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Wireless Sensor Network and Emergency Communication System for Fire Safety

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Yogesh.S.Kale[1], A.V. Bapat[2], Piyush Pande[3]
Shri Datta Meghe College of Polytechnic[1], Yashwantrao college of Engineering[2], Shri Datta Meghe college of Polytechnic[3],Wanadongri, Nagpur, India

Abstract

In this paper, we present the development of existing industrial system with the new system module used in emergency communication for fire safety. GSM SIM-300, PIC and ZigBee protocol circuit have been successfully realized as complete system. To package these devices into one embedded wireless communication system this leads to minimize communication time duration to one minute or even less instead of 15 to 20 minutes. In this way we will try to overcome the problem like fire and minimize the losses in industry.

Keywords

Industry development, wireless sensor network, GSM SIM-300, PIC microcontroller, ZigBee protocol, emergency communication, fire safety, embedded system.

1. Introduction

In the last few years, interest in wireless sensor networks has increased considerably. These networks can be useful for a large number of applications, including habitat monitoring, structural health monitoring, pipeline monitoring, transportation, precision agriculture, supply chain management, and many more. In this paper, we present the development of existing industrial system as shown in fig. 2 with the new system module for used in emergency communication for fire safety as shown in fig. 3.

GSM SIM-300, PIC and ZigBee protocol circuit have been successfully realized as complete system. To package these devices into one embedded wireless communication system this leads to minimize time duration to one minute or even less instead of 15 to 20 minute.

The Embedded system will work as follow. It started from, Fire sensor, it will sense the fire, send it to microcontroller through ZigBee protocol, after that microcontroller give command to GSM SIM-300 and finally SIM-300 will send message and blank to all key authority person relates to fire safety.

In this we will send messages as well as blank calls of four rings through GSM SIM-300 to all key authority persons because, message is not a reliable communication so to make it reliable communication we do both. Here we used ZigBee protocol because of their advantages as compare to other protocol, such as low latency; low power consumption.PIC microcontroller is most widely used in industrial purpose. GSM SIM-300 is used to communicate globally.

Wireless sensor networks are one of the technologies that are gaining a considerable attention. To their potential application in various fields, WSN has attracted many research interests in recent years. It has been used in applications such as environmental and natural habitat monitoring, medical instrumentation, industrial automation, and military surveillance [1], [2]. Typically, the sensor nodes should be inexpensive and physically small for large-scale deployment. Furthermore, the power consumption of the sensor node is required to be small to prolong the operational life span for several years. Recent advancements in microelectronics have resulted in versatile microcontrollers that have been used in a wide range of applications such as motor drive, light dimmer control, uninterruptible power system, and power source [3].

For WSN, most of the WSN platforms use a microcontroller as the central controller to perform multiple tasks such as reading of various sensors' information, performing network protocol, processing of signals, managing the power consumption, etc.

2. Fire Safety System

Fire is a chemical reaction of oxygen, heat and fuel as shown in Fig.1.

If we want to extinguish fire take away any of the above things and fire will be extinguished. This section presents the existing system safety approach at industry it takes around 15 to 20 minutes to communicate or we say control the fire. The following flowchart will give clear idea about working of existing system about fire safety.

