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# Reliable Wireless Sensor network for Greenhouse monitoring

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## Abstract

*In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of the big greenhouse to make the greenhouse automation system work properly. Cabling would make the measurement system expensive and vulnerable. Moreover, the cabled measurement points are difficult to relocate once they are installed. Thus, a Wireless Sensor Network (WSN) consisting of small-size wireless sensor nodes equipped with radio and one or several sensors is an attractive and cost efficient option to build the required measurement system. In this work, we developed a wireless sensor node for greenhouse which can monitor humidity and temperature in green house. This can help farmers to understand the environmental conditions & they can adopt different methods to increase the crop production. All monitored parameters are transmitted through a wireless link to PC. All measured parameters are displayed on Graphical User Interface (GUI) designed in Labview.*



## 1. Introduction

Wireless sensor network consists of specially distributed autonomous devices using sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion at different locations. Application areas for WSNs include geographical monitoring (seismic activity), precision agriculture (soil monitoring), habitat monitoring (tracking of animal herds), transportation (traffic monitoring), military systems, business processes, & in future, possibly cooperating small things [1].

One example of WSN is automatic meter reading system [3]. Here ZigBee module is connected to each customer's meter. The GSM module takes data from the ZigBee modules which are in its range and transfer it to central computer. Another example is wireless sensor network deployed in crop field [4]. Temperature, humidity & light intensity in brinjal field is sensed by different sensor nodes deployed in field. This data is transferred to centralize computer for monitoring purpose. Greenhouse is kind of advanced hortical facility which changes plant growth environment creating suitable conditions for plant growth, avoiding the outside season change & the adverse effects caused by bad weather. Greenhouse is playing important role in production of out of season vegetables, flowers as well as high value of delicate plants. The purpose of greenhouse environment is to increase crop yields and to improve quality of crops [2].

## 2. Block diagram

Fig. 1 shows topology of WSN implemented in design of WSN for greenhouse. There are total four sensor nodes. Each node is sensing humidity, temperature in addition to general purpose computing and networking. Since the wireless communication range provided by the radio frequency (RF) module is more than 100m, the sensor node can be widely separated.Node N-1 and N-2 act as End-devices. They transmit their data through wireless link to node N-3.N-3 act as router. It collect data coming from node N-1 and N-2 transmit to coordinator along with their own data. Here it is considered that end devices are away from co-ordinator or beyond the range of communication. Hence role of router is like repeater. This 2 hop network also increases range of operation of wireless sensor network. All measured parameter are displayed with the help of GUI on computer. So it will be helpful to analyze the data.

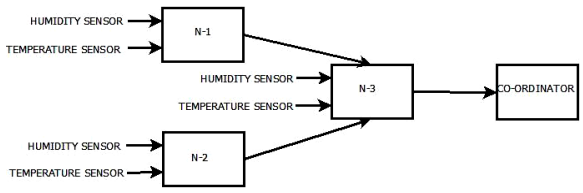


Fig1. Block diagram of Green House Monitoring System

## 3. Working of End device

1.Sensor node is initialize microcontroller, Zigbee module, and ADC.It choose the router 1 as default destination

2.Node read the different kind of sensor attached to it one by one.

3.Node send all sensor readings to the router 1 and wait for 'acknowledgement ' from router 1.

4.If acknowledgement is received from router 1 it keeps router 1as destination for next transmission.

5. If acknowledgement is not received from router 2 it keeps router 1as destination for next transmission.

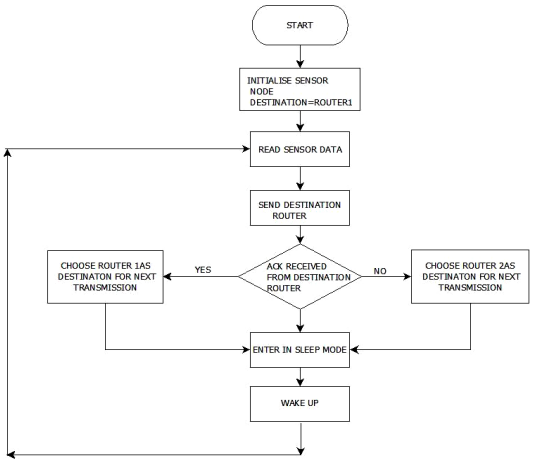


Fig.2 Working algorithm of end device

## 4.Working of Router

1.Sensor node is initialize microcontroller, Zigbee module,and ADC.Timeout period is set during initialization. This timeout period will decide time interval in which router is listening from end device.

2. After initialization node enter in reception mode. And wait for data coming from end device.

3. If data is received from end device then node read the data from sensor attached to it. Encapsulate all data and send it to co-ordinator. And go to step 2.

4.If data is not received from end device then node check the timeout period is expire or not. If timeout period is not expired then it goes to step 2.If timeout period is expired, then node read sensor data and send it co-ordinator and go to step 2.

