Sun Tracking Solar Panel

Using ESP32 Microcontroller

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PROJECT GUIDE

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INTRODUCTION

What is a Sun Tracking Solar Panel?

A solar panel that is equipped with a tracking system that allows it to follow the sun's path across the sky in order to maximise efficiency.

LITERATURE SURVEY

SCIENTIFIC PAPER

Review on sun tracking technology in solar PV system

Department of Electrical Engineering, UEC, Ujjain, India

PROBLEM

Algorithm to calculate sun's position

WORK USED

The Parameters required to find Suns position in the sky.

- Latitude
- Angle of incident
- Real time and date
- Solar declination angle

LITERATURE SURVEY

SCIENTIFIC PAPER

A Review Paper on Solar Tracking System for Photovoltaic Power Plant

Paper ID : IJERTV9IS020103

PROBLEM

How to control a solar panel with a servo motor.

WORK USED

METHODS OF TRACKING AND TYPES OF TRACKING.

METHODS

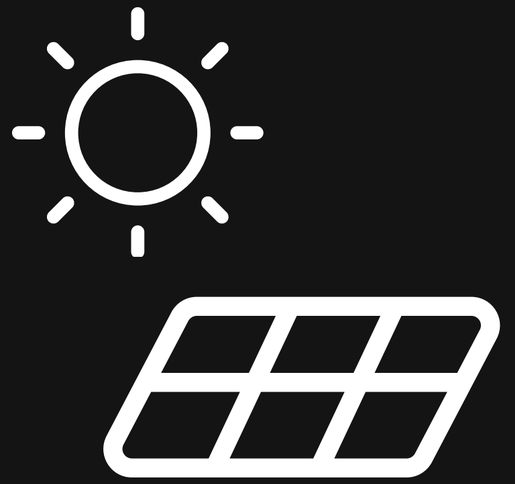
- Active Tracking
- Passive Tracking
- Chronological Tracking

TYPES OF TRACKING

- SINGLE AXIS
- DUAL AXIS

PROBLEM STATEMENT

Conventional Solar Panels are static while the the Sun is not.This leads to reduced efficiency in most circumstances, which can be solved using a moving solar panel that adjusts according to Sun's position.



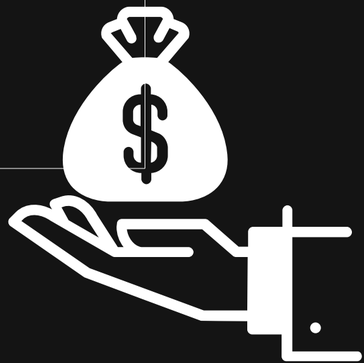
LDR VS SOLAR POSITION ALGORITHM

WHY THE ALGORITHM METHOD IS BETTER?

- MORE ACCURATE
- ROBUST
- MORE ECONOMICAL
- LESS HARWARE OVERHEAD
- EASY MAINTENANCE

BENEFITS OF SINGLE AXIS SOLAR TRACKER

INCREASED PRODUCTIVITY		INCREASED OUTPUT		GLOBAL DEMAND
Solar trackers can help to extend the lifespan of solar panel by reducing the amount of wear and tear on the panels since the panels are not constantly exposed to the elements.		The average increase in solar panel output with a single-axis tracker is 15-25%		The global market for single-axis solar trackers is expected to reach $1.5 billion by 2025.



SUN TRACKING SOLAR PANELS COMPARISON

How different are they?

METRIC	CONVENTIONAL	SINGLE-AXIS	DUAL-AXIS
ENERGY OUTPUT AVERAGE	1000W	1150W	1200W
COST	$12,500 to $22,500	$15,000 to $27,000.	$17,500 to $28,800
ENERGY CONSUME (% OF OUTPUT)	0%	C	4%

"Comparison of Conventional, Single Axis, and Dual Axis Solar Panels" by the National Renewable Energy Laboratory (NREL).

