Design and Development of Automated Monitoring and Controlling System for Environment and Soil Parameter of Polyhouse

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Abstract: Agriculture is the biggest sector in India. More than 50% population of India depend upon agriculture for their livelihood. But the condition of agricultural sector is getting worse day by day. To improve the quality and yield of the crops a lot of research is being done by different institutes in India. In existing system, different ways of farming techniques are developed by researchers which improve the condition of agricultural sector. Polyhouse farming is one of them. It helps farmers to increase their profit, yield and quality of crops. In Polyhouse, yield is improved four to five times as compared to traditional techniques. The growth of the crops highly depends on environmental parameters as well as on soil parameters. This research focus to improve existing system by measuring both environmental and soil parameters from different parts of Polyhouse by wireless nodes. These nodes are connected to base station with the help of ZigBee. Environmental parameters are measured by DTH11 (temperature and humidity sensor) and soil parameters are measured by pH probe and EC electrodes. Measured data from different nodes is generalized by base station and stored for further analysis. Control operation is performed by base unit. The develop system helps farmer to monitor and control polyhouse online.

Keywords: *ZigBee, Soil EC and pH , GUI, PIC Controller.*

I. INTRODUCTION

India ranked second in the world in crop production. More than 1.4 million square-kilometers of land in India is under cultivation [8]. Almost every type of crop is produced by Indian farmers. In India, an agriculture's contribution to the national income is about 16% of GDP and adds 10% to exports. Over 70 % of the rural families depend on agriculture [9]. But in India, Farmers have to deal with several problems, for example, farmers have small land area and small land area results in poor yields. These types of problems are because of reliance on conventional methods of farming, too much dependence on natural phenomena such as rainfall and other parameters. To improve economy condition, we have to enhance the method of farming by adapting e-technology. One of the method is Polyhouse farming. A Polyhouse also known as polytunnelis a tunnel made of polyethylene, usually semi-circular, square or elongated in shape. Plastic sheet of thickness 15mm is used in order to construct Polyhouse. The Polyhouse is designed according to the requirements to get maximum output. Mostly the direction of the Polyhouse is kept from East to West. By this, Polyhouse will efficiently get maximum sunlight and to improve quality environmental and soil condition s need to be controlled.

II. RELATED WORK

Various systems for Polyhouse automation have been designed. These systems can only measure environmental parameters (temperature, humidity, light etc.) and control these parameter according to growed crop. In 2013, Polyhouse Automation System was developed, This system measures the environmental parameters like temperature humidity and light [1]. The real time values of these parameters are measured by, sensor nodes and measured data display on the LCD screen. These systems used analoge sensor and ADC is used because the rest circuit is digital circuit. In 2013, another system wireless solution for polyhouse cultivation using embedded system is developed, This system is based on 8051 microcontroller[2]. In this system temperature and humidity measured and using a GSM module, a farmer can control the various systems by staying outside the Polyhouse farm. Applications like, controlling the fan, water, humidity can be achieved with reduce human effort.

In 2012, a system digitally greenhouse monitoring and controlling of system based on embedded system is developed this system is based on 8051 microcontroller. It measure temperature, humidity and light. In addition, controlled the fan water pump, cooler devices for controlling that parameter. In 2011, design and implementation of sensor node for wireless sensors network to monitor humidity of high-tech polyhouse environment system is developed this system contracted on humidity controlling [5] because it is important to monitor the humidity in a Polyhouse environment, as it is a crucial parameter for increasing the crop yield. This system is developed using AVR microcontroller. This system used wireless network to send measured data to base station. In

2011, sensor node for wireless sensors network to monitor humidity of high-tech polyhouse environment is developed [11]. This node is based on AVR microcontroller and these are capable for measuring humidity and transmitted measured data to base station. A person can observe the parameter in different regions of a Polyhouse to provide a controlled environment for increasing the crop yield.

