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# Autonomous Greenhouse using Internet of Things with ThingSpeak

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**Abstract -** *Greenhouse forming gives high crop yield and low risks against the obstacles like variable climatic conditions, pests and insects. Autonomous greenhouse advantages the farmers in different ways by detecting the soil moisture, water quality and automatic irrigation. This process is scientific. It boosts the benefits on agricultural tasks. The greenhouse can be monitored by the IoT system and it collects data and sends to the cloud server for further action making. This paper deals with the system design and implementation for IoT based agricultural greenhouse system for higher crop yield. For device to device communication the system uses ESP8266 Wi-Fi module. Objective of this paper is to leverage an IoT based agriculture system in a greenhouse to reduce human intervention by automatically detecting and controlling different climatic conditions such as humidity, soil moisture and light intensity to automatically monitor the irrigation, aeration and lighting facilities of the greenhouse.*

***Key Words***: IoT, Greenhouse, Cloud Server, Aeration, Irrigation, Lighting

## 1. INTRODUCTION

The invention of new technologies in the domain of information science and communication has stamped its benefits for different applications. Specifically the applications of IoT in agriculture is ever expanding hugely, as it offers a well-controlled and automated farm for the farmers, better forecast of weather and crop yields for the agriculturists and knowledge on the consuming products for the common people.

As in one side the designer food products count is increasing significantly, and it is also our responsibility to preserve and produce the natural food yields in well and faster scale. Here, we need the deployment of a fully-equipped and hence a well-organized greenhouse which gives various benefits for better agriculture production. Greenhouses provide constrained shelter and a controlled environment for the food crops, by providing the required temperature and aeration. This temperature controlled atmosphere gives the plants a healthy environment for its good yield in greenery, flowers and fruits. Stunted growth in plants seen in open-air nurture, delays the plant produce period. This can be extremely avoided with the use of a greenhouse as it helps the plants to maintain moisture in its surrounding and in the soil as well. For the growing and end of a plant's normal life cycle, it requires some vital factors like light [1], nutrients absorbed from soil [2, 3], nutrients absorbed from air and water, proper temperature and humidity [4, 5].

In the conventional process, the farmer has to visit the entire field regularly at odd hours to confirm the well-being of his farm, which mostly includes the switching ON/OFF motor to ensure that his plants are watered. Sometimes, the plants are not watered enough and hence essential nutrients aren't absorbed from the soil. Sometimes, the motor pumps are left running for longer than what is necessary because of the effort involved to turn OFF the motor and hence leads to water logging, rotting of roots and deprivation of oxygen from the soil. Hence it is clearly evident that conventional process lead to improper use and wastage of the resources available.

Soil erosion and salinization, eutrophication, water depletion are some problems encountered with traditional agriculture. An automated greenhouse helps to monitor the soil moisture and its nutrients levels, air moisture and macro nutrients, and light intensity through several sensors. Agricultural greenhouse enhances the management efficiency and optimizes the agricultural resources [6, 7, 8, 9].

IoT takes agriculture a step above just the traditional agricultural processes by collecting and analysis of sensed data and decision making. This process can also actuate various activities in an automated greenhouse system, which supports the farmers in various ways and conserving their efforts and time for further increasing the productivity. Fogger in greenhouses helps to maintain moisture in air. This prevents the drying of leaves and flowers and in turn improves the production rate. Green house monitoring devices can also have inbuilt energy harvesting modules to increase the life time of the system. Various plant groups requires various environmental support and nutrients, greenhouse helps to grow such types of crops, and the threshold based monitoring and actuating can also be performed.

This paper contains the sections like system framework, system model along with the methodology followed, results and conclusion.

## 2. SYSTEM FRAMEWORK

This paper presents an autonomous greenhouse model designed with low cost constraints and power efficiency. So that helps the greenhouse farmers to attain good field yield. This also helps the technicians to monitor automated system. The data which is sensed by the sensors can be used for decision making activities and actuate the greenhouse end devices.

