POWER GENERATION THROUGH SOLAR THERMAL ENERGY

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Certification

This is to certify that **[Ammad Adeeb]**, **[004]** and **[Hamza Tariq]**, **[009]** have successfully completed the final project **[Power Generation Through Solar Thermal Energy]**, at the **[Foundation University]**, to fulfill the partial requirement of the degree **[Bachelor of Sciences in Electrical Engineering]**.

Project Supervisor

[Dr. Haneef]

[AssociateProfessor]

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Project Title (Solar Thermal Energy)

Sustainable Development Goals

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9 ✓	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12 ✓	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13 ✓	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7 ✓	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

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Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

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Abstract

Energy is the basic need for development, economic growth and modernization. The solar thermal energy is basically an initiative towards zero carbon energy and sustainable energy. Thermal applications are gaining attention in solar energy research field day by day because of their energy conversion efficiency and high performance. The two main component are solar collector dish and generation of electricity (Turbine). Our paper will deeply focus on latest developments and further advancements in solar thermal application. Solar parabolic dish collector is reviewed and discussed in terms of concentrating collector. The key aspects are sun-tracking mechanisms, optical optimization and heat loss reduction. Design criteria is the important feature for heat transfer enhancement. Solar collectors are providing effective alternative for fossil fuels as environmental benefits. Typical application of solar collector is the achievement of heat demand temperature.

Due to increase in global energy demands ,solar thermal energy fulfils the requirements of up to date energy demand of any sector. About 30 – 35% of total energy is used by industries. The calculations show that about 240watt of solar energy is received per meter square by the earth. Where as Economic growth is directly propotional to the energy consumption. The 80% of total energy is comprised from conventional resources and are towards depletion due to their limited sources. Solar collector dish is an efficient from all other models because of its compatibility and receives solar radiation from all aspects that are deviated to its focal point. This behavior of dish causes maximam radiations to fall on a single receiver that approaches to 450 degree centigrade. More efficient system can increase this level. The absorber or receiver is the main component of dish that can be upgraded by alternation. Conical flask with spiral tube is an excellent receiver for absorbing maximum solar radiation. This scenario is expressed through a conical flask receiver having spiral tube for direct steam generation.

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Undertaking

I certify that the project **[Power Generation Through Solar Thermal Energy]** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

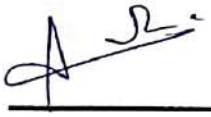

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Table of Contents

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Chapter 1

1.1 Introduction

Globally, energy demands were increasing day by day. Production of energy through fossils fuel emits carbon emissions which lead to environmental pollution. Developed economies set their goals in order to produce energy without carbon emissions and used renewable resources such as wind, solar, thermal, biomass for fulfilling SDG-7 sustainable and clean energy. Renewable energy resources provide most effective and efficient solutions for producing energy worldwide especially in developing and least developing economies. Non-renewable energy resources cannot be replenished once used whereas renewable energy resources can be recycled through sustainable practices. Non-renewable energy resources takes too long time to be restored but renewable energy resources doesn't need to be restored. Non-renewable energy resources are not eco-friendly because when they burn releases carbon emissions and pollutants while sustainable practices used in order to produce energy through renewable resources. Renewable Energy keeps earth biodiversity and reduces environmental pollution.

1.2 Statement of the problem

Electricity is the highest grade of energy that facilitates technological advancement and stimulates economic productivity for modern society. The power sector of Pakistan economy is constantly under stress due to the imbalances between demand and supply of energy. No power development has caused Pakistan to import electricity that cost 10$ billion annually causing double digit inflation. Fuel power plants are vulnerable to global supply shocks. Earth absorbs about 240w of solar power per square meter that can be utilized for electricity production. Solar PV modules and solar thermal energy are the efficient sources for their production. We will concentrate on solar thermal technology because it is comparatively simple, relatively low cost and easy to adopt. The use of dish technology, maximum utilization is achieved comparative to other it has about 20% more efficiency. Widely use of this technology is based on heating systems and cooking purposes only due to its heat production while in respect to power production minimum work has been done. This scenario is expressed through a conical flask receiver having spiral tube for Direct Steam Generation

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1.3 Importance of Project

Energy is the basic need now a days. This project resolves many problems in maintaining modern society. New solar tracking system is an important aspect to overcome the limitations of previous researches and for the improvement of the tracking efficiency. This project solely focuses on the solar radiation exposure to the planet surface. Clear day has high level of radiations reaching towards earth surface. The maximum efficiency is achieved when the dish tracks the sun and the absorber receives maximum heat for the direct steam generation.

1.4 Scientific Contribution

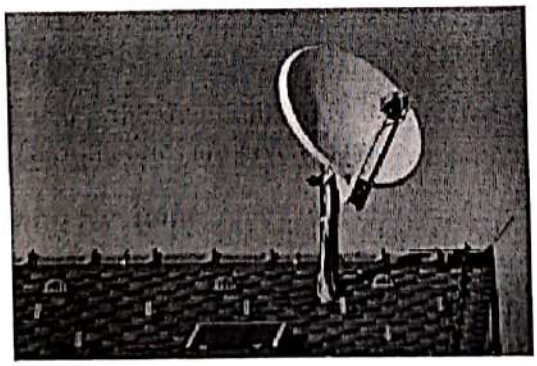
The smoothness of movement of dish according to the movement of sun is the scientific contribution for further developers to mainly focus on the power generation projects. This effective movement causes higher efficiency than the previous proposed systems. Our paper has a extensive research of the ardiuno and the software maintaining the dish movement by taking the average of the sun.

1.5 Background

The system is only efficient if the solar radiations are directed to the center of the dish for this purpose two kind of theories are given that are:

1.5.1 Non Tracking System

Sun rises from the east and sunsets at west. This means that the position of sun changes every minute. This system will only work when the rays are directly pointed towards the solar dish. As the circle always bend the light towards the center of the circle this means all the rays pointed on the surface of the solar dish are directed to the center of the focal point. The non tracking system cannot move with the movement of the sun and should be set manually. This hard work requies a person for this job. Hence non tracking system is not valid for this system.



