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WIRELESS FOREST FIRE CONTROL SYSTEM AND REMOTE MONITORING

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Abstract: Forest fire is a major Hazard causing damages to trees and animals and it is very important to detect the fire in early stages so that mitigation actions are taken immediately. Taking advantages of the advances in digital electronics and information technology a simple system is designed to detect the fire early and take remedial actions to prevent massive losses due origination of fire. This implementation can also be used in forests to save the wild life and trees form fire. Water can be taken from water resources available in the forest. The proposed system is based on carbon dioxide combustion based fire sensor to detect the occurrence fire in the forest. A low cost microcontroller based fire monitoring circuit is designed. Here two sensors are arranged and two motors are also given to switch on respective motor when particular sensor is detected. This is to represent two different places. Immediately a buzzer also get to the on condition that is to intimate others about the danger. At the same time remote alert is given in the PC using Zigbee communication. The growth of wireless transmission and embedded sensors resulted in easier and simpler implementation of wireless sensor networks. We have discussed different configuration of ZigBee network and tried to adapt the best network for the current system. The proposed system can be further extended to cloud based system for implementation of IoT technology. The progress in the IoT technology has resulted in numerous IoT solutions. Due to this industry is focused on developing IoT applications for all safety critical systems. This project aims at developing a hardware that shall enable IoT solutions for forest fire control and monitoring suitable applications as a future enhancement. However implementation of IoT itself is not the scope of this project. Specific focus is given in the design to select low power components to keep power consumption level to minimum. Though current prototype design is based on 230V AC supply ultimately system needs work with battery powered systems as availability of AC power in forest areas is very limited. The system works on 230V AC supply. In the forest environment the availability of 230V AC supply may be a limitation hence the system can be easily modified to work on Battery applications

I. INTRODUCTION

Related Work

Forest resources are very important wealth and is key element in maintaining earths echo system. Forest is resources are sometimes destroyed by the factors beyond human control. Forest fire is one such cause which severely affects the forest resources. Therefore it is necessary to protect the forest from being destroyed. Current advances in sensor technology and wireless networks has enabled to develop systems to monitor the abnormalities and control the effect of the same. The table below describes approaches to contain the forest fire in the different papers as listed in Reference section.

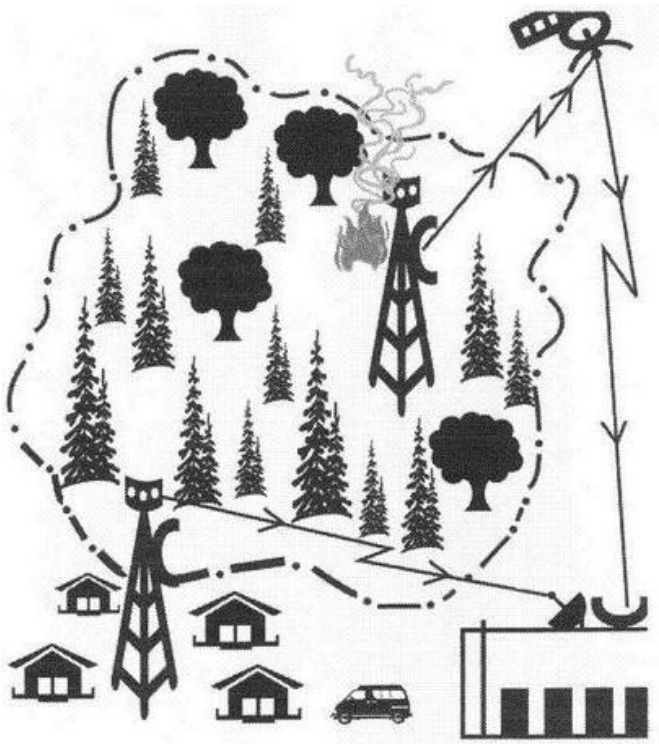

Figure 1 Forest Fire Monitoring System

Paper	Highlights
[1]	This literatures describes how to address the critical issues of wireless sensor based systems. It emphasizes on nodes positioning, sensor positioning. It also describes about the protocols. Advantages: Addresses the critical issues in deploying forest fire monitoring system sensor networks and protocols. Disadvantages: Does not cover the implementation issues in detail.

