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Solar Tracking and Automatic Sprinkler Irrigation

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Abstract

Solar energy is an increasingly popular renewable energy source, however, maximizing its efficiency is crucial for long- term energy production. This project focuses on designing and implementing a Solar Tracking and Automatic Sprinkler Irrigation system to improve solar panel efficiency and automate plant watering. The objective is to develop a system that can track the sun's movement and adjust the position of the solar panels accordingly to maximize efficiency. Additionally, the system will automatically water plants based on specified parameters to improve plant growth. The system utilizes a microcontroller, sensors, motors, and a water pump to achieve these duties. The project's results show improved solar panel efficiency and increased plant growth due to the automated irrigation system. Overall, the development of prototype systems presents an innovative solution to enhance renewable energy production and agricultural practices.

1. Introduction

In recent times, the importance of sustainable agriculture practices has been increasingly recognized, leading to the development of innovative technologies aimed at improving crop productivity and water conservation. Solar tracking systems have gained popularity for their ability to optimize energy efficiency in solar panels, while automatic sprinkler irrigation systems have revolutionized the way water is distributed in agricultural fields. This project aims to develop a solar tracking and automatic sprinkler irrigation system that utilizes a combination of solar panels, DC water pump, Arduino UNO microcontroller, LDR sensor, lithium-ion battery, and soil moisture sensor. By harnessing the power of renewable energy sources, the system will be able to efficiently track the movement of the sun and adjust the position of the solar panels accordingly to maximize energy generation [1]. Additionally, the automatic sprinkler irrigation feature will enable precise and timely watering of plants based on real-time soil moisture readings, ensuring optimal growth and health [2]. Through the integration of innovative technologies and sustainable practices, this project seeks to address the challenges faced in traditional plant care methods and provide a user-friendly solution for plant enthusiasts and agricultural practitioners [3].

By combining the benefits of solar tracking and automatic irrigation, this system aims to promote environmental sustainability, reduce manual intervention, and enhance productivity in plant maintenance [4]. The goal of this project is to create a robust and efficient system that will revolutionize the way we approach plant care and contribute to a greener and healthier future [5]. Figure 1 shows the block diagram of Solar Tracking and Automatic Sprinkler Irrigation.

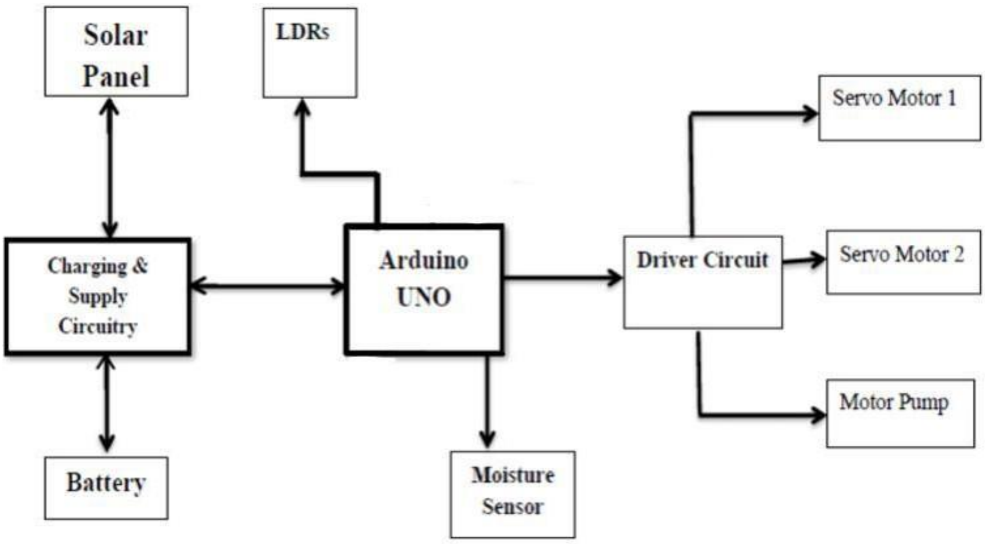


Figure 1 *Block diagram of solar tracking and automatic sprinkler irrigation system.*

2. Materials and Methods

2.1 Block Diagram

The block diagram of the Solar Tracking and Automatic Sprinkler Irrigation system consists of the following components: solar panel, LDRs, Arduino UNO, Driver Circuit, Servo Motor 1, Servo Motor 2, Battery, Moisture Sensor and Motor Pump. The solar panel is used to charge the battery, which supplies power to the system. The LDRs are used to detect the light intensity, and the moisture sensor is used to detect the moisture level in the soil. The Arduino UNO is used to control the system, and the driver circuit is used to drive the servo motors. The servo motors are used to adjust the position of thesolar panel and the sprinkler. The motor pump is used to pump water from the reservoir to the sprinklers.

