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USE OF SOLAR TRACKING SYSTEM TO INCREASE THE EFFICIENCY OF PV CELL

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Abstract- *The aim of the present study was to design solar tracking system with reflecting mirror using microcontroller system to increase the efficiency of solar photovoltaic (PV) panel. The objective of this project is to generate maximum power by tracking the sun throughout the day. The solar tracker tracks the sun from East to West throughout the day. More energy is collected by monitoring the solar panel to track the sun like a sunflower. The solar tracking system is a mechatronic system that integrates electrical and mechanical systems, and computer hardware and software. The proposed approach in the present study is to employ a mirror augmented PV solar panel to track the sun and reflect rays on the PV panel. The increase percentage in the output of panel and discharge differs with the solar radiation along daytime. The application of mirror is an efficient and effective way to enhance the performance of solar photovoltaic cell with the same panel area. Maximum power point tracking (MPPT) used in this research is the process to maximize the output power from solar panel by keeping the solar panel's operation on the knee point of P-V Characteristics.*

Key words: Solar energy, photovoltaic panel, reflecting mirror, tracking system, microcontroller.

1. INTRODUCTION

The increasing demand for energy, the continuous reduction in existing sources of fossil fuels and the growing concern regarding environment pollution, have pushed mankind to explore new technologies for the production of electrical energy using clean, renewable sources, such as solar energy, wind energy, etc. Among the non- conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet. Solar power (photovoltaic) systems are a sustainable way to convert the energy of the sun into electricity. The expected lifetime of a system is 25-30 years [1]. Production of electricity from sunlight with a conversion ratio of about 15% by the use of the photovoltaic technology.Lots of research has been carried out in improving solar cells efficiency. But, unfortunately, it is still suffering from few draw backs. The first one is the relatively high cost of the cells. The second one is that the efficiency is still low even at the current rate of 33%.The third one is the positioning of the solar cells, especially during the long summer days where the sun shines for more than 16 hours a day and fixed cells do not extract maximum energy. In the past, people using solar energy fix the panels midway between the geographical east and west with approximately 30 degrees towards the south.Studies have shown that this is not ideal positioning in order to maximize energy extraction. Among the proposed solutions for improving the efficiency of PV conversion, we can mention solar tracking [2]-[4], the optimization of solar cell configuration and geometry [5]-[6], new materials and technologies [7]-[9], etc. By tracking the sun the efficiency can be increased by 30-40% [10].

2. MATERIALS AND METHOD

2.1 Project Design Methodology

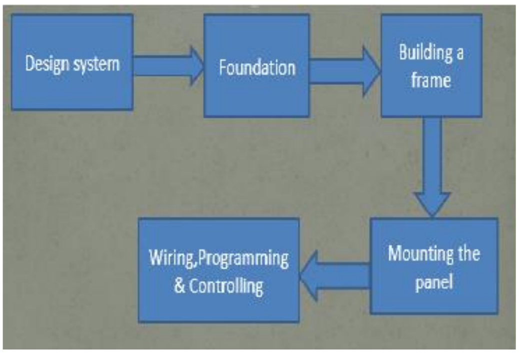

Fig.1: Block diagram of project design methodology

Design System: Firstly to build a solar tracker designing, model is a basic need. The solar panel is fastened to the frame, as well as the mirror to improve the design. The mirror will help to increase the fall of the sun rays upon the panel. The factor in which design criteria depends are: (i) Dimension of the panel. (ii) Capacity of the panel. (iii) Selection of structural material. (iv) Selection of stepper motor, (v) Space available.

Foundations: For balancing the solar tracker a good foundation is a very important thing. Secondly basic foundation is needed to implement this project. The foundation should have adequate strength to hold the total system.

Fig.2: Foundation of the solar tracker

Building Frame: To set the solar system building a frame is also an important thing. The panel and mirror are stay in the frame.

Mounting the Solar Panel: Here to mount the solar panel, fasten the panel to the frame has done.

Fig.3: Mounting the panel on the frame

Proper wiring system to control the motor program is set and also to control the overall system.

