DESIGN OF SOLAR DUAL-AXIS TRACKING WITH IMPLEMENTATION OF WEATHER DEPENDENCE

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ABSTRACT:
To achieve the most energy generation from Solar photovoltaic cell during the day time, this project implements a tracking system on the Arduino Uno Board. This article's primary idea is the setup of an automated dual-axis solar tracking system which is Solar panel alignment with the sun is experimented to obtain maximum solar radiation. Using the maximum power point (MPP) as a reference, this approach tracks the maximum intensity of light. Its alignment automatically changes to capture and determines the direction of the maximum amount of light when there is a Light Energy. This project demonstrates the use and examination of a dual-axis solar tracker. The goal of dual axis solar tracking with weather monitoring is to optimize solar panel energy output while diminish the influence of weather conditions.
KEY WORDS – Dual-Axis Solar Tracking System, Arduino UNO.

I. INTRODUCTION

The depletion of traditional energy sources has led many scholars to explore alternative renewable energy options. Among these, solar energy stands out as a particularly promising resource. Solar technologies utilize the sun's energy to produce heat, light, and electricity. Despite its abundance, effectively harnessing solar energy poses challenges due to the limited efficiency of solar cells. Previously, solar cells were fixed at specific angles and couldn't adapt to the sun's movement, resulting in lower electricity generation efficiency. For instance, in northern India, the optimal elevation angle for maximum sunlight exposure throughout the day is 40.5°. However, fixed solar panels are unable to capture the sun's energy optimally, limiting the efficiency of solar energy conversion. To address this issue and ensure more consistent energy production, photovoltaic panels need to adjust their orientation throughout the day to track the sun's movement across the sky. This is achieved through an automated solar tracking system, as depicted in Figure 1.

By incorporating weather monitoring into the dual axis solar tracking system, the panels can be adjusted to compensate for these conditions. For example, if cloud cover reduces the amount of sunlight reaching the panels, they can be tilted to a steeper angle to capture more light. If high winds are detected, the panels can be automatically stowed in a safer position to prevent damage. The solar panel's orientation adjusts in accordance with the sun's position, optimizing solar energy capture and consequently enhancing device efficiency. This dynamic adjustment reduces the required number of solar panels for a given output power, as its efficiency surpasses that of fixed solar panels by 25-40 percent.

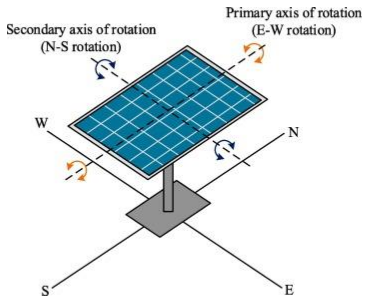


Fig. 1. Dual-axis solar tracking

II. LITERATURE SURVEY

A Dual-Axis tracker enhances energy production by constantly adjusting the solar panel to follow the sun's rays, ensuring optimal positioning in different directions throughout the day.

Implementation of Dual-Axis Solar Tracking System [1]

In this article, Sun oriented vitality, the endless, pollution-free vitality source of long-term , is creating as our vitality needs increment. The programmed sun based following framework, based on the Arduino demonstrate, is planned utilizing the Arduino microcontroller, four LDRs and three stepper engines. A combination of equipment and firmware programming is utilized to function the machine. Four light- subordinate resistors (LDRs) are utilized to detect the greatest voltage within the

equipment. Within the LDR prepare, three stepper engines are utilized to move the sun based board concurring to the incoming light. computer program controls the vertical tilt point and flat revolution of the sun oriented board. In this way, the sun powered board can rotate not as it were vertically but moreover on a level plane, taking after the heading of the sun, depending on the sun oriented issue. The gadget moreover gives great lighting and decreases vitality generation costs by requiring a least number
of sun oriented boards.

