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Cloud based Intelligent Plant Monitoring Device

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Abstract - *Issues concerning agriculture, countryside and farmers have been always hindering India's development. The only solution to these three problems is agricultural modernization. The Introduction of cloud computing and Internet of things into agricultural modernization will probabaly solve the problem. Cloud computing is closely related to Internet of things. A perfect combination of them can promote fast development of agricultural modernization, realize smart agriculture and effectively solve the issues concerning agriculture, countryside and farmers. This project is designed as a smart plant monitoring system based on IoT through this one can easily monitor the light intensity, humidity and temperature like quantities of a plant from anywhere in the world. The data visualization can be achieved by using a android/ios application.*

Key Words: Nodemcu ESP8266 boards, Adafruit IoT cloud platform, Environmental factors, Sensor, IoT, Wi-Fi.

1. INTRODUCTION

International Telecommunication Union defines IoT as "A global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies."

IoT is also defined as "The network of physical objects – devices, vehicles, buildings and other items – embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure."

At its very basic level, IoT refers to the connection of everyday objects to the Internet and to one another, with the goal being to provide users with smarter, more efficient experiences. Some recent examples of IoT products include the Nest Protect smoke detector, August door locks and Nest thermostat. One of the known examples is the Nest thermostat. This Wi-Fi connected thermostat allows you to remotely adjust the temperature via mobile device. The potential value is that we can save money on utility bill by being able to remotely turn off air condition, which we forget to do before leaving the house.

We live in a world where everything can be controlled and operated automatically, but there are still a few important sectors in our country where automation has not been adopted or not been put to a full-fledged use, perhaps because of several reasons one such reason is cost. One such field is that of agriculture. Agriculture been one of the primary occupations of man since early civilizations and even today manual interventions in farming are inevitable.

Plant monitoring form an important part of the agriculture and horticulture sectors in our country as they can be used to grow plants under controlled climatic conditions for optimum produce. Automating a plant monitoring andcontrolling of the climatic parameters which directly or indirectly govern the plant growth and hence their produce. Automation is process control of industrial machinery and processes, thereby replacing human operators.

In this paper the presented plant monitoring system technology to provide feedback to the user through smart phone. The automated system will reduce the need of man power hence reducing the error for a large scale area, it is quite impossible for a farmer to monitor the efficiency of the system by implementing this technology, the farmers can easily monitor the system using there smart phone.

Certain important factors such as temperature, humidity, light and the level of carbon dioxide has an impact on the productivity of plant growth. Therefore, continuous monitoring of these environmental factors gives information to the user, how each factor affects growth and how to maximize the growth of plants. In recent year's precision agriculture has become the trend in agriculture. Here the focus is mainly on understanding the environment through the interpretation of wide variety of data. The main idea of the system is to monitor the plants whether they get required amount of water and light. If there is enough moisture in the soil, the same will be reported to the user.

This will help the user to give the resources to the plants every day without much manual effort and constantly monitor the health of a plant from a remote location. Improvement of agricultural field has become biggest challenge for countries like India, so new technologies are to be adopted. We have implemented a novel methodology of physical parameter monitoring,

data integration to the cloud, alert generation and predicting the future values.

We have used Temperature humidity sensor, Soil moisture sensor and Light intensity sensor. These sensors have been installed in the agriculture field to collect the data, and thus data is stored into the cloud using Adafruit IO IoT cloud platform.

2. LITERATURE SURVEY

Teemu Ahonen, Reino Virrankoski and Mohammed Elmusrati [1], have done a research in Martens Greenhouse Research Center in the Narpio town in Western Finland, they had integrated three commercial sensors with Sensinode's sensor platform to measure four environmental key variables in greenhouse control. The system feasibility was verified in a simple star topology setup in a tomato greenhouse. The sensors used were SHT75 humidity/temperature sensor and TSL262R light irradiance sensor, and Figaro's TGS4161 CO2 sensor used. Application of the concept in the greenhouse: temperature, luminosity and humidity sensors measured climate variables and communicated directly with the gateway node. The gateway node acted as a coordinator and received the measured data from the sensor nodes. The maximal communication range, 15 meters was figured out in individual test where the distance between the coordinator and the sensor node inside the greenhouse dense flora was increased, the reliable communication range fell to one third in the greenhouse's dense flora.

