IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SOLAR POWER TRACKING DEVICE USING EMBEDDED SYSTEMS

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Abstract: Solar energy is very important means of expanding renewable energy resources. In this paper is described the design and construction of a microcontroller based solar panel tracking system. Solar is nonconventional source of energy, considering this we have develop solar panel so that we can fulfil our electricity in need. But due to revolution of the earth, solar source ie. Sun does not face the panel continuously hence less electricity is produced. The energy panel should face the sun till its is present in day. The problem above can be solved by our system by automatic tracking the solar energy.

The main objective of this project is to development of an automatic solar tracking system where by the system will caused solar panel which will keep aligned with the sunlight in order to maximize in harvesting solar power. The system focuses on the controller design where by it will cause the system able the track the maximum intensity of sunlight is heat. When the intensity of sunlight is decreasing this system automatically changes its directions to get maximum intensity of sunlight. LDR light detector act as sensor is used to trace the coordinate of the sunlight by detecting brightness level of sunlight. While to rotate the appropriate positions of the panel a DC gear motor is used. The system is contolled by to relays as a DC gear motor driver and a microcontroller as main processor. This project is covered for a single axis and is design for low power and residential usage applications. For the hardware testing, the system is able to track and follow the sunlight intensity in order to get maximum solar power at the output regardless motor speed.

Index Terms **– Solar Energy Tracking, Solar Energy, Embedded Systems, LDR, Microcontroller, DC gear motor**

I. INTRODUCTION

Man has needed and used energy of an increasing rate for his sustenance & well being, ever since he came on Earth. Primitive man used to derive his energy by eating plants or animals which he hunted. Subsequently he discovered fire and his energy demand had increased. With the span of time energy needs for mankind reached heights. It has increased to such an extent that, in today's life man is totally dependent on energy resources. Well now, when we come to a point that solar energy developed from sun is only resource of fulfilling the energy needs in our daily life, there is no question left about any debate resourceful energy & existence.

1.1 Solar Energy

Solar energy is a very large, inexhaustible source of energy. The power from the sun intercepted by the Earth is approximately (1.8 x 1011) MW which is many a thousand times larger than the present consumption rate on the Earth of all commercial sources. This means, solar energy could supply all present and future energy supply needs of the world. In addition to this, solar energy has two other factors in its favor. Firstly, unlike fossil fuels and nuclear power, it is an environment friendly source of energy. Secondly, it is free & available in adequate amount in almost all part of the world. Our project is based on natural sun tracker "Sunflower" which always faces towards the sun throughout the day. Sunflower is a real example of sun tracking system.

1.2 Current Global Scenario

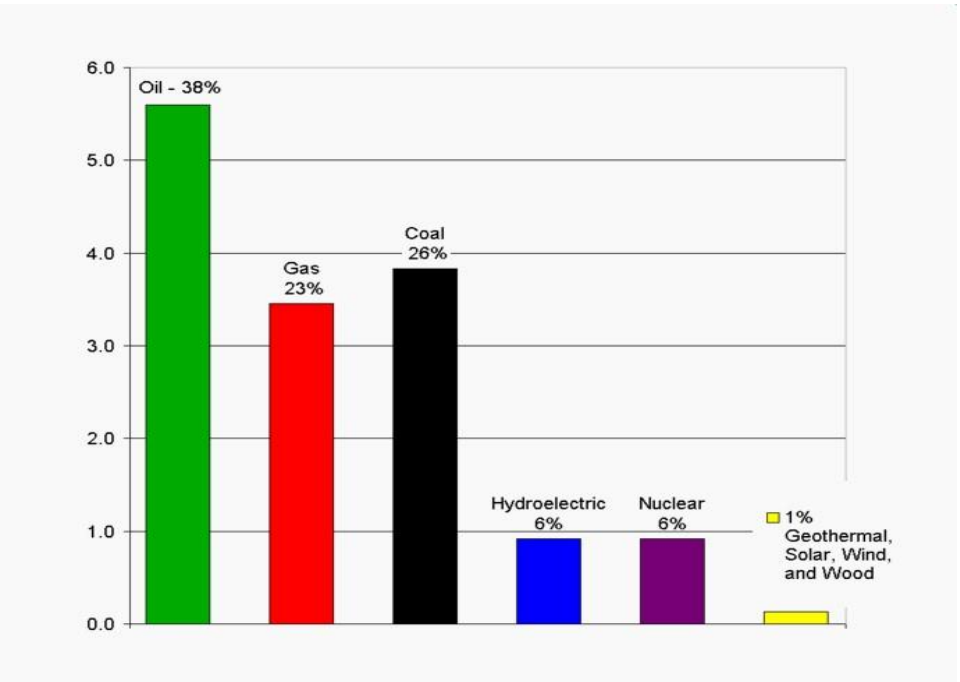


Fig. 1.1 Worldwide Energy Sources

The above statistical graph shows the worldwide energy sources which are utilized for generation of electricity. In this graph, oil acquires the first position with a maximum utilization of 38%, while non conventional sources acquire the last position with utilization of only 1%. By the use of oil, gas & coal up to such high extent, the pollution across the globe has increased by huge amount. The following chart explains the carbon dioxide emission per year of different countries. India is ranked 4th in the chart with an annual emission of 1,510 metric tons of carbon dioxide gas which contributes about 5.3% of total emission of carbon dioxide. China is the highest carbon dioxide emitter which contributes a total of 21.5%. Carbon dioxide is one of the main culprits which is responsible for Global Warming.

