ISSN: 0974-5823 Vol. 6 No. 3 October-December, 2021

International Journal of Mechanical Engineering

Greenhouse monitoring using IoT- A Review

R.Neelaveni
Professor, Electrical and Electronics Engineering, PSG College Technology, Coimbatore – 641 004
rnv.eee@psgtech.ac.in

M.Kathiresh
Assistant Professor, Electrical and Electronics Engineering, PSG College Technology, Coimbatore – 641 004
mkh.eee@psgtech.ac.in

P.Sweety Jose
Assistant Professor, Electrical and Electronics Engineering, PSG College Technology, Coimbatore – 641 004
psj.eee@psgtech.ac.in

Abstract—

This paper is a brief summary about the various Greenhouse monitoring techniques pursued by using internet of things (IoT) technology. IoT is network of interconnected devices that are capable of communicating with each other. IoT is a great platform for information analysis and it is used in the greenhouse for monitoring various parameters like temperature, pH Value, humidity etc and taking necessary actions. Greenhouse is used to nurture various plants in a restricted environment with optimal climatic conditions as it prevents the plants from critical environmental constraints like overheating, drying, etc. The main aim of the paper is to project a simplified idea of IoT based greenhouse monitoring.

Keywords—Environment, Greenhouse, IoT, Monitoring.

I. INTRODUCTION

Greenhouse is room with glass to grow various types of plant such as flowers and vegetables under constrained environment. The greenhouse provides light to the plants by allowing sunlight to pass through their glassy exterior. Plants use this light for photosynthesis to combine CO_2 and sunlight to produce food. The greenhouse also provides heat, when the sunlight hits any solid surface it turns to heat. Due to this the temperature inside the greenhouse is much higher when compared with normal room temperature. This concept becomes an advantage during seasons when there is less sunlight. Various parameters are important for the plants inside the greenhouse to survive and produce better yields apart from heat and light. Such parameters include

1. Temperature

The optimal temperature for plants is 75 - 80˚ at daytime and 60-75˚ during night. Various sensors are present to measure the temperature and take appropriate actions using actuators like heaters, fans and vents. As greenhouse is capable of concealing the heat from sunlight, the temperature might become unstable at times. Therefore fan and vents are used to cool down the temperature if it is above the optimal value and heaters are used to bring the temperature to an optimal level.

2. Humidity

Due to respiration of plants, the humidity in greenhouse may tend to increase. The optimal value of humidity should be around 70-85%. So that plants are protected from various problems like fungal disease, early bolting, and growth weakness. Sensors measure humidity in parts per million (ppm) and according to this, if the value is low water is sprayed on the floor and if it is high exhausting some of the humid air will be helpful.

3. Soil Moisture

The amount of water content is soil is called soil moisture. This parameter is important for plant growth as they absorb water readily available in soil. There are various advantages of maintaining the soil moisture like it contains essential nutrients, it regulates soil temperature and it may ultimately result is higher crop yield. The soil moisture content is measured with the sensor and the value is sent to the controller to check for optimal values. To regulate the content of soil moisture drip irrigation can be used.

4. pH Value

The pondus Hydrogenii (pH) value will indicate the presence of acidity or alkalinity in the soil. For a plant to grow without any problem, the soil pH level to be a little acidic having an optimal value between 5 to 6.5. This acidity is essential for the plants to determine quality, characteristics,

absorbability etc. This value is measured by the pH sensor at various sample points in the soil bed. According to the value if it is too acidic, then nitric acid or phosphoric acid can be added to reduce the acidity levels. If the value is too alkaline the pH value is neutralized by adding sulphur or acidifying fertilizer.

II. RELATED WORK

Priyanka P. Deshmukh [1] They have designed a wireless greenhouse monitoring setup which monitors various parameters like temperature, humidity, light and soil moisture. This paper proposes to use GSM-SMS and sensors to transmit the measured values wirelessly. Various actuators are present to control the greenhouse environment and keep them in the optimal values. There are relays connected to fan, sprinkler, rooftop, etc. The system proposed in the paper consists of a microcontroller with sensors and relay connected to it. The measured values are displayed in the LCD and these values are sent as an SMS using the GSM modem. The various parameters that are measured is done through the sensor nodes and they are controlled and conducted through an Android smartphone. This system was successful in reducing the power consumption, complexity and maintenance at the same time provides precise and flexible form to maintain the greenhouse environment.

