

WIRELESS SENSOR NETWORK USING ZIGBEE FOR FOREST ENVIRONMENT MONITORING SYSTEM

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ABSTRACT

A wireless sensor network (WSN) consists of sensors which are densely distributed to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. The sensor data is transmitted to network coordinator which is heart of the wireless personal area network. In the modern scenario wireless networks contains sensors as well as actuators. ZigBee is newly developed technology that works on IEEE standard 802.15.4, which can be used in the wireless sensor network (WSN). The low data rates, low power consumption, low cost are main features of ZigBee. WSN is composed of ZigBee coordinator (network coordinator), ZigBee router and ZigBee end device. The sensor nodes information in the network will be sent to the coordinator, the coordinator collects sensor data, stores the data in memory, process the data, and route the data to appropriate node.

Zigbee is a low-rate, low-cost and low-power kind of transient wireless network communication protocol. Compared with other wireless methodologies, Zigbee has unique advantages of safe and reliable data transmission, an easy and flexible network configuration, low equipment costs and long-standing batteries. By applying a wireless sensor network based on Zigbee to a forest fire supervising system, information such as temperature and humidity at any part of the forest covered by the network could easily be collected, dealt with and examined at any time. In addition, the system can be extended significantly.

Keywords: Forest fire, Zigbee, Sensor Network, Zigbee-Co-ordinator, Zigbee-End-Device.

INTRODUCTION

WSN A wireless sensor network is a collection of nodes. Each node consists of processing capability (one or more MCUs or DSP chips), multiple types of memory (program, data and flash memories), a RF transceiver, a power source (batteries), and accommodates various sensors and actuators [11]. The nodes communicate wirelessly and often self-organize after being deployed in an ad hoc fashion. A WSN is a distributed real time system. Most past distributed systems research has assumed that the systems are wired, have unlimited power, are not real time, have a fixed set of resources, treat each node in the system as very important and are location independent. In contrast, for wireless sensor networks, the systems are wireless, have scarce power, are real-time, utilize sensors and actuators as interfaces, have dynamically changing sets of resources, aggregate behavior is important and location is critical. Many wireless sensor networks also utilize minimal capacity devices which places a further strain on the ability to use past solutions. Usually these devices are small and inexpensive, so that they can be produced and deployed in large numbers, and so their resources in terms of energy, memory, computational speed and bandwidth are severely constrained. There are different Sensors such as pressure, accelerometer, camera, thermal, microphone, etc. They monitor conditions at different locations, such as temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, the current characteristics such as speed, direction and size of an object. Normally these Sensor nodes consist there components: sensing, processing and communicating. Wireless Sensor Networks (WSNs) are traditionally

composed of multiple sensor nodes that sense environmental phenomena and generate sensor readings that are delivered, typically, through multi-hop paths, to a specific node (called the sink) for collection [6].

NEED OF STUDY

As it's possible to form a wireless sensor network to cover harsh large area and that network can be design using zigbee modules we can help forest department to monitor all its coverage area from one point as well as get an alert to forest official in case of any emergency.

[23] Eastern Australia is one of the most fire-prone regions of the world, and its predominant eucalyptus forests have evolved to thrive on the phenomenon of bushfire. It is estimated that the 2019–2020 bushfires led to the deaths of at least 33 people and over 3 billion animals.

[24] This one is taking place in forests, where the latest fire seasons have been raging with unprecedented ferocity, from the Amazon to the Arctic: in April 2020, the number of fire alerts across the globe were up by 13% compared to last year – which was already a record year for fires.¹ Persistent hotter and drier weather due to climate change, and other human factors such as land conversion for agriculture and poor forest management are the main drivers behind the increase. Climate change and wildfires mutually reinforce each other, and the fires burning today in many parts of the world are bigger, more intense, and last longer than they used to.