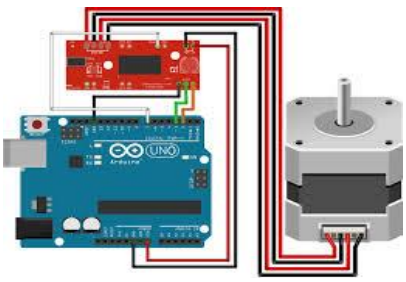

Fig.4: Wiring with Arduino & Stepper motor

2.3. Boosting the Solar Panel

Solar panels are a great way to make some green electricity for our home and workplace but they are kind of expensive and sometimes the wattage produce can be a bit disappointing. If we use a sun tracking system to keep our panels facing the sun we can considerably improve the power yield but these are not cheap and on a small system they can add considerably higher cost. Here is a relatively cost effective and simple way to get 75% more power from any ordinary solar panel. Most of the time a solar panel is working well below peak power, on hazy days and when the sun is lower in the sky, early morning, and late afternoon is the example. The light levels are just not high enough, so to boost the light level aligning a mirror will reflect more light onto solar panel. It worked really well and after a bit of experimentation it was found that placing a mirror at least twice the size of the solar panel on the ground in front of the panel could boost the output by as much as 75%.

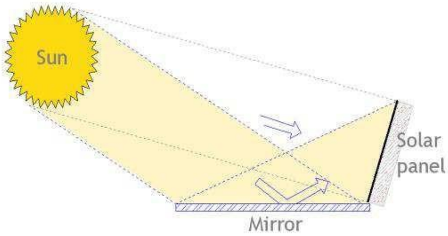

Fig.5: Boosting the solar panel

Using a bigger mirror can reflect light onto panel over a longer period during the day so tracking the sun is not needed, just face the panel and mirror due south. This is probably one of the cheapest and easiest ways to boost the power of a small solar panel, but this method does have some limitations. Using more mirrors to reflect more light onto the solar panel increase its power further but on a sunny summer's day the extra light can build up a lot of heat that may damage the panel. Placing mirrors either side of the panel to reflect doesn't work well because as the sun moves west it will cast a shadow across the panel. The only place that the mirror won't cast a shadow at any time in the day is on the ground in front of the solar panel. On a dull day the mirror doesn't give much of a power boost at all.

The experimental result is depends on i) solar intensity ii) area of the PV cell iii) voltage iv) current. The total system set on the direction of the sun. If the panel does not get its position perfect, it will track automatically the maximum light of sun by its sensors. Thus a current & voltage drop is found. Then by using millimeter, the readings of voltage and current is noted down. The photovoltaic trainer instruments give the solar intensity for different period of time. By measuring theses values, the power output of the solar panel and its efficiency can be calculated.

3. RESULTS & DISCUSSION

With the application of reflector on the photovoltaic panel the incident, the actual effect increases. Consequently, temperature of the panel increased with the application of the reflector due to extra solar radiation. Therefore, it is necessary to evaluate in what extend the power and efficiency of the panel increased with application of reflector. From Table-1, it is clear that the performance of the panel improved by the application of the reflector. The total experimental process is done in summer and waiting for the winter season.

3.1. In Summer Season:

Table 1: (10 May 2015) Effect of stationary reflector on the photovoltaic panel

Time	Non tracked (PV module)			Tracked (PV module with Reflector)		
	Voltage (V)	Current (A)	Power (W)	Voltage (V)	Current (A)	Power (W)
09.00 am	18.5	0.15	2.78	19.1	0.21	4.01
10.00 am	18.6	0.16	2.98	19.2	0.22	4.22
11.00 am	18.7	0.17	3.18	19.4	0.24	4.66
12.00 pm	18.9	0.19	3.59	19.5	0.25	4.88
01.00 pm	19.2	0.22	4.22	19.8	0.28	5.54
02.00 pm	19.2	0.22	4.22	19.9	0.29	5.77
03.00 pm	19.3	0.23	4.44	20.1	0.31	6.23
04.00 pm	19.0	0.20	3.80	19.8	0.28	5.54

Voltage vs. Day Time Curve:

Voltage increases with respect to the day time because intensity increases from 9 am to 2 pm. After 3 pm the intensity decreases as a result, the voltages automatically decrease. This figure- 5 shows difference of voltage output resulted between with tracking and without tracking system.

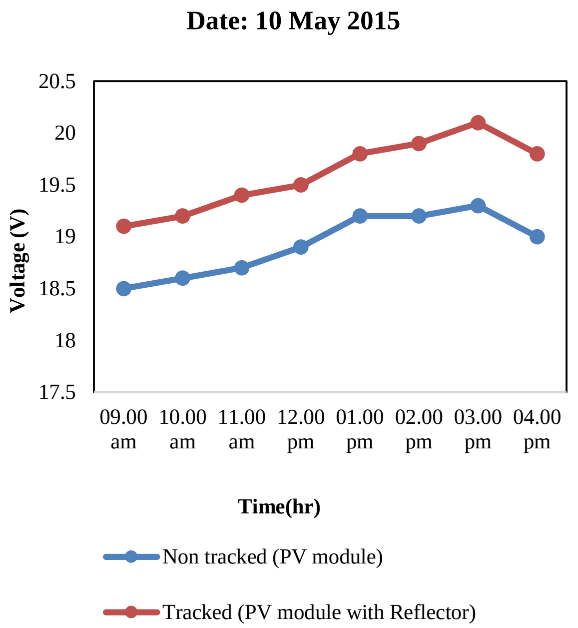

Fig.5: Voltage vs. Day time curve.