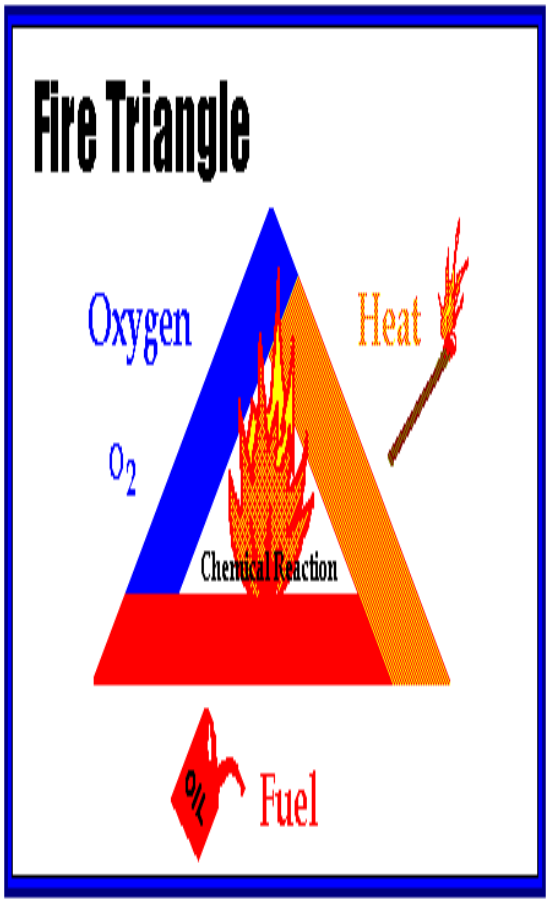
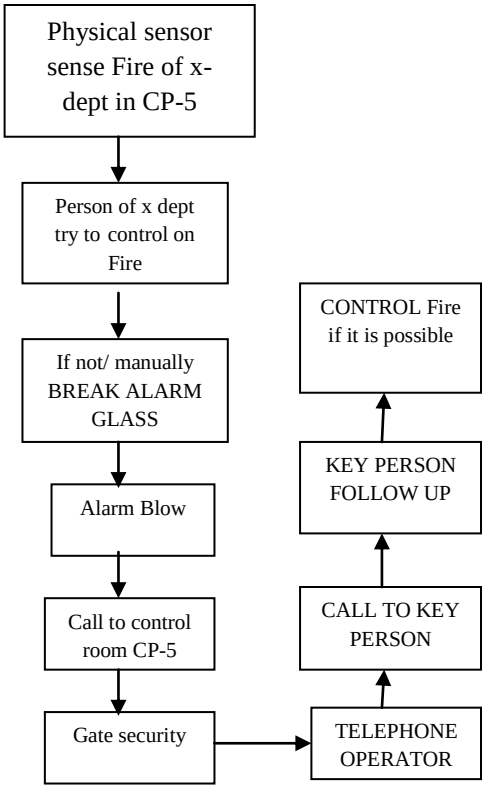


Figure 1. Fire Triangle

So fire safety, at its most basic upon the principle of keeping fuel sources, ignition sources separate. So fire safety is very important in every aspects, such as industry, homes etc.

A main objective of this paper is to make Emergency Communication System for Fire Safety using Wireless Sensor Network. Now we analysis and formulate the existing system and try to minimize the communication time delay from 15-20 minutes to around 1 minute or even less with new system. The following flowchart will give clear idea about working of new system about fire safety.



CP- Continuous Polymerization

Figure 2. Diagram of Existing system

3. Description of New system

As shown in fig. 3, the fire sensor is usually the part that will be continuously monitored or sense fire and send it to ZigBee transmitter for transmission towards ZigBee receiver. ZigBee protocol receiver is physically attached with microcontroller for controlling and sent command to GSM SIM-300 [4][5]. It can send messages or blank call to all respective numbers are stored in microcontroller. So in this way this block diagram will work and takes 1 minute or even less for communication to all respective authority persons such as fire safety department and all.

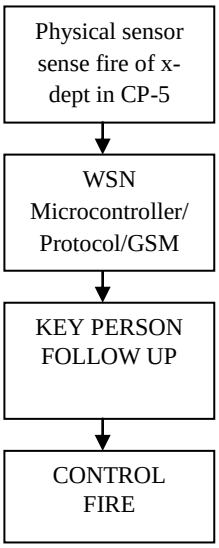


Figure 3. Diagram of New system

Designing a new system for fire safety, in this we replace wired system with Wireless Network Sensor (WSN) system. There are two types of fire sensors they are Ionization Detectors and other is Photoelectric Detectors. Mostly in industrial application fire Photoelectric Detectors are used instead of Ionization Detectors. It can have the disadvantage of possibility of false alarm because they are very sensitive. Photoelectric Detectors can detect the presence of visible particles (larger than 3 microns) in the air. In this LED, that directs a narrow beam of infrared light across the detection chamber. When smoke or dust particles enter the chamber, the infrared light beam is scattered. A photodiode usually placed 90 ° to the beam, will sense the scattered infrared light and when a preset amount of light is detected, the alarm will sound. Here we have two options one is Ionization Detectors and other is Photoelectric Detectors.

