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Campus Security Wireless Sensor Network

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***Abstract*—In today's world we are faced with many different types of emergencies in the indoor environment. Response to such emergencies is critical in order to protect resources including human life. In this paper, we present an emergency response system which is easy to deploy and can report the emergency to the users in various forms, such as pop-ups on a computer screen, SMS on their cell phones and so on. Due to this flexibility of reporting, low cost and easy of deployment, wireless sensor network (WSN) emergency response systems will be the preferred emergency response systems of the future.**

I. INTRODUCTION

In today's world we are faced with increasingly many types of emergencies in our environments. One example which stands out is the gun violence which has plagued our universities and communities alike. In addition, institutions with poor infrastructure may not be able to minimize loss of resources and human life in times of natural catastrophes. The objective of this project is to design a wireless network using 802.15.4 and Zigbee to respond to any emergency and inform appropriate individuals in a timely and cost effective manner. The project further aims to enable ease of installations of variety of sensors and networking possibilities with a variety of networks such as a desktop program in order to make messaging easily integrated with existing systems.

II. WIRELESS SENSOR NETWORK

A wireless sensor network (WSN) is as a wireless network which consists of equally distributed autonomous devices using sensors capable of monitoring the physical or environmental conditions such as temperature, sound, vibration, pressure, motion or pollutants, at various different locations especially for buildings in campus. In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery [17-19].

The envisaged size of a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust, although functioning 'motes' of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from hundreds of rupees to thousands, depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth [18-19].

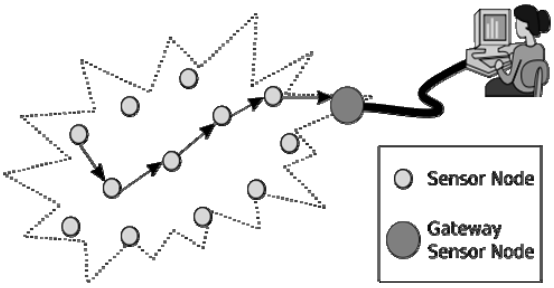

Fig 1: Typical Multihop Wireless Sensor Network Architecture [24]

III. CURRENT EMERGENCY SYSTEMS AT CAMPUS

The existing technology used up tile was simple and works in limited area. They include simple sensors circuits and less efficient, most of them are not wireless, also notification system is poor. Before ZigBee based wireless sensor networks are tested for their efficacy, we first studied existing technology in place to do emergency response. The efficacy of ZigBee based wireless sensor networks is studied over and above existing systems.

A. *Emergency Notification System*

Emergency Notification includes how the notification is done about the current issues. Their are different ways through which we can notify the concerned people about the emergency scenario it includes through sms, email, broadcasting it in network etc. the technologies used previously were simple and most of them don't communicate via electronic medium. They are not interfaced with the computer so provides only limited area for notification. As they are not interfaced with computers we are not able to study all the detail information about the scenario. The model we are proposing will communicate wirelessly and are interfaced with the computers so that a detail study of that scenario can be done, we can store log, also can detect the level of emergency and based upon that appropriate steps can be undertaken. The notification can be done by all of above mentioned services to the concerned people only as stored in database so that awareness can be done. The notification can also be done through Radio Frequency by placing the station to the concerned people's places.

B. *Response Time*

Based on study of current sensor network responses, we found that the time required by the sensor network to notify the people is more. The response time of campus emergencies depends on current load, emergency type and how quickly it is detected. As a result action can be taken lately but if wireless network that we are presenting is implemented the response time can be reduced. Effort is being made to reduce response time to as short as possible such as increase patrol of campus police, easy emergency reporting platforms and installation of smart sensors

C. *Consistency and Reliability*

The current networks we are using are not interfaced with the computer as a result we can't determine functioning all the time. We can't determine whether they are working properly or not. They also not able to tell the level of emergency, the values provided can also be false. The WSN based on zigbee is interfaced with computer so that we can actually monitor all sensor nodes and also where the scenario has been happened.

Given below are some key factors we look into, as we develop a wireless emergency notification network:

- Effectiveness of the sensors to detect an emergency.
- Transmission delay between sensing and reporting of information from the sensor to the central processing unit, personal area network coordinator (PANC)?
- Threat validation delay once the emergency has been detected.
- Overall notification delay to end user.

IV. ZIGBEE

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 standard for WSN. ZigBee devices can be interfaced to the computer or other end points. We need a ZigBee modem in order to connect to user understandable digital interface, such as the computer. Zigbee Modems connect to the USB port of the computer, and mounts on a COM port (a standard serial port) [8].

