NATIONAL INSTITUTE OF TECHNOLOGY
MEGHALAYA

A PROJECT REPORT ON DUAL AXIS SOLAR TRACKING SYSTEM

(BATCH: 2022-2026)

(COURSE CODE:EC311)

SUBMITTED TO

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INTRODUCTION:

A solar tracking system is a mechanism that orients solar panels toward the sun throughout the day to capture maximum sunlight, thereby enhancing energy generation. This project focuses on designing and implementing an Arduino-based solar tracking system that uses a stepper motor for precise positioning. The system tracks the sun's position in real-time by detecting its location in the sky using light-dependent resistors (LDRs) as sensors. The data from the sensors is processed by an Arduino microcontroller, which controls the stepper motor to adjust the solar panel's angle.

COMPONENTS USED :

ARDUINO UNO

RESISTORS

BREADBOARD

JUMPER WIRES

STEPPER MOTOR/SERVO MOTOR

SOLAR PANEL

ARDUINO UNO

Arduino is a single-board microcontroller meant to make the application more accessible which are interactive objects and its surroundings. The hardware features with an open-source hardware board designed around an 8-bit Atmel AVR microcontroller or a 32-

bit Atmel ARM. The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button.

RESISTORS

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. Resistors are used in the solar tracking system to create voltage divider circuits with LDRs for light detection and to limit current, protecting components like the Arduino.

BREADBOARD

Breadboard is used as a prototyping tool to facilitate the temporary connection of electronic components without the need for soldering.

JUMPER WIRES

Jumper wires are used to establish electrical connections between components on the breadboard.

LDRs(LIGHT DEPENDENT RESISTORS):

Light Dependent Resistors (LDRs), also known as photoresistors, are sensors whose resistance decreases as the intensity of light increases.

In a solar tracking system, LDRs detect sunlight direction by producing variable voltage signals in a circuit, enabling the Arduino to determine and adjust the solar panel's position.

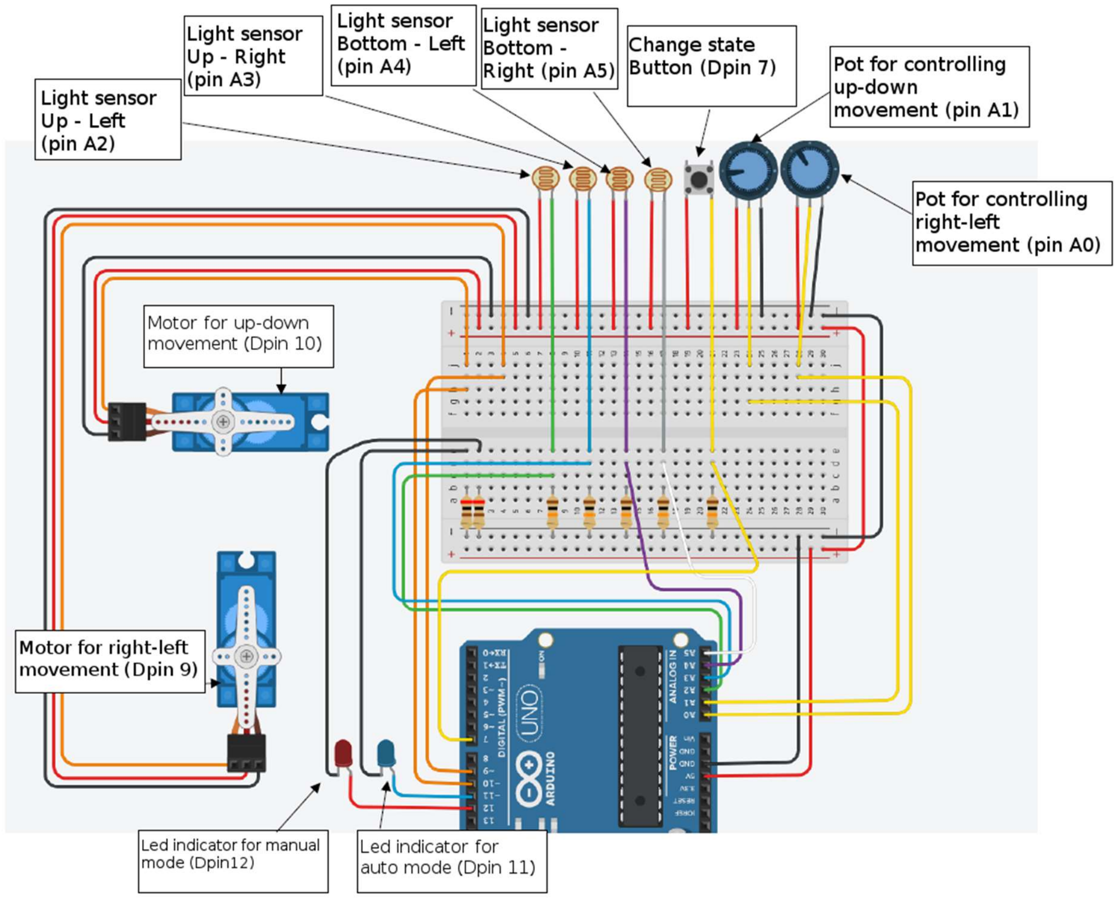
STEPPER MOTOR:

A stepper motor is a precise and reliable electric motor that rotates in discrete steps. Unlike regular motors, it can move incrementally, allowing accurate control of angular position, speed, and direction. In a solar tracking system, the stepper motor adjusts the solar panel's position based on signals from the Arduino, ensuring it aligns with the sun's path throughout the day.

SOLAR PANEL:

A solar panel is a device that converts sunlight into electrical energy using photovoltaic (PV) cells made from semiconductor materials. When exposed to sunlight, these cells generate direct current (DC) electricity. Solar panels are a key component of renewable energy systems, and in a solar tracking setup, they are dynamically positioned to face the sun, maximizing energy output.

SCHEMATIC DIAGRAM:



IMPLEMENTATION :

Setup Components: Connect LDRs, resistors, and a stepper motor with its driver to the Arduino. Mount the solar panel on a motor-controlled frame.

Circuit Design: Use voltage dividers with LDRs to detect sunlight direction and interface the motor for precise movement.

Programming: Write an Arduino program to read LDR inputs, calculate sunlight direction, and control the stepper motor.

Operation: The motor adjusts the solar panel's angle dynamically to align with the sun.

Testing: Calibrate and test the system to ensure smooth and accurate tracking for optimal sunlight capture.

Code Overview:

```
#include <Stepper.h>


const int stepsPerRevolution = 2048;

Stepper stepperHorizontal(stepsPerRevolution, 2, 3, 4, 5);
Stepper stepperVertical(stepsPerRevolution, 8, 9, 10, 11);

const int ldrLeft = A0;
const int ldrRight = A1;
const int ldrTop = A2;
const int ldrBottom = A3;


const int threshold =20;

const int motorSpeed = 15;
const int maxSteps = 2048;

void setup() {
  Serial.begin(9600);


  stepperHorizontal.setSpeed(motorSpeed);
  stepperVertical.setSpeed(motorSpeed);
```

