Smart Protecting Roof Impervious to Sun and Rain using Arduino

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ABSTRACT: Modern human existence should be smarter, simpler, easier, and much more comfortable given that we live in an era of advanced technology and electronics. So, to decrease everyday chores and responsibilities, there is a need for numerous automated systems in daily life. Here, a smart automated roof-protecting system is a great example of one of these systems which is very useful. The development of a smart roof-protecting system designed to protect buildings, agricultural fields, poultry farms, terrace gardens, universities or working companies and in hospitals from the harmful effects of rain and sun. The proposed system is based on an Arduino Uno and utilizes various sensors and actuators to monitor and control the roofing system. The system is capable of detecting rain and automatically closing the roof to prevent water from entering the building. Additionally, it can monitor the intensity of the sun and adjust the angle of the roof to provide shade and reduce the amount of heat entering the building.

The proposed system provides a cost-effective solution for protecting buildings from the elements while also reducing energy consumption and increasing comfort. This technology is becoming increasingly popular in industries such as construction, agriculture, and transportation, where outdoor equipment is frequently exposed to rain, sun, and other weather elements. The system's effectiveness was evaluated through various tests and simulations, and the results show that it can effectively protect buildings and agricultural fields from rain and sun while also reducing energy consumption.

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INTRODUCTION:

Roofing systems play a critical role in protecting buildings from the elements. Rain and sun can cause significant damage to buildings, leading to high repair costs and reduced comfort for occupants. Conventional roofing systems typically rely on manual intervention to protect buildings from the elements. For example, building occupants must manually close windows or adjust blinds to prevent water from entering the building during rain or to reduce the amount of heat entering the building during sunny weather. However, these manual interventions can be inconvenient and time-consuming, leading to potential damage to the building and discomfort for occupants.

To address this issue, we have proposed the development of smart roofing systems that can automatically monitor and control the roofing system based on weather conditions. These systems can help reduce energy consumption, increase comfort, and protect agricultural fields, poultry farms, terrace gardens, universities, or working companies and in hospitals from the elements. With the innovative roof that protects crops with the ongoing development of technology, a fresh and creative method of crop protection has arisen. In the agricultural sector, a roof that is resistant to the corrosive effects of the sun and rain can assist to preserve the durability and prosperity of crops. In this comparable project, we are concentrating on installing such a roof in colleges and hospitals so that people may stroll pleasantly in the sheds when the sun or rain comes the roof helps in resistance to rain and sunlight. This project aims to provide an overview of the smart protection roof impervious to rain and sun system, including its components, benefits, and potential applications. We will also explore the potential impact of this technology on the construction industry.

The smart protection roof impervious to rain and sun system has the potential to provide significant benefits to occupants, protecting the building from the harmful effects of harsh weather conditions and reducing repair and maintenance costs. As this technology continues to develop, it is likely to become an increasingly important aspect in agricultural fields and poultry farms, contributing to a more sustainable and resilient built environment.

- Smart protecting roof is something which helps us to resist sun and rain and we construct in such a way that it can be easily tilted or opened or closed as per the requirement of the user.
- It detects the direction of sun and rain and make changes to the roof accordingly.
- In case of sunlight:
  - Sensor detects whether the sun is in EAST or WEST direction, and make changes accordingly. It either tilts or opens or closes as per the requirement.
- In case of Rain:
  - Rain sensor detects the rainfall and accordingly the shed opens or closes or tilts.

Background of the System:

The use of smart technology in building automation has become increasingly popular in recent years. One area where smart technology can have a significant impact is in the design and implementation of smart roofing systems. These systems can help protect buildings and other agricultural fields and pedestrians from the elements, reduce energy consumption, and increase occupant comfort. One such system is the smart roof impervious to rain and sun using Arduino Uno.

In addition to buildings, this technology can also have various applications in other fields such as agriculture, poultry farms, hospitals, and other working companies and universities.

- For example, in agriculture, smart roofing systems can help protect crops from extreme weather conditions such as heavy rain, and sun exposure. They can also be used to control the temperature and humidity levels in greenhouses and other agricultural facilities.
- In poultry farms, smart roofing systems can help regulate the temperature and humidity levels in chicken coops, ensuring optimal conditions for the birds. They can also be used to protect the birds from extreme weather conditions such as heavy rain and sun exposure.
- In hospitals and other working companies and universities, smart roofing systems can help reduce energy consumption and increase occupant comfort. They can be used to control the temperature and humidity levels in buildings, ensuring optimal conditions for patients, employees, and students. They can also be used to protect buildings from extreme weather conditions such as heavy rain and sun exposure, reducing the risk of damage to the building and its contents.

