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AN INNOVATIVE LOW COST SOLAR TRACKER

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ABSTRACT

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. The concerns for climate change and energy security have given impetus to the exploitation of solar energy. Boost to the solar energy utilization for power as well as for thermal applications including capacity-building for the manufacturing sector. Solar tracking devices maximize the energy collected by solar panel placing the photovoltaic (PV) panels perpendicular to the sun's direct radiation throughout the day. The PV panels have a low conversion efficiency of around 12 percent. 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. This paper deals with the design and execution of a solar tracker system dedicated to the PV conversion panels. The proposed single axis solar tracker device ensures the optimization of the conversion of solar energy into electricity by properly orienting the PV panel in accordance with the real position of the sun. The operation of the experimental model of the device is based on a Stepper motor intelligently controlled by a dedicated drive unit that moves a mini PV panel according to the signals received from two simple but efficient light sensors. A solar tracking system increases the input energy to the PV panels and, thereby, the energy output of the PV panels with almost the same conversion efficiency. Solar tracked PV panels may generate up to 15 percent (single axis) and 25 percent (dual axis) more electricity as compared to the fixed PV panels. The

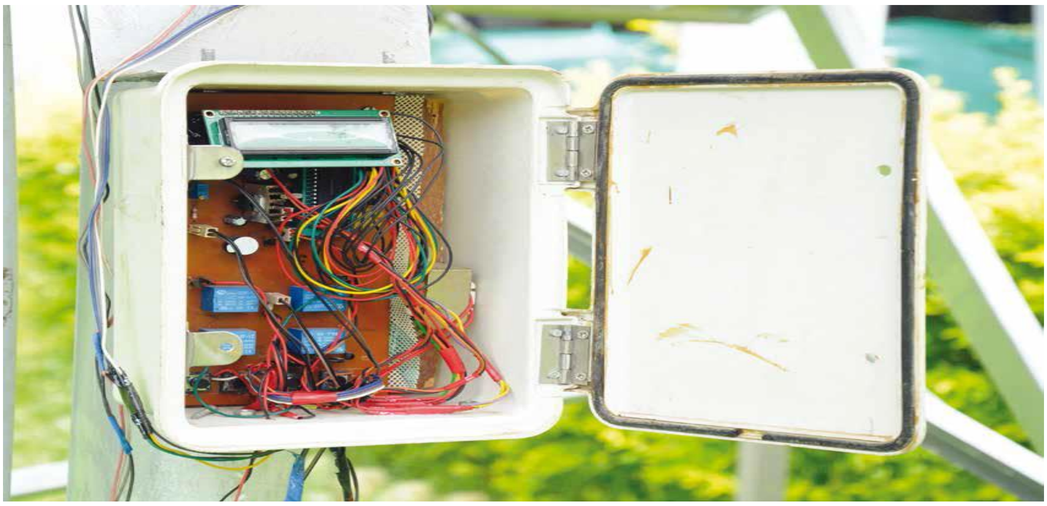
system comprises a solar PV panel mounting structure with tilting adjustment and a rigid pole at the center .The PV panels of 1 kWp capacity are mounted on the tracker. Two photo sensors (photo diodes) are fitted at 45°.A control circuit is used for moving the solar PV panel in the high solar intensity region. The semicircular structure provides smooth and controlled movement of the tracking system. In this paper mechanism of building an efficient solar tracking system with the help of Lab view software is discussed and also discussed about the control strategy of the stepper motor. From the study it is found that the motor will move the solar array according to the light intensity of the sun.

Keywords: PV Panels, Photo Diodes, Solar Intensity, Solar Tracking System, Light Intensity, Lab View, Stepper Motor Etc.

I. INTRODUCTION

Sun tracking systems are, in general, timer controller-based (15° per hour rotation) and require manual intervention for starting and stopping the system because solar time changes throughout the year. The electro-optical automatic, two axis sun trackers, based on the imported technology, are very expensive and the local facilities for their repairs are generally not available. Keeping this in view, a Programmable Intelligent Computer (PIC) microcontroller-based solar tracking system using commercially available low cost components has been designed and developed. | The design of an innovative Programmable Intelligent Computer (PIC) microcontroller-based solar tracking system which is cost effective and also increases the overall energy output. The average daily energy output of the tracked panels was found to be 16–20 percent more than the stationary panels (Picture 1).