[2]	This paper presents fuzzy logic approach to detect the fire instances. This enables the intelligent decision making capability (IDM). Simulation results are provided for the detection of the probability of fire based on fuzzy logic rules. Advantages: Provides an innovative approach using fuzzy logic to detect the fire instance using five elements temperature, light, humidity, smoke and distance. Disadvantages: Again this paper does not focus on implementation issues in detail.
[3]	This paper proposes a WSN network for real-time forest fire detection. The proposed method can detect and predict the fire instance more accurately than the general satellite-based sensing. It focuses on the data collection method for real-time forest-fire detection. A neural network method is applied to in-network data processing.
[4]	This paper presents the concept and verification of a WSN for early detection of fires. The approach uses Fire Weather Index (FWI) system. Key aspects of fire weather system is provided by analyzing FWI system. Then, fire detection problem is modelled as a k -coverage problem in Wireless sensor networks.
[5]	This describes about vision-enabled WSN node for monitoring of fires. The proposed method integrates a smart imager with commercial wireless platform. The system is enabled with vision features and wireless communication. The test results have proved that this is a highly reliable system.
[6]	This paper presents a cluster type WSN platform for forest fire real-time detection was put forward in this paper. Some of the important issues discussed are network technologies, hardware node designing, the forest-fire forecasting model and the propagation characteristic of UHF wireless signal and so on.
[7]	This paper describes an approach to minimize unnecessary communication between the sensor nodes. The data filtering technique using sliding window skylines is detailed in this paper. The algorithm is evaluated and its practical relevance is explained.
[8]	This paper discusses research topics in ZigBee based WSN networks
[9]	This white paper by NXP describes how IoT can become reality and explains different approaches for the same.

Table 1 Literary Survey

II. ADVANTAGES OF NEW DESIGN

The work carried out on forest monitoring systems described in above papers describe how to make forest fire monitoring system smart. After the system becomes smart through the use of embedded processing and integrated circuits the next thing is to how to communicate to the far off stations to get real-time monitoring and controlling capabilities. The advances in automation and sophisticated cloud based computing technologies enable the final goal of IoT applications. The systems with devices that has sensors and with communication link over internet enhance the local embedded processing capabilities to take advantage of remote computing nodes with higher computational capabilities. This facilitates system to use better sophisticated analysis, make better decisions and reacts to local situations fast, more often with no personal intervention required. The typical use of IoT is Pervasive Remote Tracking or

Monitoring. This means remote tracking or monitoring and, if required, command, control and routing. Most of the functions are carried out manually today. To do remotely it requires additional set ups. As we know in most houses today, it's a manual process to switch turn on and off lights, set temperatures and to operate a washing machine. In the coming days, doors, lights and appliances will become smart with a unique ID. These intelligent devices can then be interconnected via wired or wireless communication, enabling the users to monitor their home remotely. To enable IoT new kind of communication processing is required to keep all the nodes (In this case forest nodes) connected. The challenge will be to build a secure network with reduced energy consumption and cost of the network. In our project we have selected ZigBee network for remote communication as the WSN network for remote control and monitoring requirement. The main advantage of ZigBee is it solves interoperability issues from physical layer to application layer. ZigBee is a proven set of specifications for wireless networking that is digital wireless connections between computers and other devices. ZigBee supports for devices that have low data rates, draw less power and thus supports long battery life. Thus ZigBee makes it possible to network the entire nodes where all the devices are able to interact and managed by a dedicated system. There are three types of network in ZigBee. 1. Star 2. Tree and 3. Mesh Networks.

A ZigBee coordinator is responsible for controlling the network. A star network has a coordinator. The node devices are directly connected to the coordinator. In case of Tree and Mesh networks, devices shall interact with each other in a multihop fashion. The network will have Coordinators and routers. For tree and mesh networks the network is formed by one ZigBee coordinator and multiple ZigBee routers. A device can join a network as an end device by the associating with the coordinator or a router.

