PROJECT REPORT

(COMPUTER ORGANIZATION & ARCHITECTURE)

B.Tech (CSE) Semester V

AUTOMATED SOLAR PANEL CLEANER

SUBMITTED TO:

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OBJECTIVE

Solar panels, although efficient in converting solar energy to electricity, face significant performance degradation when dust, dirt, or other pollutants accumulate on their surface. Manual cleaning of solar panels can be labor-intensive, time-consuming, and impractical for large-scale installations. This project aims to develop an automated cleaning system that detects dirt accumulation using light intensity sensors and cleans the panel using a servo motor-controlled wiper mechanism. The goal is to maintain the solar panels' efficiency while minimizing human intervention.

INTRODUCTION

Solar energy has become a primary source of renewable energy globally. Solar panels operate efficiently only when their surface is clean and unobstructed, allowing maximum sunlight to reach the photovoltaic cells. Accumulation of dust, especially in areas prone to high pollution or sandstorms, can reduce the efficiency of a solar panel by up to 20-30%. Traditional cleaning methods rely heavily on human effort or expensive automated solutions, which may not be feasible in remote or large-scale setups.

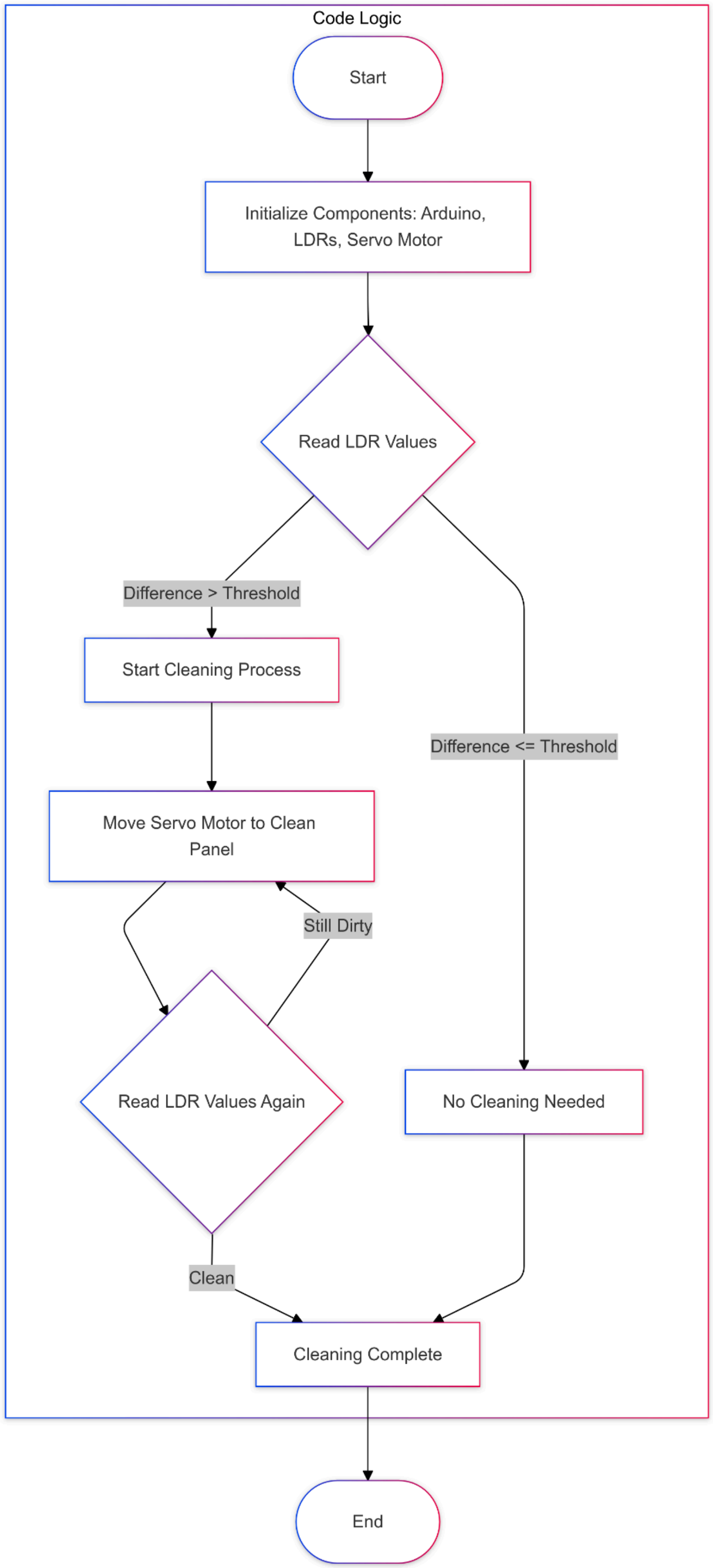
In this project, we propose a simple and cost-effective automated cleaning mechanism using a pair of light intensity sensors (or LDRs) and a servo motor. The system compares the light intensity readings from a clean reference surface and the solar panel. If the difference between the two values exceeds a predefined threshold, the cleaning system activates a wiper mechanism driven by the servo motor to clean the panel.

