© November 2017 | IJIRT | Volume 4 Issue 6 | ISSN: 2349-6002

IoT based weather controlled smart green house

Roopa S.[1], Yashwanth H.P[2]
[1]*Associate professor, Dept. of E & C, Siddaganga Insitute of Technology, Tumakuru*
[2]*Dept. of E & C, Siddaganga Insitute of Technology, Tumakuru*

Abstract- **Internet of Things (IoT) is a way of connecting 'Things', using a bunch of modern day technologies, to the internet and eventually to each other. This saves cost and achieves control like never before. Green House automation is an area which has seen the least development unlike home automation which has seen a tremendous development over the years. The existing systems do not provide complete user control over the actuators and also real time data of sensors is not updated to user properly. In this paper, implementation of greenhouse using IOT is carried out, which makes use of internet to communicate between user and sensor nodes controlled by Raspberry-Pi. The sensor data is constantly monitored and required information is conveyed to the user. The proposed system is implemented in a real time environment.**

Index Terms- **Raspberry-Pi, IoT, greenhouse.**

1. INTRODUCTION

People have tried various methods over the years to automate the greenhouse and they are successful in doing so. All the previous efforts to automate included sensors to monitor the temperature, rain and soil moisture accordingly action was taken to irrigate and regulate the exposure to the elements of nature. A GSM module was also used to regularly inform the owner about the inner conditions of greenhouse [1]. But only few of the systems were able to control the functionalities from a place far away from the farm. One such approach is made in this paper to enable control over the greenhouse parameters both manually and automatically from anywhere in the world using the concept of Internet of things (IoT). 'Things' here refers to objects of day-to-day use and other machines

The agriculture though a backbone of our economy has miserably failed to take advantage of the connected world. Green House is an enclosed space where commercial crops are grown. These crops require a specific weather pattern for their better growth and more yield. Many times crops are affected due to adverse climatic conditions like no or too much of rain, high winds, high temperature etc. As there is a rapid advancement in technologies, greenhouse automation can be achieved using one of these various technologies.

The authors in [1] introduced a PIC microcontroller based system for greenhouse automation. The system detects various parameters like temperature, humidity, intensity. This information is conveyed to user by GSM modem and not over the Internet. The drawback of this system is that users are just informed about the greenhouse conditions but the control of parameters lacks a graphical user interface. Users have to control by sending an SMS and they have to remember which buttons to press for the control of connected devices.

The authors in [2] have suggested the implementation of smart green house by monitoring various parameters like light intensity, humidity, soil moisture and temperature. The control system is fully automated. Algorithm which is prewritten for specific conditions controls various parameters with the help of water pump, cooler, heater and artificial light which is not user controllable. Each and every parameter that is monitored is automatically controlled but sometimes there will be need for user control which is not present in this system. Another disadvantage of this system is that monitoring of green house is not that user friendly. Carrying laptop everywhere is not feasible instead one can carry a portable device like smart phone for real time monitoring and control of green house.

The authors in [3] have suggested the implementation of irrigation automation and crop monitoring based on Arduino controller and the system detects various parameters like temperature, moisture, humidity and light. All these parameters are regulated automatically without the intervention of user. However there is no effort made to control the process manually or to inform the user about the status of green house.

The authors in [4] have used the android application along with 8051 microcontroller to automate the greenhouse but there is no scope to change the threshold for each crops. Lack of adoption of latest technologies in current agricultural system is one of the key aspects for hindrance in agricultural growth of nation.

Hence in this paper, an attempt is made to connect greenhouse to the internet and there by opening a whole new world of possibilities. Connecting the greenhouse to virtual world enables us to remotely monitor and control all the functionality. The proposed system concerned with monitoring and controlling of weather of enclosed space by using various sensors and other connected electronic circuitry. The entire proposed system is controlled through internet remotely from anywhere and anytime leading to a better technique which helps in healthy growth of crops.

The paper is organized as follows. Section 2 describes the block diagram of the proposed system. The hardware used in the proposed system is given in the section 3. The software tools used, flow chart and the implementation of the proposed system is depicted in section 4. Section 5 shows the results obtained after implementing the system in real time scenario. Section 6 concludes the work done.

