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Detection of Flame and Fire Startle Using Zigbee Protocol

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Abstract **- Nearly all our buildings and workspaces are protected against fire breaks, which may occur due to some fault in the electric circuitries and power sources. The immediate alarming and aid to extinguish the fire in such situations of fire breaks are provided using embedded systems installed in The buildings. But as the area being monitored against such fire threats becomes vast, these systems do not provide a centralized solution. For the protection of such a huge area, like a college campus or an industrial park, a centralized wireless fire control System using Wireless sensor network technology is developed The system developed connects the Two dangers prone zones of the campus with a-central control room through a Zigbee communication interface such that in case of fire break in any of the building, a direct communication Channel is developed that one lies out of reach of the central node. And with the help of the signal received in the control room, the exact building where the fire break occurred is identified and fire extinguishing is done.**

Keywords **- Zigbee, Embbed system.**

I. INTRODUCTION

A fire alarm system has a number of devices working together to detect and warn people through visual and audio appliances when smoke, fire, carbon monoxide or other emergencies are present. These alarms may be activated automatically from smoke detectors and heat detectors or may also be activated via manual fire alarm activation devices such as manual call points or pull stations. Alarms can be either motorized bells or wall mountable sounders or horns. They can also be speaker strobes which sound an alarm, followed by a voice evacuation message which warns people inside the building not to use the elevators.

Fire alarm sounders can be set to certain frequencies and different tones including low, medium and high, depending on the country and manufacturer of the device. Most fire alarm systems in Europe sound like a siren with alternating frequencies. Fire alarm electronic devices are known as horns in the United States and Canada, and can be either continuous or set to different codes. Fire alarm warning devices can also be set to different volume levels.

Some fire alarm systems utilize emergency voice alarm communication systems (EVAC) to provide pre-recorded and manual voice messages. Voice alarm systems are typically used in high-rise buildings, arenas and other large "defend-in-place" occupancies such as hospitals and detention facilities where total evacuation is difficult to achieve. Voice-based systems provide response personnel with the ability to conduct orderly evacuation and notify building occupants of changing event circumstances. In high rise buildings, different evacuation messages may be played to each floor, depending on the location of the fire. The floor the fire is on along with ones above it may be told to evacuate while floors much lower may simply be asked to stand by. Most fire sensor networks are built based on CAN bus in currently used automatic fire alarm system, in which signals and data are transferred through cable. Compared to traditional distributed cable network, bus network have greatly improved in expansibility and difficulty of construction and maintenance.

But there are still some defects. The cables are easily to be eroded, bitten by rats, frayed, causing to high fault rate and high false alarm rate. The cable transmission distance is limited, usually no more than 1km, otherwise the attenuation and interference will lead to failure of system. We may conceive that, constructing automatic fire alarm system in wireless transmission way, can avoid above problems. A new way of wireless signal relay also can increase alarm signal transmission distance. With microelectronics and wireless communication technology development in recent years, this can become a reality. This paper introduces a method of constructing automatic fire alarm system based on ZigBee technology.

II. FIRE ALARM USING ZIGBEE

- Since this proposed system is wireless, the damage of communication cable will reduce?
- Fire extinguisher can be sent soon.

- Easy accessing of rooms of a complex or college etc.
- It can identify the spot of fire easily and immediately.

III. BLOCK DIAGRAM

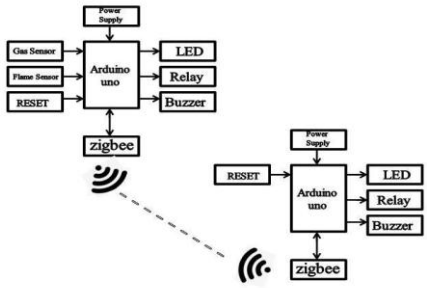

Fig. 1 Block diagram of Fire alarm using Zig Bee

1. Receiver Module

- Receiver module is a small electronic device used to transmit and/or receive radio signals between two devices.
- In an embedded system it is often desirable to communicate with another device wirelessly.
- This wireless communication may be accomplished through optical communication or through radio frequency communication.

