Automatic Crop Plantation Prediction Based on Meteorological Data using Wireless Sensor Network

D.D.Chaudhary, Suraj.V.Shinde

***Abstract*— Advanced technological development in wireless sensor network made it possible to use it in monitoring and control of Greenhouse parameters. In this paper, my aim is to develop a central monitoring and control system for the Greenhouses to predict and act on situations for perfectly controlled climatic conditions. This can be managed from one control station wirelessly using GSM module. Only user from remote location can select the crop from system database and all related readings of that particular would be selected from the system database and sent through GSM to the selected Greenhouse controller.**

Multiple crops readings like temperature, humidity, moisture, etc. are suitable for that particular crop can be set from the central unit and sent to controller through GSM module. By comparing monitored readings with database readings we get the idea to turn on/off the irrigation motor. So, we can give water to the Greenhouse field properly if required otherwise water and power will be saved. This encouraged to farmer to increase growth of crop yield and production with higher quality as well as quantity with reduced cost.

Another interesting point in my paper is that it has a systematic architecture which can be applied for small/medium Greenhouse applications.

***Index Terms* – Data acquisition, FPGA, Greenhouse, Real time monitoring, Wireless Sensor Network.**

I. INTRODUCTION

WSN can reduce the cost of maintenance, installation and eliminates connectors. WSNs benefits are catastrophic failures, conservation of natural resources, improve manufacturing productivity, improved emergency and quick response. The ideal role of WSN is networking and scalable, which consumes very less power, is smart and software programmable, capable of fast data acquisition. WSN is reliable and accurate over the long term, whose cost is little to purchase and install, and requires no real maintenance. For Selecting the optimum sensors and wireless communications link requires knowledge of the application and problem definition. For selecting Sensors some features are to be considered such as Battery life, sensor update rates, and size are all major design considerations. Examples of low data rate sensors include temperature, humidity, and moisture captured passively.

A Wireless sensor network generally consists of base station that can communicate with a number of wireless sensors via a radio link. Power unit produces the power. Data Processing unit have the FPGA (Field Programmable Gate Array), which is the fully responsible to get sensed data and transmit over another network. The FPGA performs tasks, processes data and controls the functionality of other components connected with him. Sensing Control unit has the sensors and analog to digital converter (ADC) to convert analog sensed signal to digital signal [1].

A. Greenhouse Technology

Greenhouse is a designed farming structure build to provide a more controllable environment for better crop production and quality improvement. In developed countries, the use of greenhouse has been growing for commercially for fruits, fresh flowers and vegetables purpose [2]. Greenhouse environment is very complex which strongly influences crop cultivation. The efficiency of crop production in greenhouse depends on climate growth parameters to achieve high yield at low expense, with good quality. To increase crop production, parameters such as air temperature, humidity, light intensity, and carbon dioxide concentration must be controlled optimally through heating, lighting, ventilation [3].

In this paper, we propose a system that can collect the information related to greenhouse environmental parameters and crop status to control the greenhouse automatically based on the collected information to predict and act on situations for perfectly controlled climatic conditions. By properly monitoring climatic conditions, this research has the purpose of establishing or to developing an automated computerized monitoring system for greenhouse facility that provides adequate control regarding to plant type or species, and using this information to help farmers to increase yield, improve quality of crops [4].

Computer controlled software will provide data Monitor and control, real time graphical display, dates and time tags of information and stores it for current or future use. Zigbee is a low power wireless sensor network. This paper shows the model for perfect real time crop field monitoring by forming zigbee network and obtaining experimental results of that model when deploying nodes in real time. IEEE 802.15.4 will support Physical and MAC (Medium Access Control) layers of zigbee. The functionality of both zigbee transmitter and zigbee receiver are combined into a single

Manuscript received May 16, 2015.
Mr.D.D.Chaudhary, Department of Electronics and Telecommunication, Sinhgad Institute of Technology, Lonavala, India, +919372810161,
Suraj.V.Shinde, Department of Electronics and Telecommunication, Sinhgad Institute of Technology, Lonavala, India, +917387909245,

device known as transceivers. Zigbee transceivers are used for transmission purpose [4].