Bluetooth (over IEEE 802.15.1), ultra-wideband (UWB, over IEEE 802.15.3), ZigBee (over IEEE 802.15.4), and Wi-Fi (over IEEE 802.11) are four protocol standards for short range wireless communications with low power consumption. From an application point of view, Bluetooth is intended for a cordless mouse, keyboard, and hands-free headset, UWB is oriented to high-bandwidth multimedia links, ZigBee [6] is designed for reliable wirelessly networked monitoring and control networks, while Wi-Fi is directed at computer-to-computer connections as an extension or substitution of cabled networks.

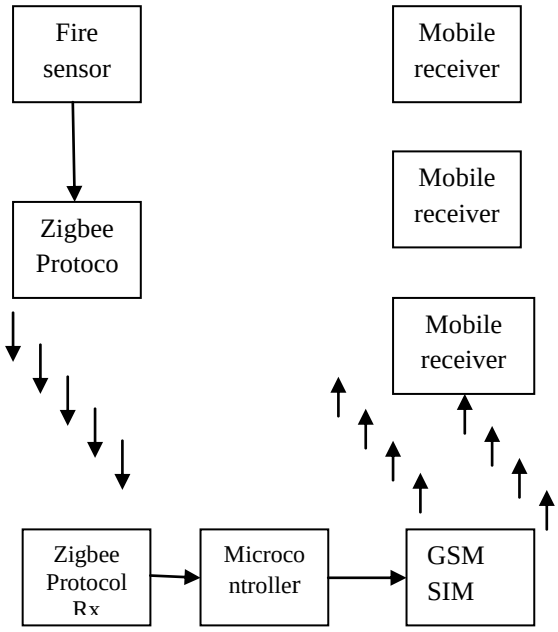


Figure 4. Block Diagram of Proposed work

Radio Channels

Bluetooth, ZigBee and Wi-Fi protocols [6] have spread spectrum techniques in the 2.4 GHz band, which is unlicensed in most countries and known as the industrial, scientific, and medical (ISM) band. Bluetooth uses frequency hopping (FHSS) with 79 channels and 1 MHz bandwidth, while ZigBee uses direct sequence spread spectrum (DSSS) with 16 channels and 2 MHz bandwidth. Wi-Fi uses DSSS (802.11), complementary code keying (CCK, 802.11b), or OFDM modulation (802.11a/g) with 14 RF channels (11 available in US, 13 in Europe, and just 1 in Japan) and 22 MHz bandwidth. UWB uses the 3.1-10.6 GHz, with an unapproved and jammed 802.15.3a standard, of which two spreading techniques, DSUWB and MB-OFDM, are available.

Security

All the four protocols have the encryption and authentication mechanisms [6]. Bluetooth uses the E0 stream cipher and shared secret with 16-bit cyclic redundancy check (CRC), while UWB and ZigBee adopt the advanced encryption standard (AES) block cipher with counter mode (CTR) and cipher block chaining message authentication code (CBC-MAC), also known as CTR with CBC-MAC (CCM), with 32-bit and 16-bit CRC, respectively

Power Consumption

ZigBee are intended for portable products, short ranges, and limited battery power [1]. Consequently, it offers very low power consumption and, in some cases, will not measurably affect battery life. UWB is proposed for short-range and high data rate applications. Bluetooth and ZigBee protocols consume less power as On the other hand, Wi-Fi is designed for a longer connection and supports devices with a substantial power supply.

