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Smart Greenhouse System using IOT & Crop Recommendation using Machine Learning

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ABSTRACT: Greenhouse is a facility where crops are cultivated in a regulated manner. The available greenhouse systems are human-monitored systems that require constant human visits that cause the worker discomfort and also decrease the yield if the temperature and humidity are not controlled properly and consistently. That paves the way for the concept of greenhouse automation. Greenhouse Automation System, formed by the integration of the Internet of Things and the integrated system, addresses the problems faced in the green house and provides for the automated control and monitoring of the greenhouse environmentto increase the operational rate and minimize the inconvenience caused to farmers. It eliminates the direct control of the human being. The paper also proposes a crop recommendation system using machine learning using the temperature data from greenhouse.

KEYWORDS: Smart Greenhouse system, IOT, Agriculture, Automation, Sensors, Machine Learning, Random forest algorithm

I. INTRODUCTION

The agriculture industry is accountable for fulfilling human's need for food, energy, and shelter to a great extent.Agriculture Modernization has already started by the tech savvy farmers. For the next generation agriculture fields, data collected from sensors would become the fertilizer to grow crops.

There are a variety of problems related to conventional farming practices. Due to lack of awareness among farmers, they are not in a position to carry out their activities precisely.

In order to produce better and more reliable results, a smart greenhouse system will be built that reduces man's work and produces better results. A crop recommendation module will suggest the crop to farmer based on the temperature readings, leading to higher production with less human supervision.

As we know, the greenhouse features environmental parameters such as humidity, temperature, humidity, light, etc. And often because of the lack of awareness among farmers, they are not able to carry out their activities precisely. Typically, they conduct such activities on the basis of their own past observations and their gut feelings, which can lead to unpredictable outcomes for most of the time. So in order to cover it up and to achieve better and more precise outcomes, we developed this system.

II. LITERATURE SURVEY

[1] **Mohammad Ullah(2019)**Internet of Things (IoT) is used for remote monitoring and analysis of data. Also, an android application is developed to display those data in a short range through Bluetooth technology. The system controls the temperature, humidity, and light and soil moisture level by sensing the values from sensors and controlling heaters/coolers, sprayers, bulbs and water pumps accordingly. The proposed system monitors temperature and humidity, soil moisture and take action according to results. The systems do not need any human interaction. It also includes with a database helpful for future analysis and reports. This system is very suitable to be deployed at places like North Pole and winter climate countries where people live but plant does not grow due to heavy winter. If this system is used in those countries, one person can manage multiple Green-houses to grow a vast number of plants due to its efficient use of time and automatic controlling ability. That person will only need

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to monitor about the condition of the green-houses and fix something that cannot fixed by the proposed system such as cutting off any infected leaves of the plants, uprooting any infected trees and so on. Also, IoT will enable a person to monitor from remote distances and efficiently utilize the time and energy.

[2] **RohitRajak(2017)**This method is characterized by a soil database collected from the farm, crop provided by agricultural experts, achievement of parameters such as soil through soil testing lab dataset. The data from soil testing lab given to recommendation system it will use the collect data and do ensemble model with majority voting technique using support vector machine(SVM) and ANN as learners to recommend a crop for site specific parameter with high accuracy and efficiency.

[3] **Devdatta Bondre(2019)**This paper proposes and implements a system to predict crop yield from previous data. This is achieved by applying machine learning algorithms like Support Vector Machine and Random Forest on agriculture data and recommends fertilizer suitable for every particular crop. The paper focuses on creation of a prediction model which may be used for future prediction of crop yield. It presents a brief analysis of crop yield prediction using machine learning techniques

[4] **Hyun Yoe(2017)**A WSN technology was successfully applied to the agricultural sector. Middleware, which can connect WSN hardware, applications, and enterprise systems, is required to construct ubiquitous agriculture environment combining WSN technology with agricultural sector applications, but there have been insufficient studies in the field of WSN middleware in the agricultural environment, compared to other industries. This paper proposes a context-aware middleware to efficiently process data collected from ubiquitous greenhouses by applying WSN technology and used to implement combined services through organic connectivity of data.