If current trends continue, there will be devastating long-term consequences. A greater number of more intense fires will release millions of extra tonnes of carbon, decimate biodiversity, destroy vital ecosystems, impact economies and people, threaten property and livelihoods, and cause severe long-term health problems for millions around the world. It is estimated that humans are responsible for around 75% of all wildfires,² and much of the increase in fire incidents during 2020 can be directly linked to human actions. This means solutions are in our grasp too. There's no magic bullet that will fix the issue overnight, but there are ways forward if behaviours of the past are changed. Proactivity and commitment must be at the heart of a global response to fires that needs to play out at local, sub-national, national and regional levels. Preventing fires before they occur is paramount, and far preferable in all respects to only suppressing them when they are burning. Good intentions and commitments need to be followed up by real and effective actions on the ground.

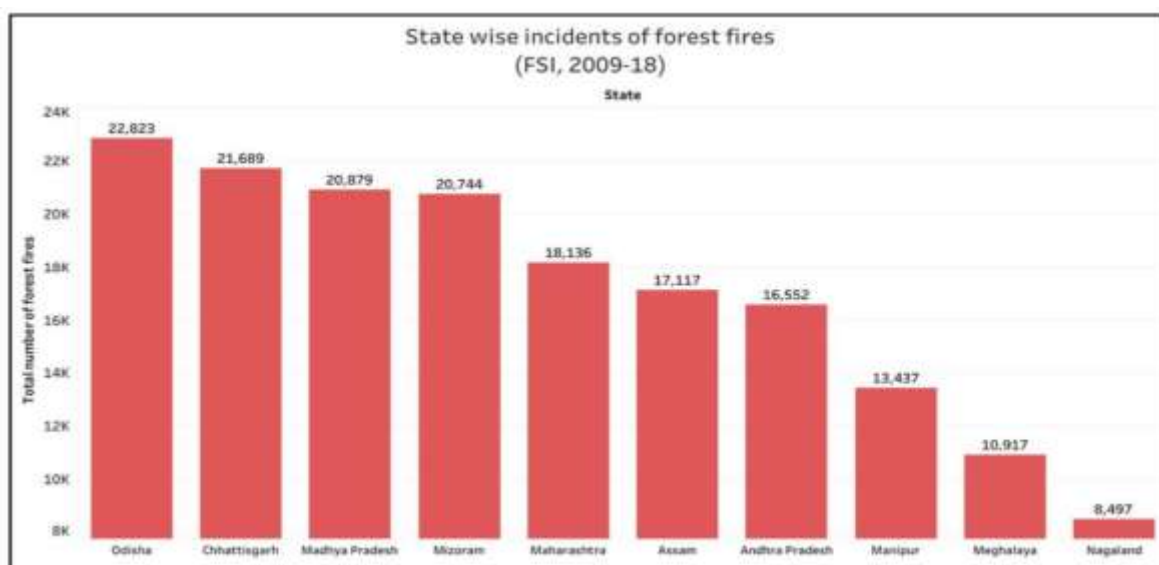


Fig-1.1: state wise incidents of forest fires.

OBJECTIVES

Integration of the multiple wireless sensor node is challenging task, wireless node should be run on low power & should be running 24x7, here proposed system uses ZigBee for wireless communication, ZigBee is newly developed technology that works on IEEE standard 802.15.4, which can be used in the wireless sensor network (WSN). The low data rates, low power consumption, low cost are main features of ZigBee. WSN is composed of ZigBee coordinator (network coordinator), ZigBee router and ZigBee end device. The sensor nodes information in the network will be sent to the coordinator, the coordinator collects sensor data, stores the data in memory, process the data, and route the data to appropriate node. Parameters that will be sense are:

1. Temperature
2. Humidity
3. Light intensity

SYSTEM ARCHITECTURE

The block diagram of wireless sensor network of the project is as shown figure below. The ultrasonic proximity sensor is connected to SPI of a controller STM 32 F 103 through buffer IC74LS125. The ZigBee module-1 (Tarang F4) is also connected to SPI via buffer. They are communicating alternatively via buffer IC. The temperature sensor LM35 is connected to port-1 via ADC-0804. The LCD is connected to port-2 of MCU. ZigBee module-1 is communicating to ZigBee module-2 (Tarang F4) via wireless radio link. The ZigBee module-2 is connected to PC via RS-232 cable. The sensing data is displayed on the LCD then to PC Hyper-terminal. The ultrasonic proximity sensor is used to measure the distance of any stationary object. The sensor data is captured at serial port of an MCU. This data is stored in MCU memory as well as displayed on LCD. The sensor can measure distance minimum 10cm and maximum 400cm (4m). If distance is less than 10cm the message is displayed on LCD that distance is lesser than min range. The data pin of ultrasonic proximity sensor is connected to RXD pin of MCU through buffer. The data received on RXD pin by the MCU is in ASCII format at data rate of 9600 baud rate. The received data format is XXX.XXcm, where X is '0' to '9' ASCII character and is carriage return where the string terminates.

