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Multi Axis Solar Tracking system

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ABSTRACT:- The goal of this work is to develop a prototype model of solar tracking system, which is used to enhance the performance of the photovoltaic modules in a solar energy system. The operating principle of the device is to keep the photovoltaic modules constantly aligned with the sunbeams, which maximizes the exposure of solar panel from the solar radiation. As it result to more power output that can be produced by the panels. This project included design of hardware and implementation with software programming for microcontroller unit to solar tracker. The system utilized an ATMEGA328P microcontroller to control motion with servo motors, which rotate solar panel in different axes. The amount of rotation was determined by the microcontroller, based on inputs retrieved from photo voltaic sensors located next to solar panel. At the end of the project can able to function the solar tracking system, it was designed and implemented and it can able to keep the solar panel aligned with the sun rays.

Key words:- Reduced Instruction Set Computer, Azimuth elevation (AE), dual-axis solar tracker, microcontroller

INTRODUCTION

General background solar energy is clean and available in abundance. Solar technologies use the sun for provision of heat, light and electricity. These are for industrial and domestic applications. With the alarming rate of depletion of depletion of major conventional energy sources like petroleum, coal and natural gas, coupled with environmental caused by the process of harnessing these energy sources, it has become an urgent necessity to invest in renewable energy sources that can power the future sufficiently. The energy potential of the sun is immense. Despite the unlimited resource however, harvesting it presents a challenge because of the limited efficiency of the array cells. The best efficiency of the majority of commercially available solar cells ranges between 10 and 20 percent. This shows that there is still room for improvement. This project seeks to identify a way of improving efficiency of solar panels. Solar tracking is used. The tracking mechanism moves and positions the solar array such that it is positioned for maximum power output. Other ways include identifying sources of losses and finding ways to mitigate them. When it comes to the development of any nation, energy is the main driving factor. There is an enormous quantity of energy that gets extracted, distributed, converted and consumed every single day in the global society. Fossil fuels account for around 85 percent of energy that is produced. Fossil fuel resources are limited and using them is known to cause global warming because of emission of greenhouse gases. There is a growing need for energy from such sources as solar, wind, ocean tidal waves and geothermal for the provision of sustainable and power. Solar panels directly convert radiation from the sun into electrical energy. The panels are mainly manufactured from semiconductor materials, notably silicon. Their efficiency is 24.5% on the higher side. Three ways of increasing the efficiency of the solar panels are through increase of cell efficiency, maximizing the power output and the use of a tracking system. Maximum power point tracking (MPPT) is the process of maximizing the power output from the solar panel by keeping its operation on the knee point of P-V characteristics. MPPT technology will only offer maximum power which can be received from stationary arrays of solar panels at 2 any given time. The technology cannot however increase generation of power when the sun is not aligned with the system. Solar tracking is a system that is mechanized to track the position of the sun to increase power output by between 30% and 60% than systems that are stationary. It is a more cost effective solution than the purchase of solar panels. There are various types of trackers that can be used for increase in the amount of energy that can be obtained by solar panels. Dual axis trackers are among the most efficient, though this comes with increased complexity. Dual trackers track sunlight from box axes. They are the best option for places where the position of the sun keeps changing during the year at different seasons. Single axis trackers are a better option for places around the equator where there is no significant change in the apparent position of the sun. The level to which the efficiency is improved will depend on the efficiency of the tracking system and the weather. Very efficient trackers will offer more efficiency because they are able to track the sun with more precision. There will be bigger increase in efficiency in cases where the weather is sunny and thus favorable for the tracking system.