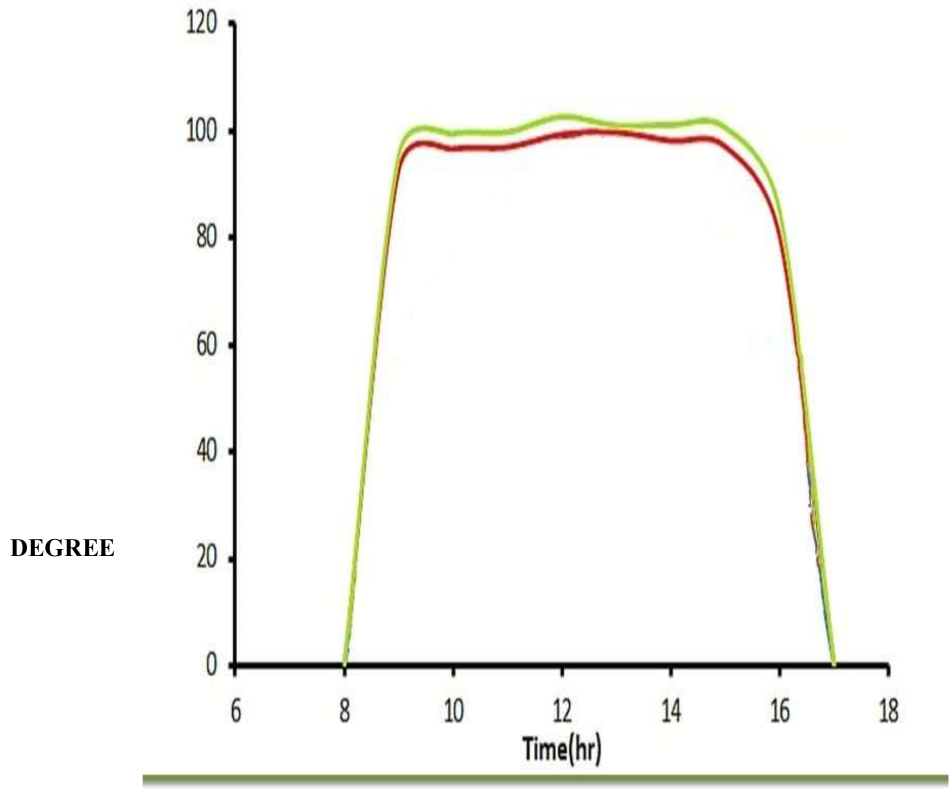
```
}

void loop() {

  int leftVal = analogRead(ldrLeft);
  int rightVal = analogRead(ldrRight);
  int topVal = analogRead(ldrTop);
  int bottomVal = analogRead(ldrBottom);



  int horizontalDiff = leftVal - rightVal;
  int verticalDiff = topVal - bottomVal;



  if (abs(horizontalDiff) > threshold) {
    int steps = map(abs(horizontalDiff), 0, 1023, 0, maxSteps);  // Map
diff to steps
    if (horizontalDiff > 0) {
      // Move left
      stepperHorizontal.step(-steps);
    } else {
      // Move right
      stepperHorizontal.step(steps);
    }
  }
```

```
  if (abs(verticalDiff) > threshold) {
    int steps = map(abs(verticalDiff), 0, 1023, 0, maxSteps);  // Map diff to steps
    if (verticalDiff > 0) {

      stepperVertical.step(-steps);
    } else {
      // Move up
      stepperVertical.step(steps);
    }
  }

  // Print LDR values for debugging
  Serial.print("Left: "); Serial.print(leftVal);
  Serial.print(" | Right: "); Serial.print(rightVal);
  Serial.print(" | Top: "); Serial.print(topVal);
  Serial.print(" | Bottom: "); Serial.println(bottomVal);

  delay(50);
}
```

TIME VS ROTATION GRAPH:

GREEN: Y AXIS MOTOR

RED:X AXIS MOTOR



Advantages:

Increased Efficiency: Maximizes solar energy capture by tracking the sun.

Low-Cost Implementation: Affordable solution using Arduino and stepper motors.

Precision and Control: Stepper motors ensure accurate panel positioning.

Simple and Flexible Design: Easy to program and customize with Arduino.

Energy Saving: Optimizes solar panel performance, reducing power needs.

Applications:

Solar Power Plants: Enhances energy efficiency by tracking the sun for large-scale solar farms.

Residential Solar Systems: Improves energy generation in home solar installations.

Solar-Powered Vehicles: Used in solar-powered cars, boats, or drones to maximize solar energy capture.

Agricultural Solar Systems: Powers irrigation or greenhouses by ensuring efficient energy use in agriculture.

RESULT AND DISCUSSION

Result:

After the successful completion of the project we observed that the solar tracker:

1) was capable of self-operating,
2) was capable of tracking the space with higher brightness,
3) Electrical energy from the solar panel can be stored in a capacitor and used for applicable purposes (for e.g. Mobile charging)

Discussion:

The prototype of the dual axis solar tracker was made according to the circuit diagram. The output of the project was as per the expectation. The solar panel moved itself in the direction of maximum intensity of light. It remained unmoved when equal intensity of light was focused on the LDRs.

The electrical energy from the solar panel was stored in the capacitor and it was used for charging mobile.

CONCLUSION

The project has presented a means of tracking the sun's position with the help of microcontroller and LDR sensors. Especially it demonstrates a working solution for maximizing solar cells output by positioning a solar panel at the point of maximum light intensity. The attractive feature of the designed solar tracker is simple mechanism to control the system.

As solar power production is used in large scale worldwide so, even an increment in efficiency by 1% than stationery plane will increase the net power production by large amount. Hence, no matter by how much tracker increases an efficiency it is always welcomed...