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Raspberry-Pi Based Dual Axis Solar Tracking System

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ABSTRACT: This project design and implementation of an energy efficient solar tracking system from a normal single axis to a dual axis. All ready the single axis tracking system is invented but after comparing with dual axis, it is found that it is not efficient as dual axis tracking systems. For optimizing the solar tracking mechanism electromechanical systems were evolved through implementation of different evolutional algorithms and methodologies. To present the tracker, a dual-axis solar tracking system will designed based on light sensor called (LDR) and microcontroller based continuous tracking mechanism. These light sensors also compare the darkness and cloudy and sunny conditions assisting daily tracking. For efficient tracking we invent one device which mounted on panel. designed tracker can track sun's apparent position at different months and seasons. The heart of our system is Raspberry-pi,It's actually a mini computer highly efficient performing operation in very good manner. The main objective of this research is whether single axis or static solar panel is better than solar tracker or not. This work is divided into two parts, hardware and software system.The outcome come of solar tracking system is analyzed and compared with single axis solar tracking systems or static solar system found better performance in terms of voltage,current, &power. Therefore, solar tracker is proved more practical in capturing maximum sunlight supply for our various industrial and commercial applications.

I.INTRODUCTION

Now a day's our social and economical growth depends on a lot of electrical energy. However, in developing countries, this electrical energy is weakly managed.So we can solve this problem by using renewable energy.The government promoted the use of renewable energy so they provide subsidies on it.Solar, wind, gas, biomass, water etc. sources of renewable energy. Among this solar power is being rife a ttribu table to its non - contaminated assets . This solar power is regenerated into electricity for supplementary use. This revolution is done by exploitation photo-voltaic switch. .

However solar tracker is best than the panel because it senses the twist of the world rotates by its axes following the formatter will need to create these components, incorporating the applicable criteria that follow. Solar energy is the main furnish source of all energy produced by sunlight. The energy of the sun reaches on earth with entirely different rays. A huge amount of energy is transmitted from the sun every day; within the earth, we get a diminutive magnitude of it . The larger part of the solar energy is lost within the world. It sparkling and absolve to the entire and that we can never face the insufficiency of solar energy like more than a few different energy. During this work dual axis , solar tracker is the main focus to talk about .This paper also demonstrates the renewable energy state of dealings, entirely special light sens ors, some expected value of solar tracker etc. We are going to end with the premeditated tricks which might be functional for upward the solar energy.

The below figure shows the illustration of solar angles: (a) altitude angle, (b)azimuthal angle.

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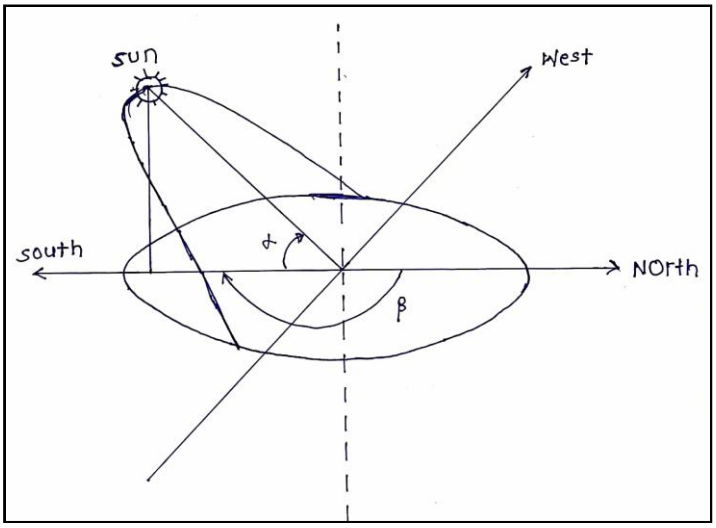

Figure 1-Illustration of the solar angles: (a) altitude angle, α; (b) azimuthal angle, β

energy production to become a reality it has to compete with other available sources of energy.Solar energy is coming up as a major source of energy. The need of the hour is renewable energy resources with cheap running costs. With the current systems for solar energy harvesting, we have high production only at fixed times mostly noon. This project proposes a dual axis solar tracker system that increases the productivity by a significant margin.The angle of inclination ranges between -90° after sun rise and +90° before sunset passing with 0° at noon.