The Microcontroller

This part acts like the brain of the system. The microcontroller is able to communicate with the GSM SIM-300[1][4] when there is a need to access the network for sending messages and blank calls. The microcontroller takes the data from the pooling method and then translates the data into AT commands so the module can understand it.

1. Steps of initializing the module

Before programming there are some steps that have to be made in each program that controls the module. These steps initialize the module and make the programming functions work .

1.1. Include the required include files into the project directory. At least deftypes.h, RS232 [4][5].h, SerComm.h, and ATCommand.h. Include also all the h files of the ensembles you use in the project. Call AT_InitializeData. Although this is not compulsory for Windows systems, in which memory reservation and initialization is realized each time a program is called, using AT_Initialize Data is very useful in cases when dealing with embedded systems that not reinitialize memory after a reset. Note: AT_InitializeData, restores the table of serial channels, and events. This function is used before initializing channels or registering events.

1.2 AT+CMGF, this is format command it must before sending messages.

1.3 AT+CMGS, this is message sending command for sending messages.

2. "ATDT", ASCII Value, "mobile number", ASCII value , this is dialing command to all mobile numbers.

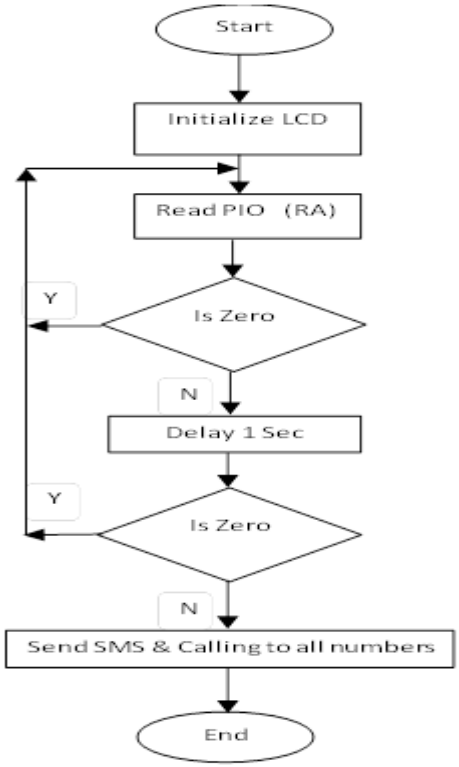


Figure 5. Flow chart of program

Algorithm

The Embedded system will work as follow.

I. It started from, Fire sensor, it will sense the fire, send it to microcontroller through ZigBee protocol.
II. After that microcontroller give command to GSM SIM-300.
III. Finally SIM-300 will send message and blank to all key authority person relates to fire safety.

3. The GSM SIM-300 (module)

As shown in fig.4, the module must have a Subscriber Identity Module card (SIM card) to make the network identify the user and provide the user the GSM services [5]. The module takes the AT commands from the microcontroller and send them to the other end of mobile numbers by the GSM network [4]. The AT (AT tention) commands have a very large number of commands; each command performs a certain task. The GSM SIM-300 module is intended for use in 900/1800 and 850/1900 MHz GSM bands respectively. The module is used to make a connection to the GSM network and send and

receive SMS and GPRS services and to make a voice calls as well.

4. Conclusion

Thus, the new system has been designed using ZigBee protocol, GSM SIM-300 and microcontroller. The new system will overcome the problem of communication delay in the existing system. The advantage of this new system is it takes one minute time for the communication instead of 15 to 20 minutes. Thus, this type of system can be for many wireless applications for overcoming the losses and mostly reduced communication time delay.

Acknowledgment

Industry people help right from problem identification to problem formulation. It helps industry people and us to develop a new system to overcome time duration.

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Mr. Yogesh S. Kale, lecturer of Electronics & Communication Department Shri Datta Meghe Polytechnic 2nd Shift, Nagpur. Date of Birth: - 21/06/1986. Subject thought: - Analog Communication, Audio Video Engineering, and Fundamental of Engineering. Also participated in International conference ITAC Jan 2012 at Yeshwanrrao Chavan College of Engineering, Nagpur.