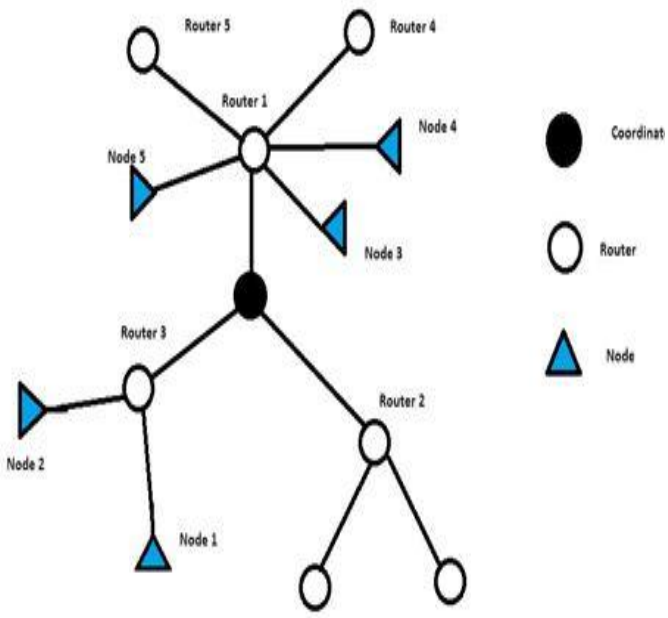

Figure 2 ZigBee Network

III. SALIENT FEATURES OF THE DESIGN

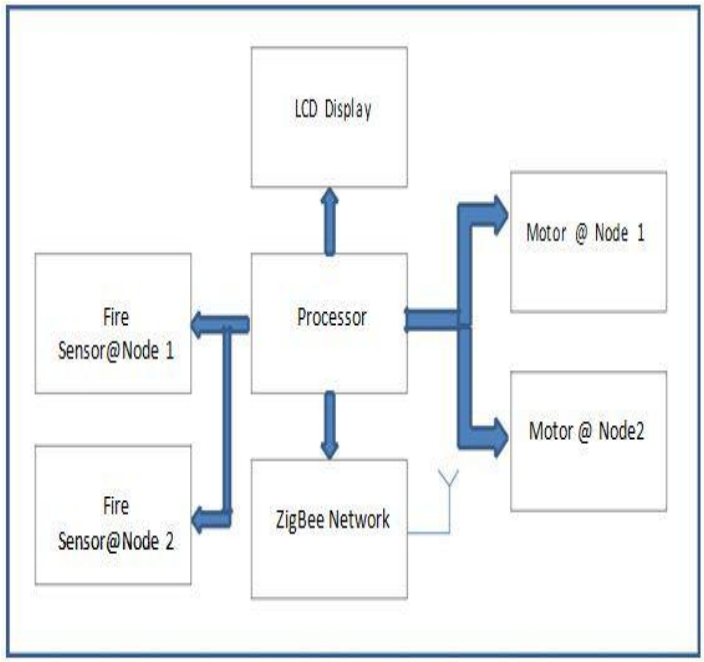

Figure 3 ZigBee Network

The design is based on a low cost microcontroller. The interfaces include fire sensor input, motor control, LCD display and buzzer output.

Fire detection mechanism is based on the principle that detection devices can identify ultra violet or infrared spectrums. Flame detectors can easily capture rapid origination of fire. The electronics circuits inside the flame detectors consists of electromagnetic receivers. They get energized when they are exposed to radiations.

IR3 sensors can sense a 0.1m2(1 ft2) gasoline pan fire at up to 65meets (215 feet) in about five seconds. Infrared Radiation detectors are designed to overlook IR radiations, which is present in most of the environments. They detect abruptly changing sources of the radiation. IR and UV/IR detectors can result in false alarms when exposed to changing patterns of non-flame IR Radiation. IR3 detectors are less sensitive but are they are immune to false alarms.

ZigBee sensors XBee Promodules are used in the design. These modules are having has following advantages.

- No configuration is necessary for out of box RF communications
- AT & API command modes
- Small size
- Low Power
- ADC and I/O Line support
- Point to point, point to multipoint and peer-peer topologies supported
- Supports to source to destination addressing
- Wide range of command sets

IV. RESULTS

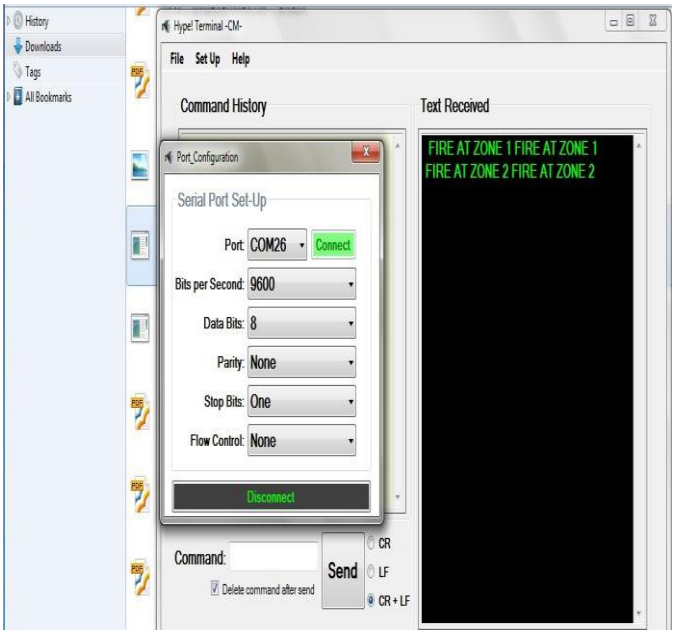

Figure 4 ZigBee Network

In this project, we have demonstrated that a low cost solution can be develop a smart forest fire monitoring system. The current system is demonstrated with two nodes and it can be further extended to multiple nodes. The system provides audio visual alarm as well as water spray system with the help of submersible motors. The system has Zigbee interface which provides WSN coverage for wireless applications. This enables extension of this system to IoT applications with the help of cloud based systems. This project can be applied in various areas like spinning industries, offices and in manufacturing of home appliances etc.

Figure 4 above shows the results captured with hyper terminal. Fire simulation is done at Zone 1 and Zone 2. The information is passed on to the remote computer through ZigBee network.

V. CONCLUSIONS

In this project, we have demonstrated that a low cost solution can be develop a smart forest fire monitoring system. The current system is demonstrated with two nodes and it can be further extended to multiple nodes. The system provides audio visual alarm as well as water spray system with the help of submersible motors. The system has Zigbee interface which provides WSN coverage for wireless applications. This enables extension of this system to IoT applications with the help of cloud based systems. This project can be applied in various areas like spinning industries, offices and in manufacturing of home appliances etc.

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