

Zigbee Based Real - Time Monitoring System of Agricultural Environment

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ABSTRACT

Irrigation System is required to be automatized in the area of agricultural field. Presently automatic systems have few manual operations, insufficient flexibility and accuracy. Therefore agricultural field prefer automatic control system and provide adequate irrigation to specific area. Proposed system is primarily designed for wide range control applications and to replace the existing non-standard technologies. Current system control parameter like temperature and soil moisture however present of toxic gas in atmosphere and water level of well plays an important role in cultivation of crops. Proposed system is designed to control water level monitor, presence of toxic gas, temperature variation and moisture content of soil. The proposed system is based on microcontroller for the control of various parameters of irrigation system. In addition to the proposed system uses zigbee technology for the long distance communication.

Keywords – LCD Display, Sensors, Pic Microcontroller, Precision Agriculture, Zigbee

I. INTRODUCTION

The need for intelligent farming especially in developing countries like India has grown to a greater extent. Moreover, research in area of Zigbee based wireless sensor network in agriculture, such as monitoring of environmental conditions like weather, soil moisture content, temperature and monitoring growth of the crop, precision agriculture, automated irrigation facility has taken a new dimension.

Nowadays, awareness about implementing technology for agricultural environment has been increased. Manual collection of data for desired factors can be sporadic, not continuous and produce variations from incorrect measurement taking. This can cause difficulty in controlling environmental important factors. Wireless distinct sensor nodes can reduce time and effort required for monitoring the environment. The logging of data allows for reduction of data being lost or misplaced. Also it would allow placement in critical locations without the need to put personnel in hazardous situations. Monitoring systems can ensure quicker response times to adverse factors and conditions. The utilization of proposed technology would allow for remote measurement of factors such as temperature, humidity, soil moisture, water level.

The purpose of proposed system is to improve the irrigation system of Indian agriculture and also to provide adequate irrigation to particular area. Nowadays every system is automated in order to face new challenges. In the present days automated systems have less manual operations, flexibility, reliability and accuracy. Due to this demand every field prefers automated control systems. Especially in the field of electronics automated systems are giving good

performance. And this is realized by making use of Zigbee technology for communication [1].

II. OVERVIEW OF ZIGBEE TECHNOLOGY

Based on the IEEE 802.15.4 standard physical layer (PHY) and media access control layer (MAC) which ZigBee defines a system of high-level, including the network layer (NWK), application layer (APL) and security services specification. Each layer is responsible for completion of the task, and provides services to upper layer, the interface between the layers communicate by the defined logical link, of which application layer also provides many other services to enhance the properties of the network self-organization, dynamic management features and security. ZigBee's frequency bands is 2.4GHZ, Europe (868MHZ) and the United States (915MHZ) are free to apply band [2]. Table 1 shows the radio specification of IEEE 802.15.4. ZigBee can establish reliable, open and global standards. As the duty cycle is very short, send and receive messages with lower power consumption, so under normal circumstances, two 1.5V batteries can be support to six months to two years. It achieves energy-saving effect and provides a rich application space.

Table 1 Radio Specifications

	CSMA MAC	IEEE 802.15.4
Frequency Band	315/433/868/916 MHz	2.4 GHz
Data Rates	20-50 kbps	250 kbps
Range	300m outdoor	125m

2.1 Zigbee Topologies

Zigbee supports three topologies, namely, (i) star, (ii) mesh and (iii) cluster-tree as illustrated in "Fig.1". In star topology, each node or end node is connected to the coordinator and communication is carried out by Zigbee Coordinator (ZC). In mesh topology, each device communicates with any other device within its radio range or through multi-hop. In cluster tree topology, there is a single routing path between any devices [3].

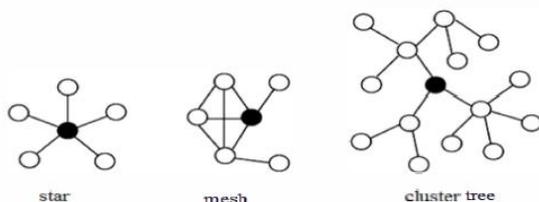


Figure 1 Zigbee topology

2.2 Zigbee Framework

ZigBee framework is made up of a set of blocks called layers. Each layer performs a specific set of services for the layer above. As shown in Fig.2. The IEEE 802.15.4 standard defines the two lower layers: the physical (PHY) layer and the medium access control (MAC) layer. The ZigBee Alliance builds on this foundation by providing the network and security layer and the framework for the application layer. The IEEE 802.15.4 has two PHY layers that operate in two separate frequency ranges: 868/915 MHz and 2.4GHz. Moreover, MAC sub-layer controls access to the radio channel using a CSMA-CA mechanism. Its responsibilities may also include transmitting beacon frames, synchronization, and providing a reliable transmission mechanism [4].

