SOLAR TRACKING: AN EFFICIENT METHOD OF IMPROVING SOLAR PLANT EFFICIENCY

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ABSTRACT

Energy conservation is a necessity of present time. In order to keep a check on global pollution, the use of non-conventional sources of energy has also been necessitated. Photovoltaic systems using solar panels are commonly used for this purpose. To enhance the overall efficiency of solar panels by keeping them aligned along with the sun position, Solar tracking system is used nowadays. In this paper, a study of various types of solar tracking systems has been presented. In addition a new scheme of efficient street light system using single axis solar tracking with 89S51 microcontroller has been proposed.

Keywords: Solar Tracking, Light Detecting Resistors, 89S51 Microcontroller

I. INTRODUCTION

The sun is the main source of energy for the earth's surface which is used directly or indirectly. Indirect form of energy comes from fossil fuels like coal, petroleum etc. We must use direct form of energy as the fossil fuels are in limited quantity & will extinct one day [1]. But, the efficiency of solar panels is very low, i.e. of the order of 10-12% [2]. Solar tracking is one of the various techniques used to increase the efficiency of solar panels.

Light gathering by solar panels is dependent on the angle of incidence of light rays to the solar cell's surface. If a flat solar panel is mounted on level ground, the sunlight will have an angle of incidence close to 90° in the morning as well as in the evening hours [2]-[4]. At such an angle, the light gathering ability of the cell is essentially zero, resulting in no output. As the day progresses to midday, the angle of incidence approaches 0°, causing a steady increase in power until the light incident on the panel is completely perpendicular, and maximum power is achieved [2]. Further, as the day continues toward dusk, the reverse happens, and the increasing angle causes the power to decrease again toward minimum again.

Hence, there is a need to maintain the maximum power output from the panel by maintaining an angle of incidence as close to 0° as possible [4]. The process of sensing and following the position of the sun is known as Solar Tracking [2]. In this work, various methods of solar tracking have been discussed along with their benefits & shortcomings. An efficient street lighting system using solar tracking with 8051 microcontroller has also been proposed.

II. METHOD OF SOLAR TRACKING

Solar tracking is one of the most appropriate technologies so as to increase the efficiency of solar panels. Rather than purchasing additional solar panels, they can help to harness solar energy in more efficient way even with respect to cost. In this section, various types of solar trackers have been discussed along with their advantages and disadvantages.

2.1 Passive Solar Tracker

his passive tracking system (as shown in Fig. 1) realizes the movement of the system by utilizing a low boiling point liquid. This liquid is vaporized by the added heat of sun and the center of mass is shifted leading to move the system to a new equilibrium position [3]. Sun's heat moves the liquid from side to side. This action allows gravity alone to turn the Track rack to follow the sun [5]. Shipped partially assembled, it is easy to install and is module specific.

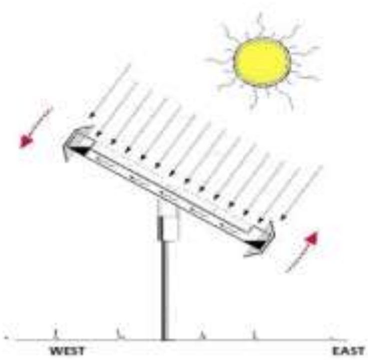

Fig.1 Passive Solar Tracking [3]

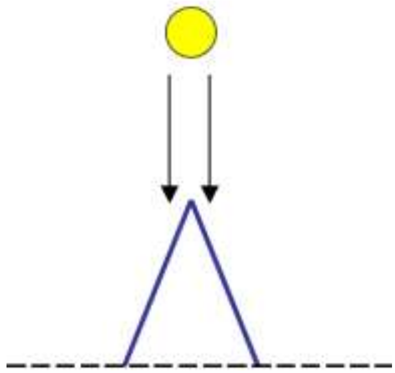

Fig.2 Triangular Solar Panel [2]

2.2 Active Solar Tracker

2.2.1 Triangular Solar Panel

In this panel, a simple triangular set-up uses two solar cells facing opposite directions as shown in Fig. 2. In its rest position, both the solar cells receive an equal amount of sunlight, as the angle of incidence, although not 90°, is equal in both cases [2]. As the sun moves in the sky, the angle of incidence of light to the reference panels will cause more light to fall on one cell than the other. This cause a voltage difference. It results in a detectable signal at each cell, which can be processed by a suitable circuit. The efficiency of triangular solar panel is 18% [2]-[8], i.e. higher than fixed solar panel.

