**DESIGN OF A LOW COST SOLAR TRACKING SYSTEM**

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 ***ABSTRACT***

**In this paper the aim is to design the system, which will automatically track the position of sun and accordingly change the direction of the solar panel to get the maximum output from the solar cell. Solar energy is rapidly advancing as an important means of renewable energy resource. More energy can be produced by tracking the solar panel to remain aligned to the sun at a right angle to the rays of light. This paper describes in detail the design and construction of a prototype for solar tracking system which detects the sunlight using photocells. Its active sensors constantly monitor the sunlight and rotate the panel towards the direction where the intensity of sunlight is maximum. The light dependent resistors(LDR) senses the change in the position of the sun which is dealt by the respective change in the solar panels position by switching on and off the geared motor. An improvement in the hardware design of the existing solar energy collector system has been implemented in order to provide higher efficiency at lower cost. Actuation of the panel tilt for azimuth tracking and rotation of the panel for solar tracking are operated with a gear motor- based control system for adjusting the PV mount system’s position so as to collect maximum solar radiation. The gear motor controller module is built with state-of- the-art, low-cost digital logic circuit with built-in flexibility to accommodate position adjustments of the PV mounts.**

**Keywords: - Solar Tracker, PV cells, Azimuth &Zenith angle, Light Sensor, P-V Curve,LDR(lightdependent resistors).**

**I** **INTRODUCTION**

These days electrical generation is typically provided by fossil fuels such as coal, natural gas, and oil and also as nuclear power some of today’s most serious environmental problems can be linked to world electricity production based primarily on the use of non-renewable resources. Currently one third of the world population do not have access to electricity and are not connected to the national grid. One solution to this problem is renewable energy in the form of photovoltaic (pv) systems despite high capital cost, pv systems are still a viable solution for rural areas. Studies suggest that the rate at which fossil fuels are consumed today, there are high chances that they will deplete by the end of this century. For a long time, it has been thought that atomic energy would be a solution for the growing energy problem, but in recent times solar energy has proved to be an efficient, more secure and safe way of providing energy concepts related to the solar energy have constantly been under heavy research and development. the basic objective is to optimize the energy produced from photovoltaic cells, by making the overall systems more efficient and cost effective. Most solar panels are statically aligned; they have a fixed position at a certain angle towards the sky. Therefore, the time and intensity of direct sunlight falling upon the solar panel is greatly reduced, resulting in low power output from the photovoltaic (pv) cells. Solar tracking system is the solution to this issue as it plays a major role in overall solar energy optimization.[1]

**II IMPORTANCE OF TRACKING**

In order to ensure maximum power output from PV cells, the sunlight’s angle of incidence needs to be constantly perpendicular to the solar panel. This requires constant tracking of the sun’s apparent daytime motion, and hence develops an automated sun tracking system which carries the solar panel and positions it in such a way that direct sunlight is always focused on the PV cells. This paper is about moving a solar panel along with the direction of sunlight; it uses a gear motor to control the position of the solar panel.[1]

 **III EXPERIMENTAL WORK**

Two light dependent resistors (LDR) is used for each degree of freedom. LDRs are basically photocells that are sensitive to light. Software will be developed which would allow the relay to detect and obtain its data from the two LDRs and then compare their resistance. The two LDRs will be positioned in such a way, so that if one of the two comes under a shadow, the relay will detect the difference in resistance and thus actuate the motor to move the solar panel at a position where the light upon both LDRs is equal. Two separate but identical circuits will be utilized for both axes.





Fig 1: Flow Chart Of The Operation Of Sensor Module

Sensor Module Operation of sensor module LDR come under shadow

 Fig 2: Operation Of Sensor Module



 Fig 3: Model Diagram For Project

 Fig 4 : Block Diagram Of Solar Tracking System

**IV DESCRIPTION**

Firstly on board light sensor is installed across mobile frame and over the panel inside the hollow pipe.Sun follows a particular path along its orbit.This is being sensed by light sensor.Sensor actuates the motor accordingly move the panel in alignment with the sun exact position.The alignment of sun and the light sensor is to be perpendicular with each other.When the position of sun changes the motor trips and panel will acquire the position exactly perpendicular to the sun.This will provide maximum efficiency at that instance.Again the sun comes perpendicular to light sensor and again the process repeats till dark.

 **COMPONENTS USED**

|  |  |  |
| --- | --- | --- |
| SR NO | COMPONENT | RATING |
|  1 | SOLAR PANEL | 17.6V 0.58 amp, 10 WATT |
|  2  | GEAR REDUCTION MOTOR | 12V,60mAmp,10 rpm |
|  3 | LDR | 1KΩ |

 **V SOLAR TRACKING AND PV PANEL EFFICIENCY**

Compared to a fixed panel, a mobile PV panel driven by a solar tracker is kept under the best possible insolation for all positions of the Sun, as the light falls close to the geometric normal incidence angle. Automatic solar tracking systems (using light intensity sensing) may boost consistently the conversion efficiency of a PV panel, thus in this way deriving more energy from the sun. Technical reports in the USA have shown solar tracking to be particularly effective in summer, when the increases in output energy may reach over 50%,while in autumn they may be higher than 20%, depending on the technology used.[3]