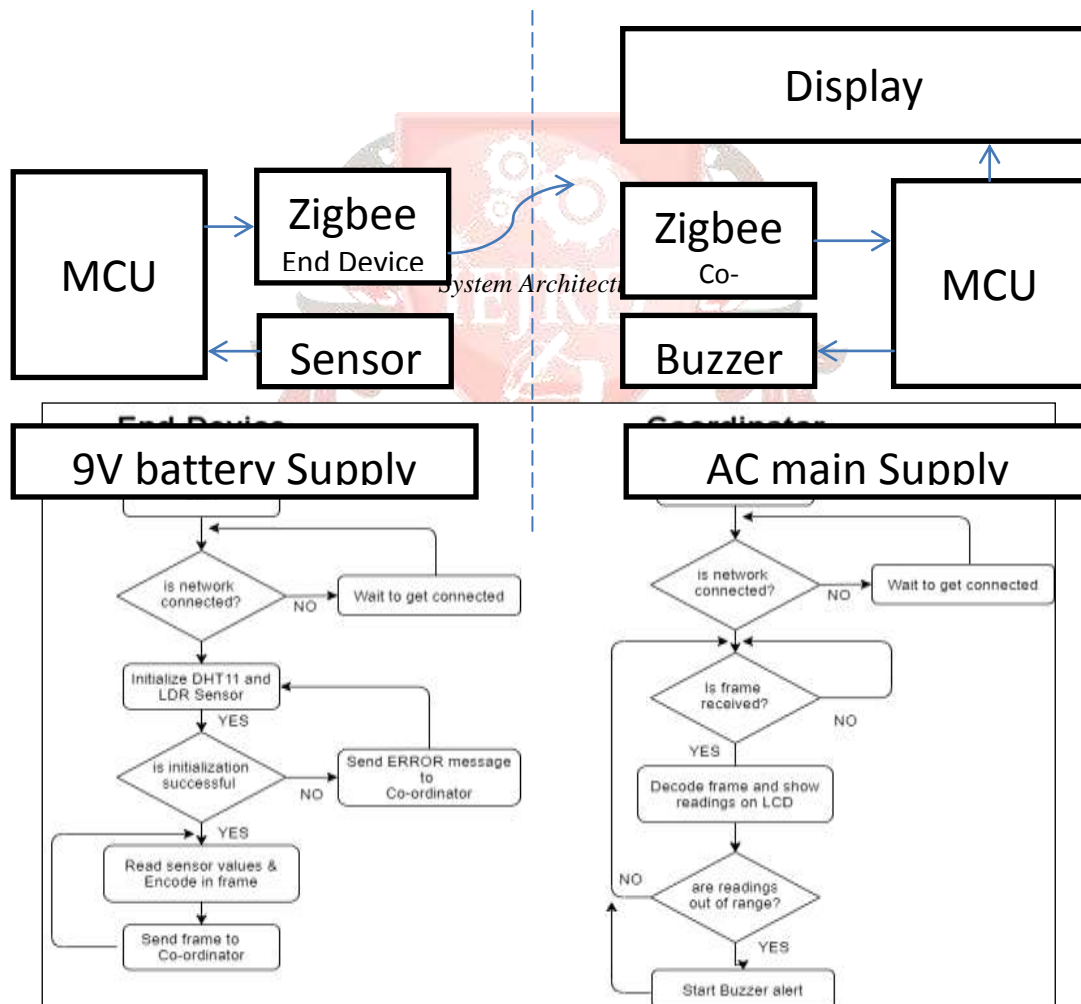
The temperature sensor LM-35 is used to sense the environmental temperature. The Vout pin of LM-35 is connected to Vin pin of ADC for analog to digital conversation. The 8 bit digital output DB0 to DB7 is connected to port1 of MCU. The temperature reading of 8 bit stored inside MCU memory. The LM35 is precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. This will require a voltmeter to sense the temperature. Vout can be measured by voltmeter. The output voltage is converted to temperature by a simple conversion factor. The sensor has a sensitivity of 10mV/. Hence conversion factor is the reciprocal, and that is 100 /V. The general equation used to convert output voltage to temperature is: So if Vout is 1V, then, Temperature = 100 . The output voltage varies linearly with temperature.