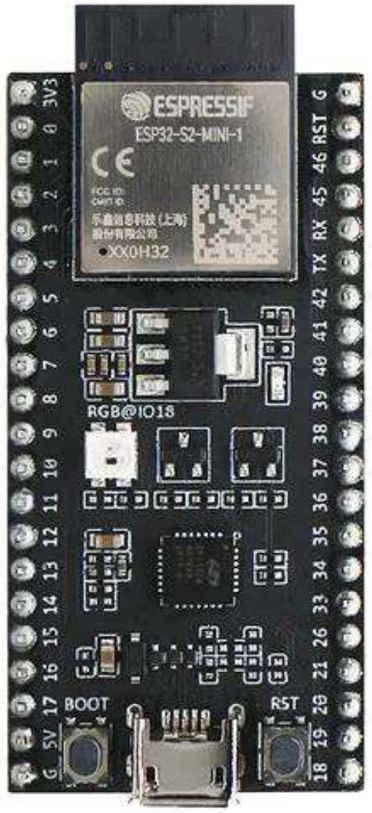
PROPOSED SOLUTION

- The proposed system will be mounted on a fixed frame placed in the required area.
- Required inputs are provided to the system.
- It will be able to track the sun throughout the day, allowing the solar panel to receive more sunlight.
- The system is expected to increase the output of the solar panel by 20% to 30%.

WHY CHOOSE THE ESP32 OVER OTHER POPULAR MICRCONTROLLERS?

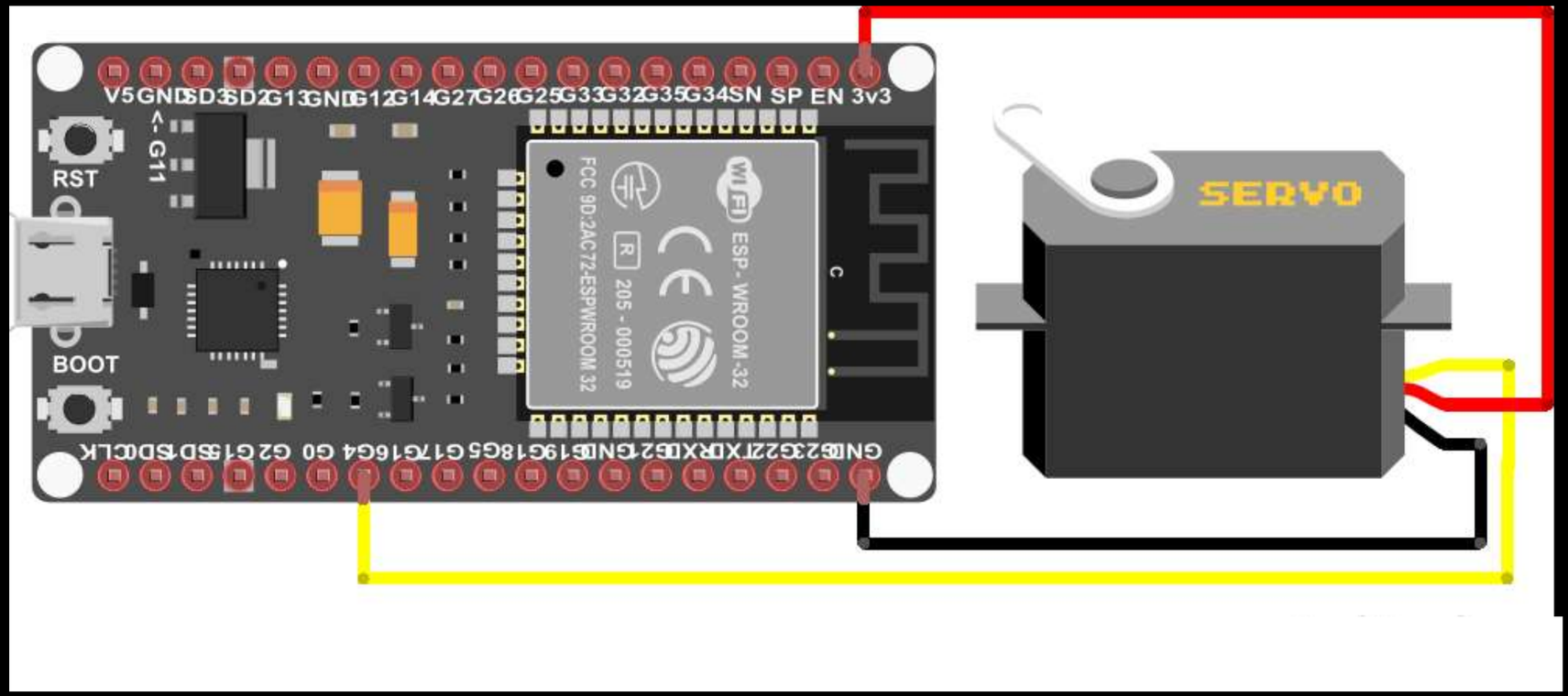
- ESP32 HAS AN INBUILT WIFI MODULE AND REAL TIME CLOCK.
- WORKS ON THE ARDUINO IDE.
- EXTREMELY COST EFFICIENT AND POWER EFFICIENT