Problem Definition:

Traditional roofing systems require manual intervention to protect buildings from rain and sun exposure. This manual intervention can be time-consuming and inconvenient, leading to potential damage to the building and discomfort for occupants. Additionally, traditional roofing systems are not optimized for energy efficiency, which can result in increased energy consumption and associated costs. Furthermore, in fields such as agriculture, poultry farms, hospitals, and other working companies and universities, there is a need for effective protection against extreme weather conditions such as heavy rain and sun exposure. These conditions can have a
significant impact on the health and productivity of crops, animals, and people.

To address these issues, there is a need for a smart roofing system that can automatically detect and respond to changes in weather conditions, protecting from rain and sun exposure while reducing energy consumption and increasing occupant comfort. The system should be cost-effective, easy to install and maintain, and suitable for various applications such as agriculture, poultry farms, hospitals, and other working companies and universities.

**OBJECTIVES:**

The objectives of this project are to develop a smart roofing system impervious to rain and sun using Arduino Uno that can be used in various applications such as agriculture, poultry farms, hospitals, and other working companies and universities. Specifically, the objectives of this project are:

1. To design and implement a smart roofing system that can automatically detect rain and close the roof to prevent water from entering the building or facility.

2. To design and implement a smart roofing system that can monitor the intensity of the sun and adjust the angle of the roof to provide shade and reduce the amount of heat entering the building or facility.

3. To evaluate the effectiveness of the proposed smart roofing system through simulations and experiments in various applications such as agriculture, poultry farms, hospitals, and other working companies and universities.

4. To demonstrate the feasibility and cost-effectiveness of the proposed smart roofing system as a viable solution for protecting buildings and facilities from the elements and reducing energy consumption in various applications such as agriculture, poultry farms, hospitals, and other working companies and universities.

**METHODOLOGY/PROCEDURE:**

**Step 1: Components**

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Sensor</td>
<td>2</td>
</tr>
<tr>
<td>LDR Sensor</td>
<td>2</td>
</tr>
<tr>
<td>Servo Motor</td>
<td>1</td>
</tr>
<tr>
<td>Jumper Wires</td>
<td>2 sets</td>
</tr>
<tr>
<td>Arduino Uno</td>
<td>1</td>
</tr>
<tr>
<td>Wooden Structure</td>
<td>1</td>
</tr>
<tr>
<td>Cardboard</td>
<td>1</td>
</tr>
<tr>
<td>Wood Gum</td>
<td>1</td>
</tr>
<tr>
<td>Double side Plaster</td>
<td>1</td>
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</tbody>
</table>
Step-2: HARDWARE CONNECTIONS

- Take an Arduino UNO board.
- Connect the Rain Sensors to the Arduino UNO board.
- Connect the LDR Sensors to the Arduino UNO board.
- Connect the Servo motors to the Arduino UNO board.

1. **RAIN SENSOR CONNECTIONS:**
   - We are incorporating two rain sensors to work in either direction.
   - Connect both rain sensors to the respective modules.
   - Connect the VCC pin of both modules to the 5V of the Arduino UNO board.
   - Connect GND pin of both modules to the GND of the Arduino UNO board.
   - Connect the Analog Output (AO) pin of both modules to the analog input of the Arduino board pin no.2,3.

**Rain Sensor:**
It has 3 pins to be connected.

<table>
<thead>
<tr>
<th>RAIN SENSOR-1</th>
<th>RAIN SENSOR-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC → 5V in Arduino UNO board</td>
<td>VCC → 5V in Arduino UNO board</td>
</tr>
<tr>
<td>GND → GND in Arduino UNO board</td>
<td>GND → GND in Arduino UNO board</td>
</tr>
<tr>
<td>Digital Output → pin 2</td>
<td>Digital Output → pin 3</td>
</tr>
</tbody>
</table>
CIRCUIT DIAGRAM

WORKING OF RAIN SENSOR:

- As described above, we make hardware connections and run code accordingly.
- In this procedure, we are using two rain sensors which are placed exactly opposite to each other and we will place servo motors near each sensor.
- Let’s name them as Rain-1, Rain-2 (placed at East, West) and servo-1, servo-2.
- Two servo motors are initially set at 0° angle of rotation.
- When the rain fall is in East, Rain sensor-1 which is placed at East will detect the direction of Sun and the Servo-1 rotates 180° in clockwise direction.
- When the rain fall is in West, Rain sensor-2 which is placed at West will detect the direction of Sun and the Servo-2 rotates 180° in clockwise direction.
- And as soon as the rainfall stops, sensor will automatically preset and attain 0° angle of rotation.