With the unavoidable shortage of fossil fuel sources in the future, renewable types of energy have become a topic of interest for researchers, technicians, investors and decision makers all around the world. New types of energy that are getting attention include hydroelectricity, bioenergy, solar, wind and geothermal energy, tidal power and wave power. Because of their renewability, they are considered as favorable replacements for fossil fuel sources. Among those types of energy, solar photovoltaic (PV) energy is one of the most available resources. This technology has been adopted more widely for residential use nowadays, thanks to research and development activities to improve solar cells' performance and lower the cost. According to International Energy Agency (IEA), worldwide PV capacity has grown at 49% per year on average since early 2000s. Solar PV energy is highly expected to become a major source of power in the future

However, despite the advantages, solar PV energy is still far from replacing traditional sources on the market. It is still a challenge to maximize power output of PV systems in areas that don't receive a large amount of solar radiation. We still need more advanced technologies from manufacturers to improve the capability of PV materials, but improvement of system design and module construction is a feasible approach to make solar PV power more efficient, thus being a reliable choice for customers. Aiming for that purpose, this project had been carried out to support the development of such promising technology.

1.1 Problem statement

A solar tracker is used in various systems for the improvement of harnessing of solar radiation. The problem that is posed is the implementation of a system which is capable of enhancing production of power by 30-40%. The control circuit is implemented by the microcontroller. The control circuit then positions the motor that is used to orient the solar panel optimally.

1.2 Project justification

The project was undertaken to ensure the rays of the sun are falling perpendicularly on the solar panel to give it maximum solar energy. This is harnessed into electrical power. Maximum energy is obtained between 1200hrs and 1400hrs, with the peak being around midday. At this time, the sun is directly overhead. At the same time, the least energy will be required to move the panel, something that will further increase efficiency of the system. The project was designed to address the challenge of low power, accurate and economical microcontroller based tracking system which is implemented within the allocated time and with the available resources. It is 3 supposed to track the sun's movement in the sky. In order to save power, it is supposed to sleep during the night by getting back into an horizontal position. There is implementation of an algorithm that solves the motor control that is then written into C-program on Adriano IDE.

1.3 OBJECTIVES:

The Project Was Carried Out To Satisfy Two Main Objectives

1. Design a system that traces the sunlight for solar panels.
2. Increasing efficiency and accuracy than other solar tracking system
3. The range of increase in efficiency is expected to be between 30 and 40 percent

1.3 Methodology

Methodology The circuit of the solar tracker system is divided into three sections. There is the input stage that is composed of sensors and potentiometers, a program in embedded software in the microcontroller and lastly the driving circuit that has the servo motor. The input stage has two LDRs that are so arranged to form a voltage divider circuit. A C program loaded into the Atmega 328P forms the embedded software. There is a metallic frame that houses the components. The three stages are designed independently before being joined into one system. This approach, similar to stepwise refinement in modular programming, has been employed as it ensures an accurate and logical approach which is straight forward and easy to understand. This also ensures that if there are any errors, they are independently considered and corrected

1.5 Scope of the project

The solar project was implemented using a servo motor. The choice was informed by the fact that the motor is fast, can sustain high torque, has precise rotation within limited angle and does not produce any noise. There is the embedded software section where the at mega 328P is programmed using the C language before the chip removed from the Adriano board. The Adriano IDE was used for the coding. It is then used as a standalone unit on a PCB during fabrication and display. The design is limited to Single Axis tracking because the use of a dual axis tracking system would not add much value. Nairobi has coordinates of 1.2833^{0}S, 36.8167^{0}E and therefore the position of the sun will not vary in a significant way during the year. In the tropics, the sun position varies considerably during certain seasons. There is the design of an input stage that facilitates conversion of light into a voltage by the light dependent resistors, LDRs. There is comparison of the two voltages, then the microcontroller uses the difference as the error. The servo motor uses this error to rotate through a corresponding angle for the adjustment of the position of the solar panel until such a time that the voltage outputs in the LDRs are equal. The difference between the voltages of the LDRs is gotten as analog readings. The difference is transmitted to the servo motor and it thus moves to ensure the two LDRs are an equal inclination. This means they will be receiving the same amount of light. The procedure is repeated throughout the day

