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Automatic Greenhouse System Using IoT Along with plant disease detection

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Abstract: This paper discusses the automation of the greenhouse by monitoring the temperature level, maintaining the soil moisture, keeping track of fertilizer level in the fertilizer tank and monitoring the light intensity. It also incorporates the intrusion detection using the pir sensor and the buzzer is turned on if the intrusion is detected, thus providing security to the greenhouse. All of this is done by integrating sensor data with arduino uno. The plant disease detection is also incorporated which predicts if the leaf of the plant is diseased or healthy. If the plant is diseased it also provides the possible solution. The sensor data from the sensors is sent to the hive mq cloud using node mcu wifi module. The user interface displays the sensor data along with the actions taken if the sensor's value increases or decreases with the set threshold. And the user interface is also provided with the plant disease detection where users can upload the leaf of the plant and check for the health of the plant and can also get the possible solution if the leaf is diseased.

Keywords: Greenhouse, Automation, IOT, Arduino uno, Temperature, soil moisture, fertilizer level, Light intensity, Intrusion detection, Node mcu, hive mq, Plant Disease Detection.

I. INTRODUCTION

The population explosion, fast change of climate and reduction in arable land are the main reasons for new approaches to ensure food supply and sustainable agriculture. Greenhouses are considered to be a good alternative and sustainable solution which can overcome the future food crisis by controlling harsh outdoor conditions and growing the crops all year round. However green house farming persists many challenges for efficient operation and management. In the majority of the greenhouse there is no fully automated system to monitor the growth of the plants. All the work should be done manually such as irrigation, maintaining the temperature, maintaining soil moisture, detecting the intrusion, maintaining the intensity, knowing the health condition of the plant and knowing the fertilizer level in the tank. Suitable climatic conditions for the plants are not being provided. In very few greenhouses there are automatic irrigation systems and temperature monitoring of the system. At present there is no fully automated system which can be monitored from any place with many useful features. And there is no system to detect the disease of the plant and there is no intrusion detection system.

II. DESIGN AND IMPLEMENTATION OF THE AUTOMATIC GREENHOUSE WITH PLANT DISEASE DETECTION.

A. Integrating the sensors

The temperature and humidity sensor DHT11,Soil Moisture Sensor, PIR sensor ,two LDR sensors, Ultrasonic sensor, two relay module, motor, fan, buzzer, light bulbs all of these are integrated using the Arduino Uno microcontroller .The arduino uno uses the ATmega328P microchip.

B. Monitoring Temperature and control

Temperature is one of the important factors in the growth of the crop. The temperature is obtained from the DTH11 sensor. If the temperature is above the pre set value the relay is triggered which in turn switches on the fans. The humidity level is also read from the DTH11 sensor.

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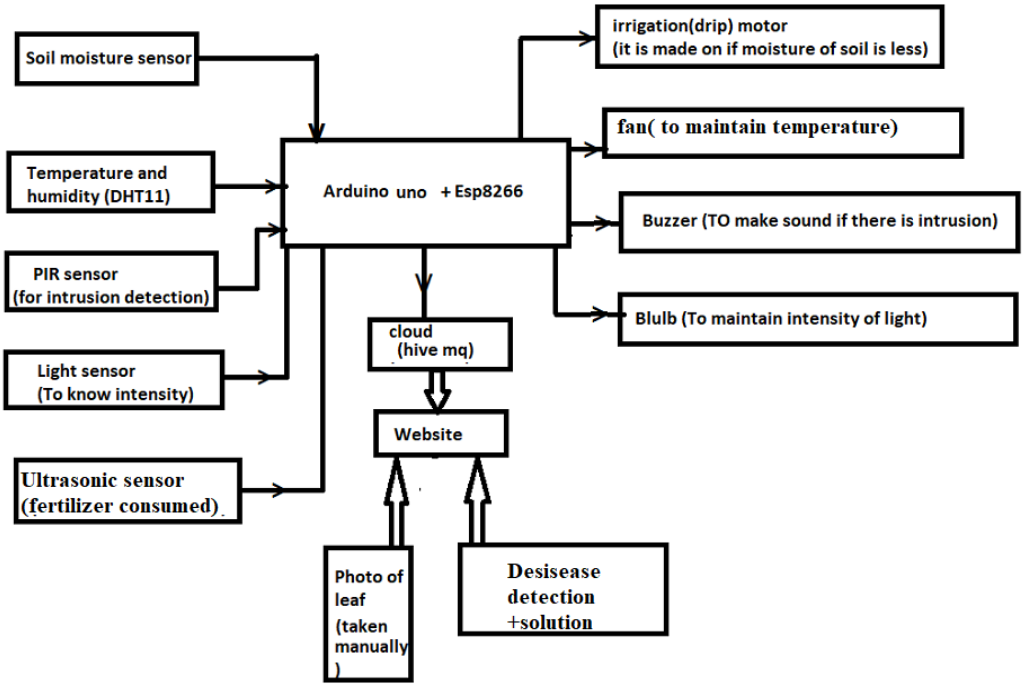

