIXED VS DUAL-AXIS [2].

HOUR	POWER FOR FIXED MOUNT(W)	POWER FOR DUAL-AXIS(W)
0700	14.575	38
0800	23.987	49.728
0900	43.876	52.701
1000	47.94	54.9519
1100	52	52.974
1200	57.6666	59.6156
1300	57.96	58.0488
1400	56.412	56.5687
1500	54.6883	55.3151
1600	48.174	54.8562
1700	36.96	52.3698
1800	27.72	52.668
1900	12.69	33.22

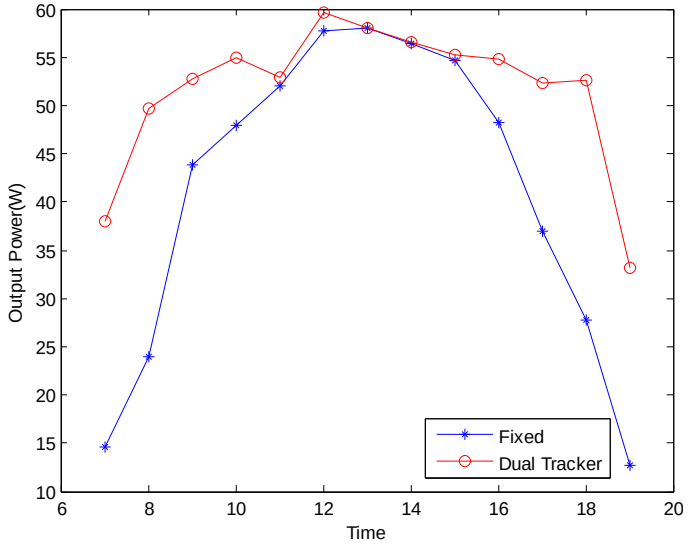

Fig. 8 Simulation Result for Comparison of Fixed Mount and Dual Axis Tracker System

IV. PROPOSED WORK

In our work, we propose to use DC motor instead of AC motor. The main advantage of DC motor over an AC motor is speed control, position control and operating at low speed. The AC motors are more expensive than DC motors for most horsepower rating. The speed of the DC motor can be controlled with a less complicated control unit than the unit required for the AC motor. This can reduce the cost and the complexity of the circuit. Due to the precise speed control of the DC motor we can increase the efficiency of the Dual-axis tracker system when compared with the existing tracker system.

V. CONCLUSION

After studying the papers [1] and [2], we have come to a conclusion that both single-axis and dual-axis are highly efficient in terms of the electrical energy output when compared to the fixed mount system. Dual-axis tracking system works well even during cloudy days when compared with single-axis tracker. Hence the efficiency of dual-axis tracker system is higher when compared with single-axis tracker system. Even though the hardware complexity is higher in the Dual axis tracker when compared with fixed and single tracker it provides a higher efficiency and it is also cost effective.

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