Dual Axis Solar Panel Tracker

Project report submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

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SECTOR-62

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Candidates' Declaration

This is to certify that the work which is being presented in B.Tech Minor Project Report entitled **Dual Axis Solar Panel Tracker**, submitted by Dev Uppal and Rohit Goel, in partial fulfillmentof the requirements for the award of degree of **Bachelor of Technology** in **Electronics & Communication Engineering** and submitted to the Department of Electronics & Communication Engineering of Jaypee Institute of Information Technology, Noida is an authentic record of our own work carried out during a period from August 2022 to December 2022 under the supervision of **Mrs. Shradha Saxena**, ECE Department. The matter presented in thisreport has not been submitted by us for the award of any other degree elsewhere.

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This is to certify that the above statement made by the candidates is correct to the best of myknowledge.

Mrs. Shradha Saxena

Date:

Acknowledgement

We take this opportunity to convey our gratitude to all those who have been kind enough to offer their advice and provide assistance when needed which has led to the successful completion of the project.

We would like to express my immense gratitude to, **Prof. Shweta Srivastava**, the Head of the ECE department for their constant support and motivation that has encouraged us to come up with this project and also for providing the right ambience for carrying out the work and the facilities provided to us.

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List of Acronyms and Abbreviation

PV	Photovoltaic
DOF	Degree of Freedom
PV Panels	Photovoltaic Panels
MPPT	Maximum Power Point Tracking
DC	Direct Current

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CHAPTER 1

Introduction

1.1 Background:

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. The world population is increasing day by day and the demand for energy is increasing accordingly. Oil and coal are the main source of energy nowadays but there is a fact that the fossil fuels are limited and hand strong pollution. Even the price of petroleum has been increasing year by year and the previsions on the medium term there are not quite encouraging. Utilization of this resources increases the emission of carbon monoxide (CO), hydrogen chloride (HCL), Nitrogen Oxides, and Sulphur Oxides which are responsible for the global warming and greenhouse effect. This results the devastating effect in the environment.

With the view point of minimizing above mentioned problems, many researched have been carried since late 19th century by researchers and engineers. Renewable energy sources as an alternative to fossil fuel were the major found out. They are derived from natural processes that are replenished constantly. Renewable energies are inexhaustible and clean. The energy comes from natural resources such as sun, wind, tides, waves, and geothermal heat. Solar energy is quite simply the energy produced directly by the sun. The history of solar energy is as old as humankind. In general, solar energy is radiant light and heat from the sun harnessed using a range of technologies such as photovoltaic and concentrator. In the last two centuries, we started using Sun's energy directly to make electricity.

In 1839, Alexandre Edmond Becquerel discovered that certain materials produced small amounts of electric current when exposed to light. In 1876, When William Grylls Adams and his student, Richard Evans Day, discovered that an electrical current could be started in selenium solely by exposing it to light, they felt confident that they had discovered something completely new. Werner von Siemens, a contemporary whose reputation in the field of electricity ranked him alongside Thomas Edison, called the discovery “scientifically of the most far-reaching importance.” This pioneering work portended quantum mechanics long before most chemists and physicist had accepted the reality of atoms. Although selenium solar cells failed to convert enough sunlight to power electrical equipment, they proved that a solid material could change light into electricity without heat or any moving parts.

Later in 1905 Albert Einstein published the first theoretical work describing the photovoltaic effect, titled “Concerning a Heuristic Point of View toward the Emission and Transformation of Light.” In the paper, he showed that light possesses an attribute that earlier scientists had not recognized. Light, Einstein discovered, contains packets of energy, which he called light quanta. Einstein’s bold and novel description of light, combined with the [1898] discovery of the electron, gave scientists in the second decade of the twentieth century a better understanding of photo electricity. They saw that the more powerful photons carry enough energy to knock poorly linked electrons from their atomic orbits in materials like selenium. When wires are attached, the liberated electrons flow through them as electricity. By the 1920s, scientists referred to the phenomenon as the “photovoltaic effect.” In 1953, Bell Laboratories (now AT&T labs) scientists Gerald Pearson, Daryl Chapin and Calvin Fuller developed the first silicon solar cell capable of generating a measurable electric current. The New York Times reported the discovery as “the beginning of a new era, leading eventually to the realization of harnessing the almost limitless energy of the sun for the uses of civilization. After years of experiments to improve the efficiency and commercialization of solar power, solar energy gained support when the government used it to power space exploration equipment in 1958. The first solar-powered satellite, Vanguard 1, has traveled more than 197,000 revolutions around Earth in the 50 years. Consequently, in 1982 and 1985 first solar parks and retractable RV solar panels are created respectively. In 1994, the National Renewable Energy Laboratory developed a new solar cell from gallium indium phosphide and gallium arsenide that exceeded 30% conversion efficiency. By the end of the century, the laboratory created thin-film solar cells that converted 32% of the sunlight it collected into usable energy Due to dedicated research worldwide, the efficiency of photovoltaics has continued to increase while production costs have also dropped substantially over the years. A solar cell (also called a photovoltaic cell) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure.

The majority of modules use wafer based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural member of a module can either be the top layer or the back layer. Electrical connections are made in series to achieve a desired output voltage and in parallel to provide a desired current capability. Several types of solar cells are available. Monocrystalline Solar Cells, Polycrystalline Solar Cells, Amorphous Silicon (aSi) Solar Cells, Cadmium Telluride (CdTe) Solar Cells. 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 any given time. Automatic solar tracker increases the efficiency of the solar panel by keeping the solar panel aligned with the rotating sun. Solar tracking is a mechanized system to track the sun's position that increases power output of solar panel 30% to 60% than the stationary system.

1.2 Solar energy distribution in global context:

The global solar energy market has enjoyed growth at an exceptional rate over the recent years, facilitated by the rising solar power output from world's top solar energy producing countries. With the growing demand for alternative and eco-friendly energy that significantly reduces carbon emissions around the world, many major countries have been rapidly increasing the capacity of their solar power facilities and other renewable energy installations over the past few years. While the global solar energy market continues to surge, the world's top solar energy producing countries, including China, Japan, Germany and the USA are expected to maintain their leadership in global solar energy capacity in the future.

Within global renewable energy installations, solar power plants have enjoyed the fastest growth in volume over the past few years. Thanks to the vast availability and certainty of sunlight, solar power projects have outperformed other forms of renewable energy sources such as wind and geothermal. Moreover, with the advancements in technologies, including concentrated solar power generation techniques, and a decline in prices of PV modules, solar energy has become the most cost-effective source of renewable energy.

According to the report from BP, total solar PV power generating capacity reached 301 GW by the end of 2016, representing a 33.2% increase from 2015. A total 75 GW of new installations were added to the global solar energy capacity in 2016. The largest increments in 2016 were recorded in China (34.5 GW) and the US (14.7 GW), together accounting for two-thirds of the growth in global solar capacity. Japan provided the third largest addition (8.6 GW). China also leads in terms of cumulative installed capacity (78.1 GW), with more than a quarter of the global total. Japan (42.8 GW) moved past Germany (41.3 GW) to take second place, with the US (40.3 GW) now close behind Germany.

1.3 Statement of Problems

The main goal is to keep solar PV panel perpendicular to the sun throughout the day in order to increase the energy generation. Dual axis solar tracking system can be an effective way to increase the efficiency of solar cells. The devastating problem on both biotic and abiotic components of our home (i.e., pollution) can be reduced by using solar energy as the major source for power generation. The natural gift like fossil fuels, woods, etc. which are limited in amount can be saved from crisis and extinction. For people, due to its more efficiency and less harmful impacts dual axis solar tracking system might be good decision for the intermediate future. So, this project can practically demonstrate effect of this variation to people. Intermediate future. So, this project can practically demonstrate effect of this variation to people.

1.4 Objectives

i. To design and fabricate a dual axis PV system that tracks the sun path.
ii. To study different solar parameters and methods of harvesting solar energy.
iii. To understand the working mechanism of PV module and tracking system.