CHAPTER-2

LITERATURE SURVEY

Hossein Mousazadeh et Al.,[(2011), Journal of Solar Energy Engineering,Vol.133] studied and investigated maximization of collected energy from an on-board PV array, on a solar assist plug-in hybrid electric tractor (SAPHT). Using four light dependent resistive sensors a sun tracking system on a mobile structure was constructed and evaluated. The experimental tests using the sun-tracking system showed that 30% more energy was collected in comparison to that of the horizontally fixed mode. Four LDR sensors were used to sense the direct beams of sun. Each pair of LDRs was separated by an obstruction as a shading device. A microcontroller based electronic drive board was used as an interface between the hardware and the software. For driving of each motor, a power MOSFET was used to control the actuators. The experimental results indicated that the designed system was very robust and effective.

K.S. Madhu et Al., (2012) International Journal of Scientific & Engineering Research vol. 3, 2229–5518, states that a single axis tracker tracks the sun east to west, and a two-axis tracker tracks the daily east to west movement of the sun and the seasonal declination movement of the sun. Concentrates solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light into electric current using the photoelectric effect. Solar power is the conversion of sunlight into electricity. Test results indicate that the increase in power efficiency of tracking solar plate in normal days is 26 to 38% compared to fixed plate. And during cloudy or rainy days it's varies at any level.

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V Sundara Siva Kumar In general, the single-axis tracker with one degree of freedom follows the Sun's movement from the east to west during a day while a dual-axis tracker also follows the elevation angle of the Sun.

2.1 Introduction

A solar tracker is a device used for orienting a photovoltaic array solar panel or for concentrating solar reflector or lens toward the sun. The position of the sun in the sky is varied both with seasons and time of day as the sun moves across the sky. Solar powered equipment work best when they are pointed at the sun. Therefore, a solar tracker increases how efficient such equipment are over any fixed position at the cost of additional complexity to the system. There are different types of trackers. Extraction of usable electricity from the sun became possible with the discovery of the photoelectric mechanism and subsequent development of the solar cell. The solar cell is a semiconductor material which converts visible light into direct current. Through the use of solar arrays, a series of solar cells electrically connected, there is generation of a DC voltage that can be used on a load. There is an increased use of solar arrays as their efficiencies become higher. They are especially popular in remote areas where there is no connection to the grid. Photovoltaic energy is that which is obtained from the sun. A photovoltaic cell, commonly known as a solar cell, is the technology used for conversion of solar directly into electrical power. The photovoltaic cell is a non-mechanical device made of silicon alloy. Solar Cell 6 The photovoltaic cell is the basic building block of a photovoltaic system. The individual cells can vary from 0.5 inches to 4 inches across. One cell can however produce only 1 or 2 watts that is not enough for most appliances. Performance of a photovoltaic array depends on sunlight. Climatic conditions like clouds and fog significantly affect the amount of solar energy that is received by the array and therefore its performance. Most of the PV modules are between 10 and 20 percent efficient

2.2 The Earth

Rotation and Revolution The earth is a planet of the sun and revolves around it. Besides that, it also rotates around its own axis. There are thus two motions of the earth, rotation and revolution. The earth rotates on its axis from west to east. The axis of the earth is an imaginary line that passes through the northern and southern poles of the earth. The earth completes its rotation in 24 hours. This motion is responsible for occurrence of day and night. The solar day is a 7 the movement of the earth round the sun is known as revolution. It also happens from west to east and takes a period of 365 days. The orbit of the earth is elliptical. Because of this the distance between the earth and the sun keeps changing. The apparent annual track of the sun via the fixed stars in the celestial sphere is known as the ecliptic. The earth's axis makes an angle of 66.5 degrees to the ecliptic plane. Because of this, the earth attains four critical positions with reference to the sun