II. LITERATURE REVIEW

Greenhouse system network which senses, processes and store temperature, humidity, moisture values manage these values by comparing the measured values with the expected ones and take action if it is necessary. This solution aims flexibility, maintainability and usefulness. Some following terms associated with it and infused into the system [5].

Sensing Nodes:

The practical work of design having sensing node consists of hardware and software parts:

A. Temperature Sensor: LM35

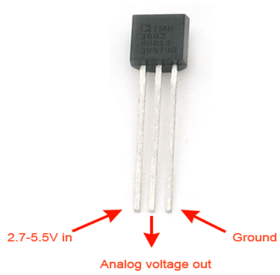

Fig: 1 Temperature Sensor

The Temperature sensor LM35 is as shown in figure- 2. The LM35 are precision integrated temperature sensor, whose output voltage is proportional to Celsius temperature [5]. The LM35 for plant (flowers or vegetables) growth require Day temperature around 26 ^{0}C to 30 ^{0}C, Night temperature around 15 ^{0}C to 18 ^{0}C. This temperature can be controlled using Ventilation or fan pad cooling systems [7].

Features:

- Low impedance output.
- Calibrated directly in Celsius.
- Suitable for remote application.

B. Light Sensor: LDR

Light sensor is made using an LDR (Light Dependent Resistor).The resistance of LDR varies according to intensity of light falling on the surface. When Light is turned on, the résistance of the LDR falls and allows current to pass through it as shown in figure 2 [5].

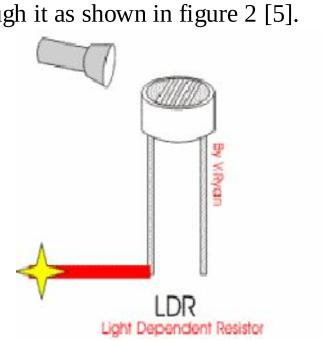

Fig: 2 Light Sensor

Proper Growth of plants in Greenhouse require light intensity should be around 50,000 to 60,000 LUX. In India, Light intensity is around 40,000 to 1, 40,000 LUX. Using shade nets we have to reduce this light intensity [7].

Features:

- Low cost.
- Wide spectral response.
- Wide ambient temperature range.

C. Humidity Sensor: SY-HS-220

Fig: .3 Humidity sensor

The humidity sensor SY-HS-220 can operate up to the range of 95% RH (Relative Humidity). We know that level of humidity in the air is also a function of temperature. Excess humidity can cause growth of fungus in planted trees. Also, too little humidity can cause spread of unwanted dust, which contributes to allergies. SY-HS-220 which produces more accurate and linear voltage output [5].
Features:

- High reliability and long term stability.
- Wide temperature range.
- High sensitivity.
- Compact size and cost effective.

D. Moisture Sensor

Fig: 4 Moisture Sensor

Soil moisture sensor measures water content in soil. Soil moisture probe is made up of multiple soil sensors. Soil moisture sensors measure some properties such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for moisture content. It is very important in agriculture to help farmers to manage their irrigation systems more effectively.

III. SYSTEM ARCHITECTURE

The system architecture mainly consists of two units namely (system board, control center)**.** The Control center consists of pc and mobile phone connected together through the serial communication port RS232. The system board consists of following two units-