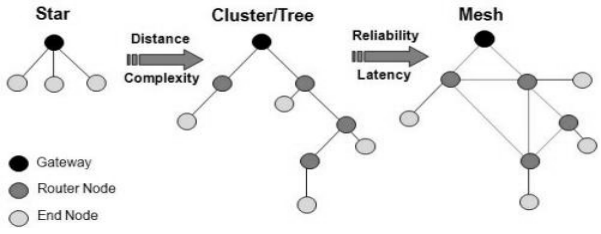

Fig. 2: Routing Topologies

The ZigBee provisions for devices to communicate with each other using a Mesh, Tree or Star topology. As a result, ZigBee modems can be used to talk to many ZigBee devices and we can choose which device we want to talk to at any time. The module shown in Fig. 1 is the ZigBee module. Mesh networking allows our computer to talk to devices that are out of range by talking to devices that are in between [11].

One of the main design goals of our emergency response system is to have a cost effective WSN. Currently blue tooth offers short personal area coverage however it does not offer the Mesh or Tree networking of ZigBee. Bluetooth is also an IEEE 802.15 WPAN standard and also uses the 2.4-GHz unlicensed frequency band. Like ZigBee Bluetooth also uses small form factors and low power. Some technical differences between Bluetooth and ZigBee can be found in [15].

IEEE IEEE 802.11 standard specification provides MAC and PHY layers which can also be used for effective indoor communication over several hundreds meters. Here we compare IEEE 802.11, 802.15.4 wireless standards with an emphasis on the physical layer. Interfacing of 802.15.4 to 802.11 devices can be found in [15-16].

TABLE 1: FREQUENCIES OF OPERATION FOR 802.11 AND 802.15

Standard Frequency Data rate Range Type
802.11a 5 GHz 54 Mbps 120m LAN
802.11b 2.4 GHz 11 Mbps 140m LAN
802.11g 2.4 GHz 54 Mbps 140m LAN
802.11n 2.4/5 GHz 248 Mbps 250m LAN
802.15.4 0.868/0.915 240 kbps 75m PAN
/2.4 GHz

V. IMPLEMENTAION PLAN

The eventual goal for the model is to use PC's as the 'sink' in order to collect data from various sensors and provide them in a user friendly fashion. This data can then be stored appropriately as well as rendered to users in a user friendly manner through the base stations. Client software can be developed and can be programmed to read out messages or pop out notifications that are deemed as emergency based on a preexisting criterion.

There are 4 modules in our model aims in developing the different sensor networks. That are-

- Base station
- Sensors
- Communication protocols
- System Integration and testing

VI. NETWORK STRUCTURE FOR WSN

Wireless networks can have two distinct modes of operation: Ad hoc and infrastructure. Infrastructure wireless networks usually have a base station which acts as a central coordinating node. The base station is usually AC provided in order to enable access to the Internet, an intranet or other wireless networks. Base stations are normally fixed in location. The

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disadvantage over ad hoc networks is that the base station is a central point of failure. If it stops working none of the wireless terminals can communicate with each other [15].

Differently from previously proposed solutions, the protocol, termed clique clustering (CC), includes in its operation a fail-safe mechanism for dealing with node failure or removal, which are typical of WSN, [14]. More specifically, the network is partitioned into clusters that are cliques i.e., nodes in each cluster are directly connected to each other. An efficient mechanism for building a connected backbone among the clique clusters is provided. Clustering, backbone formation and backbone maintenance are completely localized, in the precise sense that only nodes physically close to a failing node are involved in the reconfiguration process. For more details on the protocol refer [14].

One of our main design goals is to be able to interface Zigbee devices to a PC. Zigbee Interface Module allows for this to happen. Zigbee Interface Module with XR Allows us to Add more relays to this Device and UXP allows us to Add I/O Expansion Modules to the Device expansion ports. This Device Acts like it is Directly Connected to the Serial Port of a PC. This ProXR series controller offers wireless serial communications, requiring only a 12VDC Power Supply. Once powered up, the relay controller waits for a command. A command consists of a few bytes of data, usually between 2 and 6 bytes. You can send commands to activate relays, deactivate relays, control all the relays at one time, plus you can send commands that tell a relay to turn on for a few seconds, minutes, or hours. For more information about interfacing ZigBee to PC refer [11].