Teemu Ahonen [2] They have designed cost effective wireless sensor node (WSN) which contains various small sensors to measure various parameters of the greenhouse like temperature, humidity, irradiance, CO2. The feasibility analysis of this project is done in marten's greenhouse research foundation. The collected data is evaluated to show that the system is able to detect microclimate layers. The networks will also detect local difference in measured values of the parameters due to various disturbances in the greenhouse. The various parameters are measure every 15-60 seconds by the computer unit containing the climate control algorithm. The future work of this project is to add a probe to the WSN to measure the Soil Moisture, pH values etc. It is also planned to provide data analysis, control solutions and also complex network setups.

ViswanathNaik [3] They have implemented a greenhouse monitoring system using Internet of Things technology. The user can access the measured data from anywhere in the world with the help of IoT. The parameters measure in this paper is temperature, humidity, and soil moisture. This paper proposes a flexible and low cost greenhouse monitoring system with a microcontroller having wifi connectivity. This system will offer a light weight communication protocol to actively monitor and also to control the environment. This proposed system uses a protocol called MQTT which uses an online broker to which the measured values are sent, form the broker the subscribers for eg the user can get the data from anywhere in the world through internet.

Ravi Kishore Kodali [4] They have implemented a system to produce better yields. This greenhouse monitoring model will helps the farmer to automatically carry out the work in farm without any manual inspection. The irrigation for the plants is done through automatic drip irrigation that operates based on the soil moisture value measured. Various other parameters like nitrogen, phosphorus, potassium and other minerals can be measured and supplied through drip fertigation methods. Temperature and humidity are controlled with the help of sensors and fogger. Water management is also made with the help of ultrasonic sensors and it is managed by sending GSM based SMS to switch on or off the pumps. In addition to this a beehive is installed and monitored to measure the quantity of honey present. All these measure details are sent to the cloud and the users can view data from anywhere. The quantity about the yield is also forwarded to an e-commerce company to sell the products. This smart greenhouse in future can be installed in any individual house and can grow any kind of plant without any knowledge about farming.

D.O.Shrisath [5] They have established a system to overcome the limitations of the other existing system. Greenhouse monitoring and controlling is automated to avoid manual supervision. Data from the sensors is collected from various multiple sensors and these data are used for simulation and processing to provide enhancement for growth of plants in the greenhouse by comparing them with the optimal values and determining the actions to be performed. Various parameters measured are the temperature, humidity CO2 gas and soil moisture. The measured value is graphically displayed to the user using LabVIEW and arduino mega is used as a microcontroller to obtain data from sensors connected to it. IOT is used to display the data measured graphically in web portal, so that user can view it from anywhere in the world. The main advantage of the project is that it can be used domestically, easy to use operate and troubleshoot and useful for farmers and greenhouse owners.

C.R.Dongarsane [6] They have designed a system which monitors the climatic conditions inside the greenhouse using IOT. This system associates with monitoring and controlling of parameters like temperature and humidity. This system is proposed to overcome the limitations of Bluetooth and GSM by using wireless sensors and the concept of IOT. The data measured by these sensors are continuously updated to the microcontroller and it processes the data and transmits to an internet hosted web page through Wifi. The system uses a Real Time Sensor circuit so that the acquisition of data is real time. The main advantage of the system is that it is portable and can be used anywhere, it is also affordable and can be used domestically. As they are using IOT, communication are scalable and the monitoring can be increased to a network of sensors to sense many climatic parameters.

Ruchika [7] They have designed a smart agricultural monitoring system using IOT and WSN. Various parameters measured are temperature, humidity and soil moisture. This system proposed is mainly focused to help farmers measure the

agriculture parameters, send them to the processing unit and update the information on a real time database application firebase. It uses an arduino based hardware for sensing the parameters and sends them to the web hosted server for the users to acces the data from anywhere in the world. The system updates the real time database application every 2 seconds. The improvement needed for the system is to control appliances from the internet and do analytic work on the data obtained.