Pic.1: Solar Tracker Mounted with 1kWp PV Modules



Pic.2: Sun Tracking Systems are Generally Controlled by a Timer and Manually-Run

II. SALIENT FEATURES OF THE TRACKING SYSTEM

The system has the following noticeable features:

- It is low cost, has a simple design, and is easy to operate.
- There is a single pole support system suitable for mounting up to 105 kg mass of PV panels.
- It can sustain up to 1 kWp of PV panels (around 7.75 m^2 area).
- Photo sensors, DC motor, PIC microcontroller, and all the other components are low cost and commercially available.
- The minimum angle of tracking is 0.1°.
- The electricity generated by the PV panels is used for operation of the system. It may also be adapted for the state grid supply.
- North West setting of the tracker is done manually once every three months.
- It may be scaled up for mounting PV panels up to 35m^2 area by increasing the number of the supporting poles.

III. DESIGN AND DEVELOPMENT

The system comprises a solar PV panel mounting structure with tilting adjustment and a rigid pole at the centre. The PV panels of 1 kWp capacity are mounted on the tracker. Two photo sensors (photo diodes) are fitted at 45°.A control circuit is used for moving the solar PV panel in the high solar intensity region. The semi-circular structure provides smooth and controlled movement of the tracking system. The combinations of chain and sprocket and compound wheel drives are used to achieve the desired speed. Figure 1 shows the schematics of the solar tracking system(Picture 2).All the components of the solar tracking system are low cost and commercially available. Figure 2 illustrated the schematics of the control circuit. The microcontroller has been programmed such that when the intensity of light is less than 98 percent and greater than 60 percent the microcontroller drives the motor in forward direction (towards west) and if the intensity is more than 102 percent and less than 150 percent it drives the motor in reverse direction (towards east).

IV. TRACKER PERFORMANCE

In tracking mode, the PV panel surface rotated slowly and remained perpendicular to the sun throughout the day, thereby reducing the cosine losses at the PV panel surface. The PV system output was connected to a DC pumping system and efficiency of the tracking system was worked out.

Various parameters of the tracker system were monitored and recorded for tracking and fixed modes of operation. Total electrical energy outputs in the fixed and tracking modes were 3.12 and 3.68 kWh respectively, for solar radiation of 5.24

KWh/m2/day (Table1). As compared to the fixed mode, the PV panels generated 18 percent more energy in the tracking mode. Besides, variations in the electrical energy output were lower in the tracking mode than the fixed mode. The sun tracking system was found to be more effective during morning and late afternoon hours. Figure 3 shows the energy gained in the tracking mode (1 percent tracking error) as compared to the fixed mode.