Dual-Axis Solar Tracking System with Weather Sensors [2] .
In this article, Nowadays, our lives depend on vitality. The advancement of a nation is, to a few degree, around being solid. Sun based vitality is the foremost vital, renewable, and clean vitality. It can be used effectively with the assistance of sun oriented photovoltaic (PV) boards. In any case, we regularly see that most sun powered boards are put at an point. To complement the sun powered vitality put away by sun powered boards, we utilize sun based following gadgets whose errand is to take after the sun oppositely to the sun, in this way progressing the vitality potential of the sun powered board. framework. This article covers the improvement and plan of a dual-axis sun oriented board following framework and an exploratory think about of the execution of double- pivot sun powered trackers compared to settled sun based boards. Following the sun requires a light-dependent Resistor (LDR) as a sensor to distinguish greatest light and two DC engines take the position of the sun for two-axis development (i.e. vertical and level) sun based board. The program portion is done utilizing code composed utilizing the Arduino Uno controller.
Dual-Axis Solar Tracking System with Weather Sensor and Efficient Power Generation [3] .
In this article, this article depicts a cheaper control framework and a audit of a dual-axis sun powered tracker utilizing Arduino Mega. The objective of the extend is to screen discuss perceivability and temperature. This venture is particularly partitioned into two stages:
equipment and code . In hardware development, four light-dependent diodes (LDR) were used to determine extreme light from the sun based board. A servo engine and a DC double equip engine are utilized to turn the sun based cluster for the most part in (east-west) and (north-south) bearings, the light source is identified by the LDR. Progressed innovation can capture most of the vitality utilized within the sun based framework. As for the coding system half, the code made by abuse C programming dialect and focused on to the Arduino Mega controller. In this, the voltage is calculated from board to board from time to time in an interim of 1hr and this voltage is utilized to sense the climate conditions and show the climatic temperatures.

III. PROPOSED METHODOLOGY

3.1 BLOCK DIAGRAM WITH DESCRIPTION
The whole set up is isolated into 4 parts:
3.1.1 Rotational Unit:
the light identifying unit, observing unit and the development controlling unit i.e., A sun oriented board, an Arduino chip, and sensors make up the sun based following framework. Light must be radiated by the sun for this framework to operate. The LDRs act as sensors, identifying the sum of light entering the sun powered boards. The LDR at that point transmits information to the Arduino microcontroller. The servo motor circuit is at that point built. The servo has three pins, the positive side of which is associated to the +5v of the Arduino microcontroller. The servo's negative is associated to ground. The servo's information point is connected to the microcontroller's simple point. Fig. 2 shows the block diagram of Arduino based Dual-axis Solar tracker.
3.1.2 Light Identifying Unit:
It comprises of four light identifying resistors each shaping a match of two. It measures the light escalated and changes over it into analog voltage and gives the input to the controller. One match of LDR follow the area of sun in east- west course and the other match faculties within the north-south course. Resistance is inversely proportional to concentrated of light and subsequently it diminishes with increment in light concentrated. The relationship between light escalated and resistance is given within the condition underneath. RL = 500/LUX.

3.1.3 Checking Unit:
Arduino is the most observing unit of the whole device as appeared in Fig.1. LDR is associated to the primary four pins of Arduino i.e. A0- A4. Arduino takes the input from the LDR and based on that it gives informational to servomotors to pivot either in flat or vertical bearings.

3.1.4 Development Controlling Unit:
The development controlling unit comprises of two DC engines. The Arduino gives an yield of 5V which is utilized to drive the DC engine which can be driven by an input of around 4.5 volts. One of the engines controls the even revolution whereas the other controls the vertical rotation.

