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Smart Indoor Plantation System Using Soil Moisture Sensor and Light Dependent Resistor Sensor

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ABSTRACT

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Plantation methods, including hydroponics, have been extensively used in agriculture. They also employed a time-based irrigation system for the plant. The goal of this project was to create a self-sustaining indoor plantation system that uses soil moisture sensor data to control the flow of water when the sensor detects that the soil is almost dry. Soil conditions are monitored, and crops are irrigated more efficiently with the help of this new technology. Water is conserved by just watering the plants when they absolutely need it, rather than watering them continually all the time as the traditional method would require. Light-dependent resistors are used to measure the brightness of the surroundings in this project. As a result, the grow light will be activated when the ambient light level drops. With the help of a soil moisture sensor and a light-dependent resistor (LDR), one can create a system that automatically waters and lights plants. Finally, the soil moisture sensor collects data for the sprinkler system and displays it on the LCD screen, and then the appropriate measures are taken. When the soil's humidity level is high, the water that flows will be stopped.

1. Introduction

1.1. Project Background

As the human population grows and space becomes an issue in the twenty-first century, things like houses, interior design, and gardens are becoming more and more vertical [1]. In urban areas, the main purpose of indoor plantation is to produce more crops in a limited space [1]–[5], and the plants are stacked in layers, which are usually integrated into buildings like skyscrapers and warehouses, and they will produce food as with conventional cultivation [6]. Therefore, the towers must be filled with cultivated crops and nutrients, as well as a fusion of natural and artificial light to maintain the perfect light intensity in the room [7]. In conventional cultivation, water and energy consumption are extremely high [8]–[12]. Most of the time, these resources are not being used effectively, but indoor plantations can grow crops with less water than the required amount of normal cultivation [13]. In order to resolve this problem, an Automated Indoor Plantation System using Light Dependent Resistor (LDR) and soil moisture sensor has been introduced.

When plants are subjected to excessive quantities of water, they might get wilted and die [14]. As a result, a soil moisture sensor was implemented to determine the relative wetness of the soil. A signal from the soil moisture sensor is sent to the controller unit to determine if the plant needs water [6][8]. [15]-[18] Humidity levels will be shown on the LCD panel in order to inform the user of soil

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humidity [19]. When the soil is at a low humidity level, the water pump will switch on automatically to water the plants [20]. When the soil is at a high humidity level, the water pump will not switch on to water the plants [14], [21], [22]. Besides that, light plays an important role in the development of a plant [23]. Processes such as photosynthesis depend on the availability of light sources. Photosynthesis occurs as the plant converts light energy into chemical energy to produce glucose, which provides the plant with food and allows it to live, grow, and reproduce. In order to resolve this problem, a light-dependent resistor (LDR) is used to control the light intensity [24]. When the light level decreases, the LDR will send the signal to the controller unit to switch ON the light. When the light level increases, the LDR will not send the signal to the controller unit, and the light will remain off.

In this project, an indoor plantation system with a soil moisture sensor [25] and LDR [24] is designed to reduce waste and minimize human involvement in the system while fulfilling the needs of the plants. At the beginning of the project, we summarized the details of the problem. The objective and scope of the project are discussed and listed. Besides that, we review some general designs for indoor plantation systems from online websites, journals, and books. The research to investigate the flow rate and amount of water needed by the system is discussed. Lastly, the design for the automated indoor plantation system is finalized, and recommendations are discussed for further improvement.

1.2. Problem Statement

The fast growth of the nation has a negative impact on agriculture since agricultural land has been demolished to make way for new housing and commercial space [1], [2], [22], [26]. People who have limited room for gardening might benefit from indoor planting [27]. This type of plantation is suitable for those who have a busy schedule as this system requires the least amount of human attention compared to outdoor plantations. Next, to avoid waste. It is because, usually in the market, they are sold in bunches, but for simple cooking, one only needs a little of that vegetable to cook. Moreover, it will help to save and cut expenses [15]. So, to resolve this problem, automated indoor plantation systems using soil moisture sensors and light-dependent resistors (LDR) have been introduced. Indoor plantations are most suited for plants that don't grow to great heights and may be mounted on walls, fences, balconies or used to pack more plants into a smaller space [28].

1.3. Objectives

The objectives of the project are to create and design a light-dependent resistor and soil moisture sensor-based automatic indoor plantation system (LDR), to configure the soil moisture sensor and the Light Dependent Resistor (LDR) sensor, and to construct an automatic irrigation system for Indoor Plantation System.

1.4. Project Scope

This project is focused on the development of an automated indoor plantation system using soil moisture sensors [25], [29]–[32] and Light Dependent Resistor (LDR) [24], [33]. The scope of our project is Resistive Soil Moisture Sensors, and LDRs will be used to keep tabs on the plants by the system.