[5] **LiaKamelia(2015)**In this paper presents a system to overcome the drawbacks in the current greenhouse monitoring structure. The proposed system in this paper monitors the humidity levels and surrounding temperature and control fans, humidifiers, dehumidifiers and heaters. The designed system has two modes as manual and auto mode. Furthermore, parameter values such as maximum and minimum temperature, maximum and minimum humidity values can be changed by sending a SMS to the system. This system has been developed by using Arduino microcontroller, GSM module and DHT11 temperature/humidity sensor. This design can be used for monitoring and controlling temperature and humidity value via SMS.

Each stage of cultivation required different climatic conditions, so it takes complicated treatments if it done conventionally. In this paper, a comprehensive review of the literatures that deal with the application of automation control technology in chrysanthemum green house. The representative application of each technology as well as its advantages and limitations are discussed Control is conducted base on the factors that affect the greenhouse climate, such as temperature, humidity, and lighting. In the first phase of planting, it will focus to control the irrigation system and temperature control which will automate the operation of the heater and fan for cooling, based on the results of the temperature sensor and humidity sensor. Vegetative phase focused on the control of lighting, irrigation systems and temperature, based on the results of the temperature sensors, humidity sensors and light sensors. While in the flower induction phase it focused on irrigation systems and temperature controlling. The discussions ended with the conclusion and identify several important areas where further research could be done.

III. METHODOLOGY

A. *Analysis:*

Automation of farm activities can transform agricultural domains from being manual and static to intelligent and dynamic leading to higher production with lesser human supervision. The agriculture in the greenhouse is more affected by environmental factors. Key environmental factors for the quality and improved productivity of plant growth are temperature, relative humidity, Lighting, soil moisture and CO2 levels in the greenhouse. Continuous monitoring of these factors offers relevant information on the individual impact of the different factors on the achievement of maximum crop yields.

The system would carry out tasks such as the Smart Light System Using IoT Technology is often used to sense the dark space and the lights are turned on automatically. It automatically turns on the lights when the sunlight is below

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the visible area of our eyes. The temperature sensor senses the temperature of the atmosphere and maintains the temperature in the greenhouse on the basis of the data obtained.

The crop recommendation system recommends crop based on the temperature and Ph data. This is achieved by applying machine learning algorithms like Random Forest on agriculture data(Temperature, Ph) and recommend suitable crop.

IV. SYSTEM DESIGN

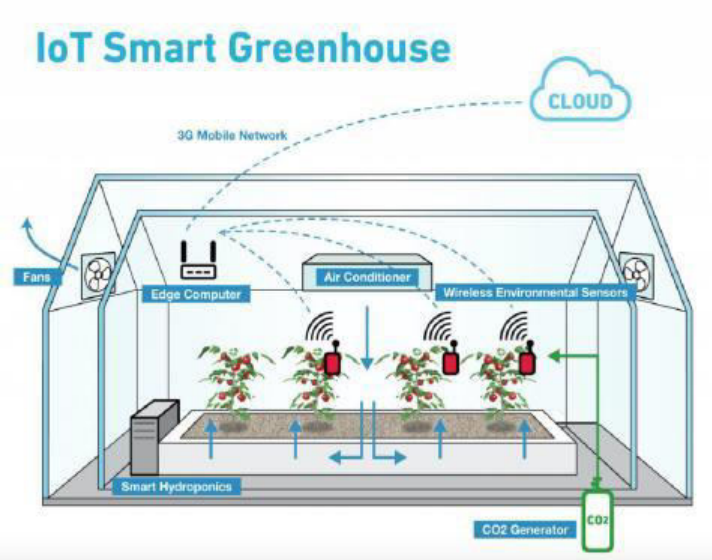

Fig.1.Smart Greenhouse System Structure

Within the greenhouse, soil sensors and other environmental sensors are established inside the greenhouse in order to collect environmental statistics applicable to the greenhouses' crop growth including temperature, CO2 level, and humidity. And soil data like soil humidity, soil moisture.These sensors collectively represent a wireless sensor network to gather environmental and soil records from the greenhouse.