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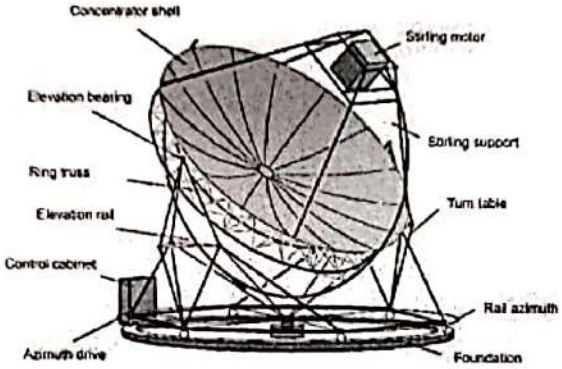
1.5.2 Solar Tracking System

Our solar thermal system is moveable and robust. If it is without tracking system then the dish may be rotated manually , a hard task to do. The solar tracking system tracks the sun and move the system towards the sun. the solar dish moves according to the sun and the rays are directed to the solar dish all the time. The tracking system comprise a sensor and a servo motor combination. The LDR sensor senses the light intensity and then the motor are rotated as the sun moves. This movement causes the maximum solar radiations to fall on the solar dish with maximum efficiency. This tracking may be slow but is controlled by two motors. The two motors rotates along x-axis and y-axis. The x-axis rotation moves the dish on the elevation and declined of the sun while y-axis rotation moves according to the sun from east to west. This is an efficient method to track and move the solar dish having highest efficiency.



1.6 Components used:

Arduino Nano:

We are using the microcontroller Arduino Nano. A computer, another Arduino, or other microcontrollers can all be communicated with using the Arduino Nano's many communication features. UART TTL (5V) serial connection is provided by the ATmega328 and is accessible on digital pins 0 (RX) and 1. (TX).The packaging for this Nano board is unique, though. It lacks a DC jack so that the power source can be supplied via a tiny USB port rather than by directly connecting to pins like VCC and GND. Using a small USB port on the board, 6 to 20 volts can be provided to this board.It is advisable to choose Nano if the project is straightforward, inexpensive, and has a compact profile because it can be utilised for portable electronics and sensor gathering. Uno is the finest option for desktop prototyping with ethernet shields and they can also be utilised in IOT sensors.

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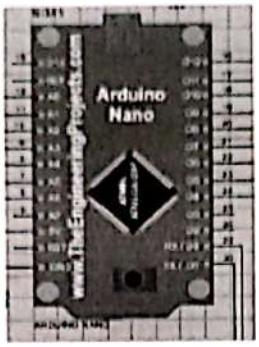
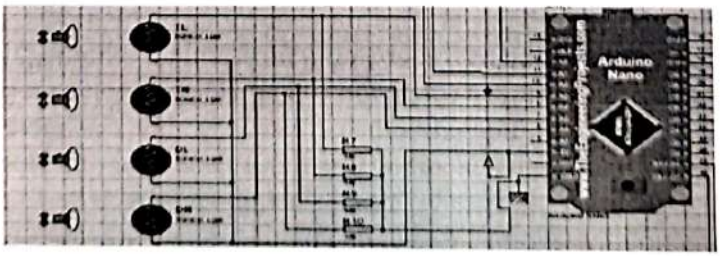


Figure : Microcontroller

Light Detecting Resistor:

We have used 4 Ldr's to sense the rays of the sun from all directions i.e. North, west, east and south. The sensors are all interfaced with the microcontroller's analog pins A3,A4,A5 and A6 respectively. One end of each ldr is connected to the power which is also interfaced with the arduino's pins as mentioned above and the other leg is connected to a pull down resistor which is then grounded. The only difference between pull-down resistors and pull-up resistors is that they pull the pin to a logical low value. They are attached to a device's pin that corresponds to ground between those points. The pull-down resistor guarantees that the wire is operating at a specified low logic level even when there are no active connections with other devices. When there is no other connected active device, the pull-down resistor maintains the logic signal close to zero volts (0V). To avoid an undefinable condition at the input, it draws the input voltage all the way down to ground. The microcontroller collects the analog data from these sensors as wall as the solar voltage divider circuit, the current sensor and the battery voltage divider circuit and converts it into the digital data ranging from 0-1023 which is readable by the computer through an inbuilt Analog-to-digital converter (ADC).



Figure

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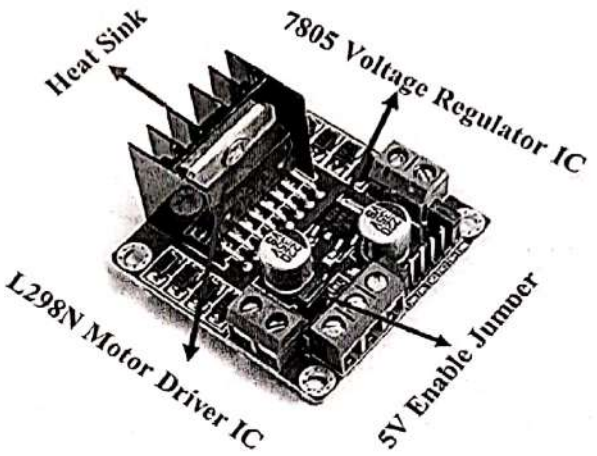
Motor driver:

The L298 is an integrated monolithic circuit in a 15- lead Multi watt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors.



Stepper motor:

An electro-mechanical device that converts electrical pulses into precise mechanical movements. They are well know for their ability to provide accurate position control and holding torque without using feedback sensors. Commercially, stepper motors are used in floppy disk drives, flatbed scanners, computer printers, plotters, slot machines, image scanners, compact disc drives, intelligent lighting, camera lenses, CNC machines, and 3D printers.the characteristics of stepper motor are as follow.

1:Step Angle

It moves in discrete steps and refers to the angle of rotation for each step.Common stepper motors move about 1.8 to 0.9 degrees.

