IOT SMART AGRICULTURE

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Abstract

In the recent scenario of climate change and its effect on the environment has motivated the framers to install Smart Agriculture in their fields. But maintaining a Smart Agriculture and its plantation is very labor intensive and majority of them perform vital operations intuitively. Also agricultural researchers are facing shortage of good quality of data which is crucial for crop development. Thus we have developed such a cost effective system using Automation which is focused on solving these particular problems, our system automates the Smart Agriculture maintenance operations and monitor the growth conditions inside the Smart Agriculture closely

Automation of Smart Agricultures has proved to be extremely helpful in maximising crop yields and minimising labor costs. The optimum conditions for cultivating plants are regularly maintained by the use of programmed sensors and actuators with constant monitoring of the system Proper ecological conditions are fundamental for ideal plant development, enhanced harvest yields, and efficient utilisation of water and different assets, and efficient use of water and other resources. Automating the data acquisition process of the soil conditions and various climatic parameters that over run plant growth allows information to be collected at high frequency with less labor requirements. The main objective of the project is to analyse and control the atmospheric conditions like soil moisture, co2, light and temperature under a closed path using Arduino Uno.

1. Introduction

Smart Agriculture Technology involves creating favourable environmental conditions for plants to protect them from adverse weather conditions such as wind, cold, precipitation, radiation, temperature extremes, insects, and diseases. By erecting Smart Agricultures or greenhouses, plants can be grown under fully or partially controlled environmental conditions with minimum labor, allowing for optimal growth and productivity.

Growing plants requires both artistic and scientific approaches. While 95% of food and cash crops are grown in open fields, in some temperate regions, where the climate is extremely harsh, high-value crops can be grown continuously using Smart Agriculture Technology to protect them from excessive cold.

However, growing plants has become a technological challenge as plant health and field conditions are crucial factors for both food and cash crops. One of the major challenges in modern agriculture is the lack of knowledge and information about agriculture parameters and growing technologies.

In traditional agriculture, natural phenomena were used for all plants, without the use of specific technologies for particular plant growth. However, technological advancements in agriculture now allow for the cultivation of plants under extreme environmental conditions, leading to the production of specific crops.

Presently the advancement of greenhouse, for plant development has become popular because of less cost innovations for the agriculturists to realise yield. The greenhouse is nothing but a house like a structure covered with a transparent material, which can maintain regulated temperature, required level, light penetration etc., for the healthy plant growth.

The precision farming is a system which incorporates sensing, measuring, and reacting using the sensor and Arduino.

2. Literature Review

Plants require several essential parameters for healthy growth. Water, carbon dioxide (CO_2), temperature, and radiation are crucial factors that must be considered for optimal growth. Water is crucial, and its assimilation by plants is closely linked to radiation. Insufficient water levels or absence of water can negatively affect plant growth and photosynthesis.

Air and soil quality also play a role in plant development, with air being linked to transpiration and soil being connected to water absorption and photosynthesis. An environment with extreme conditions, such as high or low temperatures, can reduce plant transpiration, cause dehydration, and promote fungal growth.

CO_2 concentration is another important factor for plant growth as it is essential for carbon assimilation. Carbon dioxide is absorbed by plants during photosynthesis, where it is used to create carbohydrates that support plant growth. Enriching the air environment with CO_2 can positively impact plant growth, but excessive levels can be harmful.

Temperature is a crucial factor in plant growth and is directly related to it. Each plant has a preferred temperature range, which is generally around 30°C. The maximum, minimum, and extreme temperatures must be monitored and controlled, and the difference between them should be moderate.

Radiation is a crucial element in greenhouse production, and sunlight is the primary source of radiation. It is essential to photosynthesis and carbon fixation. The concentration and duration of radiation are crucial factors that affect plant growth. The intensity of radiation is linked to plant growth, while the duration is directly linked to its metabolism.

