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Design and Manufacturing of Single Axial SolarParabolic Trough

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Abstract— **This research paper presents the design and manufacturing of a single-axis solar parabolic trough tracking system for efficient solar energy collection. The system is composed of a parabolic trough reflector, a receiver, a tracking mechanism, and a support structure. The parabolic trough reflector is designed to concentrate sunlight onto the receiver, which absorbs the thermal energy and converts it into useful applications such as electricity generation, space heating, or industrial process heat. Experimental testing was conducted to evaluate the system's performance in terms of efficiency and cost-effectiveness. The results demonstrate that the single-axis solar parabolic trough tracking system is an efficient and sustainable way to collect and utilize solar energy.**

***Keywords*— Parabolic Trough Collector, PV cells, Arduino Board, Stepper Motor.**

I. Introduction

This Solar energy is a clean, green and freely available energy source across the globe. At present, solar energy is being harvested mainly by two methods: solar PV and solar thermal. The solar thermal method can harness energy using a range of technologies such as concentrated solar power systems, flat plate collector, and evacuated tube collectors. concentrated solar power systems can further be classified into Scheffler collector, linear Fresnel collector, solar tower, parabolic dish concentrator, compound parabolic collector, and parabolic trough collector.

Solar energy sector has experienced significant growth in recent years due to emergence of new technologies for harnessing energy from the sun. There are two basic technologies for generating electricity using solar energy. The first technology is Photovoltaic (PV) solar panels where sunlight is directly converted into electricity. The second technology is Concentrating Solar Power (CSP), where the energy from sun is concentrated using reflectors to produce electrical energy. CSP has high energy efficiency and better thermal energy storage capacity compared to PV, which makes CSP power plants ideal for large scale electricity generation. Globally, the most commonly used CSP technology is Parabolic Trough Collectors. In this paper, the design and implementation of a parabolic trough solar thermal collector has been presented. In addition, a 3d model of the designed parabolic trough collector has been presented.

Components used are Solar Panels, Parabolic Trough Collector, L-shaped link rollers, Support structure, Stepper Motor, Arduino Board.

II. Proposed System

The proposed electronic components required for above mentioned active tracking system are as follows. The idea behind the tracking system is the use of PV cells on both sides of the parabolic trough, choosing the size of the PV cell such that it shall be enough to produce the electricity to charge the battery which will drive the stepper motor over the span on 10 hrs, throughout the day. The same battery will run the Arduino board which is programmed to measure current and voltage output from attached PV cells and command the stepper motor to run screw jack and track the sun’s path in the sky. The setup mainly contains a PV cell, stepper motor, Arduino board, current and voltage sensor, battery, and some software like LABVIEW to write the program for the Arduino board. A stepper motor is an electric motor whose fundamental feature is that its shaft rotates in steps, or moves by a predetermined number of degrees. That is useful for a tracking system because tracking is not a continuous process. The stepper motor is selected based on the torque required to turn the collar of the screw jack used for tracking. It has been decided that the entire system is going to run on 12V of potential difference. 12 V system is preferred if someone intended to run applications via batteries. In comparison to higher operating voltages, this is a safer voltage for DC circuits. Most appliances, especially those used in the home, run on 12-volt systems, making it the most extensively used voltage on the planet.

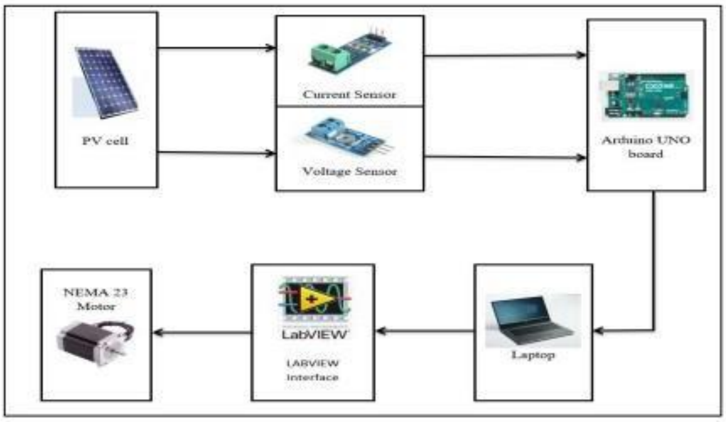

Fig 1. Components of Active Solar Tracking System

This image displays the components of active solar system which are being used for manufacturing of the tracking system. Solar cells, Arduino Uno Board, Stepper Motor are the main components used.

