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Design of Dual Axis Solar Tracking System Using Arduino

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Abstract: This paper outlines the design and practical implementation of a simple dynamic dual-axis solar tracker (DAST) that uses fewer segments and is less expensive to track the sun's evolution. A dual-axis device is designed to tilt the PV board using a servo motor and rotates with a mechanical motor in response to the strongest daylight detected by light-dependent resistor sensors fixed along the frame's four edges. To determine its effectiveness, the DAST model was essentially developed and tested using a real-time virtual instrument that was dependent on Dominate. Additionally, a correlation based on trial results between the energy produced by the clever DAST and a fixed board reveals that the former generates 36.26% more energy than the latter. It is easy to implement the suggested dynamic DAST without having extensive knowledge of sun-oriented electronic design and sun-oriented following innovations.

Keywords: Arduino: servomotor: LDR

1.INTRODUCTION:

Due to the rapid advancement of technology, the majority of people on the planet require energy to finish their daily tasks. The use of numerous natural energy sources is growing in society. Solar energy, which makes use of solar panels and solar trackers, is one of them. The solar panel is a type of panel used to harness solar radiation and use it to generate electricity.

When it comes to solar tracking, the dual axis principle could yield 40% more power than a single axis solar tracker [1]. When compared to a single axis solar tracker, the dual axis tracking system is able to angle itself to be in line with the Sun light, allowing it to track the Sun light both vertically and horizontally. This allows the system to maximize the amount of energy produced by the solar panel. Previous studies have employed a single-axis solar tracker, which wastes solar energy and does not precisely track the sun to produce the most electricity. It has been demonstrated that the dual-axis tracking system had an annual energy gain of 36.504% when compared to the single-axis system [2].

The world's researchers, technicians, investors, and decision-makers are becoming interested in renewable energy sources due to the inevitable future scarcity of fossil fuels. Tidal power, wave power, hydroelectricity, bioenergy, solar, wind, and geothermal energy are some of the new energy sources that are gaining attention. Due to their renewable nature, they are regarded as advantageous alternatives to fossil fuels. Solar photovoltaic (PV) energy is one of those forms of energy that is most readily available. Thanks to research and development efforts to increase the efficiency and decrease the cost of solar cells, this technology is now more widely used in homes. The International Energy Agency (IEA) reports that since the early 2000s, the average annual growth rate of global photovoltaic capacity has been 428%. It is very likely that solar PV energy will grow to be a significant power source in the future.

2.PROPOSED SYSEM

In order to track daylight more successfully, the proposed global positioning framework allows PV boards to pivot along two different hubs [3]. The microcontroller analyzes the data from the light-detecting receptor (LDR). The LDR's value changes based on the intensity of the sunlight, and the microcontroller instructs the servo to rotate in response to the intensity of the sunlight. This causes the solar panel that is placed above the servo motors to face the direction of intense sunlight. The microcontroller maintains communication with the servo motors and LDRs in order to obtain high solar efficiency. The battery stores the energy from the solar panel, and a charge controller is used to store the desired amount of power in the battery. A load is used to symbolize the working, and an inverter is used to convert DC to AC [4]. In order to increase efficiency, a moisture sensor is also attached to the solar panel. This sensor senses moisture and communicates with the microcontroller. If the humidity is high, the microcontroller notifies the servo to move the wiper, which removes moisture from the top of the solar panel. This is because the efficiency of the solar panel may decrease due to humidity formation on its surface. Thus, moisture on the panel's top is removed using a moisture sensor, servo motor, and wiper. When rain or mist occurs, the dampness sensor detects it and activates the wiper to remove the surface moisture from the board. This helps to minimize the impact of dampness on the board on the productivity of sun-oriented boards. At that point, a charge regulator separates our voltage and force, and the energy is stored in a battery.

3.SOLAR TRACKING SYSTEM:

The single-axis tracking system revolves the panel around a slanted shaft while a bi-directional DC motor is controlled in accordance with the direction of the sun as determined by two light intensity sensors [5]. Two LDRs, spaced apart by a black card box on either side of the solar panel, are part of the light sensors. One of the LDRs will be shaded and the other will be illuminated by the sun's rays, depending on their intensity.

In order to ensure that the solar panel is always facing perpendicularly toward the sun, the dual axis tracking system rotates the panel using two motors. Five light-diode registers (LDRs) serve as sensors, detecting areas of higher sunlight intensity and sending feedback to the Arduino UNO microcontroller. It is able to travel in all directions in the direction of the brighter light.

