Wi-Fi Enabled IoT Based Smart Greenhouse

V. Sai Ganesh, Soma Ram Ganesh, Mir Faraazuddin Hamza, Dandu Sandeep, Siddhartha Ghosh

Abstract: In this present state-of-the-art, Internet of Things (IOT) is an emerging technology that is making our world smarter. Wi-Fi enabled greenhouse monitoring is an intelligent system which is based on several sensors that monitor various changes in temperature, gas concentrations, light and soil moisture in the greenhouse. This comes with an added advantage or provision of linking all these sensors to your mobile phones or computers/laptops using Wi-Fi and internet services through the concept of Internet of Things (IoT), so that if there are any fluctuations, you will be notified immediately. This provides convenient control, through manual operations if necessary, of the greenhouse anytime and anywhere as long as the device is connected to the internet. In this an artificial environment is created so that the crops yield more crops per square meter compared to open field cultivation since the micro climatic parameters that determine crop yield are continuously examined and controlled to ensure that an optimum environment is created.

Index Terms: Automation, Internet of Things, Micro controller, sensors, monitoring and web server.

I. INTRODUCTION

The **Internet of things (IoT)** is a network of physical things (usually non-living things) where the devices are web-enabled and can be connected with an IP address. This network is organized in order to automate day to day processes and reduce human exertions, increase economic benefits and efficiency of the particular process.

Automation includes the concepts of prediction of future and improving the process which falls under artificial intelligence and machine learning, which also provides security and privacy of data, transmitted during the process.

A very simple example for internet of things is when an alarm is turned off in the morning, the bath tub is automatically filled with hot water.

Greenhouse System optimizes environmental conditions to enhance plant growth with improved yield in minimum possible time, which is one of the key aim of the modern agricultural system. [5] They are specifically equipped with plastic wall or glass to absorbs the heat but also allowing the light to go pass through. In this system plants are grown in a particular specific temperature variation for better plant grown under monitored and controlled condition with less man power and more automation in it.

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II. SYSTEM SURVEY

Most of the previous system used smartphones and text messages primarily based approach to manage and monitor such reasonably greenhouses however during this project we tend to create this greenhouse self-control as we conjointly implement all the operations of the greenhouse victimization the Nodemcu microcontroller that may be a distinctive approach at the time of the implementation of this project.

In this system, we have used Nodemcu which act as a processor and Wi-Fi module for sending the data to the cloud acquired from the sensors. Here all the devices are connected to the relays, and automatically controlled using the different environmental parameters such as Temperature, Soil moisture and light intensity.

Within the greenhouse environmental conditions can be controlled which might be very simple by just opening a ridge vent or as comprehensive as regulating the operation [6], we have installed exhaust fans and their number and operating speed can be changed to keep remain the greenhouse internal environment as per the predetermined conditions. The environmental variables that we are controlling within our greenhouse are the temperature of the air, and relative humidity. For the purpose of cooling, fresh air should be entered in the greenhouse which we have done using the vent.

III. EXISTING WORKS

HOVE International, Inc. has been developing a partial and fully automated greenhouse bench systems, multilevel growing, potting equipment etc., which are used to decrease labor cost by switching and automatically distributing and placing plants uniformly. The Greenhouses which use their technologies include Burnaby Lake Greenhouses ltd., Westbrook greenhouse systems ltd. Etc.,

Intel smart greenhouse uses AWS and IoT technologies to automate the door opening and closing according to the sunlight and fresh air needed. Some of its actions include turning on fan when room temperature exceeds 80.5F, turning on misters when soil moisture drops below 70% until moisture level reaches 75%, turning room misters until humidity reaches 80%.

IV. PROPOSED SYSTEM

For this proposed system, the Arduino IDE is used for programming all the sensors and components that are necessary. The list of components used is:

These sensors and components are used to obtain the main objective of the project which is:

1.SENSORS	i. MQ-135 ii. MQ-2 iii. LDR(LIGHT DEPENDENT RESISTOR) iv. TEMPERATURE SENSOR(LM35) v. SOIL SENSOR (YL-69) vi. TEMPERATURE AND HUMIDITY SENSOR(DHT11)
2.GATEWAYS/ PORTAL NETWORKS	i. THINGSPEAK ii. BLYNK
3.MAJOR COMPONENTS	i. NODEMCU ii. MULTIPLEXER iii. RELAY

i. To obtain certain level of moisture of soil of each crop using ***soil sensor*** and ***motor pump.***

ii. To obtain optimum air quality by using ***mq135***, ***mq2*** and ***exhaust fan***.

iii. To maintain accurate temperature needed by the crops by using ***lm35***, ***dht11*** and ***exhaust fan***.

iv. To maintain correct exposure of crops to light by using ***ldr*** and artificial light (***led***).

v. To observe and receive the values of sensors and their behavior through ***nodemcu***, ***thing speak*** and ***blynk***.

