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Real Time Data Acquisition System for WSN Using Arduino for Polyhouse

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Abstract— In this paper, a real time data acquisition system based on wireless sensor network is implemented using XBee Digi modules and open source hardware platform Arduino. This wireless sensor nodes are deployed in Fan and Pad Polyhouse. This system consists of two sensor nodes and a base station. These two sensor nodes are deployed at different location in polyhouse. The concept of Arduino UNO is used here to design nodes. Each node is equipped with Atmega 328 micro controller, XBee S2 module and DHT11 sensors. Both sensor nodes sense the temperature and relative humidity and then the collected information are sent to the sink node for storing with specific node ID. Each node also can store its own data using small memory at node level. Arduino Integrated Development Environment (Arduino IDE) is used here to upload programs to Arduino Hardware. The proposed system has been tested for three days and it is observed that results are satisfactory. It indicates that this system can be very useful for greenhouse monitoring and can control various physical parameters in the field as future work.

Keywords—Arduino, XBee, DHT11 sensor, Wireless Sensor Network, Polyhouse

I. INTRODUCTION

Polyhouse farming is a modern farming which is one of the types of greenhouse farming. We can protect our crops from any adverse environment such as high temperature and high humidity in polyhouse. In polyhouse, polyethylene is used as main material for construction that stabilizes the ultraviolet rays and helps in proper photosynthesis in crops. Polyhouse is constructed mostly in east to west direction to allow proper entry of sunlight.

In this work wireless sensor network is deployed in Fan and Pad Polyhouse in which a "fan and pad" system exist that uses exhaust fans to pull air through evaporative cooling pads. It utilizes the cooling effect produced when water evaporates and cools the air as it is pulled through the pad. In this system, Cellulose or aspen pads are mounted in one end wall or side wall of the greenhouse. The drawn air through the wet pads is saturated by fans mounted in the opposite end wall or side wall that cools the greenhouse. The pads are sometimes removed to allow more light to enter the greenhouse or polyhouse for the winter.

Various factors like temperature, humidity, light etc. affect the growth of plants. For productivity improvement and for achieving remarkable energy savings the greenhouse climate adjustment can enable us. For controlling these parameters, it is necessary to monitor greenhouse environment continuously.

In this work, data are collected from sensor nodes and transmit it to base station that is capable to store data. Data can be obtained at sensor node level also. Temperature and relative humidity at sensor nodes are displayed by using LCD. For making these sensor nodes X-bee Digi modules and open source hardware platform Arduino are used. In future work, we can connect our base station to automated controlling system in greenhouse based on data collected in regular way.

Rest of the paper is organized as follows, Section I contains the introduction of fan and pad polyhouse and proposed Data Acquisition System, Section II contains the related work of Wirelesss Sensor Network using Zigbee Technology, arduino and greenhouse, Section III contains System Implementation, Experimental Design of proposed Data Acquisition System and technique. Section IV describes results and discussion, Section V concludes research work with future scope.

II. RELATED WORK

Sensor nodes creation using arduino is emerging as a novel area of research and it offers wide application areas. Data acquisition from WSN using arduino and XBee creates new opportunities for low cost WSN and its applications.

In [1], Nabiha Faisal et. al. designed a system such a way that provide constant monitoring of certain parameters i.e

Light, Humidity and Temperature by using sensors and arduino for better growth of plants in greenhouse. A log was maintained stating the current climatical condition and the action taken accordingly. The system proposed in this paper, has been successfully implemented and extensively tested in the premise of Bahria University Karachi Campus.

A. V. Zade et.al, [2], proposed a Smart Green House Automation System which monitors parameters like Temperature and Humidity in the greenhouse. Controlling of these parameters also take place after monitoring. This system uses an Android mobile phone for monitoring as well as controlling greenhouse, connected to a central server which is connected to a microcontroller via serial communication and wireless connection. The system consists of Arduino microcontroller and DHT11Sensor.

K. Lokesh Krishna et.al, [3], presented a ZigBee based energy efficient environmental monitoring; controlling and alerting system for agriculture is designed and implemented. The system utilizes an ARM7 processor, various sensors and ZigBee communication module. In this system sensors gather various physical data from the field in real time and transmit it to the end user and to the processor via ZigBee communication. After that necessary actions are initiated to perform action.

In [4], Jaymala C. Patil et.al, presented a project is to develop a smart wireless sensor network (WSN) for an agricultural environment in greenhouse. This project monitors agricultural environment for various factors such as temperature, humidity and Light Intensity. This system uses Zigbee trans-receiver, sensors, & LPC2138 microcontroller. Here, Zigbee technology is used for the long distance communication.

Ruchika et.al, [5], investigated a smart agriculture monitoring system using arduino which senses the values of the parameters such as temperature, humidity and soil moisture, and sends data to a controller that collects the data, analyses it and updates it to a real-time monitoring system called firebase.