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2:Coil arrangments

Stepper motors are in different arrangment of coils. These are unipolar and bipolar. Bipolar motors have two coils. While unipolar motor have multiple center-tapped coils.

3:Electromagnetic Principle

Stepper motor operates on the principle of electro-magnetisms. By energizing coils magnetic field is produce that interacts with permanent magnets to produce rotational movement.

4:Driver circuitry:

Stepper motor requires a motor driver that determines the sequence and timing of the coil energization for precise motor movement.

5:Control Interface:

These motors can be controlled by various interfaces including digital signals or dedicated stepper motor controllers.

6:Position Control

They are widely used for accurate position control. The number of steps and sequence of coil magnetization the motor hold the exact position without any feedback sensors.

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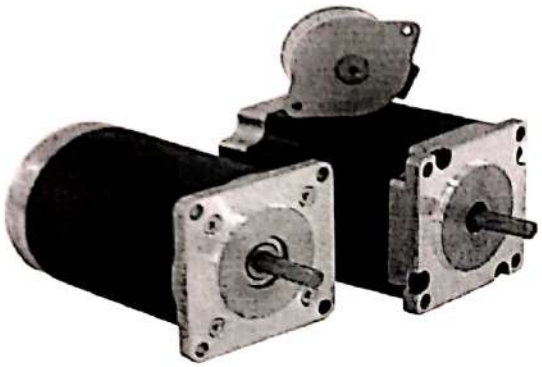
7:Torque and Speed

They offer high holding torque that allow them to hold the position even when powered is off. Their speed is usually lower compared to other motors.



1.7 Report Overview

Renewable energy resources usagecan increase diversity in global energy supply markets, secured long term sustainable energy supplies, help decrease local and universal environmental emissions, and provide commercially strikingopportunities to meet specific energy needs, particularly in developing nations. Renewable energy resources also known as indigenous resources which are exists naturally. These resources include solar, wind, biomass, hydropower and geothermal energy which can provide sustainable energy services. In this paper, we focused on the production of energy through solar thermal power system because this power system experienced quick sales growth, reducing capital cost and declinedcost of produced electricity.

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Chapter 2

2.1 Literature Review

Amin, W., Ahmad, F., Umer, K., Khawaja, A. H., Afzal, M., Ahmed, S. A., & Chaitanya, S. (2022) analyze an Optimal Solution for Energy Shortage in Pakistan. Pakistan has four primary Public and Private energy producers, i.e., Water and Power Development Authority (WAPDA), Pakistan atomic energy commission, Independent Power Plants(IPPs), and Karachi Electric Supply Company (KESC). All energy generation companies (GENCO) utilize energy generation sources, i.e., water, fuel, natural gas. Authors examined that continuous supply of energy improves the standard of living and economic development by using green energy which involves renewable energy resources such as wind, water and solar resources.green energy resources also reduces the Carbon (CO_2) emission.

Authors used the peer to peer frame work for reducing energy stress in order the meet the local energy demand and uniform pricing method which increases services for market participants. These services involves saving in energy bills for consumers and profitability for sellers. Authors also apply the criteria of solar energy penetration on environment and consumer satisfaction level. Result shown that 35% of solar penetration may reduce the stress on energy sectors of Pakistan and also helpful in reducing carbon emissions[1].

Pakistan has limited fossils fuels which are a challenging situation to produce energy through non-renewable resources so, in order to overcome this challenge production of energy through solar, thermal, wind and biomass resources have been discussed. Bhutto, A. W., Bazmi, A. A., &Zahedi, G. (2012) examined issues and challenges for Pakistan in order to produce greener energy by using renewable resources. Authors discussed that Pakistan has remote village areas and hilly regions where there is no electricity supply and it is difficult for government to link national energy to those areas because of the budgetary investment. Solar energy technologies might be the lower cost options in rural Pakistan's villages, where population and load density are low. Photo voltaic and concentrated solar thermal technologies have been discussed in the article.

The main restrictions to widespread utilization of solar PV technologies are; high initial cost of PV system, inadequate renewable energy policy, unawareness in local communities, and inadequate availability of technical knowhow. In Pakistan, cheap labor and high levels of solar radiations country receives throughout the year make condition favorable for development and promotion of solar energy. The main attractiveness of the PV technology is low maintenance, and no pollution. Both conventional PV and concentrated solar thermal technologies have clear room for development in the country [2].

Pakistan is the sixth richest country for coal reserves and has a great capacity to generate electricity from geothermal, coal, nuclear, solar and wind but country has a serious deficit in the supply of the main necessities of life such as water, electricity and gas.Authors discussed different energy related projects which maximize energy production and boost up the economic development. These projects involve CPEC Project, CPEC infect, coal-fired power generation projects, wind energy projects,

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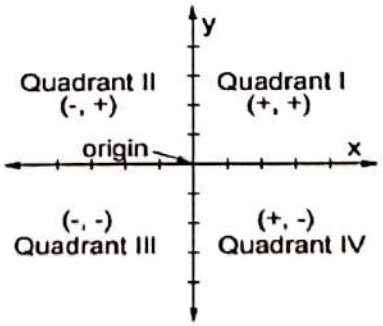
Sindh engro coal mining projects, hydro power projects and solar energy projects will end energy drought in the country.Pakistan can produce 100,000MW of electricity from Thar coal for 20 years, 56,000MW of hydroelectricity, 150,000MW of wind energy and 50,000MW from solar sources. Pakistan needs to focus on indigenous energy resources such as wind, solar and thermal energy instead of imported energy resources, in order to obtain sustainable development [3].

2.2 Previous Inventions

Energy invention, efficient energy and saving are the important factors for the socio-economic development for an economy. Previous study has been focused on flat plate solar thermal collectors. Globally, these collectors were used because of low cost, easy and cheap maintenance. New models were designed to increase the solar thermal efficiency which involves cylindrical collector, double and single pass solar air heater, solar air collector of pin-fin integrated absorber and stationary V-trough collector. Interesting technologies were explored which shows innovative improvements in the scenario of future solar thermal market. these promising technologies includes innovative materials, innovative geometries, integrated solar thermal collectors, heat-pipe collectors, innovative heat transfer fluids in solar flat thermal collectors and hybrid PV-solar thermal collectors.