2. BLOCK DIAGRAM

The block diagram of IoT based weather controlled smart greenhouse is shown in Fig. 1. The apparatus used in building the proposed system is briefly described as follows.

The raspberry pi is a credit-card sized single-board computer that plugs in to a computer or TV, and uses standard keyboard and mouse. It is capable of doing everything similar to desktop computer. It can be programmed using Python language. As we know temperature and humidity are the main factors affecting the conditions of greenhouse, the temperature sensor outputs the current temperature of the greenhouse.

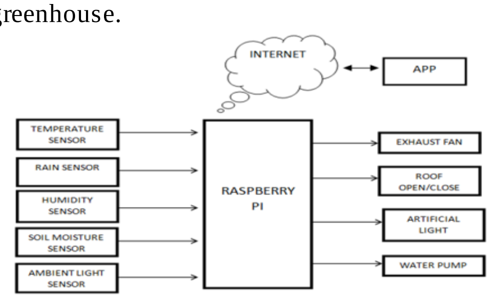

Fig. 1: Block diagram of the proposed weather controlled smart greenhouse using IOT

Excess rain is the major cause for crop failure. Thus the rain sensor indicates the rainfall, this data is fed to the raspberry pi. As we know that excess or scanty moisture level in the soil directly affects the yield of the crop. Thus maintaining moisture balance in the soil is necessary. Hence a soil moisture sensor provides the moisture information to the pi. The process of photosynthesis is optimum if the amount of light energy is above specific level. This is taken care by the ambient light sensor and its data is fed to the pi. Artificial lights are provided to aid continuous light energy for photosynthesis which will be activated when energy from sunlight is not sufficient. The process is controlled by pi depending on the value from ambient light sensor. To provide optimum moisture balance in soil, it is necessary to have water supply that can provide required water for plant metabolism. The water pump is used to support this cause. The roof slider (open/close) is the new idea made in this paper.

3. HARDWARE DESCRIPTION

The hardware used in implementing the proposed consists of the following:

- MCP3008 as ADC
- Raspberry pi
- DHT11 as Temperature and Humidity sensor
- YL-69 as Soil moisture sensor
- Rain sensor
- LDR as Ambient light sensor

MCP3008 is a successive approximation 10-bit Analog to- Digital (A/D) converter. The IC is provided with a on-board sample and hold circuitry. The ADC takes analog input from various sensors to its serial channels and produces corresponding digital output. Raspberry Pi, has 40 GPIO pins out of which 17 pins can be interfaced with sensors. The main GPIO connectors are shown in Table 1. The temperature sensor, rain sensor, anemometer, soil moisture sensor, ambient light sensor, water pump, roof sliders, windows sliders and artificial light are interfaced to the GPIO pins.

Table 1: Main GPIO connections

Pin#	NAME	NAME	Pin#
01	3.3v DC Power	DC Power 5v	02
03	GPIO02 (SDA1 , I²C)	DC Power 5v	04
05	GPIO03 (SCL1 , I²C)	Ground	06
07	GPIO04 (GPIO_GCLK)	(TXD0) GPIO14	08
09	Ground	(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)	(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)	Ground	14
15	GPIO22 (GPIO_GEN3)	(GPIO_GEN4) GPIO23	16
17	3.3v DC Power	(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)	Ground	20
21	GPIO09 (SPI_MISO)	(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)	(SPI_CE0_N) GPIO08	24
25	Ground	(SPI_CE1_N) GPIO07	26
27	ID_SD (I²C ID EEPROM)	(I²C ID EEPROM) ID_SC	28
29	GPIO05	Ground	30
31	GPIO06	GPIO12	32
33	GPIO13	Ground	34
35	GPIO19	GPIO16	36
37	GPIO26	GPIO20	38
39	Ground	GPIO21	40

DHT11 digital temperature and humidity sensor is a composite sensor contains a calibrated digital signal output of the temperature and humidity. Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors. The relation between the measured property and soil moisture must be calibrated and may vary depending on soil type. Measuring soil moisture is important in agriculture to manage their irrigation systems more efficiently.

