2017 International Conference on Big Data, IoT and Data Science (BID)
Vishwakarma Institute of Technology, Pune, Dec 20-22, 2017

Remote Sensing and Controlling of Greenhouse Agriculture Parameters based on IoT

Pallavi S., Jayashree D. Mallapur, Kirankumar Y. Bendigeri
Department of Electronics and Communications Engineering
Basaveshwar Engineering College, Bagalkot-587102, INDIA
Email : pallavi.kotla@gmail.com, bdmallapur@yahoo.co.in, kiranbendigeri@gmail.com

Abstract— **The new era in computer communication is Internet of Things (IoT), gaining its importance because of wide variety of application in oriented project developments. The IoT is furnishing people with smart and remote approach, the remote applications such as smart agriculture, smart environment, smart security, and smart cities etc. These are the upcoming technologies now a day, making the things easy. The IoT has essentially, increased the remote distance control and variety of interconnected things or devices, which becomes an interesting aspect. The IoT includes the hardware and internet connection to the real time application. The main components of IoT are sensors, actuators, embedded system, and internet connection. Therefore, we are interested in developing an IoT application for smart agriculture.**

The paper proposed a remote sensing of agriculture parameters and control system to the greenhouse agriculture. The plan is to control CO_2, soil moisture, temperature, and light, based on the soil moisture the controlling action is accomplished for the greenhouse windows/doors based on crops once a quarter complete round the year. The objective is to increase the yield and to provide organic farming. The result shows the remote control of CO_2, soil moisture, temperature, and light for the greenhouse.

Keywords: CO_2, soil moisture, temperature, and light.

I. INTRODUCTION

Developing plants has turned out to be innovative test in light of the fact that the field and strength of the plants are vital parameter now a day either for cash crops or food crops. One of the significant issues in the present agriculture is the less learning of the agriculture parameters, and less information about the developing innovations.

In the past agribusiness structure our people of old avoid the use of a specific development for specific plant growth, they rather used regular marvel for all plants. The technological change in the agriculture can develop plants under uncommon normal natural conditions, also this develops specific plants under specific condition which in turn help to get more yield and less compost.

Presently the advancement of precision agriculture in green house, for plant development has turned out to be prominent on account of less cost innovations for the agriculturists to rearrive yield. The greenhouse is a house like a structure covered with a transparent material, which can keep up controlled temperature, required moistness level, light infiltration and so on, for the healthy plant growth.

The precision agriculture is a framework which incorporates detecting, measuring, and responding. It is a technique for recognizing greenhouse climate, at that point identified data is sent to the cloud and afterward required action taken by the agriculturist in view of the received data. This can be expert by the present advancement called Internet of Things (IoT), it is the innovation which is interface with everything or every contraption by techniques for web.

The précised agriculture framework going towards its improvement, in light of the innovative progression in Wireless Sensor Networks (WSN) that is nothing but an IoT. The irreregular climate conditions for the plants in greenhouse will influence the development of the plants, and less yield toward the end of the cultivation. So, that it is necessary to control and monitor the greenhouse parameters, for example, CO_2, soil moisture, temperature, light and so on.

This issue can be solved by adapting an IoT innovation in precision agriculture, which incorporates the précised application for particular greenhouse parameters, for instance controlled temperature range, water flow control, light radiation and so on for the good plant growth.

A. Greenhouse technology

A greenhouse is a structure, like a shape of the house which is covered with the transparent material to maintain microclimate such as water flow control, regulated temperature range, etc. for the healthy plant growth. Hence, it avoids excess of light penetration, extreme temperature, diseases, and insects so on. From this the farmer can grow any plant in any season by maintaining ecological conditions.

B. Precision agreiculture

The precision agriculture is the most advance farming management system in recent days. It includes sensing, measuring, responding of greenhouse information to the farmers if any sudden change in the greenhouse.

C. Internet of Things (IoT)

The IoT is made up of complex networks with interconnected billions of devices and peoples into a multi convention, multi technology, and multi stage frameworks.