Based on the data collected through various interfaces, the control system in the greenhouse will automatically control the greenhouse system to ensure better growth of the environment for the crops.

1) System Components:

a) Arduino UNO

Fig.2.Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.

It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery.

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b) Light Sensor:

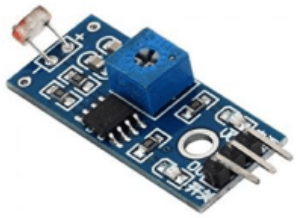

Fig.3.LDR Sensor

Fig.4.PhotoDiode

The values read from LDR sensors are used for detecting light intensity. Based on the intensity value, the lights will be turned on/off in the greenhouse.It is a form of light sensor that converts light energy into electrical energy (voltage/ current).

Photodiode is a type of semi conducting device with PN junction. ... The photo diode accepts light energy as input to generate electric current. It is also called as Photodetector, Photo Sensor or Light Detector.

b) Temperature Sensor:

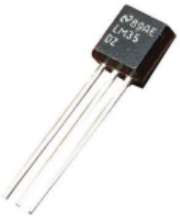

Fig.5.Temperature sensor

Plants require the proper environmental conditions for optimal growth and health. To ensure optimum plant growth, a greenhouse must be maintained at a specific temperature. As a result of this, temperature measurement is required.

The temperature sensor (LM35) will sense the temperature in the greenhouse and according to the values read, it will turn on/off the fan to maintain the temperature.

2) Random Forest:

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemblelearning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model."Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

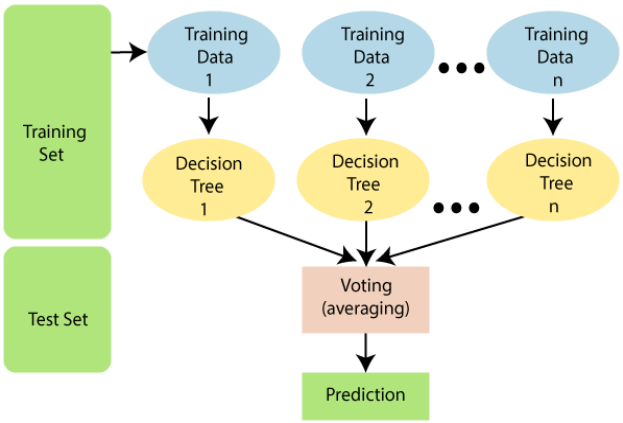

Fig.6. Random Forest Algorithm

Advantages:

- It can also handle large datasets with high dimensionality. It is capable of handling large datasets with high dimensionality.
- It enhances the accuracy of the model and prevents the overfitting issue.

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V. EXPERIMENTALRESULTS

Outcome:

1. Temperature in the greenhouse is maintained in every season.
2. Light gets automatically on when sunlight goes down from a normal eye value.
3. Website of a greenhouse is Easy to used, Reliable, User friendly for the client.

A. Temperature Controlling Module:-

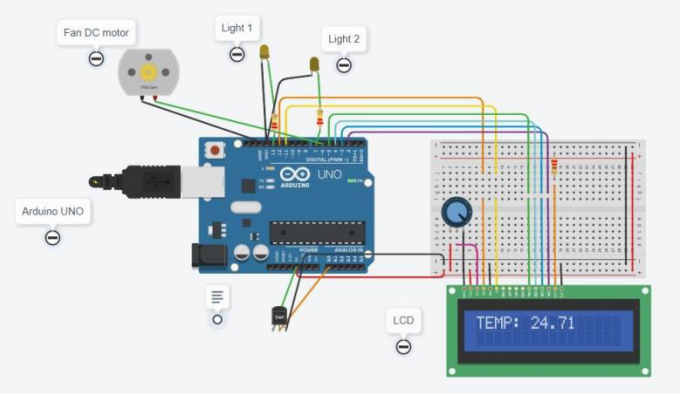

Fig.7. Here, LED1 is ON and LED2 is OFF to maintain the temperature because the temperature in the greenhouse is near to the required temperature.