1.5. List of Abbreviations and Acronyms

LDR	Light Dependent Resistor	EEPROM	Electrically Erasable Programmable Read Access Memory
LCD	Liquid Crystal Display	SRAM	Static Access Random Memory
GDP	Gross Domestic Product	ADC	Analog to Digital Converter
IDE	Integrated Development Environment	MCU	Microcontroller Unit
USB	Universal Serial Bus	DC	Direct Current
PWM	Pulse Width Modulation	AC	Alternating Current

2. Literature Review

2.1. Methods of Indoor Plantation System

2.1.1. Hydroponic System

Hydroponics is the method of growing plants by using only nutrients, a growing medium, and water [17]. In this technique of gardening, the plants develop without the need for soil [8]. Hydroponics derives its name from the Greek terms "hydro" (water) and "ponos" (work). Fig. 1 shows an example of a hydroponic system that uses a vertical living wall planter.

Fig. 1. Vertical Living Wall Planter

2.1.2. Types of System of Hydroponics

Hydroponic systems range from the rafting system [17], where roots are completely immersed in a nutritional solution, to a watering drip system particularly developed for cactus, and many more variants on that topic.

a. Wick System

The two containers that make up this system are shown in Fig. 2. A medium sits between the plant and the nutritional solution in the upper container. Plant roots may be supplied with nutrients through holes in the top container.

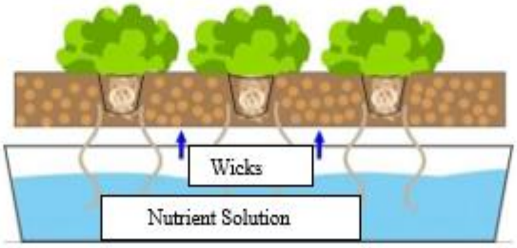

Fig. 2. Wick System

b. System Utilizing a Deep Pot

After filling a container lid with medium, it is placed on top of an empty container of soil solution to begin the process of growing [14]. As shown in Fig. 3, the nutrient feeds the plant by passing through the holes in the growth pot.

c. Raft System

Styrofoam blocks pierced to hold plants are floating in the fertilizer solution in the image shown in Fig. 4 [10]. The roots of the plant extend deep into the solution.

Fig. 3. Deep Pot System

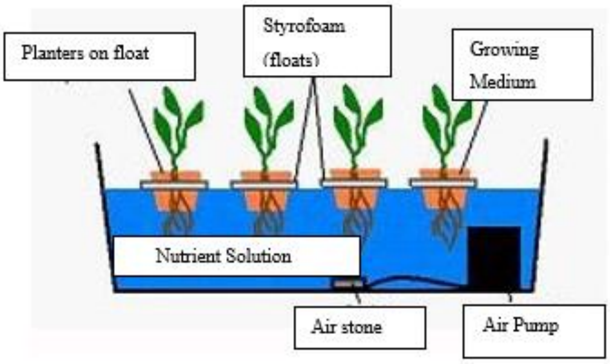

Fig. 4. Raft System

d. Drip System

Fig. 5 depicts a medium including plants in pots or troughs. The nutrient solution is delivered to the plants in a timely manner [34].

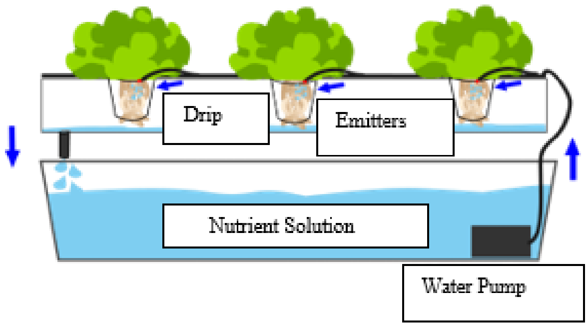

Fig. 5. Drip System

e. Nutrients Film Technique (NFT)

Fig. 6 depicts a continuous 24-hour operating system, where plants are hung in the air, and their roots are soaked in a thin layer of nutritive fluid [22].

f. Aeroponics System

As seen in Fig. 7, plants in an aeroponic system are lifted into the air and misted with a nutritious solution at predetermined intervals.

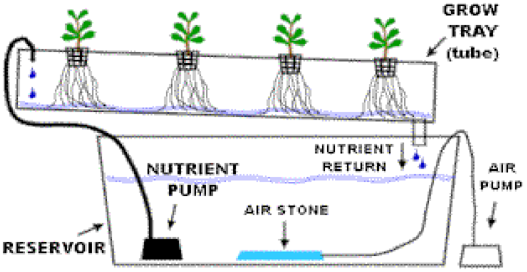

Fig. 6. Nutrients Film Technique.

