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ARDUINO BASED DUAL AXIS SOLAR TRACKER

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Abstract:
Due to a number of issues, including pollution and the high cost of non-renewable energy sources, the globe is currently shifting towards renewable energy sources. The sun is one of the main renewable energy sources. To maximise solar energy, a dual-axis solar tracking system based on Arduino is proposed in this project. The solar panel's rotation is controlled by an Arduino. To increase the power gain from solar energy, solar trackers are employed. The tilt of the earth and seasonal variations affect solar power by shifting the sun's location in the sky. In this sense, fixed mount and single axis solar tracking systems' performances are compared with that of dual axis sun tracking, which is practically realised. Ultimately, the experimental results show unequivocally that the suggested approach outperforms fixed mount and single axis solar tracking systems in terms of efficiency.
Keywords: Arduino, Ultrasonic sensor.

1.Introduction

The Arduino Uno board page on the official Arduino website can be accessed by clicking on the URL you supplied. A well-known microcontroller board built on the ATmega328P is the Arduino Uno. Its digital and analogue input/output pins are suitable for a variety of applications, ranging from straightforward LED blinking to intricate robotics and Internet of Things uses. Due to its ease of use, adaptability, and strong community support, the Uno is a popular game among enthusiasts, professionals, and students. On the website that is linked, you can discover comprehensive details regarding the features, specifications, and documentation of the Arduino Uno. J. A. Beltran, J. L. S. Gonzalez Rubio, and C.D. Garcia-Beltran's paper, "Design, Manufacturing and Performance Test of a Solar Tracker Made by an Embedded Control," most likely examines the creation and assessment of a solar tracker system that is managed by an embedded control mechanism. The project's design considerations such as component selection, mechanical design, and software implementation for the embedded control system—are probably covered in detail by the authors along with other project-related details. They might also talk about the manufacturing process, which includes assembling and integrating the hardware and software components to build the prototype solar tracker. Furthermore, it's possible that the article provides details on the performance testing protocols used to evaluate the solar tracker system's efficacy and efficiency. This could include experimental data on variables like overall system dependability under various environmental circumstances, tracking precision, and energy output optimisation. The paper "A Simple Neural Network Solar Tracker for Optimising Conversion Efficiency in Off-Grid Solar Generators," written by M. A. Panait and T. Tudorache, was presented at ICREPQ 2008 in Spain, according to the reference you gave. In order to improve the efficiency of off-grid solar power producers, this article most likely focuses on the creation and implementation of a solar tracker system using neural network technology. The article also probably contains performance evaluations and experimental results that were done to confirm the efficacy and efficiency of the suggested solar tracker system. These assessments could compare the neural network-based strategy with traditional tracking techniques, showing the advantages of the former in terms of

energy yield and system resilience. Innovative portable solar tracker solutions from Moser, LLC are available to improve sustainability and energy efficiency. Their mobile solar tracker systems are designed to maximise energy output even in difficult settings by optimising solar panel orientation throughout the day. By automatically adjusting the solar panels' orientation so that they are constantly facing the sun for maximum energy capture, these trackers make use of cutting-edge technology. Moser's trackers are lightweight and simple to set up, which makes them perfect for a variety of uses such as outdoor gatherings, off-grid installations, and short-term power requirements. Moser's mobile solar tracker systems offer an adaptable and sustainable way to effectively capture solar energy, with an emphasis on dependability and efficiency[1-4].

2. Proposed Method

Maximized Energy Capture: Dual-axis trackers precisely follow the sun's movement in both horizontal and vertical directions, optimizing energy production throughout the day. Enhanced Seasonal Efficiency: They adapt to changing sun angles during different seasons, ensuring optimal energy generation year-round. Improved Energy Yield: Dual-axis systems capture more sunlight, resulting in higher energy output compared to single-axis trackers.