978-1-5090-6593-6/17/$31.00 ©2017 IEEE

With the help of hardware devices and internet connection, the smart environment condition can be built that make intelligence to cities, industry, health, energy, and transport etc., for our everyday life. This can be possible only by interconnecting all devices any time and any place with the access of the data.

II. RELATED WORK

The MAD [1] architecture used to upload the information related to the agriculture to the cloud. The data (weather, moisture content, soil information etc.) collected from GPS and sensors will be uploaded to the cloud. This information will be provided to the farmer through an application.

The LMD (Labour Monitoring Device) which is used to monitors the labour activity in field and also the quantity of crops harvested by the labor. LMD [2] consists of RFID reader, CU (Computational Unit), GPS, and weighing machine. A labour will be provided with a wrist rubber band in which a unique RFID number will be embedded. With the help of weighing machine and computational unit the quantity of crops harvested by the labour will be calculated. This information will be uploaded to the cloud by the LMD.

IT infrastructure [3] for agriculture consists of analysis part (computer network with software's) and storage devices. The information related to soil, temperature, crop information etc. are collected using sensors and cameras. The collected information will be stored in storage devices and this will be analyzed in analyser part by agriculture experts. PDCA (Plan-Do-Check-Act) and cloud services can be used instead of deploying an IT infrastructure. Where the information collected by different sensors and cameras is uploaded to the cloud for the analysis. He also discuss about the advantages of deploying cloud services in agriculture over IT mechanism to support agriculture operation.

The solution [4] can be given to the farmers through SMS. The solution consists of client stub and a server stub. Server stub consists of group of application (message process, query process, database and analytical process) which receive the queries from client stub and deliveries the data to the client stub. The server stub contains the information about crop, fertilizers, water management, crop protection, and weather and agriculture implementation.

A system using technological development in wireless sensor networks that is Programmable System on Chip (PSOC) [5], which can monitor and control greenhouse parameter of precision agriculture by conducting several experiments. The design of this system is to avoid irregular distribution of water to the crops in the field.

The potential transpiration rate is important for healthy plant growth [6]. The reason for the transpiration fall rate below the potential value is because of variations in soil moisture level. After conducting an experiment for the soil moisture, which affects the transpiration process when fall below the potential rate with different graphical representation.

A wireless sensor network [7] is as an alternative and efficient way to solve the agriculture issues for monitoring agriculture parameters such as temperature, humidity, etc., for the précised agriculture methods. Here, the focus is on the hardware and network architecture, and software process control for the precision agriculture system.

A control system [8] for an intelligent farming composed mainly two parts in Intelligent Farming (IF) that is sensor system and control system used to monitor and control the farm field. The new technology used for this is Internet of Things (IoT) to monitor and control useful information from the farm field to the owner/farmer. The architecture for IF and the information decision are calibrated by using kalman filtering, to monitor weather condition of farm field.

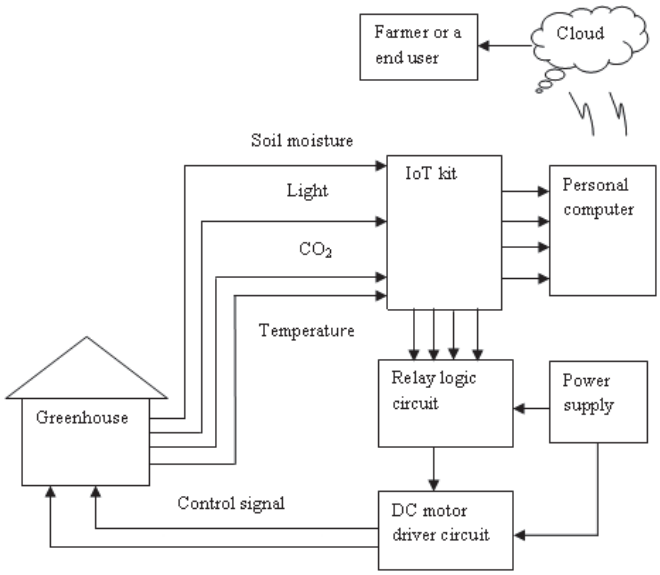
III. RESERCH METHODOLOGY

In proposed scheme, the interesting aspect to help the rancher by presenting IoT based precision agriculture framework for greenhouse. The concentration is to give field data that is remotely controlled greenhouse agriculture parameters, for example, CO_2, soil moisture, temperature, and light, to the agriculturists from long distance, and in view of the soil moisture esteems the controlling move can be made for the greenhouse windows/doors to roll on/off. This stays away from the agriculturists from physical visit to the fields. For this utilized an IoT kit with internet connection. The kit comprises of an electronic devices and different sensors.