Sheetal Vatari [8] Due to the problem of having unequal distribution of water, the farmers don't have control on the equal distribution of water to the farms and hence the greenhouse is introduced. So they have created a system to overcome the limitation present in various traditional methods for precision agriculture. This system is built upon two technologies like the IOT and cloud computing. The main parameters to look for in the greenhouse management is the temperature control, humidity control and the soil control. The threshold for each parameter is set according to the requirements of the corp. This system consists of IOT based input and output that are capable of collecting data from the environment and downloading data from the internet and perform some processing on them. Here the sensor circuit collects the data and sends it to the cloud where the data are stored and retrieved for future use. The actuator setup provides the necessary actions like turning on the relay connect to the fan based on the processed data. This system leads to the crop having higher yields, prolonged production period and use of chemical fertilizers becomes low.

Neelima Devi Boddeti [9] They have employed a smart greenhouse based on IOT to continuously monitor the parameters and update to the cloud database every 20 second through a wireless protocol. By using IOT accurate and real time environmental information can be obtained. The various values monitored are temperature, humidity, pH values, moisture content of soil and light radiation. The measured values are regularly updated in the cloud. The proposed system will also have a current sensor to indicate the power consumption. The data is stored in the cloud and viewed by the owner at anytime from anywhere. The owner is given a talkback option through which the greenhouse can be controlled. The main advantages of this system is that it is user friendly, easy to implement, resource continuity, etc. In future by building a versatile IOT framework this system can be made more adaptable to a variety of people.

Keerthi [10] They have proposed a system consisting of GSM, IOT and Cloud computing to create a model for monitoring various parameters for the greenhouse. To increase the quality and quantity of production in greenhouse this system is implemented. The owner is presented with the details of the various parameters measured through internet irrespective of their presence every 30 seconds. Traditional greenhouse monitoring is very complex and tedious process, this is overcome with the process of automating with the help of IOT. The values measured is displayed outside of the greenhouse in LCD. This system is proved to be profitable as it is optimizing the resources in the greenhouse. This model is low cost and consumes low power hence easily available to everyone.

LIU Dan [11] They have planned to develop a IOT based monitoring system that has CC2530chip as the core. It also uses a zigBEE technology and wireless sensor network to send the measured values to the core for further processing. The processed data is then sent to an intermediate node which aggregates the data and sends it to the PC. All nodes will transmit to the room gateway which receives and transforms the data so that it could be displayed or sent to the smart phone through GPRS. The GUI is implemented using labVIEW as it is easy to implement and user friendly. This system improves operational facility and system application.

Sun Jianmei [12] They designed a greenhouse monitoring system based on IOT and fuzzy control. Precision agriculture is a practice where farming is based on monitoring, measuring and responding to intra and inter field variability in crops. This system utilizes the fuzzy control which is an excellent method to overcome the complex and changeable greenhouse environment. ZigBEE protocol is used for communicating wirelessly making it easy and effective. This proposed system is a 3 layered structure consisting of the perceptive layer, network layer and the application layer. Various constraints like temperature, relative humidity and CO2 are collected through the sensors and given to the fuzzy control. This fuzzy control has some logic according to which actions are taken. The fuzzy controller is a dual-input neural network model. This model is tested for 24 hours and it produced real time results. Web pages are created to self-adjust to any device from which it is launched. This system is highly reliable and easy to extend.

Yi Jui Chen [13] They developed a model for small and medium sized greenhouse monitoring which bridges a path between technology and farming. This system uses IOT, RethinkDB, raspberry pi and splunk. It uses a web application by polling the sensors which degrades the performance. RethinkDB uses web socket which increases the performance. Sensors are connected to the raspberry pi which measures various parameters like temperature, humidity, luminosity and atmospheric pressure. The data collected from these sensors are stored in three repositories. The splunk forwarder on the raspberry pi will forward all the data to the splunk indexer which organizes the data so that the user can explore and search for the required data. This system facilitates with the efficient management of large data for real-time data analysis.

III. PROPOSED MODEL

The proposed system consists of the Raspberry Pi3 model b which acts as a controller and a gateway, sensors which is required to sense the environment for various parameter like temperature, humidity, rain sensor and a servo motor to rotate the flaps connected on the roof of the roof garden. All the collected data is sent to the Thinkspeak cloud as it provides

immediate picturing of the data in terms of graphical format. It also uses a MATLAB as a processing engine for processing the data as received.