Mancuso and Franco [2], have done a similar research work in a tomato greenhouse in the South of Italy. The Sensicast device is used for air temperature, humidity and soil temperature with wireless sensor network and a web based plant monitoring system is developed. User can read the measurements over the Internet, and an alert message is sent to his mobile phone through SMS if there are any deviations from normal measurements. Sensor node will transmit the data of temperature and relative humidity in one minute interval to the Bridge node.

3. SYSTEM ARCHITECTURE

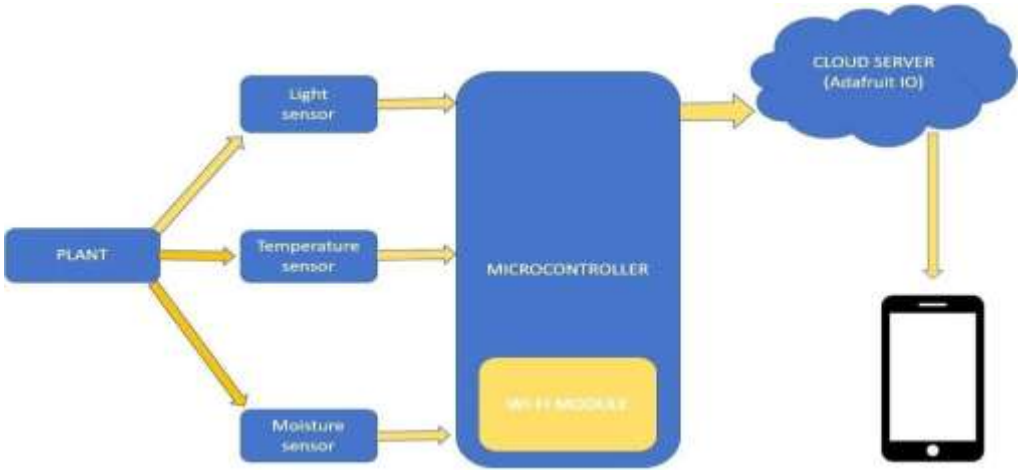

Fig -1: Block diagram of IoT based plant health monitoring system.

3.1 Temperature Sensor

Fig -2: DHT11 humidity and temperature sensor.

DHT11 is a Temperature and Humidity monitoring sensor using digital signal acquisition technique and temperature & humidity sensing technology. This sensor consists of a resistive type humidity measurement component and an NTC

temperature measurement component, connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability, low power consumption, cost effective cheap sensor and suitable for Arduino. It has following specifications humidity measuring range 20% to 90% RH with an accuracy of 5.0% RH and temperature measuring range of 0 to 50 C with an accuracy of 2.0 C.

3.2 Soil Sensor (YL-38 +YL-69)

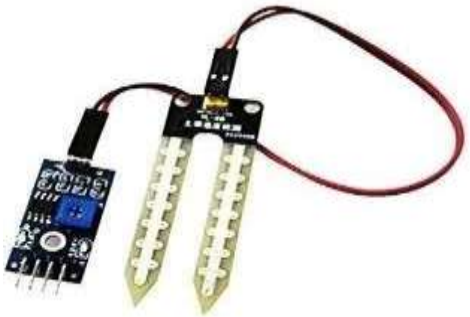

Fig -3: Soil moisture measuring sensor.

YL-38 + YL-69 is a soil moisture sensor also known as hygrometer used to detect the humidity of the soil. Which helps to monitor the soil moisture of plants or build an automatic plant watering system. The sensor is made up of two parts namely the electronic board and a probe with two pads, that detects the water content in soil. When the soil is wet the output voltage decreases and when the soil is dry the output voltage increases. The output can be a digital signal low or high, depending on the water content. If the soil humidity exceeds a certain predefined threshold value, the modules outputs low, otherwise it outputs high.