A. Micro Climate Monitoring

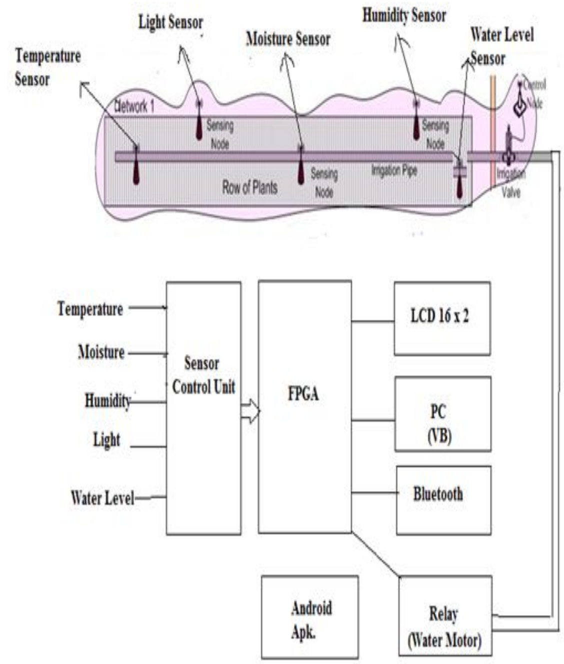

Fig: 5 System architecture of micro climate monitoring

1) System board

The system board is located in the Greenhouse land where humidity, Light intensity, moisture and temperature are measured. The main function of system board is continuously measure the environmental parameters and compares it the measured values within a threshold level, and sends message through GSM network to the control center (farmer) or we can also get readings on Android application on mobile in case of high temperature or humidity exceeds the normal level. The FPGA has many components connected with it namely: Control unit (CU), the ROM memory, the HMU (Humidity measurements unit), TMU (Temperature measurement unit) and LTU (Light Intensity Unit).

2) Control unit

The control unit will be implemented in Spartan 3 FPGA. The HMU, LTU and TMU send control signals to Control unit in case of low humidity or high temperature. The main function of CU is to send message to farmers mobile according to the given signals coming from the HMU, LTU and TMU units also it will turn on Water motor through relay if moisture or water level in field is less then we give water to the Greenhouse yield at required place. Hence, we give water to required place otherwise water and power is saved, power which used to turn water motor.

Here, we take different crops according to our database set points and irrigate crop yield with water requirement by turning on/off water motor. From this we can increase quality and productivity in Greenhouse with reduced cost.

B. FPGA Controller design

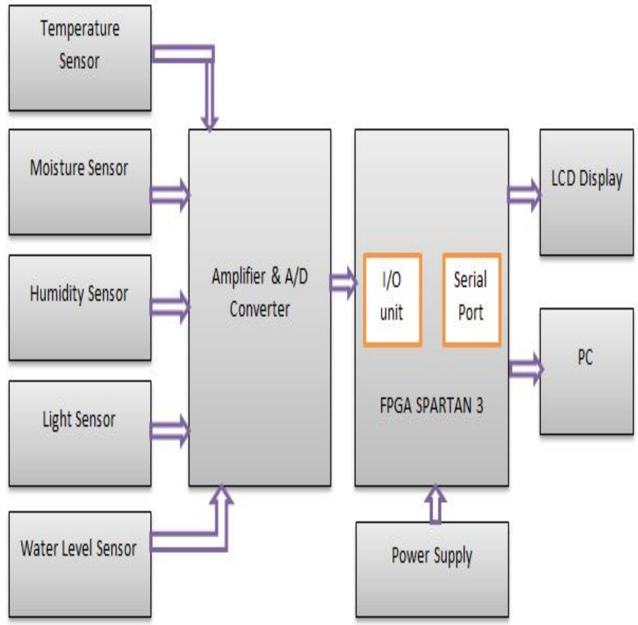

Fig: 6 FPGA controller design

The controller selected in this paper is FPGA SPARTA 3, XC3S 400 – 4PQ208. FPGA provides user with two dimensional arrays of configurable resources that can implement a wide range of arithmetic and logic function. Sources include dedicated DSP block, multipliers, dual port memories, lookup table (LUTs), resisters, tri-states buffers, multiplexers and digital clock managers.

In additional, Xilinx FPGA contains sophisticated I/O mechanisms that can handle a wide range of Bandwidths and voltage requirements. Programming tool used in this paper Xilinx 8.1 web packs which is easily available from the internet. The program can be loaded in device through parallel port thus less development time required.