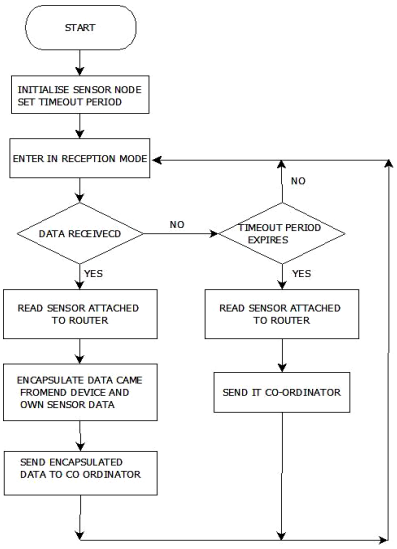


Fig Working algorithm of router

## 5. Hardware and sensor design node

The network formed consists of three nodes where each sensor node consists of small size sensor & general purpose computing elements. The sensor nodes can be deployed at various locations in a greenhouse to monitor environmental changes. The main components in sensor node are outlined below:

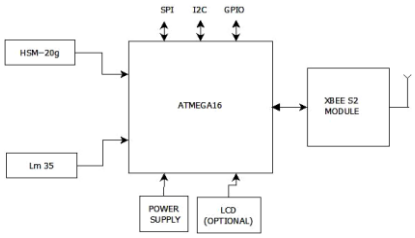


Fig.3 Basic Architecture of designed node

### A. Xbee Series 2 module:

For developing wireless sensor node, Digi's Zig Bee module also known as xbee series-2 module is used. They are easy to configure using windows based utility called X-CTU or by using hyper terminal utility. Configure modules, sending data wirelessly is as simple as serial write for microcontroller and serial read at receiver node. Some of specification of xbee RF module is as follow[5]:

Table 1: Specification of Xbee Series2

| Specification | Xbee-ZB |
|---|---|
| Indoor/Urban Range | Upto 40 m |
| Outdoor RF line-of-sight Range | Upto 120 m |
| Transmit Power Output | 2mW |
| RF Data Rate | 250,000 bps |
| Data throughput | Upto 35000bps |
| Receiver sensitivity | -96dBm |
| Supply voltage | 2.1-3.6V |

**B.Atmega 16**

Main processing unit of sensor node is ATMEGA 16.It is AVR family device from ATMEL. It have in built eight channel,10 bit resolution ADC. ATmega16 has an on board interrupt driven USART[16]. The on board hardware USART. This USART can directly connect to zig bee module.

**C. Sensors**

To measure humidity HSM-20g sensor is used. This sensors output is analog in nature and have accuracy ±5 %RH. Temperature range of this sensor is from 0 to 50 degree Celsius[13].In order to measure temperature Lm 35 is used. It have linear + 10.0 mV/°C scale factor and 0.5°C accuracy guarantee able (at +25°C) .It is rated for full −55° to +150°C range.

### I. Reliability of designed network

If the router1 is malfunctioning because of some reason, then end device1 automatically choose the router2 for next transmission. End device will continue its transmission using router 2.Hence alternate path end device1-router2-coordinator is generated.

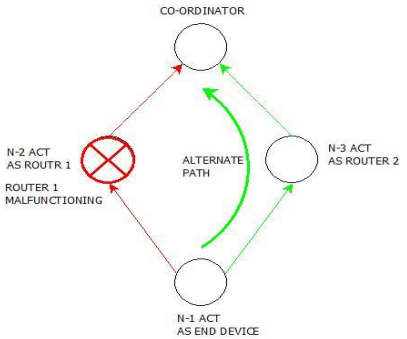


Fig. 4 Malfunctioning of router1 and alternate path is generated

After some time if router1 starts working normally and router2 malfunctioning because of some reason then end device will automatically choose the router1 for next transmission. End device will continue its transmission using router 1.

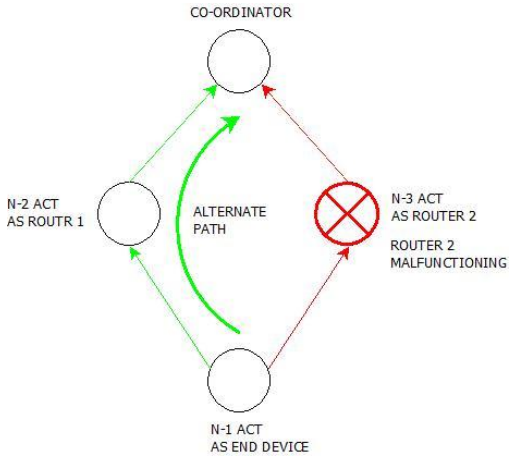


Fig. 5 Malfunctioning of router 2 and alternate path is generated

## 7. Implementation

Experimental results are shown in following figures

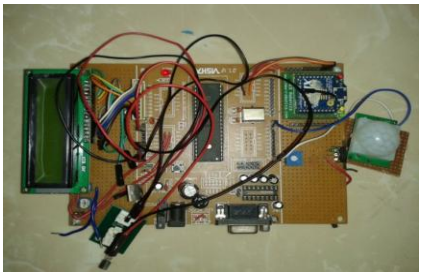

Fig.6 Image of designed node


Fig.7 Values of different sensors

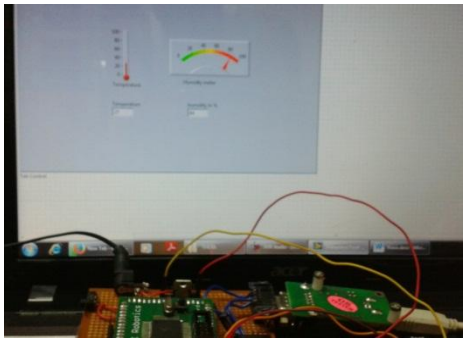

Fig.8Graphical user interface build in Labview

## 8. Conclusion

Different parameter of greenhouse are measured and displayed on GUI successfully. Designed node communicates reliably and faithfully. Network form by this node.

Coordinator collects all data from all nodes.it don't give any command to nodes. So Coordinator will give command to node to send data. All nodes will be time synchronized in order to support time co related sensor reading and low duty cycle operation of data collection. More parameters of green house will be measured.



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