2.2 Operational Flowchart

Solar tracking and automatic sprinkler irrigation are two technologies that can be used to improvethe efficiency of agricultural operations. Based on Figure 2, solar tracking involves rotating solar panels throughout the day to maximize their exposure to sunlight, while automatic sprinkler irrigationuses sensors to monitor soil moisture levels and automatically water crops when needed. This system works by first measuring the sunlight intensity. If the intensity is low, the system rotates the solar panels to maximize sunlight exposure. Additionally, the system monitors soil moisture levels and activates the sprinkler system when the soil moisture is low. This combination of technologies can help farmers save time and money, while also reducing their environmental impact.

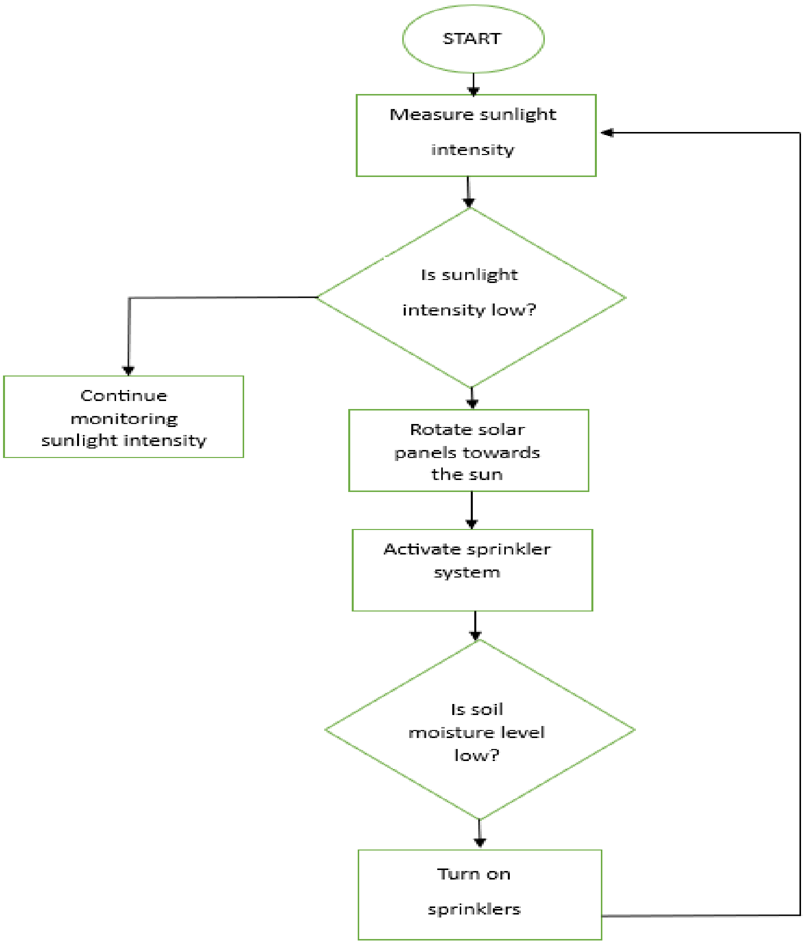
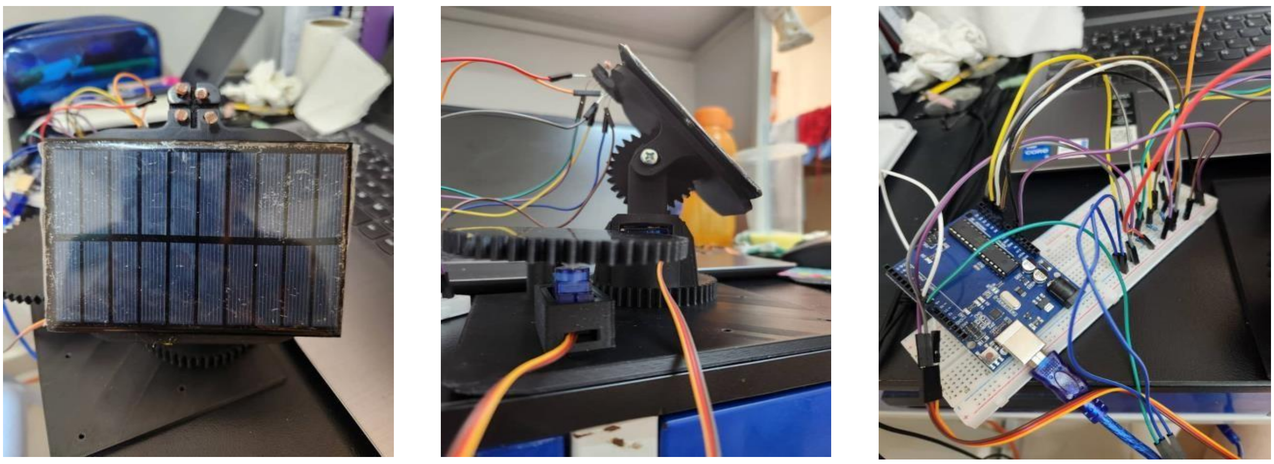


