

The Design and Implementation of Building Fire Monitoring System using ZigBee-WiFi Networks

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Abstract— Each year in the Globe a few thousand people die because of fires accidents. Fire protection is often a preventative action that falls by the wayside because many don't consider that it could happen to them. The problem is hindsight doesn't do any good where fire is concerned. Once a fire is burning, if the right fire protection resources are not in play in your home or business, your lives and everything you own are at risk. Fire protection means having a plan. Not only a course of action, but preventative technology in fire alarm testing and inspection equipment to let you know when you, your family or your employees are at risk. Here we are providing a solution based on the Zigbee-WiFi, we are committed to providing with the latest in innovative technology to prevent fires from consuming your property or harming anyone. We used Arduino UNO as central core interfaced with the Many Sensors to identify the fire and trigger the notifications over the Zigbee and pass the info to the control unit for the required actions.

Keywords: Fire Fighting, Sensors, Zigbee, Gateways, GSM,

I. INTRODUCTION

In recent years, wireless communications, wireless control, wireless localization and mobile digital technology emerge more and more frequently in our daily lives. The wireless communication technology is widely used in building automation, changing the traditional wired communication way. The comfort and safety of the building environment have become a major concern. However, the building fire is greatest threat to building safety. In consideration of the current issues on building security, For the complex environment in building, the application of wireless sensor networks to a comprehensive building monitoring has become a new trend. Modern building fire safety system mainly focuses on the fire alarm. However, the monitoring center cannot take effective evacuation and guidance in time. When the fire occurs, it is particularly important for people in danger to escape quickly. Therefore, this paper designs a long distance transmission mode of fire information within the entire building by ZigBee-WiFi network, and then the signals detected by sensors are transmitted to the monitoring center by WiFi network, which connects with personal terminal easily. Decision-making controllers need analyze the critical situation and the development trend of fire quickly and effectively. Then the investigation should be carried out on the fire place in order

to accurate the scope and range of the accident, and determine the number of people trapped and ascertain their location, choose the most rapid rescue plan. And the system can real-time monitor the corners where fire disasters most frequently take place. The design can ensure the safety of buildings and people comprehensively and effectively.

The wireless sensor network by using ZigBee technology and ZigBee-WiFi gateway which transforms ZigBee network into WiFi network, In addition, taking advantage of the ZigBee wireless sensor network locates a fire place so that the fire information is uploaded to the handheld terminal and the building security personnel work out the retreat and rescue plan in time. This paper provides a new solution for building fire monitoring system.

Objectives

This Project focuses on the issue on building fire monitoring, combined with thought of wireless sensor network technology, and comes up with a ZigBee based wireless sensor network to collect the information from the entire building, and making use of ZigBee nodes to locate the fire stations. Taking full advantages of WiFi and ZigBee, this design builds a ZigBee-WiFi network. The purpose is to design a real-time building fire monitoring system which is more facilitative to contact with the personal handy terminal and has wider covering range with in a building.

II. LITERATURE SURVEY

The literature survey is very essential for any project development and extension of project from old model to new models. Well coming of new technologies and upgrading of new technologies without disturbing its application along with increasing of its overall performances. The literature survey will full fill the complete knowledge of particular domain. It also provides author researches, scholar work and also its future work yet to finish. It also gives information about advantages disadvantages and limitations of the main domain. Hence the literature work is essential to produce new concept to this technology world.

[1] A Fire Monitoring System in ZigBee Wireless Network. In this paper, a kind of low power, multi-parameter composite fire detection node is designed, which can detect temperature, smoke concentration and CO gas concentration.