IV. PROJECT FLOW CHART

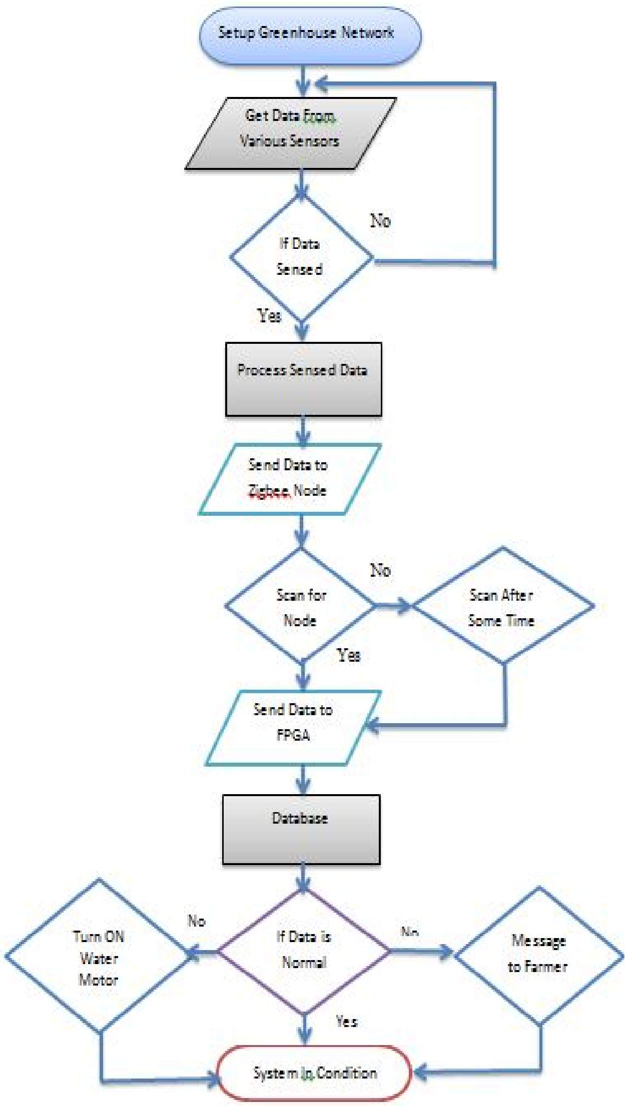

Fig: 7 Project Flow

V. EXPERIMENTAL SETUP

We used Two Zigbee nodes to form a Zigbee network. Temperature sensor, Light sensor and pressure sensor were connected to a zigbee device via FPGA and humidity sensor was connected to another Zigbee via Fpga. One zigbee node act as a router and act as a coordinator, another one act as an end device. All sensed data are sent to coordinator node which is connected to personal computer via gateway. By using this network we can sense the data such as temperature, humidity, water level, PH level of Greenhouse crop field area. Lots of wired system proposed for this type of monitoring theoretically and practically.

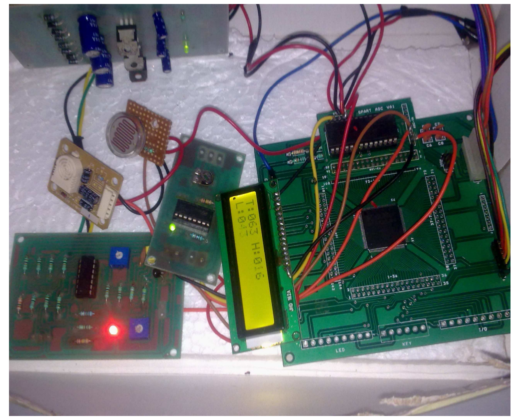

Fig: 8 Experimental Setup

We used Zigbee wireless sensor network due to which lots of wired connections will be avoided. The sensing unit consists of sensors and power supply which may be either external power supply or battery operated. The sensed data is feed to the processing unit where the controller processes the data which is send to the node for transmission over Wireless network. Zigbee node receives the data and scan for available node to transmit the data to the coordinator node. The coordinator receives the data, process and transmits to the monitoring unit, which is going to be observed by a farmer.

VI. RESULT AND ANALYSIS

Table I: Results of Temperature and Humidity sensors

Sr. No	Temperature(0C)	Humidity (%)	Time(s)
1	26.1	65	11.15
2	26.2	63	11.16
3	27.4	71	11.17
4	26.8	58	11.20
5	25.9	69s	11.21

The above result is taken from the temperature sensor, humidity sensor and moisture sensor, which are connected to the coordinator node; the coordinator node is connected to the personal computer. The above result is taken at real time in our college lab.

A. Advantages of proposed system:

In this paper, we made zigbee based smart irrigation network for monitoring the crop field area by deploying water sensors in the land to detect the places where water level is low. From these results we will irrigate that place only. Also we take humidity readings to get the idea about rainfall; farmer need not irrigate the crop field. Due to this we save water and power since we did not turn on motor.

Now a day, by using pH sensors we get the information about the soil and analyze the acidic level of soil. By which we can apply fertilizer to the place where it needs, also we can avoid over fertilization of the crops.