1.5 Significances

i. Solar tracking systems continually orient photovoltaic panels towards the sun and can help maximize your investment in PV system.
ii. One-time investment which provides higher efficiency and flexibility on dependency.
iii. Energy production is an optimum and energy output is increased year around.

1.6 Limitations

i. The reading taken will be compromised by the weather.
ii. The readings and tracking system are as good as the calibration of low-cost materials to be used in the system.

CHAPTER 2

Components & Study Design

2.1 Specification of Hardware

2.1.1 Solar PV Panel

A PV module is an assembly of photo-voltaic cells mounted in a frame work for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin film cells. The structural (load carrying) member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture.

Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to a desired voltage, and then in parallel to increase amperage. The wattage of the module is the mathematical product of the voltage and the amperage of the module.

A PV junction box is attached to the back of the solar panel and functions as its output interface. External connections for most photovoltaic modules use MC4 connectors to facilitate easy weatherproof connections to the rest of the system. A USB power interface can also be used. Module electrical connections are made in series to achieve a desired output voltage or in parallel to provide a desired current capability (amperes) of the solar panel or the PV system.

The conducting wires that take the current off the modules are sized according to the ampacity and may contain silver, copper or other non-magnetic conductive transition metals. Bypass diodes may be incorporated or used externally, in case of partial module shading, to maximize the output of module sections still illuminated.

Some special solar PV modules include concentrators in which light is focused by lenses or mirrors onto smaller cells. This enables the use of cells with a high cost per unit area (such as gallium arsenide) in a cost-effective way. Solar panels also use metal frames consisting of racking components, brackets, reflector shapes, and troughs to better support the panel structure.

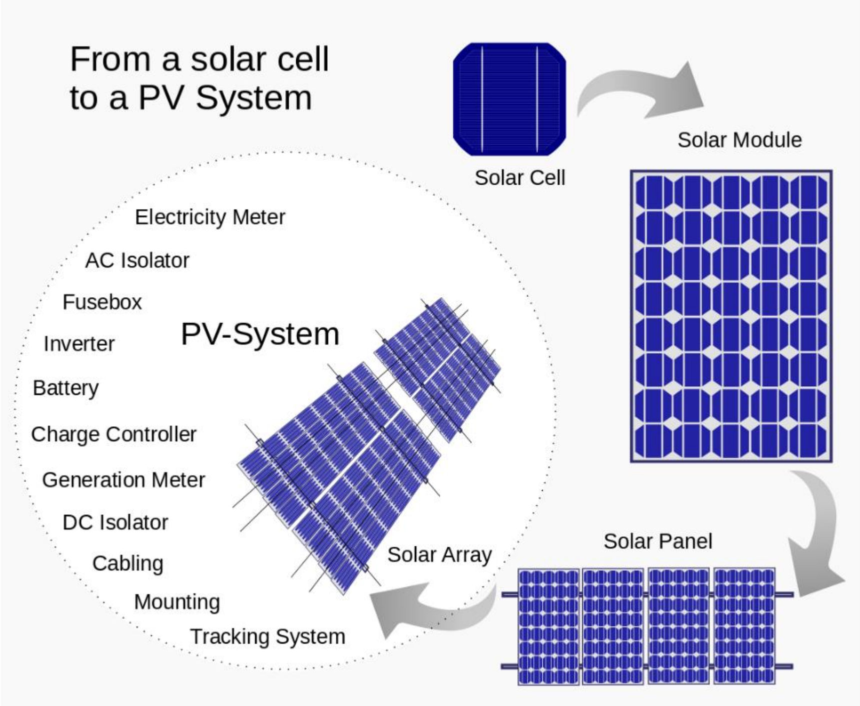


Figure 1: PV System [5]

2.1.2 LDR (Light Dependent Resistor)

A Light Dependent Resistor (also known as a photo resistor or LDR) is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photoconductors, photoconductive cells or simply photocells. They are made up of semiconductor materials that have high resistance. There are many different symbols used to indicate a photo resistor or LDR, one of the most commonly used symbols is shown in the figure below. The arrow indicates light falling on it.

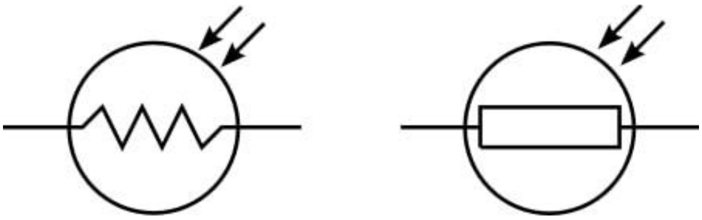


Figure 2: LDR Symbols[4]

Photo resistors work based off of the principle of photoconductivity. Photoconductivity is an optical phenomenon in which the material's conductivity is increased when light is absorbed by the material. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the bandgap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy strikes on the device, more and more electrons are excited to the conduction band which results in a large number of charge carriers. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased.

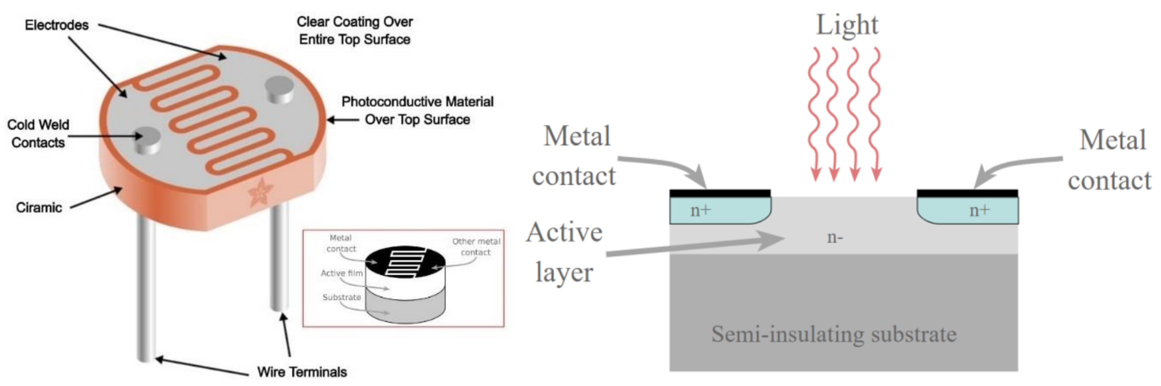


Figure 3: LDR Structure[4]

2.1.3 LM358 IC

LM358 IC is a dual operational amplifier integrated circuit with two Op-Amp powered by a common power supply. It consists of two independent compensated operational amplifiers with low power and high gain frequency.

LM358 is specially designed to operate from a single supply over a wide range of voltage. It is more flexible for low voltage AC and moderate voltage DC applications. LM358 is available in a cheap-sized package so it is widely used in real-life applications including transducer amplifier, DC gain block, active filter, and conventional op-amp circuit design. LM358 IC can handle 3V- 32V DC supply and source up to 20 mA per channel.

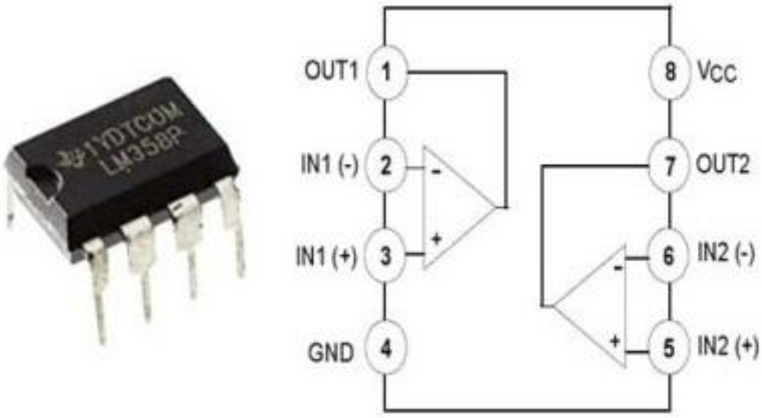


Figure 4: LM358P IC Pinout [7]

2.1.4 555 timer IC

The 555 timer IC is an integral part of electronics projects. Be it a simple project involving a single 8-bit micro-controller and some peripherals or a complex one involving system on chips (SoCs), 555 timer working is involved. These provide time delays, as an oscillator and as a flip-flop element among other applications.