WORKING

The working of the system is divided into the following steps:

1. **Initialization**: The system initializes the light intensity sensors and the servo motor.
2. **Data Collection**: The light intensity values are read from two sensors:
    - **Clean Sensor**: Measures light intensity from a clean surface (reference).
    - **Dirty Sensor**: Measures light intensity from the solar panel.
3. **Comparison**: The difference between the two values is calculated.
    - If the difference exceeds the threshold, the panel is considered dirty, and the cleaning process is initiated.
    - If the difference is below the threshold, no cleaning is required.
4. **Cleaning Process**: The servo motor drives the wiper mechanism to clean the panel.
5. **Recheck**: After cleaning, the light intensity values are read again to confirm that the panel is clean.
6. **Completion**: Once the panel is clean, the system waits for the next reading cycle.

FLOWCHART


Code Logic
Start
Initialize Components: Arduino, LDRs, Servo Motor
Read LDR Values
Difference > Threshold
Start Cleaning Process
Difference <= Threshold
Move Servo Motor to Clean Panel
Still Dirty
Read LDR Values Again
No Cleaning Needed
Clean
Cleaning Complete
End

HARDWARE COMPONENTS AND PROGRAMMING LANGUAGE

Hardware Components:

- **Arduino Uno**: Microcontroller used to process sensor data and control the servo motor.
- **Light Intensity Sensors (LDRs)**: Two sensors used to measure light intensity on clean and dirty surfaces.
- **Micro Servo Motor**: Used to move the wiper mechanism for cleaning the solar panel.
- **Solar Panel**: A test panel to simulate dirt accumulation and cleaning.
- **Power Supply**: Provides power to the Arduino and servo motor.
- **Resistors:** Used with LDRs in a voltage divider circuit to convert changes in light intensity into a measurable voltage.
- **Breadboard**: A prototyping platform for connecting components without soldering, allowing flexible testing of the circuit.
- **Connecting Wires**: Jumper wires (male-to-male and male-to-female) used to connect sensors, servo motors, and other components to the Arduino.