2.3 Quadrants

When we join the coordinate plane into four equal parts by intersecting X-axis and Y-axis then these four sections were stated as quadrants. X-axis represents the horizontal number line whereas Y-axis represents the vertical number line in quadrant.



The upper right quadrant is denoted as Quadrant I in which X-axis and Y-axis both have positive values. The upper left quadrant is denoted as Quadrant II in which X-axis has negative values whereas Y-axis has positive values. The bottom left quadrant is denoted as Quadrant II in which both X-axis and Y-axis has negative values. The bottom right quadrant is denoted as Quadrant II in which X-axis has positive values whereas Y-axis has negative values.

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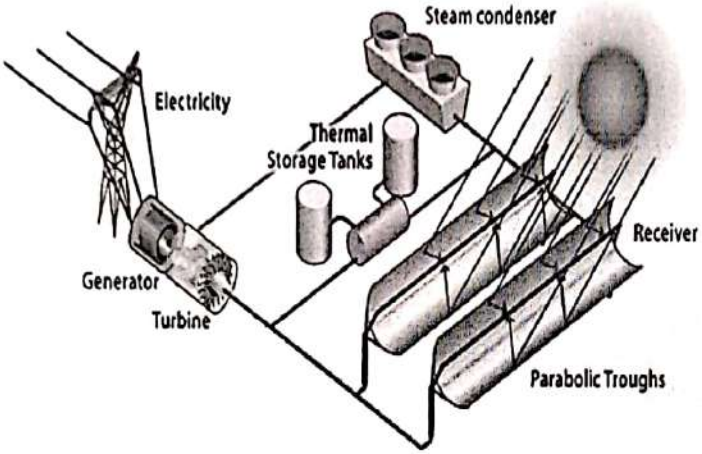
2.4 Classification of Different Solar Thermal System

These are further classified into different categories. They are define as

2.41 Parabolic solar thermal system:

Parabolic solar thermal power system proved that they are the most mature and successful electricity generation systems. This system contains trough or curved mirrors in order to focus on solar energy by using a factor 80 onto receiver tubes that are locate on the focal length of parabolic solar thermal system. These systems are one of the cheapest ways to produce energy from the sun and it creates extreme high temperature which helps in producing steam.



When sunlight is focused and converted into heat, electricity is generated then that electrical energy powers a generator. the primary parts of parabolic solar system comprises of foundation and metallic framework, parabolic trough reflector, receiving tube, tracking devices, transmission system and operating fluid.

Advantages	Disadvantages
Solar thermal power plants are inexpensive and create high temperature that's helpful in producing steam. At night, these power systems reserves power in heavy insulated tanks. As compared to solar photovoltaic, these systems use cheap reflectors by covering a larger zone.	Higher concentration of sun rays would require for proper running of the system otherwise production deceases. Solar photovoltaic (PV) may be located on roofs but parabolic solar thermal plants acquires extensive quantity of land.

2.42 Solar thermal power tower system

In solar thermal power tower system, heliostats were used which focuses sunlight on the receiver at the top of tower. Heliostats are large numbers of flat solar tracking mirrors. For the generation of electricity, a heat transfer fluid heated in the receiver in order to heat up the working fluid. Some power tower system used water as a heat transfer fluid whereas, advanced power tower system used compressed air, molten salt

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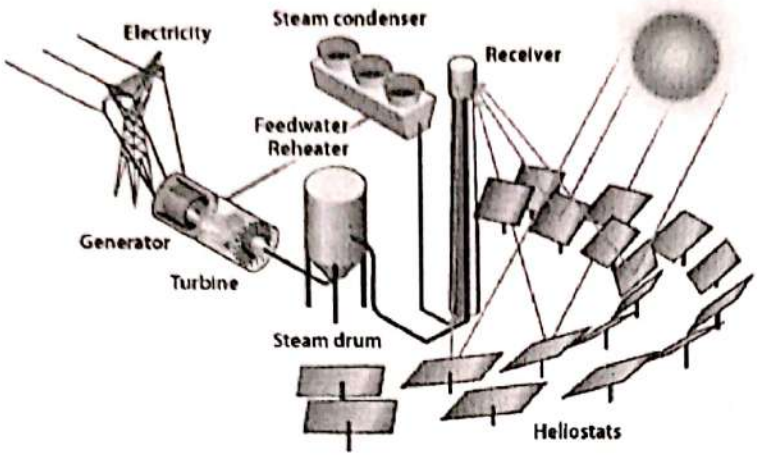
and sand-like particles for maximizing power cycle temperature. These solar thermal power tower systems can reach operational temperatures up to 1100°F.



Advantages	Disadvantages
Solar power towers dependent on sun and its ability to energize the towers rely on daylight. When sunsets these plants continue producing energy. They produced electricity throughout the day. These towers doesn't pollute environment because they doesn't produce carbon emission or waste.	Solar power towers are the most expensive form of producing energy from sun and covered large area of land. These systems efficiency will be affected by winds because heavy wind storms causing problems with the mirror. Stirling systems are well-organized than solar power tower system.