This makes the collected solar radiation to be 0% at sunrise and sunset and 100% at noon. This variation of solar radiations collection leads the photovoltaic panel to lose more than 40% of the collected energy. In this project, we take you through designing a Solar tracker so that you maximise on the solar energy collection.

III.COMPONENT USED

i. SOLAR PANEL

Figure 2-Solar panel

A solar panel converts sunlight into an electric current or heat used to provide electricity for home or building. Solar panels are constructed as a collection of lots of small solar cells that are spread over a large area to provide enough power. The larger the concentration of light hits the cell the more electricity or heat is produced.Solar energy is the photovoltaic cell which converts light energy received from sun into electrical energy. The name behind “solar” panel is they grab high powerful energy emitted from the sun. 3 watt Solar panel is used in this Dual Axis Solar Tracking System Using Raspberry pi. Solar panels work by converting light photons into electricity through the solar photo-voltaic (PV) effect. This allows for direct conversion of sunlight into solar power, or electricity. Solar panels use layers of semi-conducting material, most commonly silicon.

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Most solar modules are currently produced from crystalline silicon (c-Si) solar cells made of multicrystalline and monocrystalline silicon.
They are called "solar" panels because most of the time, the most powerful source of light available is the Sun, called Sol by astronomers. Some scientists call them photovoltaicswhich means, basically, "light-electricity."

Specification:

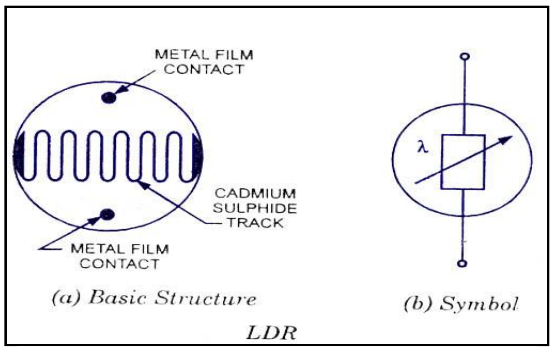
Number of Cells	36
SolarPower	**3**W
Output Voltage	10.8V

ii. GEAR MOTORS

Figure 3-Gear motor

10RPM Centre Shaft Economy Series DC Motor is high quality low cost DC geared motor. It has steel gears and pinions to ensure longer life and better wear and tear properties. The gears are fixed on hardened steel spindles polished to a mirror finish. The output shaft rotates in a plastic bushing. The whole assembly is covered with a plastic ring. Gearbox is sealed and lubricated with lithium grease and require no maintenance. The motor is screwed to the gear box from inside.
Although motor gives 10 RPM at 12V but motor runs smoothly from 4V to 12V and gives wide range of RPM, and torque. Tables below gives fairly good idea of the motor's performance in terms of RPM and no load current as a function of voltage and stall torque, stall current as a function of voltage.

iii. LIGHT SENSOR



Max power dissipation	200mW
Max voltage 0 lux	200V
Dark resistance after 1 sec	0.03MΩ
Dark resistance after 5 sec	0.25MΩ

Figure 4 - Light dependent Sensor

A Light Dependent Resistor (LDR) is also called a photoresistor or a cadmium sulfide (CdS) cell. It is also called a photoconductor. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases. This optoelectronic device is

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mostly used in light varying sensor circuit, and light and dark activated switching circuits. Some of its applications include camera light meters, street lights, clock radios, light beam alarms, reflective smoke alarms, and outdoor clocks.
The snake like track shown below is the Cadmium Sulphide (CdS) film which also passes through the sides. On the top and bottom are metal films which are connected to the terminal leads. It is designed in such a way as to provide maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light. As explained above, the main component for the construction of LDR is cadmium sulphide (CdS), which is used as the photoconductor and contains no or very few electrons when not illuminated. In the absence of light it is designed to have a high resistance inthe range of megaohms. As soon as light falls on the sensor, the electrons are liberated and the conductivity of the material increases. When the light intensity exceeds a certain frequency, the photonsabsorbed by the semiconductor give band electrons the energy required to jump into the conduction band.

iv. RASPBERRY-PI:

Figure 5- Raspberry pi b+

The Raspberry Pi 3 Model B+ is the heart of our system it is a mini computer.For increasing the speed of operation Raspberry-pi is preferable.latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.It is a tiny computer board that comes with CPU, GPU, USB ports, I/O pins, WiFi, Bluetooth, USB and network boot and is capable of doing some functions like a regular computer.