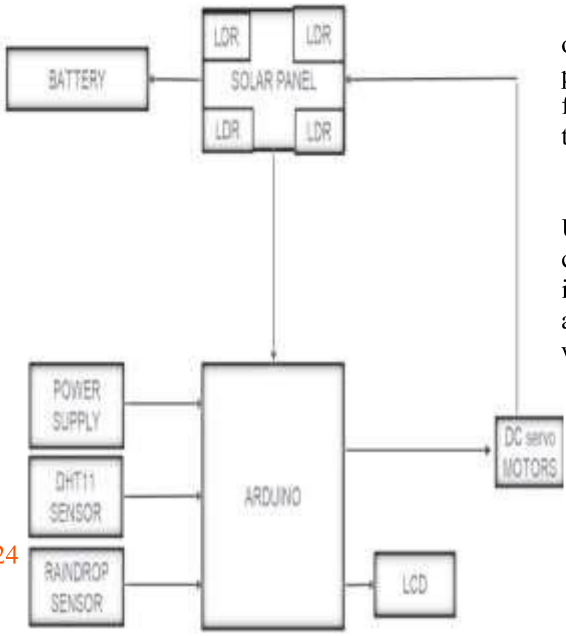


Fig 2. Block Diagram of Arduino based Dual-axis Solar Tracker

3.2 CIRCUIT DIAGRAM

The circuit diagram for an Arduino-based solar tracker with weather monitoring system is depicted in Fig.3 which incorporates several key components to optimize solar panel efficiency and adapt to changing environmental conditions. Light sensors, such as LDRs, are connected to analog input pins of the Arduino to detect sunlight intensity. These readings inform the Arduino's control of servo motors, which adjust the position of the solar panels for maximum exposure to sunlight. Additionally, sensors for temperature, humidity, and possibly rain detection are integrated into the circuit, providing data to the Arduino for weather monitoring. Power management is crucial, utilizing a solar panel to generate power, a charge controller to regulate battery charging, and batteries to power the Arduino and other components. The Arduino processes sensor data, executes predefined algorithms, and controls the system's operation. Safety precautions, proper voltage regulation, and insulation are essential considerations, as is thorough testing, calibration, and documentation for reliable performance and maintenance.The Fig 3 represents the circuit diagram of Dual-axis solar tracking System

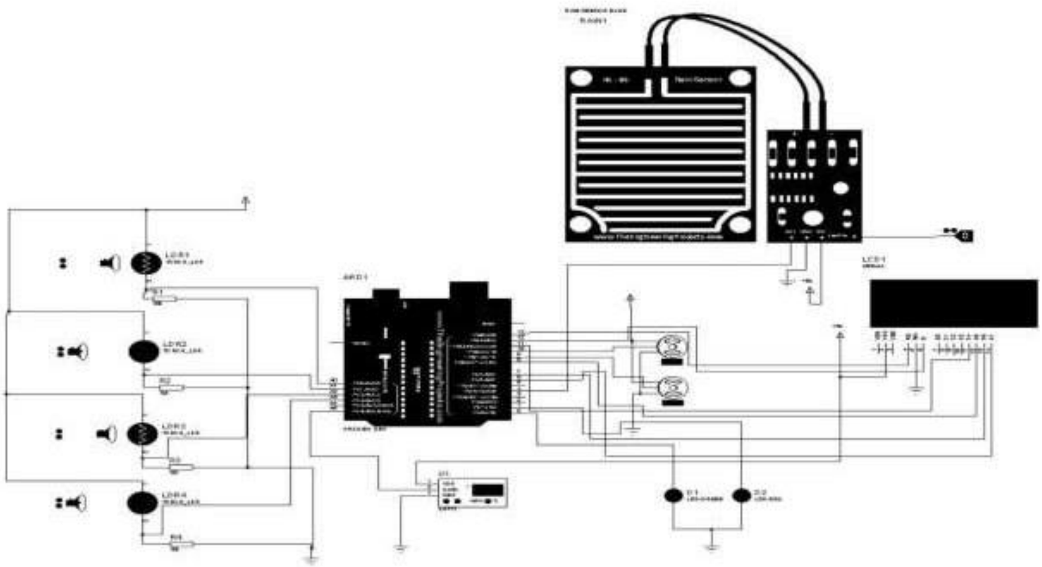


Fig 3. Circuit diagram of Dual Axis Solar Tracker

3.3 METHODOLOGY

3.3.1 Working Principle

Accordingly, to track the sun's movement throughout the day. Additionally, sensors for temperature, humidity, and possibly rain detection provide data on weather conditions, allowing the system to make adjustments to protect the panels or optimize their positioning. Power management is crucial, utilizing a solar panel to generate power, a charge controller to regulate battery charging, and batteries to ensure continuous operation, even during low sunlight periods. Overall, the system's operation relies on real-time monitoring, decision-making algorithms, and precise adjustments to optimize solar panel performance while considering environmental factors for efficient energy harvesting.