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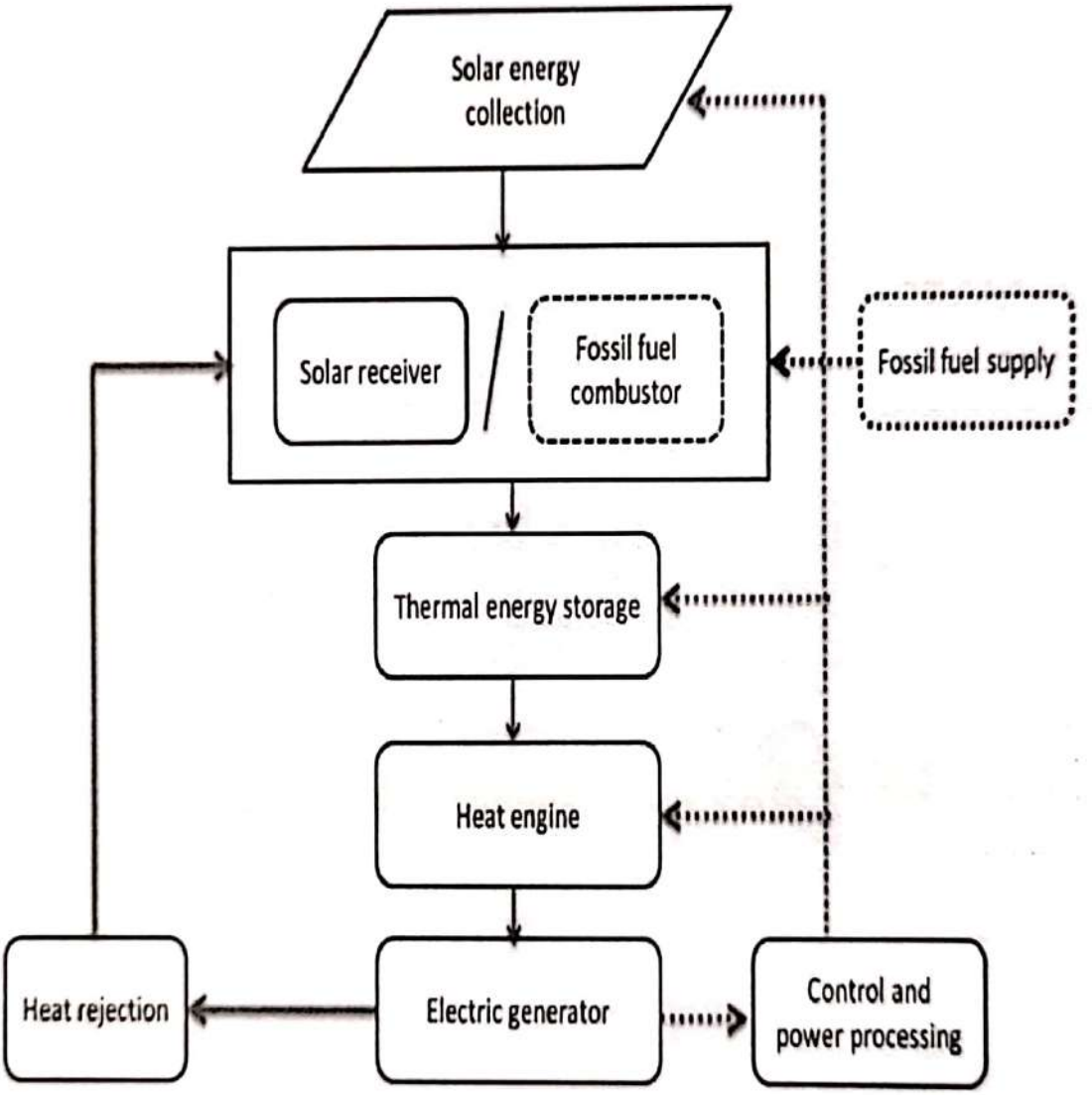
Chapter 3

Methodology

3.1 Block Diagram



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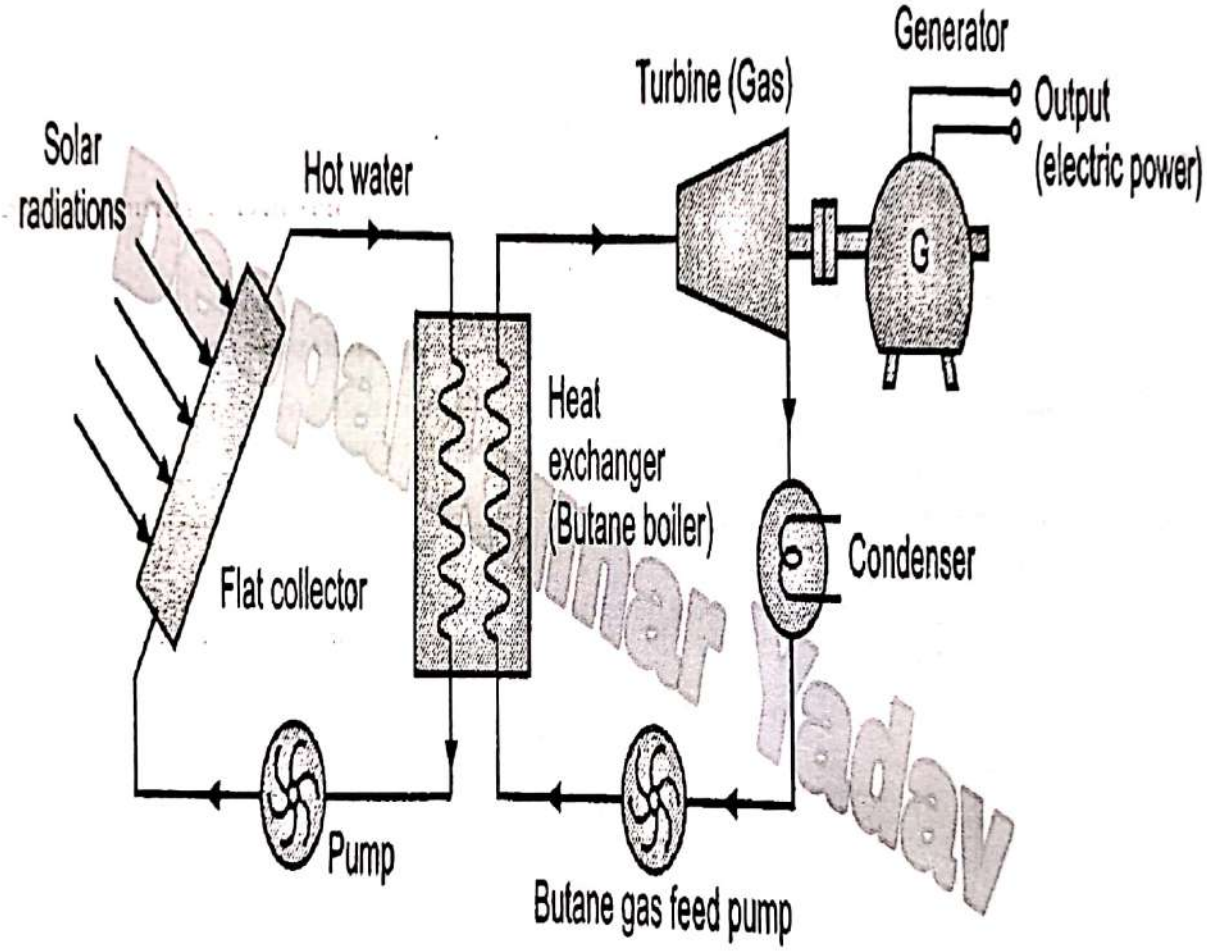
3.2 Schematic Diagram