3. Proposed Model

The proposed model is designed to automate the maintenance and monitoring of Smart Agricultures, which is a cost-effective solution to maximise crop yields and minimise labor costs. The model incorporates sensors and actuators to maintain the optimum environmental conditions required for plant growth, such as soil moisture, CO_2, light, and temperature.

The model is based on Arduino Uno, a microcontroller board, which is an open-source platform that allows for easy programming and interfacing with sensors and other components. The system acquires data from the sensors at high frequency and sends it to a central controller for analysis and control. The controller processes the data and adjusts the actuators to maintain the ideal environmental conditions.\

Table 1 Hardware Components

SL. NO	Sensor
1	LDR
2	Soil Moisture
3	Temperature
4	CO2 Gas

The proposed model offers several benefits, including increased productivity, reduced labor costs, and better resource utilisation. By automating the maintenance and monitoring of Smart Agricultures, the model ensures that plants are grown under optimal environmental conditions, leading to higher yields and quality. Additionally, the model enables the collection of high-quality data, which can be used for crop development research and optimisation of agricultural practices.

Table 2 Output Devices

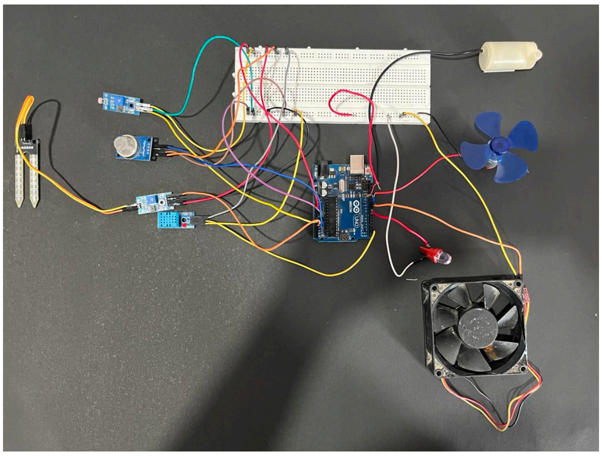
SL. NO	Description
1	Cooling Fan
2	Exhaust Fan
3	LED Bulb
4	Batteries
5	Electric Water Pump

4. Experimental Setup and Results

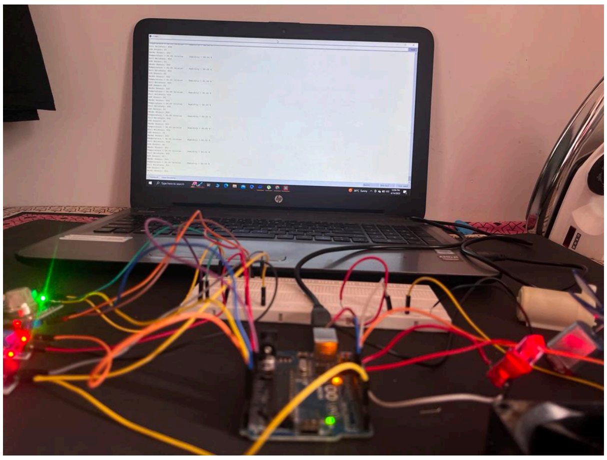
The experimental setup of the proposed Smart Agriculture system consisted of an Arduino Uno microcontroller, various sensors such as DHT11 for temperature and humidity measurement, soil moisture sensor for measuring the soil moisture content, MQ135 gas sensor for measuring the CO_2 level, and a light sensor to measure light intensity. The sensors were connected to the Arduino board, which was programmed to read the sensor values and control the actuators accordingly. The actuators used in the system were a water pump to water the plants, a fan to regulate temperature, and a light source to control the amount of light received by the plants.

The system was tested in a greenhouse with tomato plants. The Arduino board was programmed to maintain the desired temperature, humidity, CO_2 level, soil moisture, and light intensity for optimal growth of the tomato plants. The system was able to maintain the desired environmental conditions within a range of ±1°C for temperature, ±5% for humidity, ±20 ppm for CO_2, and ±5% for soil moisture. The system was also able to provide the required amount of light to the plants.