And combining with the WSN (wireless sensor network), a real time wireless fire monitoring system is established. This system is applied in fire detection of special circumstance represented by the ancient buildings. The hardware and software implementation is based on 2.4GHz wireless communication chip CC2430. ZigBee protocol is adopted in the system to form reliable wireless communication. The result of experiment shows that the sensor nodes can connect each other and form net automatically and the system works effectively and stably in wireless fire detection. Fire detection is to determine whether the fire occurred by detecting the signal of the fire characteristic parameters. Traditional fire monitoring system needs arrangement of wires in the region. The installation procedure is tedious and also makes damage to the environment. With the continuous development of WSN, the advantages of wireless network are increasingly evident. Therefore, combining fire detection technology with WSN to realize wireless fire detection is a current and important direction of fire detection research. ZigBee technology is a short-range, low power, low-speed, low-cost wireless communication technology, mainly for wireless sensor network, automatic control and remote control areas. It is generally considered as an optimal wireless communication protocol, because it fully meet the requirement of WSN application and owns such property as higher reliability, self-organization network, self-cure capacity and large network volume

[2] A complex fire monitoring system based on Ethernet. This system is designed to detect the fire in the early stage. The nodes are deployed in the monitoring area, and building up a network based on Ethernet. Two important parameters of fire, smoke and CO gas, will be detected. Nodes acquire the parameters and convert the signals of sensors to digital data, processed data are transmitted to the host computer through Ethernet. The host computer stores these data and analyzes them by Algorithms. If a fire is confirmed, alarm will be triggered. The system can also access to Internet, as a part of Internet of Things. The system is very suitable for the fire detecting in modern buildings, such as home, laboratory and office.

[3] Ancient architecture is not only the national heritage but also the material carrier of traditional culture, which is important to promote the traditional culture. Compared to modern architecture, ancient architecture has obvious characteristic, that the main structure of the great majority ancient architecture is composed of pure wood or brick. However this kind of building burns like matchwood. Electrical fire early warning system could accurately monitor the real-time faults and abnormal state of the electrical wiring, and discover the hidden danger of electrical fire then alarm, and remind relevant personnel to eliminate the hidden danger to avoid the happening of electrical fires. However, the traditional electrical fire early warning system has been used cable network for data transmission, the cost of laying lines and maintenance is high. Electrical fire monitoring system based on wireless technology for improving the reliability of fire preventing. At present, electrical fire early warning system primarily uses the RS-485 bus and CAN bus

for data transmission. On condition that the cable network for data transmission can't be realized e. g. laying lines is confined.

[4] GSM Enabled Smart Fire Alarm Controlling System with SMS Alert, This paper based on GSM automated fire alarm system for remotely alerting fire and smoke incidents to the property owner outside the building or industrial premises quickly by sending short message via GSM network. Along with study of existing fire detecting systems. The proposed system uses N-F-N Gateway which is an intelligent gateway interface for fire monitoring workstation. It also supports full panel programming using embedded C and network diagnostics. Fire points (detectors or sensors) communicate with fire alarm control unit. As part of compliance in case of any fire related event information need to be communicated to monitoring station for just in time response. Current fire panels are making use of Digital alarm communicator transmitter (DACT) which is responsible for transmitting the information to the central station.

III. METHODOLOGY

The innovation of the design is that ZigBee network and Wi-Fi network are combined to form ZigBee-Wi-Fi network. The ZigBee-Wi-Fi network is applied to building fire monitoring, the advantage are showed as follows:

a) The design not only utilizes the feature of ZigBee that network easily, but also the feature of Wi-Fi module that technologies mature, more popular and wide. Users can use mobile Phones and other hand-held terminal to access network.

b) ZigBee communication distance is within 100 meters by contrast, the transmission distance of Wi-Fi is 300 meters. ZigBee-Wi-Fi network extends the coverage and transmits distance farther than ZigBee network, which ensures the monitoring center and security personnel everywhere receive monitoring signals.

c) ZigBee is fit for transmitting the low power, small rate information such as fire signals. At the same time, Wi-Fi transmits easily the image video of every corner in buildings to the monitoring center, so as to monitor fire more accurately.

Building fire monitoring system includes data collecting module, wireless transmitting module and remote monitoring module. The system adopts the idea of ZigBee wireless sensor network nodes, which collect detected signals and locate the fire place. Then ZigBee network transforms to WiFi network, by which signals are transmitted to the monitoring center. Fire signals and localization information will be showed on the handheld terminal and control center, so as to be real-time obtained by the security personnel. ZigBee based on IEEE802.15.4 protocol and WiFi based on IEEE802.11b protocol are combined to provide a broader and more convenient building monitoring network. A low operating costless wires and suitable for building construction fire monitoring system at present is designed and developed.

