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IOT BASED SMART PLANT INCUBATOR

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Abstract:

Smart Plant Incubator has been designed to simulate the optimum atmospheric conditions like temperature, soil moisture, air humidity and light intensity required for the prime growth of the specific plant. We have come up with a unit which is fully automated thereby increasing the efficiency of growing plants. In today's world farmers are depleting the soil fertility and productivity while trying to obtain optimum condition results with the crops by using more and more synthetic fertilizers and pesticides. In contrast to this, our product already provides the favourable conditions for the plants thus eliminating such soil destruction. This an inexpensive solution to solve other problems like growing rare or exotic plants, plants with medicinal values and others that cannot be grown due to unfavorable atmospheric conditions of the areas. It has an IoT enabled system enabling the device to be controlled from any place any time. Our product provides increased automation with no human requirement to monitor changes as it automatically utilizes the stored data from the database thus simulating the climatic conditions. For monitoring the parameters as the human intervention is not involved, errors are reduced to a greater extent thereby enhancing the accuracy. Furthermore, we have integrated AWS cloud with the plant incubator to make it possible for any user to remotely access.

Index Terms: Smart, AWS, Incubator, IoT, Monitoring, Controlling, Node-Red, Greenhouse

1. Introduction:

There is a diverse pattern of climatic and environmental conditions observed in India which differs considerably from region to region. Changing environmental conditions, affects the biodiversity pattern significantly which in turn puts limitation on the crops which can be harvested. Factors like rainfall, soil, temperature vary significantly all over the country which makes the yield primarily dependent on the environmental conditions. Farmers in spite of investing a lot of money and efforts in the cultivation of their land, suffer drastic losses every year due to natural disasters. Considering the inability of predicting the natural conditions accurately, farmers have to take a risk on their money and efforts. To overcome such situations to some extent where the people involved in agricultural sector will be able to harvest crops of higher commercial value without having to worry about the varying environmental conditions, we have come up with the solution called "The Smart Plant Incubator".

Taking into consideration the primary need of farmers unable to harvest because of the unavailability of skilled labourers, our product vouches to identify this problem with its developed automation. This even enables people with specific personal interests like gardening to grow any plant of their choice using this smart incubator. The other important factor is need of a simulator which will simulate various climatic conditions in order to analyze the effects on the plant growth. People involved in R&D sector often require to experiment on plants with different sets of external parameters. They require the nearest to ideal conditions of different parameters to sustain various species to work on development of genetic evolution. Our product offers the favourable conditions in which we get an option to select from a wide range of the parameters to set. We are well aware of the changing climatic conditions and extinction of natural habitats which is affecting the bio-diversity. This product is helpful to restore these plants by simulating the natural environment to the closest possible way. The plants with rare medicinal properties require certain set of parameters for their growth and these conditions can be simulated using our product.

Plant Incubator is designed to simulate the nearest possible natural environmental conditions inside a single unit for the improvised sustenance of the plant taken.

2. Project Objectives:

The main objectives of Plant incubator are:

Incubation: The Smart Plant Incubator is used to incubate the plants according to their required environmental conditions for optimal growth and yield.

Better Growth: Adjustable lighting and temperature control helps the plants grow fully with in a shorter span of time.

Less Human Intervention: The incubator is automated to ventilate air, supply water to the plants, adjust the light intensity and temperature whenever the requirement arises. Thus requiring less human intervention.

Organic Produce: The plants grown in the incubator would be free from pesticides and chemicals which will give healthy and risk-free produce.

Re-Useable: A wide variety of plants can be grown in the same incubator multiple number of times which increases its reusability and is less hazardous to nature.

Smart Tracking: Various aspects such as temperature, humidity, Soil moisture and electricity consumption can be tracked in real-time on the internet via cloud interfacing.

2. Hardware Description:

CC3200 Development Board: The CC3200 [1] is a micro controller launch pad developed by Texas Instruments. It has 40 GP IO pins which have various functionalities including I2C protocol, analog inputs, SPI protocol. It also has a Wi Fi capability which is used to send to and receive data from the cloud dashboard. Here it is being used to control all the sensors and actuators that deal with reading and controlling all the parameters like temperature, humidity, light intensity and water flow that create the required conditions for plant growth.

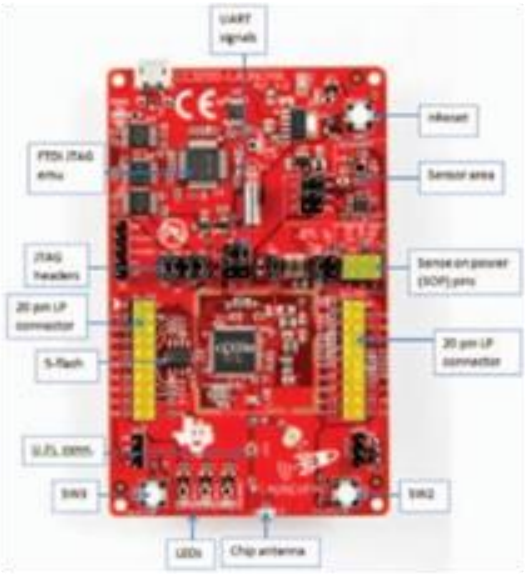

Figure 1: CC3200 Development Board

Temperature and Humidity Sensor: DHT11 is a temperature and humidity sensor that gives an analog output. It has 4 pins including Vcc, NC, DATA, GND. The module gives an output that can be used to calculate the temperature and humidity by applying different algorithms to the output data.