2.3 Revolution and rotation Solar Irradiation

Sunlight and the Solar Constant The sun delivers energy by means of electromagnetic radiation. There is solar fusion that results from the intense temperature and pressure at the core of the sun. Protons get converted into helium atoms at 600 million tons per second. Because the output of the process has lower energy than the protons which began, fusion gives rise to lots of energy in form of gamma rays that are absorbed by particles in the sun and re-emitted. The total power of the sun can be estimated by the law of Stefan and Boltzmann. $P=4\pi r2\ \sigma\epsilon T\ 4$ W T is the temperature that is about 5800K, r is the radius of the sun which is 695800 km and σ is the Boltzmann constant which is 1.3806488 × 10-23 m 2 kg s-2 K -1 . The emissivity of the surface is denoted by ϵ. Because of Einstein's famous law E=mc2 about millions of tons of matter are converted to energy each second. The solar energy that is irradiated to the earth is 5.1024 Joules per year. This is 10000 times the present worldwide energy consumption per year. Solar radiation from the sun is received in three ways: direct, diffuse and reflected. 8 Direct radiation: is also referred to as beam radiation and is the solar radiation which travels on a straight line from the sun to the surface of the earth. Diffuse radiation: is the description of the sunlight which has been scattered by particles and molecules in the atmosphere but still manage to reach the earth's surface. Diffuse radiation has no definite direction, unlike direct versions. Reflected radiation: describes sunlight which has been reflected off from non-atmospheric surfaces like the ground.

2.4 Sunlight

Photometry enables us to determine the amount of light given off by the Sun in terms of brightness perceived by the human eye. In photometry, a luminosity function is used for the radiant power at each wavelength to give a different weight to a particular wavelength that models human brightness sensitivity. Photometric measurements began as early as the end of the 18th century resulting in many different units of measurement, some of which cannot even be converted owing to the relative meaning of brightness. However, the luminous flux (or lux) is commonly used and is the measure of the perceived power of light. Its unit, the lumen, is concisely defined as the luminous flux of light produced by a light source that emits one candela of luminous intensity over a solid angle of one steradian. The candela is the SI unit of luminous intensity and it is the power emitted by a light source in a particular direction, weighted by a luminosity function whereas a steradian is the SI unit for a solid angle; the two-dimensional angle in three-dimensional space that an object subtends at a point. One lux is equivalent to one lumen per square meter; 1 lx = 1lm · mm = 1 cd · sr · mm (1) i.e. a flux of 10 lumen, concentrated over an area of 1 square meter, lights up that area with illuninance of 10 lux [1]. Sunlight ranges between 400 lux and approximately 130000 lux, as summarized in the table below. 9 Table 2.1: Range of the brightness of sunlight (lux) Time of day Luminous flux (lux) Sunrise or sunset on a clear day 400 Overcast day 1000 Full day (not direct sun) 10000 – 25000 Direct sunlight 32000 – 130000

2.4.1 Elevation angle

The elevation angle is used interchangeably with altitude angle and is the angular height of the sun in the sky measured from the horizontal. Both altitude and elevation are used for description of the height in meters above the sea level. The elevation is 0 degrees at sunrise and 90 degrees when the sun is directly overhead. The angle of elevation varies throughout the day and also depends on latitude of the particular location and the day of the year.

2.4.2 Zenith angle

This is the angle between the sun and the vertical. It is similar to the angle of elevation but is measured from the vertical rather than from the horizon 10

2.4.3 Azimuth angle

This is the compass direction from which the sunlight is coming. At solar noon, the sun is directly south in the northern hemisphere and directly north in the southern hemisphere. The azimuth angle varies throughout the day. At the equinoxes, the sun rises directly east and sets directly west regardless of the latitude. Therefore, the azimuth angles are 90 degrees at sunrise and 270 degrees at sunset

2.5 Types of solar trackers and tracking technologies

There are various categories of modern solar tracking technologies.

2.5.1 Active tracker

Active trackers make use of motors and gear trains for direction of the tracker as commanded by the controller responding to the solar direction. The position of the sun is monitored throughout the day. When the tracker is subjected to darkness, it either sleeps or stops depending on the design. This is done using sensors that are sensitive to light such as LDRs. Their voltage output is put into a microcontroller that then drives actuators to adjust the position of the solar panel

2.5.2 Passive solar tracking

Passive trackers use a low boiling point compressed gas fluid driven to one side or the other to cause the tracker to move in response to an imbalance. Because it is a non-precision orientation it is not suitable for some types of concentrating photovoltaic collectors but works just fine for common PV panel types. These have viscous dampers that prevent excessive motion in response to gusts of wind.