LDR SENSOR CONNECTIONS:

- We are incorporating two LDR sensors to make the prototype work and detect in either direction.
- Connect both sensors to the breadboard.
- Connect one end of both sensors to 10KΩ resistors.
- Ground the other pin of both resistors.
- Connect the 2nd end of LDR sensors to A0, A1 of Arduino UNO board.
**SUN SENSOR:**
It has 2 ends to be connected.

<table>
<thead>
<tr>
<th>LDR-1</th>
<th>LDR-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; end → A0 in Arduino UNO board</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; end → A1 in Arduino UNO board</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; end → GND in Arduino UNO board</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; end → GND in Arduino UNO board</td>
</tr>
</tbody>
</table>

**CIRCUIT DIAGRAM:**
SERVO MOTOR CONNECTIONS:
- We are incorporating two Servo motors in opposite directions.
- Connect the brown wire of both Servomotors to GND.
- Connect the red wire of both Servomotors to 5V of the Arduino UNO board.
- Connect the Orange wire of the Servomotor to pins no.9,10 of the Arduino UNO board respectively.

<table>
<thead>
<tr>
<th>SERVO MOTOR-1</th>
<th>SERVO MOTOR-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>BROWN ➔ GND in Arduino UNO board</td>
<td>BROWN ➔ GND in Arduino UNO board</td>
</tr>
<tr>
<td>RED ➔ 5V in Arduino UNO board</td>
<td>RED ➔ 5V in Arduino UNO board</td>
</tr>
<tr>
<td>ORANGE ➔ pin 9</td>
<td>ORANGE ➔ pin 10</td>
</tr>
</tbody>
</table>

STEP 3: CONSTRUCTION OF ROOF
- First, we place the four rods in the four directions of the shed by using iron or any metal.
- Then the roof is made using cloth.
- The cloth is placed in such a way that it opens or closes as per the user’s requirement based on the rotation of the servo motor.
- The sensors detect the direction of sun and rain and make changes to the roof accordingly.
  - **In the case of sunlight:**
    - LDR sensor detects whether the sun is in the EAST or WEST direction, and makes changes accordingly. It either tilts or opens or closes as per the requirement.
  - **In case of Rain:**
    - Rain sensor detects the rainfall and accordingly the shed opens or closes or tilts.

RESULTS AND DISCUSSION:

PICTURE OF RAIN SENSOR CONNECTIONS:
We are using two rain sensors which are placed exactly opposite to each other and we will place servo motors near each sensor.

Let’s name them as Rain-1, Rain-2 (placed at East, West) and servo-1, servo-2.

Two servo motors are initially set at 0° angle of rotation.

When the rainfall is in the East, Rain sensor-1 which is placed in the East will detect the direction of Sun and Servo-1 rotates 180° in the clockwise direction.

When the rainfall is in the West, Rain sensor-2 which is placed in the West will detect the direction of the Sun and the Servo-2 rotates 180° in the clockwise direction.

And as soon as the rainfall stops, the sensor will automatically preset and attain a 0° angle of rotation.

PICTURE OF LDR SENSOR CONNECTIONS:

We are using two LDR sensors which are placed exactly opposite to each other and we will place servo motors near each sensor.

Let’s name them as LDR-1, LDR-2 (placed at East, West) and servo-1, servo-2.

Two servo motors are initially set at 0° angle of rotation.

As the Sun will be in the East during the morning, LDR-1 which is placed in the East will detect the direction of Sun and the Servo-1 rotates 180° in the clockwise direction.

And as the Sun will be in the West during the evening, LDR-2 which is placed in the West will detect the direction of Sun and the Servo-2 rotates 180° in the clockwise direction.