Current Sensor: AMC1300 is a current sensor developed by Texas Instruments. It is connected in series with the power supply to keep a track of power consumption of the incubator.

Soil Moisture Sensor: Soil Moisture Sensor is a 4 pin sensor module. Its pins include Vcc, D0, A0, GND. DO is the digital value output connector 0 or 1, AO is the analog value output connector.

Exhaust fan: The exhaust fan is attached with a carbon filter which filters out any scent released from the plant that would attract insects. It also maintains circulation of air into the incubator.

TEC Peltier Module: The TEC Peltier module is an actuator that is interfaced with a heat sink and fan for cooling or heating the incubator thus achieving temperature control.

Water Pump: The Water pump acts as water supply to the plant and is controlled based on the amount of soil moisture detected by the sensor.

LED Light Source: The LED light source provide slight energy to the plant. It is a mixture of blue and red lights, which are the two colours that are essential to plant growth and health.

3. Software Description:

AWS Cloud: AWS is a cloud service that provides cloud databases with the capabilities of remote access. It also provides many cloud computing services like ec2, s3 and lamb data functions. In this project we are using an ec2 instance with the linux operating system. To allow remote monitoring of sensor data and controlling of actuators we are using the Node RED dash-board with capabilities of programming the nodes to perform specific functions. We have a small dataset stored in our ec2 instance which automatically sets the temperature, humidity, light intensity and soil moisture of few plants.

Node RED: Node-RED [2] is a platform that allows to program the communication between different devices in an IoT system by treating them as nodes and setting different protocols for the exchange of data between them. It is being used here to log sensor data and perform computations on it to extract required information to perform required IoT tasks.

Code Composer Studio: Code Composer Studio is a platform that allows us to program the micro

processor to perform a specified task. It allows the programmer to write a C program for the function that the programmer wants the microprocessor to implement and converts it into machine language to burn to the micro-processor.

4. Methodology:

The CC3200 module is interfaced with all the above mentioned sensors and actuators. The inputs data is received from the temperature, moisture, humidity sensors and sent to the Node-red dash board on AWS. The communication with AWS cloud is controlled via Node-RED. The function no dein no dered flow calculates the values of temperature, humidity and soil moisture using the sensor data. Thus monitoring of sensor data is achieved by logging it on to the cloud dashboard. In order to perform control actions, user data is input onto the cloud dash board for comparisons. The required value of temperature, humidity and soil moisture is set by the user. The function node compares these values with the values obtained from sensor data. If the temperature is lower than the required value, the cloud controls the Peltier module and fan to raise the temperature. If it is higher, the cloud controls the module requirement of plants with rare medicinal properties not available in all areas.

Absence of Human Intervention for Plant Care Due to Automation:

Figure 2: Control Dashboard

As we can see in the figure 3 below, sensor data is sent from micro controller to the Node-Red dashboard hosted on AWS cloud. Via this dashboard, user can monitor these parameters over the internet.

Figure 3: Monitoring Dashboard

5. Conclusion:

This proto type is different from others due to the inculcation of IoT. With this we can control and monitor device the device from any place at any time providing better analysis. Furthermore the parameters will be automatically synced to the real time current condition of parameters [3] e.g. If we want the climatic conditions of North America to grow a certain type of plant adapted to those conditions, the device will maintain similar temperatures, soil moisture, humidity as is in North America. This is possible as device is connected to the internet cloud so simultaneous assessment of data is made possible. This ensures better plant growth a sit experiences all seasonal conditions with enhanced natural growth. The following are the salient points:

Unique Value Property:

- IoT enabled system which allows the user to control the incubator remotely at anytime [4] [5]
- Comes with installed sensors
- Portable unit and one time investment - no harmful by products
- Once parameters set can be used multiple automation providing for less human involvement

Problems Resolved:

- Unavailability of required environmental and climatic conditions for a given plant.
- Conservation of plants on verge of extinction.

6. Future Scope:

In the future, this product can be used to reinforce the 'Smart Nursery' concept even for the large scale housing and automatic nurturing of various kinds of rare plants, medicinal plants as well as for growing seasonal plants all throughout the year. This incubator can replace the traditional green house which currently has a constraint of growing only the plants that grow in atmospheric conditions of the specific region only. Thus this product can be very congenial and would support the 'Smart City' projects. In this present day, more and more people are becoming health conscious and want to grow their own organic plants to consume. This along with many other objectives like growing plants with greater efficiency and scientific research on rare and medicinal plants can be achieve data larger scale.

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