Temperature reading is also displayed on LCD with the distance reading. ZigBee module1 is connected to MCU via SPI. The Dout pin of ZigBee module is connected to RXD pin of MCU via buffer IC and Din pin of ZigBee module is connected to TXD pin of MCU. Both the sensor data can be transfer to ZigBee module1 through wired connection. This sensor data is transferred to ZigBee module to via radio link. ZigBee module2 is connected to COM port of PC via RS232 cable. The same sensors reading displayed on the LCD can be displayed on PC in hyper terminal. Here the network formed by both the ZigBee module is unicast network,

communication between two nodes only. For unicast network it needs to assign source address and destination address for both of the ZigBee module.

The Zigbee module used in this project is Tarang-F4 module, which works on 3.3v to 3.6v operating voltage and ISM 2.4 GHz band of frequency. Fig- 3: Block diagram of wireless sensor network 5. ZIGBEE/IEEE STANDARD 802.15.4 ZigBee is a worldwide open standard for wireless radio networks in the monitoring and control fields. The standard was developed by the ZigBee Alliance (an association of international companies) to meet the following principal needs:

- Low cost
- Ultra-low power consumption
- Use of unlicensed radio bands
- Cheap and easy installation
- Flexible and extendable networks
- Integrated intelligence for network set-up and message routing



System Flow Chart.

INTEGRATED DEVELOPMENT ENVIRONMENT

An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of at least a source code editor, build automation tools and a debugger.

ZIGBEE CONFIGURATION

Let us start with the configuration. Plug the S2C modules on to the USB adapters & connect to USB ports of your PC.

Open the new XCTU Software .S2C can be configured with this new XCT. The classic old XCTU does not support the S2C module.

- Click on the SEARCH icon on top to detect the USB ports.
- A list of active USB COM ports will be displayed.
- Select the COM ports where you've connected the USB adapters. To confirm you can verify your DEVICE MANAGER for the proper COM ports.
- In our case one of the USB adapters is allotted COM3 & the other one COM31.

9600N1 is the default. 9600 is the BAUD RATE, 8 Data Bits, No Parity & 1 Stop bit.

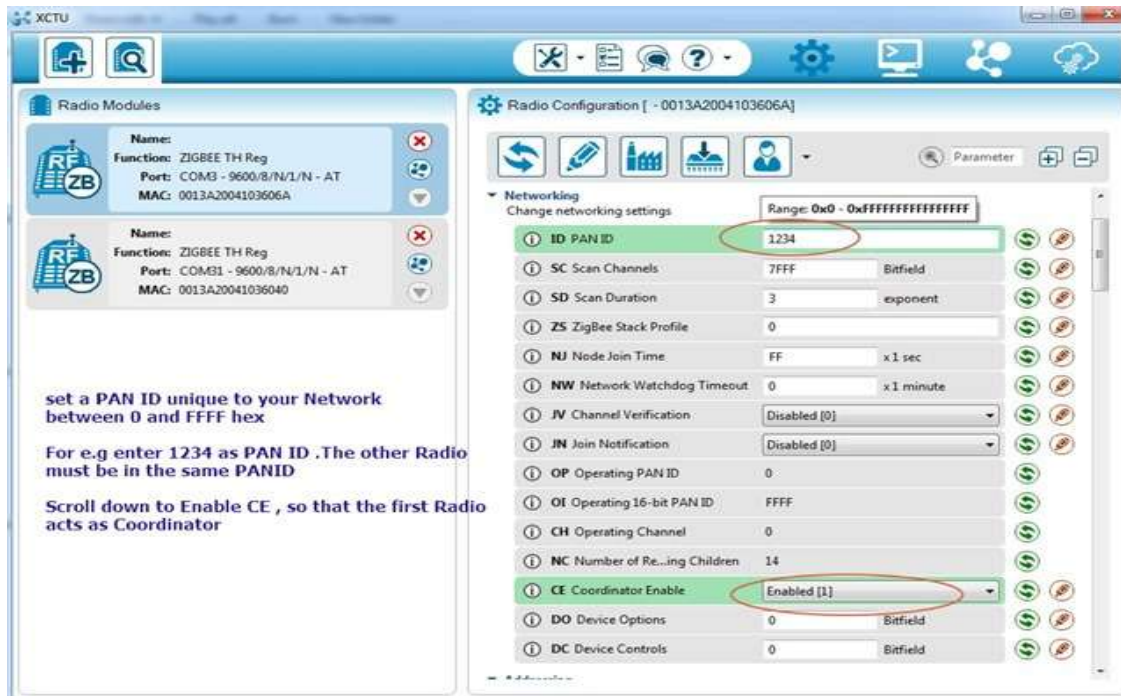
The XCTU scans the USB ports selected & lists the RADIOS found with their unique 64 bit address. Now both the Radios appear on the left pane.