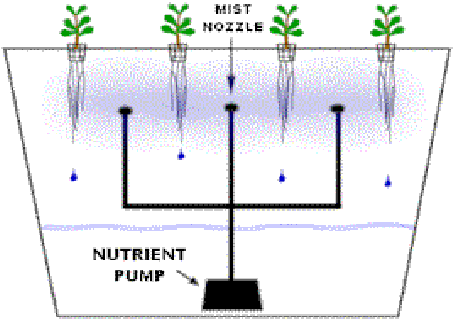

Fig. 7. Aeroponics System.

2.2. Comparison Between Normal Indoor Plantation System and Automated Indoor Plantation System

The automated indoor plantation system using soil moisture sensors and LDR has been compared with normal indoor plantation systems, which are mostly used in hydroponics systems [8], [14], [35], [36]. Basically, hydroponics does not use soil as its medium of gardening as it uses water and nutrients to grow the plants. Meanwhile, automated indoor plantation systems use soil moisture sensors to measure the wetness of the soil [14]. If the soil moisture sensor detects that the soil humidity is low, which means in dry conditions, the system will automatically water the plant. Therefore, the automated indoor plantation system also uses LDR to control the brightness of the grow light, which will automatically open when the LDR detects the darkness in the surrounding [37]. It is much better than normal indoor plantation systems because by using technology, we can reduce humans' work and energy as they automatically work themselves. Moreover, the automated indoor plantation system has a lot of advantages and works very efficiently.

2.3. Comparison of Component Selection

2.3.1. Microcontroller

As a tiny integrated circuit, a microcontroller governs a particular embedded system function [28]. In a typical microcontroller, one'll find a CPU, memory, and peripherals all on the same chip. In addition to robots, automobiles, office machines, household appliances, mobile radio transceivers, vending machines, medical equipment, and microcontrollers may be found in a variety of different devices [37]. They have advanced to the point that microcontrollers can now be used in more complicated applications. The number of possible uses for today's microcontrollers is further increased by the fact that many of them can be programmed. There are three types of Arduino controllers, which are the Arduino Uno R3, the Arduino Nano, and the Arduino Mega. These types of Arduinos produce the same function, but they are slightly different in the number of inputs and outputs [34]. Table 1 shows the specifications of different types of Arduino controllers.

For more specifics, in this project, we are using an Arduino Mega, which is an ATmega1280-based microcontroller board. Among its many features are an ICSP header, a power connector, a 16 MHz crystal oscillator, an onboard reset button, and a USB connection. Digital input and output pins: 54 of them can be used for input and output. Fourteen of them can be used for PWM outputs. An AC-to-DC converter, a USB cable, and a battery are all included to get started with the microcontroller.

Table 1. Comparison Between Controllers

Types of Arduino	Uno R3	Nano	Mega
Microcontrollers	ATmega328P	ATmega328	ATmega1280
Recommended Supply Voltage	7-12V	7-12V	7-12V
Operating Voltage	5V	5V	5V
Size	2.7”×2.1”	0.7” ×1.9”	4” ×2.1”
I/O’s	22	14	54
Analog Inputs	8	6	16
Flash Memory	32KB	32KB	128KB
EEPROM	1KB	1KB	4KB
SRAM	2KB	2KB	2KB
Clock Speed	16MHz	16MHz	16MHz
PWM’s	6	6	15

2.3.2. Sensors

When a sensor senses a change in the physical environment, it reacts accordingly [4]. There are a plethora of possible inputs, including light, heat, movement, moisture, pressure, and a slew of other environmental factors. At the sensor site or electronically, the output is often a signal that is converted into a human-readable display for viewing or further processing. There are two types of soil moisture sensors [38]: resistive and capacitive soil moisture sensors. Fig. 8 shows two types of soil moisture sensors.

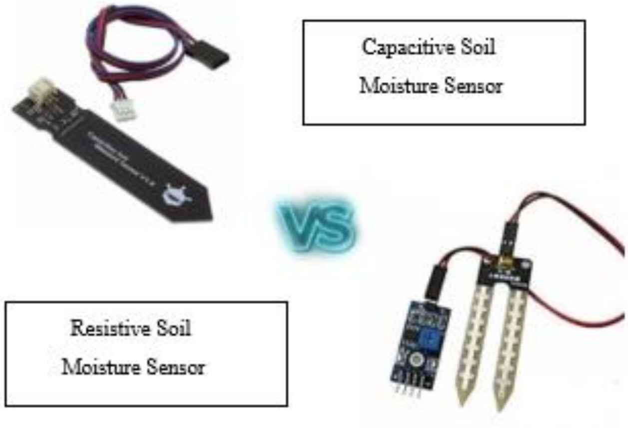

Fig. 8. Types of Sensors for Soil Moisture.

