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ZIGBEE BASED REAL TIME MONITORING AND CONTROLLING FOR PRECISION AGRICULTURE USING LABVIEW

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Abstract-Agricultural field is required to atomize in area of irrigation system. In country like India, there is no systematic organizational and institutional planning involved in cultivation, irrigation, harvesting etc...So farmers faced tough times as they have lack of information and absence of systematic monitoring and controlling. The use of wireless sensor network (wsn) is necessary to implement control technology in application areas such as precision agriculture. The propose system has been tested with the help of Arduino, LabVIEW and Zigbee Tech. Data is continuously monitored to achieve temperature, humidity and soil moisture. All monitoring of various parameters being sensed by arduino and then it is transmited through WSN with help of ZigBee placed at field station to ZigBee placed at base station. Arduino is the heart of the system which is used to interface the physical environment and LabVIEW through ZigBee N/W. The data received by ZigBee placed at the receiver end can be used directly by the computer and is sent to LabVIEW to process the data. Based on analysis of data at base station through LabVIEW program, controlling action is also done in case soil moisture value is less than set value. The control signal generated is transmitted by ZigBee N/W which when received at FS coordinates the action by running the motor. The whole control and coordination of system is recursive in nature. We use the LabVIEW as a hub which governs the entire system for monitoring and controlling. This work is an example of embedded system which uses software as well as hardware implementation to achieve pre specified goal.

Index Terms: Precision Agriculture, Zigbee, Labview, Field Station, Base Station

1. INTRODUCTION

Another name for precision agriculture is Site-Specific Management. Precision agriculture makes sure that better quality control of the produce must be obtained and quicker response times to adverse climatic conditions and yet a lower labor cost. Precision Agriculture refers to use of information and control technologies in agriculture [1] Precision Farming also makes the use of completely automated machinery, a possibility. This form of highly programmed agriculture requires thorough sensing of climatic conditions at the ground level and speedy communication of the raw data to a central repository. At the central server, with the availability of computational power, decision making and technologies reduce the pressure on man labor. The Precision farming system has the following parts. First, it will monitor agricultural parameters and then second part is to recognize sensing location and gather data .Third part is to transfer data from field station to base station for making decision. Fourth part is to actuate and control decision based on sensed data.

Precision irrigation is an important practice in water-saving agriculture cropping system, which allows producers to maximize their productivity while saving water [2].Precision agriculture can be applied using WSN. Wireless sensor network WSN consists of spatially distributed sensor [3] which concentrates on providing the means for observing, assessing and controlling agricultural practices. It concerns as well pre- and post-production aspects of agricultural enterprises. WSN have several advantages over traditional data schemes. It has Potential to make exact evaluation of new crop methods and techniques. It is extremely versatile and has low maintenance. It is relatively inexpensive, it has been suggested that the total system cost (for both materials and installation labor) can be reduced by over 80% by using commercially available WSNs over using a wired solution. Sensor nodes are small in size and weight and require no wiring which means that they are easy to install in most locations and applications. So precision agriculture with WSN refers to a set of technologies that introduced the concept of the local variation into the large scale mechanization, which is essential to large fields [4].

2. OVERVIEW OF ZIGBEE

WSN system for PA requires a centralized control unit with user interface, communication gateways and router, power element and the most importantly are the sensors [5]. ZigBee is a wireless network with short range and low power consumption. It is also known as a LP-WPAN (Low Power-Wireless Personal Area Network). It is characterized by a range of a few hundred meters and a defined rate of 250000kbit/s. The standard was conceived to inter-connect embarked units like sensors. It is based on the standard IEEE 802.15.4. ZigBee can work on three frequency bands: 868MHz (Europe), 915MHz (North America) and 2.4GHz (INDIA).

ZigBee standard supports three types of device support to it system: ZigBee Coordinator, ZigBee Router and ZigBee End Device.[6]-[8]. ZigBee Coordinator (ZC) should be one in each network and is at the top in mesh topology. It starts the network formation, pick frequency to be used by the network and permit devices to connect. ZigBee Router (ZR) allows ZigBee end devices or nodes to connect with ZC. ZigBee End devices (ZED) can talk to ZigBee router as well as ZigBee Coordinator. It is actually responsible for reporting sensor states.