Table 1.1: Countries with the highest CO2 emissions

Country	Carbon dioxide emissions per year (106 Tons) (2010)	Percentage of global total
China	6,103	21.5%
United States	5,752	20.2%
Russia	1,564	5.5%
India	1,510	5.3%
Japan	1293	4.6%
Germany	805	2.8%
United Kingdom	568	2.0%
Canada	544	1.9%
South Korea	475	1.7%
Italy	474	1.7%

1.3 Sources of Energy

Since electrical energy is produced from energy available in various forms in nature, it is desirable to look into the various sources of energy. These sources of energy are:

(i) The Sun (ii) The Wind (iii) Water (iv) Fuels (v) Nuclear energy

Out of these sources, the energy due to Sun and wind has not been utilized on a large scale due to a number of limitations. At present, the other three sources viz:- water ,fuels and nuclear energy are primarily used for the generation of electrical energy.

(i) The Sun: The Sun is the primary source of energy. The heat energy radiated by the Sun can be focused over a small area by means of reflectors. This heat can be used to raise steam and electrical energy can be produced with the help of turbine – alternator combination. However, this method has limited application because :

a) It requires a large area for the generation of even a small amount of electric power
b) It cannot be used in cloudy or at night
c) It is an uneconomical method.

Nevertheless, there are some locations in the world where strong solar radiation is received very regularly and the sources of mineral fuel are scanty or lacking. Such locations offer more interest to the solar plant builders.

(ii) The Wind: This method can be used where wind flows for a considerable length of time. The wind energy is used to run the wind mill which drives a small generator. In order to obtain the electrical energy from a wind mill continuously, the generator is arranged to change the batteries. These batteries supply the energy when the wind stops. This method has the advantages that maintenance and generation costs are negligible. However, the drawbacks of this method are variable output, unreliable because of uncertainty about wind pressure & power generated is quiet small.

(iii) Water: This method can be used where wind flows for a considerable length of time. The wind energy from a wind mill continuously, the generator is arranged to change the batteries. These batteries supply the energy when the wind stops. This method has the advantages that maintenance and generation costs are negligible. However, the drawbacks of this method are variable output, unreliable because of uncertainty about wind pressure, power generated is quiet small.

(iv) Fuels: The main sources of energy are fuels viz:- solid fuel as coal, liquid fuel as oil and gas fuel as natural gas. The heat energy of these fuels is converted into mechanical energy into electrical energy. This method of generation of electrical energy has become very popular because it has low production and maintenance costs.

(v) Nuclear energy: Towards the end of Second World War, it was discovered that large amount of heat energy is liberated by the fission of uranium and other fissionable materials .It is estimated that heat produced by 1 kg of nuclear fuel is equal to that produced by 4500 tons of coal. The heat produced due to nuclear fission can be utilized to raise steam with suitable arrangements. The steam can run the steam turbine which in turn can drive the alternator to produce electrical energy. However, there are some difficulties in use of nuclear energy. The principal one`s are (a) high cost of nuclear plant (b) problem of disposal of radioactive waste and dearth of trained personnel to handle the plant.

1.4 Available Non-Conventional Sources in the World

Following diagram shows the non-conventional sources available throughout the world. Solar energy which is available throughout the globe is 86,000 TW which is highest as compared to the other form of non-conventional sources (as shown in diagram below). The global consumption of non-conventional energy is around 15 TW. This shows that, solar energy is having enough potential to solve the energy crisis around the world. Other non-conventional sources also posses the potential to solve the problem, but they are variable or intermittent. This is the reason why solar energy has gained such an importance.