ESP32 is a 32-bit microcontroller, while Arduino is an 8-bit microcontroller. This means that the ESP32 has a faster clock speed and more memory than the Arduino.



CIRCUIT DIAGRAM

Interfacing the Servo motor with ESP32 Microcontroller.



SOFTWARE AND HARDWARE TOOLS

Arduino IDE

ESP32 Libraries

WIFI LIBRARY
WIFIUDP LIBRARY
ESP32SERVO MODULE
NTPCLIENT LIBRARY
WEBSERVER LIBRARY

Web Development Tools

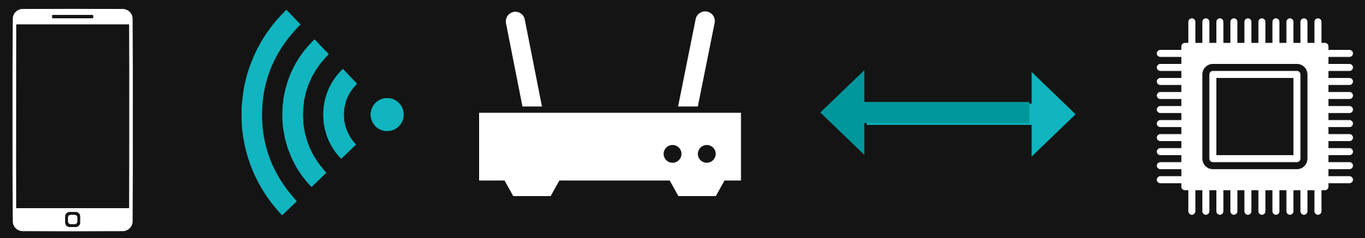
HTML
CSS
JAVASCRIPT

- **ESP32 MICRCONTROLLER**
- **C PROGRAMMING LANGUAGE**
- **SERVO MOTOR**
- **CONNECTING WIRES AND POWER SUPPLY**
- **COMPUTER**
- **ESPRESSIF FILES**

SOFTWARE MODULES USED

WIFI LIBRARY

The WiFi library provides a number of functions that allow you to connect to a Wi-Fi network, send and receive data over Wi-Fi, and control the Wi-Fi settings of the ESP32