Fig. 1 Design of the System

C. Monitoring Soil moisture and control

By analysing the soil moisture we can irrigate the land if required.By doing so we can reduce the unwanted irrigation. The soil moisture is obtained from the soil moisture sensor .If the moisture of the soil is below the threshold, the relay is triggered and the water pumps are turned on.

D. Monitoring Light Intensity and control

Light is the important factor for the growth of plant because it helps in the photosynthesis of the plant. The Intensity is read from the LDR sensor. If the intensity of light is less than the desired level the relay is triggered automatically and the bulbs are turned on. The another LDR sensor which is present near the bulb, its reading is used to analyze the proper working of the bulb.

E. Analysing the fertilizer level

Knowing the amount of fertilizer consumed is also a very important factor as it provides the plant the necessary nutrients like potassium, nitrogen, sodium, calcium etc. But excessive fertilization is also harmful to the plants. So to keep track the amount of fertilizer consumed we are making use of the data obtained from the ultrasonic sensor HC-SCR04.Here the amount of fertilizer remaining in the tank is checked using the ultrasonic sensor and from this amount of fertilizer consumed is known.

F. Intrusion Detection and action

Protection to the greenhouse from the intruders is also very important. Since the greenhouse is fully automated it reduces the human intervention, However it might make a way for the intruder. So for detecting the intrusion the PIR sensor is used, the reading from it is used to detect the intrusion and if there is any intrusion detected the buzzer is turned on automatically.

G. Node mcu as wifi module for IOT gateway

The sensors data include the temperature reading, humidity reading, soil moisture reading, LDR reading, ultrasonic sensor value, PIR value through the wifi module which is node mcu will get accumulated in the broker hive cloud. The stored data is retrieved from here to display in the user interface.

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H. Hive Mq Cloud

It is a public cloud and it uses mqtt protocol. The security to the data is provided because the topic is known only to the user. The sensors are integrated using arduino uno. The arduino uno is connected to the Node mcu that acts as the IOT gateway to the hive mq cloud. The sensors data include the temperature reading, humidity reading, soil moisture reading, LDR reading, ultrasonic sensor value, PIR value via the node mcu wifi module gets stored in the hive mq cloud.

I. Plant disease detection and solution

Initial symptoms of the disease appear at the leaf of the plant. Hence the leaf of the plant is used for detecting the disease. So for analyzing the disease the trained deep learning model which uses the densenet121 architecture is used. And if there is any disease detected the possible solution for the respective disease is provided.This solution helps the users to take the necessary measures to avoid further spread of the disease.

Layer (type)	Output Shape	Param #
input_2 (InputLayer)	[(None, 64, 64, 3)]	0
conv2d (Conv2D)	(None, 64, 64, 3)	84
densenet121 (Functional)	(None, None, None, 1024)	7037504
global_average_pooling2d (Gl	(None, 1024)	0
batch_normalization (BatchNo	(None, 1024)	4096
dropout (Dropout)	(None, 1024)	0
dense (Dense)	(None, 256)	262400
batch_normalization_1 (Batch	(None, 256)	1024
dropout_1 (Dropout)	(None, 256)	0
root (Dense)	(None, 15)	3855