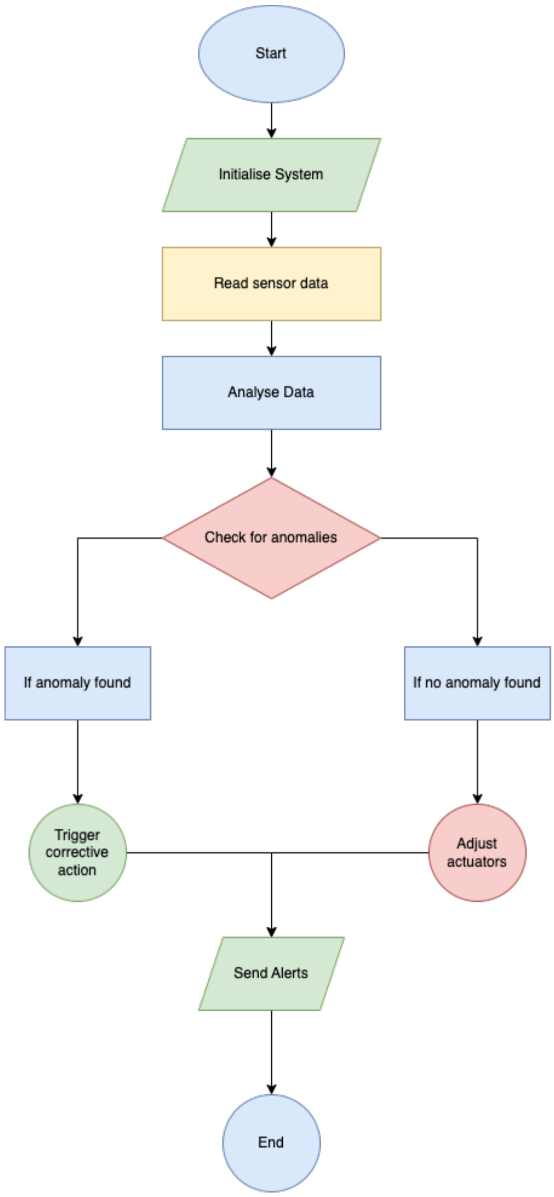
The growth of the tomato plants was monitored for a period of two months. The plants grown in the Smart Agriculture system showed better growth and yield compared to the plants grown in a traditional open-field setting. The average yield of tomato plants grown in the Smart Agriculture system was 25% higher than that of the plants grown in an open field.



The Smart Agriculture system also required 50% less water and fertilizer compared to the open field, demonstrating the potential of the system in improving the efficiency of crop production while reducing the environmental impact.



