SUN TRACKING SOLAR PANEL SYSTEM

A Project

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DEPARTMENT OF MECHANICAL ENGINEERING

SONARGAON UNIVERSITY (SU)

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DECLARATION

We, hereby, declare that the work presented in this project is the outcome of the investigation and research work performed by us under the supervision of, Nuruzzaman Rakib, Assistant Professor, Department of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award of any degree.

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CERTIFICATION

This is to certify that this project titled "SUN TRACKING SOLAR PANEL SYSTEM" carried out by, Md. Rakibul islam Foysal(BME1902018229) , Saiful Islam(BME1902018171) ,Tanmay Das (BME1902018311) , Md. Saurav Islam , (BME1902018260) , Md. Abdul Latif ,(BME1902018351) , meets the regulations governing the award of degree of Bachelors of Science (B.Sc) in Mechanical Engineering, Sonargaon University (SU), and it is approved for its contribution to scientific knowledge and literary presentation.

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ABSTRACT

The phrase the sun is the source of all energy implies that solar energy is an essential element for the earth. Sun-powered vitality is fast becoming a substantial approach for renewable energy source assets. The sun is a plentiful source of vitality, and this sun powered vitality may be effectively dealt with by employing sunlight-based photovoltaic cells and photovoltaic impact to convert sun powered energy into electrical vitality. The solar tracking system maximizes the power generation of solar system by following the sun through panels throughout the day, optimizing the angle at which panels receive solar radiation. Compared to stable solar panels, a solar tracking system using solar panel linear actuators or gear motors can increase the efficiency of solar panels by 25% to 40%. The transformation efficiency of any sun-based application increases when the modules are consistently adjusted to the optimal edge as the sun crosses the sky. A dual-axis tracker allows panels to move on two axes, both north-south and east-west parallel. This paper presents the design and implementation of a single-axis solar panel based on the Arduino UNO microcontroller.

Keywords-- Arduino UNO, LDR Sensor, Servo motor, Solar panel, Battery.

CHAPTER 01

INTRODUCTION

1.1 Background of the Study:

The exploitation of coal, oil, natural gas, and other mineral resources and the development of nuclear energy are all aimed at meeting energy needs. At the same time, the carbon dioxide produced by the use of mineral energy has caused a global greenhouse effect. The use of this energy source has many side effects. Solar energy, wind energy, tidal energy, and other new energy all use the innate energy of nature. The process of using them is basically collection, so these are clean energy. More and more countries and regions value its development and use and increase investment. Among these clean energy sources, solar energy is the most used, the most stable, and the most convenient.

The sun is a numerous source of vitality, and this sun-powered vitality may be effectively dealt with by using sun-oriented photovoltaic cells and photovoltaic impact to convert vitality into electrical vitality. However, the transformation capability of a standard PV cell is limited. The major reason for this is because the output of PV cells is dependent on the light intensity, and with the sun's location in the sky changing constantly, the efficiency of a solar panel would be much lower at a specific time of day and year. Solar PV cells are most productive when they are perpendicular to the sun and least productive when they are parallel to the sun. As a result, solar panels are necessary to increase energy output while also improving efficiency. Through the programming-based arrangement, the sun-based tracker also provided a valuable solution for poor nations to easily coordinate it into their nearby planetary system. The analysis discovered that using a stepper motor allows for precise tracking of the sun and the LDR resistors needed to determine the solar powered light force.

Experts predicted that incorporating a global positioning framework with a sun-oriented board will provide precise and appropriate responses to meet the demands of the force in a variety of operating scenarios. A solar-powered global positioning framework designed with microcontrollers and LDRs to follow the sun and modify its location as needed to increase energy production. The LDR fused on the sun-oriented board aids in differentiating daylight and so advances the board in a similar manner.

The sunlight-based tracker demonstrated a more improved way to increasing the force consumption by the sun powered board from the sun by simply spinning the sun-powered board in accordance with the location of the sun. Looking at the results, it was discovered that immediate light emission aids in the creation of vitality more than when the sun oriented board is fixed. The proposed have shown that the efficacy of sun-powered boards may be increased in general if the sun-oriented boards continue to rotate toward the sun. To track the sun, a microcontroller and a series of LDR sensors can be used.

Regardless, the framework was less effective due to the poor affectability and disturbing effects of light ward resistors. Another mechanical construction for solar panels comprises of two stepper engines with the expectation of complementary rotation on X and Y hubs.

The turn is limited by a pre modified 2K microcontroller device that offers a simple programming process in C language. The structured computation was based on the measurement of the power of sunlight-based radiation, which was captured by a bright sensitive device known as a parano meter. The framework had been tested, and the results demonstrate an extraordinarily large influence on the mechanical structure, regulating computation, and the cost of the turn of events. In recent years, the use of solar energy has yielded fruitful results and there is a certain scale. Solar automated tracking systems have different methods such as differential pressure type, photoelectric type, and day-dependent trajectory type and each has its advantages and disadvantages but lacks accurate tracking and intelligence. To improve the efficiency of the use of solar energy, the method of combining image processing with the trajectory of the sun is used to perceive the solar panel for tracking the sun with high accuracy.

1.2 Aims and Objectives of Study:

The aim of this project is to sun tracking solar panel system.

The objectives of this project are:

1. To design a sun tracking solar panel system.
2. To implement to renewable source of sun power.
3. To evaluate the performance of the implemented sun tracking system.
4. To rotate the tracker with the usage of a controller alongside the overall ecliptic.
5. To consume maximum solar energy through solar tacking panel.

1.3 Statement of Problem:

In the earlier kind of solar tracking system, there are numerous issues that arise. The solar panel in question, which is only used in fixed installations, is the issue. The amount of power that can be generated is limited as a result of this issue. Another issue is that a family using more energy than normal must pay a high price for a solar tracking system because additional solar panels must be installed to generate enough power. Therefore, the goal of this project is to address the issue. The 180-degree rotation can be detected by this sun tracking technology. As a result, the solar panel's potential output is far higher here than it would be if it could only face one way. The second issue is associated with solar energy. Because of the earth's perpetual rotation, the stationary solar panels cannot point exactly at the sun. As a result, this gadget does not produce as much power as it should. Solar tracking system is the better option for this system to achieve the greatest output power. The project solar tracker was created primarily for this purpose. To increase output power, the solar tracker will follow the sun. It will indirectly lower the cost of purchasing more solar panels. These technologies also shorten the time it takes for customers to turn solar panels so that they face the sun.

1.4 Motivation of Study:

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. Solar tracking uses complex instruments to determine the location of the Sun relative to the object being aligned. These instruments typically include computers, which can process complicated algorithms that enable the system to track the Sun, and sensors, which provide information to a computer about the Sun's location or, when attached to a solar panel with a simple circuit board, can track the Sun without the need for a computer. 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.