Connected Zigbee devices

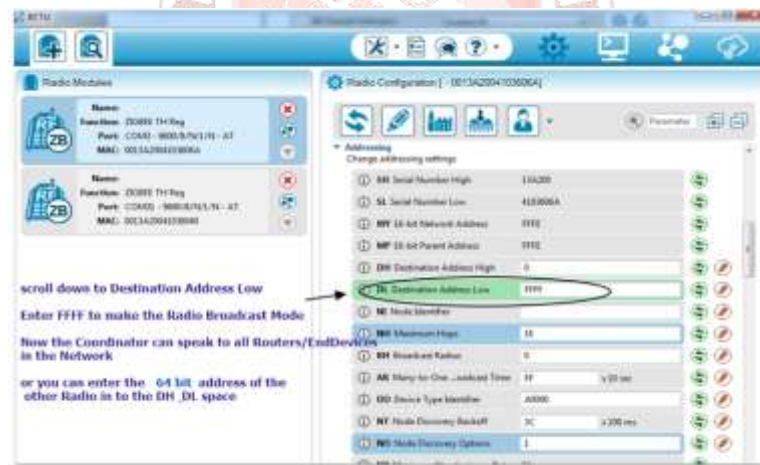
COORDINATOR

Let us configure the RADIO at COM3 as COORDINATOR first. Once the parameter settings are loaded you can see that the product family is **XB24C** (in case of old S2 it is XB24-ZB & of S1 is 802.15.4). First thing is to set the PAN ID of the Network. This can be from 0 to FFFF hex. In my case I'm setting it to 1234. The other Radios also to be set in the same PAN ID. Scroll down further & Enable the CE Coordinator (Enable)



Zigbee coordinator setup-1.

The Destination address DH is left to default 0. The Destination Address DL is set to hex FFFF which makes the Radio work on BROADCAST mode, so that it can communicate with all Radios in the same PANID. The Node Identifier can be given any name like “Coordinator”. This naming is optional.

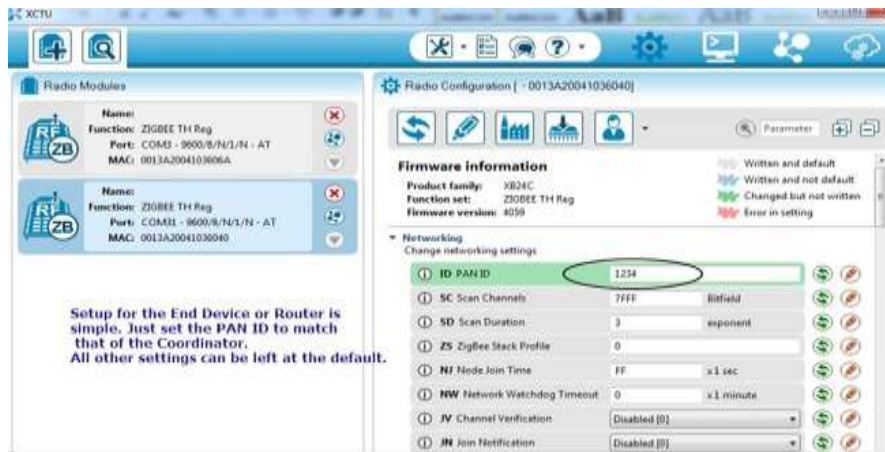


Zigbee coordinator setup-2.