ZigBee standard architecture

Most network protocols use the concept of layers to separate different components and functions into independent modules that can be assembled in different ways. ZigBee is built on the Physical (PHY) layer and Medium Access Control (MAC) sub-layer defined in the IEEE 802.15.4 standard. These layers handle low-level network operations such as addressing and message transmission/reception. The architecture of ZigBee is explained by Open system Interconnect (OSI). The ZigBee specification defines the Network (NWK) layer and the framework for the application layer. The Network layer takes care of the network structure, routing, and security. The application layer framework consists of the Application Support sub-layer (APS), the ZigBee Device Objects (ZDO) and user-defined applications that give the device its specific functionality.

3. SYSTEM DESIGN

Full hardware consists of four nodes. Three nodes placed at field station and one node placed at base station. The node placed at field station consist of arduino uno, zigbee, and two sensors, relay and submersible water pump connected to it One such node is shown in fig 3.1. The details of different component are given below.

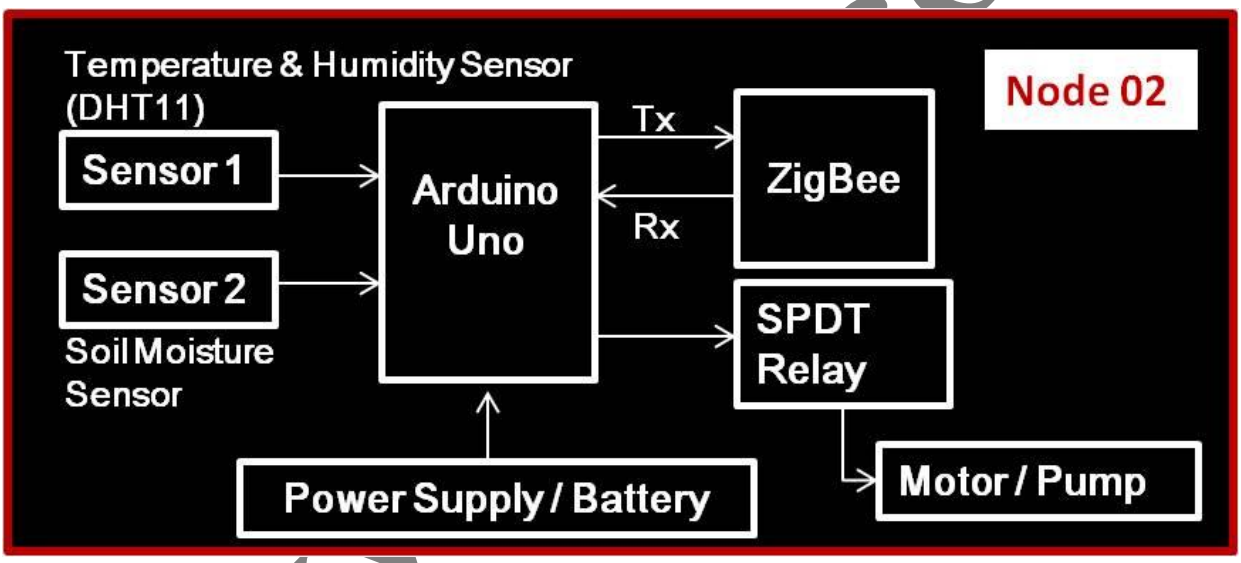

Fig.3.1 Block Diagram of Node Placed At Field Station

Arduino The arduino uno board is based on the atmega328. It has 6 analog inputs, 14 digital input/output pins, a usb connection, a 16 Mhz crystal oscillator, a reset button, a power jack, and icsp header. It contains whole lot needed to support the microcontroller, simply power it with a ac-to-dc adapter or battery or connect it to a computer with a usb cable to get started. Original picture of arduino during its testing is shown in fig 3.3.

ZigBee Module The zigbee module used here is zigbee S2C. The zigbee modules provide wireless connectivity to end-point devices in zigbee networks .Indoor range is 30-40m and outdoor range is of few hundred meters. Voltage required is 2.1V-3.6V

Humidity and Temperature Sensor This dht11 humidity and temperature sensor features a temperature & humidity sensor composite with a calibrated digital signal output. Power supply required by dht11 is 3-5.5v dc. Measurement range for humidity is 20-90% humidity and measurement range for temperature is 0-50^{0}C.