The components used are

1. IoT kit
2. sensors
3. Relay logic circuit
4. DC motor driver circuit
5. DC motor
6. Internet connection
7. Cloud account

Block diagram



A. Greenhouse

The development of the greenhouse in view of the harvest accommodation is imperative, here in the proposed conspire, and chose shade net sort greenhouse for regulated temperature range, easy ventilation, required light infiltration and so on.

B. IoT kit

The IoT kit utilized here is comprises of a 32 bit on chip processor and Wi-Fi microcontroller framework. It additionally comprises of various sensors, for example, CO_2 sensor, soil moisture sensor, temperature sensor, light sensor, and so forth. The detected analog information from the sensors are given to the processor to change over these signal into digital form and furthermore for other handling reason. The digital values can be seen on the consol of the personal computer.

C. Relay logic circuit

The relay logic circuit commonly used to control output devices with respect to input signals. It is a low powered electrical network with required input and output. The input to the relay logic circuit may be control relay or a switch. Here, in our proposed scheme it is used to control DC motor direction in clockwise and anticlockwise direction.

D. DC motor driver control circuit

The DC motor driver control circuit consists of an IC L293D; it is used to control DC motor in clockwise and anticlockwise directions. The input signal to the IC is from relay logic circuit.

E. Personal computer

With the help of personal computer we can monitor the greenhouse parameters such as CO_2, soil dampness, temperature, and light.

F. Cloud

The IoT kit is compatible with the Amazon Web Service (AWS) cloud benefit, by having a cloud account farmer can get to greenhouse data. This innovation comprises of a virtual groups of personal computer with RAM memory, CPU, hard disk, OS, and so on. With the assistance of sign in facilities, farmer can get to information from the cloud.

G. Farmer or a end user

The farmer or an end user can get greenhouse data by having web association in his portable devices with sign in to the AWS account.

IV. Algorithms

Nomenclature: CO_2=400 to 600ppm, Temperature=20 to26°C, Light=650 to 750cd, Soil moisture= 100 to -3 volt

Algorithm 1: Main program

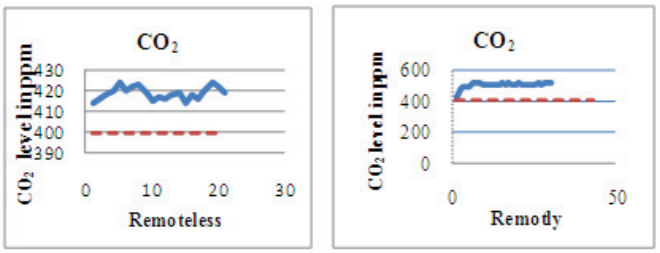
Begin
Step1: Initialize CO_2, soil moisture, temperature and light Sensor;
Step2: Compare threshold value received with initial values;
Step3: If the readings are low compared to threshold value call Algorithm 2;
Step4: Further refreshes time is reset;
Step5: The refresher time is 4 hours interval set for bell Pepper;
End

Algorithm 2: Automatic directional door roll on/off

Begin
Step1: Initialize IoT port reader;
Step2: read soil moisture, temperature, light, and CO_2 values;
Step3: The direction of the door is decided upon time of reading;
Step4: The door is roll on/off;
Step5: The motor is stopped after doing the stop signal;
Step 6: return;
End

V. Result Analysis

In the proposed conspire, there is an analyzation for the execution parameters of greenhouse, for example, CO_2, soil moisture, temperature, and light for bell pepper plant with practical outcomes by utilizing IoT kit. And based on the soil moisture values the greenhouse doors/windows can be roll on/off.