2.5.3 Chronological solar tracking

A chronological tracker counteracts the rotation of the earth by turning at the same speed as the earth relative to the sun around an axis that is parallel to the earth's. To achieve this, a simple rotation mechanism is devised which enables the system to rotate throughout the day in a predefined manner without considering whether the sun is there or not. The system turns at a constant speed of one revolution per day or 15 degrees per hour. Chronological trackers are very simple but potentially very accurate.

2.5.4 Single axis trackers Single axis trackers

Have one degree of freedom that act as the axis of rotation. The axis of rotation of single axis trackers is aligned along the meridian of the true North. With advanced tracking algorithms, it is possible to align them in any cardinal direction. Common implementations of single axis trackers include horizontal single axis trackers (HSAT), horizontal single axis tracker with tilted modules **(HTSAT)**, vertical single axis trackers **(VSAT)**, tilted single axis trackers **(TSAT)** and polar aligned single axis trackers **(PSAT)**.

2.5.5 Dual axis trackers

Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to each other. The primary axis is the one that is fixed with respect to the ground. The secondary axis is the one referenced to the primary axis. There are various common implementations of dual trackers. Their classification is based on orientation of their primary axes with respect to the ground.

2.6 Fixed and tracking collectors

Solar energy can be harnessed using either fixed or movable collectors**.**

2.6.1 Fixed collectors

Fixed collectors are mounted on places that have maximum sunlight and are at relatively good angle in relation to the sun. These include rooftops. The main aim is to expose the panel for maximum hours in a day without the need for tracking technologies. There is therefore a considerable reduction in the cost of maintenance and installation. Most collectors are of the fixed type. When using these collectors, it is important to know the position of the sun at various seasons and times of the year so that there is optimum orientation of the collector when it is being installed. This gives maximum solar energy through the year. The sun chart for Nairobi is shown below. Sun path diagram for Nairobi Key: 13 Through the use of the chart, it is possible to ascertain the position of the sun at different times and seasons so that the panel can be fixed for maximum output. Fixed trackers are cheaper in tropical countries like Kenya. For countries beyond +10 degrees North and -10 degrees south of the equator, there is need for serious tracking. This is because the position of the midday sun varies significantly. The chart shows that the position of the sun is highest between 1200h and 1400h. For the periods outside this range, the collectors are obliquely oriented to the sun and therefore only a fraction reaches the surface of absorption.

2.6.2 CASE I

The Fixed Collector For collectors that are fixed, the projection area on the area that is perpendicularly oriented to the d direction of radiation is given by S = So cos θ, where θ changes in the interval $\frac{-\pi}{2}, \frac{+\pi}{2}$ during the day. The angular velocity of the sun as it moves across the sky is given by ω = $\frac{2\pi}{T}$ = 7.27×10-5 rad/s with the differential of the falling energy given by dW = ISdt.

2.6.3 Tracking collectors

Improvement of efficiency for tracking collectors, theoretical extracted energy is calculated assuming that maximum radiation intensity I=1100W/m2 is falling on the area that is perpendicularly oriented to the direction of radiation. There is comparison of intensity on the tracking collector and the fixed one. More energy is gotten from the tracking collector than the fixed one.

2.6.4 CASE II

The Tracking Collector For tracking collectors, if atmospheric influence is neglected, the energy per unit of area for an entire day is given by W = ISt = 4.75 × 10Ws, (4) 14 = 13.2kWh/m2 day. Comparing the theoretical results for the two cases, more energy is obtained from the second case, for the tracking collector. However, as the rays of the sun travel towards the earth, they go through the thick layers of the atmosphere in both of the cases. That notwithstanding, the tracking collector has more exposure to the sun's energy at any given time.