Low Temperature Solar Power Plant

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3.3 Proposed solar tracking system

In this section, the solar thermal sensor based solar tracking system is proposed. An overview of the system is illustrated in Fig. 3.1. According to this system all work done and its methodological derivatives are given.

3.4 Designing Stirling Dish

Mirrors act as a reflector but when they are spherical the polished side describes its behavior . Either act as concave mirror or as convex mirror depending on their polished side. this project is purely based on concave mirror .Focal point defines its index where all the rays coincide with each other. These solar radiations are focused or concentrate into specific area for focus.

the radius of the dish is called center of curvature while half of it is known as focal point. it is estimated that parabolic dishes have highest efficiency of 29.4% by achieving 450 C. The distance of the focal point measured the vertex depends on the dish diameter and concavity of the dish. The more concave the dish the more closer the focal point will be.

$F= D^2/ 16d$

d= depth of parabolic curve

D= diameter of dish

f= focal distance

3.5 Low Boiling Mineral Oil

Oils are effective for absorbing heat and transferring heat to the other substances. The oil with the lowest boiling points are the fraction of petroleum such as kerosene oil. These oils are highly flammable. They are flammable because of the chemical mixture of hydrocarbon molecules. The oil we will use is the synthetic mineral oil. As synthetic mineral oil has boiling point of upto 300 degree centigrade. The absorber fluid we will use in this project is the mineral oil. Instead of water we use oil because water has only 100 degree centigrade that causes the impact on the flow when absorber temperature approaches up to 450 degree centigrade. Mineral oil has many Benefits because of its viscosity index between 95 to 100. The colorless liquid has a freezing point of -24 degree that does not causes any impact during winter time.

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3.6 Direct Steam Generation

DSG stands for direct steam generation. Direct steam generation is the easiest way of making steam when directly exposed to heat. In previous system mineral oil ws used for this process which further then heats up the water for steam generation. This has a drawback because it water has boiling point of 100 degree centigrade. By using high pressure pump the steam generation can be utilized for the movement of the turbine for energy production.

3.7 X-Y Movement Of Dish

The system will move on X-Y rotation for the movement of the collector dish. This movement is responsible for tracking the sun and its movement will move according to the elevation of the sun. The mounting framework of the collector solar dish will vary and adjust itself based on the program installed by taking average of the solar light intensity. The speed of the solar dish will vary according to the primary and secondary rotation. The primary and secondary rotation shows X-Y plane. The X plane will move according to the sun daily movement from east to west, while Y plane will move according to its elevation. The main working only resides by the primary movement while the secondary movement has very low load on the system. These movements are either controlled by the servo motors or DC motors. These motors are mounted on the supporting structure of the collector solar dish. The rotational movement positioned the solar dish according to the sun. this movement will achieve maximum solar radiation and its absorption will increase up to 80 percent. The maximum absorption will give as a result maximum efficiency. As solar rays are only for the day time so achieving and collecting more radiations will cause a efficient and smart system for the energy production.

3.8 LDR Sensor Judgment

In order to track the sun we will use sensors for its location. Many sensor are available in market in order to loacate the exact position of the sun. The sensing capability is the important task of the project for maximum solar absorption. The sensor used in our project will be the light detecting resistor. Main working of this sensor is the only detection of light and its intensity. The intensity of light will decide the resistance of the LDR sensor. This LDR if connected in series will give some resistance output. This resistor works on photoconductivity. The resistance decreases as the intensity of light increases while the resistance increases as the intensity of light decreases. Mainly in dark modes or at night the resistance of LDR is very high that no current can be conducted through the circuit. The LDR resistance vary from about 100ohm in day light while at night the absolute darkness has about 10mega-ohm. This variation of the resistance is converted into voltage variation as Vout. The four LDR

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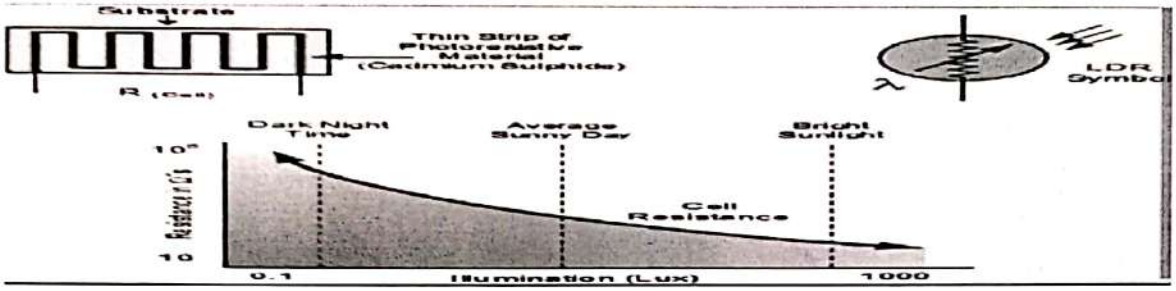
senses the light intensity and gives an output as in the form of average. This average further defines the movement of motors.