1.5 Significance of Study:

The main issue for the next fifty years is the generation of electricity through the use of less fossil fuel. When compared to other renewable energy sources, the concept of employing photovoltaic panels to transform solar energy into electrical energy occupies the front row. However, the solar panel's output is decreased due to the sun's constant shift in angle with respect to the earth. The greatest choice in this situation to boost photovoltaic panel efficiency is a solar tracking device. Throughout the day, solar trackers shift the payload in the direction of the sun. Different tracking system types are covered in this essay along with their benefits and drawbacks. The outcomes of this review's analysis demonstrate that the azimuth and The azimuth and altitude dual axis tracking system is more effective than other tracking systems, according to the findings of this review. However, a single axis tracking system is more practical than a dual axis tracking system from a cost and flexibility perspective. Keywords: Photovoltaic panel, solar tracker, latitude, azimuth, and passive actuator.

1.6 Scope and Limitation of Study:

Because they are thought of as sophisticated systems with moving parts, solar trackers are slightly more expensive than their stationary counterparts. In comparison to fixed systems, trackers need greater upkeep. The amount and frequency of maintenance depends on the type and quality of the solar tracking device. Every tracking system requires extensive site preparation. Additional trenching is needed for wiring and grading as well. From the perspective of a financier, financing tracking initiatives is viewed as a more difficult and risky undertaking. Solar trackers are only suitable in hot areas and do not work well in cold weather. Compared to tracking systems, fixed systems are more weather-resistant. Field-compatible fixed tracking devices that can accommodate E/W slopes of up to 20%. While tracking systems normally accommodate a smaller slope, approximately 10% in the N/S direction.

1.7 Organization of Study:

Solar power is a massive, plentiful, environmentally friendly, and cost-free source of energy. The globe is currently investigating and researching the most practically optimized technique to harness this energy because of the aforementioned attributes, and solar tracking system is a product of this effort. This essay begins with a basic overview of solar PV cells and the components that went into making them. The various solar tracking systems and solar PV system types are also covered. The design and performance evaluation of the numerous dual-axis tracking solar systems that have been put forth recently are the key areas of concentration. Although the choice to employ trackers primarily depends on the topography of the area, this technique has generally shown to be more effective and better than its fixed and single-axis alternatives.

CHAPTER 02

LITERATURE REVIEW

2.1 Historical Background:

Power production has become more difficult as a result of the depletion of fossil fuels throughout time. When discussing renewable energy sources, photovoltaic panels that harness solar energy are given priority. The solar panel's output power is directly inversely proportional to the angle of the sun with respect to the earth. Thus, as the relative angle changes, the amount of watts delivered decreases. In this sense, a solar tracking device can boost the PV panel's efficiency. Solar trackers guide the payload toward the sun throughout the day. This project illustrates various tracking system types and their benefits.

A single axis solar tracker or a dual axis solar tracker are the two major types of tracking devices. A single horizontal or vertical axis is the foundation of the single axis system. The position of the system where it will be installed determines the axis' direction. A system known as a dual axis has both a horizontal and vertical axle. Anywhere in the world, this kind of tracking system can precisely follow the sun's movement.

2.2 Previous Work of sun tracking system:

Haneih (2009) carried out research on the demand for solar panels that track the sun in Amman, Jordan. The main topic of this study was improving PV panel efficiency in desert areas. The author outlined how two degrees of freedom orientation may be accomplished by utilizing some of the solar panel's power output. If we take the system's symmetry into account, astronomical calculations can be used to govern the system's kinematics. Close loop control can be added to the system by using feedback control loops and solar tracking sensors. This fixes the issue of overcast days. The author went on to say that the grid layout of the panels in the collecting plants should receive special attention.

Another study by Rao et al. (2012) described a project that used an ARM7 TDMI CPU. The processor was in charge of gathering data from the sensors and instructing the motor to follow the sun. For the development and implementation of closed loop algorithms are the foundation of a monitoring controller. Maximum current from solar panels as a result increased energy production.

Kancevica et al. identified a distinction between a stationary collector and a solar tracking device (2012). The author highlighted how, in a solar tracking device, flat plate collectors were impacted perpendicularly by solar radiation as opposed to stationary collectors of the same size. On average, 1.4 times more heat energy was produced.

2008 saw the introduction of a computerized sun tracking device by Abdallah, which rotated the solar still in accordance with the motion of the sun. The contrast between fixed and sun tracked solar stills was displayed by the researcher. Because there was a 2% gain in efficiency, productivity improved by about 22% when sun monitoring was used. By employing the sun tracker, the water's thermal capacity decreases and its temperature rises. Both the evaporation rate and the distillation rate rise as a result.

2.3 Comparative Work:

Balabel et al. (2013) optimized the operational efficiency of a solar photovoltaic module using mathematical analysis. On control system design and testing, he concentrated. The study's calculations of the altitude angle at Taif, Saudi Arabia, served as its foundation. According to how it is managed, the researcher demonstrated that the sun tracking algorithm may be classified into closed-loop and open-loop systems.

Rhif et al. conducted a review of the literature on the dual axis sun tracker's sliding mode control law tracking procedure (2010). Use of this autonomous dual axis sun tracker can boost electricity production by up to 40%. The outcome demonstrated the strength, utility, and superior sliding mode observer of the sliding mode control in the tracking process.

The sun is monitored from east to west by a single axis tracker, according to Madhu et al. (2012), as opposed to the daily east to west movement of the sun and the seasonal declination movement, which were recorded by a two axis tracker. Using lenses or mirrors, a huge region of sunlight is condensed into a narrow beam. PV uses photoelectric current to transform solar energy into electrical current. According to test data, monitoring solar plates have an increased electricity efficiency of 26 to 38% compared to fixed plates. And on days when it's gloomy or wet, it changes to any degree.

Solar panels typically don't track the sun's movements because they are stationary. In this project, a solar tracker device follows the sun's path across the sky and works to keep the solar panel perpendicular to the sun's rays, ensuring that the panel receives the most sunlight possible throughout the day. The solar tracking system begins following the sun at daybreak, continues through the day and into the night, and then restarts at dawn the next day. Solar panels are effective ways of storing energy, and how well they function at this is directly related to how they face the sun. Because PV cells work best when they face the sun, a stationary solar panel collects less sunlight than one that moves with the sun as it moves across the sky. The dual axis system, which has both a horizontal and vertical axis, is employed in this project. The tracking technology in this project can precisely follow the motion of the sun at any location worldwide.