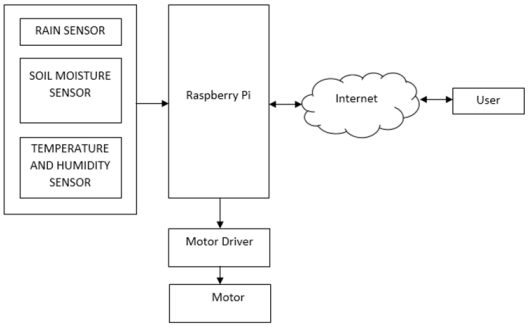

Fig.1 Block Diagram of the Proposed System

The inputs from various sensors are connected to the raspberry pi which acts as a microcontroller to collect the data received from the sensors. It acts as a gateway which sends the data to the cloud i.e. Thingspeak cloud with the help of inbuilt Wi-Fi module to display it in graphical format. Depending on optimal values stored in the controller necessary action like rotation of the motor is taken.

RASPBERRY PI

Raspberry pi is a small, cost efficient computer that runs on Raspbian OS which is built on debian (linux). Therefore it is easy to use and all debian processors are run from the terminal so it has inbuilt security. Raspberry pi has many versions consisting of the following hardware and connectivity characteristics.

Table 1.Versions of Raspberry pi

	Raspberry Pi 1 Model A	Raspberry Pi 1 Model A+	Raspberry Pi 1 Model B	Raspberry Pi 1 Model B+	Raspberry Pi 2 Model B	Raspberry Pi 3 Model B	Raspberry Pi Zero
Release Date	2013	2014	2012	2014	2015	2016	2015
SoC	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2835	Broadcom BCM2836	Broadcom BCM2837	Broadcom BCM2835
CPU Speed	700 Mhz ARM-1176JZF-S	700 Mhz ARM-1176JZF-S	700 MHz ARM-1176JZF-S	700 Mhz ARM-1176JZF-S	900 Mhz ARM-Cortex-A7	1.2 Ghz ARM-Cortex-A53	1 Ghz ARM1176JZF-S
Cores	1	1	1	1	4	4	1
SDRAM	256 MB	256 MB	512 MB	512 MB	1 GB	1 Gb	512 MB

Raspberry pi is used as a controller to collect the data from sensors and also as a gateway to connect to the internet. Based on the needs of connectivity, Raspberry pi 3 model B is selected.

DHT11 SENSOR

Digital humidity and temperature sensor that is capable of measuring both temperature and humidity and gives the output in digital format. This sensor consists of thermistor to measure the temperature and a capacitive humidity to measure the humidity. This sensor is cheap and perfect choice where the environmental parameters which are measured are not critical data. This sensor can sense the environments for every one second and has an inbuilt ADC to produce the digital data.

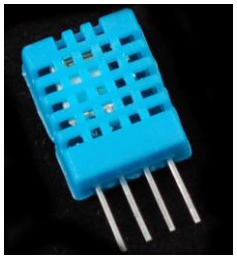

Fig. 2. Digital humidity and temperature sensor

RAIN SENSOR

This sensor is activated by the presence of water droplets in the rain board connected to the control board. This sensor is placed at the top covering of the rooftop garden that is able to rotate to specific angles. This rain sensor can detect the presence or absence of rain and it is also able to tell the intensity of rainfall.

Fig. 3. Rain Sensor

SOIL MOISTURE SENSOR

The volumetric content of the soil is measured using this sensor. Since soil moisture is important for the growth of the plants in greenhouse this is measured and the value is sent to the raspberry pi for comparing with the optimal value. If the measured value is less than the optimal value the soil moisture content is revived with the help of drip irrigation.

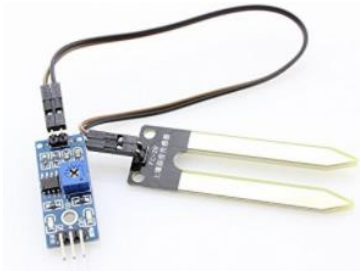

Fig 4. Soil Moisture Sensor

SERVO MOTOR

This is an actuator used for precise control of the angular movement. Servo motor is placed at the flaps used to cover the rooftop garden. This main functionality is that when the measured rainfall intensity from the rain sensor is low, the servo motor is made to move to 90˚ so that the rainfall will water the plants and when the measured rainfall intensity from the rain sensor is high, the servo motor is made to move to 180˚ so that the rainfall will be runoff of the rooftop and stored in a tank for later used.