Depending on the manufacturer, the standard 555 timer package includes 25 transistors, 2 diodes and 15 resistors on a silicon chip installed in an 8-pin mini dual-in-line package (DIP-8). Variants consist of combining multiple chips on one board. However, 555 is still the most popular. Let us look at the pin diagram to have an idea about the timer Integrated Circuit (IC) before we talk about 555 timer working.

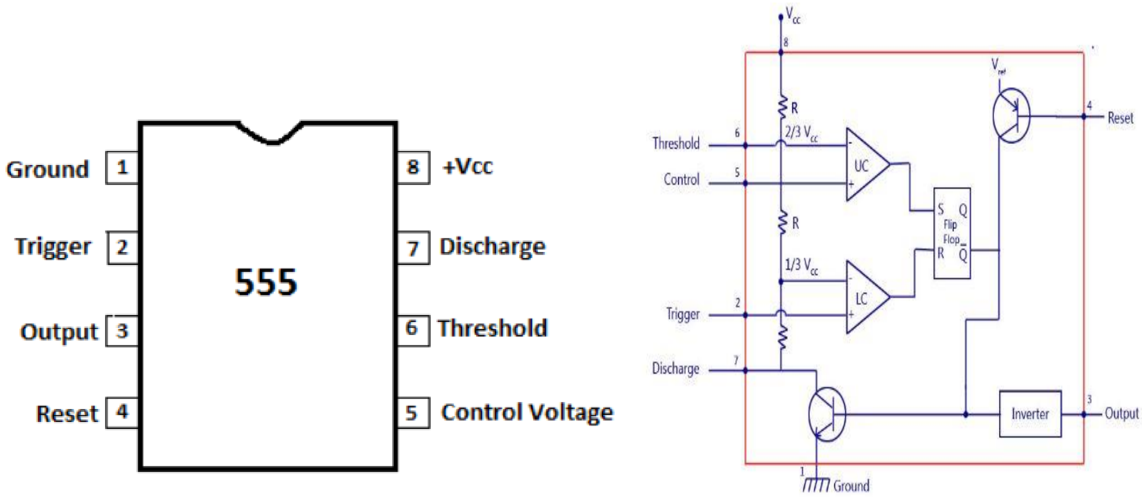


Figure 5: 555 timer IC Pinout [6]

2.1.5 L293D Motor Driver

A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between Arduino and the motors . The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. We will be referring the motor driver IC as L293D only. L293D has 16 pins.

- 1 - Enable 1-2, when this is HIGH the left part of the IC will work and when it is low the left part won't work.
- 2 - INPUT 1, when this pin is HIGH the current will flow though output 1
- 3 - OUTPUT 1, this pin should be connected to one of the terminal of motor
- 4,5 - GND, ground pins
- 6 - OUTPUT 2, this pin should be connected to one of the terminal of motor
- 7 - INPUT 2, when this pin is HIGH the current will flow though output 2
- 8 - VCC2, this is the voltage which will be supplied to the motor.
- 16 - VCC1, this is the power source to the IC.
- 15 - INPUT 4, when this pin is HIGH the current will flow though output 4
- 14 - OUTPUT 4, this pin should be connected to one of the terminal of motor
- 13,12 - GND, ground pins
- 11 - OUTPUT 3, this pin should be connected to one of the terminal of motor
- 10 - INPUT 3, when this pin is HIGH the current will flow though output 3
- 9 - Enable 3-4, when this is HIGH the right part of the IC will work and when it is low the right part won't work.

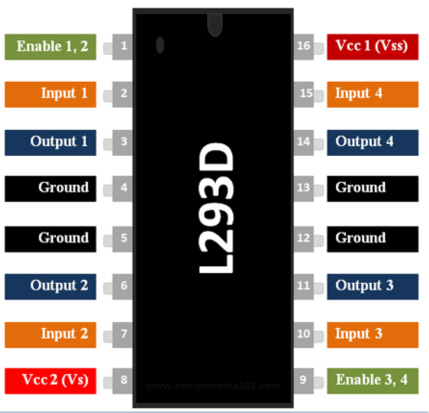


Figure 6: L293D Motor Driver Pinout [8]

2.1.6 LM2587 IC (DC to DC boost converter)

The LM2587 series of regulators are monolithic integrated circuits specifically designed for flyback, step-up (boost), and forward converter applications. The device is available in 4 different output voltage versions: 3.3V, 5.0V, 12V, and adjustable. Requiring a minimum number of external components, these regulators are cost effective, and simple to use. Included in the datasheet are typical circuits of boost and flyback regulators. Also listed are selector guides for diodes and capacitors and a family of standard inductors and flyback transformers designed to work with these switching regulators. The power switch is a 5.0A NPN device that can stand-off 65V. Protecting the power switch are current and thermal limiting circuits, and an undervoltage lockout circuit. This IC contains a 100 kHz fixed-frequency internal oscillator that permits the use of small magnetics. Other features include soft start mode to reduce in-rush current during start up, current mode control for improved rejection of input voltage and output load transients and cycle-by-cycle current limiting. An output voltage tolerance of ±4%, within specified input voltages and output load conditions, is guaranteed for the power supply system.

Figure 7: LM2587 IC

2.1.7 LiPo Battery Charger Module Mini TP4056 IC

Lithium-ion batteries are rechargeable batteries that charge using BMS. For a wide range of applications, from lighting up an LED bulb to powering up a microcontroller. This charging module adds portability to your project. It can eliminate the removable battery and charge them through a mini-USB.

This module uses a TP4056 chip, which is a Li-ion battery charger. It has a micro-USB port and solder pads to be used for the power supply to charge the battery.

When in use with a charger, the output pins draw current from the charger module, and the remaining current goes to charge the battery. It has an under-voltage and short circuit protection. The full charge voltage of the battery is 4.2V. It has LED indicators that indicate charging(red) and full charge(blue) status.

Figure 8: Mini TP4056 IC [9]

2.1.8 Servo motors

A servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight package. Doe to these features they are being used in many applications like toy car, RC helicopters and planes, Robotics, Machine etc.

Servo motors are rated in kg/cm (kilogram per centimetre) most hobby servo motors are rated at 3kg/cm or 6kg/cm or 12kg/cm. This kg/cm tells you how much weight your servo motor can lift at a particular distance. For example: A 6kg/cm Servo motor should be able to lift 6kg if the load is suspended 1cm away from the motors shaft, the greater the distance the lesser the weight carrying capacity. The position of a servo motor is decided by electrical pulse and its circuitry is placed beside the motor. A servo consists of a Motor (DC or AC), a potentiometer, gear assembly and a controlling circuit. First of all we use gear assembly to reduce RPM and to increase torque of motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now difference between these two signals, one comes from potentiometer and another comes from other source, will be processed in feedback mechanism and output will be provided in term of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with potentiometer and as motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

Figure 9: Servo motor [15]

CHAPTER 3

Methodology

3.1 Theoretical Framework

Solar panel is mainly made from semiconductor materials. Si used as the major component of solar panels, which is maximum 24.5% efficient. Unless highly efficient solar panels are invented, the only way to enhance the performance of a solar panel is to increase the intensity of light falling on it. 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. MPPT technology will only offer maximum power which can be received from stationary arrays of solar panels at any given time. The technology cannot however increase generation of power when the sun is not aligned with the system. Because the position of the sun changes during the course of the day and season over the year. So, the implementation of a solar tracker is the best solution to increase energy production. Solar tracking is a system that is mechanized to track the position of the sun and align perpendicular 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. Some researchers have conducted various studies to establish the optimal degree of tilt of a solar panel to increase the output power. Currently, there are two main types of solar trackers: the one axis and two axes.