2.4 Theoretical Background:

The photovoltaic effect is the underlying theory that powers the cells. The photons, which act as the charge carriers for an electric current when the light beam strikes the solar panel, stimulate the electrons to a higher energy state. In the panel structure, there is an electric field that, when paired with the motion of the electrons, results in an electric current. A solar cell's output is related to the intensity of the incident light and the angle at which the panel is held in relation to it. Power density on the panel is at its highest when it is kept parallel to the sun. Power density is 0 when the panel is parallel to the sun's rays. Significant advantages for renewable energy are offered by solar trackers. Power output can be improved by between 30% and 40% with solar tracking. New markets for solar energy are anticipated to be created by the rise in electricity output. Solar trackers do, however, have a number of significant drawbacks. A static solar panel might have a decades-long guarantee and need little to no upkeep. On the other hand, solar trackers need one or more actuators to move the panel and have substantially shorter warranties. As a result of these moving parts, active tracking systems may also utilize a small amount of energy, which raises installation costs and decreases reliability (passive systems do not require additional energy). Solar trackers using computer-based algorithms are more expensive, need more upkeep, and age considerably more quickly than static solar panels since they make use of quickly changing electronic parts that may be challenging to replace in comparatively short amounts of time.

CHAPTER 03

SYSTEM DESIGN

3.1 Geometrical Constraints:

There are various limitations that need be taken into account once we opted to develop the dual axis solar tracker system for the project. The primary challenge was first to design a solar tracker system that was manageable in terms of size. The key issue was that the performance and efficiency of the dual axis solar tracker should not be impacted by its size. Numerous research were conducted in order to produce a final product that was well-balanced.

3.2 Sustainability:

With the exception of the solar panels, which need particular maintenance, a whole system should be able to maintain its physical and functional integrity. The system must operate for a long time to recoup the cost of the device. The distinguishing feature of this system is that it uses the sun as a guiding source rather than the earth as a point of reference. Active sensors track the sun's movement and spin the panel in that direction when the sun's intensity is at its highest.

3.3 Environmental Concern:

There will be abundant availability of solar energy in the nature because the sun emits energy at an extremely large rate. The world’s energy demand could be fulfilled if all the solar energy is converted in to useable forms. Solar energy can be converted to more usable energy forms through solar tracking solar panel. There is unprecedented interest in renewable energy, particularly solar energy. Our project solar tracking solar panel highlights the use of abundant source of energy particularly in Saudi Arabia which is going wasted unused.

3.4 Social Impact:

On one hand we can see that the world’s energy resources depletion will be one of the major problems and on other hand we know that global warming is major concern of the world. But solar energy which we can gain from solar panel, we can gain maximum energy which is clean and green and improving its efficiency by using sun trackers is a great option in near future.

3.5 Economic:

The major constraint of the project was the financial concerns related with the creation of the system. Solar energy can reduce the electricity bills of households since solar energy can be used to supplement other resources of energy. One might install a solar tracking system with a solar panel considering the advantages like the efficiency increases by 20-60% that is equivalent to more money. The space requirement is reduced for solar park and they sustain the same output the profit time of the investment is reduced. Long-term maintenance concerns for tracking systems are drastically reduced by advancement in technology and reliability in electronics and mechanism.

3.6 Safety:

Our design has also been planned to sustain safety at all times during its functional lifespan. The solar tracking solar panel system is securely mounted to prevent it from becoming a failing hazard.

3.7 Ethics:

Solar tracking solar panel designs and models are already in use in markets and in our daily life but we intend to present this solar tracking solar panel system with some modifications in it. The aim of this project is to ensure the sunlight rays are falling perpendicularly on the solar panel to give the maximum solar energy. An automated system is required to get a constant output, which should be capable to constantly rotate the solar panel. The solar tracking system was made as a prototype to solve the problem. It will be automatic and keeps the panel in forward-facing of sun until that is visible.

CHAPTER 04

REQUIRED COMPONENTS

4.1 Component table and equipment:

To accomplish the system, some components are needed. They are listed in Table:

SL NO	COMPONENTS	QUANTITY
1	Arduino UNO	1
2	Servo Motor	1
3	LDR (250 kilo ohm)	2
4	Solar Panel	1
5	Resistors	3
6	Jumper wire	Not specific
7	Battery	1

Table 01: Component table.

A short definition for components that using in system prototype is given below:

4.2 ARDUINO UNO:

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-toserial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-toserial converter. The Arduino advantages are independent platform, construction robust and low price.

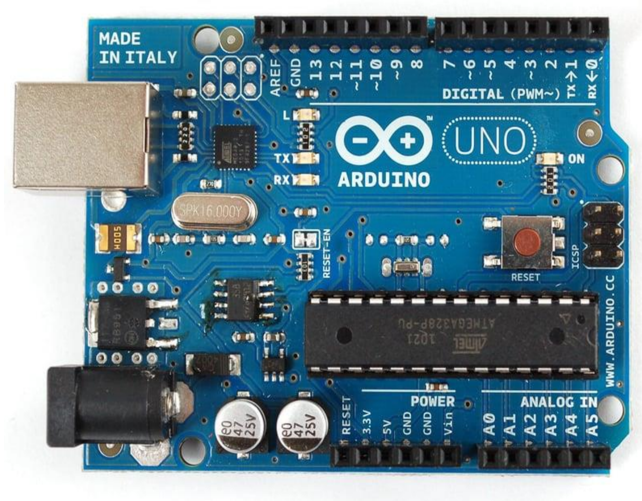


Fig 01: Arduino Uno.

Arduino Uno Specifications:

Microcontroller	ATmega328P – 8 bit AVR
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
DC Current on I/O Pins	40 mA
Frequency (Clock Speed)	16 MHz

Table 02: Audrino UNO Specifications.

4.3 LIGHT DEPENDENT RESISTOR (LDR):

The fixed resistor and the light-dependent resistor make up the lighting sensor (LDR). LDR voltage cannot be wired directly to the controller since the supply voltage is 5V.In order to read the voltage of the LDR, the voltage divider method is used. Due to the fact that the motor cannot be rotated continuously throughout the day, the value of the voltage difference between two LDRs is compared to the sensitivity. The voltage difference between two LDRs is what determines whether the solar tracking system rotates in CW or CCW directions. The motor turns in the direction indicated by the sensitivity. The motor turns in the appropriate direction depending on whether or not the voltage difference exceeds the sensitivity. LDR**s** are also named as photo conductors or photo resistors and the photoconductivity is the principal of their working. LDR resistance is increased with decrease light intensity and vice versa. Solar energies catch by purpose sensing which are done by using LDRs before providing the input analog to Arduino.

