Bangladesh University of Business and Technology

Department of Electrical and Electronics Engineering

Faculty of Engineering

Course Name: Power System-I (Lab)

Course Code: (EEE-306)

Project Report

on

Solar Panel with Dual Axis Solar Tracker without Arduino

Submitted by: **Team “Kinetic-Vision”**

Name	ID	Intake/Section
Md. Mehedi Hasan	20212208019	32/01
Md. Sabbir Hasan	20212208020	32/01
Soyod Rahabar A Islam	20212208022	32/01
Mamun Or Rashid	20212208025	32/01
Rahmatullah Alamin	20212208005	32/01

Submitted to:

Shadath Hossain

Teaching Assistant

Department of EEE, BUBT

Dedicated to

Our Parents

and

Honorable Teacher

ACKNOWLEDGEMENT

I express my gratitude and sincere thanks to my teacher Shadath Hossain, Department of Electrical and Electronics Engineering for his gracious efforts and keen pursuit, which has remained as a valuable asset for the successful of our project report. His dynamism and diligent enthusiasm have been highly instrumental in keeping my spirits high. His flawless and forthright suggestions blended with an innate intelligent application have crowned my task with success. I truly appreciate and value his esteemed guidance and encouragement from the beginning to the end of this thesis. I am indebted to him for having helped me shape the problem and providing insights towards the solution.

At last, but not the least I am highly thankful to the THE ALMIGHTY, who has given me the courage and wisdom throughout this whole journey.

Table of Contents

Chapter: 01

Abstract

We have made a solar tracker solar panel with dual axis. In this project we have used a 5volts,6watts solar panel. This is a solar tracker and it has two axis (x and y). To move the solar panel, we have use four LDR sensors. In this project, we have used low pass filter with every LDR sensor. We have used two servo motor for two axis. When the value of light starts changing then value of resistor starts changing, then the panel starts moving towards the light. In this circuit, we have made PWM pulse generating system to produce pulse which can control the speed of the servo motors.

We have used a 5V,6W solar panel and we have used battery as storage. In this project, we have used a Lithium-ion battery charger to store the charge from the panel. In this circuit we have used a DC-to-DC boost converter which increase the voltage at output than input voltage.

Chapter: 02

Introduction

2.1 Description:

Solar Tracker, 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. Studies have shown that the angle of light affects a solar panel's power output. 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. As a result, although tracking east to west is important, north to south tracking has a less-significant impact.

2.2 Objectives:

- To know about the structure and making of o sun tracker.
- To know about the making of a solar panel and the laws of solar technology.
- To know how to increase the using of solar energy to produce electricity.
- To know about the working principle of a solar tracker without Arduino.
- To demonstrate a small project of solar tracker.

Chapter-03

Background

3.1 Description:

Solar trackers provide significant advantages for renewable energy. With solar tracking, power output can be increased by about 30 to 40 percent. The increase in power output promises to open new markets for solar power. However, solar trackers have several important disadvantages. A static solar panel may have a warranty that spans decades and may require little to no maintenance. Solar trackers, on the other hand, have much shorter warranties and require one or more actuators to move the panel. These moving parts increase installation costs and reduce reliability; active tracking systems may also use a small amount of energy (passive systems do not require additional energy). Computer-based algorithm solar trackers are more expensive, require additional maintenance, and become obsolete much faster than static solar panels, since they use fast-evolving electronic components with parts that may be difficult to replace in relatively short periods of time.

3.2 Motivation:

We know because of the global position of Bangladesh; solar panel should have to be set at 23-degree angle. At this angle the solar can get maximum photon in Bangladesh but sunlight doesn't come from the same direction all the time. Because our planet is moving. That's why when the sun stays at 90 degrees, the solar panel can get maximum photon to produce maximum electricity. But when sunlight doesn't come perpendicularly, then the production starts decreasing. So, we need to move the panel, so that the solar panel can stay towards the sunlight. As a result, we will get the maximum production as long as the sunlight lasts the whole day. To solve this problem, we have made this solar tracker solar panel system and because of these problems, every organization wants to set the solar panel with solar tracker because it increases the production of electricity which increase the amount of interest. That's why it has a big demand in the market.