3.3 Light Sensor (TEMT6000)

TEMT6000 is a sensor to measure the light intensity so that we can know how much light the plant is receiving. Sensor acts like a transistor greater the incoming light, higher will be the voltage on signal pin. It detects the light density and reflect the analog voltage signal back to Arduino controller. It mimics the human eye, it does not react well to IR or UV light. TEMT6000 has following specifications like supply voltage range from 3.3V to 5.5V, operating temperature range 40 to 85 C and illumination range 1 to 1000 Lux.

Fig -4: (TEMT 6000) Light Intensity monitoring sensor.

3.4 Microcontroller (Nodemcu ESP8266)

NodeMCU is an open soure LUA based firmware developed for ESP8266 wifi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit . NodeMCU Development board.

NodeMCU Development board is featured with wifi capability, analog pin, digital pins and serial communication protocols. This chip has both networking and processing capabilities which makes it favourable for Internet of things enabled devices.

Fig -5: Microcontroller + Wi-Fi Module (Nodemcu ESP8266).

3.5 IoT Cloud Server (Adafruit IO)

Adafruit.io is a cloud service - that just means we run it for you and you don't have to manage it. You can connect to it over the Internet. It's meant primarily for storing and then retrieving data but it can do a lot more than just that!

4. METHODOLOGY

The Project is a combination of both hardware and software. The main working of the project or plant monitoring device starts from its insertion into the soil of the plant pot.

The working of plant monitoring device has been discussed below in advance:-

Insertion of the plant monitoring device into the soil.

The working initiates from the insertion of the plant monitoring device into the plant soil which is to be monitored via mobile application from anywhere in the world. When the plant monitoring device is inserted into the soil then the first task it performs is to sense the three important quantities related to plant which are highly responsible for its growth. The three quantities involves humidity ,temperature, moisture content of the soil and the last but not the least light intensity falling on the plant.

Assembly of the plant monitoring device

The plant monitoring device aka plant assistant is embedded with industrial grade sensors like light sensor, humidity sensor, temperature measuring sensor and soil moisture sensor. All these above scripted sensors measure there respective quantities every second and transmit it to the Adafruit IO IoT Cloud server for processing of the data measured via sensors.

The sensors are described in detail below:

Temperature Sensor

Since, temperature plays a vital role in the growth of a plant so; here we have used a temperature sensor which measures the real time temperature of the plant so, that actions can be done.

Soil moisture Sensor

This sensor detects and measures the moisture content of the soil. This sensor is highly sensitive so, a minimum increment in the soil's moisture can also be registered.

Light Intensity Sensor

This is a real time light measuring and detecting sensor which detects the light falling on the plant body and send the data in lumens to the controller unit.

All the cluster of sensors detects and measures realtime quantities like light intensity falling on the plant, moisture level of the soil and the temperature range of the plant.