3.9 STRENTHING FRAME

THE FRAMEWORK INVOLVED FOR REINFORCING AND ENHANCING THE STABILITY ,RIGIDITY AND LOAD BEARING CAPACITY TO IMPROVE ITS OVERALL DURABILITY.WE HAVE USE 22 GUAGE METAL SQUARE PIPE WITH EFFECTIVE TECHNIQUE OF WELDING AND BASE STRENGHTH. THE STRENGHING INVOLVE MULTIPLE SITUATIONS

INCREASED LOADS

STRUCTURAL DAMAGE

UPGRADING STANDARDS

3.10 LOAD PLACEMENT

If load is not balanced equally then disbalancing occur. The efficient way is to get exact load positions for eeficient working of out dish. If load exceed the design capacity then the structure collapses. For these safety measures quality assurance is very important aspect . the dish is so equally adjusted that does not causes any additional effect on the motors.

3.11 Height Factor

The important aspect is the height of the power system beacause of many reasons. It is worth noting that structure with minimum height have more strenght than the taller objects. The word wind speed means the spped of wind that is measured is either

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measured in kilometer per hour , miles per hour and meter per second. In normal conditions wind speed ranges from 10 to 30 km/h. In rawalpindi the wind breeze becomes severve during wind storm. This ranges from 40 to 55 km/h. this is harmful to low strenghing models so strenghing is very important ket factor.

3.12 Relevent Speed of Sun

The earth rotates around the sun and completes one revolution in 365 days. The day and night depends on the rotation of earth around its axis. The relevent speed of sun to earth is 29.8 kilometer per hour or in other words 18.5 miles per second. This information shows that according this relevent speed the sun moves about 15 degree per hour with respect to earth during summer seasons and move about 19.4 degree in winter seasons. This means that when a dish maintains its position the motors are in rest motion for about 1 hour.

3.13 Position of Sun

In asia the sun rises from the east and sets in the west. The azimuthal angle describes the relative motion of the sun. The sun rises and achieved its higher position at noon. Means rises from 0 degree and achieves 90 degree in noon while sets at 270 degree.

3.14 NEMA 23 Stepper Motor

The word NEMA means national Electrical Manufactures association. This names refers to the mounting flange and shaft size.

Size:

Nema 23 means the frame size of motor is 2.3 inches or 57.15 millimeter.

Step Angle:

Typically nema 23 has step angle of 1.8 degrees per step . this means that the rotor moves 1.8 degree with each step.this allows for precise contriol.

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Holding torque:

The holding torque of nema 23 is about 300 ounce per inches . this means the torque produced is 21N while holding torque.

Running Torque:

The running torque is less than the holding torque. It is about 250 ounce per inches. The torque is 17.5 N.

Current Ratings:

The typical range is from 1 to 4 ampere per phase depending upon the application requirements.

Coil Configuration:

The motors are either unipolar or bipolar. In our case we are using motor driver and controls as multiple center tapped coils.

Contol Driver:

For this model we use EB6600 motor controller. This driver converts electrical signals to necessary current and voltage to drive the motor.

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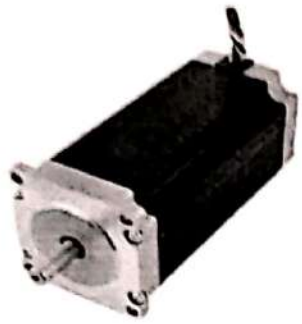
Wiring:

These motors have four to six wires configuration . these motors are convertible to bipolar to unipolar.



3.15 Motor Driver TB6560

The TB6560ndriver is a very common driver available in market that are usually used in CNC. The important aspect of this module are as given.

Driver Chip:

This module is built around the TB 6560AHQ motor driver IC. This module is capable of driving bipolar stepper motors.

Motor Compatability:

This driver handels apto 3.5 ampere per phase. It supports various modes such as full step , half step, 1/8 step etc.

Control Signals:

The step signal determines the movement of shaft by series of pulses. While direction signal controls the rotation direction in clockwise or anticlockwise direction.

Power Supply:

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The voltage input ranges from 9volts to 42volts . It is very important to select appropriate power supply to match the motors voltage and current requirements.

Current Adjustment:

It has a built in potentiometer for adjusting the current. This is very important for optimizing motor performance and preventing overheat.

Micro Stepping:

The microstepping allows more precise ans smoother compare to full or half stepping. Micro stepping basically subdivides the full steps into smaller increments resulting in finer motor controlling.

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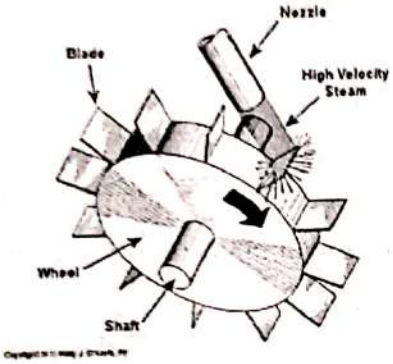
3.16 Turbine

A turbine is a mechanical device that basically converts any movement into rotational mechanical energy. It is a rotor assembly with different arrangmenmt of blades that are direct targeted through steam that rotates the vanes. These turbine are basicallybthen furthur used for generating electricity.the steam energy is then converted to rotaional energy which drives a generator dor electricity production.



3.17 Generator

When a turbine is directly connected to a generator then they collectively are called as turbogenerator. This mechanical is now converted into electrical energy. The working are as followed.

Mechanical Power Generation

The turbine moves at high speedthat is driven by a high pressure steam. This steam then causes the turbine blades to move at high speed converting into rotational mechanical energy.

Shaft

The shaft of turbine is connected to the shaft of generator. They maybe cannected through gears or directly to each other.