It is necessary to employ a resistive soil moisture sensor with two probes in order to determine the volumetric water content of the soil. To detect soil moisture, two probes are used to enable the current to flow through it, and the resistance value is then calculated. There is less resistance for electricity to flow through the soil when there is a lot of water in it [15]. As a result, there will be a greater degree of wetness. Because soil conducts electricity less well when it is dry, there is more resistance to current flow when the soil is depleted of its water. Consequently, humidity levels will be reduced.

Capacitive soil moisture sensors, unlike other types of soil moisture sensors, employ capacitive sensing to measure soil moisture levels. Corrosion resistance means it will last for a long time in any environment. Additionally, an onboard voltage regulator enables the gadget to function between 3.3 and 5.5 volts [39]. With microcontrollers that function at low voltage, it is possible to employ this component (both 3.3V and 5V logic). The Raspberry Pi requires a converter of ADC in order to work properly.

Corrosion and electrolysis of the sensor probes, not only because they are in direct contact with the soil but also because of a DC current flowing, are important problems with resistive soil moisture meters [36]. A resistive soil moisture sensor is utilized in this experiment to detect the soil's relative humidity. Soil moisture sensors are compared in Table 2.

Therefore, a Light Dependent Resistor, also known as a Photoresistor, as shown in Fig. 9, is utilized in this project as a sensor to detect the brightness of the surroundings [40]. Light-controlled photoresistors are a type of variable resistor. Photoconductivity is the ability of a photoresistor to lower its resistance as the intensity of the light it receives rises [33], [37], [41]. As well as light-sensitive detector circuits, photoresistors may be used in circuits that are triggered by either light or dark [42]. High-resistance semiconductors are used to make photoresistor devices. To put it another way, a photoresistor in the dark may have up to several megohms of resistance (M), but in light, it can only have resistance in the hundreds of ohms range. Table 3 also shows the specifications of the photoresistor.

Table 2. Resistive and Capacitive Soil Moisture Sensors

Types of Soil Moisture Sensor	**Resistive Soil Moisture Sensor**	**Capacitive Soil Moisture Sensor**
Operating voltage	5 V_{DC}	3.3 ~ 5.5 V_{DC}
V_{out}	0 ~ 4.2 V_{DC}	0 ~ 3.0 V_{DC}
Working Current	<20 mA	5 mA
Interface	Analogue	Analogue
Dimension	63×20×8mm	98×22.99mm
Weight	3g	15g

Fig. 9. Photoresistor

Table 3. Specifications Of Photoresistor

Max. voltage	200 V
Max. power dissipation	200 mW
Typ. Resistance	0.7 kΩ
Maximum Resistance	4.5 kΩ
Minimum Resistance	1.8 kΩ
Dark resistance after 5 sec	0.25 MΩ
Dark resistance after 1 sec	0.03 MΩ
Peak wavelength	600 nm

2.3.3. Liquid Crystal Display (LCD)

A display technology that utilizes liquid crystals that open or shut when driven by an electric current is known as a liquid crystal display (LCD) [37]. LCD technology is based on liquid crystals. An important advance in display technology, LCD is utilized in a wide range of consumer goods, such as microwave ovens and laptop computers. Since LCD screens are lighter and thinner, they're chosen over other display technologies [43].

In this project, we use this LCD to display the condition of the water pump, whether it is running or not. There are two lines on the LCD display, and the LCD display can show up to 16 characters, so the LCD display type is 2 by 16. Fig. 10 shows the LCD 16×2.

Fig. 10. LCD 16×2.

Table. 4. Pin Description of Lcd 16×2

Pin	Name of Pin	Details of Pin:
1	Ground, V_{ss}	The ground pin is linked to the system's ground.
2	+5 Volt, V_{dd}	It uses +5V (4.7-5.3 Volts) to provide power to the LCD.
3	Contrast Voltage, V_E	Controls the display's contrast by setting the pixel density. Grounded to make the most of the contrast.
4	Register Select	An interface for swiping data in/out of the microcontroller.
5	Write/Read	For writing and reading data. The LCD is normally grounded while writing data to it.
6	Enable Pin	Using a Microcontroller Pin to flip between 1 and 0 to acknowledge data.
7	Pin 0: Data	It is an 8-bit data line that connects pins 0 to 7. Using a Microcontroller, 8-bit data may be sent. Data pins 4, 5, 6, and 7 will be free if these LCDs are used in 4-bit mode.
8	Pin 1: Data	
9	Pin 2: Data	
10	Pin 3: Data	
11	Pin 4: Data	
12	Pin 5: Data	
13	Pin 6: Data	
14	Pin 7: Data	
15	LED Positive	A positive LED backlighting pin
16	LED Negative	A negative LED backlighting pin

