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Solar Tracking System using DC Gear Motor

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***Abstract* —** In an ordinary solar power system the sunlight was not used to the maximum extent and so in order to take the system to the highest potential, solar tracking system was employed. This paper shows design and realization of automatic solar panel orientation system in order to achieve high performances. This can be done by keeping the solar panel at 90 degree to the sun rays. To achieve this, components like PIC microcontroller, a DC gear motor, four solar cells, and a gear wheel arrangement were used. The solar tracking system operates by the comparison of voltages using solar cell array, which is connected to the PIC microcontroller. And so, the main panel rotates where the maximum light is absorbed. As a result of using this solar tracking system, the efficiency of the system was found to be increasing when compared to the system that does not use the process of solar tracking.

Keywords — Solar Tracking, Solar Panel, Microcontroller, DC Gear Motor.

I. INTRODUCTION

One of the most promising renewable energy sources characterized by a huge potential of conversion into electrical power is the solar energy. The conversion of solar radiation into electrical energy by Photo-Voltaic (PV) effect is a very promising technology, being clean, silent and reliable, with very small maintenance costs and small ecological impact. The interest in the Photo Voltaic conversion systems is visibly reflected by the exponential increase of sales in this market segment with a strong growth for the next decades.

The continuous evolution of the technology determined a sustained increase of the conversion efficiency of PV panels, but nonetheless the most part of the commercial panels have efficiencies, no more than 20%. A constant research preoccupation of the technical community involved in the solar energy harnessing technology refers to various solutions to increase the PV panel's conversion efficiency. Among PV efficiency improving solutions we can mention: solar tracking, optimization of solar cells geometry, enhancement of light trapping capability, use of new materials, etc. The output power produced by the PV panel depends strongly on the incident light radiation. The continuous modification of the sun-earth relative position determines a continuously changing of incident radiation on a fixed PV panel. The point of maximum received energy is reached, when the direction of solar radiation is perpendicular on the panel surface.

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Thus an increase of the output energy of a given PV panel can be obtained by mounting the panel on a solar tracking device that follows the sun trajectory. Unlike the classical fixed PV panels, the mobile ones driven by solar trackers are kept under optimum isolation for all positions of the Sun, boosting thus the PV conversion efficiency of the system. The output energy of PV panels equipped with solar trackers may increase with tens of percent, especially during the summer when the energy harnessed from the sun is more important. Photo-Voltaic or PV cells, known commonly as solar cells, convert the energy from sunlight into DC electricity. PVs offer added advantages over other renewable energy sources in that they give off no noise and require practically no maintenance. A tracking system must be able to follow the sun with a certain degree of accuracy, return the collector to its original position at the end of the day and also track during periods of cloud over.

The major components of this system are as follows.

1. Solar cell & Solar Panel
2. PIC Microcontroller
3. Output mechanical transducer (DC motor)
4. Relay Circuit
5. Gear Arragement

II. BACKGROUND

A Solar Tracker is a device into which solar panels are fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. The Solar Tracker will attempt to navigate to the best angle of exposure of light from the sun. A brief introduction to Solar Panel and Solar Tracker is explained in the Literature Research section. Basically the Solar Tracker is divided into two main categories, hardware and software. It is further subdivided into four main functionalities: Method of Tracker Mount, Drives, Motors, and Power Supply of the Solar Tracker is also explained and explored. The reader would then be brief with some analysis and perceptions of the information.

By using solar arrays, a series of solar cells electrically connected, a DC voltage is generated which can be physically used on a load. Solar arrays or panels are being used increasingly as efficiencies reach higher levels, and are especially popular in remote areas, where placement of electricity lines is not economically viable. This alternative power source is continuously achieving greater popularity especially since the realisation of fossil fuels shortcomings. Renewable energy in the form of electricity has been in use to some degree as long as 75 or 100 years ago. Sources such as Solar, Wind, Hydro and Geothermal have all been utilised with varying levels of success. The most widely used are