V. SYSTEM ARCHITECTURE

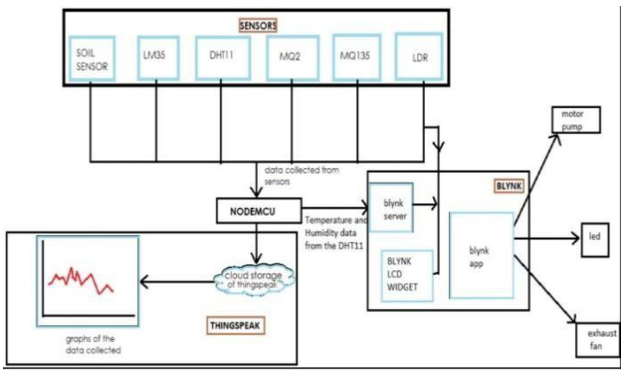

Fig: 1 Block Diagram

The system architecture of this model is as follows as **Fig 1**:

ThingSpeak is used to store data sent from various sensors in a graphical manner. Temperature and Humidity data from the **DHT11** sensor is collected using **Blynk**.

Apart from that, Blynk can also be used to control the components like lights, fans, motor, etc., manually and remotely using mobile phone connected through the internet (Wi-Fi).

Blynk also provides a virtual LCD widget for display. A **nodemcu** is used which has an inbuilt processor and is Wi-Fi compatible directly, without the use of any extra modules like the ESP8266 Wi-Fi module and requires an FTDI module to be Wi-Fi compatible.

A **multiplexer** is used to choose and display one output at a time when several inputs are given. In our scenario of a smart greenhouse, there are inputs coming from different sensors and therefore a multiplexer is necessary to execute different parts of the code at different inputs and to display the outputs sequentially and in a readable and an understandable manner.

We use **Relay**s because the Arduino or Raspberry Pi devices cannot switch on high power devices like lights or fans as they have only 3V or 5V connections. A small LED is also present on each relay channel to display which channels are receiving power, indirectly telling us which are switched on. The circuit is switched i.e. it gets closed and power flows through it to the connected device when a particular expression or condition written in the program becomes true and when it fails, the circuit switches again and results in an open circuit leading to no power to the connected devices. This concept of the relay is used in this model to switch on the exhaust fan, water pump and the LEDs (lights) whenever the temperature or humidity increases, moisture in the soil reduces and natural light decreases respectively.

VI. EXPERIMENTAL RESULTS

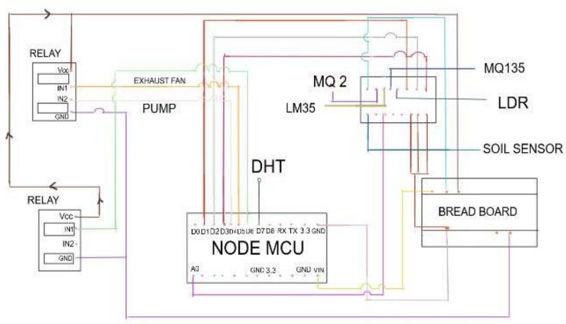

Fig: 2 Circuit Diagram

In **Fig: 2** we can see the basic circuit of the proposed system in this all the sensors are connected to the nodemcu and relays are used for switching purpose. When given condition is satisfied then an action is done.

1. Soil Moisture Sensor

Below Fig: 3 shows the data of soil moisture sensor graphically, here values recorded will be displayed in both blynk and thingspeak which can be controlled and monitored through blynk.

Different plants have different moisture requirements in the soil. Therefore, multiple **soil sensors (YL-69)** are installed in various patches or places of the greenhouse to monitor the moisture and different plants are grown.