Chapter-04

Equipment

- VPC Card board (3mm)
- VPC Card board (5mm)
- Solderless Breadboard
- LM 358 IC
- 555 Timer IC
- LDR Sensor
- L293D Motor Driver
- 10k Resistor
- 1k Resistor
- Blue LED
- 104pf Capacitor
- 103pf Capacitor
- 10k Variable Resistor
- 100k Variable Resistor
- 4148 Diode
- MG996 Servo motor
- Male Header
- 5v LED Light
- 5v DC Fan
- 5v 6W Solar Panel
- dc to dc boost converter LM2587
- LiPo Battery Charger Module Mini TP4056 IC
- On/Off Switch x 3
- 18650 Battery Holder – 1 Cell
- 18650 Battery Cell 3.7V

Chapter-05

Literature Review

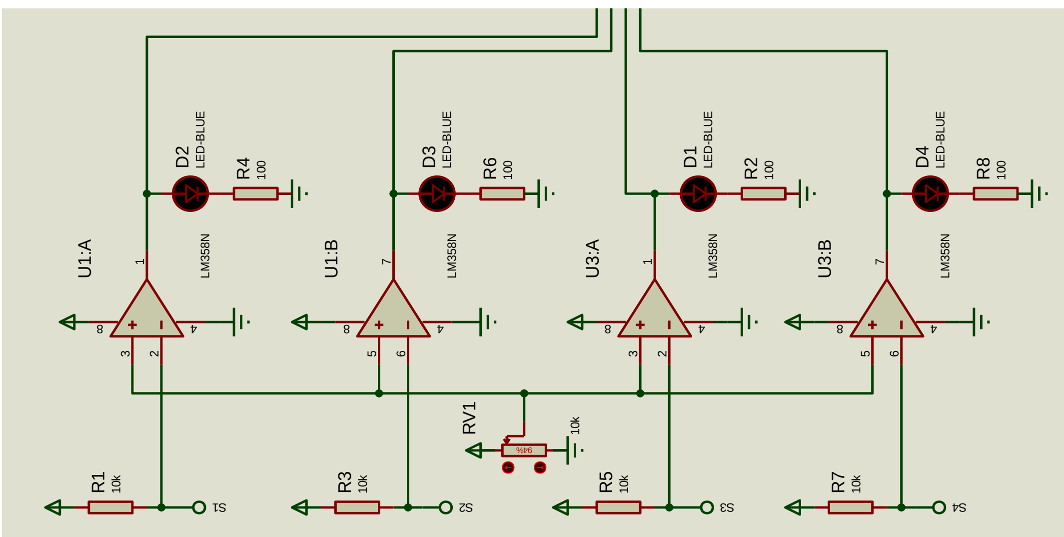
5.1 The Solar Tracker:

A solar tracker is a device or system that automatically positions solar panels or solar thermal collectors to optimize their exposure to sunlight throughout the day. The purpose of a solar tracker is to maximize the energy output of solar systems by ensuring that the panels are always facing the sun at the most optimal angle.

5.2 Solar Panel with 5V,6W:

We have used solar panel with 5V,6W. We have used 3 panel which contains of 5V, 2W each and each panel consists 36 cell and 4 strings and each string contains 9 sells in series. That means the whole solar panel is made of 108 cells. This solar charger can produce 5v which going to batteries through LiPo battery charger module.