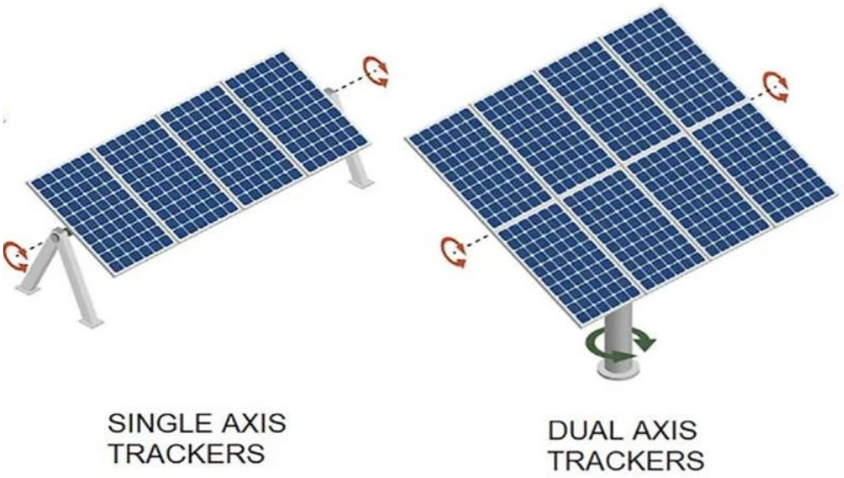


Figure 10: a) Single axis solar tracker, b) Dual axis solar tracker [10]

Single-axis trackers have only one axis of movement as shown in Fig 9a), usually aligned with North and South. This allows the panels to arc from east to west, tracking the sun as it rises, travels across the sky, and sets. Dual-axis trackers have two degrees of freedom as shown in Fig 9b), that act as axes of rotation, aligned with North-South and with East-West, giving them a wide range of position options. When seasons changes, the sun's path goes from low in the sky in winter too high in the sky in summer. So, in order to accurately follow the sun, the two-axis tracking is required as solar azimuth angle as well as solar altitude angle of sun varies (in two axis) all the time. This optimizes maximum power from the PV system over a day than non-tracking system.

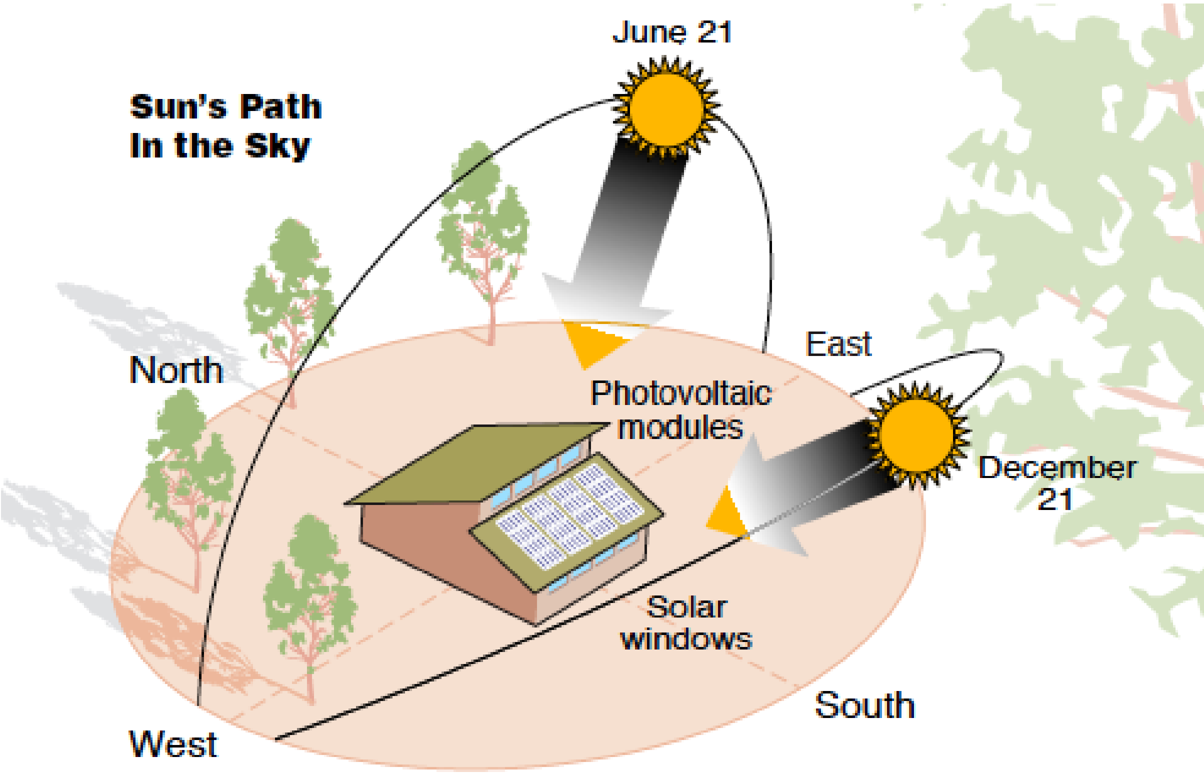


Figure 11: Variation in trajectory of sun from winter to summer [11]

3.2 Literature Review

3.2.1 Thermal Application of Solar Energy

As we know that the sun produces both heat and light energy in the form of electromagnetic radiation. When it comes to thermal use, it is mainly used for water heating and heat sources to different types of concentrator for various heat application.

1) WATER HEATER

Solar water heaters also called solar domestic hot watersystems, can be a cost-effective way to generate hot water for your home. They can be used in any climate, and the fuel they use: sunshine, is free. Working of solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't.

i. Active solar water heating systems

Active systems use one or more pumps to circulate water and/or heating fluid in the system. Though slightly more expensive, active systems offer several advantages. There are two types of active solar water heating systems.

- **Direct circulation systems**

Pumps circulate household water through the collectors and into the home. They work well in climates where it rarely freezes.

- **Indirect circulation systems**

Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water that then flows into the home. They are popular in climates prone to freezing temperatures.

ii. Passive solar water heating systems

Passive solar water heating systems are typically less expensive than active systems, but they're usually not as efficient. However, passive systems can be more reliable and may last longer. There are two basic types of passive systems: • **Integral collector-storage passive systems**

These work best in areas where temperatures rarely fall below freezing. They also work well in households with significant daytime and evening hot-water needs.

• **Thermosiphon systems**

Water flows through the system when warm water rises as cooler water sinks. The collector must be installed below the storage tank so that warm water will rise into the tank. These systems are reliable, but contractors must pay careful attention to the roof design because of the heavy storage tank. They are usually more expensive than integral collector-storage passive systems.

3.2.2 Solar Concentrator

As the maximum temperature of a normal place can vary from 20-40 °C. But we may need higher temperature for different heating purpose. So, various types of concentrators are designed to generate a required amount of heat and temperature in a surface. Different types of concentrators with their temperature production and principle of operation are shown in table.

Table 1: Types of concentrators

Type of Collector	Temperature of working fluid	Principle of Collection
Flat plate	Low temperature around 150°C	Radiation received by the surface without focusing.
Parabolic trough type with line focus	Moderate temperature around 300°C	Parabolic through shaped mirrors reflect the beam radiation on axial pipe.
Paraboloid dish with point focus	High temperature around 500°C	Paraboloid dish shaped reflectors focus the reflected rays on the focus point.

Fresnel lens with centre focus	High temperature around 500°C or higher	Lens focus the light at the central point.
Heliostats with central receiver focusing	High temperature 1200°C	Several nearly flat mirrors on ground reflect the beam radiation on a central receiver on a tall tower.