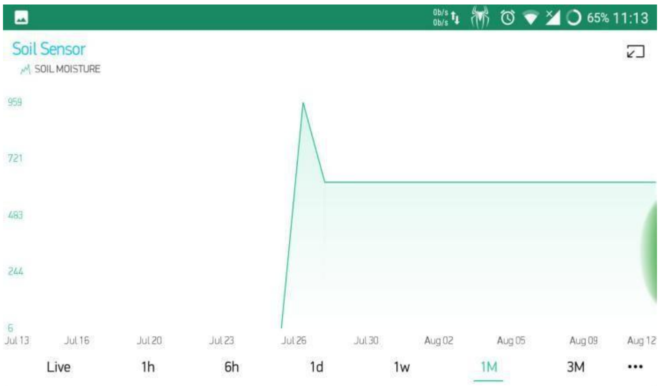

Fig: 3 Soil Moisture Sensor data has been Plotted

Whenever the moisture in the soil is less, a water pump is started for a few seconds and the plants are watered automatically. For this, a tank filled with water, pipes and motors are required.

2. Air Quality Sensor

Fig: 4 Air Quality Sensor Data

As in **Fig 4**, the current air quality level is 750. The exhaust fan started working to purify the air, until the air quality level reached 600.

The air quality is sensed using **MQ135.**

1) If the air quality is till 650 PPM - then it is good and optimal for plant growth.
2) If it greater than 650 PPM, it is not suitable.
3) If the quality is not up to the mark, the manager of the greenhouse will be immediately notified and the exhaust fans start rotating.

3. Temperature and Humidity

Temperature and Humidity in the greenhouse are continuously monitored by DHT11 Sensor, as in **Fig: 5** Whenever the Temperature or Humidity increases in the greenhouse, fans are switched on so that the warm and humid air inside goes out. This maintains the optimum temperature and humidity for plant growth. The data from DHT11 sensor is read using the cloud based applications like Blynk and Thing Speak, is used to store the observations. Graphs showing the changes can also be obtained using Thing Speak.

Fig: 5 Temperature and Humidity readings in Blynk

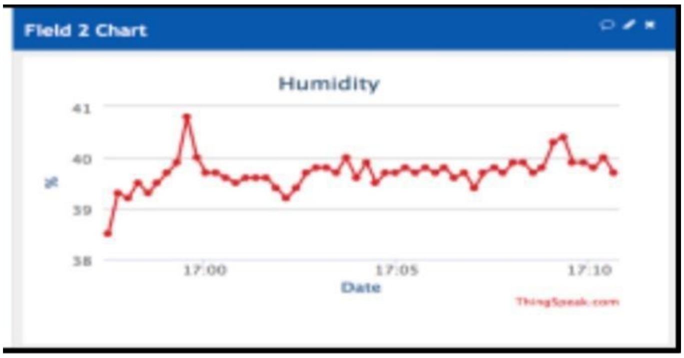

Fig: 6 Humidity Sensor Values in Thingspeak

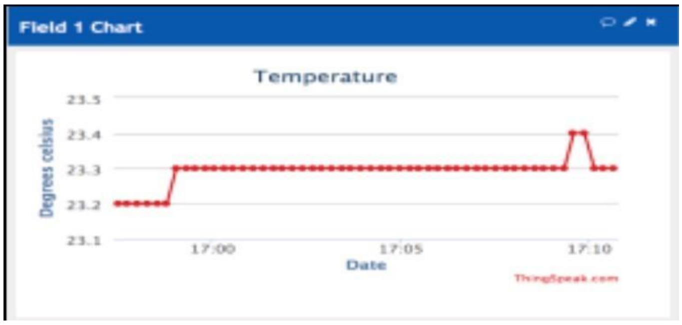

Fig: 7 Temperature Sensor Readings in Thingspeak

From **Fig: 5, 6 and 7** shows the data of the DHT11 sensor data.

In this model, the maximum temperature is assumed as 30°C. Whenever the temperature in the greenhouse exceeds 30°C, the exhaust fan will be switched ON to improve the air circulation inside the greenhouse and a notification/email will be sent to the manager of the greenhouse.

From below **Fig: 8, 9 and 10** we can observe the values of various sensors used in this system which are displayed in both blynk and thingspeak. Further this can be used for checking or controlling each sensor and their functioning separately.