5.3 Low pass filter with LDR:

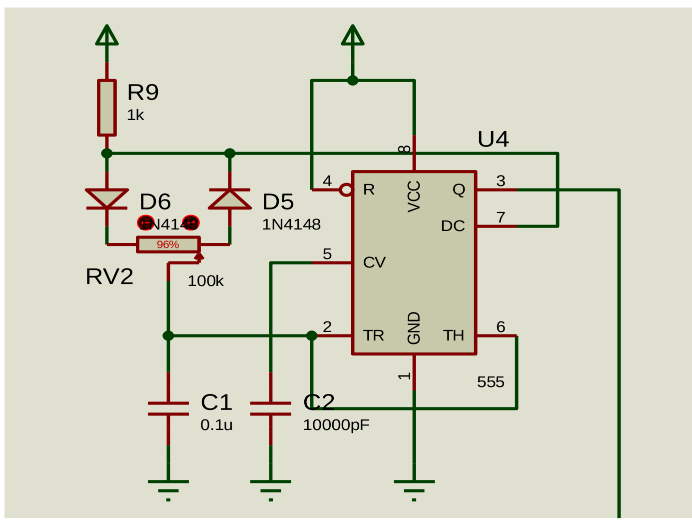


A low-pass filter is an electronic circuit that allows low-frequency signals to pass through while attenuating or blocking higher-frequency signals. It can be used in conjunction with a Light Dependent Resistor (LDR) to filter out high-frequency noise or rapid fluctuations in the LDR's output signal. In the context of a solar tracker, a low-pass filter may not be directly used within the tracking mechanism itself. However, it can be employed in the signal processing or control system of the tracker to filter out high-frequency noise or fluctuations that could affect the accuracy and stability of the tracking mechanism.

In some cases, the sensor signals may contain high-frequency noise or fluctuations due to environmental factors, electrical interference, or sensor inaccuracies. If these high-frequency components are not filtered out, they can introduce errors or instability in the solar tracking system.

By incorporating a low-pass filter in the control system, the high-frequency noise can be attenuated, allowing only the slower changes or variations in the sensor signals to pass through. This filtering helps to smoothen the signals and remove rapid fluctuations that might not accurately represent the position of the sun. The specific design parameters of the low-pass filter, such as the cutoff frequency, filter type, and order, depend on the characteristics of the noise or fluctuations and the requirements of the solar tracking system. The goal is to strike a balance between filtering out unwanted noise and preserving the relevant information necessary for accurate solar tracking. By incorporating a low-pass filter in the control system, the solar tracker can mitigate the effects of high-frequency noise and fluctuation.

5.4 Pulse generation circuit:



In a sun tracker, the pulse generating system plays a critical role in providing precise control signals to adjust the position of the solar panels or tracking mechanism. The pulse generating system in a sun tracker can be used to generate pulses that control the movement of the tracker, ensuring that the solar panels continuously face the sun for optimal energy capture.

Here's a simplified overview of how a pulse generating system can work in a sun tracker:

5.4.1 Sun Position Calculation: The tracker system typically incorporates sensors or algorithms to calculate the position of the sun relative to the tracker's location. This information is used to determine the desired position of the solar panels.

5.4.2 Control Logic: Based on the calculated sun position, the control logic of the tracker determines the necessary adjustments to be made to align the solar panels correctly. This control logic generates control signals to actuate the tracker mechanism.

5.4.3 Pulse Generation: The pulse generating system generates pulses that act as control signals to drive the motors or actuators responsible for adjusting the position of the solar panels. These pulses are typically generated by a pulse generator circuit or a microcontroller.

5.4.4 Pulse Characteristics: The pulse generator determines the characteristics of the pulses required for the specific tracking mechanism. This includes parameters such as pulse width, pulse repetition rate, and duty cycle, which determine the timing and magnitude of the control signals.

5.4.5 Actuation and Tracking: The generated pulses are sent to the motors or actuators that move the solar panels. The pulses control the direction and speed of the motors, allowing the panels to track the sun's movement across the sky. The pulses enable precise and incremental adjustments to maintain accurate solar tracking.

5.4.6 Feedback and Iteration: The tracker system continuously monitors the position of the solar panels and compares it to the desired position based on the sun's calculated position. Any deviations are detected through feedback mechanisms, and the pulse generating system generates corrective pulses to make necessary adjustments.

By generating pulses with the appropriate characteristics, the pulse generating system in a sun tracker provides the necessary control signals to accurately position the solar panels. The system continuously generates pulses based on sun position calculations, allowing the panels to track the sun's movement throughout the day for optimal sunlight exposure and energy generation.

5.5 DC to DC boost converter LM2587:

A DC-to-DC boost converter, also known as a step-up converter, is a type of power electronics device that converts a lower DC voltage to a higher DC voltage. It is commonly used to charge batteries or power devices that require a higher voltage than the available power source. Here's a general overview of how a boost converter works to charge a battery:

5.5.1 Input Stage: The boost converter takes a lower DC voltage input from a power source, such as a battery, solar panel, or DC power supply. This voltage is typically lower than the desired voltage required for charging the battery.

5.5.2 Inductor Charging: The boost converter circuit includes an inductor, a switch (typically a MOSFET), a diode, and a capacitor. Initially, the switch is closed, allowing current to flow through the inductor from the input source. The inductor stores energy in its magnetic field.