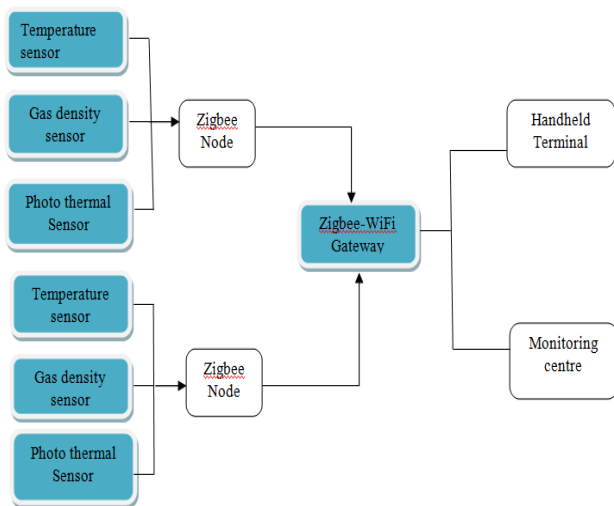


Fig1: Structure of the system

FIRE MONITORING SYSTEM

Monitoring and control of a home or an hospital has become more and more common now a days, and perhaps even a necessity. However the monitoring costs for professional monitoring can be very expensive and provide limited remote control of the system. The WSN based monitoring system lays the foundation for a self-monitored home alarm and control system. Sensors have to be placed at different locations of a building to monitor the most sensitive areas. The data is read from these sensors and appropriate actions will be taken for the changes took place. An LCD is used to display the current room temperature. A speech recording unit is used to play the message when the temperature crosses the threshold or when an intruder is detected.

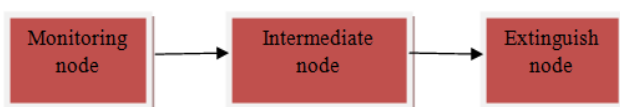


Fig 2: Monitoring system

MONITORING NODE

In this node, we have a temperature sensor, a PIR sensor, a PIC microcontroller and a zigbee unit. These sensors continuously sense the changes around them and the sensed data is provided to the PIC Microcontroller. The continuous change in the temperature is displayed on the LCD. Any intruder passed by is also sensed and the same is displayed on the LCD. PIC Microcontroller processes the received data and provides it to the zigbee unit, which transmits the data to the extinguishing node. As shown in figure, appropriate signal conditioning has to be done before the transmission of data.

INTERMEDIATE NODE

In this node, we have a Zigbee and WiFi unit. The Zigbee unit acts as a transceiver, the data is received from the monitoring node and the same is transmitted to the extinguishing node after conditioning. The intermediate node

is used only when the distance between the monitoring node and the extinguishing node is very large.

EXTINGUISHING NODE

In this node, we have a Zigbee unit, a PIC microcontroller, zigbee unit receives the data transmitted by the transmitter and provides it to the PIC Microcontroller after signal conditioning. PIC microcontroller indicates messages as per the data received.

IV DESIGN

ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

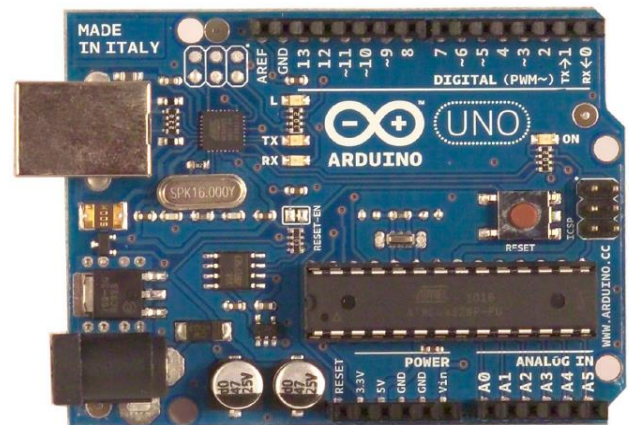


Fig 3: Arduino Uno board

MEMORY

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the boot loader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