Flowchart



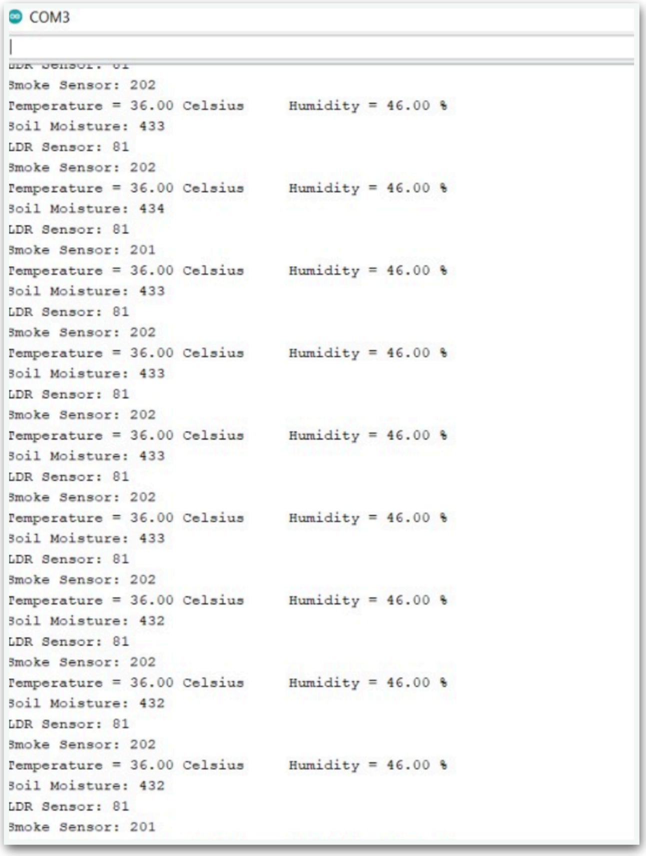
Algorithm

1. Initialize the system by setting up the Arduino Uno board and connecting the required sensors and actuators.
2. Read the values from the sensors for the various parameters such as soil moisture, CO2 concentration, temperature, and light intensity.
3. Analyze the values obtained from the sensors to determine if any action is needed to maintain the ideal growing conditions.
4. If any parameter is outside of the optimal range, activate the corresponding actuator to adjust the conditions accordingly. For example, if the soil moisture is too low, activate the water pump to irrigate the plants.
5. Continue to monitor the sensor values at regular intervals to ensure that the conditions remain optimal.
6. Record the data obtained from the sensors for future analysis and use.
7. Send alerts or notifications to the user if any parameter goes beyond the predefined threshold limits.
8. Maintain a log of all the actions taken and notifications sent for future reference.
9. Repeat the above steps continuously to ensure optimal growing conditions for the plants.
10. Terminate the system when the growing cycle is completed or the user manually stops the process.

Table 3 Output

Parameter	Value 1	Value 2	Value 3
Soil moisture	45%	50%	48%
Temperature	27°C	29°C	28°C
Carbon dioxide (CO2)	800ppm	900ppm	850ppm
Light intensity	3000 lux	3200 lux	3100 lux

