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SOLAR TRACKING SYSTEM FOR RENEWABLE ENERGY

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ABSTRACT – Solar panel has been used increasingly in recent years to convert solar energy to electrical energy. The solar panel can be used either as a stand-alone system or as a large solar system that is connected to the electricity grids. The earth receives 84 Terawatts of power and our world extracts about 12 Terawatts of power per day. To extract maximum energy from the sun using solar panel and conversion from solar to electrical energy is the difficult task. To overcome this, the solar panels have to be positioned towards the sun.

Thus the tracking of the sun's location and positioning of the solar panel are important. The objective of this project is to design an automatic tracking system, which can locate position of the sun. The tracking system will move the solar panel so that it is positioned perpendicular to the sun for maximum energy extraction at all time. Hence the efficiency of the system may increased to about 16 percent to 20 percent. Light Dependent Resistors (LDR) will be used as sensors in this system.

KEY WORDS : Solar panel, 555 IC, L293D IC, Light Dependent Resistor (LDR), 7805 Voltage Regulator, Battery, Battery Cap, Resistors, Capacitor, Light-Emitting Diode (LED), Switch, DC Gear motor.

1.INTRODUCTION

The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, in continuous development, being clean, silent and reliable, with very low maintenance costs and minimal ecological impact. A photovoltaic panel is a device used to capture the suns radiation. These panels consist of an array of solar cells. The solar cells are made up of silicon (sand). They are then connected to complete a photovoltaic (solar) panel. When the sun rays are incident on the solar cells, due to the photovoltaic effect, light energy from the sun is used to convert it to electrical energy. We know that most of the energy gets absorbed, when the panels surface is perpendicular to the sun. Stationary mounted PV (photo voltaic) panels are only perpendicular to sun once a day but the challenge for is to get maximum energy from the source, so for it we use trackers on which the whole system is mounted. In tracking system, solar panels move according to the movement of sun throughout the day. There are three methods of tracking: active, passive, chronological and manual tracking systems. In active tracking system, the position of the sun is determined by the sensors. These sensors will trigger the motor to move the mounting system so that the panels will always face the sun rays perpendicular to it throughout the day. But in this system it is very difficult for sensors to determine the position of sun in cloudy days. So it is not a very accurate. In its Passive tracking systems, which determines the position of the sun by moving the panels in response to an imbalance pressure between the two points at both ends of the trackers. The imbalance pressure caused by solar heat creates a gas pressure on a low boiling point compressed gas fluid that is driven to one side or the other accordingly, which then moves the system.

This method is also not accurate as the shade /reflectors that are used to reflect early morning sunlight to "wake up" the panel and tilt it towards the sun can take nearly an hour to do so. A chronological tracker is a timer-based tracking system whereby the structure is moved at a fixed rate throughout the day. The theory behind this is that the sun moves across the sky at a fixed rate. Thus, the motor or actuator is programmed to continuously rotate at a slow average rate of one revolution per day (15 degrees per hour).

This method of sun-tracking is very accurate. However, the continuous rotation of the motor or actuator means more power consumption and tracking the sun. In manual tracking system, drives are replaced by operators who adjust the trackers.

This has the benefits of robustness, having staff available for maintenance and creating employment for the population in the vicinity of the site.

Tracker systems follow the sun throughout the day to maximize energy output. The Solar Tracker is a proven single-axis tracking technology that has been custom designed to integrate with solar modules and reduce system costs. The Solar Tracker generates up to 25% more energy than fixed mounting systems and provides a bankable energy production profile preferred by utilities

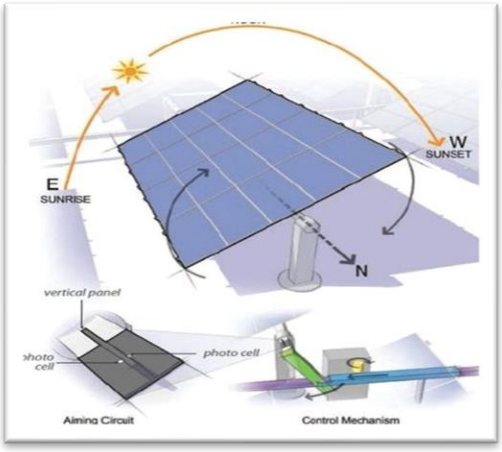

Fig 1.1. Single Axis Tracking System

1.1 OBJECTIVE

To reduce the power quality issues in AC micro grid by adopting Model Predictive Power Control (MPPC) and Model Predictive Voltage Control (MPVC) schemes. MPPC schemes maintain the DC bus voltages and smoothen the Photo Voltaic (PV) output, MPVC scheme controls the parallel inverters for load sharing.