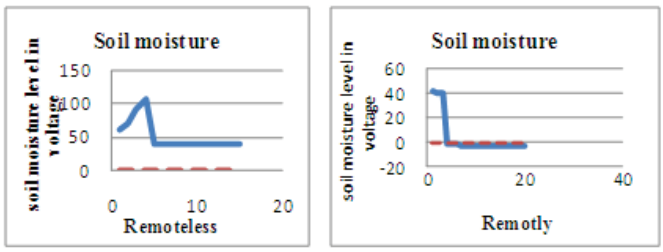


(a) CO_2 concentration level 1 (b) CO_2 concentration level 2

Fig 1. Concentration gradient representation of CO_2 concentration level in greenhouse

The plant photosynthesis process required a most extreme measure of CO_2 concentration level and water around evening time contrasting with day time; with the assistance of these two energies the photosynthesis procedure keeps the plant cool and aides in quick development of the plants.

After conducting a experiment for the CO_2 concentration level in green house, maintained a CO_2 level maximum at night time as shown in figure 1 (b), because from day time the greenhouse start to consume CO_2 level till night time. So, the CO_2 level at day time is less as shown in figure 1 (a).

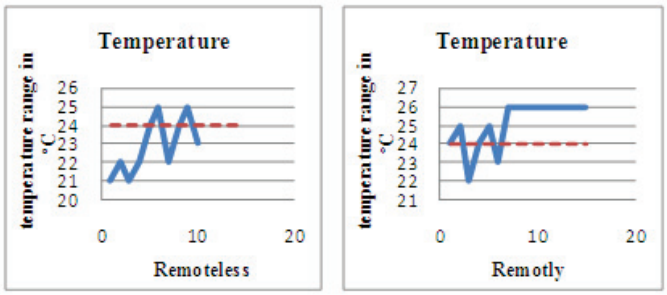


(a)Dry soil **(b) Wet soil**

Fig 2. Representation of Soil moisture measurement in greenhouse.

Water content in the soil is important factor because for the plant, excess of water can produce a fungal infection at the same time plants with less water becomes dry or sometimes they may get damage.

So, the required level of water to the plant is very much essential. At, night time plants require a more water with CO_2 for photosynthesis process. In IoT kit the soil moisture sensor gives a negative value it means the full of water is covered by the plants as shown in figure 2 (b), at that time the greenhouse windows/doors will be closed automatically with the help of DC motor. The positive value indicates the dryness of the soil as shown in figure 2 (a), so need to re-wet the soil.

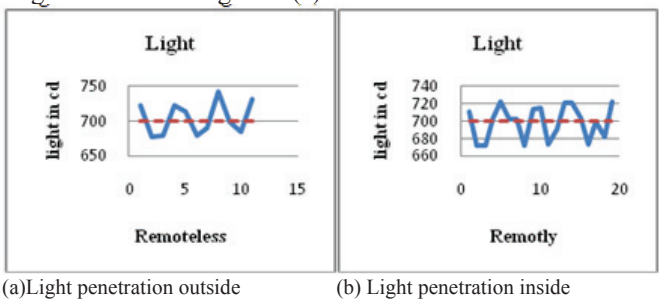


(a) Temperature range outside greenhouse (b) Temperature range inside greenhouse

Fig 3. Representation of Temperature range control in greenhouse

The temperature is also a one of the important parameter in greenhouse; the temperature should be maintained maximum. Because, the temperature helps in flowering, fruits, photosynthesis, seed germination, etc.

Therefore in greenhouse maintained a maximum amount of temperature range as shown in figure 3 (b), compared to outside greenhouse environment temperature range as shown in Figure 3 (a).



(a)Light penetration outside greenhouse (b) Light penetration inside greenhouse

Fig 4. Representation of Light penetration in greenhous

The different colors of sun light are useful in photosynthesis process, which is present in the green part of the plants used for plant growth, flowering, and shape of the plant.

Thus, maintained a sustainable amount of light penetration inside the greenhouse as shown in figure 4 (b), compared to normal light penetration outside of the greenhouse as shown in Figure 4 (a).