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Transfer OF Rotaional Energy

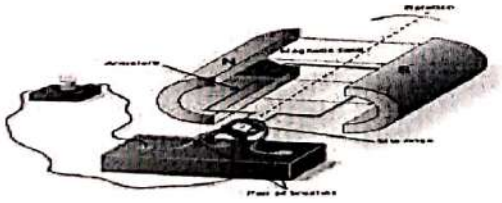
As the turbine rotates its shaft is connected to the shaft of generator. The rotational energy of turbine is then transferred to the generator. This energy then rotates the rotor of the generator.

Electromagnetic Induction

A generator consists of conductive coils that are wrapped around an iron core. As the rotor moves by the turbine this causes changing magnetic field. This changing magnetic field induces an electric current in wires through electromagnetic induction.

Electrical Energy Generation

The induced electric current generated in coils of generator is an alternating current. This can be rectified by AC to AC convertors by using a stabilizer that is then step up or down by using different means.



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Chapter 4

Implementation &Simulation

4.1 Code

```
#include <Servo.h>

Servo servohori; //horizontal servo(BOTTOM SERVO)

int servoh = 0; //assign servo at 0 degree

int servohLimitHigh = 180; //maximum range of servo is 180 degree(it is variable you can also change)

int servohLimitLow = 10;   //minimum range of servo is 10 degree(it is variable you can also change)

Servo servoverti; //vertical servo(TOP SERVO)

int servov = 0;

int servovLimitHigh = 180;

int servovLimitLow = 10;

int ldrtopr = 1; //top right LDR A1 pin

int ldrtopl = 2; //top left LDR A2 pin

int ldrbotr = 0; // bottom right LDR A0 pin

int ldrbotl = 3; // bottom left LDR A3 pin

 void setup ()

 { servohori.attach(10); //horizontal servo connected to Arduino pin 10

  servohori.write(0);

   timeserver.attach(9); //vertical servo connected to Arduino pin 9
```


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```
servoverti.write(0);
 delay(500); //delay }
void loop()
{ servoh = servohori.read();
 servov = servoverti.read();
int topl = analogRead(ldrtopl); //read analog values from top left LDR
 int topr = analogRead(ldrtopr); //read analog values from top right LDR
 int botl = analogRead(ldrbotl); //read analog values from bottom left LDR
 int botr = analogRead(ldrbotr); //read analog values from bottom right LDR
  int avgtop = (topl + topr) / 2; //average of top LDRs
 int avgbot = (botl + botr) / 2; //average of bottom LDRs
 int avgleft = (topl + botl) / 2; //average of left LDRs
 int avgright = (topr + botr) / 2; //average of right LDRs
if (avgtop < avgbot)
 {servoverti.write(servov -1);
  if (servov > servovLimitHigh)
   { servov = servovLimitHigh;}
  delay(8);}
 else if (avgbot < avgtop)
 {servoverti.write(servov +1);
  if (servov < servovLimitLow)
```


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```
{ servov = servovLimitLow; }
 delay(8);}
else
{servoverti.write(servov); }
 if (avgleft > avgright)
{servohori.write(servoh -1);
 if (servoh > servohLimitHigh)
 {servoh = servohLimitHigh;}
 delay(8); }
else if (avgright > avgleft)
{servohori.write(servoh +1);
 if (servoh < servohLimitLow)
{servoh = servohLimitLow; }
 delay(8);}
else
{ servohori.write(servoh); // write means run servo }
delay(50);}
```


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Chapter 5

5.1 Summary and Future work

The effect of the research was to construct a modified version of the traditional LDR tracker using parabolic concave mirror and demonstrates that the heat production has a greater output for voltage, current, and power and is more efficient. The designed tracker was constructed using both a UV sensor and an LDR and can function in both modes; the modes may be changed by modifying the code. We suggested a novel UV sensor-based dual-axis solar tracking system to increase tracking motions and energy generation by exploiting the advantages of UV radiation intensification and UV sensor capabilities. Following the installation of the solar tracking system, four intensity signals of UV radiation received by UV sensors are compared and utilized as inputs to the system, which is capable of tracking the sun's route across daily and elevation angles. In a comparative study, the suggested solar tracking system's solar tracking performance is compared to that of a stationary system and a traditional LDR-based solar tracking system. Our tracking system provides more energy than the permanent parabolic dish system and the LDR-based solar tracking system, according to the testing results.

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Chapter 6

6.1 Conclusion

This paper primarily presents the design and implementation of an innovative solar thermal system based on heat . The system leverages the benefits of heat enhancement and the capabilities of mirror to enhance tracking movements of sunrays. A pseudo-azimuthal mounting structure was utilized to track the sun's trajectory in terms of daily and elevation angles. The proposed tracking system compares the signals obtained from UV sensors mounted on the rotation axes to accurately track the sun's position.

The experimental results in Chapter 5 indicate that the proposed tracking system achieved higher heat production on sunny days. In other conditions, although the gain was positive for the proposed system, it was observed to be lower compared to the studied parabolic system. Conversely, the LDR-based tracking system exhibited inefficiency during low-visibility conditions, leading to higher operational energy consumption and occasionally resulting in a marginally negative gain. Consequently, the experimental results demonstrate the significant improvement in energy generation achieved by our tracking system. The observations further confirm the effectiveness of the tracking system .

Based on these findings, it can be concluded that the UV sensor-based solar tracking system exhibited remarkable superiority in solar tracking performance compared to the LDR-based tracking system. This development represents a significant milestone in solar tracking system research and can contribute to enhancing solar energy generation with single- or dual-axis tracking systems. Moreover, the system's application potential extends beyond solar energy in various domains.

Although this study has made significant contributions in the development of a energy production using mirros , future considerations should include techno-economic optimization to maximize energy generation gain and minimize operational energy consumption through configuration and tracking strategies. Additionally, to ensure generalizability, it is crucial to analyze the accuracy of the proposed tracking system in tracking the sun's actual position across seasons and regions.

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The Internet links shall be complete URLs to the final article.

[1] http://dx.doi.org/10.1016/j.apenergy.2012..11.051

[2] https://doi.org/10.1787/ 557a761b-en.doi:10.1787/557a761b-en.

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