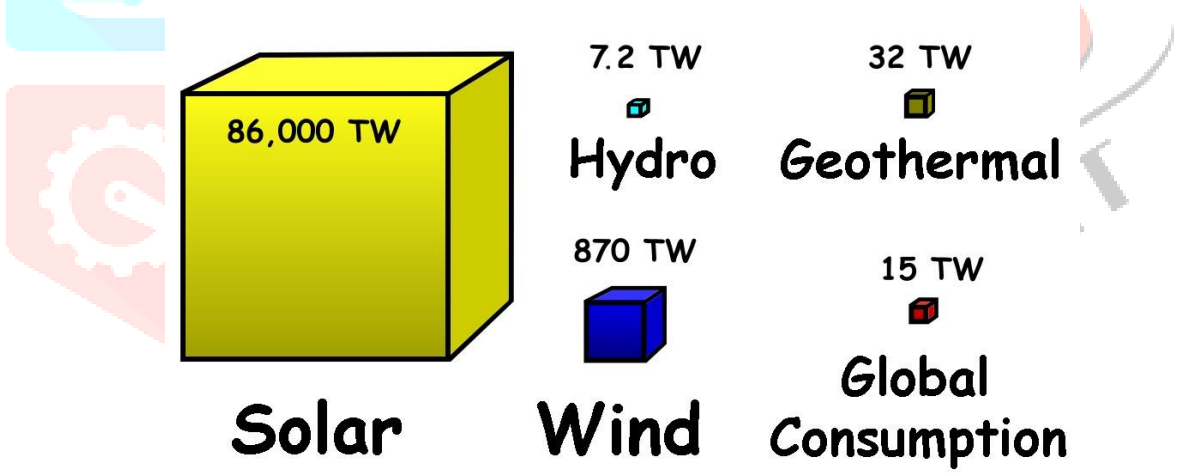


Fig. 1.2: Sources available throughout the world

1.5 Solar Power in India

With about 300 clear, sunny days in a year, India's theoretical solar power reception, on only its land area, is about 5 Peta Watt-hour per year or PWh/year (i.e. 5 trillion kWh/yr = 600 TW).The daily average solar energy incident over India varies from 4 to 7 kWh/m2 with about 1500–2000 sunshine hours per year, depending upon location. This is far more than current total energy consumption. For example, even assuming 10% conversion efficiency for PV modules, it will still be thousand times greater than the likely electricity demand in India by the year 2015. The amount of solar energy produced in India is merely 0.4% compared to other energy resources. The Grid-interactive solar power as of December 2010 was merely 10 MW. However, as of October 2009, India is currently ranked number one along with the United States in terms of installed Solar Power generation capacity. The government of India is promoting the use of solar energy through various strategies. In the latest budget for 2010-11, the government has announced an allocation of 10 billion (US$217 million) towards the Jawaharlal Nehru National Solar Mission and the establishment of a Clean Energy Fund. It's an increase of 3.8 billion (US$82.5 million) from the previous budget.

In this chapter importance of solar energy has been highlighted. Current Global scenario here illustrates the energy level utilization worldwide. Various sources of energy have been mentioned in this chapter to get the understanding of the sources available. Available non-conventional sources in the world are also been mentioned. Solar power reception and its utilization has been explained above. Various government projects illustrate the importance of it.

II. LITERATURE REVIEW

A solar tracker is a generic term used to describe devices that orient various payloads toward the sun. Payloads can be photovoltaic panels, reflectors, lenses or other optical devices.

In standard photovoltaic (PV) applications trackers are used to minimize the angle of incidence between the incoming light and a photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capacity. In standard photovoltaic applications, it is estimated that trackers are used in at least 85% of commercial installations greater than 1MW from 2009 to 2012.

In concentrated photovoltaic (CPV) and concentrated solar thermal (CSP) applications trackers are used to enable the optical components in the CPV and CSP systems. The optics in concentrated solar applications accepts the direct component of sunlight and therefore must be oriented appropriately to collect energy. Tracking systems are found in all concentrator applications because such systems do not produce energy unless oriented closely toward the sun. The tall poles allow walk-under and use of the ground space underneath the panels for plantings that thrive on protection from the intense mid-day summer sun at this location.

Fig. 2.1. Backyard installation of passive single–axis trackers, rated at 2340 watts.

2.1 Why Solar Tracker?

Clean Power:

There is a growing demand to find greener ways to power the world and minimize greenhouse gas emissions. The sun is a natural power source that will keep on shining for an estimated 4 billion years.

Solar power (photovoltaic) systems are a sustainable way to convert the energy of the sun into electricity. An average solar power system amortizes itself within 4 years, meaning after four years they have produced as much energy as it took to manufacture it. The expected lifetime of a system is 25-30 years.

The energy potential of the sun is immense, and it is one of the emerging energy sources, which is subsidized in order to secure the distribution of the technology worldwide.

Efficiency:

By tracking the sun, the efficiency can be increased by 30-40% more than single axis solar tracker .The photovoltaic technology allows the conversion of sunlight directly into electricity with a conversion ratio of about 15%. The efficiency of the solar power systems is increasing and it mainly depends on two factors:

- the solar panel
- the tracking system

A solar tracking system is a device for orienting a solar panel or concentrating a solar reflector or lens towards the sun. Concentrators, especially in solar cell applications, require a high degree of accuracy to ensure that the concentrated sunlight is directed precisely to the powered device.

1. The Market Scenario:

With the increasing carbon dioxide emissions from e.g. humans, the greenhouse effect has been drastically exaggerated. As a consequence, the temperature is rising. Worldwide there is an increasing awareness that we need to invest in clean sustainable power to protect our environment. This makes solar power even more interesting.

2. Improving Energy Efficiency:

Global warming and the drive to minimize greenhouse gas emissions have put the focus on how to make the most of natural energy sources. The sun and the wind are freely available almost everywhere in the world and electric actuators can help improve the exploitation and efficiency of this sustainable source of energy. Solar tracking is an obvious way to improve the efficiency of solar power plants. As the sun moves across the sky an electric actuator system makes sure that the solar panels automatically follow and maintain the optimum angle in order to make the most of the sunbeams.

2.2 Tracker Types

Photovoltaic trackers can be grouped into classes by the number and orientation of the tracker's axes. Compared to a fixed mount, a single axis tracker increases annual output by approximately 30% and a dual axis tracker an additional 6%.

