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Monitoring and Control of Agriculture Parameters in a Greenhouse through Internet

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Abstract: Greenhouse technology is the technique of providing favorable environment condition to the plants. It is rather used to protect the plants from the adverse climatic conditions such as wind, cold, precipitation, excessive radiation, extreme temperature, insects and disease. It is also of vital importance to create an ideal micro climate around the plants. It requires intensive sensing of the climate conditions at ground level and rapid communication of data to the central repository. Internet is an emerging field that can be used to monitor and control the agriculture parameters in order to make intelligent automated agriculture system. The system basically comprises of host computer having LabView software and internet connection, ZigBee wireless modules for transmitting and receiving the data signals and PIC microcontroller for calculating the agriculture parameters from the sensor voltage and to control the relays according to the control signals send by the user. PIC microcontroller converts the sensor output into serial data and passes it to the ZigBee module. The ZigBee modules are used to transmit the data from the greenhouse to the host computer. The data from sensing node is amplified and fed to ADC of the PIC microcontroller, this is then connected to the ZigBee module, which transmits the data and at the host end, another ZigBee module reads the data and displays on to the host computer via LabView. By using the LabView web publishing tool this data is published in the internet and secured by using username and password. The website is created by using PHP codes and simulated using WAMP server 2.2.The user can monitor and control the greenhouse parameters by logged into the NITT website with proper username and password. The logged user can view the same LabView window as the host with same functionality. The register facility is also available in the website for the new users.

Keywords: Greenhouse, ZigBee, Internet, LabView, PHP.

1. Introduction

The agricultural growth in future would increase immensely if improvements are made in the productivity of diversified farming systems with a specific focus on regional specialization and sustainable management of natural resources. In order to diversify agriculture, agro processing and other value added activities play a pivotal role. Climate monitoring is one of the most important aspects in agricultural production that has a direct impact on the productivity and maintenance of crop.

A huge loss occurs every year due to damage of crops by various diseases caused by improper climatic conditions. Deployment of intelligent sensor nodes, on the field, promises a wide range of new applications like plant growth monitoring and also monitoring of various environmental conditions that influences agricultural productions tremendously and man have used the wireless sensor nodes for the same purpose [6, 7]. The sensing technique allows acquisition of soil and crop information, communication and identification of environmental changes which can have devastating effects on the farm yield. With the help of that information at regular time intervals, the irrigation and climatic conditions inside the greenhouse can be controlled using automated actuation devices to increase the overall productivity.

Aim of this research work is to design, develop and implement an internet based communication system to monitor and control the agricultural parameters of a greenhouse environment. The wireless communication systems such as Bluetooth or GSM (Global Systems for Mobiles) can transmit data only to certain kilometers range [5, 9]. But internet will helps to transmit the data worldwide. So that user from anywhere in the world can access the data through internet. The user can monitor the same LabView window as the host computer and can control the greenhouse parameters with his computer system having LabView and internet connection. The sensor nodes collects the signals of greenhouse, transmits the data through the ZigBee transceiver. At the receiver end another ZigBee transceiver receives this data and send to the host computer for real time monitoring. The LabView web publishing tool in the host computer publishes these data in the internet. The clients can monitor and control the greenhouse parameters by logged into the website silver.nitt.edu/greenhouse. The first part of the paper is devoted to green house structure set up, second part deals with control through internet, third part is about experimentation and results and finally conclusions are drawn in the last part of the paper.

2. Greenhouse Climate Control

The green house structure established (area of 150 m^2) for precision agriculture is shown in Fig. 1. There is a temperature/humidity sensor placed inside the green house to monitor the climate. There are three pumps one for drip irrigation, one for fogging system and one for cooling pads and two aero exhaust fans to control temperature, humidity and irrigation.

3. Control through Internet

Fig. 3 shows the architecture of the proposed system. In this HSM 20G with signal conditioning circuit is used to sense temperature and humidity of the greenhouse. PIC18F452 converts the voltage from the sensor to the corresponding temperature and humidity with the help of equations obtained during the calibration of sensors. It also converts these data to serial data and passes it to the ZigBee transceiver.

Fig. 1. Photographs of greenhouse setup.

Fig. 2. Capsicums are planted in the greenhouse.