2.7 Effect of light intensity

Change of the light intensity incident on a solar cell changes all the parameters, including the open circuit voltage, short circuit current, the fill factor, efficiency and impact of series and shunt resistances. Therefore, the increase or decrease has a proportional effect on the amount of power output from the panel.

2.8 Efficiency of solar panels

The efficiency is the parameter most commonly used to compare performance of one solar cells to another. It is the ratio of energy output from the solar panel to input energy from the sun. In addition to reflecting on the performance of solar cells, it will depend on the spectrum and intensity of the incident sunlight and the temperature of the solar cell. As a result, conditions under which efficiency is to be measured must be controlled carefully to compare performance of the various devices. The efficiency of solar cells is determined as the fraction of incident power that is converted to electricity. It is defined as: where Voc is the open-circuit voltage; Isc is the short-circuit current FF is the fill factor η is the efficiency. 15 The input power for efficiency calculations is 1 kW/m2 or 100 mW/cm2 . Thus the input power for a 100 × 100 mm2 cell is 10 W.

2.9 Benefits and demerits of solar energy

There are several benefits that solar energy has and which make it favorable for many uses.

2.9.1 Benefits

- Solar energy is a clean and renewable energy source.
- Once a solar panel is installed, the energy is produced at reduced costs.
- Whereas the reserves of oil of the world are estimated to be depleted in future, solar energy will last forever.
- It is pollution free.
- Solar cells are free of any noise. On the other hand, various machines used for pumping oil or for power generation are noisy.
- Once solar cells have been installed and running, minimal maintenance is required. Some solar panels have no moving parts, making them to last even longer with no maintenance.
- On average, it is possible to have a high return on investment because of the free energy solar panels produce.
- Solar energy can be used in very remote areas where extension of the electricity power grid is costly.

2.9.2 Disadvantages of solar power

- Solar panels can be costly to install resulting in a time lag of many years for savings on energy bills to match initial investments.
- Generation of electricity from solar is dependent on the country's exposure to sunlight. This means some countries are slightly disadvantaged.
- Solar power stations do not match the power output of conventional power stations of similar size. Furthermore, they may be expensive to build.
- Solar power is used for charging large batteries so that solar powered devices can be used in the night.
- The batteries used can be large and heavy, taking up plenty of space and needing frequent replacement. 16 Because merits are more than the demerits, the use of solar power is considered as a clean and viable source of energy. The various limitations can be reduced through various ways

CHAPTER-3

DESIGN & WORKING PRINCPLE

Resistance of LDR depends on intensity of the light and it varies according to it. The higher is the intensity of light, lower will be the LDR resistance and due to this the output voltage lowers and when the light intensity is low, higher will be the LDR resistance and thus higher output voltage is obtained.
A potential divider circuit is used to get the output voltage from the sensors (LDRs).The circuit is shown here

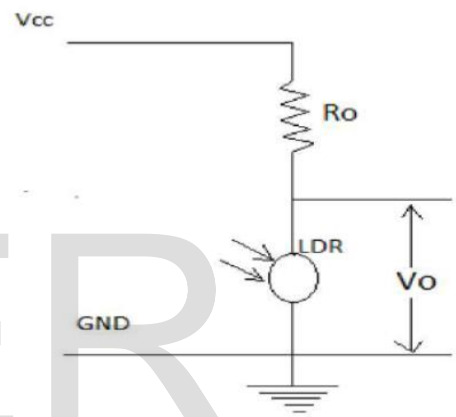

Fig 3. Potential divider circuit

The LDR senses the analog input in voltages between 0 to 5 volts and provides a digital number at the output which generally ranges from 0 to 1023
Now this will give feedback to the microcontroller using the arguing software (IDE) The servo motor position can be controlled by this mechanism which is discussed later in the hardware model