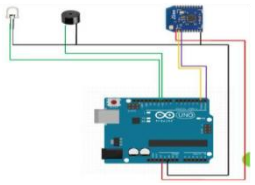

Fig. 2 Receiver module is a small electronic device.

2.Transmitter Module- transmitters are necessary component parts of all electronic devices that communicate by radio, such as radio and television broadcasting stations, cell phones, walkie-talkies, wireless computer networks, Bluetooth enabled devices, garage door openers, two-way radios in aircraft, ships, spacecraft, radar sets and navigational beacons.

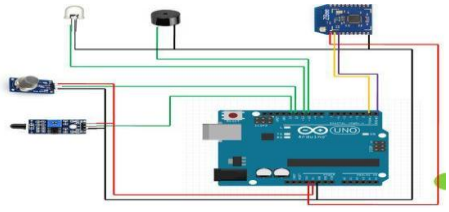

Fig.3 cell phones, walkie-talkies.

3. Use Cases

Zigbee protocols are intended for embedded applications requiring low power consumption and tolerating low data rates. The resulting network will use very little power individual devices must have a battery life of at least two years to pass Zigbee certification.

4. Typical Applications Area Include

- Home automation
- Wireless sensor networks
- Industrial control systems
- Configuration
- Zigbee is not for situations with high mobility.

IV. EVICE TYPES AND OPERATING MODES

1. Zigbee devices are of three kinds

1.1 Zigbee Coordinator(Zc)

The most capable device, the Coordinator forms the root of the network tree and might bridge to other networks. There is precisely one Zigbee Coordinator in each network since it is the device that started the network originally (the Zigbee LightLink specification also allows operation without a Zigbee Coordinator, making it more usable for off-the-shelf home products). It stores information about the network, including acting as the Trust Center & repository for security keys.

1.2 Zigbee Router (Zr)

As well as running an application function, a Router can act as an intermediate router, passing on data from other devices.

1.3 Zigbee End Device (Zed)

Contains just enough functionality to talk to the parent node (either the Coordinator or a Router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and, therefore, can be less expensive to manufacture than a ZR or ZC.The current Zigbee protocols support beacon and non-beacon enabled networks. In this type of network,

Zigbee Routers typically have their receivers continuously active, requiring a more robust power supply. However, this allows for heterogeneous networks in which some devices receive continuously. The typical example of a heterogeneous network is a switch: The Zigbee node at the lamp may constantly receive, since it is connected to the mains supply, while a battery-powered light switch would remain asleep until the switch is thrown. The switch then wakes up, sends a command to the lamp, receives an acknowledgment, and returns to sleep. In such a network the lamp node will be at least a Zigbee Router, if not the Zigbee Coordinator; the switch node is typically a Zigbee End Device.

In beacon-enabled networks, the special network nodes called Zigbee Routers transmit periodic beacons to confirm their presence to other network nodes. Nodes may sleep between beacons, thus lowering their duty

cycle and extending their battery life. Beacon intervals depend on data rate; they may range from 15.36 milliseconds to 251.65824 seconds at 250 kbit/s, from 24 milliseconds to 393.216 seconds at 40 kbit/s and from 48 milliseconds to 786.432 seconds at 20 kbit/s. However, low duty cycle operation with long beacon intervals requires precise timing, which can conflict with the need for low product cost. In general, the Zigbee protocols minimize the time the radio is on, so as to reduce power use. In beaconing networks, nodes only need to be active while a beacon is being transmitted. Zigbee devices are required to conform to the IEEE 802.15.4-2003 Low-Rate Wireless Personal Area Network (LR-WPAN) standard. The standard specifies the lower protocol layers—the physical layer (PHY), and the Media Access Control portion of the data link layer (DLL). The basic channel access mode is "carrier sense, multiple access/collision avoidance" (CSMA/CA). That is, the nodes talk in the same way that humans converse; they briefly check to see that no one is talking before he or she start, with three notable exceptions. Beacons are sent on a fixed timing schedule and do not use CSMA. Message acknowledgments also do not use

V. PIEZOELECTRIC DISK BEEPER

A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.