SPECIFICATION :
The Raspberry pi 3 model Is the final Revision in the Raspberry pi 3 Range
4Pole Sterio Output And Composite Vedio Port
Extended 40 pin GPIO header
Full Size HDMI
USB 2.0 PortsCamera Port For Connecting Raspberry Pi .

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v. L293D MOTOR DRIVER

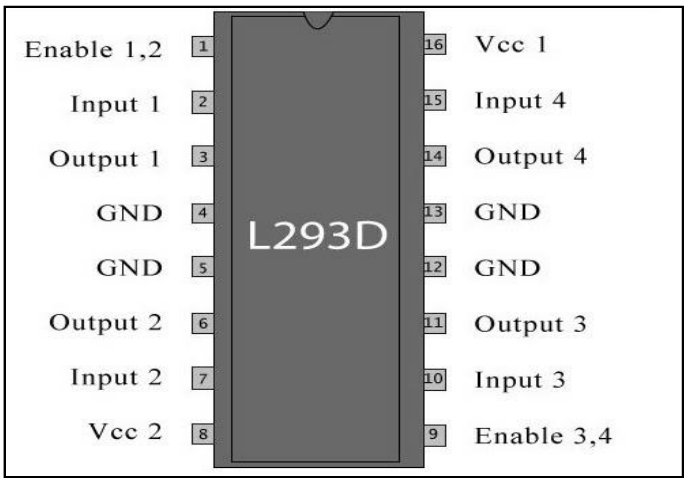

figure 6-L293D Motor Driver

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. The l293d can drive small and quiet big motors.

vi. ADC (ANALOG To DIGITAL CONVERTER) MCP3008

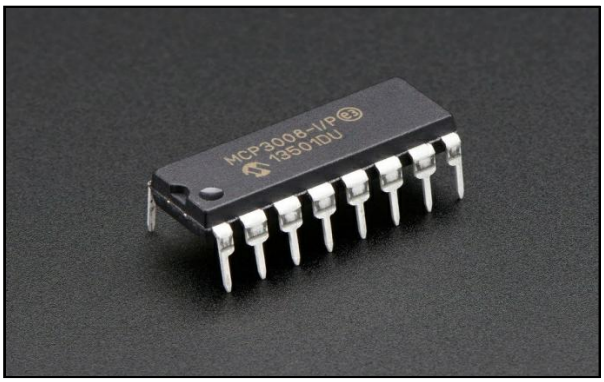

Figure 7- Analog to digital converter

An analog to digital converter is a circuit that converts a continuous voltage value (analog) to a binary value (digital) that can be understood by a digital device which could then be used for digital computation. These ADC circuits can be found as an individual ADC ICs by themselves or embedded into a microcontroller. They're called ADCs for short.
Modern day electronics is purely digital – gone are the good old days of analog computers. Unfortunately for digital systems, the world we live in is still analog and full of colour, not just black and white.

IV. BLOCK DIAGRAM EXPLINATION

In above figure we show the structure of project in this the raspberry-pi is the heart of our system. The raspberry-pi is a single computer board with credit card size, that can be used for many tasks that your computer dose, like games, word processing spreadsheets and also to play HD video. Raspberry-pi controllers movement of all the element. We use three servo motors of 10 RPM, two for vertical movement and one for horizontal movement. The servo motors is specialized for high response, high precision positioning. As motor capable of accurate rotation angle and speed control, It can be suitable for our project. We use solar panel which is compatible with our project having rectangular pv cells.For controlling movement of motors we use motor driver L-293D. The L293D motor driver is general purpose high voltage or high current driver that can handle 4.5 – 36 V , 600mA continues per channel. The signal from motor driver is given to the raspberry-pi after converting to digital from, For this purpose ADC(MCP3008) Convertor is used. The MCP 3008 analog to digital Convertor combines high performance and low power consumption in a small package

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making it ideal for embedded control application.We use LDR sensors for tracking the sun position, the LDR sensors have very much importance in our project.