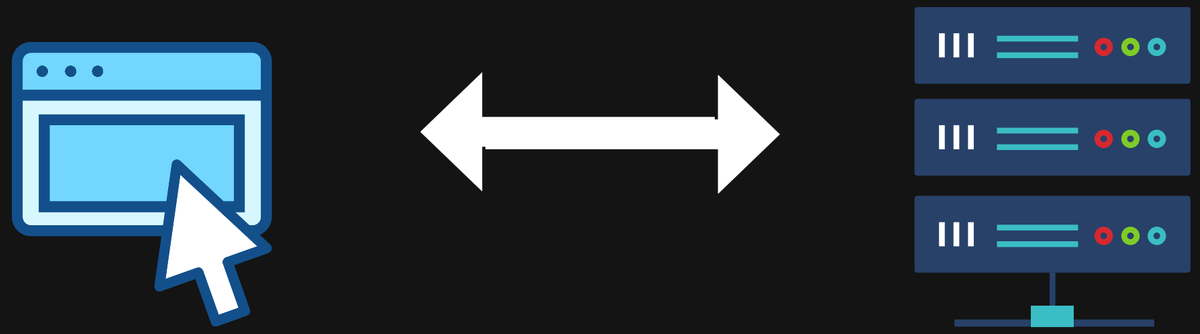


FUNCTIONS USED IN OUR PROJECT,

```
WiFi.begin(ssid, password);     //CONNECT TO NETWORK

while (WiFi.status() != WL_CONNECTED)   //CHECK IF CONNECTED
```

WEBSERVER LIBRARY

The WebServer library provides a number of functions that allow you to create a simple web server on the ESP32. This can be used to create web pages that can be accessed from a web browser.



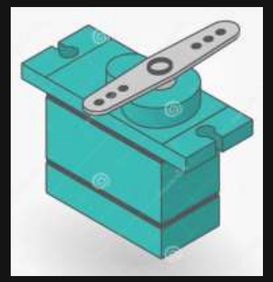
FUNCTIONS USED IN OUR PROJECT,

```
WebServer server(80);
server.send(200, "text/html", html);
server.begin();
 server.on("/", handleRoot);
```

```
//Initialise the server
   //send the html file when requested
   //begin the server
    //perform the desired option when loaded
```

ESP32 SERVO LIBRARY

ESP32Servo.h is a header file that provides an Arduino-compatible library for controlling servo motors on the ESP32. It allows you to control up to 16 servos on individual channels, and it makes use of the ESP32 PWM timers.



FUNCTIONS USED IN OUR PROJECT,

```
servo.attach(servopin);          //attach the servo to desired pin
serv0.write(0);                    //initialise servo to 0 degree
sservo.write(servoPosition);       //rotate the blade to desired position
```

NTPCLIENT LIBRARY

The #include <NTPClient.h> header file is used to include the NTPClient library in your Arduino code. The NTPClient library allows you to connect to a Network Time Protocol (NTP) server and get the current date and time.It acts as a RTC.

FUNCTIONS USED IN OUR PROJECT,

```
timeClient.begin();                    //initialise the NTP client
 timeClient.setTimeOffset(0);
timeClient.update();                     //update the time
timeClient.getFormattedTime();           // get the time
```

WIFIUDP LIBRARY

WE MAINLY USE THIS LIBRARY TO CONNECT TO THE NTP SERVER AND RETURN THE REAL TIME DATA

WORKING CHART

START

CONNECT THE ESP 32 TO THE REQUIRED WIFI NETWORK.

HOST THE WEBSITE ON THE WIFI NETWORK USING THE WIFI MODULE.

SERVER

CLIENT

CONNECT TO THE SAME WIFI AS THAT OF THE ESP AND ENTER THE IP ADDRESS OF WEBSITE.

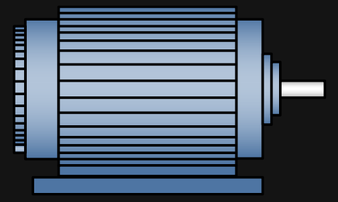
WEBSITE

ACCEPT THE LOCATION FROM USER AND INITIALISE IN THE SERVER.

SOLPOS ALGORITHM

CALCULATE SUNS DECLINATION USINF LATITUDE AND TIME.