Figure 2 *Operational flowchart of solar tracking and automatic sprinkler irrigation system.*

3. Results and Discussions

3.1 Hardware Development

Figure 3 shows the prototype of the project. This prototype has been designed with several specifications to solve the problem of this project. All the components have been installed to the model suitable for the design that has been made. The figure shows the view from front view, side view and the circuit that been placed in the prototype.



(a) (b) (c)

Figure 3 *Prototaip of Solar Tracking system shows the (a) front view, (b)side view,* *and (c) the circuit placement in the prototype.*

3.2 Software Development

Project operation is developed using Arduino IDE. Figure 4 shows that the program has been implemented in this project. Software development for this project is important to ensure the overall system functions smoothly. Thus, the code that has been created to operate this system will work according to the flowchart as shown.

```
#include <Servo.h>
Servo horizontal; // horizontal servo
int servoh = 180;
int servohLimitHigh = 175;
int servohLimitLow = 5;
// 65 degrees MAX

Servo vertical; // vertical servo
int servov = 45;
int servovLimitHigh = 100;
int servovLimitLow = 1;

// LDR pin connections
// name = analogpin;
int ldrlt = A0; //LDR top left - BOTTOM LEFT <--- BDG
int ldrrt = A3; //LDR top right - BOTTOM RIGHT
int ldrld = A1; //LDR down left - TOP LEFT
int ldrrd = A2; //ldr down right - TOP RIGHT

int soil_moisture = A4;

void setup() {
  pinMode(A4, INPUT);
  Serial.begin(9600);
  pinMode(8, OUTPUT);
  pinMode(7, OUTPUT);
  pinMode(6, OUTPUT);
  horizontal.attach(10);
  vertical.attach(11);
  horizontal.write(180);
  vertical.write(45);
  delay(500);
}
```

```
void loop() {
  soil_moisture = analogRead(A4);
  Serial.println(soil_moisture);
  if(soil_moisture < 100) {
    digitalWrite(8, HIGH);
    digitalWrite(7, LOW);
    digitalWrite(6, HIGH);
  }
  else {
    digitalWrite(8, LOW);
    digitalWrite(7, HIGH);
    digitalWrite(6, LOW);
  }

  int lt = analogRead(ldrlt); // top left
  int rt = analogRead(ldrrt); // top right
  int ld = analogRead(ldrld); // down left
  int rd = analogRead(ldrrd); // down right
  int dtime = 10;
  int tol = 90; // dtime=diffirence time, tol=toleransi
  int avt = (lt + rt) / 2; // average value top
  int avd = (ld + rd) / 2; // average value down
  int avl = (lt + ld) / 2; // average value left
  int avr = (rt + rd) / 2; // average value right
  int dvert = avt - avd; // check the diffirence of up and down
  int dhoriz = avl - avr;// check the diffirence og left and rigt
```

Figure 4 *Program Development*

3.3 Simulation

Figure 5 shows a simulation that has been made in TinkerCad to check the program that has been made. In this simulation, the LDR and soil moisture sensor is used to provide information to the Arduino UNO atmega328p microcontroller. The Arduino will receive the input and give instructions tothe output, which is a DC motor, and a DC fan represented by an LED. Based on Figure 5, this project has undergone initial testing before the actual circuit is connected. During this phase, the code was tested to ensure that it fits the project's requirements.