1. Single Axis Trackers:

Single axis trackers have one degree of freedom that acts as an axis of rotation. The axis of rotation of single axis trackers is typically aligned along a true North meridian. It is possible to align them in any cardinal direction with advanced tracking algorithms.

There are several common implementations of single axis trackers. These include Horizontal Single Axis Trackers, Vertical Single Axis Trackers, and Tilted Single Axis Trackers. The orientation of the module with respect to the tracker axis is important when modeling performance.

The other types are –

- Horizontal Single Axis Tracker (HSAT)
- Vertical Single Axis Tracker (VSAT)
- Tilted Single Axis Tracker (TSAT)

2. Dual Axis Trackers:

Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to one another. The axis that is fixed with respect to the ground can be considered a primary axis. The axis that is referenced to the primary axis can be considered a secondary axis.

There are several common implementations of dual axis trackers. They are classified by the orientation of their primary axes with respect to the ground. Two common implementations are Tip - Tilt trackers and Azimuth-Altitude trackers. The orientation of the module with respect to the tracker axis is important when modeling performance. Dual Axis Trackers typically have modules oriented parallel to the secondary axis of rotation.

The key to understanding the benefits of dual axis tracking is the significance of the incident angle, the angle at which the sun's rays strike the PV array. To see how the incident angle affects solar intensity and power production, we use the formula Intensity = Constant x cos Θ where Θ is the incident angle measured from perpendicular. So intensity is at its maximum when Θ = 0, this is when the arriving energy strikes a PV panel perpendicularly. The greater the incident angle, the smaller the amount of energy reaching the panel.

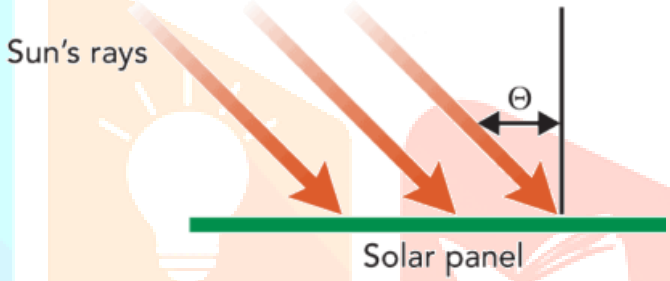


Fig. 2.2. Solar Panel

Another consequence of a large incident angle is reflection. As the incident angle increases, the glass on the front of the PV panels begins to reflect energy away from the panels, reducing the power produced. The combination of reflection and reduced available surface area is why fixed solar systems produce very little power in the morning and afternoon. For a fixed array, the incident angle changes throughout the day, from highly acute to highly obtuse. The result is that very little energy is produced during the morning and afternoon.

2.3 Tracking Increases Solar Array Performance

An optimally aligned dual-axis tracking system produces about 40% more power than an optimally aligned fixed-frame system. Because it can tilt on both, azimuth and zenith axes, a dual-axis tracking system follows the sun daily and seasonally, always positioning the solar array so that it optimally faces the sun.