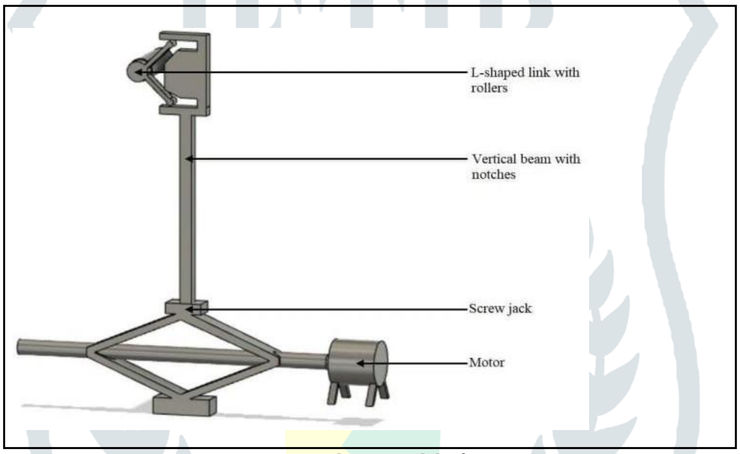

Fig 2. Proposed 3-D Model of System

The above image displays about the proposed system of the main model to be manufactured. An assembly is being shown with the naming of the components.

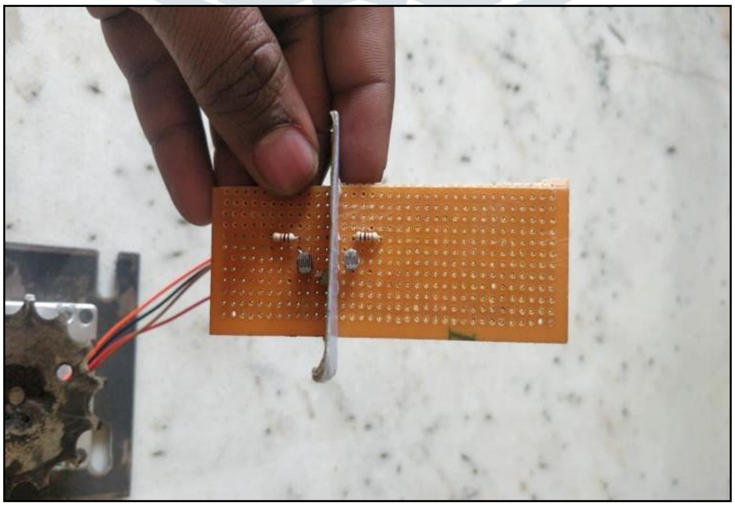

Fig 3. Tracking system Setup.

This image shows the Tracking assembly of the system. It consists of LDR sensor, Sprocket which are used to run the stepper motor.

III. Results

The designed three parabolic troughs solar collector is can be operated for 10 to 12 hours normally, but calculations have been made for 8 hours as for those hours available solar energy is maximum. Besides, in the regions like India, the rainy season are especially responsible for the low performance of the system because of the cloudy sky. Following is the mathematical performance analysis for the system.
The data regarding the city where experiment is going to be commenced is extremely important. It includes the data regarding global beam and diffused radiations reaching the surface to calculate total irradiation on the reflecting material and to find the heal flux absorbed by the receiver on the solar system. This data changes from month to 138 month as relative position of earth changes from aphelion to equinox to perihelion throughout the year.