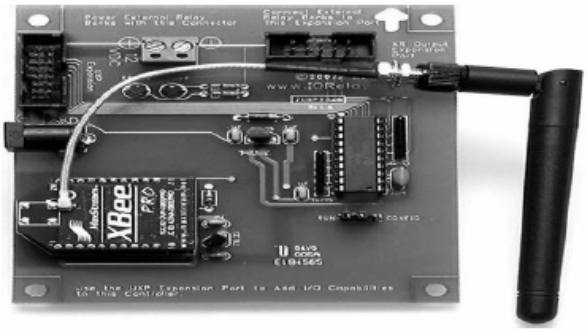

Fig.3: Zigbee Interface Module

VII. SENSORS

A sensor node is also typically known as a 'mote' a term which is chiefly used in North America. A sensor node in a wireless sensor network is capable of gathering sensory information, processing and communicating with other connected nodes in the network. The typical architecture of the sensor node is shown in Fig. 4.

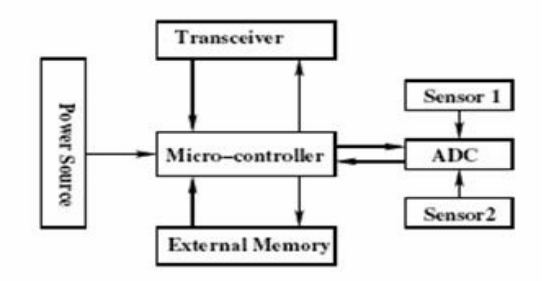

Fig. 4: Sensor Node Architecture [25]

The microcontroller in the sensor performs tasks such as data processing and controls the functionality of other components in the sensor node. Microcontrollers are most suitable for sensor nodes [5-4].

Most of the sensor nodes make use of the ISM band which gives free radio, a huge spectrum allocation and global availability. The Radio Frequency (RF) based communication is the most relevant form of communication that fits to most of the WSN applications. The WSN use the communication frequencies between about 433 MHz and 2.4 GHz, Table 1. Transceivers lack a unique identifier. The operational states are Transmit, Receive, Idle and Sleep [20-21].

From an energy perspective, the most relevant kinds of memory are on-chip memory of a microcontroller and FLASH memory - off-chip RAM is rarely if ever used. Flash memories are used due to its cost and storage capacity [20].

VII. APPLICATION OF OUR MODEL

A. Autonomus Early Detection

Autonomous early detection of an emergency is a primary way of minimizing damages or life threatening events on campus. We model the emergency detection

B. Self Powered/Renewable Energy Source

With current advancements in alternative energy the sensors used in the system can be solar powered. Such systems can benefit outdoor sensing and indoors where there are huge skylights or open areas with access to sunlight.

Power consumption is a problem currently being addressed in WSN. Solar powered sensors can provide value to WSN for emergency response by prolonging the life-times of the sensing nodes.

C. Digital Threat Verification System

WSN can be attached with a camera as a sensor instead of a temperature sensor, to record a certain area in the building. This systems can be then use as a surveillance network. Existing research discusses optimizing image segmentation algorithms based on image properties without manual intervention [5].

VIII. APPLICATION MODEL

Some of the application model that can be established using WSN:-

A. Campus Monitoring

In the wide campus, various sensors are establish and connected across the area. Motion sensors are employed at the fences, walls of the campus. Smoke sensors in workshops and laboratories etc.all the sensors are connected together and are being monitor by only one server.

B. Enemy Survilliance Application Model

The enemy surveillance is one important application using in the military application. An amount of sensor nodes are deployed in the wide environment area which may be attacked from enemies. These sensor nodes are attached with ground vibration sensor. When enemies move into the sensor area, these sensor nodes will detect the ground vibration and generate the detected data packet sending to the sink node which is interfaced with the commander.

C. Chemical Gas Cloud Detection

The chemical gas cloud detection application is very important for the industries which use the chemical gas as one of power sources. Since some chemical gas is hazardous for people, the sensor surveillance is needed to detect this gas before it emanates to the wide area.

IX. CONCLUSION

It is feasible to construct a WSN for emergency response notification using IEEE 802.15.4 and Zigbee.. This system has the potential to reduce the response time in a cost-effective way. The system is robust and efficient methods can be incorporated to validate the threat by adding some additional options to the sensors, such as image processing and multiple sensors. This can help reduce false positives.

This system at the moment will be focusing on one aspect of the emergency detection which is fire which occurs mostly in many campuses across the states. The system can be further developed to detect other emergencies such as gas leaks, gunman on campus and severe weather changes.

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