2.2. COMPONENTS DESCRIPTION:

2.2.1. SOLAR PANEL:

Solar cells, also known as photovoltaic cells is the smallest functional unit of a solar panel and are used to convert light energy into electricity. Photovoltaic cells work on the principle of the photovoltaic effect, which is similar to the photoelectric effect. Differences being that the electrons in photovoltaic are not emitted instead contained in the material around the surface, creating a voltage difference. Solar cells are forged with crystalline silicon. It is the most commonly used material in a solar cell. The use of silicon in the solar cell has been very efficient and low cost. Two forms of crystalline silicon can be used to make solar cells. Other than silicon, solar cells can be fabricated with cadmium telluride (CdTe), Copper indium gallium (di)selenide (CIGS) etc. the fabrication of solar cells with materials other silicon is slightly expensive, thus making silicon the best material to be used in solar tracking systems. Crystalline Silicon, Thin Film Silicon are the two most using solar cells. Their properties are shown in the table.

Cell Technology	Crystalline Silicon	Thin Film Silicon
Types	• Mono-crystalline silicon (c-Si) • Poly-crystalline silicon (pc-Si/ mc-Si)	• Amorphous Silicon (a-Si) • Cadmium telluride (CdTe)
Temperature Resistivity	Lower	Higher
Module Efficiency	13-19%	4-12%

Fig 2.1. Solar Panel

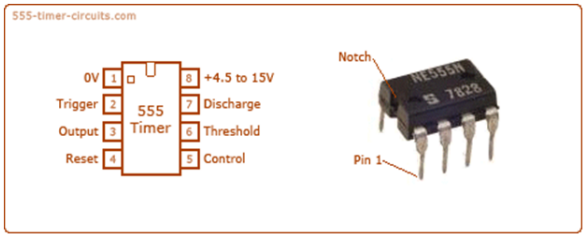

FIG 2.2. Pin Diagram of 555 IC

2.2.3. L293D IC:

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. Dual H-bridge *Motor Driver integrated circuit* (*IC*). The l293d can drive small and quiet big motors as well, check the Voltage Specification.

In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller.

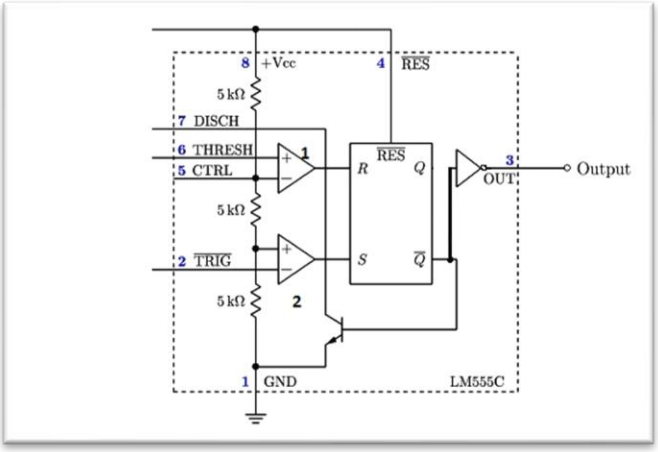

Fig 2.3. Internal Circuit Diagram of 555 IC

There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

TIP: you can simply connect the pin16 VCC (5v) to pin 1 and pin 9 to make them high.

2.2.4. LIGHT DEPENDENT RESISTOR (LDR):

A photo-resistor (light-dependent resistor, LDR, or photo-conductive cell) is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photo resistor can be applied in light-sensitive detector circuits, and light-activated and dark-activated switching circuits.