M. P. Aher et.al, [6], represented the modeling and optimizations on advanced GSM (800-900MHz)-WSN (IEEE 802.15.4) based greenhouse monitoring and controlling with SMS terminal. The sensor station and base station communicate via ZigBee wireless modules and base station and user via GSM network.

D.O.Shirsath et.al, [7], presented IOT Based Smart Greenhouse Automation Using Arduino. This paper focuses on the Generic Architecture which can be applied for other Automation Application.

In [8], R. Piyare et.al, presented performance analysis of ZigBee networks based on XBee ZB modules. For this experimentation the wireless sensor node hardware design consists of ZigBee (XBee S2) wireless communication module from Digi International. For configuring and testing the ZigBee module of each sensor node X-CTU software is utilized.

K. Mor et. Al., [9], used Zigbee application to make wireless connection with other devices. This paper state that, however some issues are associated with usage of ZigBee based Ad-hoc Wireless Sensor Networks including Quality of services and reduction in lifetime of nodes. Sensor node works on battery power which is limited for each node. Hence Zigbee based data transferring to the base station are very important.

A. Saravanan et. Al., [10], presented ZIGBEE Controlled Industrial Robot for Controlling the Fire in a Sensitive Way. This paper indicates that the entire module had to be implemented as hardware and it will sense the human inside the rooms available and will give attention to the main station. This paper uses the concept of Wireless Sensor Network and Zigbee.

III. METHODOLOGY

This data acquisition system was deployed in a polyhouse in the month of November. Here sensors collect data and send it to the base station. Data were collected for 3 days.

A. System Implementation

1. Hardware Part

- **ATmega 328**

This system used the concept of Arduino UNO which is microcontroller board based on the ATmega 328. Atmega has 14 digital input/output pins and 6 analog input. The meaning of "UNO" in Italian is one. The Uno is the latest in a series of USB Arduino boards and reference model for Arduino platform [7]. The Arduino Uno can power with external power supply or via the USB connection. This External power can come either from an AC to DC adapter or battery. This board can operate on 6 to 20 volts of an external supply.

Figure 1 ATmega 328 Microcontroller

- **DHT11**

Figure 2 DHT11 Sensor

DHT11 is a low cost humidity and temperature sensor. It provides high reliability and long term stability. The exact measure of water vapour in the air is absolute humidity. It is normally expressed in terms of relative humidity and can be expressed in percent.

- **XBee**

For this experimentation, the wireless sensor node hardware design consists of ZigBee (XBee S2) wireless communication module from Digi International. X-CTU software is utilized here for configuring and testing the ZigBee module of each sensor node.

XBee S2 follows ZigBee protocol. We deployed a wireless sensor network using the ZigBee standard. ZigBee is a protocol based on the IEEE 802.15.4 standard which defines the Medium Access Control (MAC) and physical layers, operating in an unlicensed band of 2.4 GHz with a data transfer rate of 250 kbps [8]. This protocol supports three types of communication topologies such as mesh topology, point-to-point and point-to-multipoint in terms of networking capability. ZigBee protocol supports multi-hop communication capability; therefore it provides a vast range of communication and a wide coverage area [11].

Figure 3 Xbee S2 ZigBee Module

2. Software Part

Arduino software has been used here to upload programs to arduino hardware. This arduino software is known as the Arduino Integrated Development Environment (Arduino IDE) which contains a text editor for writing code, a text console, a message area, a series of menus and a toolbar with buttons for common functions. It helps to communicate with arduino hardware. The Programs written using Arduino Software (IDE) are called sketches. Sketches are written in the text editor and saved with the file extension .ino.

B. Experimental Design

The proposed system comprises three modules: two sensor nodes and a base station. Each module consists of Atmega 328 microcontroller, Xbee S2 and LCD. Sensor nodes contain DHT11 sensors also.

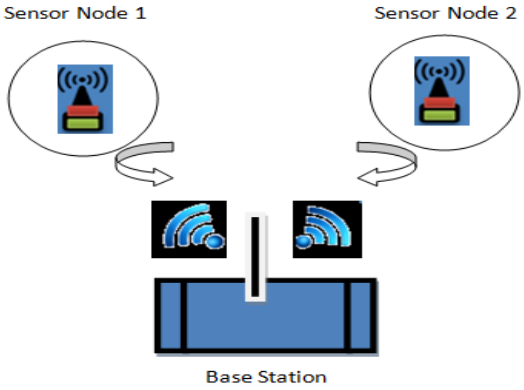

Figure 4 Network Architecture

- **Sensor Nodes**

The sensor nodes are deployed in different location of polyhouse. They perform sensing function that is collecting data. The data are sent to LCD display for examination purpose of parameters to be monitor. Nodes compare the collected data with the threshold data and decide the event parameter. Each sensor node stores values for parameters Temperature, Humidity, Event based on sensed temperature, event based on humidity. Sensed data are also made available on sensor nodes by using SD cards. Finally collected data are sent to the base station through Zigbee.