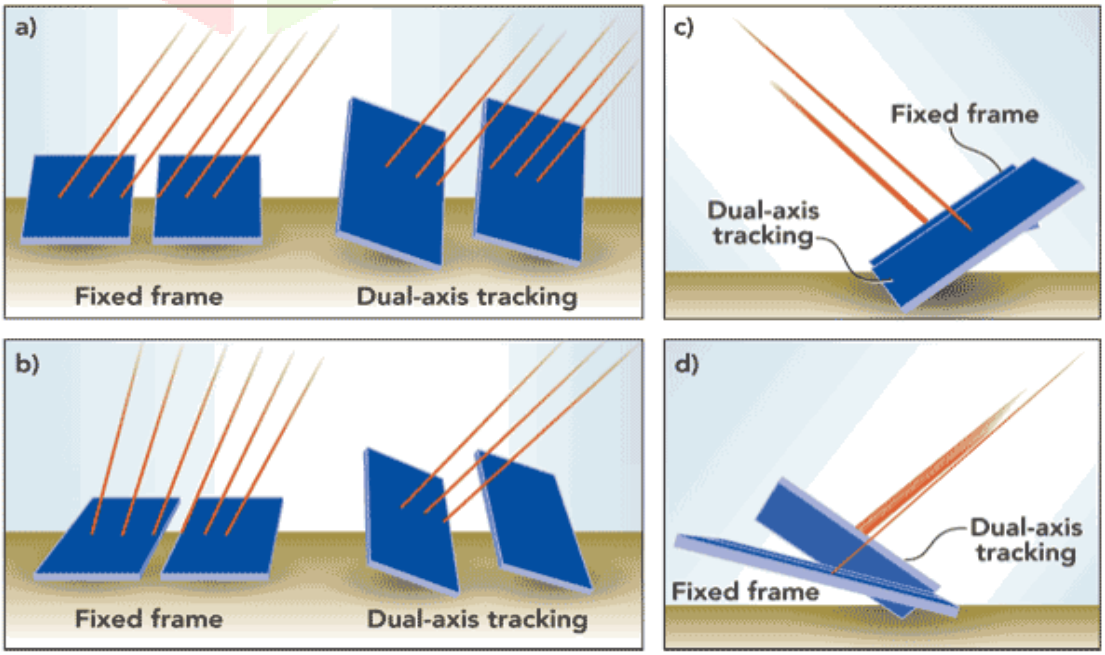


Fig. 2.3. Tracking Increases Solar Array Performance

In Fig. 2.3 a we see a fixed-array on the left and a dual-axis tracking system on the right. They are both set to true South and we can see that the lines representing the sun's rays coming into each array are at the same angle from horizontal.
In Fig. 2.3.b, we see that the panels in the tracking array are tilted towards the sun in two directions – South and East, and we see that the incident angle is 0° for the tracking array and greater than 0° for the fixed array.
In Fig. 2.3 c, we can see the angle from the tracking array side. The tracking array is tilted toward the South so, again, the incident angle is 0° and the array is generating maximum power.
Looking at Fig. 2.3 d from the fixed array side, we see that the incident angle is greater than 0° for the fixed array, so it is receiving less than full solar energy. When we combine the North/South and East/West "errors" for the fixed array, the decrease in the energy the array is receiving is significant.

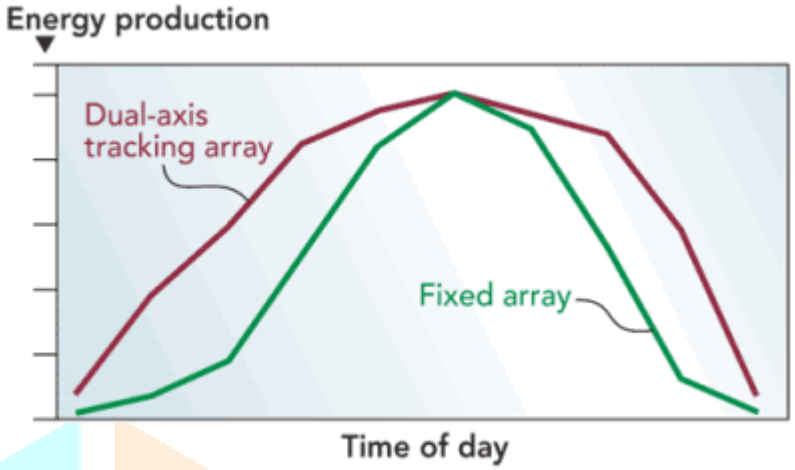


Fig. 2.4. Energy Production by a dual-axis tracking array

Above graph is a representational graph of the power produced by a dual-axis tracking array superimposed over the graph of the power produced by a fixed array. The area between the curves represents the additional power generated with dual-axis tracking.

2.4 Tracker Type Selection

The selection of tracker type is dependent on many factors including installation size, electric rates, government incentives, land constraints, latitude, and local weather.
Horizontal single axis trackers are typically used for large distributed generation projects and utility scale projects. The combination of energy improvement and lower product cost and lower installation complexity results in compelling economics in large deployments. In addition the strong afternoon performance is particularly desirable for large grid-tied photovoltaic systems so that production will match the peak demand time. Horizontal single axis trackers also add a substantial amount of productivity during the spring and summer seasons when the sun is high in the sky. The inherent robustness of their supporting structure and the simplicity of the mechanism also result in high reliability which keeps maintenance costs low. Since the panels are horizontal, they can be compactly placed on the axle tube without danger of self-shading and are also readily accessible for cleaning.
A vertical axis tracker pivots only about a vertical axle, with the panels either vertical, at a fixed, adjustable, or tracked elevation angle. Such trackers with fixed or (seasonably) adjustable angles are suitable for high latitudes, where the apparent solar path is not especially high, but which leads to long days in summer, with the sun travelling through a long arc.
Single axis trackers are typically used in smaller residential installations and locations with low government Feed in Tariffs. The study of solar tracker, its importance, utility, types has been mentioned.The solar tracker as seen above illustrates the importance in today's global market too. Various types are mentioned that include both single & dual axis tracker and the type of their installations have also been mentioned.

III. Block Diagram and Circuit Diagram of "Solar Tracking System

In this chapter, we are going to study the complete block diagram & circuit diagram of single axis tracking system. Some major components which are used in the project are described briefly.

3.1 Block Diagram Description

The Solar tracking system consist of two main parts

1. Circuit required for controlling and sensing of microcontroller and motor driver.
2. The circuit required for solar panel

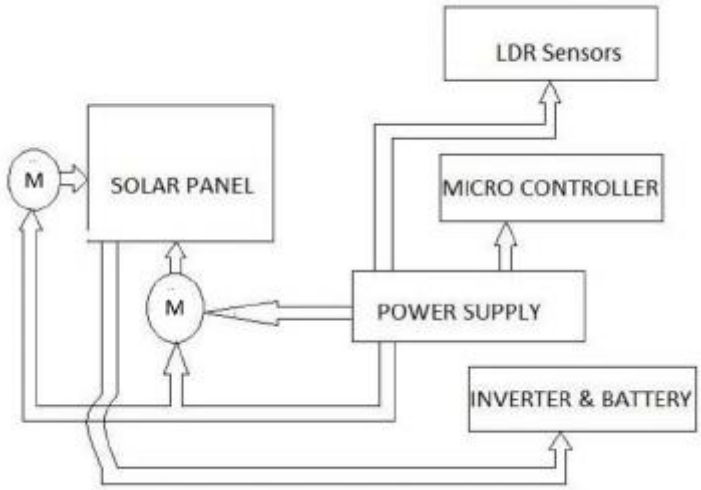


Fig. 3.1. Block Diagram of solar tracking system

Solar Panel

The solar panel which is used to convert solar energy into electrical energy. This solar panel connected to charging and battery circuit. The regulator circuit is also used to regulate the fixed supply voltage solar panel at as a sensor in our project.