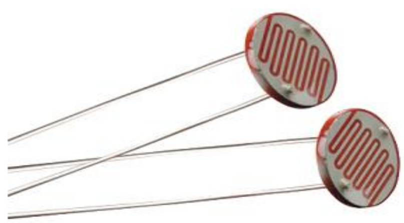


Fig 02: Light Dependent Resistor(LDR) Sensors.

Light intensity measurement:

Light intensity	LDR output (v)
dark	0.6
average	4.0
bright	4.6

Table 03: Light intensity measurement.

4.4 SERVO MOTOR:

A small, light-weight server motor with high output power is called a micro servo motor, or SG90. Servo rotates around 180 degrees (90 in each direction) and functions similarly to larger types of servo. These servos can be controlled by any servo code, hardware, or library. Good for novices who don't want to create a motor controller with feedback and gear box because it can fit in compact spaces. Hardware and three horns (arms) are included. The primary function of a three-wired DC motor with a maximum rotational angle of 180° is a servo mechanism. Due to the system's dual axis operation, there are two servo motors used for both horizontal and vertical directions. Arduino offers PWM output is used to power these servo motors.

Weight	9 grams
Stall Torque (4.8v)	1.3 kg/cm
Dimensions	23 x 11.5 x 24mm
Connector Wire Length	24.0cm (9.4 inch)
Operating Speed (4.8v)	0.15 Sec/60 Degrees

Table 04: Specification of servo motor sg90.

Fig 03: Servo Motor SG90.

4.5 SOLAR PANEL:

The photovoltaic cell is the basic building block of a photovoltaic system. The individual cells can vary from 0.5 inches to 4 inches across. One cell can however produce only 1 or 2 watts that is not enough for most appliances. Performance of a photovoltaic array depends on sunlight. Climatic conditions like clouds and fog significantly affect the amount of solar energy that is received by the array and therefore its performance. Most of the PV modules are between 10 and 20 percent efficient. Energy is a group of photovoltaic cells that produce electrical energy from sun light energy and convert the received light energy from sun into electrical energy. Solar panel extracts high-energy emitted from the sun. They are widely applications of solar panel in industrial area, domestic and street lights.

Fig 04: Solar Panel.

4.6 RESISTORS:

A resistor is a generator that interrupts the flow of electricity in an electronics circuit. If we want to know about resistor, we must first know about another thing about resistor. Resistance is a special property of conductors. The nature of the conductor for which the flow of electricity through it is interrupted or obstructed is called resistance.

Fig 05: 10K Resistors.

4.7 JUMPER WIRES:

Jumper wire connecting the servo motor to the solar panel. Sensors and other connections are to be made through the jumper wire. Connected with aurdino uno and other connections fixed with jumper wires.

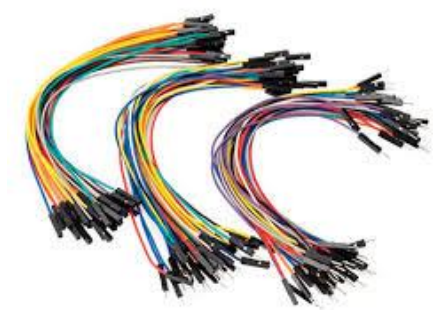


Fig 06: Jumper Wires.

4.8 Battery:

The most popular kind of battery, primary batteries, have been in use for more than a century. These are common-sized, non-rechargeable, and reliable in almost any setting. It produces a constant 1.5 volts to power a gadget and is accessible in typical sizes from AAA to D Cell. A 9V battery, which is composed of many tiny individual 1.5-volt cells, is also referred to as a main battery. For portable gadgets that don't need a lot of power and aren't used in isolated areas, primary batteries work well.

Fig 07: Battery.

CHAPTER 05

METHODOLOGY

5.1 Strategy and methodology:

A single-board microcontroller is the heart of the Arduino UNO. It is reasonable and has an open-source physical registration stage as well as an enhanced circumstance for composing programs for the board. Light Dependent Resistors (LDRs), servo-engines, and sun oriented boards are the other key segments. Light Dependent Resistor completes the solar powered global positioning architecture (LDR). Four LDR are connected to Arduino basic pins A2 to A5, which serve as the framework's contribution. Using the implicit Analog-To Digital Converter, the basic estimation of LDR is converted into computerized (Pulse Width Modulation). The servos are moved using PWM beat estimations. The information capturing the lightest power by one of the LDRs will be picked, and the servo engine will move the sun oriented board to the position of the LDR that was put up in the programming. Engine turns to serve two functions: 180 degrees and 90 degrees. LDR locations are divided into four categories: upper left, upper right, base left, and base right. The four places allow the greatest concentrated force of daylight to be recognized. The Light Dependent Resistor (LDR) provides a basic contribution to the microcontroller, which is subsequently converted into a computerized signal by an Analog-to-Digital converter. The yield delivered to the servo engine determines the growth of the sun-oriented board.

5.2 Mechanical structures:

After the solar panels and other components were selected, the overall structural design of the solar tracker as seen in Fig 08 and 12 . The compactness of the proposed solar tracker enables it to be mounted almost everywhere. It consists of the PV panel, the servo motors and Arduino Uno and the vertical pillars with base plates support. The pillars holding panel are aligned to the sides of the panel for better flexibility during the panel rotation and the servo motors are mounted in a such way the tracker system can rotates on a dual-axis freedom of 27 rotations. The sensors are fixed at the sides of the panel to obtain the sun irradiance.

5.3 Electrical system:

The overall mechanical and electrical subsystems were integrated into the solar tracker system as shown in Fig 10. The block diagram of the solar tracker system consists of mostly electrical components. The solar tracker consists of the PV cells, and other subsystems such as the LDR sensors, servo motors and the microcontroller. The LDR sensors sense the sunlight intensity and send the signal to the microcontroller to rotate the PV panel via the servo motor. The servo motor was controlled using the microcontroller. The controller uses the PWM (Pulse Width Modulation) signal to drive the servo motor at a controlled speed correspond to a maximum voltage of 6 V. The PWM wave is a continuous square wave signal that changes between 0 V and 6 V. The duration or width of the pulse determines the angle of the shaft's rotation. The microcontroller target board was used to control the servo motor. It receives the signals from the LDR sensors. The analogue voltage is converted into digital signal for processing.

