International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
National Conference on
Innovative Technologies in Electrical Engineering (NCITEE2K19)
Volume 5, Special Issue 05, May-2019.

Automatic Solar Tracking System (ASTS)

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Abstract -Renewable energy solutions are becoming increasingly popular. Photovoltaic (solar) systems are but one example. Maximizing power output from a solar system is desirable to increase efficiency. In order to maximize power output from solar panels, one needs to keep the panels aligned with the sun. As such, a means of tracking the sun is required. This is definitely a more cost effective solution than purchasing additional solar panels. It has been estimated that the yield from solar panels can be increased by 30 to 60 percent by utilizing a tracking system instead of a stationary array. In this paper, a prototype for a microcontroller based multi-function solar tracking system is described, which will keep the solar panels aligned with the sun in order to maximize efficiency. The maximum power point tracking (MPPT) data can be transmitted in real time to other solar systems in need of this data.

Keywords: Solar energy, Photovoltaic, Solar tracking, Microcontroller, Power

I. INTRODUCTION

Solar energy is the energy extracted from the rays issued from the sun in the form of heat and electricity. This energy is essential for all life on Earth. It is a renewable resource that is clean, economical, and less pollution compared to other resources and energy [1].

Therefore, solar energy is rapidly gaining notoriety as an important means of expanding renewable energy resources. As such, it is vital that those in engineering fields understand the technologies associated with this area. Our paper includes the design and implementation of a microcontroller based solar tracking system. Solar tracking allows more energy to be produced because the solar panel is tracking the maximum power point of the sun’s position. Nowadays, the popularity of solar energy and electricity combined with the reduced cost per peak watt are having a direct effect on increasing residential solar power system. But, it is still very expensive compared to what the electric utility company charges per kilowatt hour [2].

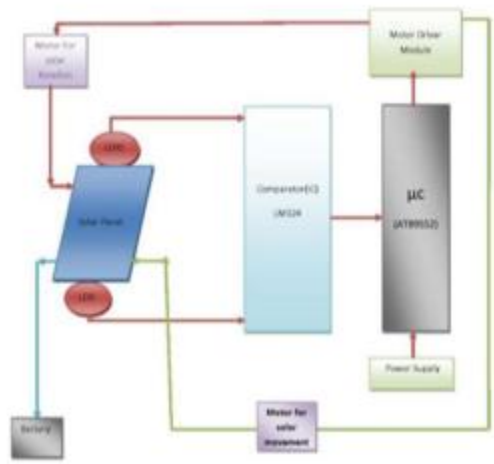
In addition, large solar panels need a perfect fixed installation to get maximum sun light and consume much power to turn left or right around a 13

II. SOLAR REVIEW TRACKER

A solar tracker is an electromechanical system used on behalf of orienting a solar photovoltaic panel in the direction of the sun. It is used in many applications such as the transportation signaling, lighthouses, emergency phones installed in the highways, etc… Its main objective is to find the maximum sun radiations in order to get maximum charge batteries that Electricity can be generated from the sun in several ways. Photovoltaics (PV) have been mainly developed for small and medium-sized applications, from the calculator powered by a single solar cell to the PV power plant. For large-scale generation, concentrating solar thermal power plants have been more common, however new multi mega watt PV plants have been built recently [3].

A photovoltaic cell (PV cell) is a specialized semiconductor that converts visible light into direct current (DC). Some PV cells can produce DC electricity from infrared (IR) or ultraviolet (UV) radiation. Photovoltaic cells are an integral part of solar-electric energy systems, which are becoming increasingly important as alternative sources of power utility [4], Solar cells generate DC electricity from light, which in turn can be used in many applications such as: charging a batteries, powering equipment, etc. They produce currents as long as light shines, as shown infigure 1. [5].

BLOCK DIAGRAM:-



A. Solar Tracker

A solar tracker is an electromechanical device for orienting a solar photovoltaic panel toward the sun trackers, especially in solar cell applications; require a high degree of accuracy to ensure that the concentrated sunlight is directed precisely to the powered device [4].

Solar trackers can be active or passive and may be single axis or dual axis [6].

Single axis trackers normally use a polar mount for maximum solar efficiency and employ manual elevation (axis tilt) adjustment on a second axis, which can be adjusted regularly during the year. It has been estimated that the yield from solar panels can be increased by 30 to 60 percent by utilizing a tracking system instead of a stationary array [7].

Trackers can be relatively inexpensive for photovoltaics. This makes them especially effective for photovoltaic systems using high efficiency panels [8].

Solar trackers usually need inspection and lubrication on a regular basis. Active trackers, which use motors and gear trains, are controlled by an electronic circuit responding to the solar direction

B. Applications

In this paper a solar tracker is realized to detect a maximum power from sunlight. The position of maximum detection power is stored in memory. The stored data can be applicable for many application such as Large photo voltaic panels can track the sun all the day light and by that give above 95% efficiency in generating electricity; solar heaters will also track the sun all the day light and by that less panels are required at the initial cost; while in the home automation systems, this system is also needed in turning light ON and Off and also for opening and closing the curtains. The detection of the position of the sun undergoes several steps. A digital system is used to calculate the maximum sun radiation. It is connected to a stepper motor and to Photoresistors to redirect the panel to the sun. It sends the received data(position of the sun) to the stepper motors in order to position it toward the sun. The position tangles are saved in the registers of the digital processor such as a microcontroller and can be displayed on an LCD or can be transmitted to control a remote system. Figure 2 illustrates the system block diagram.