Soil Moisture Sensor This soil moisture sensor measures the volumetric content of water inside the soil and gives us the moisture level as output. The volumetric water content in soil is truly measured by two probes of the soil moisture sensor. When these two probes are inserted in the soil current is passed through the soil and then it gets the resistance value to measure the moisture value. The sensor used is FC-28 soil moisture. Input voltage required is 3.3 – 5V. To connect the sensor in the analog mode, we need to use the analog output of the sensor. The soil moisture sensor gives us the value from 0-1023 when taking the analog output from it. We can further set different ranges of the moisture values and turn on or off the water pump according to it.

Relay Relay is similar to switch, it is either open or close and known as normally open (NO) and normally closed (NC). To open and close the relay electromagnet is used. When the coil controlling the electromagnet is given a voltage, electromagnetic causes the contact in the relay to connect and transfer current through the relay.

A relay is said to switch with one or more poles. Each pole has contacts that can be thrown in mainly three ways. They are **normally open contact (NO)** – NO contact is also called a make contact. It closes the circuit when the relay is activated. **Normally closed contact (NC)** – another name for NC is break contact and this is opposite to the NO contact. **Change-over (CO) / double-throw (DT) contacts** – this type of contacts are used to control two types of circuits. They are used to control both contact, NO contact as well as NC contact with a common terminal. Testing of soil moisture sensor along with the relay is shown in fig 3.4.

Receiver node The node placed at base station is ususlly known as receiver node or coordinator node and is shown in fig 3.2 This node consists of zigbee hooked up to the pc where the user can see the data being received by an zigbee. This basic building block consisting base station acting as a gateway between sensor nodes and the end user [9] [10].