4.BLOCKDIARAM DISCRIPTION:

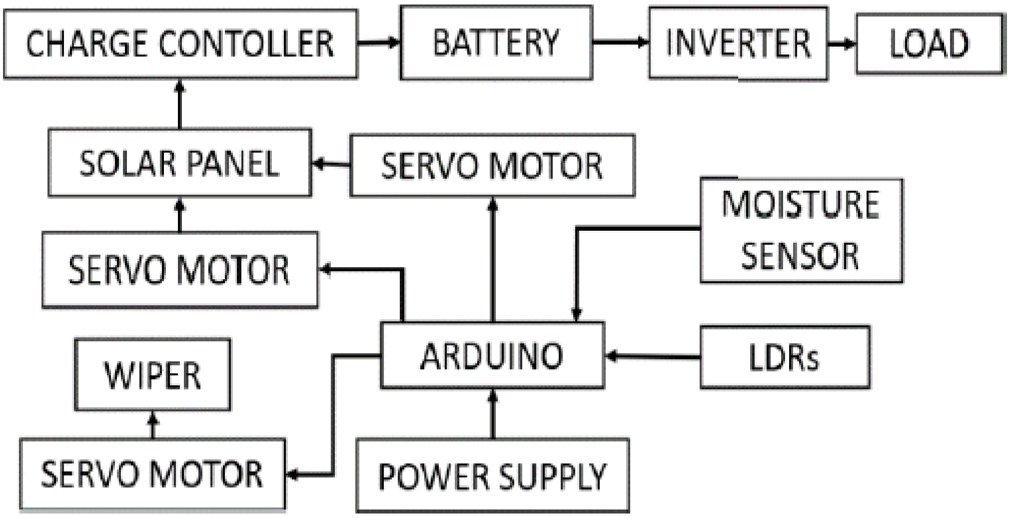

Fig 1:Blockdiagram

The microcontroller analyzes the data from the light-detector reflector (LDR). The LDR's value fluctuates based on the intensity of the sunlight. The microcontroller then instructs the servo to rotate in response to the sunlight's intensity. As a result, the solar panel above the servo motors faces the direction of intense sunlight.

The microcontroller maintains communication with the servo motors and LDRs in order to obtain high solar efficiency. The battery stores the energy from the solar panel, and a charge controller is used to store the desired amount of power in the battery. A load is used to symbolize the working and an inverter is used to convert DC to AC [4]. The solar panel also has a moisture sensor that detects moisture and communicates with the microcontroller. If the humidity is high, the microcontroller signals the servo motor to move the wiper, which removes moisture from the top of the panel to increase efficiency. Because humidity can cause the efficiency of the solar panel to drop, the moisture sensor, servo motor, and wiper work together to clean the moisture from the top of the panel.

4.1Arduino Uno:

A microcontroller board based on the ATmega328 is called the Arduino Uno. Due to its ease of use, Arduino is an open-source prototyping platform that is perfect for both professionals and hobbyists. The Arduino Uno is equipped with six analog inputs, a 16 MHz crystal oscillator, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button.It comes with everything needed to support the microcontroller; all you need to do is power it with a battery or an AC-to-DC adapter or connect it to a computer via a USB cable to get going.