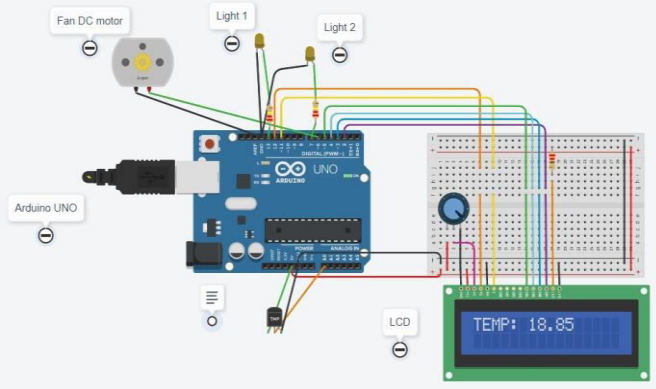

Fig.8. Here, LED1 is ON and LED2 is also ON to maintain the temperature because the temperature in the greenhouse is less than required temperature.

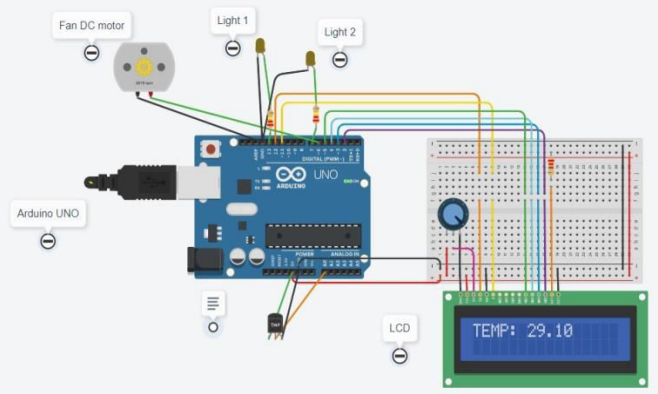

Fig.9. Here, LED1 is OFF and LED2 is also OFF to maintain the temperature because the temperature in the greenhouse is greater than required temperature.

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B. Light Automation module: -

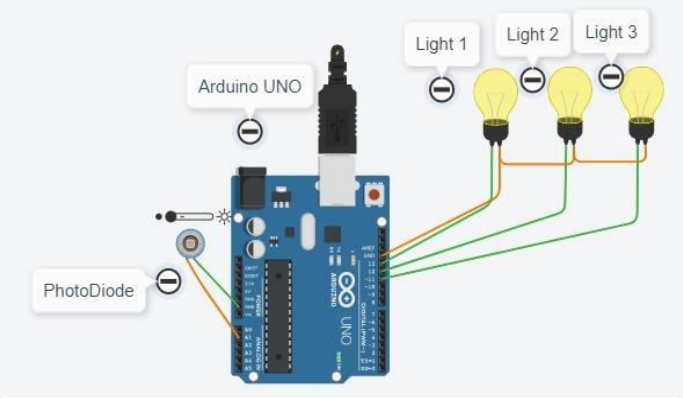

Fig.10. At the night time, LED lights gets on automatically

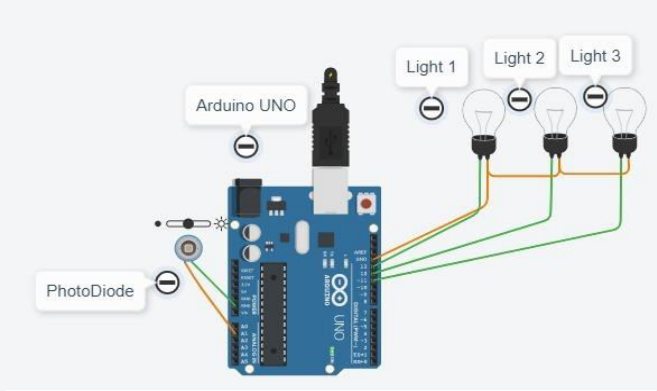

Fig.11. At the day time, light is turned OFF automatically in the greenhouse.