3.2.3 Electrical Application of Solar Energy

Today the measure concern about the solar energy is production of electricity from it with the help of PV cells or solar cells. Different types of solar cells are developed and developing to increase their efficiency. Different parameters regarding photovoltaic module are described below:

1) PV Cells

A solar cell is an electronic device which directly converts sunlight into electricity. Light shining on the solar cell produces both a current and a voltage to generate electric power. This process requires firstly, a material in which the absorption of light raises an electron to a higher energy state, and secondly, the movement of this higher energy electron from the solar cell into an external circuit. The electron then dissipates its energy in the external circuit and returns to the solar cell. A variety of materials and processes can potentially satisfy the requirements for photovoltaic energy conversion, but in practice nearly all photovoltaic energy conversion uses semiconductor materials. Photo electric effect in PV cell in the form of a p-n junction. The basic steps in the operation of a solar cell are:

- the generation of light-generated carriers;
- the collection of the light-generated carries to generate a current;
- the generation of a large voltage across the solar cell; and
- the dissipation of power in the load and in parasitic resistances.

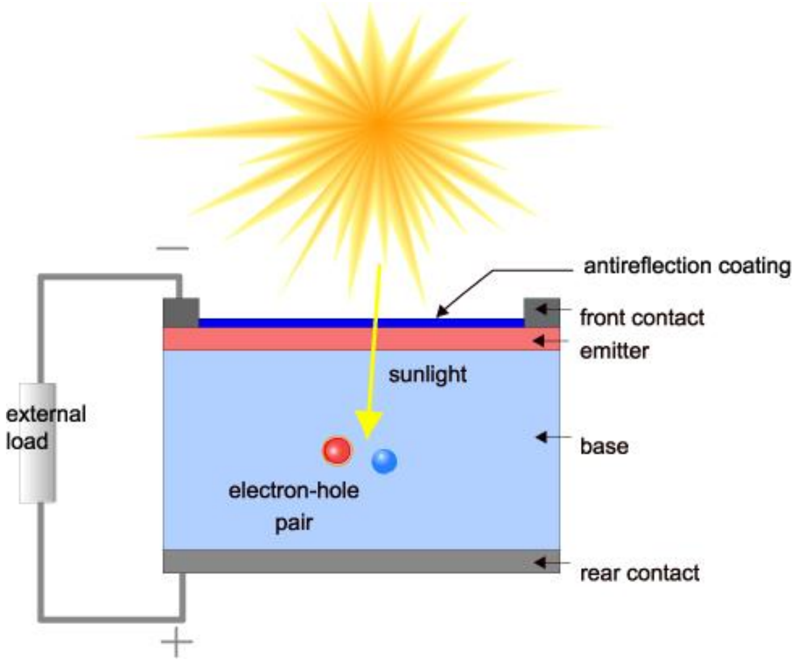


Figure 12: Photo electric effect in PV cell [15]

The generation of current in a solar cell, known as the "light-generated current", involves two key processes. The first process is the absorption of incident photons to create electron-hole pairs. Electron-hole pairs will be generated in the solar cell provided that the incident photon has an energy greater than that of the band gap. However, electrons (in the p-type material), and holes (in the n-type material) are metastable and will only exist, on average, for a length of time equal to the minority carrier lifetime before they recombine. If the carrier recombines, then the light-generated electron-hole pair is lost and no current or power can be generated.

A second process, the collection of these carriers by the p-n junction, prevents this recombination by using a p-n junction to spatially separate the electron and the hole. The carriers are separated by the action of the electric field existing at the p-n junction. If the light-generated minority carrier reaches the p-n junction, it is swept across the junction by the electric field at the junction, where it is now a majority carrier. If the emitter and base of the solar cell are connected together (i.e., if the solar cell is short circuited), the light-generated carriers flow through the external circuit. The ideal short circuit flow of electrons and holes at a p-n junction. Minority carriers cannot cross a semiconductor-metal boundary and to prevent recombination they must be collected by the junction if they are to contribute to current flow.

The collection of light-generated carriers does not by itself give rise to power generation. In order to generate power, a voltage must be generated as well as a current.

Voltage is generated in a solar cell by a process known as the "photovoltaic effect". The collection of light-generated carriers by the p-n junction causes a movement of electrons to the n-type side and holes to the p-type side of the junction. Under short circuit conditions, there is no build-up of charge, as the carriers exit the device as light generated current.

However, if the light-generated carriers are prevented from leaving the solar cell, then the collection of light-generated carriers causes an increase in the number of electrons on the n-type side of the p-n junction and a similar increase in holes in the p-type material. This separation of charge creates an electric field at the junction which is in opposition to that already existing at the junction, thereby reducing the net electric field. Since the electric field represents a barrier to the flow of the forward bias diffusion current, the reduction of the electric field increases the diffusion current. A new equilibrium is reached in which a voltage exists across the p-n junction. The current from the solar cell is the difference between IL and the forward bias current. Under open circuit conditions, the forward bias of the junction increases to a point where the light generated current is exactly balanced by the forward bias diffusion current, and the net current is zero. The voltage required to cause these two currents to balance is called the "open-circuit voltage".