VI. Conclusions and Future Scope

IoT is widely used in connecting devices and used to gather information. The system is designed to remotely monitor the greenhouse parameters such as CO_2, soil moisture, temperature, and light, this information can be collected by the farmers with the help of cloud account and internet connection. There is also controlling action taken automatically that is greenhouse windows/ doors roll on/off based on the soil moisture levels. Thus, the system will help the farmers to avoid physical visit to the field, and increase the yield with the maintenance of précised parameters such as CO_2, soil moisture, temperature, and light in the greenhouse with the help of IoT. The project is carried out with the help of IoT kit and internet connection.

The results are analyzed for the greenhouse parameters such as CO_2, soil moisture, temperature, and light for bell pepper plant with the help of graphical representation based on the practical values taken by the IoT kit. The comparative result shows the effectiveness of the proposed work.

The future work can be carried out for the other précised agriculture crops like broccoli, chard, micro greens etc.

Acknowledgment

We are thankful to Science & Engineering Board (SERB), for sponsoring the part of the project under “Empowerment and Equity Opportunities for Excellence in Science” program (SERB/F/8589/2015-16) respectively.

REFERENCES

[1] Karuna Chandraul, Archana Singh,”An agriculture application research on cloud computing”, *International Journal of Current Engineering and Technology*, volume 3, No.5, pp. 2084-2087, October 2010.

[2] Ronald Haley, Riley Wortman, Yiannis Ampatzidis, Matthew Whiting, “An Integrated cloud-based platform for labor monitoring and data analysis in precision agriculture”, IEEE 14th International Conference on Information Reuse and Integration, pp. 349-356, August 2013.

[3] Mistsuyoshi Hori, Eiji Kawashima, Tomihiro Yamazaki,” Application of cloud Computing to agriculture and prospects in other fields”, FUJITSU Sci. Tech. J., volume 46, No. 4, October 2010.

[4] B. K. Jha, S. K. Jha, R. Mukaharjee, D. Basak, “Development of guided SMS solution in local language for Demand-driven Access of agriculture information”, 7th International Conference on Communication Systems and Networks (COMSNETS), pp. 1-5, January 2015.

[5] D. D. Chaudhary, S. P. Nayse, L. M. Waghmare, “Application of wireless sensor network for greenhouse parameter control in precision agriculture”, *International Journal of Wireless and Mobile Networks (IJWMN)*, volume 3, No.1, 2011.

[6] O. T. Denmead and R. H. Shaw, “Availability of soil water to plants as affected by soil moisture content and meteorological conditions”, *Agronomy journal*, 1962.

[7] Ahmad Nizar Harun, Mohamed Rawidean Mohd Kassim, Ibrahim Mat, Siti Sarah Ramli, “Precision Irrigation using Wireless Sensor Network”, *International Conference on Smart Sensors and Application (ICSSA)*, 2015.

[8] Narayut Putjaika, Sasimanee Phusae, Anupong Chen-lm, Dr. Phond Phunchongharm, and Dr. Khajonpong Akkarajitsakul, “A Control System in an Intelligent Farming by using Arduino Technology”, *Fifth ICT international Student Project Conference (ICT-ISPC),* 2016.

[9] ZOU Cheng-jun,”Research and Implementation of Agricultural Environment Monitoring based on Internet of Things”, *Fifth International Conference on Intelligent Systems Design and Engineering Applications,* 2014.

[10] Meonghun Lee, Jeonghwan Hwang, and Hyun Yoe, ”Agriculture Production System based on IoT” , *IEEE 16th International Conference on Computational Science and Engineering,* 2013.

[11] FuBing, ”Research on the Agriculture Intelligent system Based on IoT*”,* International conference on Image Analysis and Signal Processing (IASP), page 1-4, 2012.

[12] Sanbo Li, ”Application of the Internet of Things technology in precision agriculture irrigation systems”, *International Conference on Computer Science and Service System*, 2012.

[15] Ji-chun Zhao, and Jun-feng Zhang; Yu Feng ; Jian-xin Guo, ”The Study and Application of the IoT Technology in Agriculture”, *3rd International conference on computer science and information technology,* volume 2, page 462-465, 2010.