Micro Controller

Micro controller compares the two voltages, when the panel rotate in either clockwise and anti clockwise. When the microcontroller compare two initial voltage and gives the instruction to the motor driver to steady the motor at higher voltage greater than the initial voltage. It continuous operate within a given permissible time.

The circuit diagram here helps to know the actual working of the tracker. Block diagram here illustrates the working and making clearer to the user, to get the better understanding of it. Various components information has also been described in brief to understand the role of each component and its operation.

IV. DESIGNING & PLANNING

In previous chapter, we have seen block diagram, circuit diagram and some major components involved in the project. A brief explanation of components was also given in previous chapter. In this chapter, we are going to discuss how project model is designed & fabricated. Also, we are going to discuss various procedures carried out while designing a PCB.

4.1 Model Designing & Fabrication

Model designing has been the one of difficult part. The main motive of designing the model was to achieve stability so that a well balance can be maintained when model is placed at a particular site or location.

4.2 Gear Mechanism and Motor Circuit : - This is the main component which we have used for model designing. Firstly, thought of making the gearing mechanism, pinion gear which is connected to the motor shaft and one simple gear which is connected to the pinion to rotating the motor as well as solar panel at a fix position. The solar panel which is assembled on the gear mechanism by using iron strips which is connected through small screw like a manner to bear the weight of the solar panel and gear mechanism. The motor is fixed at a position for free to rotate. The solar panel rotate freely clockwise and anticlockwise direction. All these mechanism is mounted on a wooden board. All the motor connections is connected with flexible wire. The main motive of gearing mechanism is to bear the load and rotating it both the directions at the time of solar tracking.

4.3 PCB Design and Fabrication

Generally the actual construction of the various projects can be accomplished in a variety of ways, the projects built upon a small perforated mounting board, this might also taken form of a printed circuit board is the simplest possible method has been chosen. Making of the RGB's is as much an art of a technique particularly so when they are to be fabricated in very small numbers. The making of PCB essential involves two steps.

1. Preparing the PCB drawing.
2. Fabricating the PCB itself from the drawing.

There are several ways of drawing PCB pattern and making the final board but this procedure has its own advantages, as the lateral inversion problem is overcome. Also tracing of the circuit and finding the faults is made easy, as the PCB matches exactly with the original circuit so that one has to look constantly for positions to drill the holes and place various components.

Following process is done for PCB planning: -

a. Layout Planning: -

The layout of PCB has to incorporate all information on the board one can proceed to the artwork preparation; this planning procedure depends on various factors.

b. Layout Scale:-

Depending upon the accuracy required, artwork produced should be of 1:1 or 2:2 even 4:4 scales according to the size of artwork. The layout is best prepared on same scale as artwork.

c. Layout Procedure:-

The first rule is not to start design of layout unless an absolute clear circuit diagram is available with the component list. In PCB layout it is important to divide the circuit into function subunits. All components are placed in such a manner that desoldering is possible.

d. Layout Sketch:-

The end product of layout designing is the pencil sketched component and conductor driving which is called layout sketch which contains all relevant information for preparation of artwork.

1. Preparation of Artwork:- The transparent base foil is placed on layout design on a graph sheet and with the help of pads and taps; the layout is traced on nylon sheet.

2. Etching:- Final copper pattern is formed by selective removal of all unwanted copper which is not protected by etch resist. If etching action is not stopped immediately after all unwanted copper has been removed, under etching will continue and can result in considerable reduction of conductor width. Normally FeCl3 is used as an etchants. Other etchants are CuCl2, Chromic acid, alkaline ammonia.

3. Rising:- After Etching is over, FeCl3 contaminated surface should be cleared. The usual practice follows water rinse (by volume). This clears the surface of PCB.

4. Drilling:- Drilling of mechanical holes for mounting is most important operation. Holes by drilling is done wherever superior hole finish for plates is required. Hence drilling is done by all professional grade manufacturers and laboratories.

The mechanical structure is an important point described above. Here the technique and materials used have been explained. The gearing mechanism which played vital role in our project and the PCB designing is briefly explained.