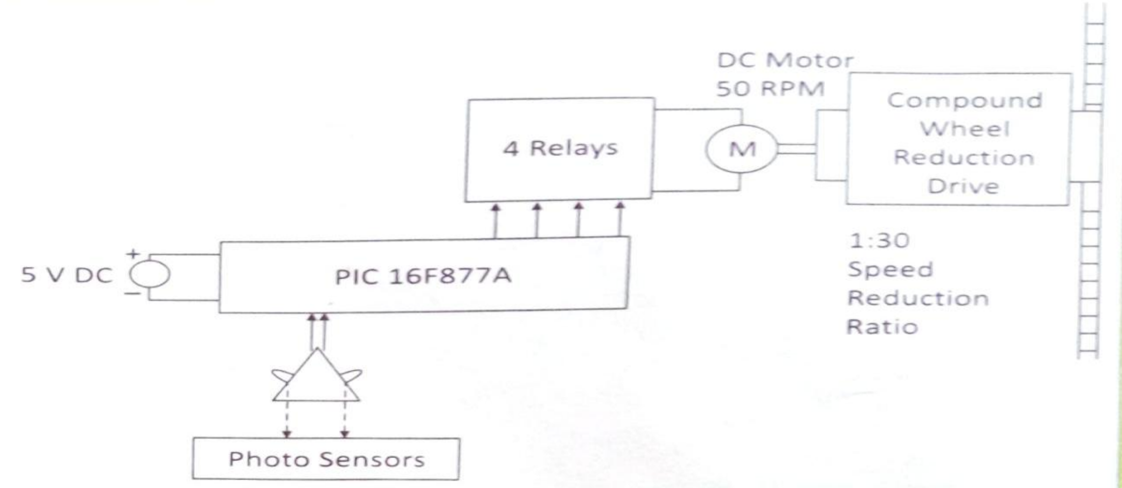


Fig. 1: Schematic Diagram of the Solar Tracking System

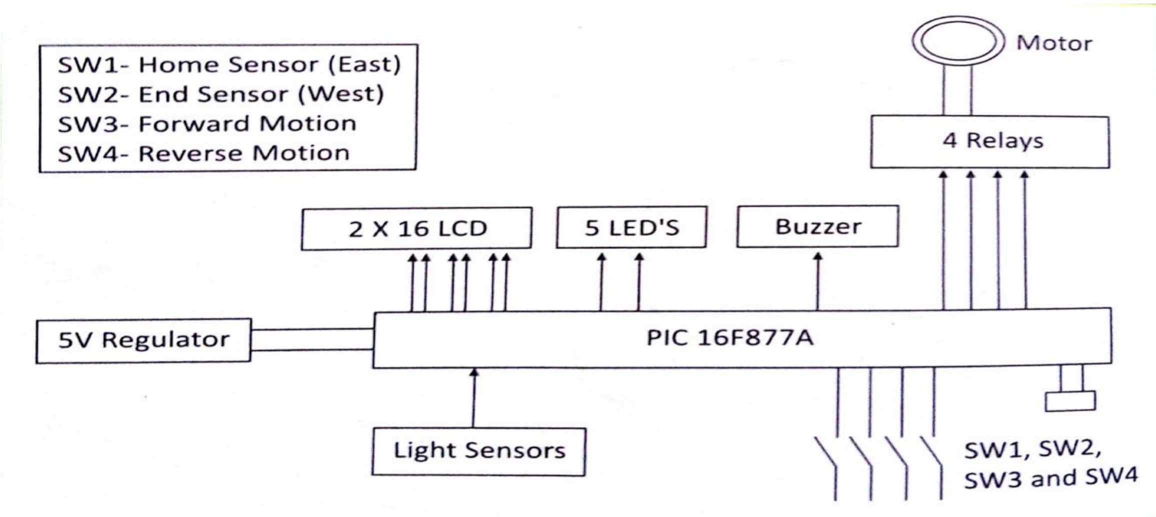


Fig. 2: Schematic Diagram of the Control Circuit

Table 1: Daily energy generated and energy gained

Mode	Energy Generated {kWh}	Energy Gained {%}
Fixed	3.12	NA
Tracking	3.68	18

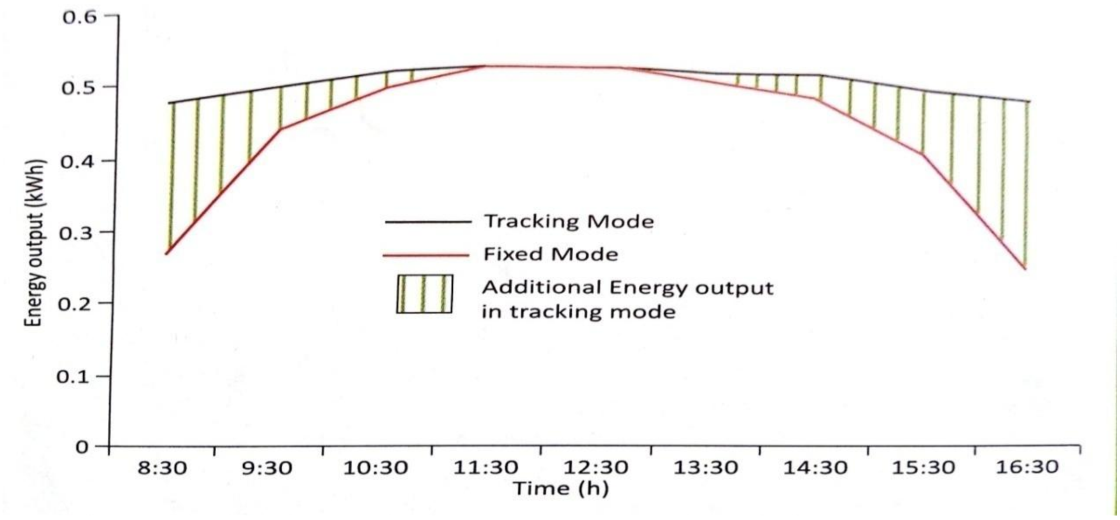


Fig. 3: Energy Gained in the Tracking Mode as Compared to the Fixed Mode

V. FINANCIAL ASPECTS

The system has the following financial aspects:

- The estimated cost of the tracker for mounting 1kWp PV panel is Rs.30,000/-.
- The pay-back period has been worked out to be six years as against expected service life of around 25 years.

VI. SUITABILITY FOR SPECIFIC CONDITIONS

In India, good solar radiation is normally available for 300 days in a year. The operation of the system is automatic, only the tilt angle is required to be changed depending on the season (3–4 times a year). The system is maintenance-free except for protection of the gear reduction drive and the DC motor from the rainwater. A low-cost solar tracker appears ideal for solar pumping, roof top PV, and other similar applications.

VII. CONCLUSION

A low-cost indigenous solar tracking system has been developed for small capacity solar power applications. The solar tracker increased energy generation by 18 percent as compared to the fixed mode.

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