2.2.2 Single Axis Tracking

Single axis tracking systems realizes the movement of either elevation or azimuth for a solar power system. A single-axis tracker can only pivot in one plane – either horizontally or vertically. This makes it less complicated and generally cheaper than a dual-axis tracker, but also less effective at harnessing the total solar energy available at a site. Trackers use motors and gear trains to direct the tracker (as commanded by a controller) towards maximum sunlight. Since the motors consume energy, one wants to use them only when necessary [10]. A horizontal-axis tracker (HSAT) consists of a long horizontal tube to which solar modules are attached. The tube aligned in a north-south direction, is supported on bearings mounted on pylons or frames, and rotates slowly on its axis to follow the sun's motion across the sky [11]. This kind of tracker is most effective at equatorial latitudes where the sun is more or less overhead at noon. For higher latitude, a vertical-axis tracker is better suited [4]. The efficiency of single axis tracking is 23% which is higher than the fixed panel & passive solar tracking [3].

2.2.3 Double Axis Tracker

Dual axis trackers have two degrees of freedom that act as axes of rotation (as shown in Fig.3). They can rotate simultaneously in horizontal and vertical directions, and so are able to point exactly at the sun at all times in any location. Dual axis tracking systems realize movement both along the elevation and azimuthally [8]. These tracking systems provide the best performance with efficiency is in the range of 27-40% [9].

Fig.3 Double Axis Tracker [6]

Fig.4 Spin Cell [14]

2.2.4 Spin Cell

In contrast to the traditional solar panels, spin cells (as shown in Fig. 4), places the solar cells on a cone shaped frame which are covered with energy concentrators. Once in operation, the whole works spins, making unnecessary the need for tracking hardware and software. [14]. The efficiency of this technology is very high with same number of solar panels, it can give 20 times more current than the traditional flat panel.

III. ENERGY EEFFICIENT STREET LIGHT SYSTEM WITH SOLAR TRACKER

Recently, a number of researchers are trying to improve the solar cell efficiency. In order to maximize the output power from solar panel, the process of maximum power point tracking is done. For this purpose a number of algorithms have been developed [15]. These algorithms help to receive the maximum power from a stationary array of solar panels. But, the power generation cannot be increased if the sun is not aligned with the system. For this purpose, automatic solar trackers are used. Use of these trackers increases the power output of solar panels to a great extent. A comparison of total energy received from the sun with and without tracker is represented in Fig.5.

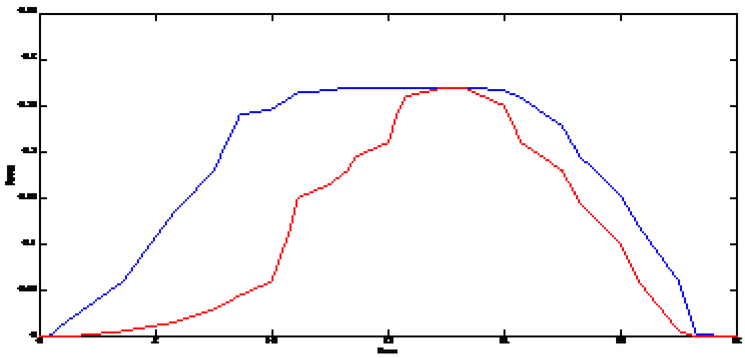

Fig.5. Comparison of Total Energy Received From The Sun With (Blue) and Without (Red) Tracker

In this work, a microcontroller based solar tracking system has been proposed. Solar tracker tracks the sun with the help of LDRs (Light detecting resistors mounted on the solar panel) which sense the intensity of the sunlight & pass signals to the 8051 microcontroller. The controller sends signal to the dc motor which rotates the panel. Rest position of the panel is achieved when central LDR becomes active by getting maximum sunlight at different hours of the day. Instructions are sent to the motor to rotate the solar panel in clockwise or anticlockwise directions depending on the state of LDRs '2' & '3' respectively. The overall process is shown in the flowchart of Fig. 6.