CHAPTER 4

Algorithm & Block Diagram of Circuit

4.1. Algorithm of The Circuit

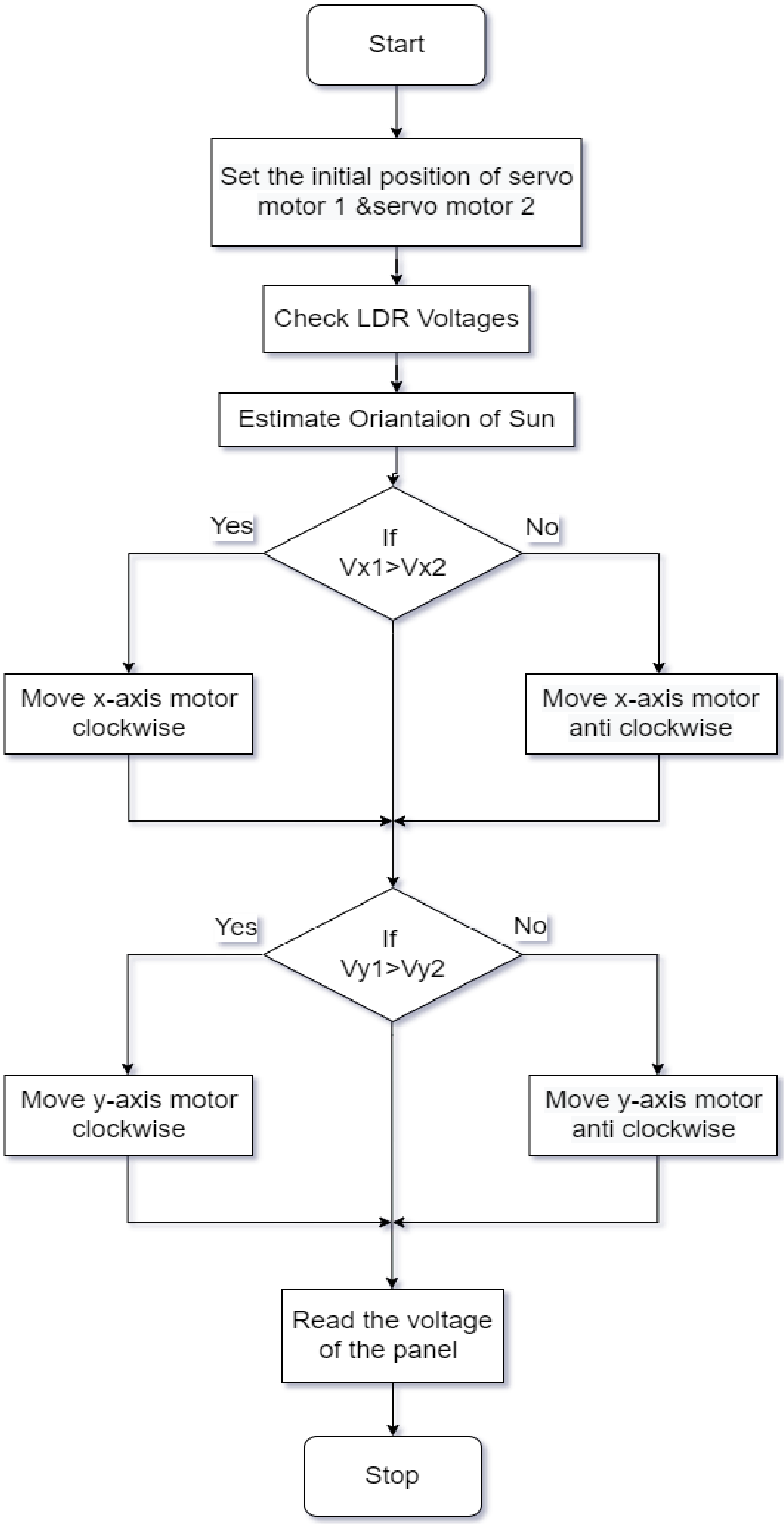


Figure 13: Flowchart of the Circuit

4.2. Block Diagram of Circuit

The key components of this project are LDR, LM253 comparator IC, L293D motor driver IC and Servo motors. Here we will use 4 LDRs, which will be placed on the four sides of the solar panel. These are measure sunlight intensity and provides four different voltage signals according to the sunlight intensity. These voltage signals are going to the LM258 comparator IC. The LM258 IC compares this voltage, then it provides voltage signals, which going to the L293D motor driver IC. Then, the L293D IC will rotate the motors in a particular direction. Here we will use two Servo Motors for moving the solar panel along the two axis. This way the solar panel moves in the direction where light intensity is high.

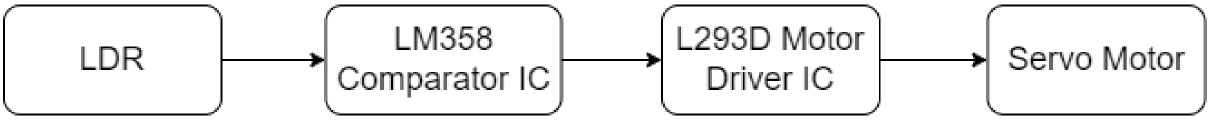


Figure 14: Block Diagram of the circuit

CHAPTER 5
Design & Construction

5.1 Mechanical Design

On the basis of availability of panel dimension, a simple tracker prototype has been designed.

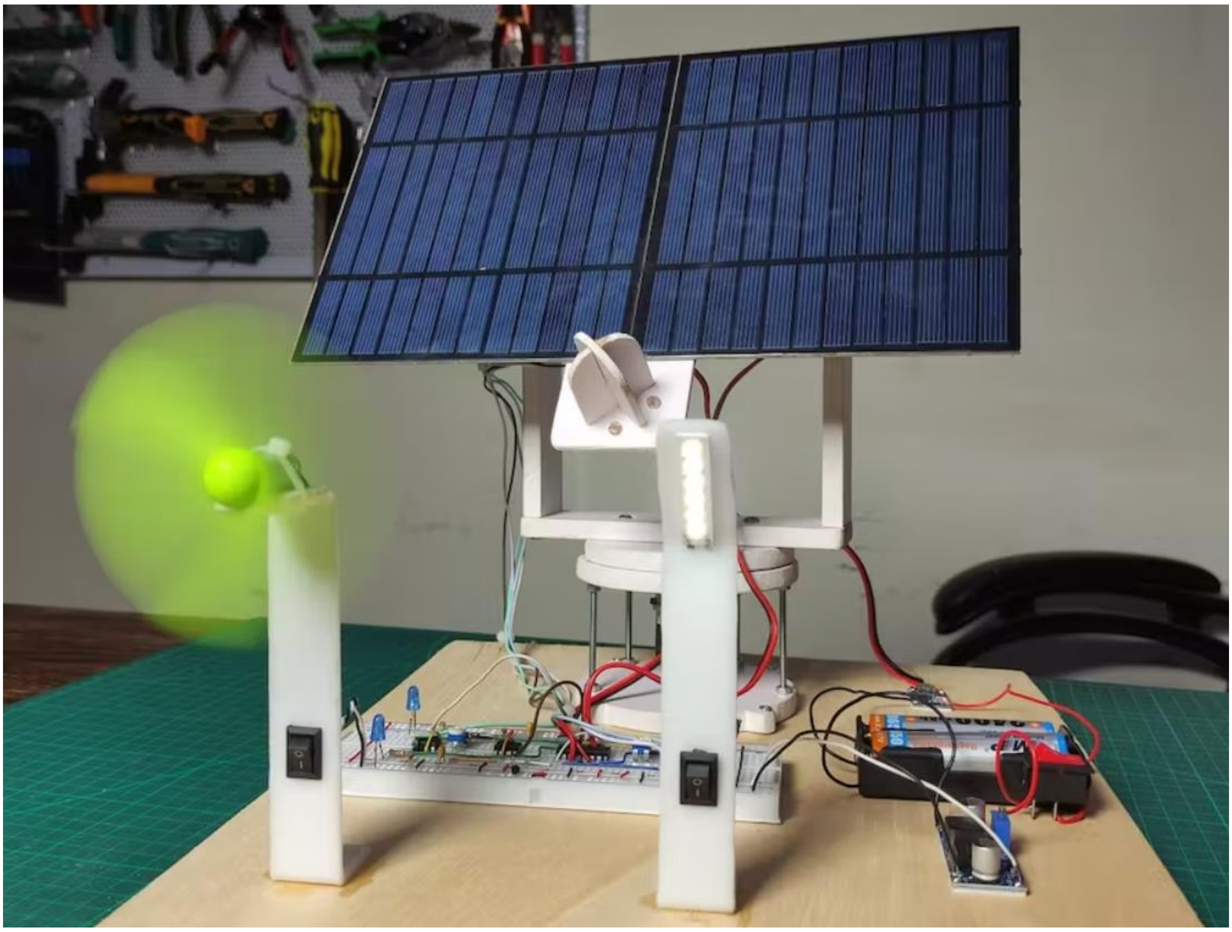


Figure 15: Mechanical Design [15]

5.2 Electrical Design

Under electrical portion, design includes the connection of LDRs, resistors, Capacitor, Variable Resistor, 4148 Diode LM 358 IC, 555 Timer IC, LDR Sensor, L293D Motor Driver, dc to dc boost converter LM2587, LiPo Battery Charger Module Mini TP4056 IC and servo motors together in the bread board. Beside this an additional connection of battery, invertor, charge controller and load are also made. The circuit diagram is shown in the figure 14.

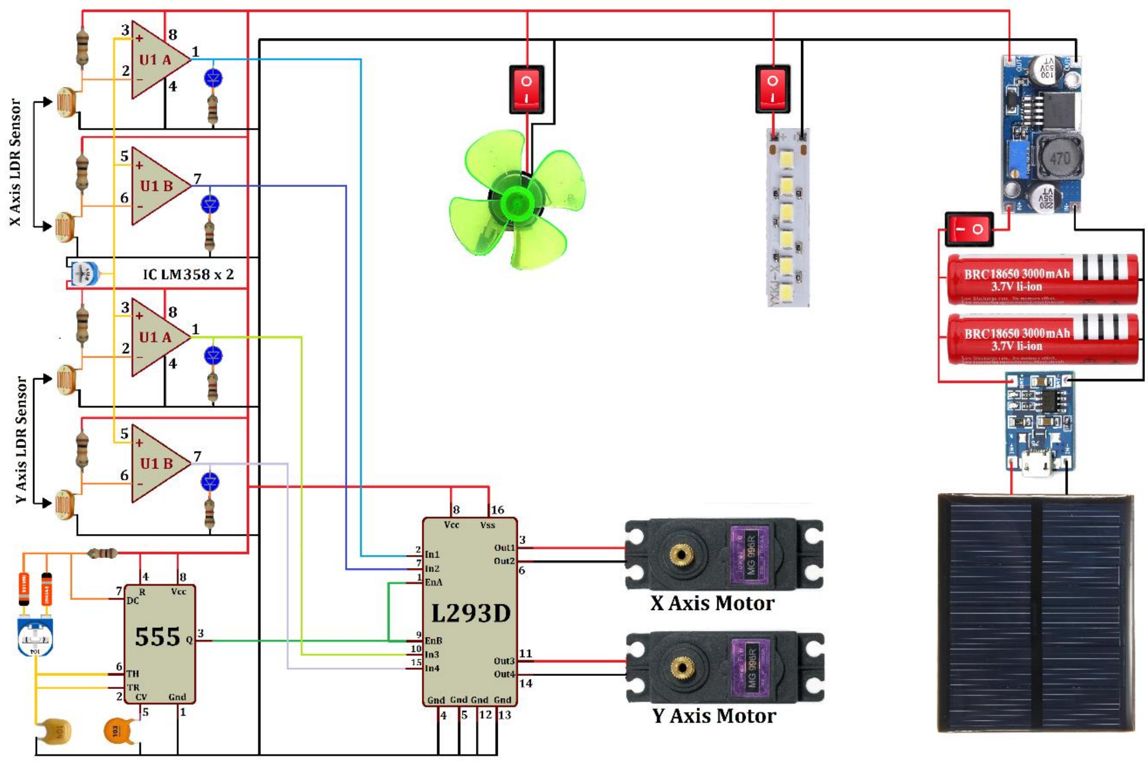


Figure 16: Circuit Diagram [15]