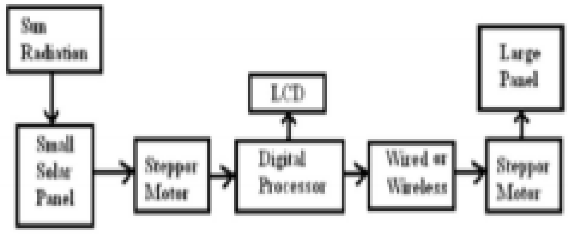


Figure 2. Block diagram of the sun tracker

III. HARDWARE SYSTEM IMPLEMENTATION OF THE PROPOSED SYSTEM

The smart solar system is a self-powered system; all components of the system depend on each others, the system does not need any supply from the external world but only sun light.Those components interconnect with each others in order to form a closed system.

The solar radiation gathered by the photovoltaic cell is transformed into electrical energy; the panel will feed the input of the charger which will charge a 12 Volt DC battery. The second functionality of the cell is to give precise voltage to the tracker, in order to reach the most efficient direction and orientation of the system which will allows maximum sunlight absorption.

The battery will supply the system with a 12 Volt DC. The motors, the charger, the tracker and the sensors are supplied by the battery. The battery is charged by the photovoltaic cell through the charger controller as shown in figure 3.

Figure 3. Relations between main parts of the system

Figure 4 shows the block diagram of the tracking system. It explains the dependency of the tracker. As for the first running, the system has to detect sun light in a quick and accurate way, for this reason photoresistors are used [9].

It will allows the tracking system to locate the nearest position of the light based on comparisons done in the digital processor, this will guide the system in a x-y-z plane, that means all angles and locations can be detected and reached due to the two motors (two rotational axes). The accuracy of the system is enhanced by the gear factor and ratio, the used steppers motors are of 3.5 degrees/step, with the gears added to the motors many factors were improved such as the degree/step (less degree per step which leads to better accuracy in position and angles) and high torque for the motors.

IV. SPECIFICATIONS AND PRIMARY RESULTS

A. Specifications

In order to demonstrate the efficiency of the proposed system, a control algorithm is generated as shown in table 1.

Step #	Action
1	Install the small PV
2	Put PV in initial position (0,0,0)
3	Find the maximum sun light, using the photoresistors, and save the position of the PV
4	Measure the current (I)
5	If I < threshold value (minimum current); wait for 30 minutes and goto step 3, otherwise goto step 6
6	Turn PV left for 3.5°, measure the current; if it is greater then the previous current continue turning left until finding the maximum current in x and y axis; Otherwise turn right and do the same. After finding the maximum current turn up or down to get the maximum current in z-axis, and wait for 45 minutes.
7	Send the coordinates (x,y,z) to the heater or large panels wired or wireless.
8	Goto step 3

B. Preliminary Results

In order to assess the efficiency of the proposed system, some measurements were taken during a sunny summer day. Table 2 shows the comparison between the maximum current using a fixed Photovoltaic panel (PV)

and using the proposed system at different times.

TABLE II. COMPARISON OF THE CURRENT BETWEEN FIXED PV AND USING THE PROPOSED SYSTEM

Time	Current using a fixed PV (Amp)	Current using the proposed system (Amp)
8:00 AM	0.42	0.85
9:00 AM	0.55	0.90
10:00 AM	0.75	0.92
11:00 AM	0.81	0.95
12:00 PM	0.92	0.99
1:00 PM	0.95	0.99
2:00 PM	0.88	0.99
3:00 PM	0.76	0.98
4:00 PM	0.42	0.95
5:00 PM	0.23	0.95
6:00 PM	0.15	0.92
7:00 PM	0.08	0.72
8:00 PM	0.01	0.25
Total	6.93	11.36.

The efficiency of the proposed system can be calculated using the equation (1):

$$Efficiency = \frac{(11.36 - 6.93)*100}{6.93} = 63.92\% \qquad (1)$$

It seems that the efficiency of the proposed system can be increased around 64% on a summer sunny day. In addition, the proposed system consumes little power to turn the PV panel using a small stepper motor instead of using large panel which consumes larger amount of power [10]. Moreover, this system can power itself from the PV panel using a 12 volt battery.

V. SUMMARYANDCONCLUSION

In this paper a universal multifunction solar tracker system is reported. The proposed system was implemented in reduced complexity architecture such as a microcontroller. The control system which is the brain of the proposed system is used to turn a small PV panel in three directions to determine the maximum output current.

Three photoresistors are used every 45 minutes to redirect the PV panel to het the nearest value of the maximum sun.

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