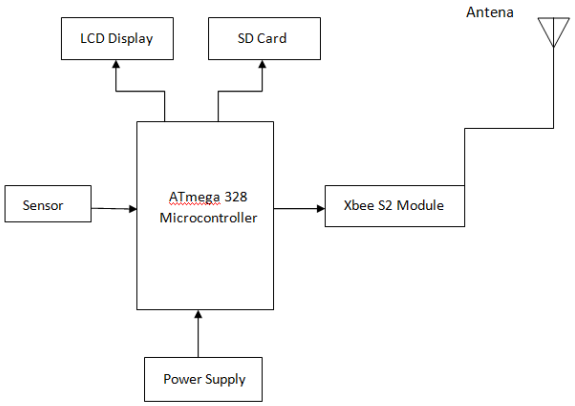

Figure 5 Block Diagram of Sensor Nodes (Transmitter Module)

- **Base Station**

The transmitted field parameters from polyhouse via Zigbee are received by base station. After receiving data, LCD on base station displays message "received" and store data from both sensor nodes with their node ID.

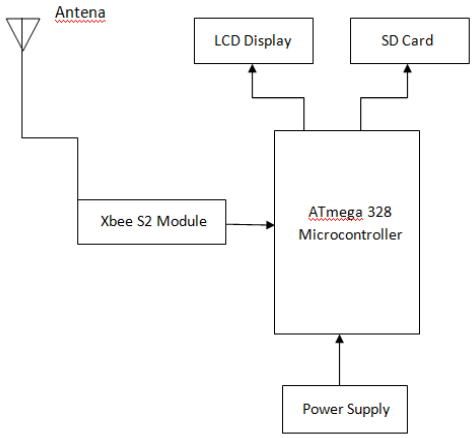

Figure 6 Block Diagram of Base Station (Receiver Module)

C. Technique used

We used the ZigBee (IEEE 802.15.4 standard) technology for networking and communication, because it has low-cost characteristics and operates at low-power. It is a Technological Standard created for Monitor and Control Sensor Networks based on the IEEE 802.15.4 standard for wireless personal area network. Very low power consumption, low data rate, low cost and network flexibility in an adhoc self-organizing network among fixed, inexpensive, portable and moving devices are the main features of this standard.

IV. RESULTS AND DISCUSSION

In this proposed system DHT11 sensor is used which measures temperature and relative humidity. Both the sensor nodes measured these parameters and sent it to base station (Sink Node) successfully, as shown in following figures. In figure (7), humidity and temperature are displaying on LCD and in figure (8), **received** message is displaying for receiver module as base station. These data has been stored here for further analysis purpose that includes event parameter also. Both dataset at sensor node level and at the base station have been collected, observed and found similar for a specific time that indicates correct data are arrived to base station.

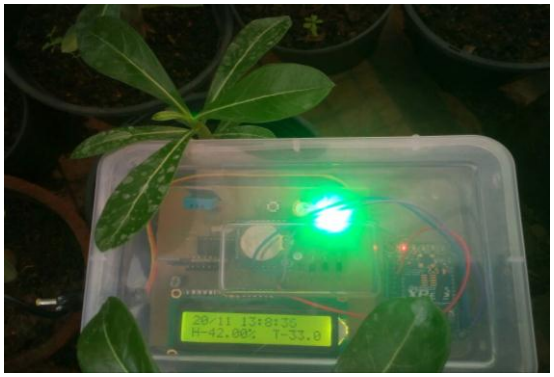

Figure 7 At Sensor Node (Transmitter Module)

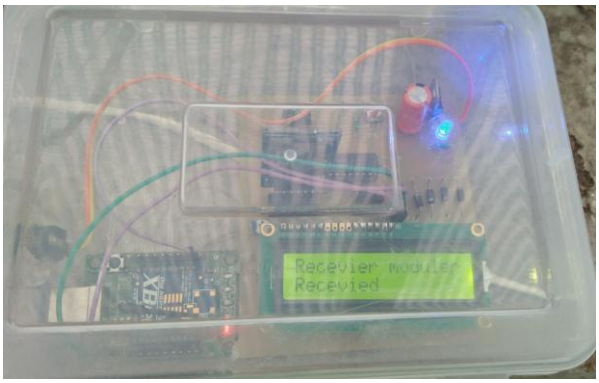

Figure 8 At Base Station (Receiver Module)

Following figures shows the images of field during observation of parameters at polyhouse.

Figure 9 During Parameter Observation at Polyhouse(Image A)

Figure 10 During Parameter Observation at Polyhouse(Image B)

V. CONCLUSION AND FUTURE SCOPE

Here proposed design for Real Time Data Acquisition System is implemented with Arduino platform for polyhouse. This System collects only real time data for wireless sensor network. In future, this system can be extended for controlling

temperature and humidity for the whole greenhouse by implementing automatic monitoring and controlling system. Data gathered from this wireless sensor network can be analysed that can help in growth in productivity.

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