The rain sensor module is an easy tool for rain detection. It can be used as a switch when raindrop falls through the raining board and also for measuring rainfall intensity. The module features, a rain board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity though a potentiometer. The analog output is used in detection of drops in the amount of rainfall. Connected to 5V power supply, the LED will turn on when induction board has no rain drop. and DO pin of rain sensor output is high. When dropping a little amount water, DO output is low, the switch indicator will turn on.

A Light Dependent Resistor (LDR) is also called a photo resistor or a cadmium sulfide (CdS) cell. It is also called a photoconductor. It is basically a photocell that works on the principle of photoconductivity. The passive component is basically a resistor whose resistance value decreases when the intensity of light decreases. This optoelectronic device is mostly used in light varying sensor circuit, in light and dark activated switching circuits.

4. SOFTWARE IMPLEMENTATION

This section describes various software tools that are used in implementing the proposed system. It deals with the cloud implementation, android app development and the software used in raspberry-pi. Android App is developed using Kivy. Raspberry-pi uses Raspbian as an Operating System and Python IDE is used for writing Python codes. In addition to these, Putty and Xming are also used for accessing Raspberry-pi terminal from a laptop without connecting raspberry-pi to monitor and separate keyboard and mouse.

The set of basic programs and utilities which are inbuilt in Raspbian helps to run python codes using Raspberry-pi. Python design emphasizes code readability, and coding in python requires fewer lines than C++ or Java. The various other features of python include automatic memory management and comprehensive standard large library. Python IDE 2.7 running on Raspbian is used in the proposed system. It already contains most of the libraries. However, a library for mqtt subscriber and publisher needs to be added.

Virtual Network Computing (VNC) provides clients and servers for many GUI-based operating systems and for Java. The software is platform independent. Multiple clients can be connected to a VNC server and operate at the same time.VNC

is a graphical desktop sharing system that remotely controls another computer using the Remote Frame Buffer protocol. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen updates back in the other direction, over a network. Kivy software is used to develop mobile apps and other multitouch application using open source Python library. In this paper, Kivy language is used in the foreground for creation of android application and python in the background.

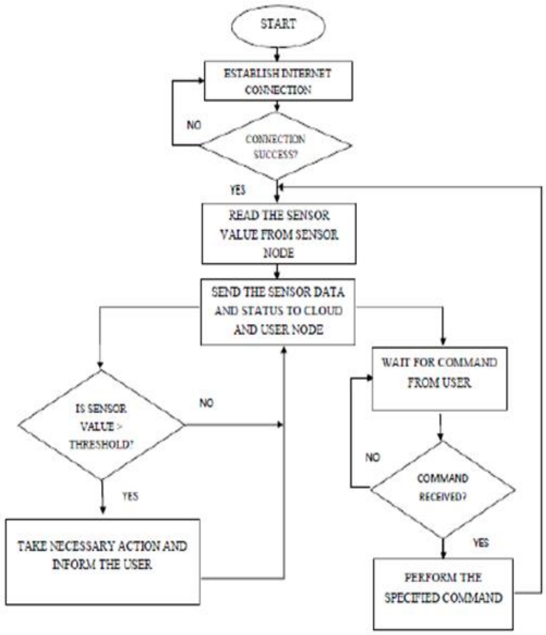

Fig. 2: Flowchart of IoT based weather controlled smart greenhouse

The flow chart of the proposed system is shown in Figure 2. The key factor for the operation of the system is establishment of stable internet connection which is checked initially. Once the connection is established the system operates in two modes namely

- Automatic mode
- Manual mode

In User controlled mode the user instructions will override the action taken in automatic mode and work based on users command.

In Automatic mode the system operates based on the sensor readings and the outputs are specified by the predetermined algorithm.

5. RESULTS AND ANALYSIS

The working of the system is tested in real time in a greenhouse on marigold saplings in both auto mode and manual mode. The real time setup of the proposed system is shown in Figure 3.