5.5.3 Inductor Discharging: The switch is then opened, causing the current flow through the inductor to cease. The energy stored in the inductor's magnetic field seeks to maintain the current flow. As a result, the inductor induces a voltage across its terminals, which is of the opposite polarity to the input voltage.

5.5.4 Voltage Boost: The diode acts as a one-way valve, allowing the inductor's induced voltage to charge the output capacitor. The capacitor voltage increases, raising the output voltage to a level higher than the input voltage. This voltage boost is achieved by transferring energy stored in the inductor during the charging phase to the output capacitor.

5.5.5 Feedback Control: To regulate the output voltage and ensure proper battery charging, a feedback control loop is often employed. This feedback loop monitors the output voltage and adjusts the duty cycle (on/off time ratio) of the switch to maintain a constant desired output voltage. By modulating the duty cycle, the boost converter can regulate the output voltage even when the input voltage or load conditions vary.

5.5.6 Battery Charging: The boosted output voltage from the boost converter is then used to charge the battery. Depending on the charging requirements, additional control circuitry may be employed to manage the charging process, such as current regulation, temperature monitoring, and safety features to prevent overcharging or damage to the battery.

By stepping up the input voltage to a higher level, the boost converter enables efficient charging of batteries or powering devices that require a higher voltage. The energy is transferred from the input source to the output load through the inductor and the output capacitor, while the feedback control loop ensures the stability and regulation of the output voltage for proper battery charging.

5.6 LiPo Battery Charging Module:

In a solar tracker system, a LiPo (Lithium Polymer) battery charger module can be used to charge and manage the LiPo batteries that power the tracker's control system or provide backup power. Here's an overview of how a LiPo battery charger module typically works in a solar tracker:

Solar Power Generation: The solar panels in the solar tracker generate DC power from sunlight. This solar power is used as the energy source for charging the LiPo battery.

5.6.1 Solar Charge Controller: A solar charge controller is typically employed in the system to regulate the charging process and protect the battery. The charge controller manages the flow of energy from the solar panels to the LiPo battery and ensures that the battery is charged safely and efficiently.

5.6.2 LiPo Battery Charger Module: The LiPo battery charger module is a dedicated circuit that handles the charging of the LiPo battery. It is often integrated within the solar charge controller or used as a separate module in the solar tracker system.

5.6.3 Charging Algorithm: The LiPo battery charger module utilizes a specific charging algorithm tailored for LiPo batteries. This algorithm manages the charging process by controlling the charging current, voltage, and charging phases to maximize the battery's performance, lifespan, and safety.

5.6.4 Power Conversion: The charger module converts the solar panel's DC output voltage to the appropriate charging voltage required by the LiPo battery. It may also include voltage regulation and current limiting functions to ensure proper charging parameters are maintained.

5.6.5 Charging Monitoring: The charger module monitors various parameters during the charging process, such as battery voltage, charging current, and temperature. This monitoring allows the charger module to make adjustments and ensure that the charging conditions are within safe limits.

5.6.6 Charge Termination: The LiPo battery charger module incorporates a mechanism to detect when the battery is fully charged. This mechanism can be based on voltage thresholds, current measurements, or a combination of both. Once the battery is fully charged, the charger module stops the charging process or switches to a trickle charge mode to maintain the battery's state of charge.

5.6.7 Battery Protection: The LiPo battery charger module includes built-in protections to prevent overcharging, over-discharging, and other potential issues that could harm the battery. These protections help maintain the safety and longevity of the LiPo battery.

The LiPo battery charger module ensures efficient and safe charging of the LiPo battery in the solar tracker system, utilizing the power generated by the solar panels. It follows specific charging algorithms and incorporates monitoring and protection mechanisms to optimize the charging process and safeguard the battery's health.

Chapter-06

Methodology

The methodology for building a solar tracker involves several key steps, from planning and design to construction and testing. Below is a general methodology for creating a solar tracker:

6.1 Project Planning and Research:

Define the objectives and goals of the solar tracker project. Conduct research on different types of solar trackers (e.g., single-axis or dual-axis) to determine the most suitable one for your application. Research and select appropriate components, such as motors, sensors, and mechanical structures.