CHAPTER 06

DESIGN AND IMPLEMENTATION

6.1 Working procedure:

The current project is based on tracking solar panels. These panels change their orientation in relation to solar radiation. This orientation helps in getting full benefit of optimal angle between solar panels and solar radiations. This increases the efficiency and results in maximum production of energy. A custom Arduino shield, sensor holder and code have been used in this project. Initially, declaration of both servos is done and creation of object. This serves to control the servo motors. To secure the reference servo positions, the variables pose and posy have been used. The working of the motors has been established by selecting a tolerance or a constant value. On the servo object, the servos are attached on digital pins. Pin Mode in used to select analog pins as input. The setting of servos is made to mid-point or original position. This is set with a 1000 m/s or 1sec delay. This is helpful in catching up with the user. To read the analog values, three variables are selected. These variables are mapped into integer's value from 0 to 1023. It will stay on its original location if the difference between the two variables is less then tolerance value. Otherwise a movement is shown towards the direction of maximum intensity of light. This is done by increasing or decreasing the values of pose and posy. The loop is repeated. This takes place till a value is achieved which is greater than the minimum tolerance. Position is set to150° if the value becomes greater than 150° and it is kept at 30° if the value is less than 30°. These angles are chosen as lower and upper limit angles.

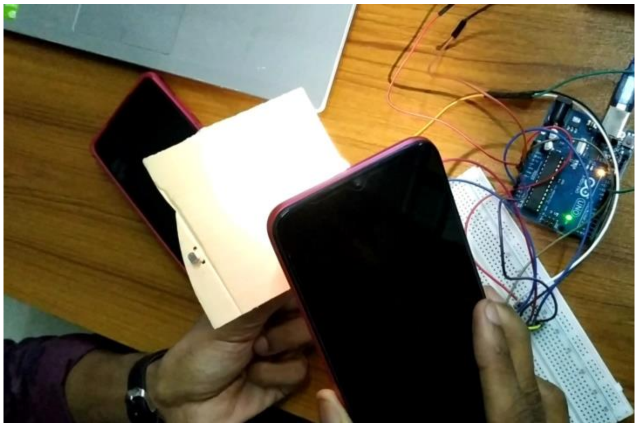


Fig 08: Implementation and testing.

6.2 Block diagram.

The block diagram of the system is working process of sun tracking soler panel system:

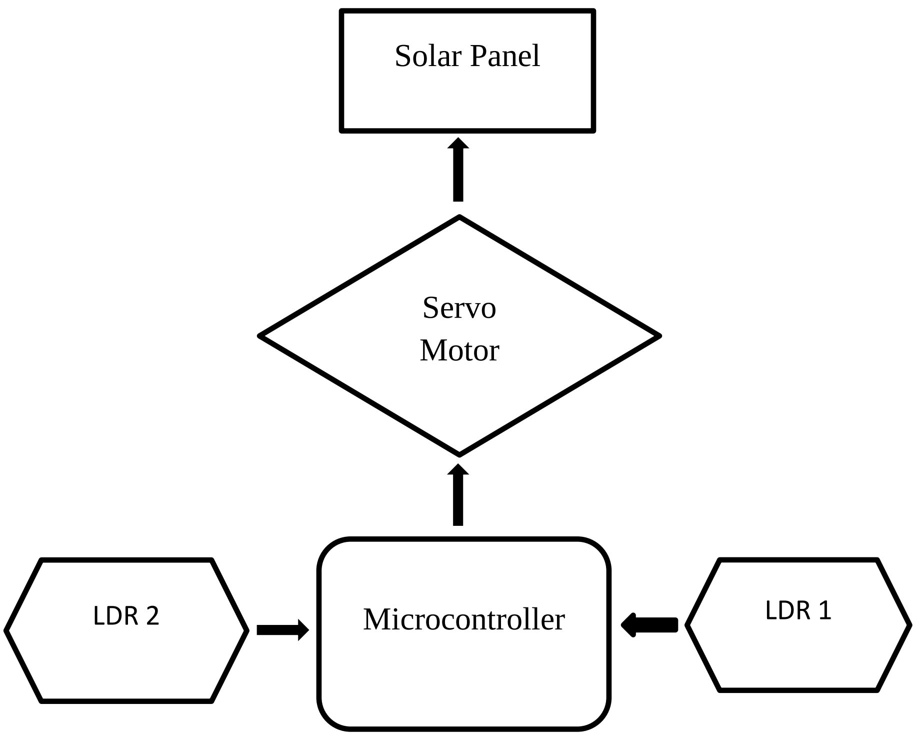


Fig 09: Block Diagram of sun tracking soler panel.

6.3 Circuit Diagram

The circuit diagram of the system is working process of sun tracking soler panel system:

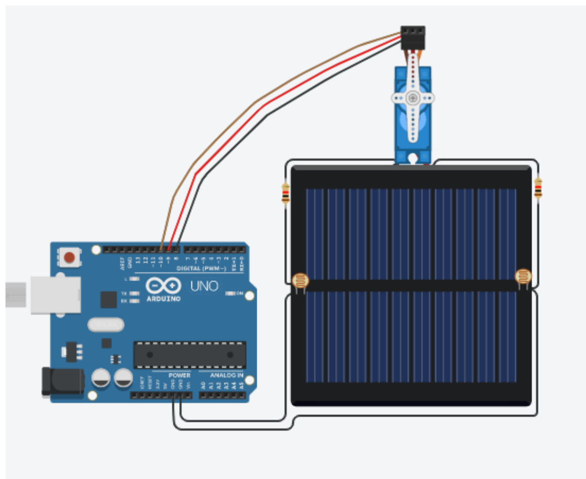


Fig 10: Circuit Diagram of sun tracking soler panel system.

6.4 Simulation and Compiling:

To simulate and compile the whole system, Arduino IDE software is established. shows the test result of compiled code is succeeded.

Coding Arduino:

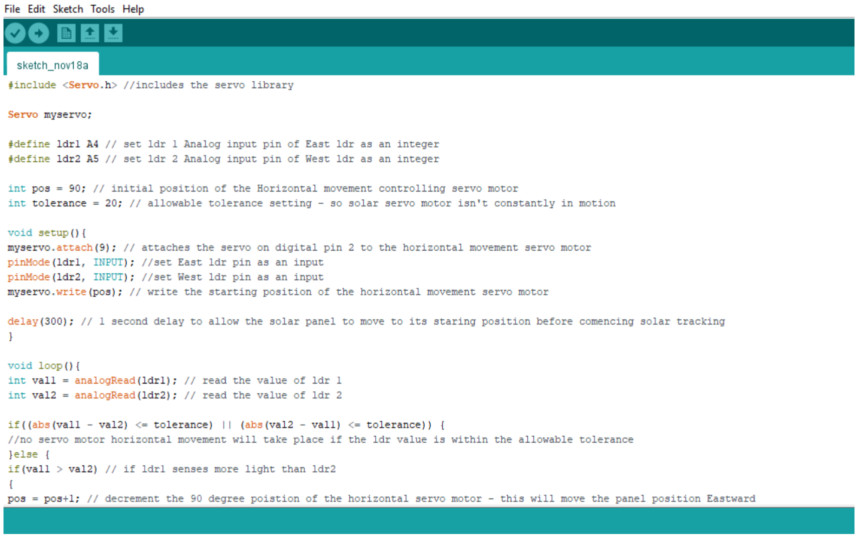
For our solar tracker system to be functional very important step is to code the Arduino. Only after the coding of the arduino which is attached to the system, solar panel will act as solar tracker. For this purpose we will be installing arduino on the mobile phone which will be attached via USB. While programming we will make sure to set our board type to Uno. We will be able to modify and manage the speed and range of the servos and the sensitivity of the sensors with the coding.

```
#include <Servo.h> //includes the servo library
```

```
Servo myservo;

#define ldr1 A4 // set ldr 1 Analog input pin of East ldr as an integer
#define ldr2 A5 // set ldr 2 Analog input pin of West ldr as an integer

int pos = 90; // initial position of the Horizontal movement controlling servo motor
int tolerance = 20; // allowable tolerance setting - so solar servo motor isn't constantly in motion

void setup(){
myservo.attach(9); // attaches the servo on digital pin 2 to the horizontal movement servo motor
pinMode(ldr1, INPUT); //set East ldr pin as an input
pinMode(ldr2, INPUT); //set West ldr pin as an input
myservo.write(pos); // write the starting position of the horizontal movement servo motor

delay(300); // 1 second delay to allow the solar panel to move to its staring position before comencing solar tracking
}

void loop(){
int val1 = analogRead(ldr1); // read the value of ldr 1
int val2 = analogRead(ldr2); // read the value of ldr 2

if((abs(val1 - val2) <= tolerance) || (abs(val2 - val1) <= tolerance)) {
//no servo motor horizontal movement will take place if the ldr value is within the allowable tolerance
```

```
}else {
if(val1 > val2) // if ldr1 senses more light than ldr2
{
pos = pos+1; // decrement the 90 degree poistion of the horizontal servo motor - this will move the panel position Eastward
}
if(val1 < val2) // if ldr2 senses more light than ldr1
{
pos = pos-1; // increment the 90 degree position of the horizontal motor - this will move the panel position Westward
 }
}

if(pos > 180) {pos = 180;} // reset the horizontal postion of the motor to 180 if it tries to move past this point
if(pos < 0) {pos = 0;} // reset the horizontal position of the motor to 0 if it tries to move past this point
myservo.write(pos); // write the starting position to the horizontal motor
delay(100);

}
```

Programming run with Aurdino UNO IDE software:




```
#include <Servo.h> //includes the servo library

Servo myservo;

#define ldr1 A4 // set ldr 1 Analog input pin of East ldr as an integer
#define ldr2 A5 // set ldr 2 Analog input pin of West ldr as an integer

int pos = 90; // initial position of the Horizontal movement controlling servo motor
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void setup(){
myservo.attach(9); // attaches the servo on digital pin 2 to the horizontal movement servo motor
pinMode(ldr1, INPUT); //set East ldr pin as an input
pinMode(ldr2, INPUT); //set West ldr pin as an input
myservo.write(pos); // write the starting position of the horizontal movement servo motor

delay(300); // 1 second delay to allow the solar panel to move to its staring position before comencing solar tracking
}

void loop(){
int val1 = analogRead(ldr1); // read the value of ldr 1
int val2 = analogRead(ldr2); // read the value of ldr 2

if((abs(val1 - val2) <= tolerance) || (abs(val2 - val1) <= tolerance)) {
//no servo motor horizontal movement will take place if the ldr value is within the allowable tolerance
}else {
if(val1 > val2) // if ldr1 senses more light than ldr2
{
pos = pos+1; // decrement the 90 degree poistion of the horizontal servo motor - this will move the panel position Eastward
```

Fig 11: Arduino Uno Run with C programming.

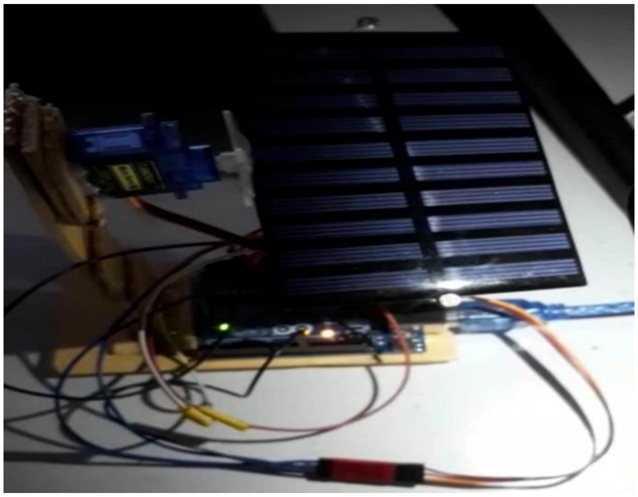
6.5 Performance of Sun Tracking Solar Panel:

2.134watts is the average power obtained from solar panel without tracking and 3.18watts power is obtained from solar panel with tracking. 41.64% is the improved efficiency neglecting the power consumption of motor. So the proposed dual axis tracking system presents efficient system to connect solar energy which ensures that consumption of energy is more than the fixed solar panel. In our project the hardware of solar tracking solar panel design and the implementation of the design has been proposed. Our result shows that the solar tracking system increases the efficiency of the solar panel. Solar tracking solar panel is completely automatic and it ensures the minimum low cost. So, it is a dual axis system which maximizes the efficiency and can be obtained over a period of time. Normally a solar panel converts only 30 to 40 per cent of the incident solar radiation in to electrical energy. An automated system is required to get a constant output, which should be capable to constantly rotate the solar panel. The sun tracking system was made as a prototype to solve the problem. It will be automatic and keeps the panel in forwardfacing of sun until that is visible.

Some steps have been taken in order to control the servo motor. They are given below:

- The four LDRs' voltages are introduced into the circuit
- The inputs are analog. They are translated to converting digital ranging from 0 to 1023.
- The four digital values are top, bottom, right and left.
- The average of top (both left and right) and bottom values are calculated.
- The Servo motor moves with the greatest intensity in the direction of the LDR.

- The software part comprises a programming language that is developed utilizing C++ programming. The codes are focused on Arduino UNO to be gathered and transferred. The equipment and programming are actualized and incorporated to structure and build up the total double hub Solar Panel.illustrates the hardware layout and interconnections.