CHAPTER 6
Marketing And Material

6.1 Marketing

Marketing is done for the purchases of IC’s, motors, bulb, breadboard and wires. While for the frame initially aluminium is preferred but due to unavailability of required thickness and difficult in fabrication, wood was used as its successor.

6.2 Fabrication

Fabrication includes the frame for panel, fixing of motors, light barriers for the LDRs and stand. This were carried out as per the design and material selection.

6.3 Testing and modification

After the completion of fabrication, project was tested for different light sources. It was not that much sensitive to the scatter light so; we should use light source that gives beam radiation for better performance.

6.4 Material selection

The material selected can be wooden, plastic, iron etc. but we have used wood as the material because it was suitable to our fund. Use of plastic can be a better option because plastic can resist itself in drastic weather changes like extreme heat and rain.

CHAPTER 7

Result

7.1. Software

7.1.1 Description of the Software:

In this project we use **Proteus 8.12,** The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

7.1.2. Result:

As a result, in the circuit designed for simulation, when we pass the light across the LDR's, the changes will be observed in the servo motors, the motor will rotate along the direction where the light will be passed.

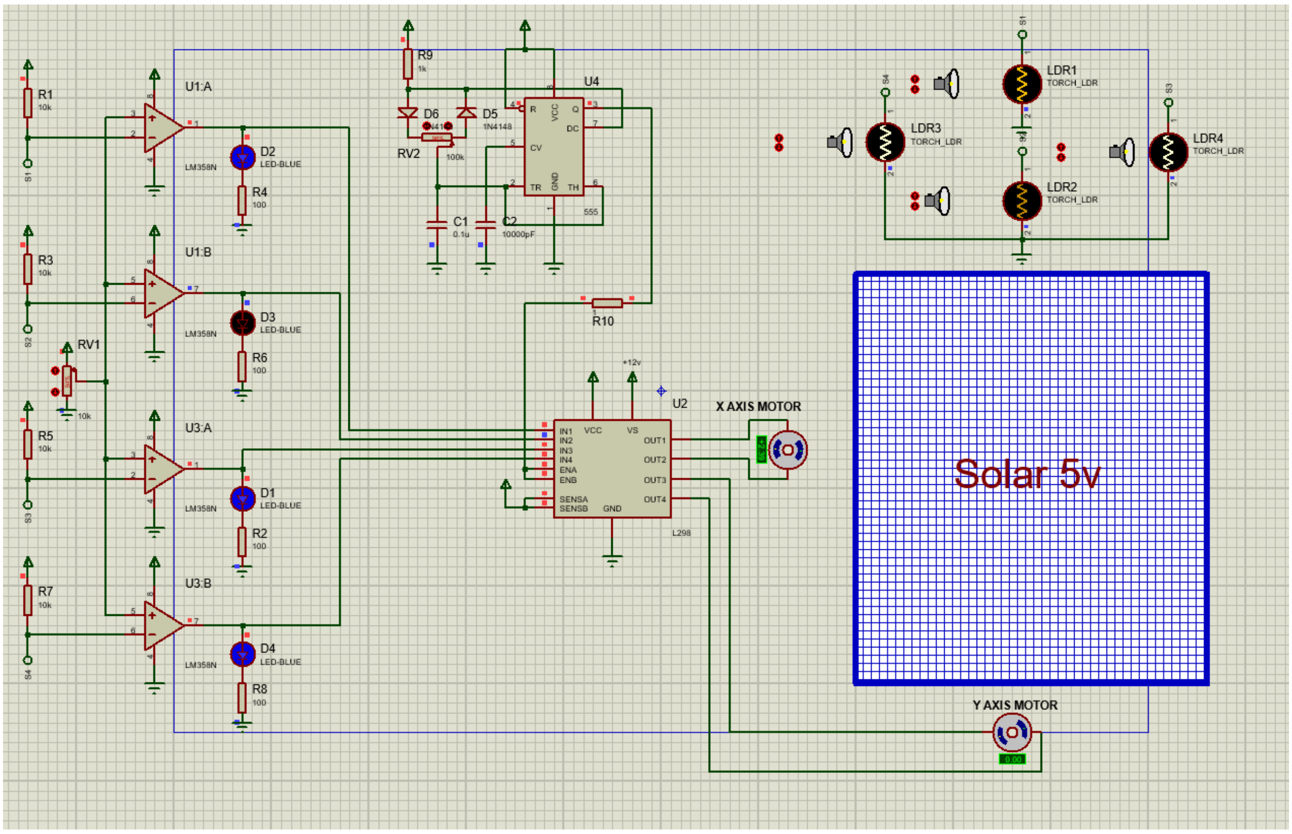
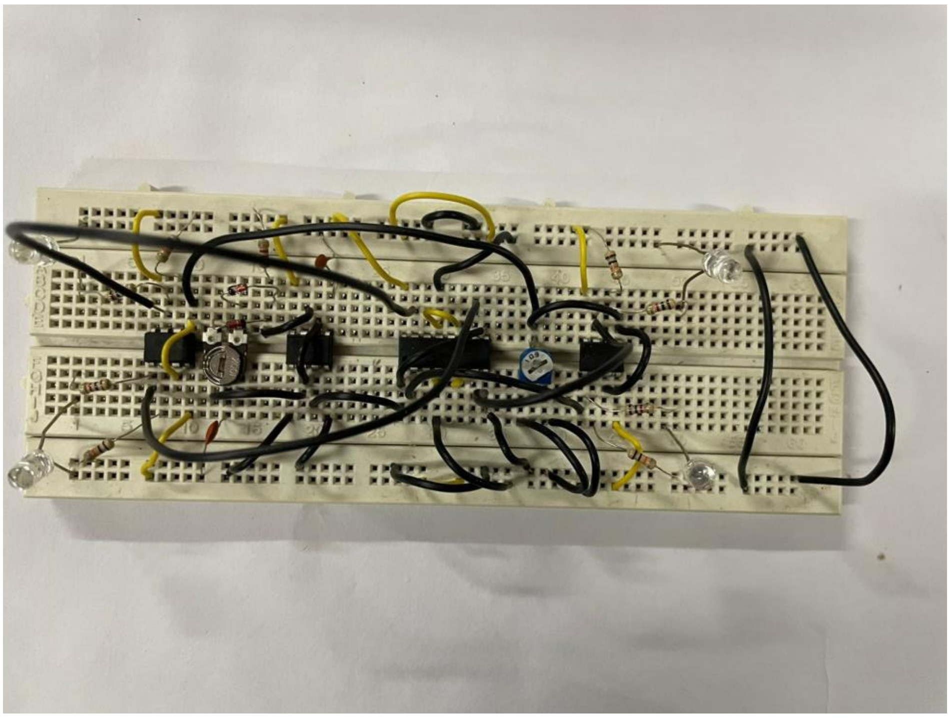
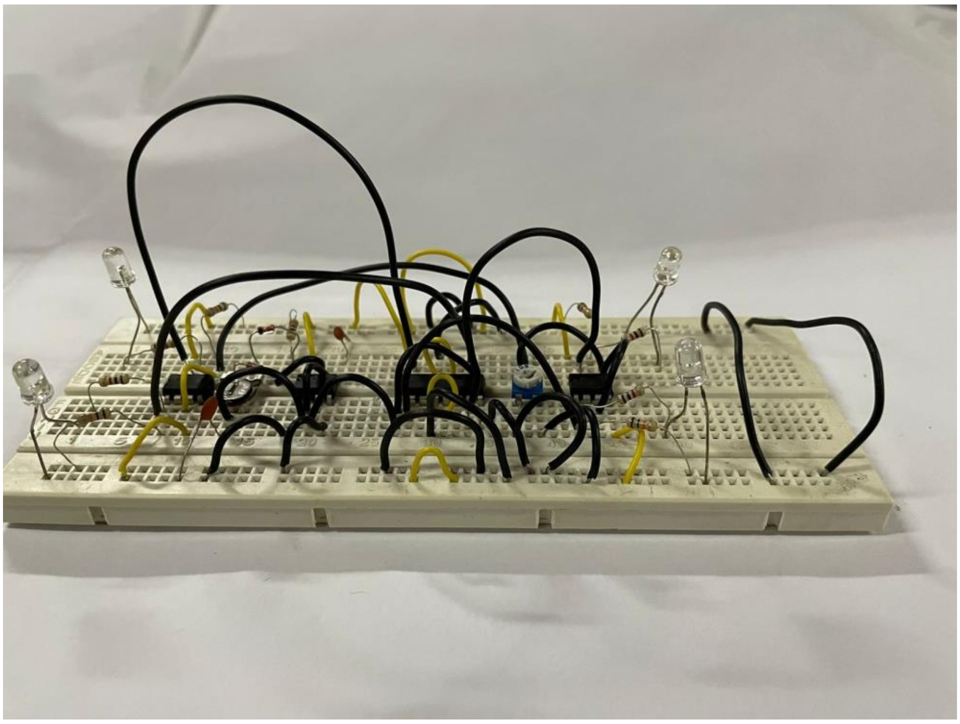
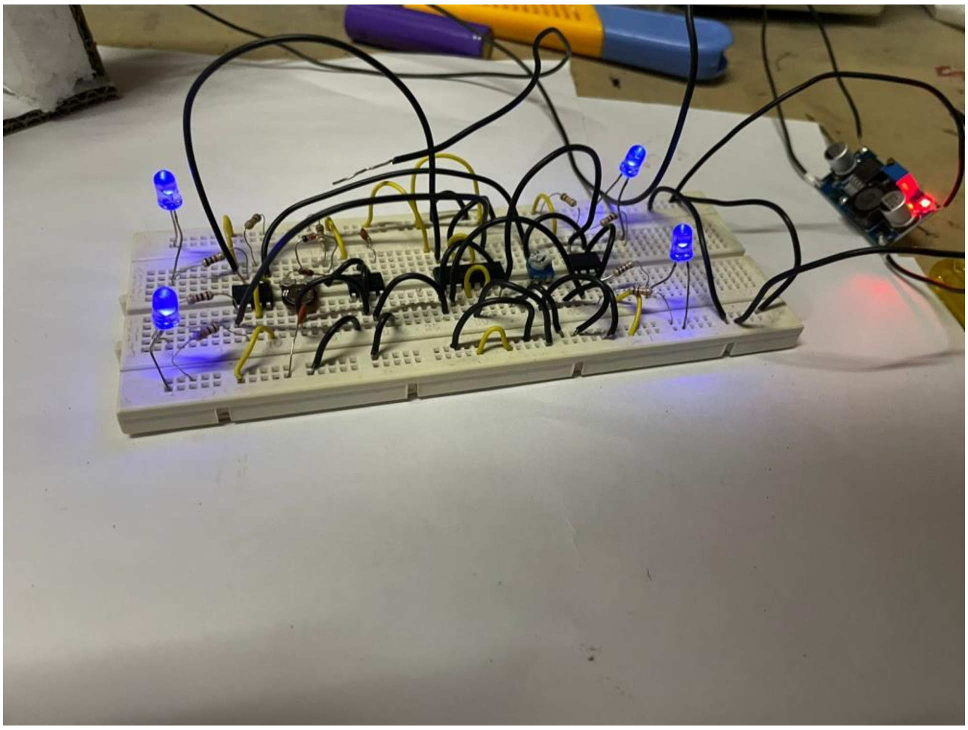