6.2 Design and System Architecture:

Create a detailed design of the solar tracker system, including the mechanical structure, tracking mechanism, and electrical circuitry. Decide on the type of sensor to be used for sun tracking (LDRs, photodiodes, etc.). Choose the appropriate motor or actuator for moving the solar panels.

6.3 Mechanical Construction:

Build a sturdy and reliable mechanical structure that holds the solar panels and allows them to move along the desired axes. Ensure that the structure is durable and capable of withstanding weather conditions, such as wind and rain.

6.4 Sensor Installation:

Mount the light sensors (LDRs or photodiodes) on the solar panel frame or nearby support structure. These sensors will detect the sun's position.

6.5 Electronic Circuit Design:

Design the electronic circuitry that processes the sensor inputs and controls the movement of the solar panels. Use comparators or other suitable components to detect the difference between the desired angle and the current angle of the solar panels.

6.6 Motor Control and Actuation:

Design the motor control circuit or motor driver that moves the solar panels based on the output from the electronic circuit. Ensure that the motors can handle the weight of the solar panels and move them smoothly and accurately.

6.7 Power Supply:

Provide a suitable power supply to power the electronic circuitry and motors. Consider using solar panels to power the tracker system for a self-sustaining solution.

6.8 Calibration and Testing:

Calibrate the solar tracker to ensure accurate tracking of the sun's position. Test the solar tracker under various conditions, including different times of day and varying weather conditions, to verify its functionality and accuracy.

6.9 Fine-tuning and Optimization:

Fine-tune the control circuitry and sensor sensitivity to optimize the solar tracker's performance and accuracy. Make any necessary adjustments to improve efficiency and energy production.

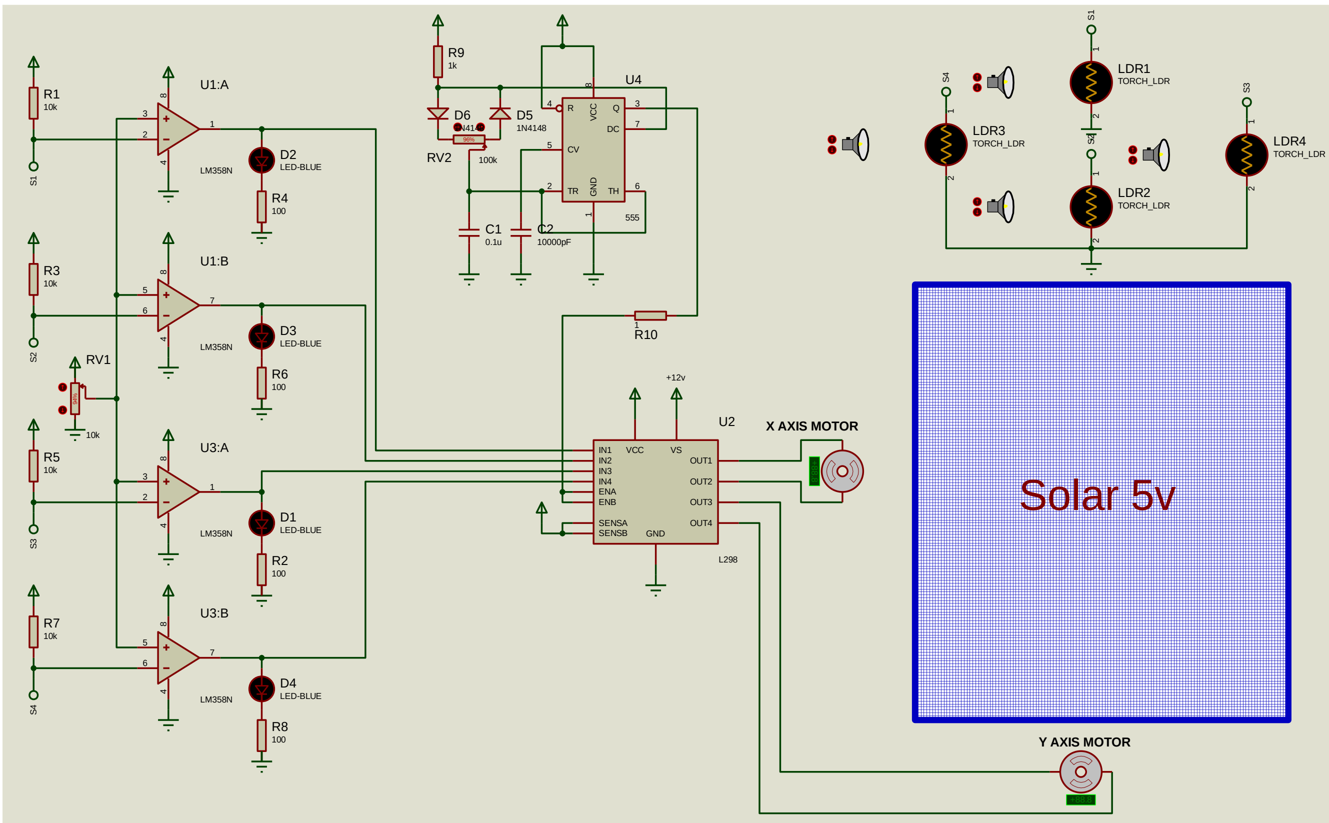
6.10 Deployment and Monitoring:

Install the solar tracker in its intended location, such as on a rooftop or in a field. Monitor the solar tracker's performance regularly to ensure it operates as expected and continues to maximize energy production.

It's important to note that the specific methodology may vary depending on the type of solar tracker, the complexity of the project, and the available resources and expertise. Additionally, safety considerations should always be a priority when working with electrical components and mechanical structures.

Chapter-07

Circuit Diagram



Solar panel with dual axis solar tracker without arduino

Chapter-08

Discussion

At first, we have made the 555 timer IC to produce pulse generation. This circuit sends pulse to low pass filters and to motor driver. This circuit removes all kinds of fluctuations and noise from the input signal which comes from the battery. Because if we use the raw input then the device will face fluctuations and noise which will decrease the accuracy of tracking and driver will not response as our expectation. We have used two the low pass filters to remove the all kind of extra signal and noise. It just accepts a kind of selected signal which is going to send the servo motor to work as our expectation. We have used LM 358 IC to make this filter. In this project we have used two low pass filter circuits for two servo motors. With these filters we have used four LDR sensors. WE have connected two sensors for each filter circuit. We have used two sensors for X-axis and one sensor is for positive shifting and another one is for negative of X-axis and another two are for Y-axis. One is for positive direction and another one is for negative direction of the Y-axis. That's why the motor has to move in both direction that means our motors has to move in both clockwise and anticlockwise direction with respect to our expectation. When sunlight falls on the sensor from any direction, then the resistance of that sensor starts decreasing and it will send a signal to low pulse filter which will active that filter and this filter circuit will filter that signal to make it appropriate and then that signal will go to motor driver IC and this driver will excite that selected motor to move towards that selected direction from where the sunlight is coming. Then the solar panel starts moving towards that selected direction. This is how the Y-axis also work in this way. And when it will come to the perpendicular position with sunlight then all sensors will get sunlight and their resistance will starts decreasing and the sensors will starts sending signals to filter circuit and these filters will send those signals to driver and the driver will face the signal in every direction of both axis and we know from vector of force that with same value of force will oppose each other and that's why the driver will be tripped and it will send signal to motor to stay at a single place And then the panel will stay stand to the sunlight. This is how the solar tracker works. Here we have used a solar panel with 5V,6W. when the sunlight will fall on this, it will produce electricity and this DC electricity will go to LiPo battery charger module then it will go to battery to charge the batteries then it will go to the booster converter which can increase the 4 volts to 5 volts because we have batteries with 4V in parallel and we have used a DC motor as a load which absorbs 5V and from this batteries we are giving input to solar tracker circuit.

Chapter-09

Social Economy Impact

10.1 Advantages:

The implementation of solar trackers with dual-axis functionality can have several social and economic impacts in the context of the solar energy industry. Here are some potential impacts:

10.1.1 Increased Energy Production: Solar trackers with dual-axis movement can significantly increase the energy production of solar systems. By continuously adjusting the tilt and azimuth angles of the solar panels to directly face the sun, they can capture a higher amount of sunlight throughout the day. This increased energy production contributes to a greater supply of clean and renewable energy, reducing dependence on fossil fuels and mitigating greenhouse gas emissions.