A photo resistor is made of a high resistance semiconductor. In the dark, a photo resistor can have a resistance as high as several mega ohms (MΩ), while in the light, a photo resistor can have a resistance as low as a few hundred ohms. If incident light on a photo resistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photo resistor can

substantially differ among dissimilar devices. More over we unique photo resistors may react substantially differently to photons within certain wave length bands.

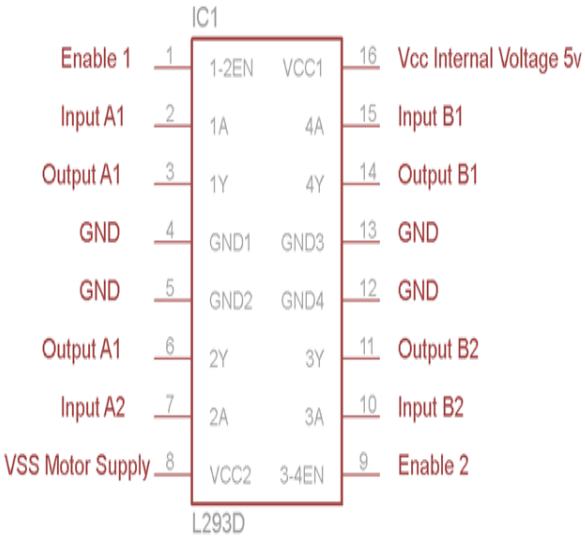

Fig 2.4. Pin Diagram of L293D

The solar tracker system will obtain its data from two CDS (Cadmium Sulfide) photocells, which are type of LDR. The material used in CDS photocell is of high resistance semiconductor. Therefore, once light falls on its surface.

Photons absorbed by the semiconductor will give bound electrons enough energy to jump in to the conduction band. As the result free electrons conduct electricity and thus lower the resistance. In case of high intensity, photocell will produce lowest resistance, the opposite will occur in case of complete darkness.

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2.2.5. 7805 VOLTAGE REGULATOR:

A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. A voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions.

There are two types of voltage regulators linear and switching

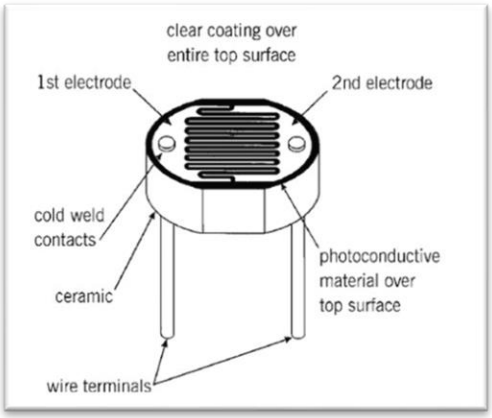


Fig 2.5. LED Diagram

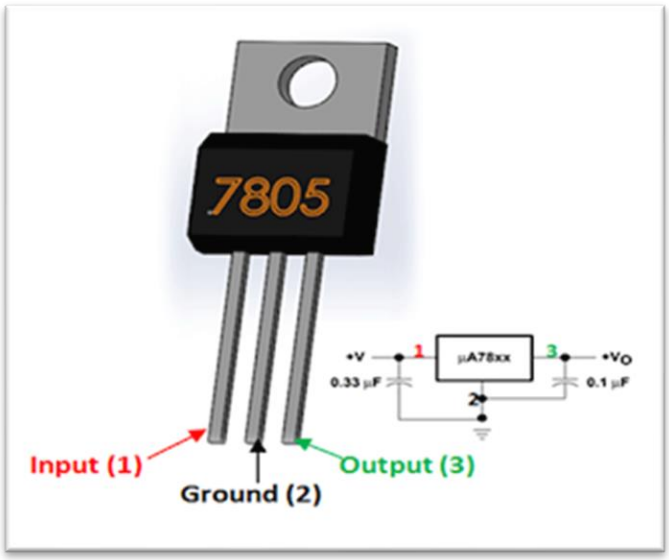


Fig 2.6. 7805 Voltage Regulator

2.2.6. BATTERY:

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its

Fig 2.7. Battery

negative terminal is the anode. The terminal marked negative is the source of electrons that will flow through an external

electric circuit to the positive terminal. When a battery is connected to an external electric load.