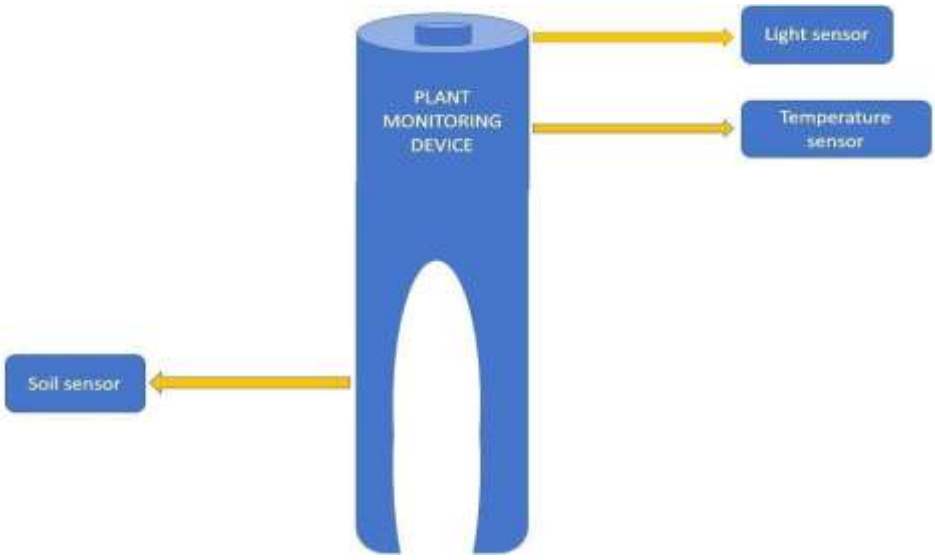

Fig -6: Production unit of plant monitoring device

Cloud computing on the Server

The Nodemcu ESP8266 Microcontroller receives the data from the three embedded sensors and send the data to the Adafruit IO Cloud server foe processing via Internet. When the data is successfully received by the cloud then start the processing part of the data. The processing algorithm is feeded up in the server from initial stage so, whenever data is received by the cloud then its pushed into algorithm and according to which actions are taken by the server.

Along with the processing the data is also made available to the android application backend server so, that simultaneously the data can also be visualized by the user.

Visualization of the realtime data

The data received by the Cloud server is then broadcasted to the android application java script client so, that the visualization can be achieved and the user or the caretaker of the plant can easily monitor the plant growth quantities by just opening a android application. The android application features include the information about the plant which is currently being monitored by levels like good, moderate, high as shown in the figure 7.

Fig -7: The android application for data monitoring.

5. EXPERIMENT AND ANALYSIS

By this work, the wastage of water and the consumption of power by motor can be reduced so that they are conserved for the future use. This system provides complete monitoring action of sensors in fields that is very easy to control the field. It also provides huge security to the plants and by using machine learning we can easily detect the plant behavior according to the environmental conditions. The sensors and microcontroller are successfully interfaced with the cloud. The data is stored successfully and can be accessed remotely. All observations and experimental set up proves that this is a complete solution to monitor the health of a plant. User can have access to the data and can know if there are any deviations with respect to temperature, humidity, soil moisture and light intensity. Implementing this system will allow users like farmers to monitor and improve the yield of crops and overall production.

6. FUTURE SCOPE

- The performance of the system can be further improved in terms of the operating speed, memory capacity, and instruction cycle period of the microcontroller by using other high end controllers. The number of channels can be increased to interface more number of sensors which is possible by using advanced versions of controllers.
- The system can be modified with the use of a data logger and a graphical LCD panel showing the measured sensor data over a period of time.
- A speaking voice alarm could be used or a mobile notification can be broadcasted to the android application.
- The device can be made to perform better by providing the power supply with the help of renewable source.
- Time bound administration of fertilizers, insecticides and pesticides can be introduced.
- The machine learning algorithms can also be used to study the behavior oof plant according to different environmental factors.
- The device can also be powered with small solar panels as a power source in order to ignite the electronics inside the smart plant monitoring device.

7. CONCLUSION

By this work, the wastage of water and the consumption of power by motor can be reduced so that they are conserved for the future use. This system provides complete monitoring action of sensors in fields that is very easy to control the field. It also provides huge security to the plants and by using machine learning we can easily detect the plant behavior according to the environmental conditions. The sensors and microcontroller are successfully interfaced with the cloud. The data is stored successfully and can be accessed remotely. All observations and experimental set up proves that this is a complete solution to monitor the health of a plant. User can have access to the data and can know if there are any deviations with respect to temperature, humidity, soil moisture and light intensity. Implementing this system will allow users like farmers to monitor and improve the yield of crops and overall production.

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BIOGRAPHIES

Miss. Gunjan Chauhan is pursuing her final year in BSC (BioChemistry) from Katkiya P.G. College, Bastar University, Chhattisgarh, India. She is currently working on effect of environmental factors on plants growth.Her area of interest are mainly focused on concepts regarding Chemistry.

Er. Yash Sharma is pursuing his final year in BE (Electronics and Telecommunication) from Bhilai Institute of Technology, Raipur , Chhattisgarh, India. He is an IoT Enthusiast and Embedded developer . He is currently working on Smart home automation products and smart voice assistants . His area of interest are Internet of Things and Machine Learning .