ZigBee transceiver module transmits these data signals and at the receiver end another ZigBee module receives these signals. This ZigBee module is connected to the host computer via RS232 cable. LabView software in the host computer displays the temperature, humidity and the relay status of the greenhouse in the front panel window. It also allows the user to write the control signals back to the microcontroller to control the relay.

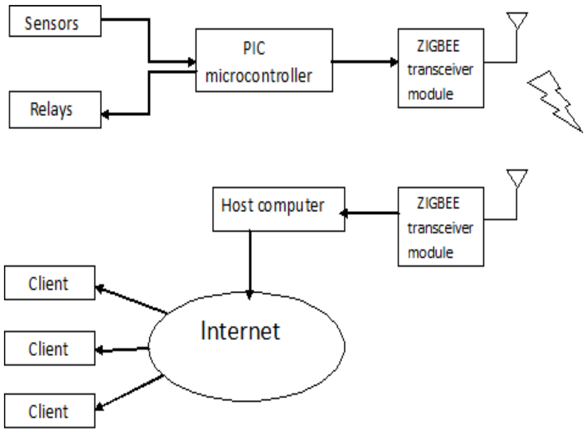

Fig. 3. Overall architecture.

By using the LabView web publishing tool this data is published in the internet. To secure data only for the specified users a website is created by using PHP programming. The distant user can monitor and control the greenhouse parameters by logged into the website silver.nitt.edu/greenhouse. The distant user can view same LabView window as the local host and also have the same functionality. He can monitor the data and passes the control signals to control the relays from his computer through internet. More than one user can monitor the greenhouse parameters at the same time.

The HSM 20 G is a precision integrated-circuit humidity and temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It requires an input voltage of 5 V. The HSM 20 G is rated to operate over a 0^0 to 50^0 C temperature range. It has 4 pin available for connection out of that two are for the power supply and other two are for humidity and temperature output signals as shown in Fig. 4.

In this work PIC 18F452 microcontroller is used to transfer the data to ZigBee module serially. PIC 18F452 has Harvard architecture with a RISC processor inside. Its standard features are on chip program (code) ROM, data RAM and data EEPROM, timers, ADC, USART etc. PIC18F452 has 10-bits in-built ADC, which converts the analog input data fed to it through PORTA pins. PIC18F452 reads the analog signals from the sensor and deploys it on in built ADC which digitizes it to a 10 bit resolution data. A proper firmware is developed for dedicated applications, which computes temperature and humidity from the equations obtained from the calibration of the corresponding sensors. The firmware also controls the relay according to the instructions from the user. These data are converted into serial data and passes to the ZigBee module through the TX pin. The RX pin is used to send the control signals back to the microcontroller.

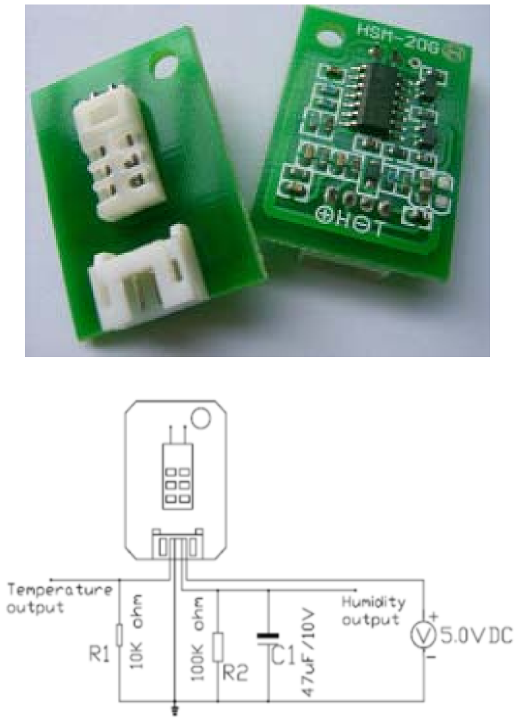

Fig. 4. Temperature and Humidity sensor HSM 20G.