10.1.2 Improved Energy Efficiency: Solar trackers optimize the capture of sunlight, resulting in improved energy efficiency. By dynamically adjusting the position of the solar panels, they maximize the utilization of available sunlight, especially during periods of low solar incidence or when the sun is at a low angle. This enhanced efficiency helps to generate more electricity from the same solar panel area, increasing the return on investment for solar projects.

10.1.3 Job Creation and Economic Growth: The adoption of solar trackers with dual-axis functionality can drive job creation and economic growth in the renewable energy sector. The installation, maintenance, and operation of solar tracker systems require skilled workers, creating employment opportunities. Additionally, the increased deployment of solar trackers can stimulate the growth of related industries, such as manufacturing, construction, and engineering, contributing to local and regional economic development.

10.1.4 Technological Advancement and Innovation: Dual-axis solar trackers represent a technological advancement in solar energy systems. Their development and deployment encourage innovation and research in the field of renewable energy technologies. This can lead to the refinement and advancement of solar tracker systems, improving their efficiency, reliability, and cost-effectiveness over time.

10.1.5 Energy Access and Affordability: Solar trackers can contribute to increasing energy access and affordability, particularly in areas with limited grid connectivity. By enhancing energy production and efficiency, solar trackers enable more electricity to be generated from solar systems, making renewable energy more accessible and affordable for communities and individuals. This can have positive social impacts by reducing reliance on expensive or polluting energy sources and improving energy equity.

10.1.6 Environmental Benefits: Solar trackers with dual-axis movement facilitate the utilization of solar energy, a clean and renewable resource. By harnessing the power of the sun, solar trackers contribute to the reduction of greenhouse gas emissions, air pollution, and reliance on non-renewable energy sources. This helps combat climate change, preserve natural resources, and create a more sustainable and environmentally friendly energy system.

It's important to note that the specific social and economic impacts of dual-axis solar trackers may vary depending on the local context, policy frameworks, market conditions, and project scale. However, overall, their adoption can contribute to the transition towards a more sustainable and resilient energy future.

10.2 Limitations of our Project:

While solar trackers offer benefits in terms of increased energy production and efficiency, they also have certain limitations that should be considered. Here are some limitations of solar tracker solar panels:

10.2.1 Increased Cost: Solar trackers are more complex and require additional components, such as motors, sensors, and control systems, compared to fixed-tilt solar systems. This complexity leads to higher upfront costs for the installation and maintenance of solar tracker systems. The increased cost may impact the overall economic viability of the project, especially for smaller-scale installations.

10.2.3 Maintenance and Reliability: Solar trackers require regular maintenance to ensure proper functionality. The moving parts, such as motors and mechanical components, may experience wear and tear over time and require periodic inspections, lubrication, and repairs. Failure of these components can lead to downtime and reduced energy production. Therefore, proper maintenance practices and skilled technicians are necessary to ensure the long-term reliability of solar tracker systems.

10.2.4 Complex Installation: Installing solar trackers requires additional expertise and effort compared to fixed-tilt solar systems. The tracking mechanism adds complexity to the installation process, including accurate alignment, proper foundation, and secure anchoring of the tracker. This complexity may increase the installation time and cost.

10.2.5 Space Requirements: Solar trackers require more space compared to fixed-tilt systems due to the need for unobstructed movement of the panels. The additional space requirement may limit the applicability of solar trackers in certain locations where land availability is limited or costly. 10.2.6 Sensitive to Shading: Solar trackers may be more sensitive to shading compared to fixed-tilt systems. Even partial shading of the solar panels can cause the tracker to adjust and potentially reduce energy production. Careful consideration of shading factors, such as nearby buildings, trees, or structures, is crucial during the installation and site selection process.

It's important to carefully assess the specific project requirements, site conditions, and economic considerations when deciding whether to implement solar trackers. While they offer potential advantages, the limitations and associated costs should be weighed against the expected benefits to determine the most suitable solar system configuration for a given project.

Chapter-10

Future Plan

The future plans for solar trackers involve continued advancements and improvements to enhance their efficiency, reliability, and cost-effectiveness. Here are some potential future developments and trends for solar trackers:

10.1 Advanced Tracking Algorithms: The development of sophisticated tracking algorithms can further optimize the performance of solar trackers. These algorithms can take into account various factors such as solar position, weather conditions, shading analysis, and energy demand patterns to dynamically adjust the tracking mechanism for maximum energy production.