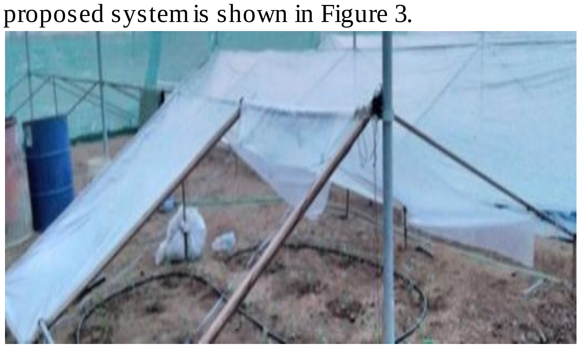

Fig. 3: The real time setup of the proposed system

The measurement section of the application will have the real time sensor readings as shown in Figure 4

Fig. 4: Measurement section

The real time actuator status is shown in the device state section as shown in Fig. 5

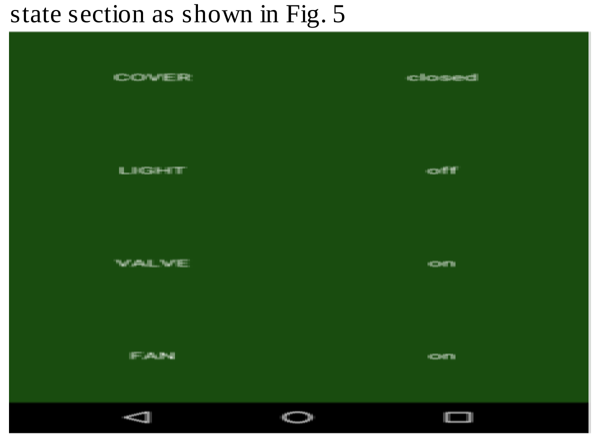

Fig. 5 Device state section

The working of roof open and close mechanism is shown in Fig. 6.

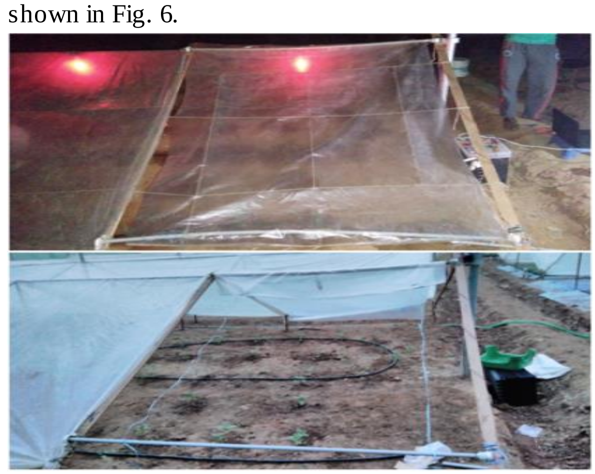

Fig. 6: Roof sliding section

The real time placement of Ambient light sensor ,temperature and humidity sensor and rain sensor is as shown in Fig. 7

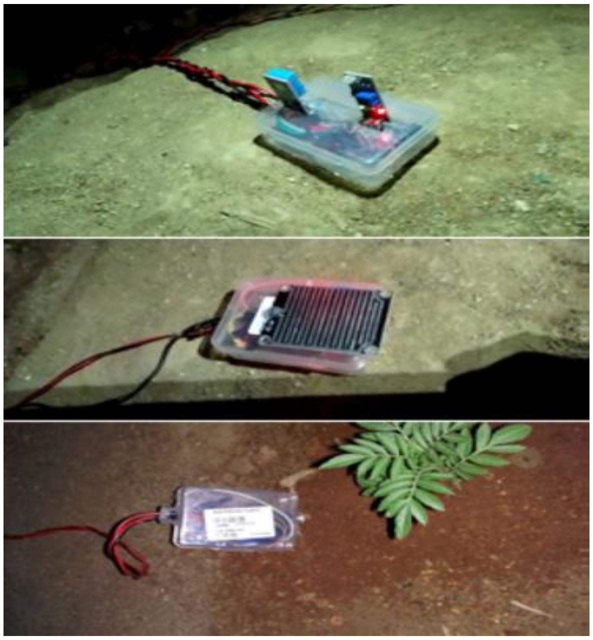

Fig. 7: Real time sensor placement

6. CONCLUSION

The proposed system is used for real time control of green house from remote location by the parameters thus obtained helps the growth of plant in a favorable controlled environment. Real-time data from the sensors can be used to modify crop maintenance procedures. This saves time and money. The system operates in two modes providing greater flexibility and thus enabling greater customization of growing conditions.

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