2.2.7. BATTERY CAP:

A battery assembled cap, a cylindrical battery with the cap and a method for making the same. The vent cap is attached to the battery cover by a hinge connection which allows for play between the vent cap and the battery cover and which allows for rotation of the vent cap.

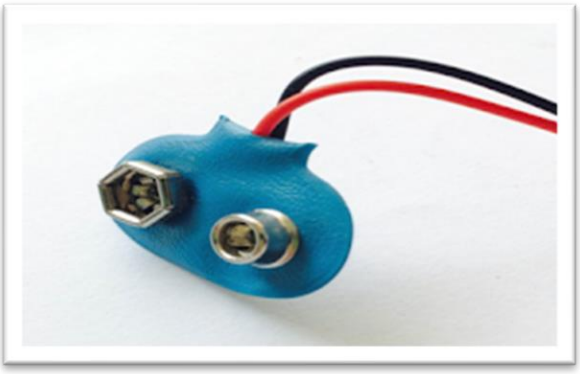


Fig 2.8. Battery Cap

2.2.8. Resistors

Fig 2.9. Resistors

It is an electrical device may be a passive two-terminal electrical part that implements resistance as a circuit component. In electronic circuits, resistors unit of measurement accustomed reduce current flow, alter signal levels, to divide voltages, bias active components, and terminate transmission lines, among completely different uses.

2.2.9. CAPACITOR:

A capacitor can store electric energy when it is connected to its charging circuit. And when it is disconnected from its charging circuit, it can dissipate that stored energy, so it can be used like a temporary battery. Capacitors are commonly used in electronic devices to maintain power supply while batteries are being changed.

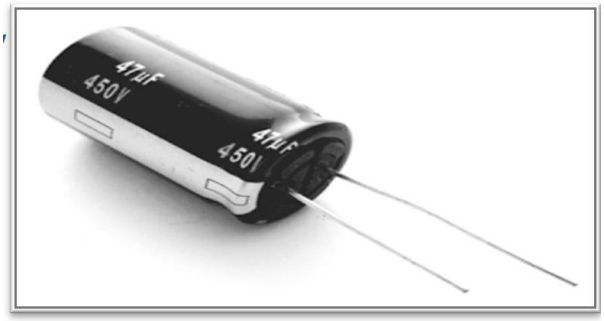


Fig 2.10. Capacitor Diagram

2.2.10. LIGHT-EMITTING DIODE:

LED is a semiconductor light source that emits light when current flows through it. When a current flows through the diode, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence. The color of the light (corresponding to the energy of the photons) is determined by the energy band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semi-conductor device Parts of a conventional LED

2.2.11. Switch:

A switch, in the context of networking is a high-speed device that receives incoming data packets and redirects them to their destination on a local area network (LAN). A LAN switch operates at the data link layer (Layer 2) or the network layer of the OSI Model and, as such it can support all types of packet protocols.

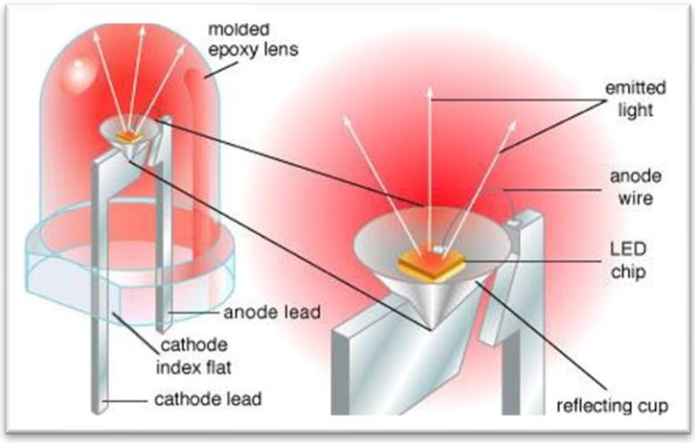


Fig 2.11. LED Diagram

2.2.12. DC GEAR MOTOR:

Gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output.