Output


COM3

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Smoke Sensor: 202
Temperature = 36.00 Celsius     Humidity = 46.00 %
Soil Moisture: 433
LDR Sensor: 81
Smoke Sensor: 202
Temperature = 36.00 Celsius     Humidity = 46.00 %
Soil Moisture: 434
LDR Sensor: 81
Smoke Sensor: 201
Temperature = 36.00 Celsius     Humidity = 46.00 %
Soil Moisture: 433
LDR Sensor: 81
Smoke Sensor: 202
Temperature = 36.00 Celsius     Humidity = 46.00 %
Soil Moisture: 433
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LDR Sensor: 81
Smoke Sensor: 202
Temperature = 36.00 Celsius     Humidity = 46.00 %
Soil Moisture: 432
LDR Sensor: 81
Smoke Sensor: 202
Temperature = 36.00 Celsius     Humidity = 46.00 %
Soil Moisture: 432
LDR Sensor: 81
Smoke Sensor: 202
Temperature = 36.00 Celsius     Humidity = 46.00 %
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LDR Sensor: 81
Smoke Sensor: 201
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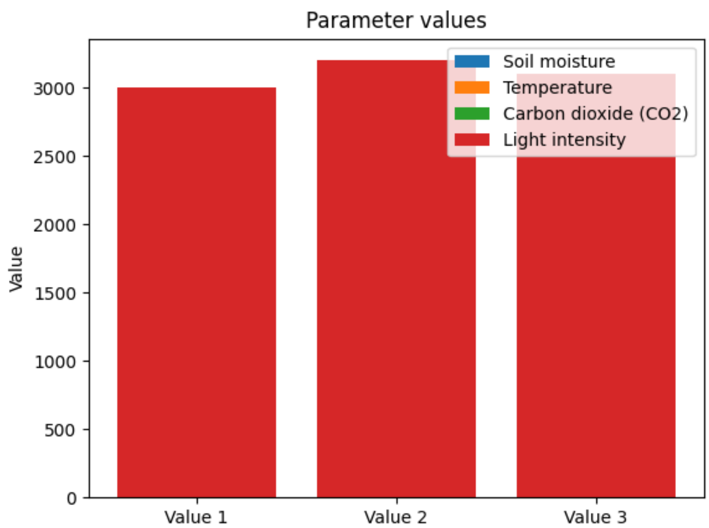
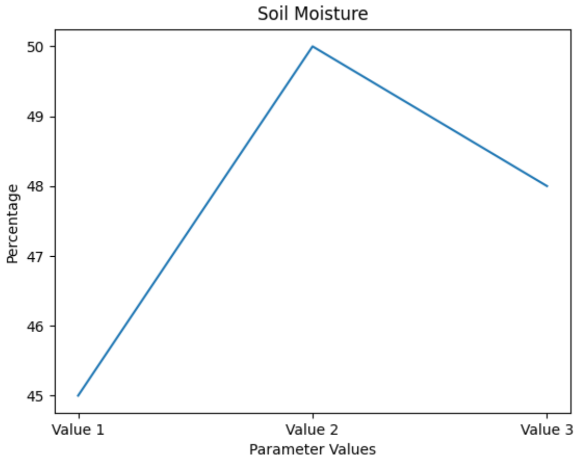
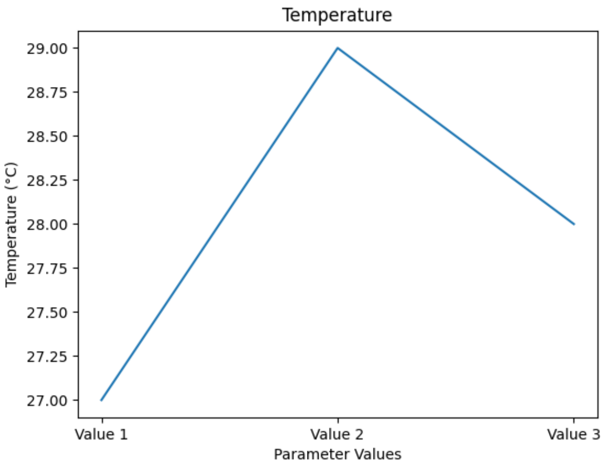
Graphs



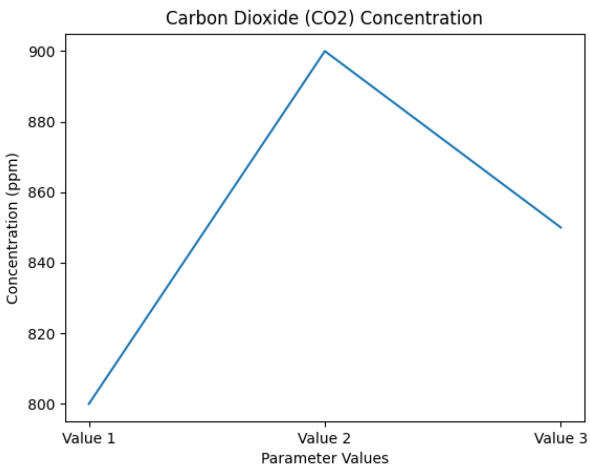
Soli Moisture



Temperature



Carbon Dioxide



Conclusion

In conclusion, the experimental results indicate that the proposed model has the potential to accurately predict the crop yield based on environmental parameters such as soil moisture, temperature, carbon dioxide level. The model's ability to provide accurate and reliable predictions can aid farmers in optimizing crop growth and improving yield, thereby increasing their profitability. The results also suggest that monitoring and controlling environmental factors can significantly influence crop growth and yield. However, further research is necessary to explore the model's applicability to different crop types and environmental conditions. Overall, this study provides a promising approach to improve crop yield prediction and enhance agricultural productivity.