Current vs. Day Time Curve:

As voltage increases with increase in intensity, current output also increases with respect to the day time between 9am – 2 pm. After 3 pm the intensity decreases so the current automatically decrease. This figure- 6 shows difference of current output between with tracking and without tracking system.

Power Vs Day Time Curve:

Power increase with respect to the day time till 2pm because intensity of insolation increases. After 3 pm the intensity of sunlight decreases so the power automatically decreases. This figure- 7 shows difference of power output between with tracking and without tracking system.

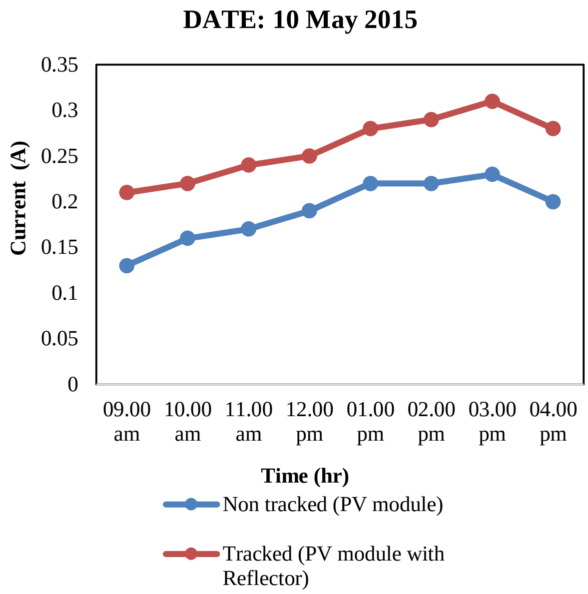

Fig.6: Current vs. Day time curve.

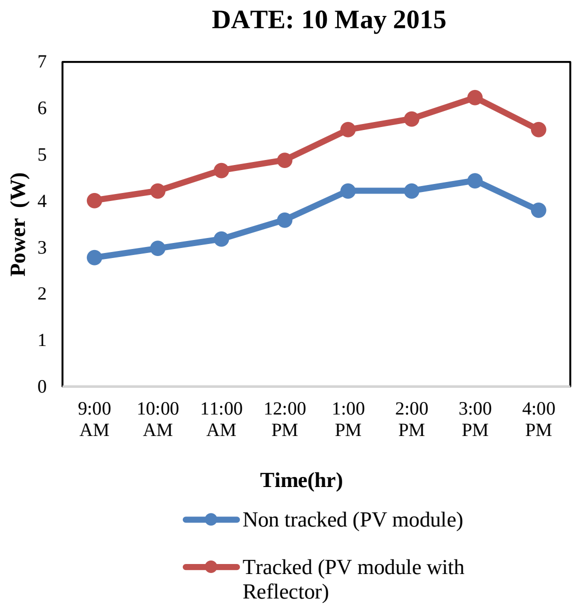

Fig.7: Power vs. Day time curve.

3.2 Efficiency calculation:

Non-tracked (PV module):

Panel Length = 0.195m
Width = 0.215m

Area of the Panel = Length × Width = 0.195 × 0.215 = 0.04m
Voltage, V = 19.6v
Current, I = 0.26A
Solar intensity, i = 1256 W/m^2
Power, P = 19.6 ×0.26 = 5.10watt
Efficiency = (V×I)÷(A× i) = (19.6 × 0.26)÷(0.04 × 1256) = 10.1%

Tracked PV module with Reflector:
Voltage, V = 20.2v
Current, I = 0.32A
Solar intensity, i = 1256 W/m^2
Power, P = 20.2 × 0.32 = 6.46watt
Efficiency = (20.2 × 0.32)÷(0.04 × 1256) = 12.9%

4. CONCLUSION

The microcontroller based solar tracking system with mirror booster has been fabricated and the efficiency of solar panel with tracking device was obtained about 12.9% whereas without tracking system it was resulted 10.1%. The proposed circuit design with stepper motor and Arduino is simple and self-contained, and very easy for programming.The proposed methodology is an innovation so far. It achieves the following attractive features are simple and cost effective control implementation, bulky but it is effective for large power generation.

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