2.4. Process Flow of Indoor Plantation System

An example of this indoor plantation system's workflow is shown in Fig. 11. To begin with, a soil moisture sensor detects the soil's wetness level [35]. This sensor will then transmit the data to the controller unit, which will then determine whether or not the plant needs water. To inform the user of the soil's humidity level, the LCD panel will show the relative humidity [37]. When the soil is at a low humidity level, the water pump will switch on automatically to water the plants. After that, a light-dependent resistor (LDR) will detect the brightness of the surroundings [40]. So, when the light level decreases, the LDR will send the signal to the controller unit to switch ON the light [24]. Next, a flow meter and a check valve are used in this system to measure the volume or mass of liquid and to allow fluid flow only in one direction, respectively. As a final step, the irrigation system uses the data collected by the soil moisture sensor, which is displayed on an LCD screen. The water that flows will stop when the level of humidity in the soil is high, which means in a wet condition.

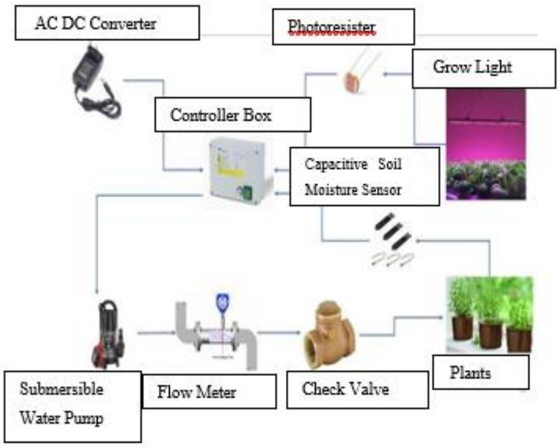

Fig. 11. Process Flow of an Automatic Indoor Plantation System.

3. Method

3.1. System Design of Indoor Plantation System

Soil moisture sensors and light-dependent resistor sensors are used in the Automatic Indoor Plantation System for irrigation and photosynthesis to automatically switch on and off a water pump, as well as grow lamp through relays when they detect soil moisture and ambient lighting [37], [44], [45]. Using this automated indoor planting system has the dual benefit of reducing human intervention while also ensuring optimum watering [14].

System blocks include a microcontroller, a transformer, and a voltage converter, which supply the whole circuit with 12 volts to 240 volts of electricity. Because of this, the Arduino Mega is designed to monitor soil moisture levels based on the sensor's readings [34]. Microcontrollers are designed to compare data from sensors to create output signals that activate the submersible water pump as well as the grow lights [12], [28], [46]. One sensor is put at each step of the planting system for the soil moisture sensor setup. If the sensors detect dry soil, the water pump will automatically start and stop when all sensors detect wetness in the soil [15], [47].

3.2. Control System of Indoor Plantation System

This system is designed as an automated indoor plantation system to help people in urban areas manage their plants with minimum supervision by using sensors [6], [8], [9]. When we conduct the analysis and research on the indoor plantation system, there are a lot of techniques and components that can be used. The resistive soil moisture sensor and the photoresistor module are the two major components in this project that make the system work, as shown in Fig. 12 and Fig. 13. To detect soil moisture, two probes of resistive soil moisture are used to enable the current to flow through it, and the resistance value is then calculated [25]. Water in the soil increases its electrical conductivity, reducing the amount of resistance. As a result, the relative humidity will be greater [19]. Soil with less water conducts electricity less efficiently, resulting in higher resistance to current flow. Consequently, humidity levels will be reduced.

Fig. 12. Resistive Soil Moisture Sensor.

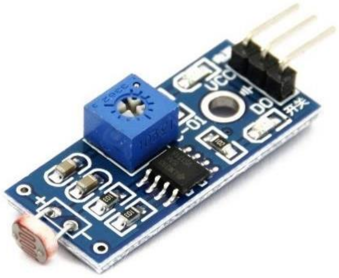

Fig. 13. Photoresistor Module.

The soil moisture sensor is responsible for measuring the wetness level of the soil and transmitting the signal to the controller, which will then turn on the water pump based on the humidity level of the soil [15]. The soil moisture sensor was the first step in this system's workflow since it measures the soil's humidity level. When the soil's humidity level drops, the water pump will switch on and begin pumping out water to irrigate the plants. When the soil's humidity level reaches the maximum specified limit, the water pump will immediately switch off [11]. While the LDR is used to measure the intensity of light [48], When the intensity of light decreases, the LDR’s resistance increases, and it will transmit the signal to the controller to turn ON the light. When the light intensity increases, the light will turn off automatically. Fig. 14 shows the flowchart of the Indoor Plantation System using a soil moisture sensor.