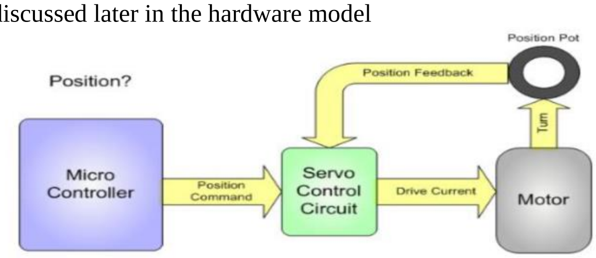

Fig 4. Servo motor

The tracker finally adjusts its position sensing the maximum intensity of light falling perpendicular to it and stays there till it notices any further change
The sensitivity of the LDR depends on point source of light. It hardly shows any effect on diffuse lighting condition.

3.1 BASIC CIRCUIT DIAGRAM

- An overview of the required circuit for the Dual-axes solar tracker is shown here.

- The 5V supply is fed from an USB 5V dc voltage source through Adriano Board
- Servo X :Rotates solar panel along X direction
- Servo Y :Rotates solar panel along Y direction

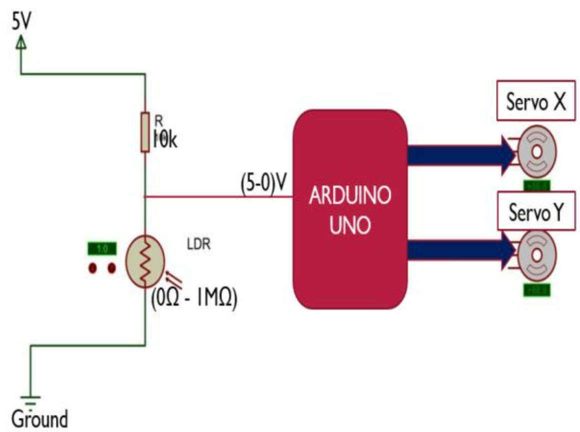

Fig 5. Basic Circuit Diagram

Light Sensor Theory and Circuit of Sensor Used Light detecting sensor that maybe used to build solar tracker include; phototransistors, photodiodes, LDR and LLS05. A suitable, inexpensive, simple and easy to interface photo sensor is analog LDR which is the most common in electronics. It is usually in form of a photo resistor made of cadmium sulfide (CdS) or gallium arsenide (GaAs). Next in complexity is the photodiode followed by the phototransistor

3.2 DESIGN

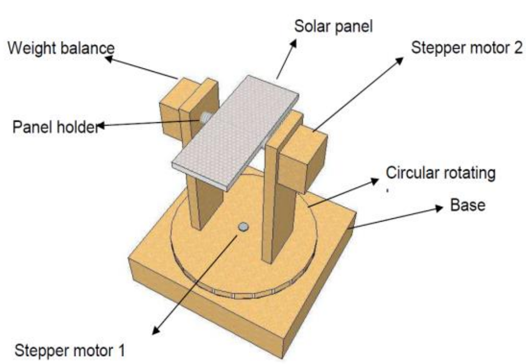

Fig 6 3D model

CHAPTER-4

MATHEMATICAL MODEL
MATHEMATICAL EQUATIONS REQUIRED
INVERSE SQUARE LAW

The illumination upon a surface varies inversely as the square of the distance of the surface form the source. Thus, if the illumination at a surface 1 meter from the source is I units, then the illumination at 2 meters will be I/4, at 3 meters will be I/9 and so on.

In fact inverse square law operates only when the light rays are from a point source and are incident normally upon the surface.