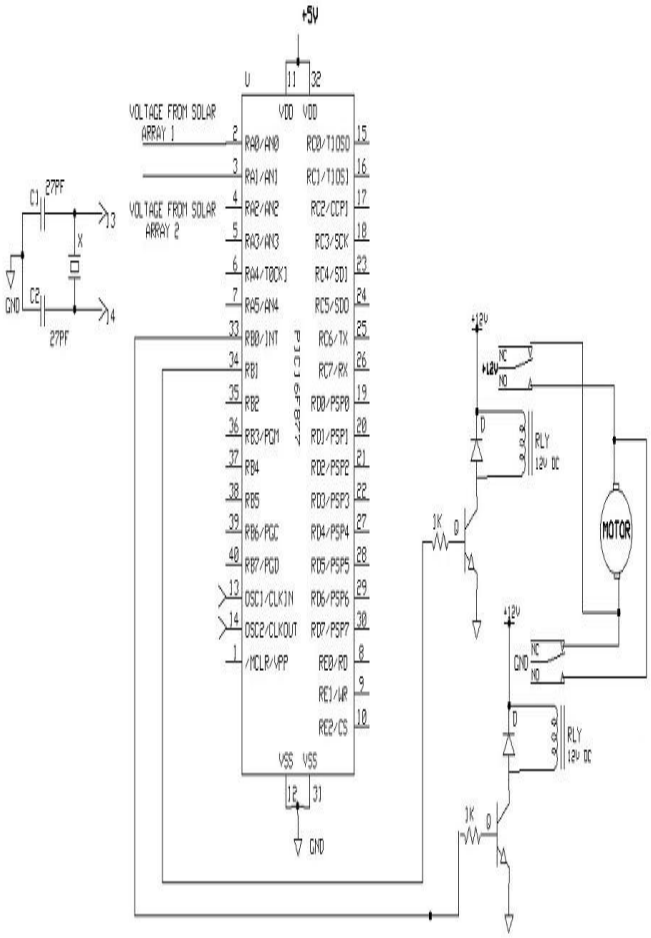

Fig. 1 Schematic representation of Solar

hydro and wind power, with solar power being moderately used worldwide. This can be attributed to the relatively high cost of solar cells and their low conversion efficiency. Solar power is being heavily researched, and solar energy costs have now reached within a few cents per kW/h of other forms of electricity generation, and will drop further with new technologies such as titanium oxide cells. With a peak laboratory efficiency of 32% and average efficiency of 15-20%, it is necessary to recover as much energy as possible from a solar power system. This includes reducing inverter losses, storage losses, and light gathering losses.

Light gathering is dependent on the angle of incidence of the light source providing power (i.e. the sun) to the solar cell's surface, and the closer to perpendicular, the greater the power. If a flat solar panel is mounted on level ground, it is obvious that over the course of the day the sunlight will have an angle of incidence close to 90° in the morning and the evening. 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 at the point where the light incident on the panel is completely perpendicular, and maximum power is achieved.

As the day continues toward dusk, the reverse happens, and the increasing angle causes the power to decrease again toward minimum again. From this background, we see the need to maintain the maximum power output from the panel by maintaining an angle of incidence as close to 0° as possible. By tilting the solar panel to continuously face the sun, this can be achieved. This process of sensing and following the position of the sun is known as Solar Tracking. The solar tracker can be still enhanced additional features like rain protection and wind protection and also dual axis rotation.

III. SOLAR PANEL SPECIFICATIONS

Thedetails of the solar panel used are included below

Table 1. Specifications of Hardware

Type	Multi-Crystalline Silicon
Maximum Power	10 Watt
Maximum Power voltage	18V
Maximum Power current	0.56A
Open circuit voltage	21.6V
Short circuit current	0.59A
Size of panel	(Wide And High) 340*280*22mm
Number of cells	36
Weight per piece	1.5 KgsD.

Table 2. Analysis without tracking system

Time	Opencircuit voltage
10 AM	19.7 V
12 PM	19.9 V
2 PM	19.64 V
4 PM	19.59 V
6 PM	17.87 V

Table 3. Analysis with tracking system

Time	Open circuit voltage
10.30 AM	20.20 V
12.30 PM	20.10 V
2.00 PM	19.80 V
3.30 PM	19.83 V
4.45 PM	19.46 V

IV. GEAR ARRANGEMENT

To make the externally connected mechanical hardware rotate at the required speed, gear arrangement was done. A small gear was attached to the motor & another large gear was attached to the hardware, so that the speed gets reduced. The speed produced by the motor gets reduced to the required number of times & then reaches the mechanical hardware through large gear & chain arrangement. The gear ratio will be 3:1.

Fig.3.Wheel Arrangement

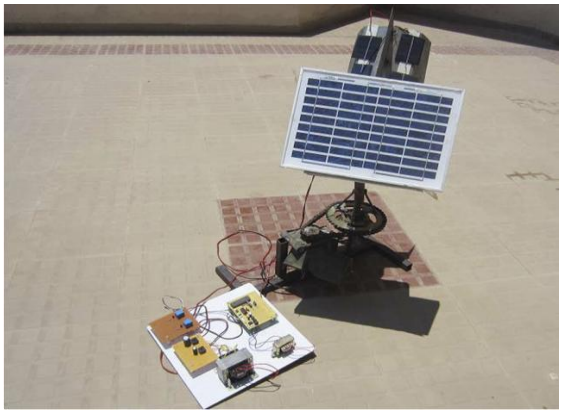

Fig4.Hardware setup of the Solar Tracking System

V.WORKING PRINCIPLE

The solar tracking system operates by the comparison of voltages that are solar cell array. The compared voltage levels are given as the input to the PIC microcontroller. Motor is use to drive the Solar Tracker to the best angle of exposure of light with the help of wheel arrangement. The required power used to run the motor and controller is provided by Step-Down transformer by using 220V AC

VI. CONCLUSION

From the design of experimental set up with Micro Controller Based Solar Tracking System using DC gear Motor, If we compare Tracking by the use of solar cell with Fixed Solar Panel System we found that the efficiency of Micro Controller Based Solar Tracking System is improved by 30% and it was found that all the parts of the experimental setup are giving good results.. Moreover, this tracking system does track the sun in a continuous manner. And this system is more efficient and cost effective in long run. From the results it is found that, by automatic tracking system, there is gain in increase of efficiency when compared with non-tracking system.

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