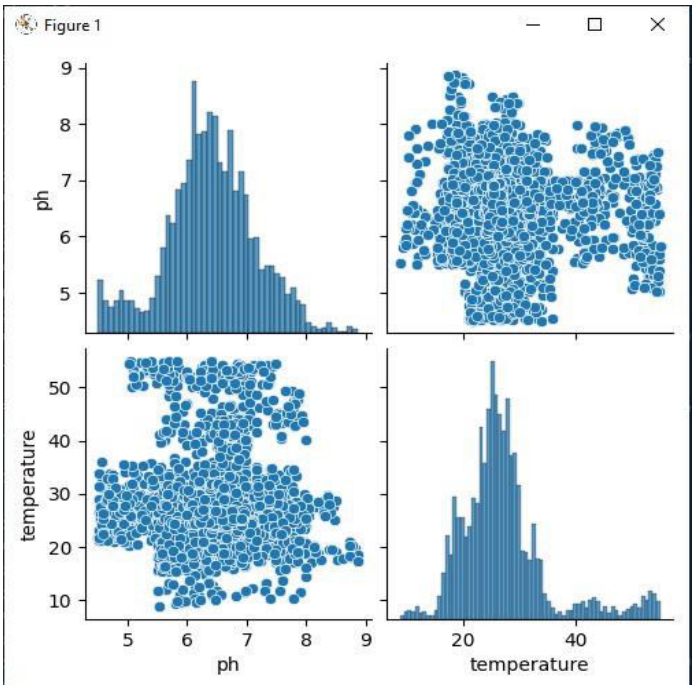

Fig.12. Graphical Representation of attributes

```
Enter the pH value
6.38533
Enter the temperature
27.17113857
Training accuracy using decision tree classifier :  100.0
Testing accuracy using decision tree classifier :  95.74074074074073
Output is : ['Sugarcane']
Training accuracy using Random Forest Algorithm :  100.0
Testing accuracy using Random Forest Algorithm  :  95.74074074074073
Output is : ['Sugarcane']
```

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```
Enter the pH value
7.8
Enter the temperature
23
Training accuracy using decision tree classifier :  100.0
Testing accuracy using decision tree classifier :  96.29629629629629
Output is : ['rice']
Training accuracy using Random Forest Algorithm :  100.0
Testing accuracy using Random Forest Algorithm  :  96.66666666666667
Output is : ['rice']
```

```
Enter the pH value
6.4
Enter the temperature
27
Training accuracy using decision tree classifier :  100.0
Testing accuracy using decision tree classifier :  97.03703703703704
Output is : ['Sugarcane']
Training accuracy using Random Forest Algorithm :  100.0
Testing accuracy using Random Forest Algorithm  :  96.85185185185186
Output is : ['watermelon']
```

```
Enter the pH value
9
Enter the temperature
20
Training accuracy using decision tree classifier :  100.0
Testing accuracy using decision tree classifier :  97.5925925925926
Output is : ['Chickpea']
Training accuracy using Random Forest Algorithm :  100.0
Testing accuracy using Random Forest Algorithm  :  97.77777777777777
Output is : ['Chickpea']
```

VI. CONCLUSION AND FUTURE SCOPE

The reliability and performance of the system is more reliable than the manual system. The proposed method is capable of calculating the actual amount of moisture present in the soil. Again, it is very difficult for humans to calculate real light intensity, temperature and humidity; whereas this proposed method can do all of them very precisely. It reduces the chance of human error to maintain a greenhouse in a particular environmental situation. It is also environmentally friendly.The work can be extended further to add following functionality. Crop diseases detection using image processing in which user get pesticides based on disease images. Implement Smart Irrigation System for farms to get higher yield.

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