Fig: 8 Blynk app sensors readings

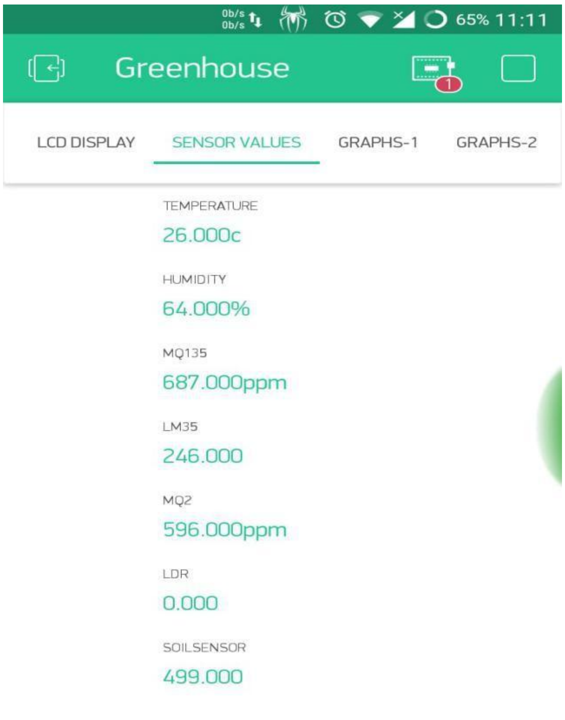

Fig: 9 Blynk application Displaying sensor values

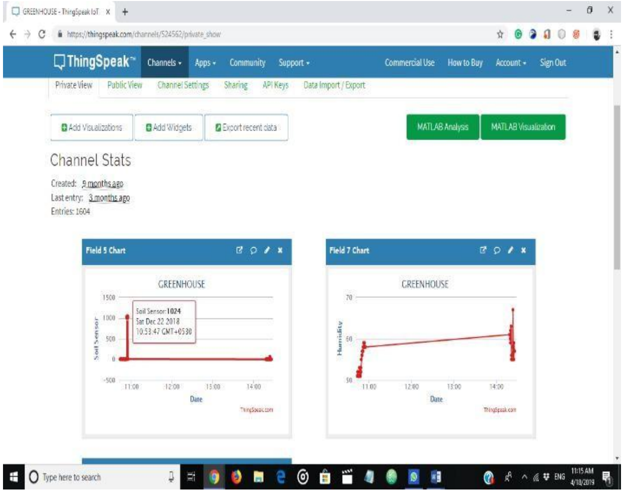

Fig: 10 Sensor values displayed in graphical way in Thingspeak

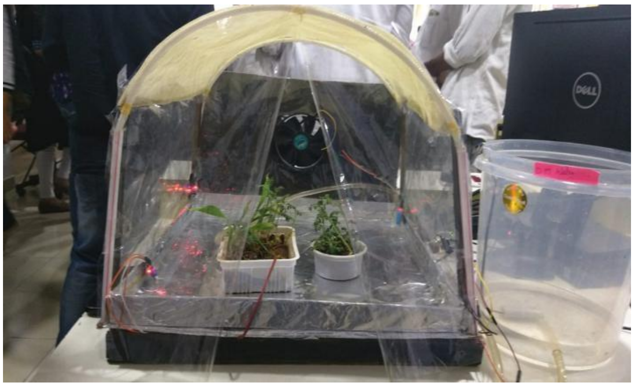

Fig: 11 Prototype of Proposed System

Fig: 12 Soil Sensor placed in the mud and DHT11 Placed inside the Greenhouse

The above **Fig: 11, 12** shows how the sensors are placed. In this temperature and humidity sensor is kept inside the smart greenhouse to measure humidity and temperature. When temperature rises above a certain level, micro-controller will trigger relay attached to the exhaust fan, which will allow little amount of water in the form of sprinkles along with it fan also starts rotating.

VII. CONCLUSION AND FUTURE SCOPE

The Smart Greenhouse can be further upgraded in many ways and can be used in wide agricultural applications. It can be placed and operated in any of the environmental conditions to grow any kind of vegetation. Non-conventional energy sources such as solar panels [10], windmills are used to supply power to the automatic greenhouse equipment. [13] Soil-less farming can be performed to further improve the nutritional value. Integration of farming with IoT can make it much more efficient.

In this proposed model, the greenhouse is automated to grow the crops in a specialized manner using various sensors and using their data the greenhouse is controlled accordingly.

The future enhancements of this model will include:

- Based on the past readings the future readings are depicted and the greenhouse is controlled accordingly using machine learning techniques.
- Using Image processing, the pests are to be identified and certain pesticides have to be sprayed in the affected area.
- For Greenhouse power can be supplied by using solar panels in the placed of battery for powering up sensors and microcontrollers.

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