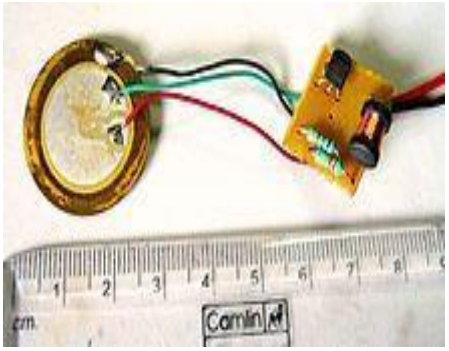

Fig.4 Piezoelectric Disk Beeper.

Interior of a readymade loudspeaker, showing a piezoelectric-disk-beeper (With 3 electrodes ... including 1 feedback-electrode (the central, small electrode joined with red wire in this photo), and an oscillator to self-drive the buzzer. A piezoelectric buzzer/beeper also depends on acoustic cavity resonance or Helmholtz resonance to produce an audible beep.

VI. MODERN APPLICATIONS

While technological advancements have caused buzzers to be impractical and undesirable there are still instances in which buzzers and similar circuits may be used. Present day applications include:

- Novelty uses
- Judging panels
- Educational purposes
- Enunciator panels
- Electronic metronomes

The schematic diagram of the module is as follows:

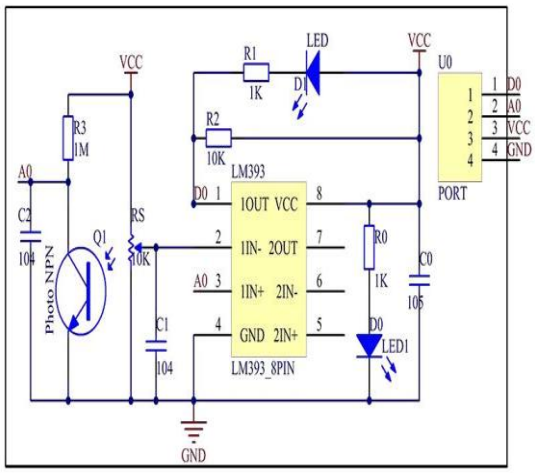

Fig. 5 Flame sensor module.

1. Features

- Equipped with power light and a signal output indicator
- Support a detection angle of appr. 60 degrees; particularly sensitive to flame spectrum.
- Contain an adjustable precision potentiometer for sensitivity adjustment .
- With a comparator LM393 to output both digital and analog signals at the same time
- Connected directly with I/O port of MCU, needless of external circuit
- Sensitive to flame, also responsive to general light; generally used for flame
- Detect flame or light of a wavelength ranging from 760 to 1100 nm.
- Output clean signals by a comparator, with good waveform and driving capability as strong as more than 15mA
- Working voltage: 3.3V - 5V; PCB size: 2.3 x 2.3 cm

2. Application

It is applicable to all kinds of flame and can be used for fire detection (e.g. flame alarm).

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VII. SIMULATION OUTPUTS FOR FLAME ALARAM

Fig.6 Simulation output

Fig.7 Simulation output.

Fig.8 Simulation output

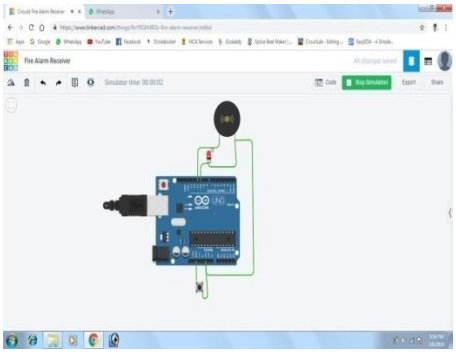

Fig.9 Simulation output

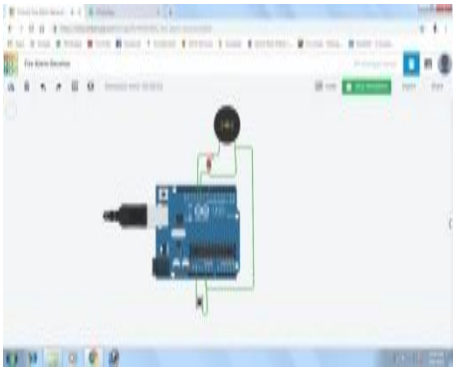

Fig.10 Simulation output.