3.3.2. Digital Voltmeter

In an Arduino-based solar tracker with weather monitoring system, a digital voltmeter plays a crucial role in measuring the voltage output from the solar panels or the batteries. By interfacing the digital voltmeter with the Arduino, the system can continuously monitor the voltage level to assess the health and performance of the solar panel array and the battery bank. This information is vital for ensuring optimal power generation and management. The digital voltmeter allows the system to detect any fluctuations or abnormalities in voltage, which could indicate issues such as shading on the solar panels, battery degradation, or insufficient charging.

3.3.3. Flow Chart of the Proposed Algorithm

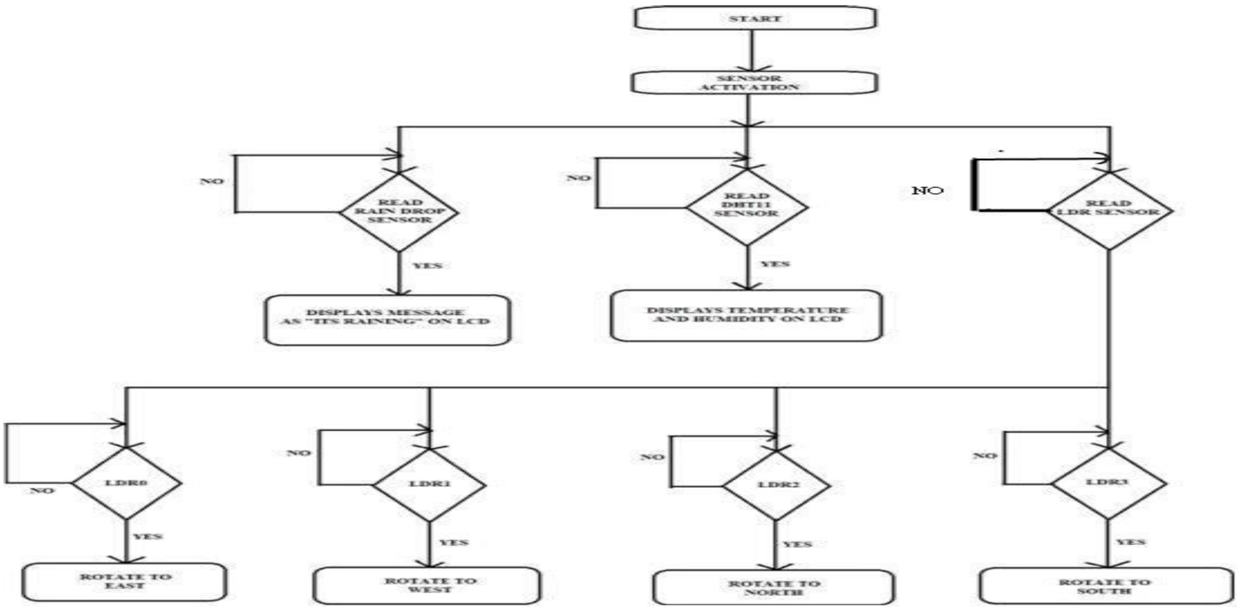


Fig.4. Flow chart of the proposed algorithm

The flow chart diagram of the tracking system is illustrated in Fig.4. The solar tracking system consists of a solar panel, an Arduino microprocessor, and sensors. This system relies on sunlight to operate effectively. The sensors, known as LDRs, are responsible for detecting the amount of light that enters the solar panels. The data collected by the LDRs is then transmitted to the Arduino microcontroller. Next, a circuit is constructed for the servo motor. The servo motor has three pins, with the positive pin connected to the +5v of the Arduino microcontroller and the negative pin connected to ground. The data pin of the servo is linked to the analog pin of the microcontroller. To control the speed of the servo motor, a potentiometer is attached.

3.3.4. Program Execution:

Two computer program are utilized in this venture:
• Proteus
• Arduino IDE
The sun oriented board tracking system recreation was performed employing a Proteus program. Recreation handle revels the precise circuit graph and association of the framework.