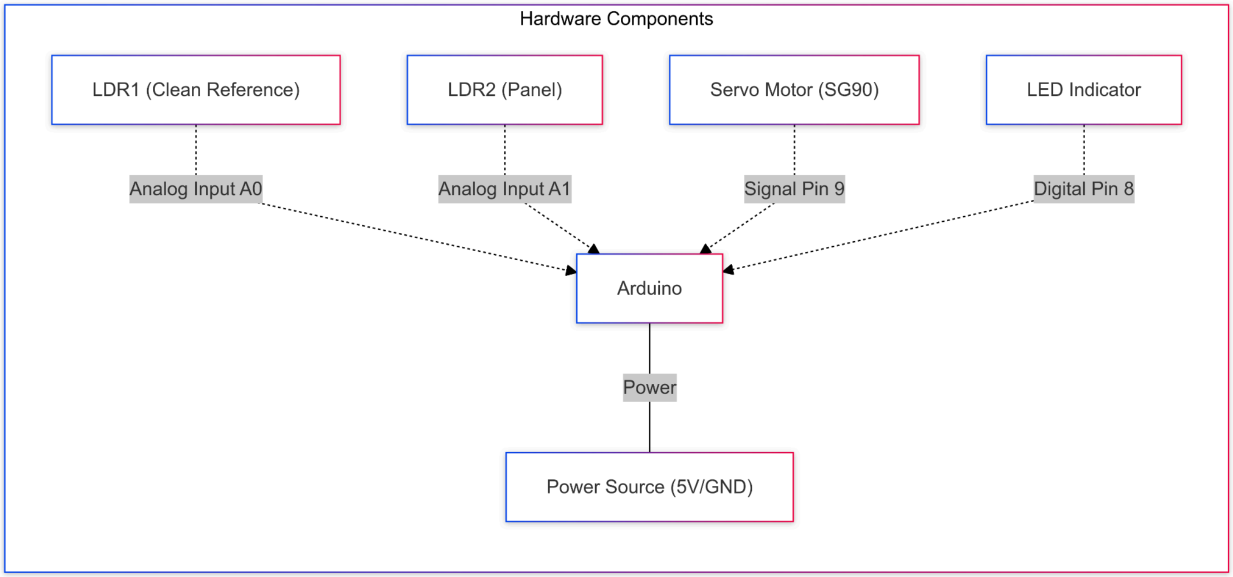
Programming Language:

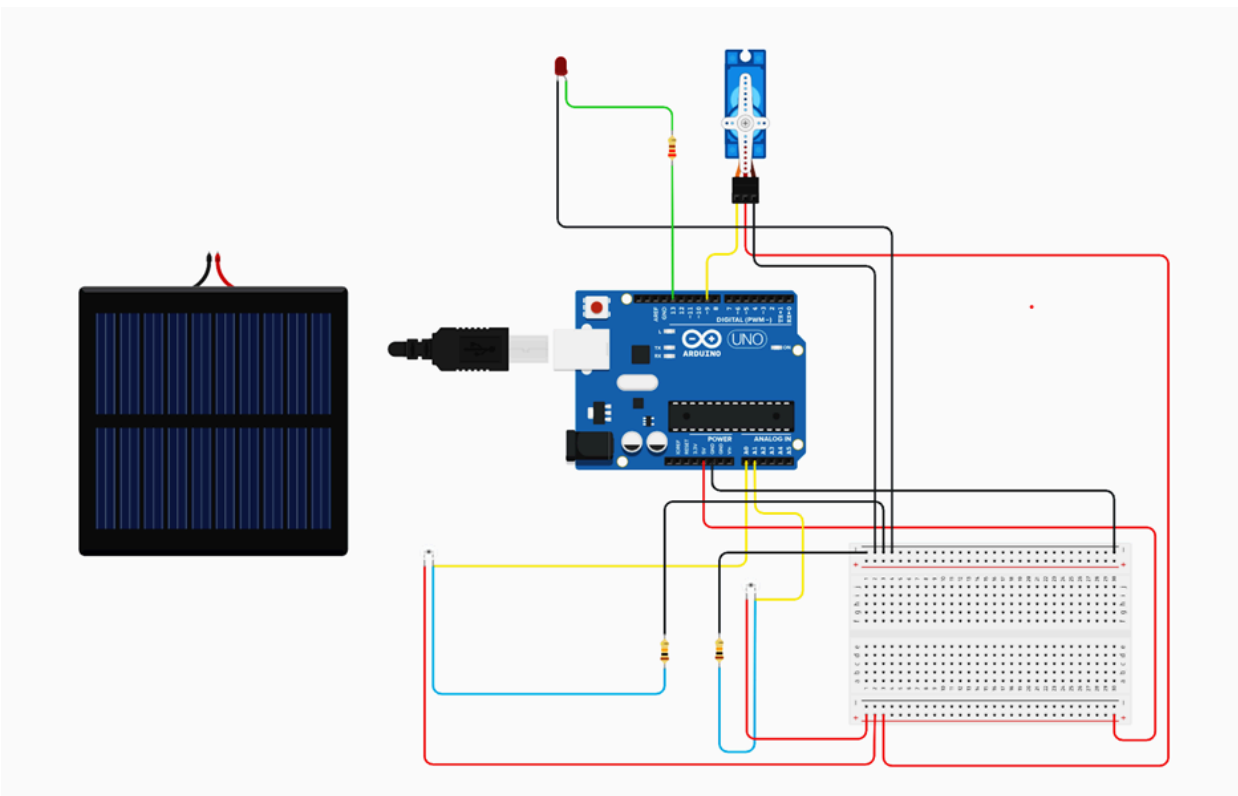
- **C++**: The Arduino IDE uses C++ for programming the microcontroller.