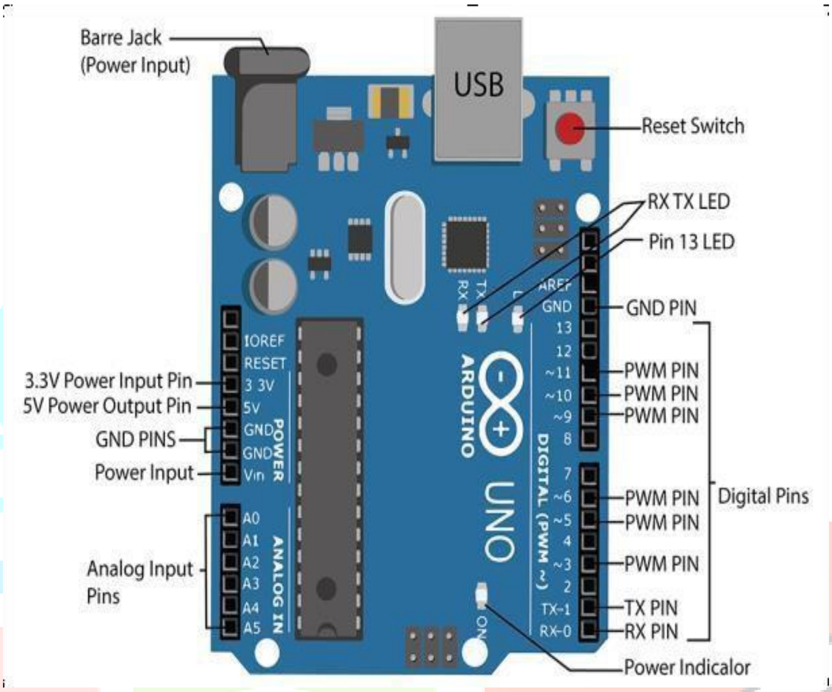

Fig 2:ATmega 328

The FTDI USB-to-serial driver chip is not used by the Arduino Uno, setting it apart from all previous boards. Rather, it has an Atmega8U2 microcontroller chip that is configured to function as a serial-to-USB converter."Uno" is an Italian word for one, and it was chosen to commemorate the impending release of Arduino 1.0. Going forward, the Arduino Uno and version 1.0 will serve as the reference versions of Arduno. The Uno is the most recent in a line of USB Arduino boards and serves as the platform's reference design.

4.2. LDR

A photo-resistor is a device whose resistivity changes depending on the electromagnetic radiation that is incident upon it. They are therefore light-sensitive gadgets. They can also be referred to as photoconductive cells, photo conductors, or just photo cells. They are composed of highly resistant semiconductor materials.The photoconductive principle underlies LDR operation.

An optical phenomenon known as photo conductivity occurs when a material absorbs light, increasing its conductivity. The most popular kind of LDR, as seen in the above image, has a resistance that decreases as the amount of light shining on it increases. Generally speaking, an LDR's resistance can have the following resistances:

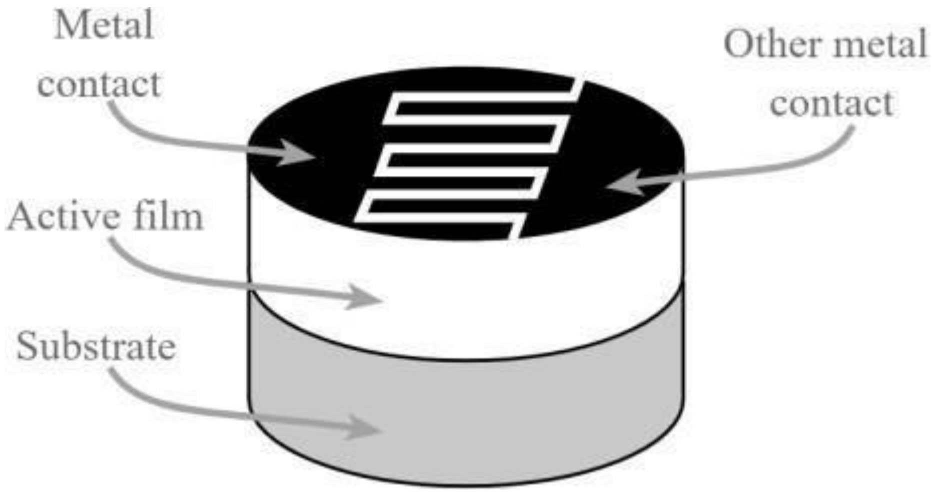

Fig 3:Photo resistor

4.3.SERVOMOTOR:

A small DC motor, gearbox, feedback potentiometer, motor drive electronic circuit, and electronic feedback control loop make up a DC servomotor. It resembles a typical DC motor in most respects. The magnet is fixed to the inside of the cylindrical frame that makes up the motor's stator. An armature coil built into a brush provides the commutator with current. To measure the rotation speed, a detector integrated into the rotor is located at the rear of the shaft. With this construction, the torque is proportional to the amount of current flowing through the armature, making it easy to design a controller using basic circuitry.

Fig 4: servomotor

5.WORKING PRINCIPLE:

The light's intensity determines the resistance of the LDR, which varies accordingly. When light intensity is high, the LDR resistance is low, which causes the output voltage to decrease; conversely, when light intensity is low, the LDR resistance is higher, which causes the output voltage to increase. To obtain the output voltage from the sensors, a potential divider circuit is utilized (LDRs).The circuit is displayed.The LDR generates a digital number at the output that typically ranges from 0 to 1023 after sensing the analog input in voltages between 0 and 5 volts.

This will now use the Arduino software (IDE) to provide feedback to the microcontroller. This mechanism can be used to control the servomotor position; it is covered later in the hardware model. After determining the maximum intensity of light falling perpendicular to it, the tracker finally modifies its position. It remains there until it detects any additional changes. The point source of light affects the LDR's sensitivity. It barely makes a difference in the diffuse lighting situation.