Total params: 7,308,963
Trainable params: 7,222,755
Non-trainable params: 86,208

Fig. 2 Summary of the trained model

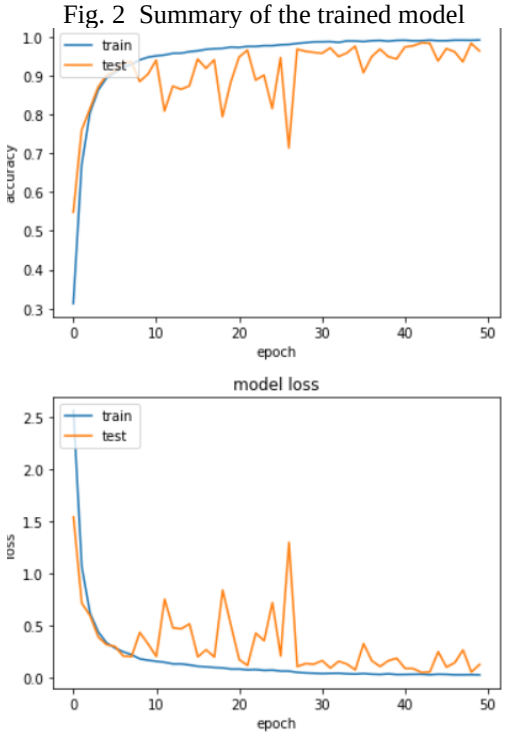

Fig . 3 Accuracy and loss graph of the trained model

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J. Greenhouse design

For the proper working of the system all sensors must be placed in the proper location so that proper data is obtained. If sensors are not placed in the proper location it may result in unwanted actions due to incorrect data. So , it's important to place sensors in proper locations. In this model to get proper data PIR sensor is placed above the door and buzzer is placed beside it, ultrasonic sensor is placed in the bottom of the lid of the fertilizer tank, one LDR sensor is placed outside the greenhouse so that the intensity of the light of surrounding environment is known which affects the intensity inside the system, another LDR is placed behind the bulb so that we can check if the bulb is on or it is damaged, temperature sensor and fan are placed in such a way that fan directly does not affect the sensor value and soil moisture sensor is placed in the soil where the crop is grown so that moisture of the required part of the land is known.

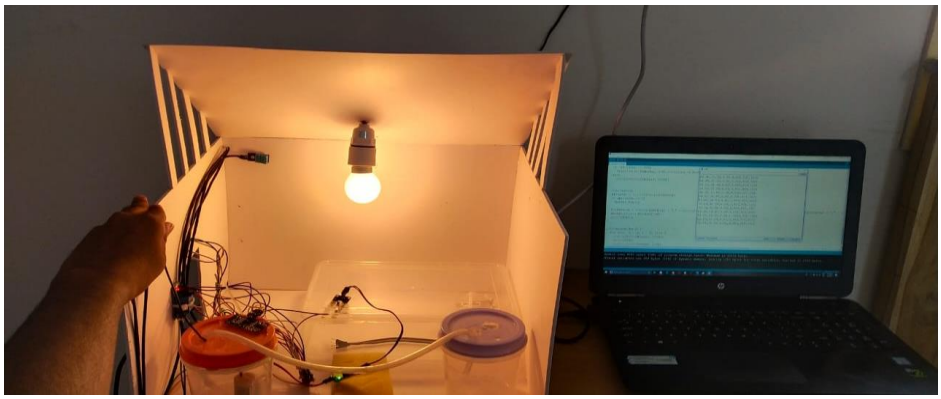

Fig . 4 Greenhouse Model

III. USER INTERFACE

The user has a main page where the provision to check the recent IOT data is provided and also for the plant disease detection.

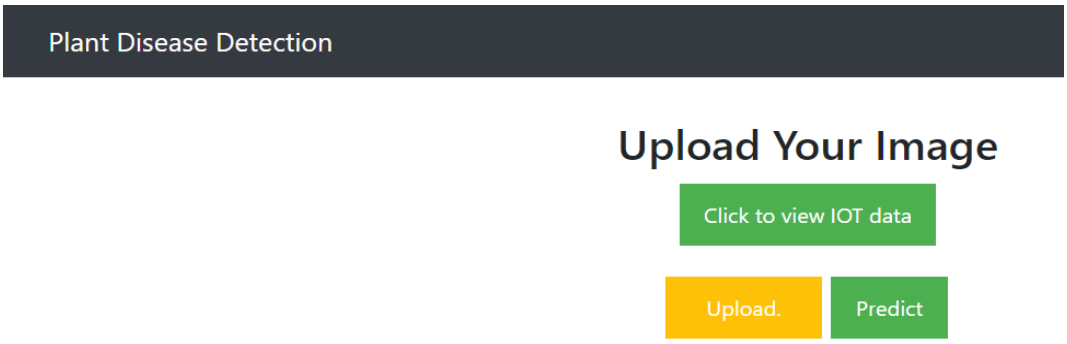

Fig. 5 User Interface main page

A. Recent IOT data

This gives the recent temperature, humidity, ultrasonic value, pir value, ldr values, soil moisture value. And it also displays the respective actions taken for each of the sensor values discussed. So if the temperature increases the above the pres set value, the fan is turned on information is displayed. If the temperature is normal, the fan is off message is displayed. If there is any intrusion, intrusion detected information is displayed. If there is no intrusion, no intrusion message is displayed. If soil moisture is below the desired level, water pump is on message is displayed. If the soil moisture is normal, water pump is off message is displayed. If the intensity of light is normal, intensity is normal

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message is displayed. If the intensity of light is not normal, light is on message is displayed. If the second LDR value is checked and if it is not working, bulb is not working message is displayed.