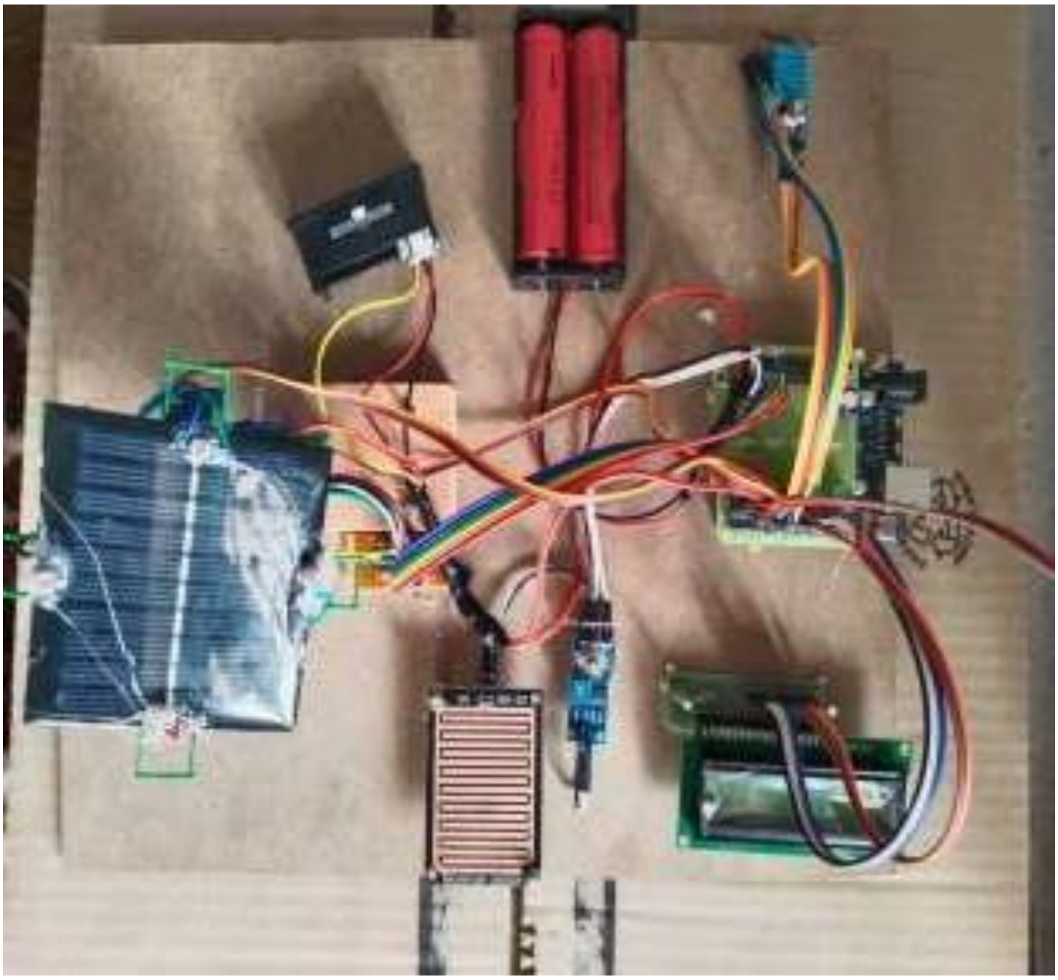
3.3.5. Equipment Usage:
• Arduino UNO
• Sun based board
• Servo Engine
• DHT11 Sensor
• LCD Show
• LDR Sensors
• Rain Drop Sensor

COMPONENTS Depiction:
The Components utilized in this extend are portrayed:
1. Arduino UNO R3 [A000066]:
• Memory size-8kb
• Arrangement Rev
• Hardware interface-USB
2. Servo Engine (SG90):
• Working speed:

0.12second/ 60degree (4.8V no stack)
• Slow down Torque (4.8V):
17.5oz /in (1kg/cm)
• Working voltage:
3.0V~7.2V
• Temperature run:
-30 to +60
• Dead band width:
7usec
3. LDR (Light Subordinate Resistor):
• 5 MΩ
4. Resistors:
• 330 Ω (Amount 4)
5. Sun based plates (Polycrystalline DIY Sun based Boards):
• The sun oriented input comprises of a sun oriented board and two photo
6. Battery 9 volts
7. Sun oriented Charge Controller
8. Rain Drop Sensor
9. DHT11 Sensors

IV. EXPERIMENTAL SETUP

The experimental setup of the project is shown in Fig. 5 by incorporating Arduino UNO, solar panels and the addition of



different sensors.