Thus illumination in lamberts/m2 on a normal plane= Candle power/ (Distance in meters) 2

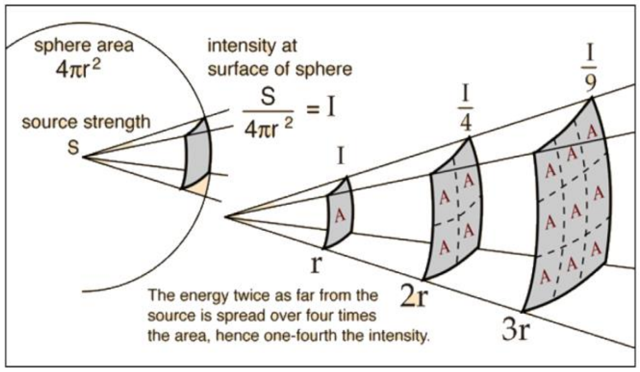

Fig7.

LAMBERT'S COSINE LAW

The illumination received on a surface is proportional to the cosine of the angle between the direction of the incident light rays and normal to the surface at the point of incidence.

This is mainly due to the reduction of the projected area as the angle of incidence increases. Thus, the equations are:

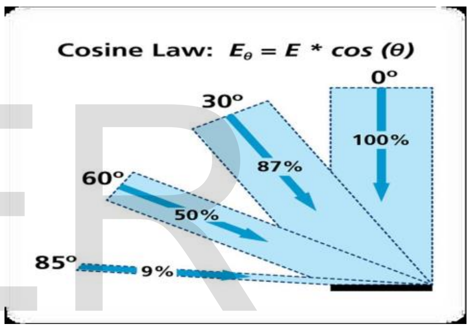

Fig 8

$E\theta = E\cos\theta = \frac{I\cos\theta}{D^2}$

Where,

Eθ= illumination on horizontal plane

E= illumination due to light normally incident

θ= the angle of incidence

D= distance

CHAPTER-5

HARDWARE MODEL

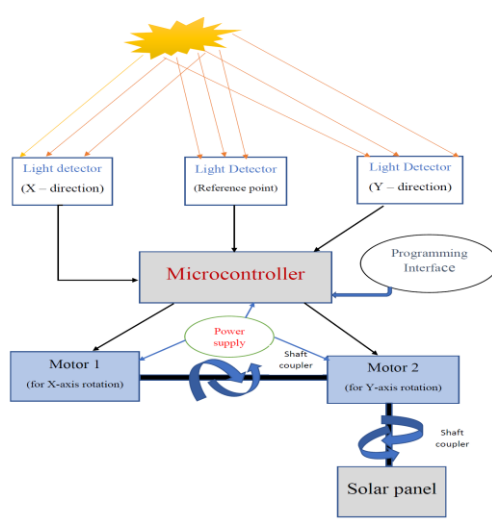

Fig 9 Block Diagram of the Solar Tracker

EXPLANATION OF THE BLOCK DIAGRAM:

As we see in the block diagram, there are three Light Dependent Resistors (LDRs) which are placed on a common plate with solar panel. Light from a source strikes on them by different amounts. Due to their inherent property of decreasing resistance with increasing incident light intensity, i.e. photoconductivity, the value of resistances of all the LDRs is not always same.

Each LDR sends equivalent signal of their respective resistance value to the Microcontroller which is configured by required programming logic. The values are compared with each other by considering a particular LDR value as reference.

One of the two dc servo motors is mechanically attached with the driving axle of the other one so that the former will move with rotation of the axle of latter one. The axle of the former servo motor is used to drive a solar panel. These two-servo motors are arranged in such a way that the solar panel can move along X-axis as well as Y-axis.

The microcontroller sends appropriate signals to the servo motors based on the input signals received from the LDRs. One servo motor is used for tracking along x-axis and the other is for y-axis tracking. In this way the solar tracking system is designed.

CHAPTER:-6

OUTCOMES AND CONCLUSION

- The project is to keep the solar photovoltaic panel perpendicular to the sun throughout the year in order to make it more efficient.
- The dual axis solar photovoltaic panel takes astronomical data as reference and the tracking system has the capability to always point the solar array toward the sun and can be installed in various regions with minor modifications.
- The vertical and horizontal motion of the panel is obtained by taking altitude angle the azimuth angle as reference.
- The fuzzy controller has been used to control the position of DC motors.

CONCLUSIONS

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