VII. CONCLUSION

The review on a ZigBee and its applications in Greenhouse automation system is presented. This Paper focuses on traditional Crop plantation methods and advanced wireless networks. This might encourage the farmers to take the path of modern Wireless Cost effective smart irrigation.

The objective of this paper is to utilize the sensor in the Greenhouse crop field area and gives proposed architecture for real time Greenhouse crop field monitoring with Zigbee smart irrigation.

ACKNOWLDGEMENT

The authors would like to thank reviewers of this paper for their valuable comments and also to the sponsored company.

REFERENCES

[1] Kudang B. Seminar, Henry Suhardiyanto, Socdodo Hardjoamidjojo, Tamrin, "A supervisory Control System for Greenhouse," Regional Computer Science Postgraduate Conference (RECSPC), 2006.

[2] D.D. Chaudhary, S.P. Nayse, L.M. Waghmare," Application of wireless sensor networks for Greenhouse parameter control in Precision Agriculture," International Journal of Wireless & Mobile Networks (IJWMN) Vol. 3, No. 1, February 2011.

[3] Mahmoud Omid, "A computer-Based Monitoring System to Maintain Optimum Air Temperature and Relative Humidity in Greenhouses," International Journal of Agriculture and Biology, 2004.

[4] Marco Mancuso, Franco Bustafa, "A wireless sensors network for monitoring environmental variables in a tomato greenhouse," IEEE International Workshop on Factory Communication Systems, 2006.

[5] Jay S. Sharma, Gautam D. Makwana," Intelligent Crop Management System for Greenhouse Environment," International Journal of Science and Research (IJSR), Vol. 2 Issue 4, April 2013.

[6] Mahmoud Shaker, Ala'a Imran, "Greenhouse Micro Climate Monitoring Based On WSN with Smart Irrigation Technique" International Journal of Electrical, Robotics, Electronics and Communications Engineering Vol:7 No:12, 2013.

[7] Mr. Dhananjay E. Upasani, Mr. Sandip B. Shrote, Ms.Vrushali P. Wani," FPGA Implementation of Intelligent Climate control for management," 2010 International Journal of Computer Applications Vol.1, No. 18, 2010.

[8] M. Dinesh, P. Saravanan," FPGA Based Real Time Monitoring System for Agricultural Field," International Journal of Electronics and Computer Science Engineering Vol: 1 No: 3, 2000.

[9]K. Nirmal Kumar, P. Ranjith, R. Prabakaran," Real Time Paddy Crop Field Monitoring Using Zigbee Network," Proceedings of ICETECT 2011.

[10] Omveer, Dr. H.K. Singh, Rishikesh Patankar, Sandeep Bansal, Gaurav Kant Yadav," A Survey on Wireless Sensor Network based Technologies for Precision Agriculture System, International open access Journal of Modern Engineering Research (IJMER), Vol. 4 Iss.7 July. 2014.

Mr.Suraj.V.Shinde[2] is doing M.E (Electronics and Telecommunication) in Sinhgad Institute of Technology, Savitribai Phule University of Pune, India. He received B.E (Electronics and Communication Engineering) from Dr. Babasaheb Ambedkar Marathwada University, Aurangbad, India in the year 2012.

Prof.D.D.Chaudhary[1] is a research student in Electronics Systems Department at **Aalborg University, Denmark** under European Union scholarship for Ph. D. extension programme. He is working as a Professor and Head of the Department of Electronics and Telecommunication at Sinhgad Institute of Technology, Lonavala. Dist. Pune, MS INDIA. He is pursuing Ph.D. From Shri Guru Govind Singh Institute of Technology, Nanded, INDIA, affiliated to Swami Ramanand Tirth Marathwada, University, Nanded, MS India. He is graduated from Govt. College of Engineering, Amravati from Nagpur University in June 1985 and Post graduate from SGSITS, Devi Ahillya Vishvavidyalaya, Indore, MP, India, in April 1991. He is had 25 years of teaching experience at degree level. Also, working as an Editorial Board member for International Journal of Computer and Electrical Engineering (IJCEE). He Member of International society of Automation (ISA). His areas of interest are wireless communication; Software defined radio, cognitive radio and wireless sensors.