V. COMPONENTS USED

List of components used in project are:-

1. Microcontroller ATMEGA8
2. Motor Driver L293D
3. Permanent Magnet DC Motor
4. Voltage Regulator 7805
5. LM324 OPAMP

5. 1. Microcontroller ATMEGA 8

Features

- High-performance, Low-power AVR® 8-bit Microcontroller
- Advanced RISC Architecture
- 130 Powerful Instructions – Most Single-clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz
- On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory segments
- 8K Bytes of In-System Self-programmable Flash program memory
- 512 Bytes EEPROM o 1K Byte Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C(1)
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- Programming Lock for Software Security Special Microcontroller Features
- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated RC Oscillator
- External and Internal Interrupt Sources
- Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby I/O and Packages
- 23 Programmable I/O Lines Operating Voltages
- 2.7 - 5.5V (ATmega8L)
- 4.5 - 5.5V (ATmega8)
- Speed Grades
- 0 - 8 MHz (ATmega8L)
- 0 - 16 MHz (ATmega8)
- Power Consumption at 4 MHz, 3V, 25°C
- Active: 3.6 mA
- Idle Mode: 1.0 mA

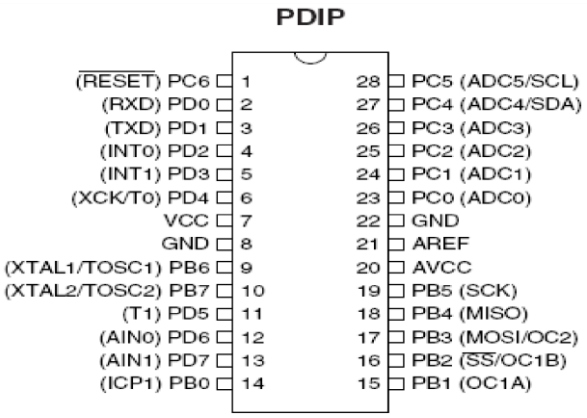


Fig. 5.1 Pin Diagram

5.2 Motor Driver L293D

L293D is a dual bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and anticlockwise direction. If we have motor with fix direction of motion we can make use of all the four I/O's to connect the DC motors. L293D has output current of 600 mA and peak output current of 1.2 A per channel more ever for the protection of circuits back EMF output diodes.

- In our project L293D is used to control the PMDC motor with interfacing microcontroller PIC25K22.
- The Pin No. 27 and 28 of the microcontroller is connected with the input pin of L293D 2 and 7.
- When the microcontroller compare the two initial voltages, if the voltage gets less than first initial voltage than its gives instruction to DLS293D to rotate the motor at a fixed degree or steps to clockwise and anticlockwise.

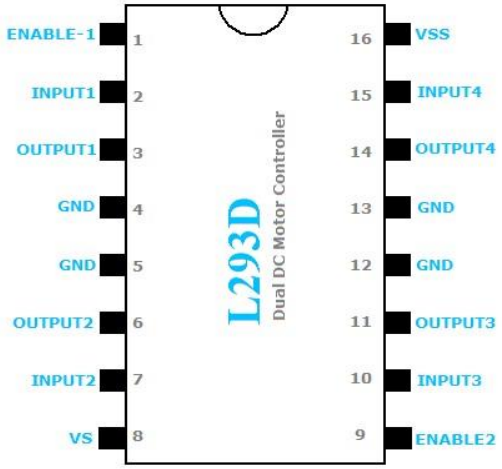


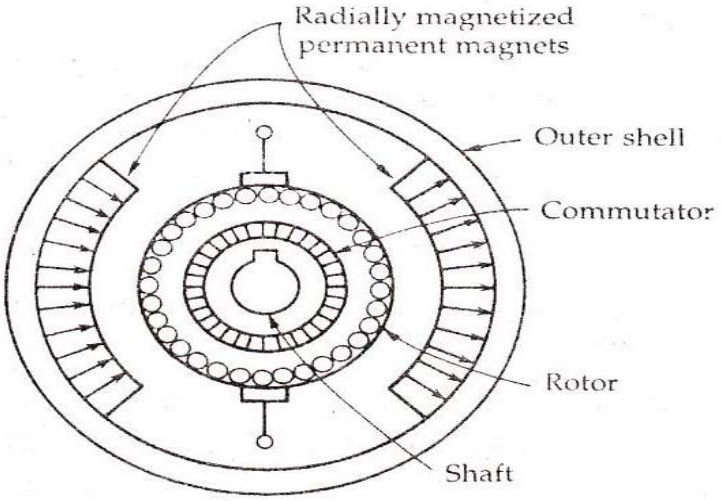
Fig. 5.2. Motor Driver L293D

Features of IC L293D:-

- 1.2A peak output current (non repetitive) per channel.
- Enable facility
- Over temperature protection
- 600mA output current capability per channel.
- high noise immunity
- internal clamp diodes

5. 3. Permanent Magnet DC Motor (PMDC Motor)

A PMDC Motor is a DC motor whose poles are made of permanent magnets. Figure shows the two pole PMDC Motor. The permanent magnet of PMDC motor are radially magnetized and mounted on the inner periphery of the cylinderical steel stator. The stator also serves as a return path for the magnetic flux.



Cross-sectional view of a PMDC motor.

Fig. 5.3. PMDC Motor

Most of the PMDC motors operates on 6 V, 12 V or 24 V, DC supply obtained from batteries or rectifiers.
Since the flux remains constant, the speed of the PMDC motor cannot be controlled by using flux control method. The speed and torque of PMDC motor can be control by armature voltage control, armature rheostat control and chopper control. These motor are therefore used only where motors speed below base speed are required.