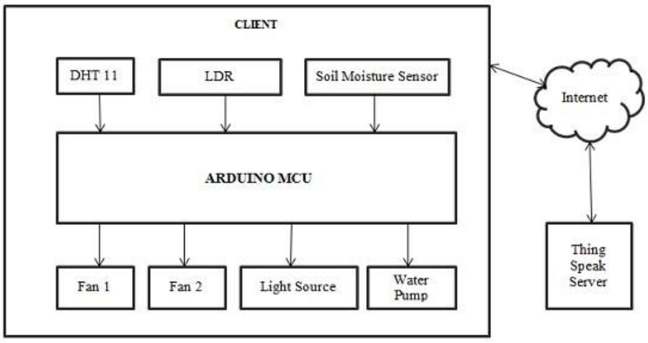


**Fig -1**: System Framework

The system can be considered of having various levels, to collect sensed data and actuate the end devices based on sensed data. The end devices are connected with the Arduino. The end devices are the following:

- Exhaust Fan
- Inlet Fan
- Light Source
- Water pump

Fig. 1 represents the system framework. The system framework is described as follows:

A. DHT 11

The DHT 11 is the temperature and humidity sensor. DHT 11 has the best features are its easy connection, good quality, less expensive, anti-interference ability and accurate calibration. It can cover the transmission area up to 20 meters.

B. Soil Moisture Sensor

Using a soil moisture sensor the amount of water content in the soil can be measured.

C. Light Dependent Resistor (LDR)

This LDR can sense the light inside the greenhouse. As the light intensity changes, LDR reacts with variable resistance. The resistance of LDR decreases as the light intensity increases.

D. Inlet and Exhaust Fans

These fans are used to push the heat outside and pull fresh air from outside into the greenhouse. This maintains proper air flow required for the in-house plants.

E. Water Pump

If the soil moisture level below or above the specified threshold, the water pump activates and switch on or off respectively.

F. ThingSpeak

ThingSpeak is an IoT analytics platform service that offers you to aggregate, visualize, and analyze live data streams in the cloud. You can also send data to ThingSpeak from your arduino, create instant visualizations of live data. Without setting up servers or developing web software, ThingSpeak enables engineers and scientists to prototype and build IoT systems.

## 3. SYSTEM MODELLING

The main objective of this research work is to concentrate on monitoring the greenhouse and actuates irrigation, aeration and lighting facility. The components used are:

- Arduino
- DHT 11
- Soil Moisture Sensor
- LDR
- Relay board
- 5V DC power Supply

Arduino is an open-source microchip platform based on user friendly hardware and software. Arduino boards able to read inputs and turn it into outputs and publishing something online. You can instruct your board what to do by sending a set of instructions to the microcontroller unit on the board. To do so you use the Arduino programming language (based on connections), and the Arduino Software (IDE), based on Processing.

Here various sensors used are temperature and humidity sensor (DHT11), soil moisture sensor, LDR. The end devices are the fans, water pump and LED light.

If the soil moisture value is below the specified threshold value the motor switched ON and pumps the water through the pipe. It can be done automatically and repeatedly until reaching the specified threshold value. Here all the threshold values are taken from the farmer observation. Here LDR stands for Light Dependent Resistor. It is used for measuring the intensity of light inside the greenhouse. DHT11 Temperature and Humidity sensor for sensing temperature and humidity values. If the temperature value is greater than or equal to the threshold value then fan1 switched ON automatically and OFF if it is less than the threshold.

If humidity value is less than or equal to the threshold value the fan2 switched ON automatically and pull the air from outside the greenhouse and OFF if it is greater than the threshold. If the light intensity is equal to the threshold then the LED turned ON automatically and OFF if it is not equal.

Fig. 2 shows the event flow of whole system. Here the data is read from various sensors the sensed data is sent to the IoT platform ThingSpeak server via internet using the ESP8266 module which is integrated on the device named Octabrix. We can also use other ESP8266 modules.

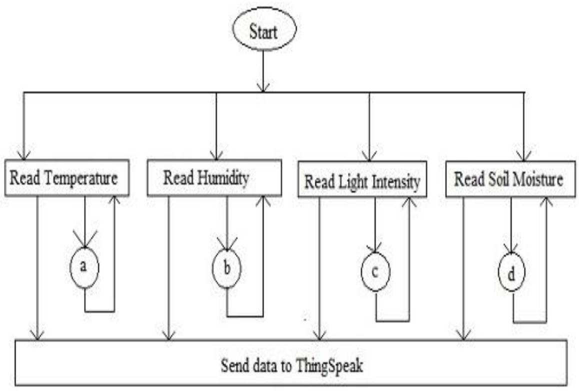


**Fig -2**: Event Flow

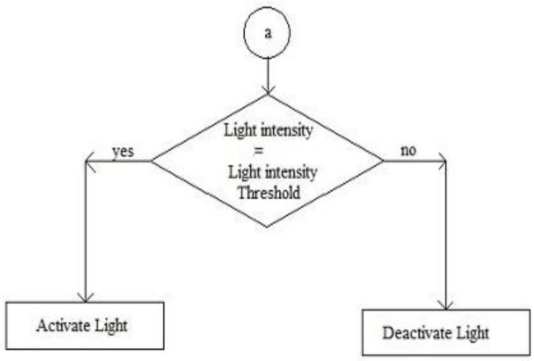


**Fig -2**a

Fig. 2a-d describes set of actions carried out by the various modules such as Temperature, Humidity, LDR and Soil moisture respectively. It checks whether the parameter values are below or the above the threshold values or not. According to the conditions the actuators are activated and deactivated.