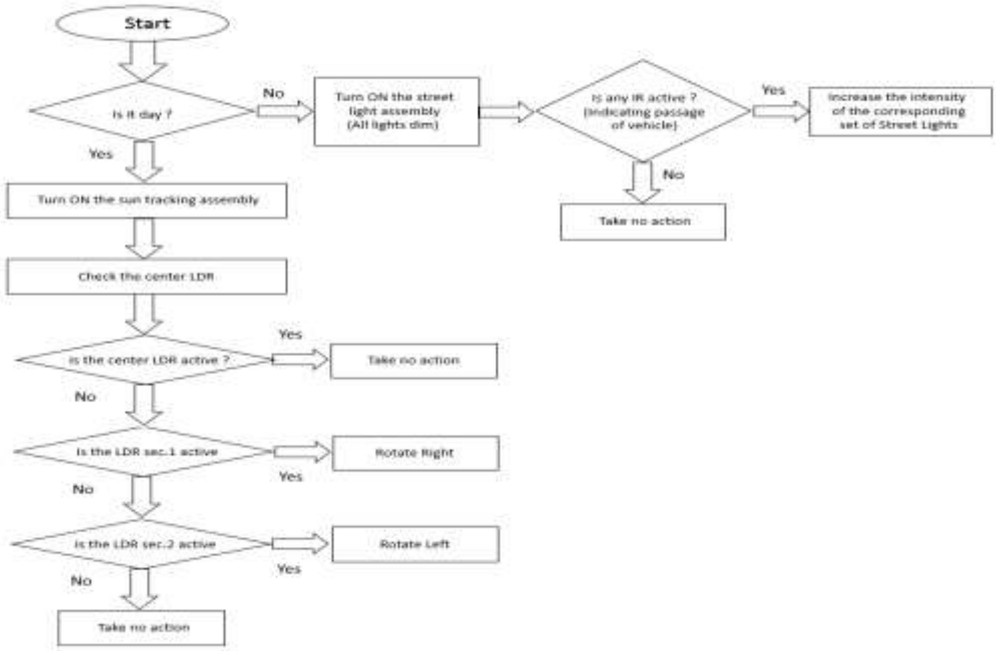

Fig.6 Flow Chart of the Energy Efficient Street Light System With Sun Tracking

The solar panel has a rating of 3- 4 V which drags 100mA current. 89S51 microcontroller has been used along with 7805 voltage regulator. As a result, the solar power harnessed by the solar panels is increased as shown in the graph of Fig. 5. The overall circuit arrangement of energy efficient street light system has been shown in Fig.7. During night, the street light assembly is turned ON with all the lights dim. As any vehicle passes by, the corresponding IR sensor senses the interruption and microcontroller gives the commands to increase the intensity of respective set of lights maximum . Thus, the overall energy consumption is reduced and maximum energy is harnessed from the Sun.

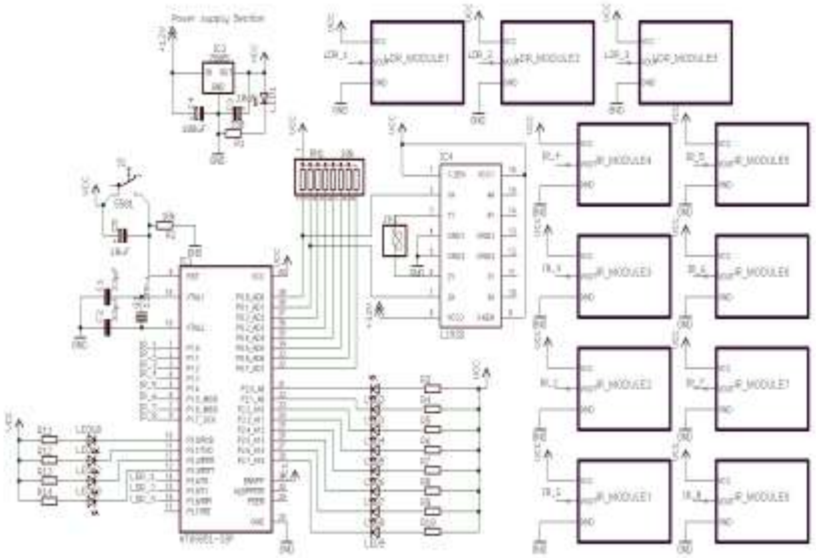

Fig.7. Circuit Arrangement of Energy Efficient Street Light System

IV. CONCLUSION

In this work, an efficient street light system with solar tracker is designed by using LDRs (Light detecting resistors) which sense the intensity of sun light & rotate the tracker with the help of DC motor. By using this method, the solar tracker is able to maintain the angle of incidence near to 0° during day time. As a result, the power of HSAT (Horizontal Single Axis Tracker) increases up to 23%. The microcontroller is also programmed to minimize the energy consumption by decreasing the intensity of street light in the absence of traffic.

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