Fig. 5. The Hardware assembly of Dual-axis solar tracking with DHT sensor and Rain sensor

V. RESULTS AND DISCUSSION

After implementation of dual axis solar tracking system with weather dependence in both software and hardware, obtained the outputs as shown in following figs. 6-14.

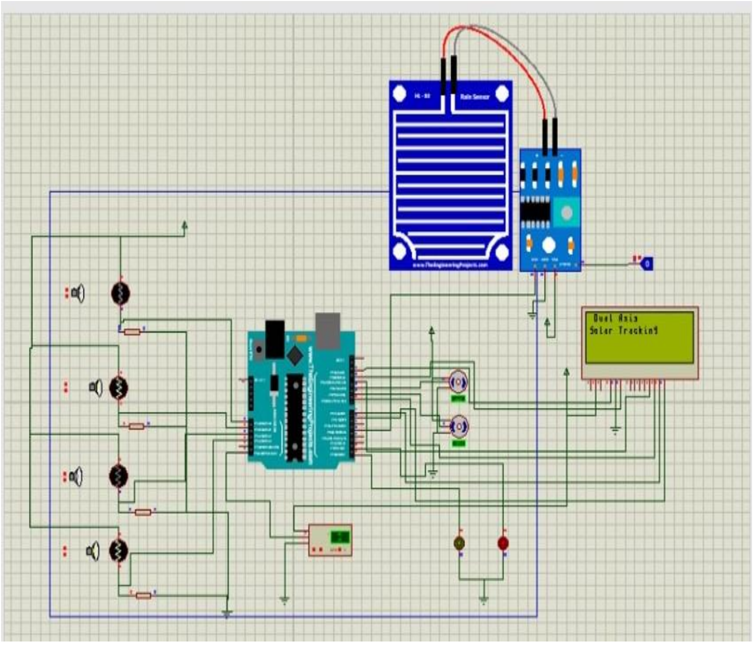


Fig.6. The Software simulation of dual axis solar tracking system in Proteus Professional

The outputs of the LDR sensors, Temperature, Humidity and Rain fall Intensity are displayed on the LCD. Whenever either temperature and humidity readings cross the threshold values it shows abnormal condition for the Solar tracking.
The threshold values set in the project / program are

$$Temperature: 37℃$$
$$Humidity : 35\%$$

Fig.7. The readings of Temperature and Humidity displayed on LCD

Fig.8. When there is no rain

Fig.9. When there is the rain

Fig.10. When LDR1 have higher intensity compared to other LDR's

Fig.11. When LDR2 have higher intensity compared to other LDR's

Fig.12. When LDR3 have higher intensity compared to other LDR's

Fig.13. When LDR4 have higher intensity captured compared to other LDR’s

Fig.14. Device to shows the Output Voltage and current produced by Solar panel

The following table will represent Output voltages (in V) of the Solar panel from morning to evening with and without tracking.

S.No.	Time (Hrs.)	Without tracking (V)	With tracking (V)
1.	08.00 AM	1.24	1.73
2.	10.00 AM	1.31	2.24
3.	12.00 PM	1.54	2.32
4.	02.00 PM	1.61	2.57
5.	04.00 PM	1.36	2.34
6.	06.00 PM	1.14	1.09

Table.1: Comparison of Panel voltage
with and without Tracking in a day

VI. CONCLUSION

In this study, solar energy emerges as a pivotal contender for future energy sources. A concise examination of solar tracking mechanisms reveals a promising avenue for enhancing solar energy capture while maintaining relatively low operational and maintenance costs. The project focuses on designing and implementing a four-axis solar tracker, utilizing motor satellite dish technology to accurately follow the sun's movement. Additionally, Light Dependent Resistor (LDR) sensors are employed to gauge sunlight intensity. Results indicate that the solar tracking system outperforms fixed solar panels, with energy gains exceeding 35%. Data analysis reveals that energy capture peaks in the morning and evening, showcasing the system's effectiveness throughout the day. This underscores the efficiency of dual-axis solar tracking systems, which offer versatility in placement and ensure consistently high energy yields.

VII. REFERENCES

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