10.2 Integration with Energy Storage: The integration of solar trackers with energy storage systems, such as batteries, can enhance their functionality and enable better energy management. By storing excess energy generated during peak sunlight hours, solar trackers combined with energy storage can provide a more reliable and continuous power supply, even during periods of low solar availability.

10.3 Hybrid Tracking Systems: Hybrid tracking systems combine the benefits of different tracking technologies, such as combining dual-axis tracking with azimuth tracking or integrating tracking systems with concentrator photovoltaic (CPV) modules. These hybrid approaches aim to improve the energy yield and overall system efficiency by leveraging the advantages of different tracking mechanisms.

10.4 Smart Tracking Systems: Advancements in IoT (Internet of Things) and connectivity technologies can enable the development of smart tracking systems. These systems can utilize real-time data, weather forecasts, and predictive analytics to optimize solar panel positioning, minimize energy losses due to shading or suboptimal conditions, and improve overall system performance.

10.5 Improved Durability and Maintenance: Future solar trackers will likely focus on improving durability and reducing maintenance requirements. This includes the use of robust and corrosion-resistant materials, enhanced monitoring and diagnostic capabilities for proactive maintenance, and the development of self-cleaning mechanisms to mitigate the impact of dust, dirt, and debris on the solar panels.

10.6 Cost Reduction: As solar tracker technologies mature and become more widely adopted, there is an expectation of cost reductions through economies of scale, improved manufacturing processes, and technological advancements. This cost reduction will contribute to the overall competitiveness of solar trackers and make them more accessible for various solar energy projects.

10.7 Environmental Considerations: Future solar trackers will likely emphasize environmental considerations, such as minimizing land use, integrating wildlife-friendly designs, and implementing sustainable installation practices. These efforts aim to strike a balance between renewable energy generation and environmental conservation.

These are just some potential future plans and trends for solar trackers. The evolution of solar tracker technology will be driven by ongoing research, industry innovation, market demands, and the push towards cleaner and more sustainable energy systems.

Chapter-11

Conclusion

In conclusion, implementing a solar tracker solar panel project offers several benefits and considerations. Solar trackers optimize the capture of sunlight, increasing energy production and efficiency compared to fixed-tilt systems. The use of dual-axis tracking allows for precise positioning of solar panels, ensuring they face the sun throughout the day, resulting in improved energy generation. However, there are important factors to consider. Solar trackers are more complex and expensive than fixed-tilt systems, requiring additional components, maintenance, and careful installation. The space requirements and potential environmental impacts should also be assessed. Despite these considerations, solar tracker projects have the potential to make a significant impact. They contribute to the adoption of clean and renewable energy, reducing greenhouse gas emissions and dependence on fossil fuels. Solar trackers can drive job creation, economic growth, and technological advancement in the renewable energy sector. Future plans for solar trackers involve advancements in tracking algorithms, integration with energy storage, hybrid tracking systems, smart tracking systems, improved durability and maintenance, cost reductions, and environmental considerations. Ultimately, the success of a solar tracker solar panel project depends on careful planning, site assessment, and evaluation of cost-effectiveness. By considering the specific project requirements, local conditions, and long-term benefits, solar trackers can play a valuable role in optimizing solar energy generation and advancing the transition to a sustainable energy future.

Chapter-12

References

- https://www.researchgate.net/publication/349419967_DualAxis_Solar_Tracker_Without_Microcontroller

- https://www.pcbway.com/project/shareproject/Dual_Axis_solar_tracker_without_microcontroller.html

- https://www.hackster.io/shashwatraj98765/how-to-make-dual-axis-solar-tracker-724681

- https://circuitdigest.com/article/servo-motor-working-and-basics

- https://www.electricaleasy.com/2015/01/how-does-servo-motor-work.html

- https://www.build-electronic-circuits.com/how-does-a-555-timer-work/

- https://www.electronics-tutorials.ws/waveforms/555_timer.html

- https://www.electronicsforu.com/technology-trends/learn-electronics/555-timer-working-specifications

- https://how2electronics.com/555-timer-ic-features-pinout-working-circuit-operating-modes/