III. PROPOSED WORK

The yield of crops and the quality of produced crop in Polyhouse farming depends upon various parameters such as soil pH, temperature, humidity and electrical conductivity. These parameters are not recorded at the time of production and hence the motive of forecasting is not achieved. These important parameters are helpful to decide the type and the yield of the crop when the data related to these parameters are recorded. So a system is designed for Polyhouse to monitor and control the soil parameter (PH, EC) and environmental parameters (temperature and humidity).

IV. BLOCK DIAGRAM

Block diagram of developed automated monitoring and controlling system is given in figure 1. It consists of following blocks:

1) Node

It is a subsystem where all the sensors for the measurement of temperature, humidity pH value and electric conductivity are placed. PIC 18f452 microcontroller has been used for controlling sensors and wireless network. DHT 11 sensor is employed for measuring temperature and humidity of the environment. It uses a single wire communication protocol to communication with controller, It used temperature sensor which have accuracy of 0.5% and relative humidity with accuracy of 5%. pH electrode is employed for measuring the pH of the soil. It generates the analog voltage according to the pH value. The signal is amplified and processed by the operational amplifier. ADC gives data to microcontroller and after complete sensing process, will transmit data to base station through the wireless medium. Electrical conductivity is measured by Wenn Array method.

2) Controlling Unit

It consists of PIC 18f452 microcontroller which controls the working of ac, fan, heater, exhaust fan. It receives the controlling signals transmitted by the base station. Depending up on the signal processed by the microcontroller action for switching ON or OFF of various appliances has been done. The solid state relay is used for controlling the appliances.

3) Base Unit

It is a personal computer which is wirelessly interfaced to the nodes and the controlling unit of the system. It transmits the signals to the controlling unit of the system after receiving the data from the various nodes employed in the system. Transmission of controlling signals to the controlling unit is done by the ZigBee module at the base station and the reception of the signal at control unit is also completed by ZigBee module. GUI has been designed in java and monitors the performance of the system at the base station and control the various parameters of the system.

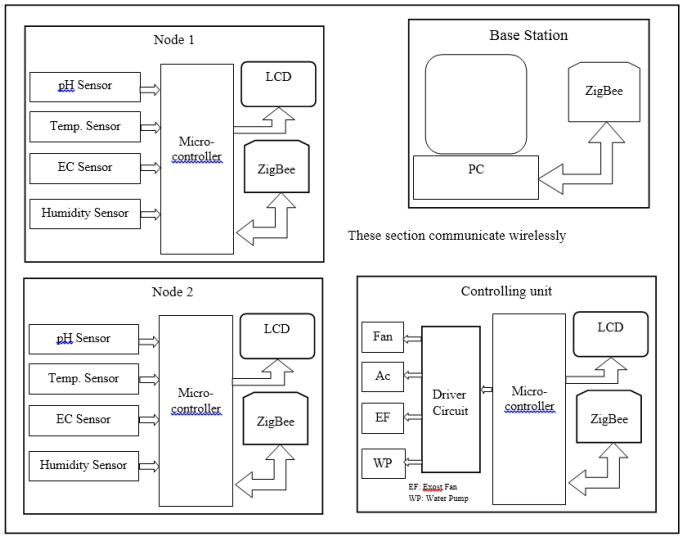

Fig. 1 Block diagram

V. SYSTEM ARCHITECTURE AND WORKING

Automated monitoring and controlling system consists of many blocks. Each block has its own specifications and whole system is easy to install on field. The system architecture identified in next sub-sections.

4) Nodes and controlling unit

Nodes can measure the parameters and update the information to base station. Controlling unit are also able to change the environment of polyhouse according to crop requirement depending upon previous stored data. There can be many nodes depending on the area of field. Each node will measure only some part of field and in this way soil parameters of the entire field can be observed using different nodes.

Figure 2 shows the designed control circuitry to perform action by analysing the data observed by the nodes in the field. It consists of microcontroller and ZigBee modules. Microcontroller measured the data with the help of associative circuitry as shown in figure 3. The ZigBee help to send this information to base station. Base station send commands to node controller for sending data through ZigBee.