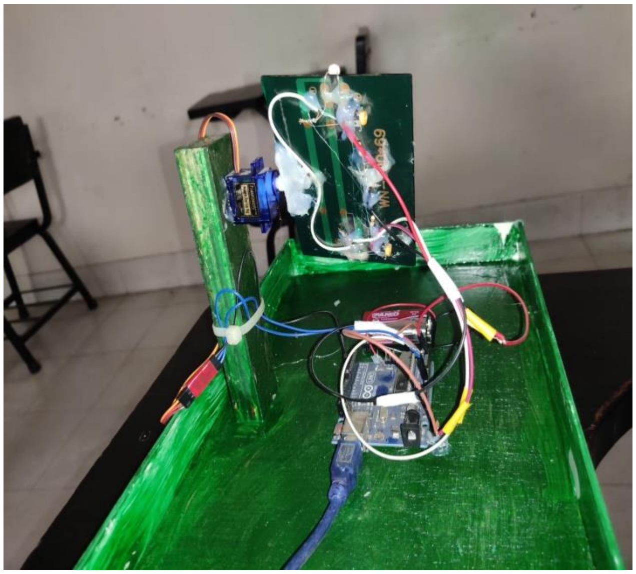


Fig 12: Final Test Running mode.

CHAPTER 07

CHALLENGES AND DECISION MAKING

Throughout the project we faced a lot of challenges and problems which needed to be resolved and rectified in order to deliver a successful project. We had to take lot of decisions while working on our project. How to manage time was of the biggest problem which was faced throughout the project. However, we were able to resolve all of these problems efficiently with teamwork. The problems which we faced are as follows.

7.1 Equipment and Device Problems:

- Servo Motor:

  A custom arduino shield, sensor holder and code have been used in this project. Initially, declaration of both servos is done and creation of object. This serves to control the servo motors. To secure the reference servo positions, the variables pose and posy have been used. The working of the motors has been established by selecting a tolerance or a constant value. On the servo object, the servos are attached on digital pins.

- Coding Arduino:

  The test that we run on our project was done in day light. When the sun rays were on their peak to run and charge its battery. The aim was to ensure the sunlight rays are falling perpendicularly on the solar panel to give the maximum solar energy. An automated system was set to get a constant output, which should be capable to constantly rotate the solar panel. The sun tracking system was made as a prototype to solve the problem.

7.2 Design Problems:

The problem which we faced after completing the solar tracking system was that it was not moving with the rays of sun. Our project was based on tracking system so to ensure the sunlight rays are falling perpendicularly on the solar panel to give the maximum solar energy, we have done several experiments. After three attempts we were able to design an automated system, an automated was set to get a constant output, which should be capable to constantly rotate the solar panel. Another problem that was faced was coding the arduino. For our solar tracker system to be functional very important step is to code the Arduino. Only after the coding of the arduino which is attached to the system, solar panel will act as solar tracker. For this purpose we will be installing arduino on the mobile phone which will be attached via USB. While programming we will make sure to set our board type to Uno.

7.3 Life-Long Learning:

Through our working with the project it is significant to have many effective learning, which reflects lots of benefits and advantages in our life learning. This project was started as a team and to set out achievable goals was our first priority. Before starting a project proper research was conducted regarding the implementation of the plan. We ensured that each member of team had ostensible information on the subject. Proper equipment was utilized for the research. We learned a lot form our blunders throughout the project and tried to work on trial and error basis.

7.4 Software Skills:

In order to achieve our objective in a professional manner it is very important to use technological advances and skills. At the point when we started our project we alluded to online websites to familiarize ourselves that which designs are in market and how can we improve. Then we designed our project by finding all constraints and started doing simulations. In addition, it is significant to get viable use for working up project's design utilizing the various kinds of software skills and to program technical connections depending on the mechanical and technical powers. With the help of these soft wares we were able to solve all the problems smoothly and quickly.

7.5 Hardware Skills:

We used very simple and straightforward hardware skills for our project. All parts which are best suitable for our engineering standards were purchased for manufacturing purpose. However, multi meter is used for calculation and evaluation of system performance that gave us the values of current and voltage. To support the hardware system in operating system the team was professionally provided with database.

7.6 Time Management:

One of the main challenges in the beginning for the team was to manage the time during working on project. We had less than four months to complete our project; we managed our time in such a manner that we were able to finish our project and to do testing beforehand. It was necessary to organize our work through team meetings and setting suitable and professional schedule for operating the different parts in the project. Gantt chart plays an important role in helping us managing our time in respect to the different tasks. Team ideas were shared for making the best in suitable assigned time.

7.7 Project Management:

To fulfill any task in a proper manner and on time project management is one of the most important factors. The first thing we did before working on our project was to make Gantt chart. Gantt chart is a kind of project management plan. In that we had specified all the tasks, their due dates and who was responsible for doing those tasks. The task was divided equally among each member and each group member was responsible for his task. It is necessary for each member in the team to focus on the task and give enough time for previewing and reviewing the missions according to the work plan which shows the responsibilities and procedures in all stages.

CHAPTER 08

IMPACT OF ENGINEERING SOLUTIONS

8.1 Society:

The use of solar tracking system is increasing with advancement of technology. The efficiency of solar panels is more important than ever because of the increasing demand for solar energy. The aim of this project is to ensure the sunlight rays are falling perpendicularly on the solar panel to give the maximum solar energy. An automated system is required to get a constant output, which should be capable to constantly rotate the solar panel; it will help society to make use of more reliable energy.

8.2 Economy:

We used simpler and less expensive parts because the cost of manufacturing was a big concern for us during the project. We have used Arduino sensor shield, nut and screws which are economically affordable material. This has too fold benefits, less manufacturing and maintenance cost. A simple system has fewer chances of breaking down and therefore leading to less maintenance cost. There is no use of implementing the project if it cannot pay more than its manufacturing cost.

8.3 Environment:

The main implication of this solar tracking system functionality is to ensure environmental preservation. Globally, the production of existing solar panel can be increased by the execution of simple machinery. The idea of investing in solar tracking system is sure to become a promising idea with successful results. This system can assist in struggle against climate change if implemented successfully. Moreover, this economy friendly system can reduce the demand of fossil fuel around the globe.

8.4 Contemporary Issues Addressed:

The issue of global warming has led to the use of scientific technologies that do not promote global warming. Solar tracking systems come under the category of good energy resource. The efficiency of solar tracking system depends on the angle of the axis. This system ensures the maximum accumulation of sunlight by tracking it and motioning along the movement of sun. The solar panel tracks the sun from east to west mechanically for maximum intensity of light. Furthermore, it deals with the issue of modification to make a concentrated solar-hybrid form which can save almost all the cost of running it. It addresses the issue of cost expenses and design of the solar energy panel was also major concern. It must also be taken in consideration that how assembling of every nut, bolt and screw must be done.