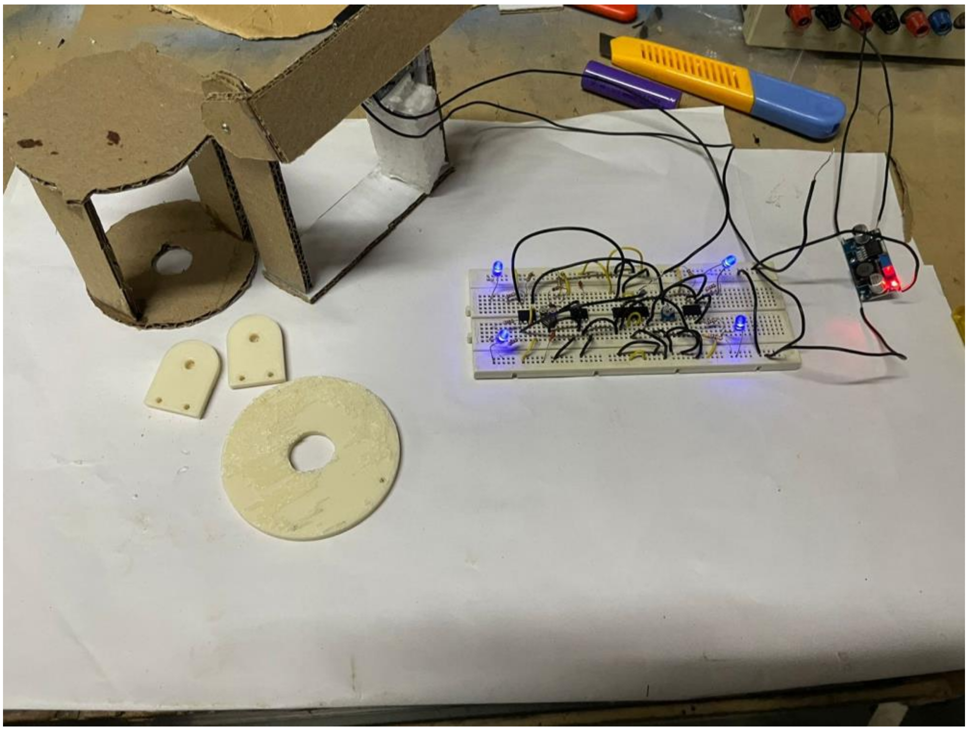
Figure 17: Simulation circuit

7.2 Hardware









CHAPTER: 8
Conclusion And Recommendation

8.1 Conclusion

The paper has presented a means of tracking the sun's position with the help of microcontroller and LDR sensors. Specially, it demonstrates a working software solution for maximizing solar cell output by positioning a solar panel at the point of maximum light intensity. Moreover, the tracker can initialize the starting position itself which reduce the need of any more photo resistors. The attractive feature of the designed solar tracker is simple mechanism to control the system. As solar power production is used in large scale worldwide so, even an increment in efficiency by 1% than stationery plane will increases the net power production by large amount. Hence, no matter by how much tracker increases an efficiency it is always welcomed. In a conclusion, this mechanism could be manifested in wide range of applications that require solar tracking such as parabolic trough collector, solar dish, lens and other PV systems to collect maximum radiation from sun.

8.2 Recommendation

Though we have performed our work in much efficient way. There is still room for improvement for this system and it is hoped that further study can be carried out to further develop the system.

- Use higher motors with large torque value for larger panel size.
- It will be better to use geographical equation algorithm for the real timing tracking.
- Use diffused reflection phenomenon.

CHAPTER 9

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