And as soon as the Sun shifts from East to West, LDR-1 automatically presets and servo-1 attains a 0° angle of rotation and the same follows in the case of LDR-2.
INTEGRATED CIRCUIT CONNECTIONS:

CONCLUSION:
The development of a smart roofing system impervious to rain and sun using Arduino Uno has the potential to revolutionize the way buildings are protected from the elements. The proposed system provides a cost-effective and efficient solution to the problem of manual intervention required by traditional roofing systems. By automatically detecting and responding to changes in weather conditions, the smart roofing system can protect occupants from extreme weather conditions, while reducing energy consumption and increasing occupant comfort.

Furthermore, the proposed system has various applications in agriculture, poultry farms, hospitals, and other working companies and universities.

- In agriculture, the system can help protect crops from extreme weather conditions, regulate temperature and humidity levels in greenhouses, and increase productivity.
- In poultry farms, the system can provide optimal conditions for the birds, ensuring their health and productivity.
- In hospitals and other working companies and universities, the system can reduce energy consumption and increase occupant comfort, ensuring a healthy and productive environment.

The evaluation of the proposed smart roofing system through simulations and experiments in various applications has demonstrated its feasibility and cost-effectiveness. The system can be easily installed and maintained, making it a viable solution for protecting buildings and facilities from the elements and reducing energy consumption.

Future Scope:
The proposed smart roofing system that is impervious to rain and sun can be further improved and optimized for various applications. For example, the system can be integrated with other smart building technologies such as lighting, HVAC, and security systems to provide a complete smart building solution. The system can also be optimized for specific applications such as greenhouses or animal shelters to provide maximum productivity and efficiency.

Moreover, the system can be further developed to incorporate predictive analytics and machine learning algorithms to improve its
accuracy and efficiency. By analysing weather patterns and occupancy data, the system can predict weather conditions and adjust the roof angle accordingly, ensuring maximum protection and comfort. In addition, the proposed system can be further extended to provide real-time monitoring and control using mobile applications and web-based interfaces. This will allow users to monitor and control the system remotely, providing greater convenience and accessibility.

Accordingly, the development of a smart roofing system impervious to rain and sun using Arduino Uno has significant potential for various applications. With further development and optimization, this technology can revolutionize the way buildings are protected from the elements and contribute to a more sustainable and efficient future.

REFERENCES:


CODES OF APPENDIX:

```cpp
#include <Servo.h>

Servo servo1; // Servo motor 1
Servo servo2; // Servo motor 2
int rainPin = A0; // Analog input pin for rain sensor
int rainThreshold = 500; // Threshold value for detecting rain
int delayTime = 500; // Delay time in milliseconds for servo movement

const int ldr1Pin = A1; // LDR sensor 1 pin
const int ldr2Pin = A2; // LDR sensor 2 pin
const int threshold = 175; // Threshold value for detecting sunlight

void setup() {
  servo1.attach(9); // Attach servo motor 1 to pin 9
  servo2.attach(10); // Attach servo motor 2 to pin 10
  pinMode(rainPin, INPUT); // Set the rain sensor pin as input
  Serial.begin(9600); // Start serial communication
}

void loop() {
  int rainValue = analogRead(rainPin); // Read the rain sensor value
  Serial.print("Rain Sensor Value: "); // Print the rain sensor value
  Serial.println(rainValue);

  if (rainValue > rainThreshold) {
    servo1.write(0); // Rotate servo motor 1 clockwise
    servo2.write(180); // Rotate servo motor 2 anticlockwise
    Serial.println("Rain detected, moving servos");
    delay(delayTime); // Wait for servo movement to complete
  } else {
    int ldr1Value = analogRead(ldr1Pin); // Read the value from LDR sensor 1
    int ldr2Value = analogRead(ldr2Pin); // Read the value from LDR sensor 2
  }
}
```
if (ldr1Value >= threshold) {
    Serial.println("Sunlight detected by LDR 1");
    servo1.write(180); // Rotate servo motor 1 clockwise
} else {
    Serial.println("No sunlight detected by LDR 1");
    servo1.write(0); // Rotate servo motor 1 anticlockwise
}

if (ldr2Value >= threshold) {
    Serial.println("Sunlight detected by LDR 2");
    servo2.write(180); // Rotate servo motor 2 clockwise
} else {
    Serial.println("No sunlight detected by LDR 2");
    servo2.write(0); // Rotate servo motor 2 anticlockwise
}

delay(750); // Wait for 750ms before reading LDR sensors again