ZigBee is a short distance, simple-structured, low power, and low transmission rate wireless communication technology. It has a transmission range of 120 m and uses ISM 2.4 GHz transmission frequencies. ZigBee is expected to provide low cost and low power connectivity for equipment that needs battery life as long as several months to several years but does not have data transfer rates as high as those enabled by Bluetooth. Tarang F4 developed by Melange Systems Pvt. Ltd. shown in Fig. 5 is used as a ZigBee transceiver module. Tarang F4 can be interfaced with the microcontroller or a PC using serial port with the help of appropriate level converter. One ZigBee module transmit the sensed data from the distant location and the other ZigBee module recieves these data and send to the host computer. Control signals are transferred in the opposite direction of the sensed data.

Fig. 5. Tarang F4 module.

MPLAB is employed as the IDE and firmware is developed in embedded C environment. Tarang F4 is configured using the TMFT 2.6 software. It provides the terminal window which displays the received data. LabView is also used for displaying the received data and to make control decisions. The ZigBee module in the field receives this control signals and transfers to the RX pin of PIC microcontroller. The relays are connected to the microcontroller through signal conditioning circuits to actuate the switches of pumps and the exhaust fans.

LabView web publishing tool is used to create LabView remote panels. A client with internet connection and LabView run-time engine can monitor and control the greenhouse parameters. The data acquisition still takes place in the host computer and the user can monitor the same LabView window as host. A website is created by using PHP programming to restrict the data only for the registered users. The PHP codes are simulated by using the software WAMP server 2.2. The client can view the same LabView window as host by logged into the website silver.nitt.edu/greenhouse. The new user can register in the website and can obtain the username and password for logged into the website to view the LabView window showing the greenhouse parameters.

PHP is a recursive acronym for "PHP: Hypertext Preprocessor". It is one of the first developed server-side scripting and that allows web developers to create dynamic content that interacts with databases. WAMP is acronym for Windows Apache Mysql Php. Apache is a web server, MySQL is an open-source database and PHP is a scripting language. WAMP is used to create the local host and to simulate the PHP programs.

4. Experimentation and Results

Inside the greenhouse the temperature and humidity is measured using HSM 20G IC sensor. The HSM 20G is calibrated for 10 % to 90 % RH and 30 ^{0}C to 70 ^{0}C using the recommended signal conditioning circuit shown in Fig. 4. The sensor output voltages are fed to the Port A of the PIC18F452. The inbuilt 10 bit ADC converts the analog signals from the sensors to digital. These digital signals are converted into the corresponding temperatures and humidity during the execution of the firmware. The observed voltage against temperature in ^{0}C and the humidity in %RH from HSM 20G sensors are shown in Fig. 6 and Fig. 7 respectively corresponding sensor equations are displayed in the plots. These equations will be used in the firmware to calculate the temperature and humidity from the voltage obtained from the sensors.

An embedded system is developed to measure humidity and temperature of the greenhouse. The sensor data is transmitted to analog input pins of the microcontroller. After processing the data, it is transmitted through ZigBee, which is connected to serial output (TX) pin of the microcontroller.

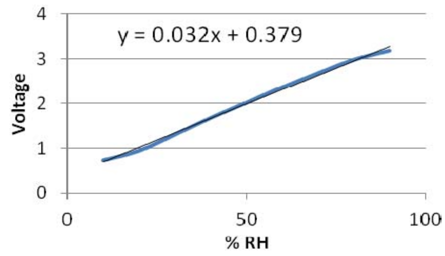

Fig. 6. Humidity vs. Output voltage.

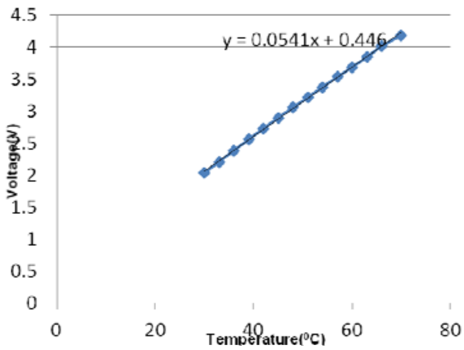

Fig. 7. Temperature vs. Output voltage.