Solar tracking systems are of several types and can be classified according to several criteria. A first classification can be made depending on the number of rotation axes.Thus we can distinguish solar tracking systems with a rotation axis, respectively with two rotation axes. Since solar tracking implies moving parts and control systems that tend to be expensive, single-axis tracking systems seem to be the best solution for small PV power plants. Single axis trackers will usually have a manual elevation (axis tilt) adjustment on the second axis which is adjusted at regular intervals throughout the year. A single-axis solar tracking system uses a tilted PV panel mount and a single electric motor to move the panel on an approximate trajectory relative to the Sun’s position.[4]

 Fig5:Tilt angle $α\&β$ of PV array

**VI LIGHT SENSOR THEORY**

A light sensor is the most common electronic component which can be easily found. The simplest optical sensor is a photo resistor or photocell which is a light sensitive resistor these are made of two types, cadmium sulfide (CdS) and gallium arsenide (GaAs). The sun tracker system designed here uses the cadmium sulphide (CdS) photocell for sensing the light. This photocell is a passive component whose resistance is inversely proportional to the amount of light intensity directed towards it. It is connected in series with capacitor. The photocell to be used for the tracker is based on its dark resistance and light saturation resistance. The term light saturation means that further increasing the light intensity to the CdS cells will not decrease its resistance any further.The average value called the solar constant E0 which is given in eqn no. 1.In the solar photovoltaic array the short circuit current generated is given by eqn 2.Maximum output power is measured by connecting the variable resistor R which will be given by RLOAD.The output signal is maximum output power of the solar PV array which will be given by PMAX in eqn no 3.[2]



Fig 6: PV cell structure and operation schematic

**FORMULAE**

1.The solar irradiance level:

E0=1.367$\pm $2W/m2…….........................(1)

IPH≈ISC=C0E……................................(2)

 Where,

E0=solar constant

E=irradiation level

2.Maximum output power:

RLOAD=

VMPP=maximum output power voltage

IMPP= maximum output power current

PMAX=IMPP$×$VMP.................................(3)

**VII TRACKER TYPES**

Solar trackers are devices used to orient photovoltaic panels, reflectors, lenses or other optical devices toward the sun. Since the sun’s position in the sky changes with the seasons and the time of day, trackers are used to align the collection system to maximize energy production. There are many types of solar trackers of varying costs, sophistication, and performance. The two basic categories of trackers are (1)single axis and (2) dual axis.

Single axis Solar trackers can either have a horizontal or a vertical axis. The horizontal type is used in tropical regions where the radiation of sun gets very high at noon, but the days are short. The vertical type is used in high latitudes where the sun does not get very high, but summer days can be very long. In concentrated solar power applications, single axis trackers are used with parabolic and linear Fresnel mirror designs.[6]

Dual axis solar trackers have both a horizontal and a vertical axis and thus they can track the sun's apparent motion virtually anywhere in the world. CSP applications using dual axis tracking include solar power towers and dish (Stirling engine) systems. Dual axis tracking is extremely important in solar tower applications due to the angle errors resulting from longer distances between the mirror and the central receiver located in the tower structure. Many traditional solar PV applications employ two axis trackers to position the solar panels perpendicular to the sun’s rays. This maximizes the total power output by keeping the panels in direct sunlight for the maximum number of hours per day.[5]

**VIII P-V Curve:**



Fig 7: Graph -Power versus voltage (p-v) characteristics of the PV module in sunlight.

The power output of the panel is the product of the voltage and the current outputs. In Figure, the power is plotted against the voltage. Notice that the cell produces no power at zero voltage or zero current, and produces the maximum power at voltage corresponding to the knee point of the i-v curve. This is why PV power circuits are designed such that the modules operate closed to the knee point, slightly on the left hand side. The PV modules are modelled approximately as a constant current source in the electrical analysis of the system.[8]

**IX AZIMUTH AND ZENITH ANGLE**

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 Fig 8:Azimuth and Zenith angle

The Zenith angle is the angle between the direction of the sun (direction of interest) and the zenith (straight up or directly overhead). The program calculates the Zenith angle in degrees and stores it in register SPA\_ZENITH. This would be the TILT angle with 0° being horizontal. The suns elevation or altitude is the angle from the horizontal plane and the Suns central ray or just the compliment of the Zenith angle (90° - Zenith angle).The Azimuth angle is measured clockwise from true north to the point on the horizon directly below the object. The program calculates the local (from observer) azimuth angle (eastward from North) [0 to 360 degrees] and stores it in register SPA\_AZIMUTH.[3]

**X CONCLUSION**

The system successfully tracks the Sun . It follows Sun from East to West and back to East in a cyclic manner (Horizontal Motor Module) and also tracks the Angular Movement of the Sun, i.e., Seasonal Movement (Vertical Motor Module).The system also tackles the problem of cloudy weather. In cloudy weather, it remains still and catches the Sun again as it slips out of clouds. The system saves a lot of energy. The system will be in ‘sleep’ mode when the night falls. In day time, motors are also in ‘sleep mode’ when light falls on the LDRs of equal intensity. The system is very simple in design, low in cost and is quite accurate.[7]

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