B. Plant disease detection

And in the main page provision is also made available to upload the image of the leaf for plant disease detection and that gives information whether the leaf is healthy or diseased. If there is any disease predicted the possible solution for the respective disease is also given. That helps the user to take necessary actions to prevent the further spread of the disease.

IV. RESULT

The Figure 6 gives the recent sensor data. The Figure 7 gives the detection of the disease and its solution when an image is uploaded. The result is that proper working of Automatic greenhouse using IOT along with plant disease detection is achieved.

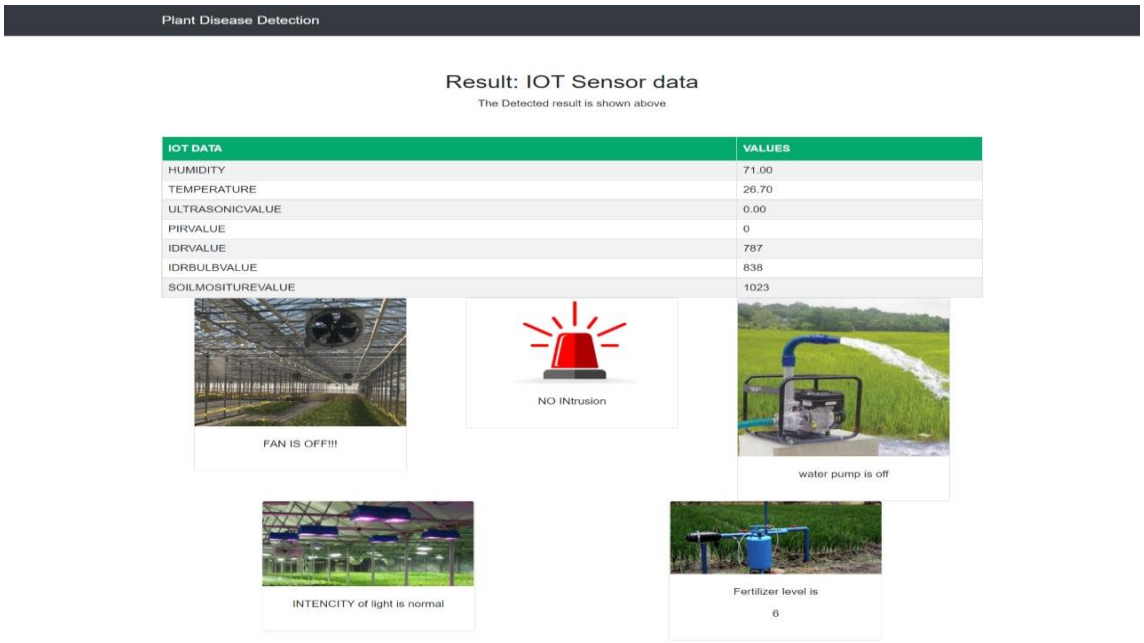

Fig. 6 Recent Sensor Data

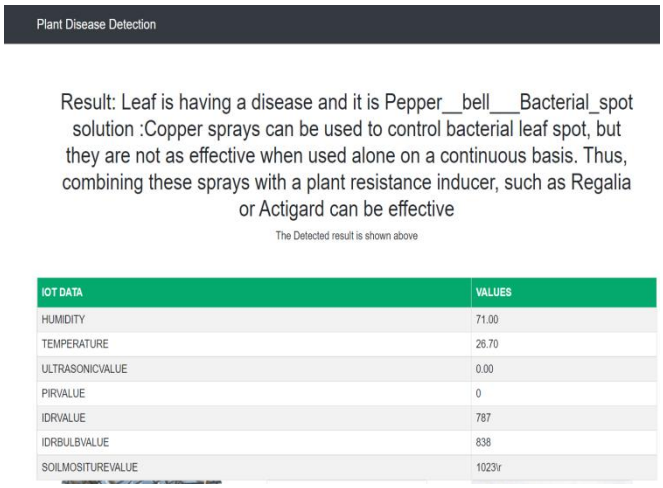

Fig. 7 Detection of the disease and its solution

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V. CONCLUSION

In this paper we have discussed the design and implementation of the Automatic greenhouse system with plant disease detection. Here we have successfully implemented the temperature monitoring and control, light intensity monitoring and control, soil moisture monitoring and control, intrusion detection. the proper working of the light bulbs is also incorporated. Keeping track of the fertilizer level in the tank is also done. Finally the plant disease detection along with the solution is also implemented.

ACKNOWLEDGMENT

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