Therefore, we also use a Light Dependent Resistor, also known as a Photoresistor, in this project as a sensor to detect the brightness of the surrounding. A photoresistor is a variable resistor that is controlled by light. In other words, the resistance of a photoresistor reduces as the intensity of the incoming light increases; in other words, it shows photoconductivity as the light intensity increases. It is possible to use a photoresistor in light-sensitive detector circuits as well as in switching circuits that are triggered by light or dark [49]. In the semiconductor industry, a photoresistor is defined as a device with high resistance. If a photoresistor is exposed to darkness, its resistance may be as significant as several megohms (M), but when exposed to light, its resistance can be as minimal as a few hundred ohms.

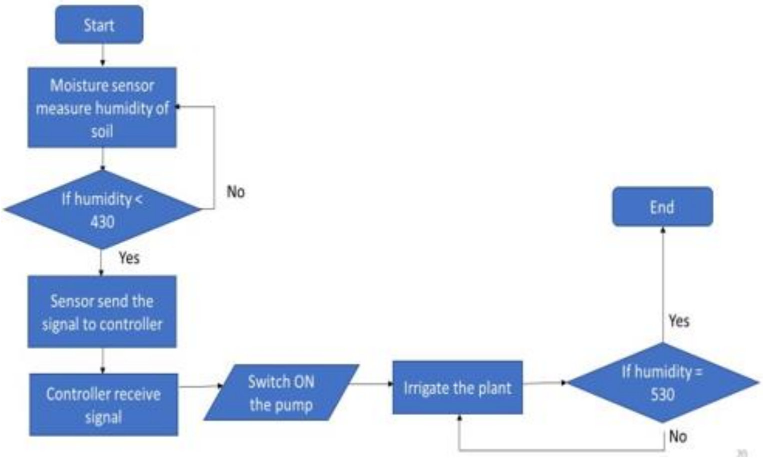

Fig. 14. Flowchart of an Indoor Plantation System Using Soil Moisture.

The photoresistor, also known as the LDR, will start by measuring the light intensity [28]. Next, the sensor will check the brightness condition of the environment if the light intensity is lower than 750, after which it will transmit the information to the control device. After the Arduino receives the signal, the controller will trigger the grow light to turn on, and then the sensor will check the condition again to see if the light intensity is higher than 950, which means bright, then it will turn off the grow light. If the light intensity is lower than 950, then it will keep the grow light on. Fig. 15 shows the flowchart of the Indoor Plantation System using a photoresistor.

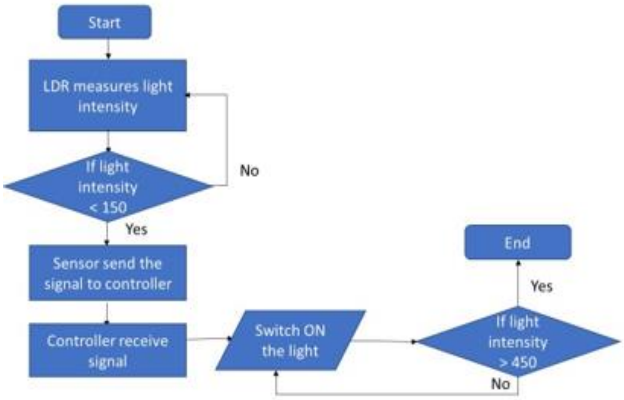

Fig. 15. Flowchart of an Indoor Plantation System Using Photoresistor.

The microcontroller that we used in this system is Arduino. There are many types of Arduinos [37], [41], [50]. For example, Arduino Uno and Arduino Mega. The number of inputs and outputs on each Arduino differs; the Arduino Mega has more inputs than the Uno R3. Fig. 16 shows the Arduino Mega.

Arduino programs may be created in any computer language using compilers that generate machine code for the target CPU. Using the Java programming language, Arduino is a platform-independent open-source electronics prototyping platform [46]. When writing an Arduino program, it is referred to as "Sketch" when using the IDE (integrated development environment). The *ino* file extension is used to save sketches on the development machine. The pre-1.0 version of the Arduino IDE (IDE) stored sketches with the *pde* extension. Special constraints on code organization are used by the Arduino IDE to accommodate the C and C++ languages [34]. The Arduino IDE includes a wiring software package that enables a wide range of standard output and input processes.

Programmable code may be loaded onto Arduino boards using *avrdude* software, which converts executable code into hexadecimal text files. The Arduino Mega's specs are seen in Table 5.

Fig. 16. Arduino Mega.