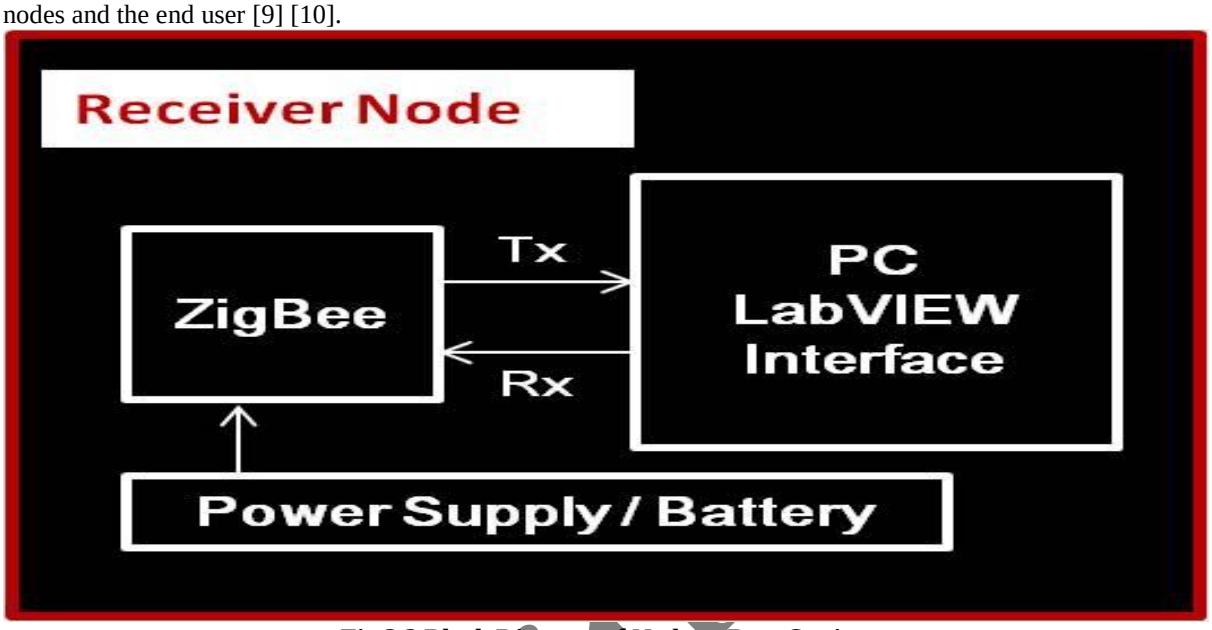

Fig 3.2 Block Diagram of Node at Base Station

Fig 3.3 Testing of Adurino

Fig 3.4 Testing of Soil Moisture Sensor and Relay

4. METHODOLOGY

The node placed at field station is a used as a Transreceiver Node. This node consists of a ZigBee which is connected to an Arduino Uno (with ATmega328 Microcontroller) with 2 sensors interfaced to it. It has temperature and humidity sensor and soil moisture sensor. The physical data acquired at this Node i.e. values

acquired for temperature, humidity and soil moisture content are transmitted to the receiver node through ZigBee and displayed on the PC using LabVIEW interface. So, that we can see the graphical presentation of all parameters on LabVIEW. Since we have soil moisture sensor values lying between 0-1023.So program in arduino software is burned in such a way that we have set three set of soil values

if(sensorvalue >0 &sensorvalue<500) then soil value is preset to be 3

if(sensorvalue >500 &sensorvalue<850) then soil value is preset to be 2

f(sensorvalue >850 &sensorvalue<1023) then soil value is preset to be 1

So, the receiver node acting as the coordinator node and runs the transreceiver function of the zigbee exclusively. This node is responsible to receive the data acquired by sensors interfaced to node at field station . This node is also responsible to coordinate the control action and generate a control signal according to analysis done by labview program for threshold set value of soil moisture to control motor automatically. The whole control and coordination is recursive in nature

5. RESULTS AND ANALYSIS

The graphical presentation of parameters of one of the node at field station with motor off indication in front panel of LabVIEW is shown in fig 5.1.

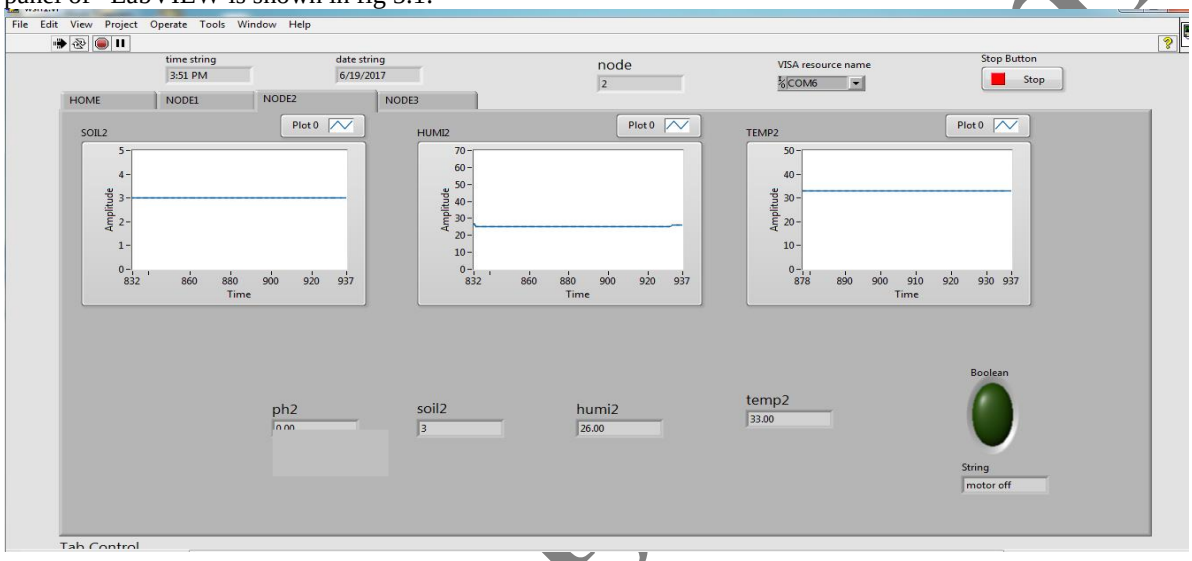

Fig. 5.1 Results of Node Displayed in Labview Front Panel (GUI) with Motor Pump off Indication

