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Advancements of Solar Tracking System with Weather Sensor

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ABSTRACT

This research paper presents the design and implementation of a dual-axis solar tracking system integrated with weather sensing capabilities. The system utilizes servo and stepper motors controlled by an Arduino microcontroller to track the sun's movement in both horizontal and vertical directions, maximizing energy generation from solar panels. Additionally, weather sensors, including rain, humidity, and temperature sensors, are incorporated to monitor environmental conditions. The collected data is displayed on an LCD screen, providing real-time feedback on weather conditions. This system aims to improve the efficiency and reliability of solar power generation in various environmental conditions.

KEYWORDS: Solar tracking,Weather sensor, Arduino, Renewable energy

I. INTRODUCTION

In this project, a dual axis solar tracking system has been developed, through which more energy from the sun can be harnessed. In this project, an Arduino Uno, which is an Atmel microcontroller-based board, has been used as the main controlling unit. To detect the position of the sun in the sky, two LDRs have been used, and to rotate the orientation of the solar PV panel, a servo motor has been used. The sensors and servo motor have properly been interfaced with the Arduino board. The servo motor has been mechanically coupled with the PV panel. The driving program has been written using the Arduino IDE. The whole system has been assembled, and its performance has been tested. This tracker changes the direction of the solar panel based on the direction of the sun facing the panel successfully. Single axis solar tracker tracks the sun on a daily basis and makes the solar panel more efficient.

This project has been designed with this in mind to make the harnessing of solar energy more efficient. The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, in continuous development, being clean, silent, and reliable, with very low maintenance costs and minimal ecological impact.. Stationary mounted PV (photovoltaic) panels are only perpendicular to the sun once a day, but the challenge is to get maximum energy from the source, so for that, we use trackers on which the whole system is mounted. In a tracking system, solar panels move according to the movement of the sun throughout the day.

Tracker systems follow the sun throughout the day to maximize energy output. The Solar Tracker is a proven single-axis tracking technology that has been custom designed to integrate with solar modules and reduce system costs. The Solar Tracker generates up to 25% more energy than fixed mounting systems and provides a bankable energy production profile preferred by utilities.

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II. LITERATURE REVIEW

The solar tracking technology is researched and utilized in power systems for its ability to utilise the tracking data from the sensor and make solar PV power generation more efficient. This section provides an overview of existing literature on current techniques of solar tracking and explores previous research.

Current solar tracking systems
There are two main types of solar tracking systems, depending on their degrees of freedoms are single axis solar tracking systems and dual axis solar tracking systems.

Active tracking : The position of the sun is determined by the sensors. These sensors will trigger the motor to move the mounting system so that the panels will always face the sun rays perpendicular to them throughout the day. But in this system, it is very difficult for sensors to determine the position of the sun on cloudy days. So it is not very accurate.

Passive tracking : The position of the sun is tracked by moving the panels in response to an imbalance of pressure between the two points at both ends of the trackers. The imbalance pressure caused by solar heat creates a gas pressure on a low boiling point compressed gas fluid that is driven to one side or the other accordingly, which then moves the system. This method is also not accurate, as the shade /reflectors that are used to reflect early morning sunlight to "wake up" the panel and tilt it towards the sun can take nearly an hour to do so.

Single-axis solar tracker : Single-axis solar trackers were originally intended to function like Venetian blinds, with solar panel rows moving in time together throughout the day. With consideration being given to tracking software for uneven light, strong wind conditions, and row and horizon shading, panel rows are now designed to compensate for diffused light, adverse weather, and row and horizon shading.

Dual-axis solar tracker : Dual-axis solar trackers, sometimes known as two-axis solar trackers, are mounted on top of a single pole with a tracking technology that provides an increased range of motion and precise sun-tracking of the installed panels.

Gaps in Literature
Though there is extensive literature on solar tracking and implementing those techniques to improve solar power generation, there are also certain gaps that need to be addressed yet. Foregoing studies have mostly focused on theoretical aspects and proofof-concept implementations, with limited emphasis on practical aspects and real-world applications of solar tracking and weather response.

III. METHODOLOGY

Hardware and Software Selection

The selection of hardware components depends on the type of project such as this project is a protype which can lead to industrial uses also. Arduino is the main key component of the system. Aproximately, every electronic equipment is working on below 5V voltage and the supply is provided from Arduino and Arduino is taking supply from a 12V DC voltage adapter. Here we are using components that are listed in Table 1.