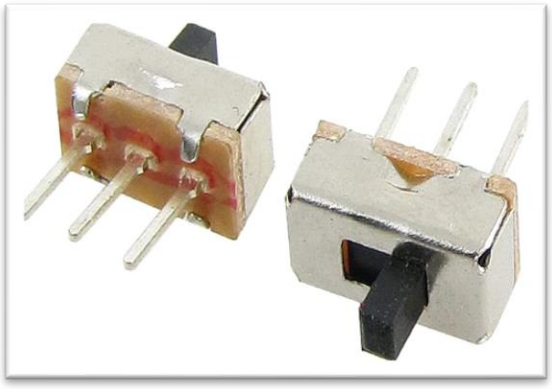


Fig 2.12. Switch Diagram

The most important parameters in regards to gear motors are speed (rpm), torque (lb-in) and efficiency (%). In order to select the most suitable gear motor for your application you must first compute the load, speed and torque requirements for your application.

Fig 2.13. DC Gear Motor

2.3 TYPES OF SOLAR TRACKER:

Types	Specifications
Active Solar Tracker	• It uses motors and gear trains or direct drive actuators, to follow the movement of the sun. • Directed by a controller. • Deactivates during darkness based on the design of the system.
Passive Solar Tracker	It uses a liquid, easily compressible and boiled. It is driven by the solar heat. The fluid moves when heated, like a teeter-totter and hence the solar panel moves.
Chronological Solar Tracker	• Works with the rotation of the earth. • Have no sensors. • Depends on the geographical location. Uses a controller to calculate the moment and position of the earth with respect to the sun at a given time and location.
Single Axis Tracker	• Tracks in a single cardinal direction. • It has a single row tracking configuration. • More reliable. • It has a longer lifespan. The common categories in which single axis trackers can be classified holds: • Horizontal single axis trackers (HSAT). • Horizontal single axis tracker with tilted modules (HTSAT). • Vertical single axis tracker (VSAT). • Tilted single axis tracker (TSAT). • Polar aligned single axis tracker (PSAT).
Dual Axis Tracker	• It moves along two cardinal directions (Horizontal & Vertical). • The axes are traditionally orthogonal. • Its efficiency is much more than any single Axis Tracker. • It conventionally follows the movement of the sun and hence captivates maximum solar radiations.

2.2 WORKING:

Solar tracker works by using a 555IC which compares light intensity illuminated onto the LDRs. The logic that works on the LDR to detect the signal is based on a resistance capacitor timing circuit, (RC constant). Once the signal is fed into the input for RB2 and RB3, the program compares the two inputs and then the differences are detected and send an output signal from port RB0 and RB1 to let the motor move clockwise and counter clock wise respectively. The signal that is sent from output port RB0 and RB1 is logic level of 1 and 0, logic 1 is high level and 0 is for low level, when logic high is sent to the base of the transistor, it energizes and makes a closed circuit, thus a current flows through the motor, only two transistors can be switched on and off at a time The materials used in the

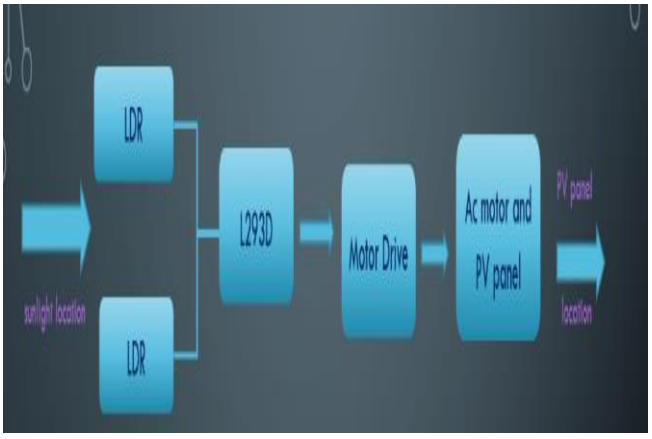
construction of this prototype include Polyvinyl Chloride (PVC), one and a half inch pipes, wooden base of Medium-density fiber board (MDF), stool which can rotate 360 degrees, automotive motor and bicycle gear mechanism.