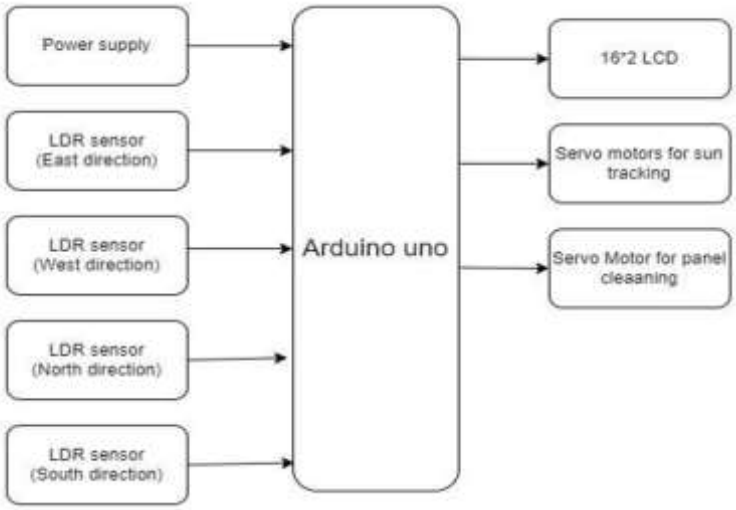

Figure.1. Block diagram for Dual axis solar tracker

2.1 Hardware description

2.1.1 Introduction to Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It consists of a microcontroller that can be programmed to sense and control objects in the physical world. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. They are used for a variety of purposes, including creating interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino boards come in various shapes and sizes, each with its own set of features and capabilities. Some of the most popular Arduino boards include:

Arduino Uno: The Uno is one of the most popular Arduino boards. It features a microcontroller, digital and analog input/output pins, USB connection, and a power jack.

Arduino Mega: The Mega is similar to the Uno but with more digital and analog input/output pins, making it suitable for larger projects that require more I/O.

Arduino Nano: The Nano is a compact board with similar features to the Uno but in a smaller form factor, making it ideal for projects with space constraints.

Arduino Due: The Due is based on a more powerful microcontroller than the Uno, making it suitable for projects that require more processing power.

Arduino Leonardo: The Leonardo is similar to the Uno but with built-in USB communication, making it easier to interface with computers.

In addition to the hardware, Arduino also provides a software development environment that allows users to write, compile, and upload code to their Arduino boards. The Arduino IDE (Integrated Development Environment) is a simple yet powerful tool that is used to write code in the Arduino programming language, which is based on Wiring, and upload it to the board.
Overall, Arduino is a versatile platform that is used by hobbyists, students, and professionals alike to create a wide range of projects, from simple blinking LED lights to complex robotics projects. Its ease of use, coupled with its affordability and flexibility, has made it one of the most popular platforms for electronics prototyping and experimentation.

2.1.2 Features of the Arduino

Arduino boards come with a variety of features that make them suitable for a wide range of projects. Some of the key features of Arduino boards include:
Microcontroller: Arduino boards are equipped with a microcontroller, which is the brain of the board. The microcontroller is responsible for executing the program and controlling the inputs and outputs of the board.
Digital Input/Output Pins: Arduino boards come with a number of digital input/output (I/O) pins that can be used to connect the board to external devices such as sensors, LEDs, and motors. These pins can be configured as either inputs or outputs, allowing the board to read data from sensors or control external devices.
Analog Input Pins: In addition to digital I/O pins, Arduino boards also feature analog input pins that can be used to read analog signals from sensors. These pins allow the board to measure variables such as light intensity, temperature, and sound level.
PWM (Pulse Width Modulation) Pins: Some Arduino boards come with PWM pins, which can be used to generate analog-like signals. PWM is often used to control the brightness of LEDs or the speed of motors.

USB Connection: Arduino boards feature a USB connection, which allows them to be connected to a computer for programming and serial communication. The USB connection also provides power to the board, eliminating the need for an external power source.
Power Jack: Arduino boards come with a power jack that can be used to connect an external power source, such as a battery or a wall adapter. This allows the board to be powered independently of the USB connection.
Reset Button: Arduino boards feature a reset button that can be used to restart the board and re-run the program.
Integrated Development Environment (IDE): Arduino boards are programmed using the Arduino IDE, which provides a simple and intuitive interface for writing, compiling, and uploading code to the board.
Open-Source: Arduino is an open-source platform, which means that the hardware designs and software libraries are freely available for anyone to use and modify. This has led to a large community of Arduino users who share their projects and collaborate on new ideas.
Overall, Arduino boards are versatile and easy-to-use platforms that are ideal for beginners and experienced makers alike. Their combination of features, affordability, and flexibility make them a popular choice for a wide range of projects, from simple blinking LED lights to complex robotics applications.