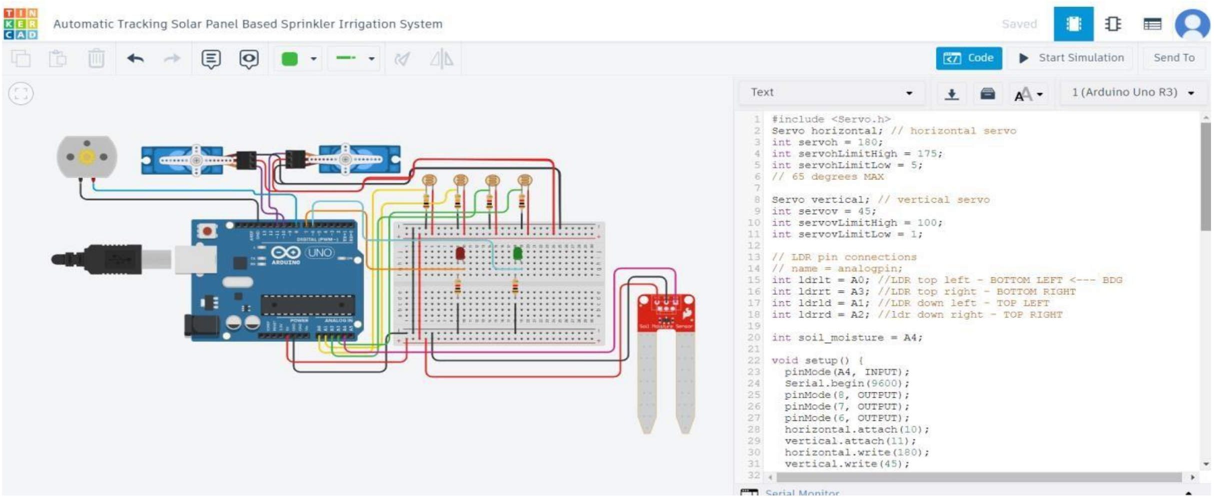


Figure 5 *Simulation on Tinkercad*

3.4 Result and Verification

Table 1 below shows specific soil moisture levels at which the sprinkler system turns on or off, along with the corresponding states of the motor and LEDs. When the moisture level is below 100, the motor is set too high, the green LED is on, and the sprinkler is on. When the moisture level is above 100,the motor is set too low, the red LED is on, and the sprinkler is off.

Table 1 System verification results

Condition	LDR	Soil Level	Motor State	LED
SprinklerTurns On	Senses Light	30	High	Green
SprinklerTurns On	Senses Light	75	High	Green
SprinklerTurns Off	Senses Light	101	Low	Red
SprinklerTurns Off	Senses Light	150	Low	Red
SprinklerTurns On	Senses Light	30	High	Green

4. Conclusion

This project has been successfully developed to enhance the efficiency of watering plants and maximizing solar energy utilization for improved plant growth. Through the integration of solar tracking technology and automatic sprinkler irrigation system, the project aims to optimize the irrigation process and ensure that plants receive adequate water and sunlight. The conclusion of this project indicates that the solar tracking system effectively tracks the movement of the sun to maximize solar energy absorption, while the automatic sprinkler system efficiently waters the plants based on their specific needs. Preliminary testing shows that the system can effectively manage plant irrigation and solar tracking, leading to improved plant growth and health. The methodology used in the development of this project has proven to be effective, providing a reliable system for plant care. Overall, this project successfully achieves its goal of enhancing plant growth and sustainability through the integration of solar tracking and automatic sprinkler irrigation systems.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Felicia Tang B. Y.;* ***data collection:*** *Felicia Tang B. Y.;* ***analysis and interpretation of results:*** *Felicia Tang B. Y., Ahmad Alabqari M. R.;* ***draft manuscript preparation:*** *Felicia Tang B. Y., Ahmad Alabqari M. R., Tengku Nadzlin T. I. All authors reviewed the results and approved the final version of the manuscript.*

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