MAPPING THE CALCULATED ANGLE WITH SERVO MOTOR

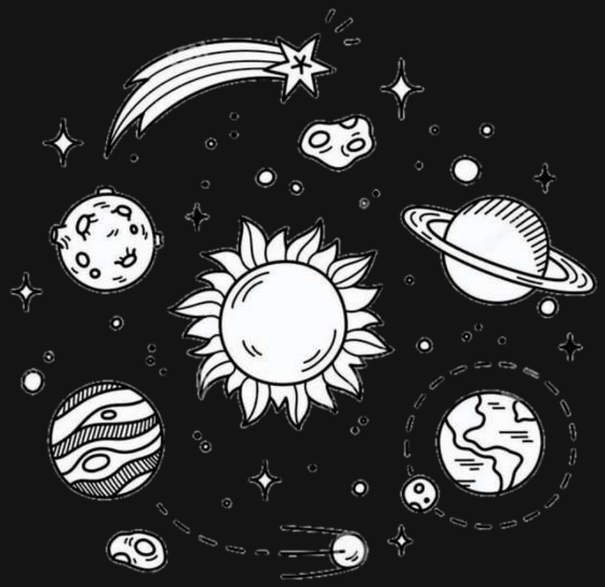


SERVO MOTOR ROTATES IN THE GIVEN ANGLE.

HOW DO WE CALCULATE THE POSITION OF THE SUN?

The physics and maths behind the project!

```
float calculateSunPosition(int month) {
 // Calculate the angle of the sun based on the month and latitude
 float latitudeInRadians = llatitude * PI / 180.0;
 float solarDeclination = 23.45 * sin(2 * PI / 365.0 * (month + 284));

 float angle = asin(sin(latitudeInRadians) * sin(solarDeclination) +
          cos(latitudeInRadians) * cos(solarDeclination) * cos(0));

 return angle * 180.0 / PI; // Convert the angle from radians to degrees
}
```

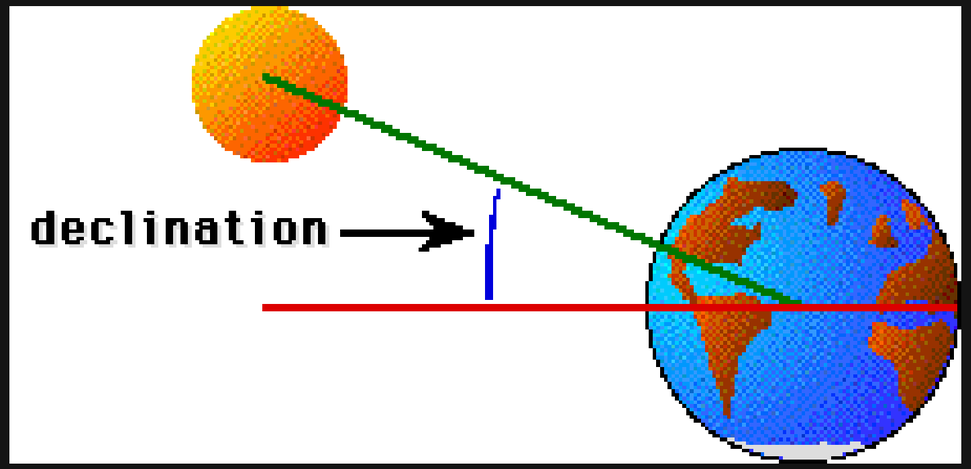


SOLAR DECLINATION ANGLE

solarDeclination = 23.45 * sin(2 * PI / 365.0 * (month + 284))

CODE SNIPPET

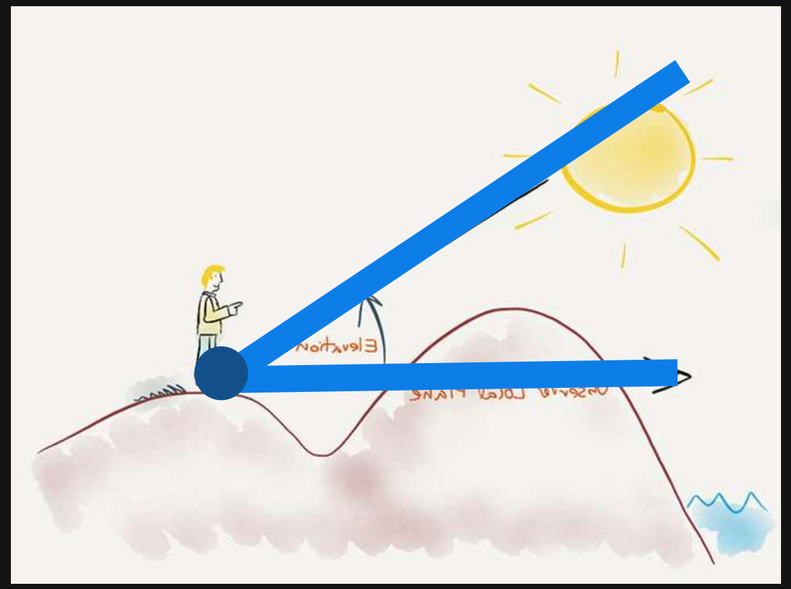
```
float calculateSunPosition(int month) {
 // Calculate the angle of the sun based on the month and latitude
 float latitudeInRadians = llatitude * PI / 180.0;
 float solarDeclination = 23.45 * sin(2 * PI / 365.0 * (month + 284));

 float angle = asin(sin(latitudeInRadians) * sin(solarDeclination) +
          cos(latitudeInRadians) * cos(solarDeclination) * cos(0));

 return angle * 180.0 / PI; // Convert the angle from radians to degrees
}
```