2.1.3 Arduino Pinout

- Arduino Uno is based on an AVR microcontroller called Atmega328. This controller comes with 2KB SRAM, 32KB of flash memory, and 1KB of EEPROM. The Arduino Board comes with 14 digital pins and 6 analog pins. ON-chip ADC is used to sample these pins. A 16 MHz frequency crystal oscillator is equipped on the board. The following figure shows the pinout of the Arduino Uno Board

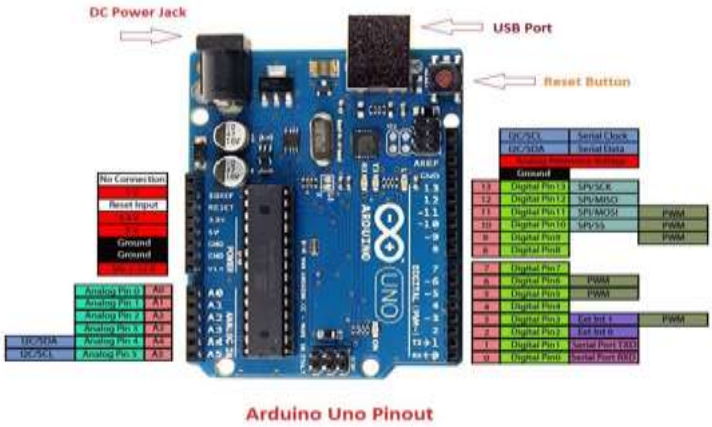

Figure.2. Arduino UNO Pinout diagram

3. Results and Discussion

3.1 Code

Sophisticated but effective, an Arduino-based dual-axis solar tracker maximises solar panel output with automatic cleaning and nighttime light activation. The tracker maximises energy capture by constantly adjusting the panels to face the sun throughout the day through the use of light sensors. In order to maintain panels operating at maximum efficiency, an automatic cleaning system also eliminates dust and debris on a regular basis. When ambient light levels drop at night, a light sensor causes LED lights to turn on, giving illumination where it's needed. By lowering the need for maintenance and increasing energy production, this integrated strategy increases the accessibility and dependability of solar energy.

```
#include <LiquidCrystal.h>
const int rs = 2, en = 3, d4 = 4, d5 = 5, d6 = 7, d7 =8; LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#include <Servo.h>
//defining servo Servo servohori; int servoh=0;
int servohLimitHigh=160; //avg position max int servohLimitLow=20; //avg position min int pos=0;
Servo servoverti;
Servo clean;
int servov=0;
int servovLimitHigh=160; //avg position max int servovLimitLow=20; //avg position min
//Assigning LDRs
int ldrtopl=A0;//top left LDR green int ldrtopr=A1;//top right LDR red
int ldrbotl=A2;//bottom left LDR yellow
int ldrbotr=A3;//bottom right LDR orange int kk=0;
int ldr=A4; int led=A5; void setup()
{
lcd.begin(16,2); lcd.print(" WELCOME"); Serial.begin(9600); servohori.attach(9);
servohori.write(0); servoverti.attach(10); servoverti.write(0); clean.attach(6); pinMode(ldr,INPUT);
pinMode(led,OUTPUT); clean.write(0); delay(500); pinMode(ldrtopl,INPUT);
pinMode(ldrtopr,INPUT); pinMode(ldrbotl,INPUT); pinMode(ldrbotr,INPUT);
}
void loop()
{
servoh=servohori.read(); servov=servoverti.read(); int lval=analogRead(ldr);
//capturing analog values of each LDR int topl=analogRead(ldrtopl);
int topr=analogRead(ldrtopr); int botl=analogRead(ldrbotl); int botr=analogRead(ldrbotr);
lcd.clear(); lcd.setCursor(0,0); lcd.print("E:"); lcd.setCursor(2,0); lcd.print(topl); lcd.setCursor(6,0);
lcd.print("W:"); lcd.setCursor(8,0); lcd.print(topr); lcd.setCursor(0,1); lcd.print("N:");
lcd.setCursor(3,1); lcd.print(botl); lcd.setCursor(7,1); lcd.print("S:"); lcd.setCursor(10,1);
lcd.print(botr); lcd.setCursor(12,0); lcd.print(lval); delay(500);
```

```
// Serial.println(topl);
// delay(500);
// Serial.println(topr);
// delay(500);
// Serial.println(botl);
// delay(500);
// Serial.println(botr);
// delay(500);
// int kval=digitalRead(kk); if(lval>800)
{
digitalWrite(led,1);
}
else
{
digitalWrite(led,0);
}
if(topl<500)
{ // Serial.println("1"); kk=0;
servoverti.write(servov +1); if(servov>servovLimitHigh)
{
servov=servovLimitHigh;
}
delay(10);
}
else if(topr<500)
{
kk=0;
//Serial.println("2"); servoverti.write(servov -1); if(servov<servovLimitLow)
{
servov=servovLimitLow;
}
delay(10);
}
else
{//Serial.println("3"); servoverti.write(servov);
}
if(botl<500)
{
kk=0;
// Serial.println("4"); servohori.write(servoh +1); if(servoh>servohLimitHigh)
{
servoh=servohLimitHigh;
}
delay(10);
}
else if(botr<500)
{
kk=0;
//Serial.println("5"); servohori.write(servoh -1); if(servoh<servohLimitLow)
{
servoh=servohLimitLow;
}
```

```
delay(10);
}
else
{
servohori.write(servoh);
}
delay(50);
if(topl>700 && topr>700 && botl>700 && botr>700 && kk==0)
{
Serial.println("cleaning"); kk=1;
for (pos = 0; pos <= 150; pos += 1)
{
clean.write(pos); delay(15);
}
for (pos = 150; pos >= 0; pos -= 1)
{
clean.write(pos); delay(15);
}
}
}
```