The graphical presentation of parameters of the node at field station with motor on indication in front panel of LabVIEW is shown in fig 5.2

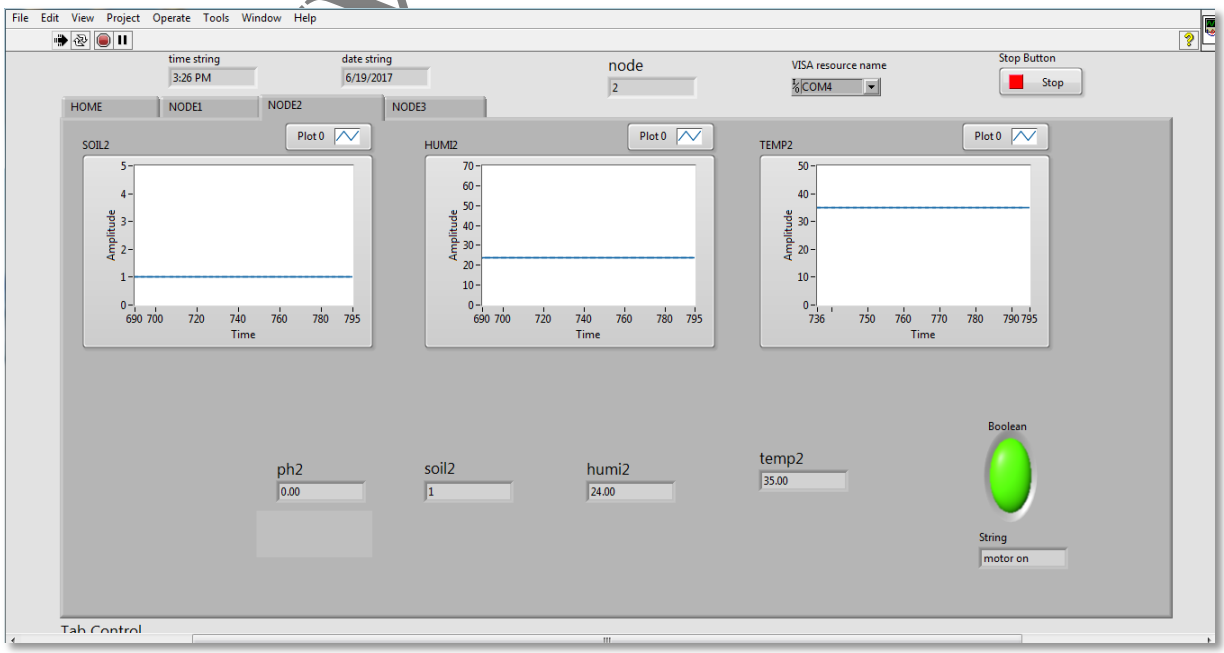

Fig. 5.2 Results of Node Displayed in Labview Front Panel (GUI) With Motor Pump on Indication

Here temp stands for temperature, humi stands for humidity, soil stands for soil moisture and 2 stands for node2. These figures clearly show when the value for soil moisture will be 1 motor pump will turns on. When soil moisture becomes 3, it turns off automatically as per the program of LabVIEW.

CONCLUSION

With the advancement of technology it becomes unavoidable for us to make sure that all the sectors of the modern society to develop equally. The precision farming is an appropriate system which help in making sure that most fundamental sector of the society get benefited .Precision agriculture and ZigBee wireless technology combines an exciting new area of research that will greatly improve quality in agricultural applications.

Designed system continuously monitored the various parameters like temperature, humidity, soil moisture through sensors that are being connected to arduino. The nodes are placed in field station along with ZigBee modules. The Results of the node have been represented graphically using LabVIEW system placed at base station. Based on value of soil moisture, start and stop of motor is being control automatically by LabVIEW. Hereby water can be conserved. So, the system reduces the mental burden of farmer. This system can be easily installed and maintained. The complete real –time information is expected to help the farmers to increase crop productivity. The operation of system is user friendly. Basically this embedded system is example of utilization of today's techonology to solve a conventional problem in agriculture.

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