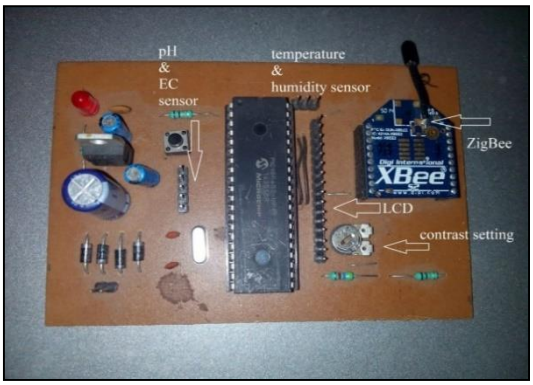

Fig. 2 Node Controlling Unit

Figure 3 represents the pH and EC sensor circuitry which helps to measure the soil and environmental parameters of field regularly. Different sensor has been used to observe field parameters like DHT11 sensor is used to measure humidity and EC electrodes are used to measure electrical conductivity and pH sensor is used to measure pH value of field.

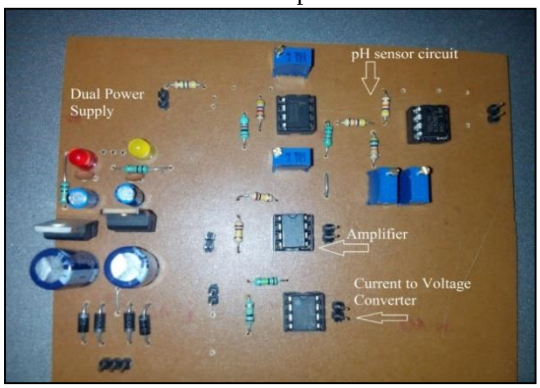

Fig. 3 pH and EC sensor circuitry

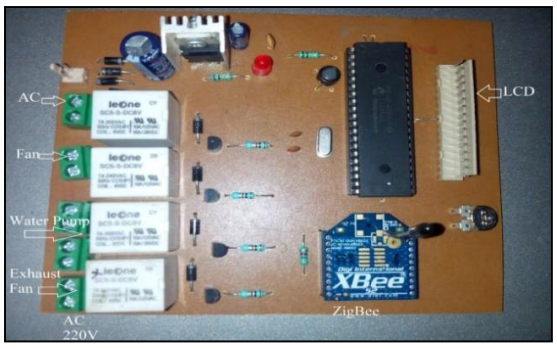

Fig. 4 Controlling unit circuitry

Figure 4 shows the designed controlling unit circuitry. This control unit circuitry will receive information signals from base station and then perform action according to that signal output. If temperature measured by nodes is greater than the crop requirement, then node will send a signal to control unit to switch on air conditioning unit. Similarly, all the unit of control circuitry helps to maintain the environment of polyhouse.

5) Base Station

Base station is the unit where all the parameters observed by nodes are stored in database. It can be personal computer and a graphical user interface is designed for observing the different parameters and will display the parameters value regularly. The base unit GUI is developed in java which is OS independence thus by developed GUI can be run on any PC irrespective to operating system. Figure 5 shows the GUI designed with parameters value measured at that time.

Fig. 5 Designed GUI in Java

6) Web Page

Web page is designed to know field parameters even when the farmer is not present in the field. All the data recorded at data base in base station has been made online using designed website. Website is secured with username followed by password. Figures 6 and 7 given below show the designed web pages for website.

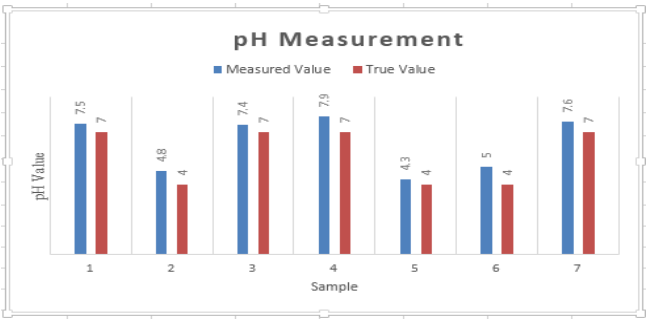

Fig. 8 Graphical representation of measured and true value of pH

Fig. 6 User login webpage

Fig. 7 Updated parameter value webpage

S.No.	Measured Value	True Value	Error
1	7.5	7	7.5%
2	4.4	4	10%
3	7.4	7	5.7%
4	7.9	7	12%
5	4.3	4	7.5%
6	4.5	4	12.5%
7	7.6	7	8.5%

VI. EXPERIMENTAL INVESTIGATION

Different experiments have been performed to obtain result values from designed device. And after obtaining these results, the parameters measured by designed system are compared with available standard instruments.