Table 5. Specifications of Arduino Mega

Microcontroller	ATmega2560
DC Current for 3.3V Pin	50 mA
Digital I/O Pins	16
Flash Memory	256 KB
Analog Input Pins	16
Operating Voltage	5V
Input Voltage (limits)	6-20V
DC Current per I/O Pin	40 mA
Clock Speed	16 MHz
SRAM	8 KB
Input Voltage (recommended)	7-12V
EEPROM	4 KB

3.3. Circuit Design of an Automatic Indoor Plantation System

The system's circuit configuration may be seen in Fig. 17. The sensors are used as an input to this system, while the water pump and grow light are used as an output. The Arduino Mega was used to receive the signal from the sensors and trigger the relay after they met the condition that had been set. The LCD is used in this system to display the condition of the water pump, whether it is on or off. Fritzing software was used to sketch the circuit, as shown in the figure.

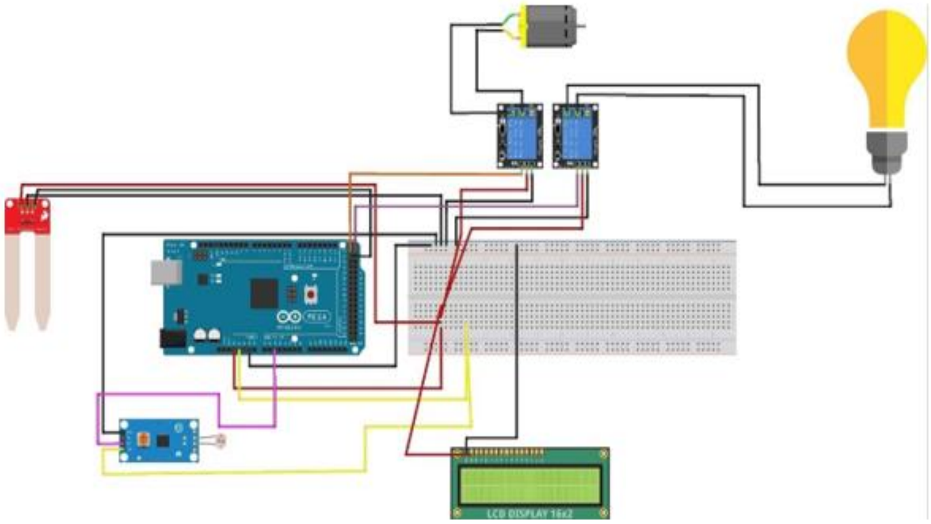

Fig. 17. Circuit Design of an Automatic Indoor Plantation System

3.4. Coding of an Arduino

Soil moisture and LDR sensors' coding may be shown in Fig. 18. It is possible for the soil moisture sensor to trigger the water pump to switch on at times of low soil moisture, while it is possible for the sensor to switch off when the soil moisture is high. For the LDR, the grow light will turn on when the condition is less than or equal to 900 and turn off when the condition is higher than the value that has been set.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd (0x27, 20,21);

int RelayPump = 22;
int sensor = 24;
int sensor2 = 26;
int sensor3 =28;
int ldr = A2;
int RelayLamp = 23;
int a =0;
int val, val2, val3;

void setup(){
   lcd.init();
   lcd.backlight();
   Serial.begin (9600);
   pinMode (RelayPump, OUTPUT);
   pinMode (24, INPUT);
   pinMode (26, INPUT);
   pinMode (28, INPUT);
   pinMode (RelayPump, OUTPUT);
}

void loop(){
    val = digitalRead (24);
    val = digitalRead (26);
    val = digitalRead (28);
    a = analogRead (ldr);
    Serial.printIn (a);
    delay (500);
    {
         if (val | | val2 | | val3 == HIGH){
             digitalWrite (RelayPump, LOW);
             lcd.setCursor (0,0);
             lcd.print (“Water Pump is ON);
        }
         else{
             digitalWrite (RelayPump, HIGH);
             lcd.setCursor (0,0);
             lcd.print (“Water Pump is OFF);
        }
    }