CIRCUIT / BLOCK DIAGRAM

The system includes the following connections:

- **Arduino**: Serves as the central controller.
  - **Clean Sensor**: Connected to analog input A0.
  - **Dirty Sensor**: Connected to analog input A1.
  - **Servo Motor**: Connected to digital PWM pin 9 for movement.
- **Power Supply**: Powers the Arduino and servo motor.


Hardware Components
LDR1 (Clean Reference)
LDR2 (Panel)
Servo Motor (SG90)
LED Indicator
Analog Input A0
Analog Input A1
Signal Pin 9
Digital Pin 8
Arduino
Power
Power Source (5V/GND)



CODE AND OUTPUT

```
#include <Servo.h>

Servo sg90;
int cleanLDR = A0;
int panelLDR = A1;
int errorMargin = 5;
int servoPin = 9;
int cleaningStart = 0;
int cleaningEnd = 180;
int cleaningSpeed = 15;

void setup() {
  sg90.attach(servoPin);
  pinMode(cleanLDR, INPUT);
  pinMode(panelLDR, INPUT);
  sg90.write(cleaningStart);
  delay(2000);
  Serial.begin(9600);
}

void loop() {
  int cleanIntensity = analogRead(cleanLDR);
  int panelIntensity = analogRead(panelLDR);
  int intensityDifference = cleanIntensity - panelIntensity;

  if (intensityDifference > errorMargin) {
    Serial.println("Cleaning required...");
```

```
    startCleaning();
  } else {
    Serial.println("Panel is clean.");
  }

  delay(2000);
}

void startCleaning() {
  for (int pos = cleaningStart; pos <= cleaningEnd; pos++) {
    sg90.write(pos);
    delay(cleaningSpeed);
  }
  for (int pos = cleaningEnd; pos >= cleaningStart; pos--) {
    sg90.write(pos);
    delay(cleaningSpeed);
  }
}
```

OUTPUT

When the program is uploaded to the Arduino:

1. The **Serial Monitor** will display:
   - Light intensity values from both sensors.
   - The calculated difference between the two readings.
   - A message indicating whether cleaning is required.
2. If the panel is dirty, the servo motor activates and the cleaning process is logged in the Serial Monitor.

CONCLUSION

This project demonstrates a simple, efficient, and automated approach to cleaning solar panels. By using light intensity sensors to detect dirt and a servo motor to clean the panel, the system eliminates the need for manual cleaning. It is scalable and can be adapted for various sizes of solar installations. Furthermore, the design is cost-effective and energy-efficient, making it an ideal solution for maintaining solar panel efficiency in remote or large-scale installations.

Future improvements could include integrating water spraying mechanisms or using solar-powered batteries to make the system completely self-sustainable.

REFERENCES

[1] **Arduino Documentation**:
Arduino, "Arduino Documentation," [Online]. Available: https://www.arduino.cc. [Accessed: Nov. 22, 2024].

[2] **Basics of Servo Motors**:
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SparkFun Electronics, "Light Intensity Sensors," [Online]. Available: https://www.sparkfun.com. [Accessed: Nov. 22, 2024].