Table 1 shows the comparison between the measured value of pH circuitry designed and pH value measured using Hpg system.

Figure 8 shows the graphical representation of pH measured by designed system and pH value measured using Hpg system (Standard value).

Experiment 2

Table II: Temperature measurement

S.No.	Measured Value	True Value	Error
1	22.50	22	2.27%
2	24.04	24	1.67%
3	26.70	26	2.69%
4	26.5	27	1.85%
5	28.46	28	1.64%
6	30.60	30	2.14%
7	22.55	22	2.5%

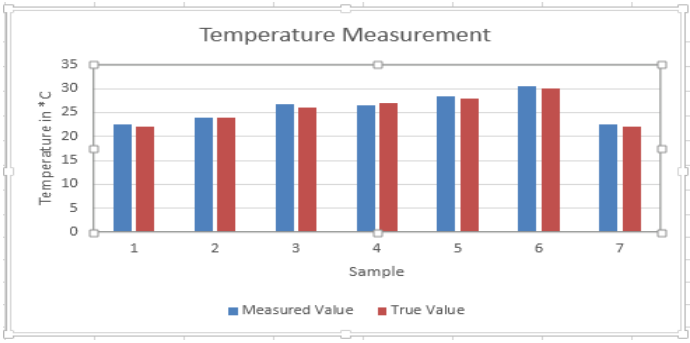

Fig. 9 Graphical presentation of measured and true value of temperature

Experiment 3

Table III: Humidity measurement

S.No.	Measured Value	True Value	Error
1	45	48	6.25%
2	45	48	6.25%
3	45	48	6.25%
4	45	48	6.25%
5	45	48	6.25%
6	45	48	6.25%
7	45	48	6.25%

The table 3 shows the comparison between the measured value of Humidity circuitry designed and Hygrometer of Silicon control system.

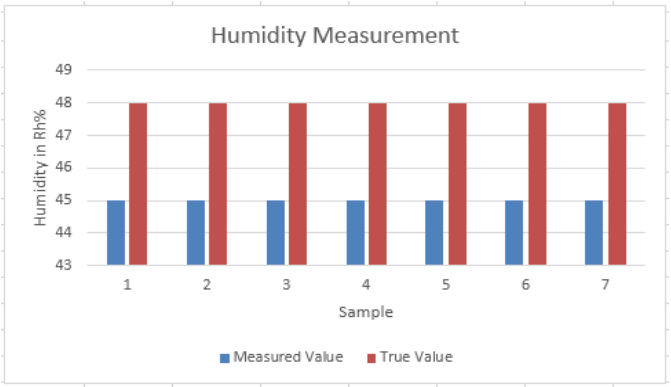

Fig. 10 Graphical representation of measured and true value of temperature

Figure 10 shows the graphical representation of humidity measured by designed system and humidity of hygrometer of silicon control system (Standard value).

VII. CONCLUSION & FUTURE SCOPE

Automated and controlled system for monitoring of Polyhouse parameters has been designed in this research work. The basic purpose for designing this system is to improve crop quality and yield performance. Another advantage includes the storage of field parameter value on database. Farmers can choose which crop will be beneficial to them by observing previous records.Designed system will also make measured data online by updating information to website. A website is designed to help farmers in such a way that they can monitor the parameters of field even when they are not present at the field. They just have to login their ID on website followed by a password and easily can observe their field parameters.This system provides automatic environment for Polyhouse according to crop requirement.It is a cost effective system because this system is developed in open source tools and resources which does not require any license fee.

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