ZIGBEE MODULE

ZigBee is the most popular industry wireless mesh networking standard for connecting sensors, instrumentation and control systems. ZigBee, a specification for communication in a wireless personal area network (WPAN), has been called the "Internet of things." Theoretically, your ZigBee-enabled coffee maker can communicate with your ZigBee-enabled toaster. ZigBee is an open, global, packet-

based protocol designed to provide an easy-to-use architecture for secure, reliable, low power wireless networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can eliminate the costly and damage prone wiring in industrial control applications. Flow or process control equipment can be placed anywhere and still communicate with the rest of the system. It can also be moved, since the network doesn't care about the physical location of a sensor, pump or valve. The ZigBee RF4CE standard enhances the IEEE 802.15.4 standard by providing a simple networking layer and standard application profiles that can be used to create interoperable multi-vendor consumer electronic solutions



Fig 4: Zigbee Module

WIFI CORE

ZigBee-WiFi network has ZigBee's features such as low complexity, low power consumption, high cost performance, self-organization, good flexibility and high fault tolerance, integrated with WiFi's features that a high communication speed, good stability, wide range, positioning function and convenient access to terminals. The transformation of both networks requires ZigBee-WiFi gateway, which integrates with ZigBee module based on CC2530F256 core chip, WiFi module based on RT5350 and serial ports.

TEMPERATURE SENSOR

The lm35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the centigrade temperature. The lm35 device has an advantage over linear temperature sensors calibrated in kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient centigrade scaling. The lm35 device does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ\text{C}$ over a full -55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level. The low-output impedance, linear output, and precise inherent calibration of the lm35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the lm35 device draws only $60\text{ }\mu\text{A}$ from the supply, it has very low self-heating of less than 0.1°C in still air. The lm35 device is rated to operate over a -55°C to 150°C temperature range, while the lm35c device is rated for a -40°C to 110°C range (-10° with improved accuracy). The lm35-series devices are available packaged in hermetic to transistor packages, while the lm35c, lm35ca, and lm35d devices are available in the plastic to-92 transistor package. The lm35d device is available in an 8-lead

surface-mount small-outline package and a plastic to-220 package.

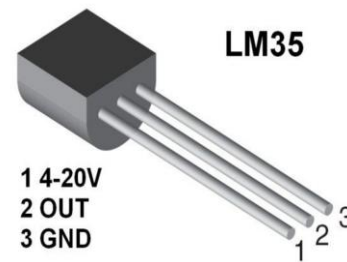


Fig 5: LM 35 temperature sensor

GAS DENSITY SENSOR

The Trafag gas density sensor type 8775 was specifically designed for the monitoring of insulation gases. This unique patented sensor technology opens new paths for the energy distributing industry to realize comprehensive trend analysis and monitoring. The digital output signal RS485/Modbus measures directly and continuously the gas density and the signal of the gas temperature.



Fig 6: Gas density sensor

GSM

GSM stands for global system for mobile communication. It is a digital cellular technology used for transmitting mobile voice and data services, gsm is the most widely accepted standard in telecommunications and it is implemented globally. It is a circuit-switched system that divides each 200 khz channel into eight 25 khz timeslots. Gsm operates on the mobile communication bands 900 mhz and 1800 mhz in most parts of the world, gsm operates in the bands 850 mhz and 1900 mhz, gsm owns a market share of more than 70 percent of the world's digital cellular subscribers and makes use of narrowband time division multiple access (tdma) technique for transmitting signals.

GSM was developed using digital technology. It has an ability to carry 64 kbps to 120 mbps of data rates. presently supports more than one billion mobile subscribers in more than 210 countries throughout the world. It provides basic to advanced voice and data services including roaming service. Roaming is the ability to use your gsm phone number in another gsm network.

V. CONCLUSION

The paper focuses on the issue on building fire monitoring, combined with thought of wireless sensor network technology, and comes up with a ZigBee-based

wireless sensor network to collect the information from the entire building, and making use of ZigBee nodes to locate the fire stations. Taking full advantages of WiFi and ZigBee, this design builds a ZigBee-WiFi network. The purpose is to design a real-time building fire monitoring system which is more facilitative to contact with the personal handy terminal and has wider covering range.

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