3.2 Results

Arduino Based Dual Axis Solar Tracker Rotating

Four Light Dependent Resistors (LDRs) are used in a dual-axis solar tracker. The LDRs are used to continually measure the sun's light intensity. To detect light in a particular direction, each pair of LDRs is usually positioned in pairs—one pair for horizontal movement and the other for vertical movement. The Arduino determines the variation in light intensity between each pair by continuously reading the data from the LDRs. In order to maximise the amount of light received, it makes adjustments to the solar panel's position in both the horizontal and vertical axes based on this information. This maximises the efficiency of energy generation by guaranteeing that the solar panel is always oriented in the best possible alignment with the sun's position throughout the day.

Figure.3. Arduino Based Dual Axis Solar Tracker Rotating

Automatic Light Off in Night By Using Battery

In order to save battery life, the system also has a light sensor that measures the amount of ambient light. The Arduino uses LEDs or another type of light source to turn on the lights when it becomes dark. The solar tracker can efficiently illuminate at night and preserve battery life during the day by utilising smart programming techniques to minimise power consumption and setting a threshold value for darkness.

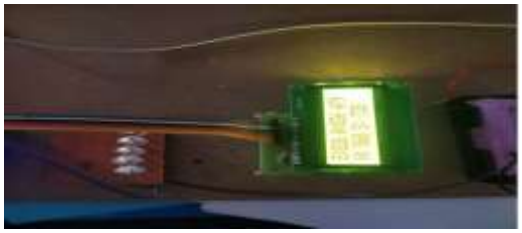

Figure.4. Automatic Light Off In Night By Using Battery

By doing this, the extra power needed to turn on the lights—which comes from solar energy—is conserved. This axis detects light with the use of sensors.

Figure.5. Automatic Light on In Day by Using Battery

Automatic cleaning

By keeping the solar panels clear of debris, this automated cleaning procedure makes sure they can effectively absorb sunlight and produce power. Consequently, the system consistently sustains peak performance and optimises energy generation.

Figure.6. Automatic cleaning

4. Conclusion

The dual axis solar tracking based Arduino solar panel is devised and successfully implemented to boost solar panel efficiency. Compared to the current single axis solar tracker and fixed mount, the suggested two axis solar tracker is more efficient. With the aid of an Arduino board, the suggested solar tracker that tracks the sun automatically in order to harvest the most solar electricity was successfully realised. The Arduino board is an inexpensive and easy-to-implement tool for tracking solar power. Lastly, the experimental system unequivocally shows that the suggested method tracks the sun in both favourable and unfavourable weather circumstances. When compared to the current approach, the efficiency of the solar panel is effectively increased at different times of the day.

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