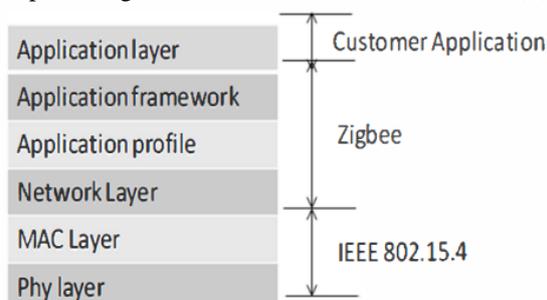


Figure 2 zigbee framework

III. Proposed System Design

The Proposed System design consists of transmitter as well as receiver. The Proposed block diagram of transmitter and receiver is shown in fig.3. Transmitter section consist of different type of sensing unit such as temperature, humidity, gas as well as the water level of well. Microcontroller for time domain multiplexing i.e. multiplexing the data obtained from different type of sensor as well as for converting the analog data into digital one [5].

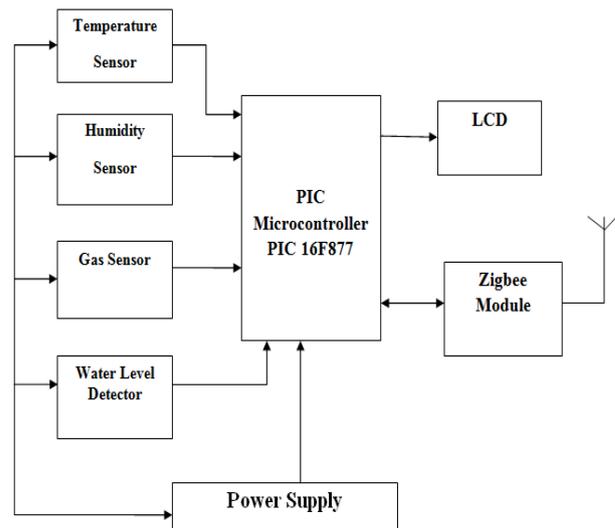


Figure 3 Transmitter block diagram

2.3 Microcontroller

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. The Proposed System Uses PIC 16F877 Microcontroller. PIC16F877 features 256 bytes of EEPROM data memory, self programming, an ICD, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI) or the 2-wire Inter-Integrated Circuit (I²C) bus and a Universal Asynchronous Receiver Transmitter (USART) [6]. In this proposed system microcontroller will take the analog data from different sensor which will gets converted into digital one with the help of ADC present in microcontroller. After conversion completion the data will be displayed on LCD and will be given to zigbee for wireless transmission.

3.2 Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C). It is used to measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. This sensor is used to monitor surrounding temperature. It gives the idea about the increase or decrease in the temperature of surrounding. If the temperature changes it is observed on LCD.

3.3 Humidity Sensor

Humidity is an expression of the amount of water vapour in air. It is an invisible gas that varies

between 1 - 4% of our atmosphere by volume. SY-HS-220 sensor module converts relative humidity (30-90%RH) to voltage and can be used in weather monitoring application. This sensor is used to monitor humidity i.e. moisture present in the surrounding.

3.4 Gas Sensor

This sensor is to sense the toxic gas like carbon monoxide present in the air. The MQ-7 can detect CO-gas concentrations anywhere from 20 to 2000ppm. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

3.5 Water Level Detector

This is used to detect/sense the water level of the well. The sensor will detect the amount of water present in the well. If the water level goes below minimum level or above maximum level a control signal is send to LCD. In addition to this a message is send to an observer situated at the remote place.

3.6 Zigbee Module

The XBee RF Modules are designed to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices. The modules operate within the ISM 2.4 GHz frequency band. It operates over a range of 100-200 meters [7]. Fig.4 shows the zigbee module.



Figure 4 Zigbee series 2 module

The receiver block diagram is shown in Fig.5. The receiver module consists of an Xbee RF module which is connected to computer system through MAX232. Thus the monitoring data received by Zigbee module is directly transferred to computer system.

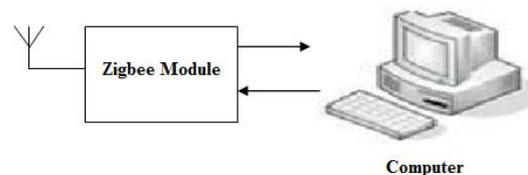


Figure 5 Receiver block diagram

IV. SOFTWARE DESCRIPTIONS

X-CTU is a Windows-based application provided by Digi's. This program was designed to interact with the firmware files found on Digi's RF products and to provide a simple-to-use graphical user interface to them. X-CTU is designed to function with all Windows-based computers running Microsoft Windows 98 SE and above. When launched, four tabs across the top of the program can be seen in Fig.6. Remote configuration is shown in Fig. 7. Each of these tabs has a different function. The four tabs are:

4.1 PC Settings

This tab allows user to select the desired COM port and configure that port to fit the radios settings.