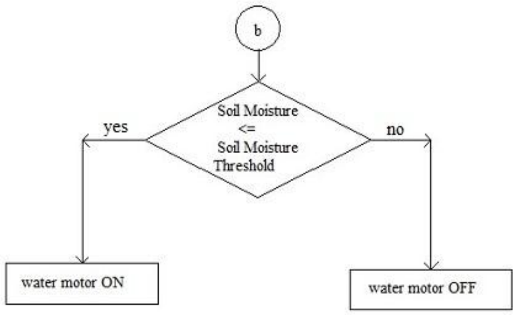


**Fig -2**b

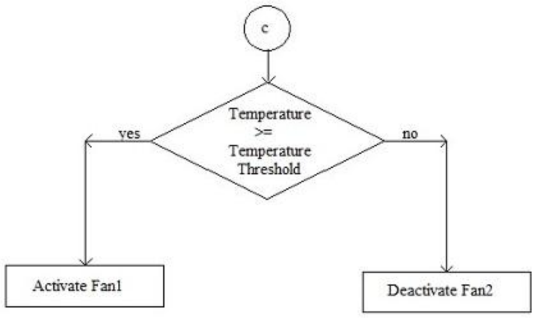


**Fig -2**c

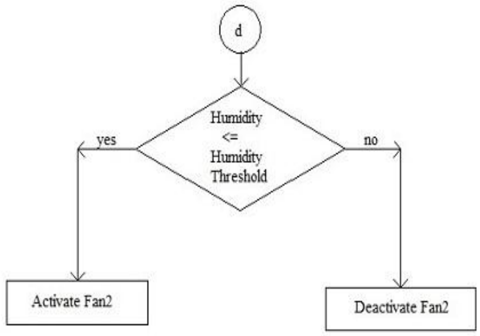


**Fig -2**d

ThingSpeak is IoT platform which helps to collect, analyze and visualize the data. It has TCP/IP for sending and receiving the data. For that we create channels in ThingSpeak. The sensed data is visualized in created channels.

## 4. RESULTS AND DISCUSSION

The proposed system works good and delivered the effective results. The end devices like light source, water pump and fans inside the greenhouse activated according to the threshold condition of parameters like temperature, humidity, soil moisture values. The data collected from the arduino sent to the thingspeak server and data visualized in the server.

Fig. 3 shows the values collected by the sensor DHT11 temperature and humidity and the soil moisture sensor. In field1 chart 1 the humidity values are varied. The variation is in the form of increasing and decreasing and stable sometime. So whenever the humidity value less than or equal to the threshold value the fan switched on automatically.

In Field2 chart the temperature values are varied. The variation is in the form of increasing and decreasing and stable sometime. So whenever the humidity value greater than or equal to the threshold value the fan switched on automatically.


**Fig -2**: Event Flow

In Field3 chart the soil moisture values are varied. The variation is in the form of increasing and decreasing and stable sometime. So whenever the humidity value greater less than or equal to the threshold value the water pump switched on automatically. In the same way Felid4 chart visualized in the thingspeak. The light will be on and off according to the LDR sensor module threshold value condition.

## 4. CONCLUSIONS

In the traditional agriculture methods the farmer is compulsory to visit the agricultural land to observe the climatic conditions. This paper determines the design and implementation of autonomous greenhouse system. It is one of the application of IoT in agriculture. It reduces the farmer involvement. The threshold values are taken in the presence of farmer, because the conditions are changed. Through this efficient system, we are able to sense the parameters regarding to the aeration, lighting and irrigation. The sensed data sent to cloud platform i.e. ThingSpeak server. The data collected in the server is visualized. The collected data is to be used for preparing the good crop yield and suitable crops.

Future scope of this project is to add additional sensors for better maintenance for example if we add MQ2 smoke sensor it detects the flammable gas, smoke and give signal as the output. The data collected from the client arduino is analyzed so we can use that analyzed data and apply data mining algorithms on it.

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