Pune Region Data
Latitude – 18° 32’ Longitude – 73° 51’

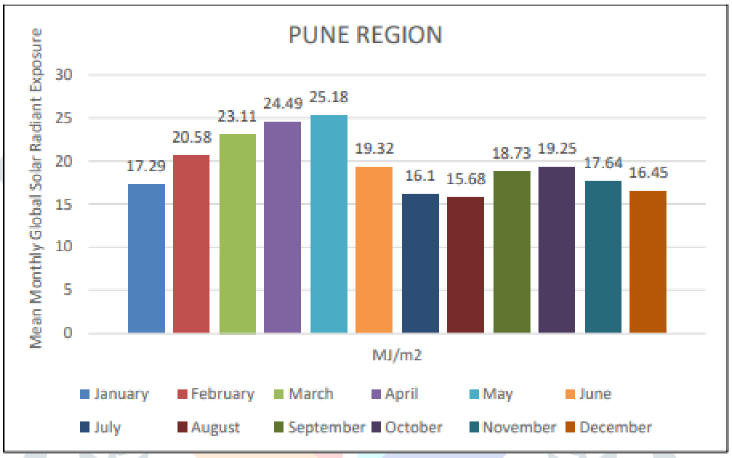

Fig 4. Solar Radiant Exposure on a Monthly Basis

1. For January 15th,

Time of the Day	Output Temperatures from Trough 1, 2 and 3 respectively		
	$T_{out\ 1}$	$T_{out\ 2}$	$T_{out\ 3}$
10:00 AM	65.1	102.0	138.9
11:00 AM	72.5	109.4	146.3
12:00 PM	75.1	112.0	148.9
1:00 PM	72.5	109.4	146.3
2:00 PM	65.1	102.0	138.9
3:00 PM	53.4	90.2	127.1
4:00 PM	38.2	75.1	112.0
5:00 PM	30.0	66.9	103.8

Fig 5. Output Temperatures of the Troughs

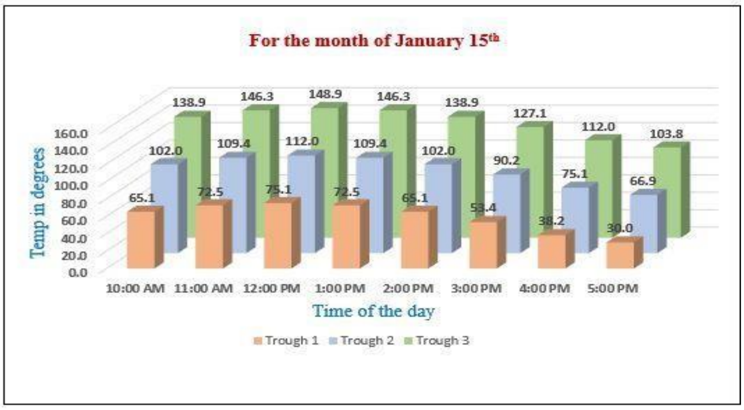

Fig 6. Graphical Representation Output Temperatures of the Troughs.

IV. CONCLUSIONS

The conventional active tracking system used LDR which is effective but delicate, susceptible to damage because of changes in atmospheric conditions, and its life expectancy is less. Apart from that, it consumes electricity continuously. The above-discussed system uses PV cells for the generation of electricity needed for running the tracking system and at the same time, it provides the base for tracking as well based on voltage change. The entire proposed system is comparatively cheaper and easy to install and therefore can be used in different solar tracking systems apart from parabolic trough collectors, this system is useful in all the collectors who uses the single axial tracking system. The tracking system must be carefully designed to ensure accurate and reliable tracking of the sun's movement along a single axis. The manufacturing process must adhere to strict quality control standards to ensure that the system operates safely and efficiently. With proper planning and execution, single axial solar parabolic trough tracking systems can provide a reliable and clean source of renewable energy, contributing to a sustainable future.

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