Applications

- The application of PMDC motor are used portable electric tools, food processor, vacuum cleaner etc.
- In our project we are used the PMDC motor to rotate the solar panel at dual axis the motor is controlled by motor driver circuit.

5. 4. Voltage Regulator (L 7805)

The L7805 voltage regulator with positive regulator is available with To-220, To-3 Packages, with several fixed output voltages making it useful in wide range of applications.
In our project we are using L7805 voltage regulator because which is very precise and gives fixed output voltage within the permissible limit.

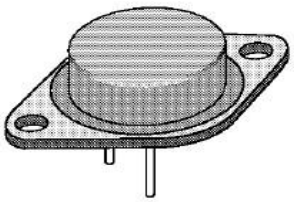


Fig. 5.4. L7805 voltage regulator

The features of 7805 are :

1. Output current upto 1.5 Amp
2. Output voltage of 5 to 24 V
3. Thermal overload protection
4. Short circuit protection

VI. APPLICATIONS

- It is useful in generating enough amount of electricity to reduce the problem of load shedding.
- It can be used for energizing street lights. Street light works only during night hours, so energy will be stored in battery during day time and utilized during night time.
- The system can be used anywhere in the world because it is having freedom to rotate in all axes. It can easily adopt itself to the geographical location and can easily convert solar energy into electricity.
- This type of system can be used on satellites to provide electricity for the various devices.
- Another advancement can be done in the circuit is by operating it through remote control. Operator can not only monitor tracker's operation status but also adjust trackers remotely, resulting in a significant reduction in maintenance cost. The monitoring system can also monitor energy output, if so configured.

VII. ADVANTAGES

- Universal application – The versatility of the solar tracker is that, it can be used for various applications and can be implemented in various parts of world except for Polar Regions.
- Generating efficiency - Over 40% increase in radiation reception from sun comparing with fixed installation. With dual axis tracker, additional over 45% increase in radiation reception from sun will be gained.
- Independent control - The important factor concerning the system is that, it can be installed anywhere where no manual operation is involved. LDR sensors play a vital role in making the system automatic by sensing the intensity resulting in generation of pulse, thus making the system independent.
- Weather resistant – The tracker's structure design can make the array move to horizontal protection position under the condition of huge wind. This design can resist wind load at 40m/s. Circuit portion can be covered and can be provided with locking arrangement.
- Lower Maintenance – The special design of driving parts makes whole system work well without maintenance for long time, which promise very lower maintenance cost. Due to lower assembly position of driving parts, the replacement of driving parts is very easy.
- Inverter flexibility - It offers complete flexibility in choice of inverters. Whether you wish to utilize a number of smaller inverters located on the tracker, or large centralized inverters, you have as many options as there are inverters.
- The circuit consumes less electricity which is obtained from solar panel.
- Switching speed is fast due to use of relays & there is no possibility of damage to IC's due to use of optocoupler for isolation purpose.

VIII. CONCLUSION

Maximum Solar Power Tracker have played a vital role in recent years thus proving to be a better technological achievement in savage of energy. The vital importance of this tracker lies in its better efficiency and sustainability to give a better output compared to a single axis solar tracker. The tracking system is so better designed that it can trap the solar energy in all possible directions. Generally in a single axis tracker sensing the intensity it moves only along a single axis and it is incapable of tracking the maximum possible solar energy. In case of trackers if the solar rays are perpendicular to panel maximum possible energy is better trapped. This happens in case of maximum solar power tracker system with microcontroller which senses the intensity and moves in direction of sun and thus trapping the maximum possible energy. Thus, the output increases and an increase in efficiency more than single axis tracker (about 30 -40% more).

IX. FUTURE SCOPE

- In India Single and Dual Axis Trackers have been installed to create awareness regarding energy crises in future. Most of them are single axis trackers. Those can be replaced by dual axis tracker thus leading to a better output and a better efficiency.
- One of the better example in India is that of a pilgrim where every day, thousands of pilgrims visit Sringeri Mutt, one of the most important places to Hinduism in Karnataka on the western coast of India. Until recently, the meals for the pilgrims have been prepared by diesel-powered cookers. Today, however, they are powered by a number of Scheffler-Solar-mirrors. These mirrors collect solar radiation, which is then loaded into a tube where water is boiled and converted to steam; the steam is subsequently pumped into kitchens where it is used for cooking purposes.
- A sophisticated steam system ensures that the kitchens function after sunset as well.
- Sringeri Mutt is only one out of eighteen places in India where temples, hospitals and schools are powered by environmentally-friendly solar energy. The new equipment will save approximately 4,000 tons of CO2 until 2012. They are produced by the Indian manufacturer Deepak Gadhia.
- The installation of this machinery has created twenty new jobs in the areas of operation and maintenance. Additionally, the air quality in the kitchen facilities has improved markedly; it has been purged of the particulates and pollution that were created by the old diesel-fueled machines.
- This can be a better application where dual axis solar tracker can be employed, a good example of pollution free and a safe device providing energy on a large scale.

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