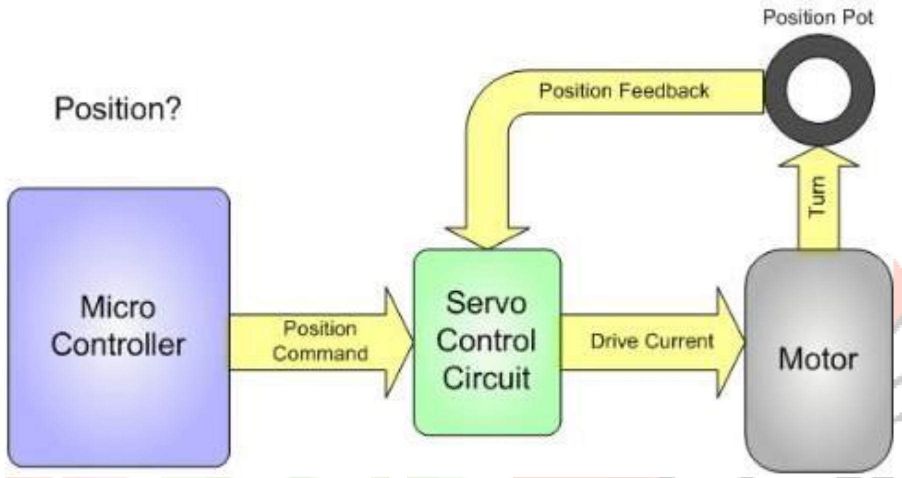

Fig 5:circuit

6. SOFTWARE PROGRA MMODEL

Programming code:

```
#include <Servo.h>

Servo x_axis; // Declare a servo object for X-axis
Servo y_axis; // Declare a servo object for Y-axis

int x_axis_pin = 3; // Pin for X-axis servo
int y_axis_pin = 5; // Pin for Y-axis servo

int photo_pin_x = A0; // Pin for X-axis photoresistor
int photo_pin_y = A1; // Pin for Y-axis photoresistor

int x_angle = 280; // Initial angle for X-axis servo
int y_angle = 280; // Initial angle for Y-axis servo

int tolerance = 5; // Tolerance for servo movement
```

```
void setup() {
x_axis.attach(x_axis_pin); // Attach X-axis servo to its pin
y_axis.attach(y_axis_pin); // Attach Y-axis servo to its pin
}

void loop() {
  int x_val = analogRead(photo_pin_x); // Read the value of X-axis photoresistor
  int y_val = analogRead(photo_pin_y); // Read the value of Y-axis photoresistor

  // Calculate the angle for X-axis servo based on the photoresistor value
  int x_diff = x_val - 512;
  if (abs(x_diff) > tolerance) {
x_angle += x_diff / 10;
    if (x_angle> 180) x_angle = 180;
    if (x_angle< 0) x_angle = 0;
x_axis.write(x_angle);
  }

  // Calculate the angle for Y-axis servo based on the photoresistor value
  int y_diff = y_val - 512;
  if (abs(y_diff) > tolerance) {
y_angle -= y_diff / 10;
    if (y_angle> 180) y_angle = 180;
    if (y_angle< 0) y_angle = 0;
y_axis.write(y_angle);
  }

delay(10); // Wait for 10ms
```

7.RESULTS

The dual axis solar tracker experimental setup is depicted in Fig. 6. The motor drivers enable the solar panel to rotate both vertically and horizontally, aiding in the tracking of intense radiation.

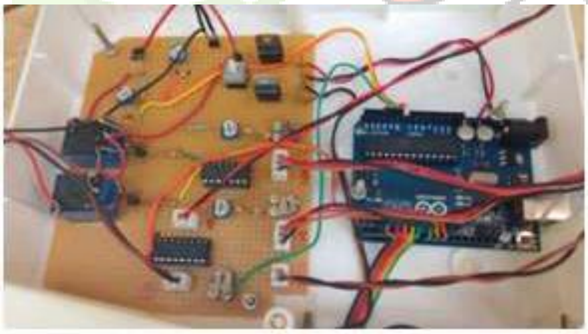

Fig 6: Experimental setup

8.CONCLUSION:

As demonstrated by the experimental results, the solar panel monitoring system's goal is to track the sun's position in order to improve solar panel performance. Industrial-scale completion of this task would benefit developed nations like Nigeria and sub-Saharan Africa. We recommend that future research take into account the use of more potent and adaptable sensors that are also less expensive to use. This would lower expenses while increasing productivity.

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