CHAPTER 09

RESULT AND DISCUSSIONS

9.1 Discuss about solar tracking system:

This system is accomplished by the use of light sensors that detect the quantity of sunshine that hits the solar panel. The values produced by the LDRs are compared, and if there is a substantial discrepancy, the panel is actuated using a servo motor to virtually perpendicular to the sun's beams. This was accomplished through the use of a system comprised of distinct phases or subsystems. Each stage plays a distinct role. The stages were:

1. A control stage that was responsible for controlling actuation and decision making.

2. A driver stage with the servo motor. It was responsible for the panel's actual movement. Because their resistance fluctuates with light, LDRs were proven to be the best choice for this project. They are widely accessible and reasonably priced. Temperature sensors for instance would be expensive. A microprocessor in the control stage receives voltages from the LDRs and decides the action to be taken. The microcontroller is configured to send a signal to the servo motor, which moves in response to the created error. The final step was the drive circuitry, which mostly comprised of the servo motor. The servo motor produced enough torque to power the panel. Servo motors are quiet and inexpensive, making them the perfect choice for this work. Shading has a negative impact on the performance of solar panels. Because the cells are frequently linked in series, the shade of a single cell has an influence on the entire panel. , it can be seen that the voltage from cloudy day is less as twice as the sunny day. But voltage difference of cloudy day is greater than the sunny day. So the motion of solar panel is infrequently changed in sunny day. As a result of the shading, the tracking system will be unable to boost efficiency as necessary. Because there is no sun radiation at night, we do not want it to function at night or during the rainy season.

9.2 Calculation:

On a Clear sky day: On a clear sky day, it was observed the solar irradiation increase steadily until it reaches its maximum intensity about 950W/m2 by midday and gradually decreases after 3.00p.m and reached about 215W/m2 at 6.00p.m. Meanwhile, the power output from single-axis tracking and fixed PV solar panel are also plotted. The single-axis tracking panel produce a steady power output approximately 30-35W throughout day from 9.00am until 6.00pm.

On a Partly cloudy day: The most additional power gain from single-axis tracking panel on this day was after 3.00p.m to 28W 6.00p.m. The total energy output for partly cloudy day from single-axis tracking was 242W. The tracking panel has produced about 28.0% higher energy output compared to fixed panel on the day.

Efficiency of PV solar panel: On a clear sky day, average panel efficiency for the single-axis tracking panel was about 67.65% for the entire day. Meanwhile, fixed panel was only about 51.65% for the same day. The percentage increase on average power output by the tracking panel over the fixed panel was 30.12%. However, tracking panel produce higher power output than fixed panel is before 11.00a.m and after 3.00p.m. During this time, the average efficiency of tracking panel was about 66.70% and fixed panel was 39.96%.

PV solar efficiency:

Day Condition	Panel	Average of Entire day		Average before 11.00am and after 3.00pm	
		Average Power Output (W)	Average Panel Efficiency (%)	Average Power Output(W)	Average Panel Efficiency (%)
Clear Sky	Tracking	33.82	67.65	33.35	66.70
	Fixed	25.83	51.65	19.98	39.96
Partly Cloudy	Tracking	30.61	61.22	28.40	56.80
	Fixed	23.30	46.61	16.34	32.67

Table 05: PV solar efficiency

Module Efficiency:

Day Condition	Panel	Time									
		9am	10am	11am	12am	1pm	2pm	3pm	4pm	5pm	6pm
Clear Sky	Tracking	20.0%	13.0%	9.8%	8.7%	8.9%	8.8%	10.1%	12.7%	18.4%	28.9%
	Fixed	3.4%	10.3%	8.9%	8.5%	8.6%	8.7%	9.8%	10.8%	5.8%	1.0%
Partly Cloudy	Tracking	24.3%	1.8%	5.7%	8.3%	8.6%	9.0%	4.4%	12.6%	18.2%	33.7%
	Fixed	9.4%	1.3%	5.3%	8.1%	8.2%	8.8%	3.8%	11.5%	6.3%	0.7%

Table 06: Module Efficiency

9.3 Result and Discussion:

A solar tracker was proposed, designed and constructed. The final design was successful, in that it achieved an overall power collection efficiency increased to a fixed panel for the same panel on the tracking device. the solar energy capture is maximized by a 2-axis tracking system because the solar energy is greatest on cloud-free days when there is ample direct sunshine, and response of a solar module to a ray of light is proportional to the cosine of the angle between a line perpendicular to the module surface and a direct solar ray impinging on the surface. In terms of real value, this means that the overall cost of a system can be reduced significantly, considering that much more power can be supplied by the solar array coupled to a solar tracking device. By extracting more power from the same solar panel, the cost per watt is decreased, thereby rendering solar power much more cost-effective than previously achieved using fixed solar panels. A single axis tracker offers a great power increase over a fixed solar panel, but a two-axis tracker would provide more power still. This could be a subject for further development. Solar tracking is by far the easiest method to increase overall efficiency of a solar power system for use by domestic or commercial users.

CHAPTER 10

CONCLUSION AND REFERENCES

10.1 Conclusion:

An Arduino based single axis solar tracking system was designed and constructed in the current work. LDR light sensors were used to sense the light intensity of the sun with the help of the photovoltaic cells. The stepper motor had enough torque to drive the panel. Stepper motors are noise free and are affordable, making them the best choice for the project. The goal of this paper is to create a simulated framework of a dual-axis solar panel that detects sunlight on the board and travels toward it to maximize solar output. The primary goals of this inquiry are as follows: When compared to previous solar panel frameworks utilized for the same application, the suggested simulated framework is simple and minimal. Because it is Arduino-based and requires no external components, programming this solar panel is exceedingly straightforward and quick to alter on the ground. The simulated architecture is simple to use and provides increased effectiveness. The system has the potential to be used on a much greater scale. The compact, cost effective and reliability of this solar tracker is intended to suitable for the rural usage. The purpose of renewable energy from this work offered advance in idea to help the people. This system can be designed to provide electricity to the entire home by changing solar panel, using more efficient sensors and designing the charge controller. Instead of single axis tracker, dual axis tracker are also performed and compared to the single axis. Solar car and solar motorbike can be developed for pollution problems without using resource from the world. In the future, one may explore using more efficient sensors that are both cost effective and require less electricity. This would increase efficiency while decreasing expenses. It would be really beneficial if there was a way to further reduce the cost of this system.

10.2 FUTURE RECOMMENDATIONS:

The goals of this project were outlined keeping in mind the timeline and resources that were attainable. However this initial design can be subjected to many improvements. Initially this design represents a miniature scale model which can be modified into a much larger scale. Easy to bend cables can be used which do not apply any force on the motor when it is rotating the solar panel. To get a better tracking precision, a photo transistor with and amplification circuit can be used. Furthermore accuracy can also be increased by utilizing dual axis design versus single axis design. Future projects can make use of microcontroller. This microcontroller can serve as standalone unit in the fabricated circuit.

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