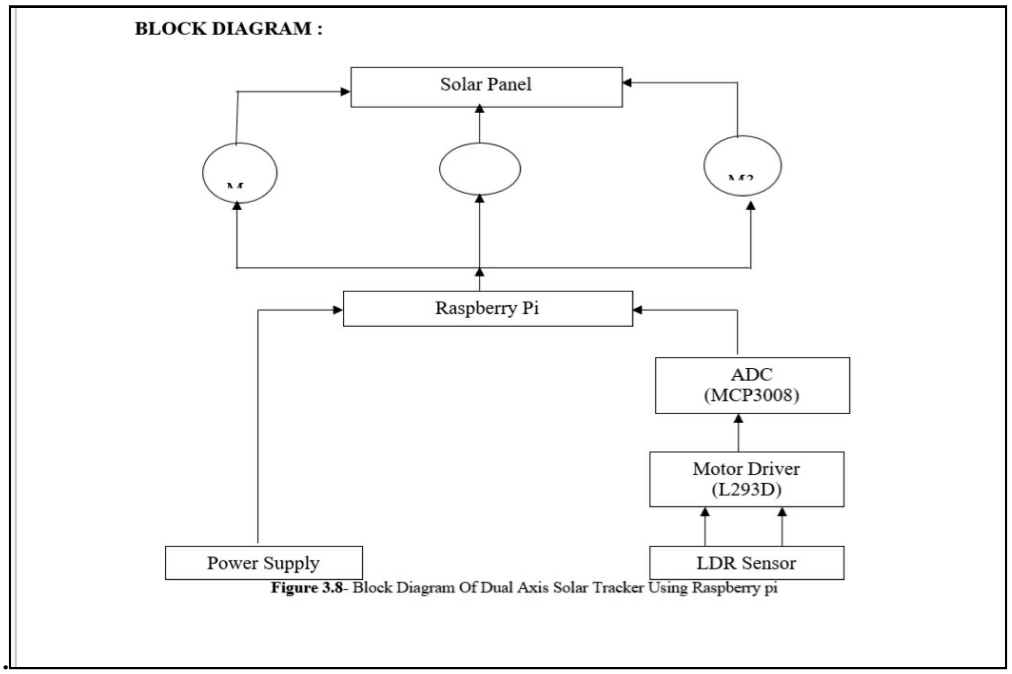

Figure8- Block diagram

We use four LDR sensors, For this sensors we design special structure having 4 part. When light is fall on the one part other three part in black and according this movement of panel is occurred. Due to the fact that the earth is rotating on a tilted axis and takes an elliptical path around the sun, a stationary PV panel's output will drastically vary thought the year and even thought the course of a day. The solar radiation fall on the panel the radiations is sensed by LDR sensors. The part of LDR sensors on which the intensity is high, the movement of panel align with that part. Solar tracking obviously addresses these issue by actively following the sun in the sky. A Standard PV panel will observe about 20-35/ under ideal conditions, while solar tracking has been known to potentially double that with 50-60/ efficieency approx under idealconditions.

V.TESTING

Figure - 9

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VI. CONCLUSION

Design, implementation, and testing of a hybrid dual axis solar tracking system is presented in the study. The Performance of the developed system was experimented and compared with both the static and continuous dual axis solar tracking system. This work demonstrates that hybrid dual axis solar tracking system can assure higher power generation compared to static panel as well as less power consumption compared to continuous dual axis solar tracking system. The result shows that the hybrid dual axis tracking system has 25.62% more average power gain over static system while it has 4.2% less average power gain compared to continuous tracking system. In hybrid dual axis solar tracking system one motor runs continuously to track continuous movement of sun due to daily motion and another motor runs once in a month to track suns seasonal motion. But in other trackers like in continuous solar tracker it needs to move both the motors continuously. Thus the hybrid system is saving motor power consumption while the power gain compared to other technology is almost marginal. So further comparative study about stepper motor power consumption shows that hybrid tracking system can save 44.44% power compared to continuous tracking system. This amount of power saving will have a significant effect in large systems like heliostat power plants where a lot of trackers are required and power saved by all the systems will show a big amount of power. Other than this the designed tracking system can also be implemented for th
e solar thermal systems. Finally the proposed design is achieved with low power consumption, high accuracy, and low cost.

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