The ZigBee module at the receiver end which is connected to the host computer through RS-232 receives these signals and passes to the host computer. The LABVIEW software in the host computer is used to present the data at the user end. This data is then stored as a text file for database maintenance. The LABVIEW program is in such a way that it can be worked in two different modes, read mode and write mode. In read mode it will read the received data and shows it in the front panel and in the write mode the generated control signals from the user are sent from the LABVIEW back to the microcontroller to control the relay. These control signals are transmitted to the ZigBee module in the field from the control room ZigBee module. The filed ZigBee module is connected to the RX pin of the microcontroller through that the control signals are passes to the microcontroller to control the relay. The host computer displays the current value of the temperature, humidity and also the status of the relays in the greenhouse. Relays are controlled by the control signals from the host computer based on the set points specified by the user. In the field these relays are connected to the microcontroller to carry out the required control function. The firmware consists of the serial reception instruction which helps to control the status of the relays [8]. The firmware controls the status of the relays according to the control signals send by the user. The implemented hardware set up is shown in Fig. 8 and 9.

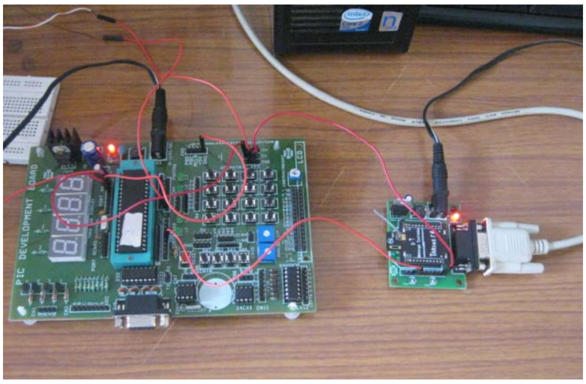

Fig. 8. Transceiver module with microcontroller board.

Fig. 9. Relays controlling motor.

The user can monitor the temperature, humidity and relay status on the 'Read Data' window in the front panel in the read mode. User can control the relay status by sending corresponding control signals in the 'write control signal' window. By using the LabView web publishing tool the same LabView window can be published in the internet. The user can access this same LabView from anywhere in the world through internet. To restrict the data only for the registered users a website is made with username and password. The website is created by using the PHP codes and simulated in WAMP server. The user can view this LabView window by logged into the website silver.nitt.edu/greenhouse. The user should have LabView run time engine in the computer system to view the LabView window.

Fig. 10 shows the website silver.nitt.edu/ greenhouse. The user can monitor and control the greenhouse parameters by logged into this website. The new user can register by clicking the 'Register' (Fig.11).

After registration the user can logged into the website by providing username and password. After logged into the website the same LabView window with same functionality will be available for the users (Fig. 12).

The user can monitor the temperature, humidity and relay status on the 'Read Data' box of the LabView font panel available through internet. He can control the relays by sending control signals through the 'Write Control Signals' box of the same front pane window. For writing control signals the user has to change the option from read to write. After writing the control signals he can change to read mode to monitor the data. This real time monitoring provides reliable, timely information of crop and soil status which is important in taking decisions for crop production improvement.

Fig. 10. Website to monitor the greenhouse parameters.

Fig. 11. Register window for the new users.

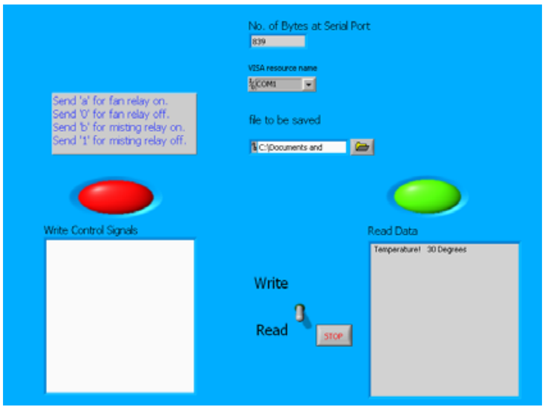

Fig. 12. LabView front panel window.

5. Conclusions

In green house technology, the automation of agricultural parameters becomes a necessary part. Hence control through internet with simple hardware and user friendly software like LabView is shown to be an efficient solution for automated green house. In this paper a precision Green house management approach to monitor and control the climate and irrigation system is demonstrated. It is proved to be a boon for Hi Tech agricultural field. Although the experimental results have shown for two parameters, the system is completely scalable. The proposed approach has a great potential for remote crop monitoring and control through internet for large scale green house. The system presented here is user friendly, low cost and can be easily implemented.

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