Click on the PENCIL icon on top to WRITE the changes made.

END-DEVICE

The Router/End-Device setting is quite simple. Now let us configure the second Radio as ROUTER. Click on the second Radio on the left pane to load the settings. Enter the PANID as 1234, same as that of Coordinator.



Zigbee end-device setup-1.

JV CHANNEL VERIFICATION is Enabled, CE Coordinator is DISABLED, Destination Address DL is left to default 0 . (0 is the default address of Coordinator)



Fig.4.3.2(b) :- Zigbee end-device setup-2.



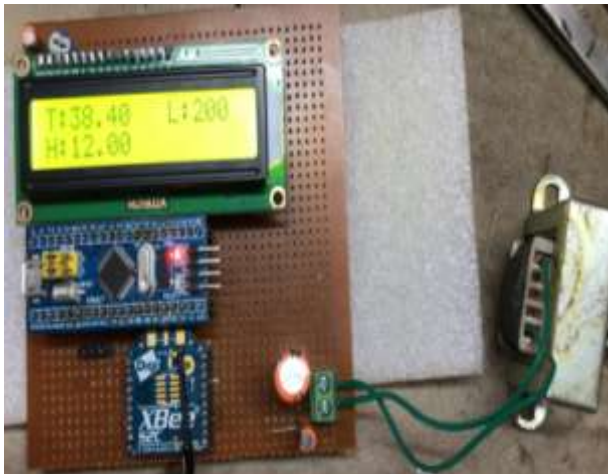
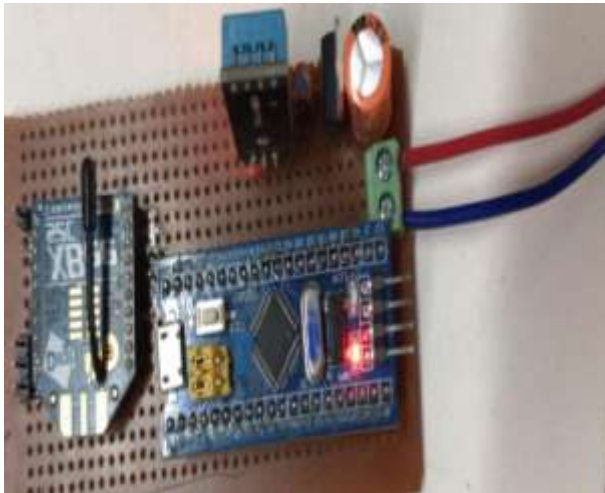
Zigbee end-device setup-3.

Click on WRITE button to save the changes made. The modules are paired & ready for communication.

EXPERIMENT RESULT

Transmitter side Implementation

Receiver side Implementation & result



CONCLUSION

From the results of proposed system we can conclude that, we depend on forests for our survival, from the air we breathe to the wood we use. Besides providing habitats for animals and livelihoods for humans, forests also offer watershed protection, prevent soil erosion and mitigate climate change.

Implementing proposed system we can immediate alert in case of any emergency and take immediate action as system is build using glow power consumption zigbee technology, it will help to keep working 24x7. Light quality measurement may be used to estimate the structural impact of forest exploitation.

Relative humidity is important because dead forest fuels and the air are always exchanging moisture. Low humidity takes moisture from the fuels, and fuels in turn, take moisture from the air when the humidity is high. When the RH drops, fire behavior increases because these fine fuels become drier. The lower the relative humidity, the more readily a fire will start and burn.

FUTURE SCOPE

- In future we can implement IoT like concept to the proposed system to store historical data of forest environment.
- It will be also possible to extend system to monitor the animal health and presence in forest along with count.
- It will be also possible to extend system to monitor and maintain the water source for animals.
- Even one can design android application to monitor and keep record of all information and send notification to the forest official in case of any emergency.

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