The description on how each section of the prototype is built is as follows: Five pieces of PVC pipe with equal length are connected back to back onto a T-junction and each junction is connected to L-shaped PVC making a stable base onto which the motor can be mounted. The length of each PVC pipe is approximately 0.5 meter. A wooden base is placed on top of the square shaped design, the motor is then mounted below the wooden board, this way the motor is upside down thus its gear is facing downward as well. The hydraulics portion of the revolving office chair is used which can rotate 360 degrees. A gear is then welded onto the hydraulics part using an electric welding machine. The chair is mounted onto the wooden base; this base has dimensions of one meter by 0.8 meter in length and width respectively. Once the hydraulic portion is mounted, the PVC base is placed in a position so that the small gear on the motor is in perfect alignment with the big gear which is mounted on the hydraulics. Once the two gears are aligned they are connected by a steel chain. The gear that is mounted on the motor has 14 teeth and that which is mounted on hydraulics portion has 30 teeth. These specific teeth are chosen because this combination produces more torque on less speed thus less current has to be applied to the motor.

The horizontal axis is constructed by using two PVC pipes of size three inches in diameter, which are cut to length of 0.3 meters in height, the (MDF) wood is then later cut, 0.4 meter by 0.3 meter in length and width respectively. The PVC pipes are mounted into the shape of T-junctions. These junctions are then mounted on the MDF base, a hole is drilled on the PVC pipe at approximately 0.6 meters from the bottom, and another one inch PVC pipe is cut to a length of 0.5 meters, this pipe is inserted inside the three inch pipe, and the solar panel is mounted on it. Finally the motor and the gear are mounted on the side and linked using a chain for the horizontal axis and all the LDR‟s are mounted and wired.

3.BLOCK DIAGRAM

3.1 BLOCK DIAGRAM



3.2 Operating Principle

A system that positions an object at an angle relative to the Sun. The most-common applications for solar trackers are positioning photovoltaic (PV) panels (solar panels) so that they remain perpendicular to the Sun’s rays and positioning space telescopes so that they can determine the Sun’s direction. PV solar trackers adjust the direction that a solar panel is facing according to the position of the Sun in the sky. By keeping the panel perpendicular to the Sun, more sunlight strikes the solar panel, less light is reflected, and more energy is absorbed. That energy can be converted into power.

A solar panel that is exactly perpendicular to the Sun produces more power than a solar panel that is not perpendicular. Small angles from perpendicular have a smaller effect on power output than larger angles. In addition, Sun angle changes north to south seasonally and east to west daily.

4. CIRCUIT DIAGRAM AND WORKING

4.1 CIRCUIT DIAGRAM:

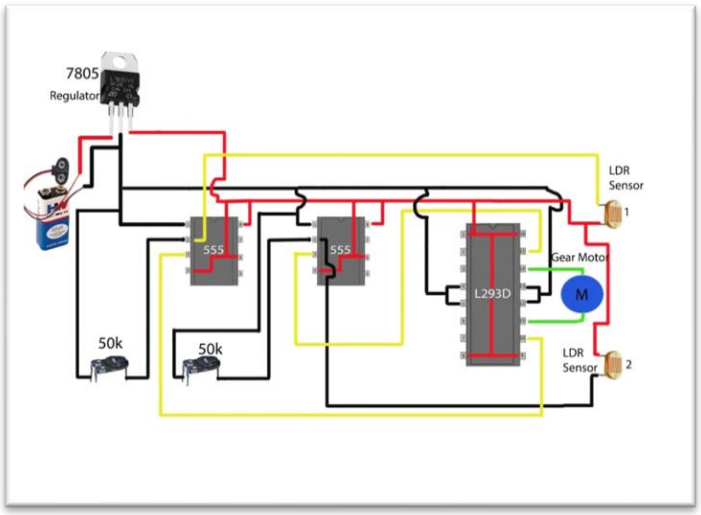
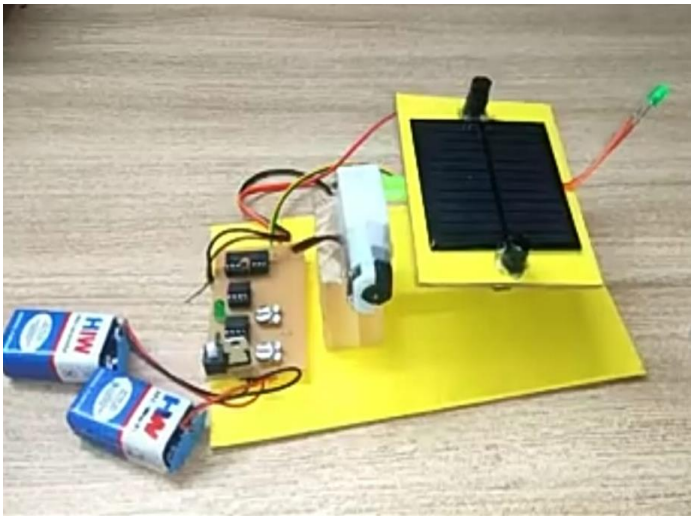