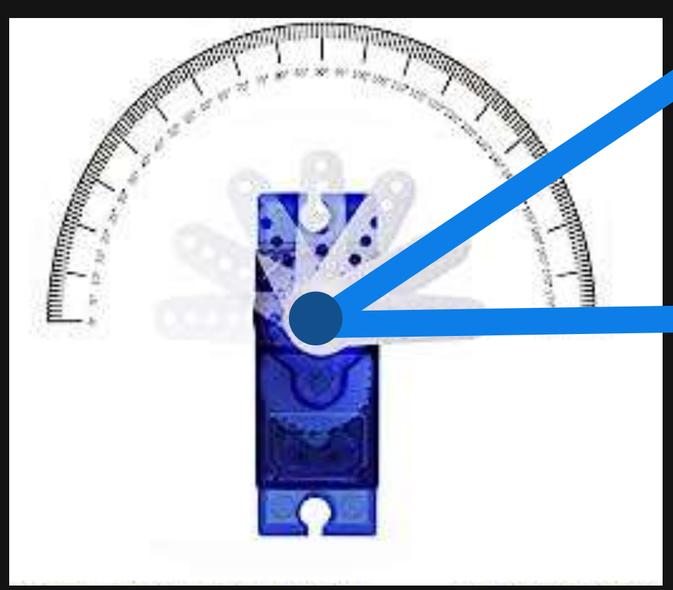
Solar declination refers to the angle between the sun and the Earth's equatorial plane.

HOW DOES THE SERVO MOVE THE PANEL TOWARDS THE SUN?

SUN'S POSITION FROM OBSERVERS PERSPECTIVE.



map(sunPosition, -180, 180, 0, 180);



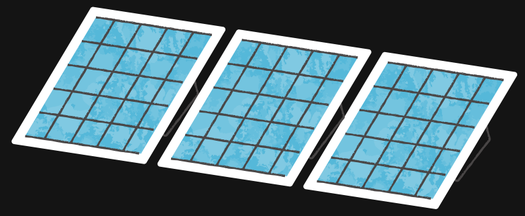
map() function is used to convert the sunPosition value from the range of -180 to 180 degrees to a new range of 0 to 180 degrees.

CHALLENGES FACED

- LOW TECHNICAL SUPPORT FOR ESP32
- INACCURATE RTC OF ESP
- USE OF COMPLEX MATHEMATICAL EQUATIONS
- PROBLEMS WITH HARDWARE DEBUGGING
- HARD TESTING PROCESS.

RESULTS AND DISCUSSIONS.

- **Using sun tracking solar panels can maximise the potential of solar panels, inturn production of renewable energy.**
- **Problems faced with dual axis and LDR solar panels can be solved with a well equipped single axis solar panel.**
- **This project proved how powerful the esp32 microcontroller is by fucntioning as a server as well as controling a servo motor.**



CONCLUSION

Dynamically adjusting the position of the solar panel based on the sun's movement, we can harness the maximum amount of sunlight and generate more electricity.

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