Hardware	9gm servo motor
	4 volt solor panel
	4 LDR sensor
	Arduino uno
	Wooden base
	16x2 LCD Display

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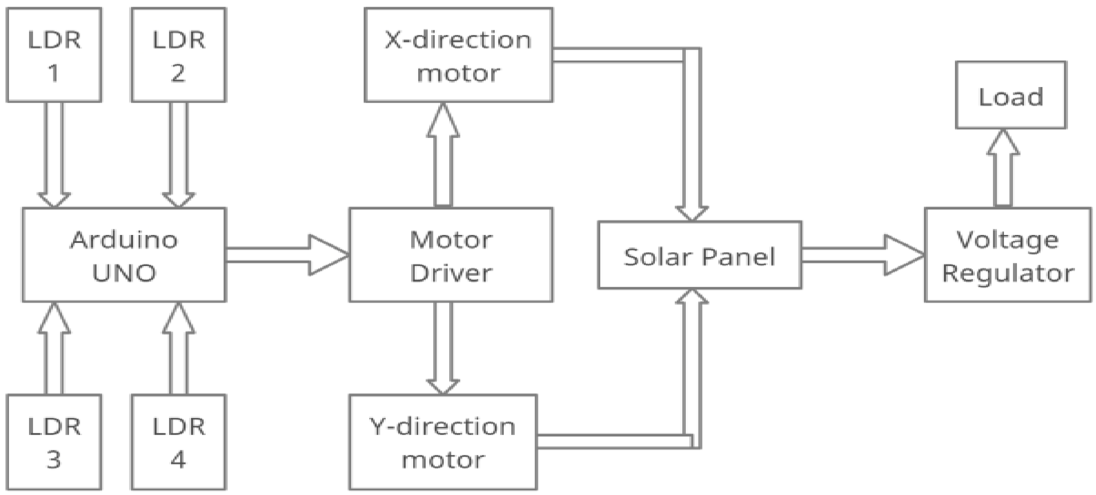
Hardware	9gm servo motor
	4 volt solor panel
	4 LDR sensor
	Arduino uno
	I2C module for LCD
	Digital Voltmeter
	220V AC to 12V DC Adopter
Software	Arduino IDE

Programming

The code manages a dual-axis solar tracker, adjusting its orientation based on light intensity readings from four directions to maximize solar exposure. It also displays humidity and temperature readings on an LCD. Adjustments are made via PWM signals to motors, ensuring optimal panel alignment. Calculations involve comparing light sensor readings to determine direction adjustments and displaying environmental data.

Circuit Design Concept



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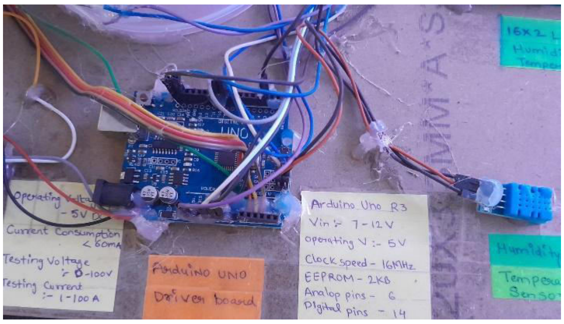
IV. DESIGN AND IMPLIMENTATION



Hardware Implimentation :

Initially, the system boots up, and the code analyzes it's current power generation without the solar tracking. The program compares the output values from the Arduino with the ratings of the power output of the solar PV panels.

If there's a margin of improvement, the LDR will sense the direction of the light source and align the solar PV panels perpendicularly to it with the help of dual axis supported servo motors.

The Arduino UNO uses the 12V DC input from the 220V AC to 12V DC Adapter and provides multiple voltage values on different terminals to the 16x2 LCD display as well as the digital voltmeter.

The weather tracking system is sensed by the change in temperature as well as the change in humidity over time. This change is then incorporated with the reference output rating to provide approximate values of the output power from the solar PV system at that time.

These output values are shown on different output devices, like the temperature and humidity is on the LCD display and the output voltage and current is on the digital voltmeter and ammeter.

Software Implementation

The programme is implemented through the Software Arduino IDE on Arduino UNO.

- The code include Liquid Crystal Library
- The code includes DHT Sensor Library
- The code includes Arduino Standard Library
- The code also uses Timer/Counter and Registers

Effects of Integration during Testing

The integration of hardware and software components is performed, followed by rigorous testing to validate the functionality and performance of the relay system.

During the tests, some key points come into play, as follows:

- The system is sensitive to changes in atmospheric shading on the solar PV panels.
- The reaction time of the servo motor is reduced so that it increases the longevity of the system and its life-time of the system.
- The cost of this scheme is 10% higher than the fixed solar PV system.
- Due to the incorporation of programming, the device is flexible towards the inclusion of several other variables that affect the performance of solar PV generation.