Fig.4.1 Circuit diagram of Solar Tracking System

4.2 HARDWARE CONNECTIONS



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CONCLUSION AND FUTURE SCOPE

5.1. Conclusion:

In this project hardware implementation of Solar Tracking system is done using 555 timer, LDR, Voltage Regulator and gear motor. Solar tracking systems are used to continually orient photovoltaic panels towards the sun and can help to maximize the energy from sun.

They are beneficial as the sun’s position in the sky will change gradually over the course of a day and over the course of a day and over the seasons throughout the year.

5.1.1. ADVANTAGES:

The main advantages of using this system are:

- Trackers generate more electricity than their stationary counterparts due to increased direct exposure to solar rays. This increase can be as much as 10 to 25% depending on the geographic location of the tracking system.
- There are many different kinds of solar trackers, such as single-axis and dual-axis trackers, all of which can be the perfect fit for a unique jobsite. Installation size, local weather, degree of latitude and electrical requirements are all important considerations that can influence the type of solar tracker best suited for a specific solar installation.
- In certain states, some utilities offer Time of Use (TOU) rate plans for solar power, which means the utility will purchase the power generated during the peak time of the day at a higher rate. In this case, it is beneficial to generate a greater amount of electricity during these peak times of the day. Using a tracking system helps maximize the energy gains during these peak time periods.
- Advancements in technology and reliability in electronics and mechanics have drastically reduced long-term maintenance concerns for tracking systems.

5.1.2. DISADVANTAGES:

Every technology has good and bad aspects.

- Solar trackers are slightly more expensive than their stationary counterparts, due to the more complex technology and moving parts necessary for their operation. This is usually around a 10 %– 25 % increase depending on the size and location of the project.
- Even with the advancements in reliability, there is generally more maintenance required than a traditional fixed rack, though the quality of the solar tracker can play a role in how much and how often this maintenance is needed.

- Trackers are a more complex system than fixed racking. This means that typically more site preparation is needed, including additional trenching for wiring and some additional grading.
- Single-axis tracker projects also require an additional focus on company stability and bankability. When it comes to getting projects financed, these systems are more complex and thus are seen as a higher risk from a financier's viewpoint.
- Solar trackers are generally designed for climates with little to no snow making them a more viable solution in warmer climates. Fixed racking accommodates harsher environmental conditions more easily than tracking systems.
- Fixed tracking systems offer more field adjustability than single-axis tracking systems. Fixed systems can generally accommodate up to 20% slopes in the E/W direction while tracking systems typically offer less of a slope accommodation usually around 10% in the N/S direction.

Overall, solar trackers are highly efficient installations and are a great fit for both large and small project sites given the proper location and site conditions.

5.2. FUTURE SCOPE:

The very embodiment through which the futuristic conundrum be set aside, is the project called "Solar Tracking System". A trailblazer by its spirit, this system works in its utmost efficiency, whether that be in terms of its pecuniary ability or in terms of its accessibility. In the smoke of the darkness where pollution engulfing every spheres of advancement as an outcome of producibility, this device in its very efficiency work towards only advancement and development by flushing out the pollution at large.

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