4.2 Range Test

This tab allows users to perform a range test between two radios.

4.3 Terminal

This allows access to the COM port of the computer with a terminal emulation program. This tab also allows the ability to access the radios' firmware using AT commands.

4.4 Modem Configuration

This tab allows the ability to program the radios' firmware settings via a graphical user interface. This tab also allows users the ability to change firmware versions [8].

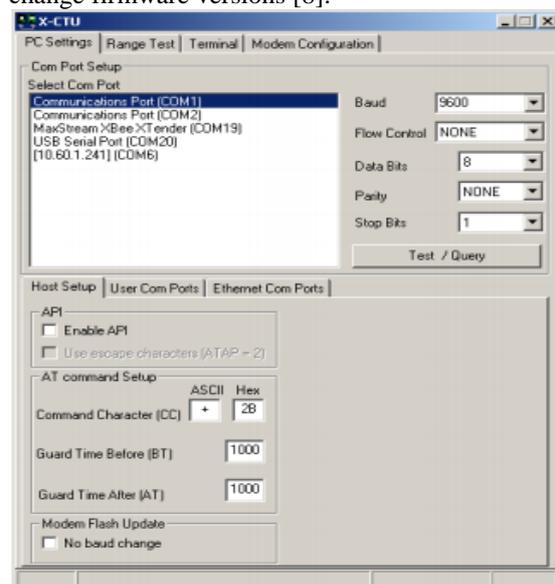


Figure 6 X - CTU setup

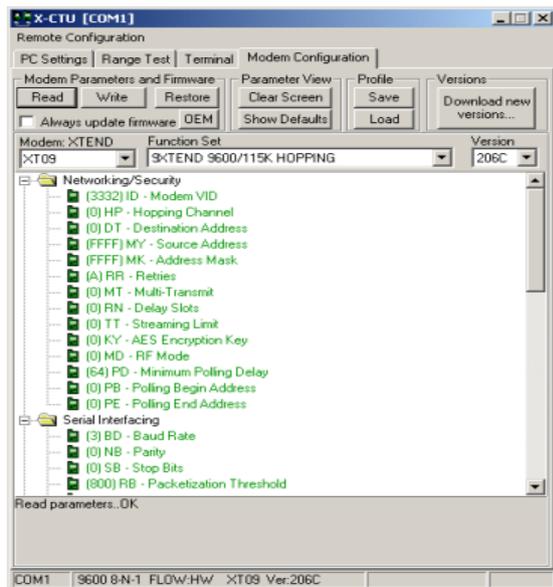


Figure 7 Remote configuration

V. SOFTWARE DESIGN FLOW FOR THE PROPOSED SYSTEM

A simplified operational flow is shown in Fig. 8. Fig.8 (a) shows the sensor unit and Fig.(b) Microcontroller section. The sensor unit will sense temperature, humidity moisture, and toxic gas present in the air from the remote place and send the data to microcontroller. For the water level of well is string value ‘n’ given it will start the motor and if ‘m’ given then it will stop the motor pump. In the microcontroller section firstly initiations take place for ADC, UART, and I2C. Then microcontroller receives data from sensor unit and start analog to digital conversion. After ADC conversion completion the data will be displayed on LCD and signal is send to zigbee module for wireless transmission at the receiver section. At the receiver section zigbee module is interface with computer with the help of Max232 and DB9. The data received from transmitter section will be displayed on computer.

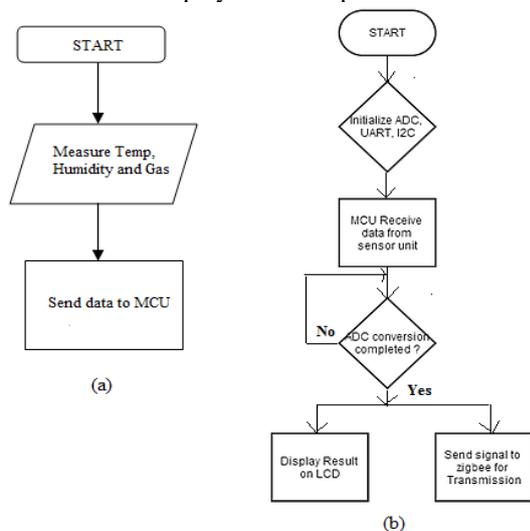


Figure 8 (a) Sensor Unit (b) Microcontroller Section

VI. CONCLUSION

The System is designed for the betterment of farmers. The uses of smart sensor based monitoring system for agriculture have been used to increase the yield of crop by monitoring the environmental conditions and providing information to observer. It would be a promising technology for the agriculturists all over the world in the present scenario of unpredicted weather conditions

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