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V. CONCLUSION AND FUTURE WORK

The key findings of this work is that with the integration of microcontrollers and sensors such as Arduino, LDRs, and moisture and temperature sensors in the current solar tracker and weather response, the overall efficiency of the solar tracking is increased, thus making it more efficient, reliable, accurate, and faster for various applications of power systems.

In the near future, this advanced solar tracker and weather response could be utilized for more applications in the power system for higher ratings, with some more inclusion in design and technology.

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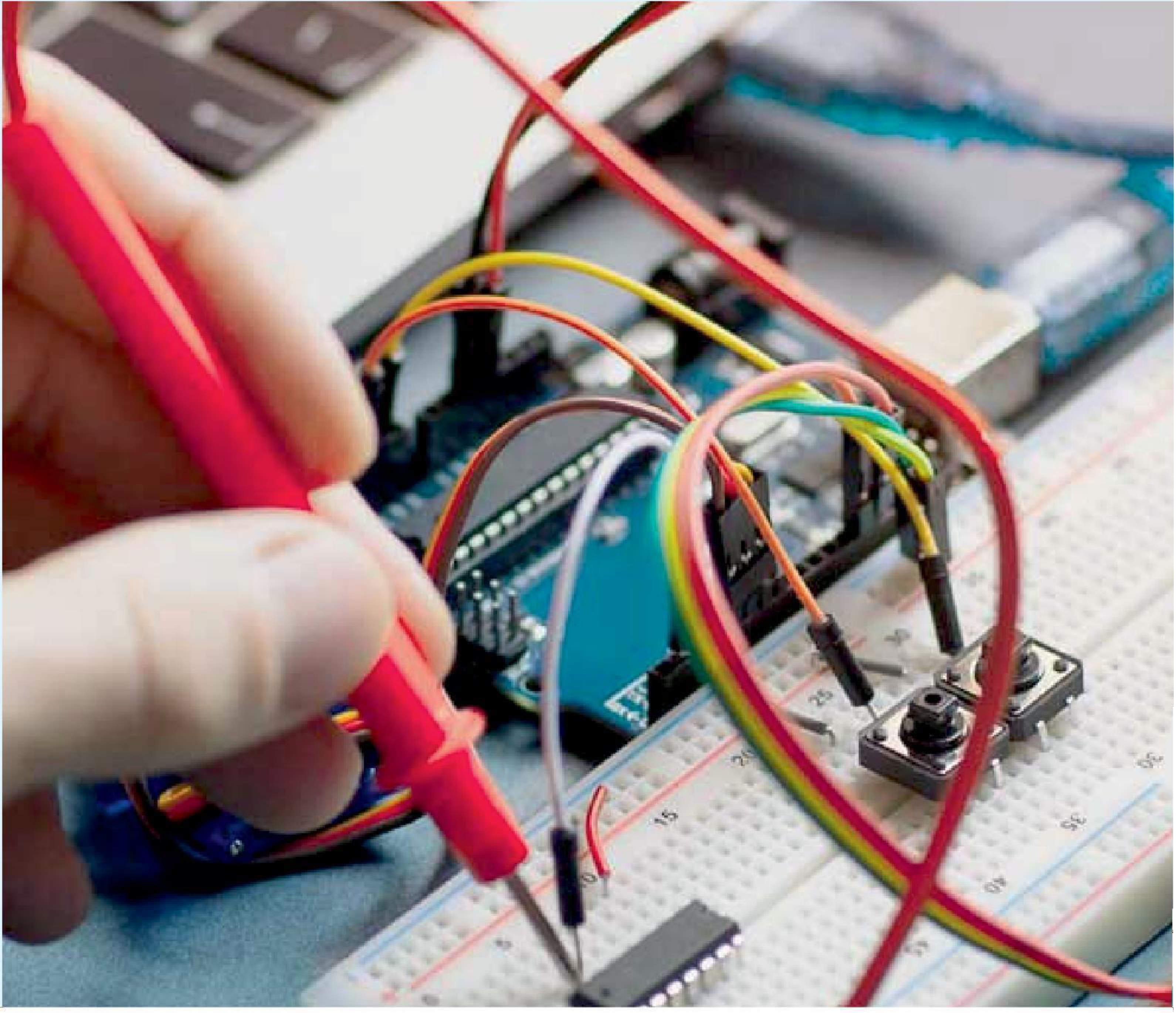

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