    {
        if (a <=900){
            digitalWrite (RelayLamp, HIGH);
        }
        else{
            digitalWrite (RelayLamp, LOW);
        }
    }
}
```

Fig. 18. Coding of an Automatic Indoor Plantation System

4. Results and Discussion

4.1. Plant Growth's Outcome

As shown in Fig. 19, Fig. 20, and Fig. 21, there is a result for the growth of the plants during the testing of our prototypes, which is from day 1 until day 10. There are three types of plants planted at different stages, which are mint at stage one, rosemary at stage two, and parsley at stage three.

Fig. 19. Plant Growth's Outcome: Day 1

Fig. 20. Plant Growth's Outcome: Day 5

Fig. 21. Plant Growth's Outcome: Day 10

Based on the observation, there was a slightly different growth of plants for each pot in each stage due to the volume of water irrigated in each pot. Some pots did not get the same amount of water as the other pots. This problem was solved by adjusting the level of the sprinkler so that each pot gets the same amount of water, which is 500 ml. Table 6 shows the result of the volume of water that irrigates through each pot for two minutes.

Table 6. Volume Of Water Irrigate for Each Pot in Two Minutes

Type of Pot	Part 1 (ml)	Part 2 (ml)	Part 3 (ml)
Pot A	600	550	300
Pot B	500	500	600
Pot C	500	500	500
Pot D	500	500	400

4.2. Commissioning and Testing

Table 7 shows that all testing has been done several times before the final program of Arduino is being done. Each component is manually tested before being assembled into the prototype with the full program.

Table 7. Commissioning And Testing

Electrical Part	Test	Result
Resistive Soil Moisture Sensor	Connect to the power supply and check the signal with a reading voltage of multi-meter	Sensors work and give the output in voltage
MCBs and ELCBs	Short circuit checking method	The current is cut off completely
Power Supply (Converter AC to DC)	Connect to the input (Plug) and measure the output and the continuity by using the multimeter	The supply is in requirement condition. The output is correct. Continuity is checked and connected properly
Arduino	Connect and program it to the supply	Arduino works
Grow Light LED	Connect the supply and check the output lamp	Grow Light turns on.
Water Pump	Connect the AC supply and check the water flow	Water pump works

4.3. System Voltage and Current Measurement

The system of the prototype used a 240 VAC and a 24 VDC supply. Therefore, maintaining the normal voltage of the converter, Arduino, water pump, relay, etc., is necessary to maintain the level of the current flow in the circuit.

4.3.1. Prototype’s Measurement of Voltage and Current in the circuit: DC Circuit

Table 8 shows the voltage and current data measured from the system in direct current (DC).

Table 8. Voltage And Current at Controller DC

DC Controller	Voltage (V)	Current (A)
Arduino	9	0.29
LCD	4.9	2.29
Converter	24	5.0
Relay	5.0	1.18
Water Pump	24.0	4.5

4.3.2. Prototype’s Measurement of Voltage and Current in the circuit: AC Circuit

Table 9 shows the voltage and current data measured from the system in alternated current (AC).

Table 9. Voltage And Current at Controller AC

AC Controller	Voltage (V)	Current (A)
RCCB	236	40.0
MCB C6	236	6.0
MCB C20	236	20.0
Grow Light LED	220	27.3mA

4.4. Ethical Consideration

In order for us to complete our project, several work ethics should be followed. The priority was safety precautions while doing our project. Safety is the most important thing for students to follow to make sure that there will be no accidents in the workplace. The safety of the component must also be a priority because the use of low-spec or non-standardized components will result in prototype damage. The system has also been protected by an ELCB, MCB, and a fuse to prevent the system from short-circuiting or causing an electrical shock to the user. With a pipeline, we will ensure that there are no leakages by using pipe glue or silicon glue because there is an electrical connection between the pipes. The next ethical consideration is university rules. At our university, there are plenty of rules to be followed by students. For example, before getting into a workshop or any laboratory, students should get permission from the supervisor first and wear appropriate PPE (Personal Protective Equipment) to ensure that they are protected from any object that might be harmful. Besides, plagiarism is strictly prohibited in proposal writing because it may prevent the student from thinking creatively and outside the box. Sometimes the ideas from the students are better than the ideas that they found from the references. Some companies may not easily share their data with us because that data might be confidential to them.

5. Conclusions and Recommendations

We were successful in constructing an automated indoor plantation system employing a resistive soil moisture sensor and a light-dependent resistor, which we used in conjunction with other components. The manufacture of mechanical components fulfills the goal set out in the design. The experiment also demonstrated that the electrical system for this prototype's design was very well-designed and functioned. Furthermore, the irrigation of a water system may be used to manage plant development and guarantee that water is accepted equally in all locations. The plants do not need a large quantity of water to survive, but an excessive amount of water will cause the crops to die. Because the soil moisture sensor can figure out how humid a certain area of land is, the water pump can irrigate it with the right amount of water. Therefore, this system is suitable for those who have a hectic schedule and do not have time to monitor the plant. So, this automatic indoor plantation system can help them solve this problem because it requires only minimal human attention and does not need to be monitored every day. In the future, this system will be perfect for planting in the house and leaving the plant for a long time.

There are a few improvements that can be made for the future development of the Automated Indoor Plantation System. Resistive soil moisture sensors can be replaced with higher precision and more precise humidity sensors. Installation of solar panels to provide electricity for the system and reduce its need for grid power. Develop and apply the Internet of Things (IoT) for the mobile application of Automated Irrigation Systems for user-friendly.

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