This method can also be implemented in the Rainwater harvesting thereby saving water in an underground tank. By doing so the underground water level is raised and water is saved.

IV. CONCLUSION

This paper proposes a model that is cost efficient, user friendly, easily expandable and provides a solution for water shortage in urban areas. The use of drip irrigation can reduce the consumption of water in water scarce region. The Thingspeak cloud provides a free cloud service with limited data storage which is enough for household applications. This provides an automation solution for all the users by avoiding manual monitoring of the environmental parameters.

This system can be further expanded by adding other sensors like pH sensor to measure the pH value of the soil from various points in the soil bed, water level sensor to indicate the level of water in tank and a water meter to supply the collected water in tank. Many other features like monitoring the measured data from an android app can be added.

References

[1] Priyanka P. Deshmukh, and Swarup D. Deshmukh, “Greenhouse monitoring and controlling using GSM and Android,” in International journal of scientific and engineering research, vol. 7, issue 2, pp. 507-517, Feb 2016.

[2] Teemu Ahonen, Reino Virrankoski, and Mohammed Elmusrati, “Greenhouse Monitoring with Wireless Sensor Network”, in International Conference on Mechtronic and Embedded Systems and Applications, pp.1-6, Oct 2008.

[3] Viswanath Naik S., S.Pushpa Bai, Rajesh P. and Mallikarjuna Naik B., “IoT based greenhouse monitoring system,” in International journal of Electronics and Communication Engineering and Technology, vol. 6, Issue 6, June 2015, pp. 45-47.

[4] Ravi Kishore Kodali, Vishal Jain, and Sumit Karagwal,” IoT-based smart greenhouse, “ in 2016 IEEE Region 10, Humanitarian Technology Conference (R10-HTC), Year: 2016, pp. 1-6.

[5] Prof. D.O.Shirsath, Punam Kamble, Rohini Mane, Ashwini Kolap, and Prof. R.S.More, “IOT Based Smart Greenhouse Automation Using Arduino ” ,International Journal of Innovation Research in Computer Science and Technology, vol 5, Issue 2, pp. 234- 238, March 2017.

[6] C.R. Dongarsane, Patil Pranav Balasaheb ,Patil Nilesh Rangrao , and Patil Pranit Ramesh, “Greenhouse automation using IoT,” International Research Journal of Engineering and Technology, vol. 4, Issue 1, pp. 1485-149, Jan 2017.

[7] Ruchika, and Ruchi Taneja , “ Smart Agriculture Monitoring Through IOT “ , International Journal for Scientific Research & Development, Vol. 3, Issue 05, January 2015.

[8] Sheetal Vasari, Aarti Bakshi, and Tanvi Thakur, "Green House by using IOT and Cloud computing", IEEE International Conference On Recent Trends In Electronics Information Communication Technology, May 2016.

[9] Neelima Devi Boddeti and Sugandhi Naidu Y., "IoT (cloud) based greehouse monitoring and controlling system", International Journal of Applied sciences, Engineering and Management, vol 5, issue 6, Nov 2016.

[10] Keerthi V. and Dr.G.N.Kodandaramaiah, "Cloud IoT based greehouse monitoring system", International Journal of Engineering research and applications, vol 5, issue 10, Oct 2015.

[11] Liu dan, Cao xin, Huang chongwei and Ji Liangliang, "Intelligent agriculture greenhouse environment monitoring system based on IoT Technology", International Conference on intelligent Transportation,Big Data and smart city, 2015.

[12] Liu dan, Sun jianmei, Yu Yang and Xiang jianqiu, "Precise Agricultural greenhouse based on IoT and Fuzzy Control", International Conference on intelligent Transportation,Big Data and smart city, 2016.

Yi jui chen and hung yu chein, "IoT based greehouse system with splunk data analysis", International Conference on Awareness science and technology, 2017