VIII.PROGRAM

1. Transmitter Module

```
/*Transmitter Module
12 gas sensor
11buzzer
10relay
8  flame sensor
9  LED
*/
int
gas=12,buzzer=11,relay=10,flame=8,led=9,stateflame=0,s
tategas=0;
void setup() {
// put your setup code here, to run once:
Serial.begin(9600);pinMode(gas,INPUT);
pinMode(flame,INPUT);pinMode(led,OUTPUT);
pinMode(buzzer,OUTPUT);
pinMode(relay,OUTPUT);
}
void loop() {
// put your main code here, to run repeatedly:
stateflame=digitalRead(flame);
if(stateflame==0)
{
while(1)
{
Serial.write(1);
digital Write(buzzer,HIGH);
digital Write(led,HIGH);
digital Write(relay,HIGH);
delay(1000);
digital Write(buzzer,LOW);
digital Write(led,LOW);
delay(1000);
}
}
else
{
Serial.write(0);
}
```

```
}
```

2. Receiver Module

```
/*Recevier Module
12relay
11buzzer
10LED
*/
int buzzer=11,relay=12,led=10,stateflame=0; void setup()
{
// put your setup code here, to run once: Serial.begin(9600); pinMode(led,OUTPUT);
pinMode(relay,OUTPUT); pinMode(buzzer,OUTPUT);}
void loop() {
// put your main code here, to run repeatedly: if(Serial.available()>0)
{
State flame=Serial.read();
if(state flame==1)
{
while(1)
{
Digital Write(buzzer,HIGH);
Digital Write(led,HIGH);
digitalWrite(relay,HIGH);
delay(1000);
digitalWrite(buzzer,LOW);
digitalWrite(led,LOW);
delay(1000);
}
}}}
```

3. Advantages

- Identifying the spot of fire easily and immediately
- Fire extinguisher can be sent soon
- Easy accessing of rooms of a complex or college etc
- Due to wireless the damage of communication cable will reduce

4. Disadvantages

- Up to the zigbee range it can be used
- Need to provide a battery back up
- The distance of fire sensing is poor

5. Applications

- College
- School
- Malls
- Hospitals
- Shopping Complex
- Industries
- Commercial Places
- Homes
- Hotels etc….

IX. LITERATURE SURVEY

Design and Development of Forest Fire Monitoring Terminal

Author: Wu Fengbo,Lv Xitong,Zhang Huike

Year: 2018

This paper describes forest fire causes serious harm,in order to achieve real-time monitoring of forest environment, this paper designs the forest environment monitoring system which consists of three parts, environmental data collection node, environmental monitoring terminal and environment data server. The forest environment data acquisition nodes expand their peripherals as environment acquisition modules, such as wet temperature, smoke concentration, light intensity and flame, these collection nodes through ZigBee networks send the collected information to the environmental monitoring terminal.

The environmental monitoring terminal using STM32 as the main controller ,summary and processing analysis the data uploaded by the collection nodes, and then send the data to the remote server through the GPRS module the server receives the environmental data uploaded by the environmental monitoring terminal and through the data fusion algorithm uses the data collected by the sensors to output the three fire levels of the forest area. The results indicates that the forest fire monitoring system works stably which enables the collection of environmental data as well as the functions of remote sending and remote alarming.

Contikios Based Library Fire Detection System

Author: Burak Karadumam, Raheleh Eslampanah

Year :2018

In this paper, a ContikiOS based Library Fire Detection System has been designed and implemented using wireless sensor networks. The system consists of Atmel AVR IRIS motes which are operating with IEEE 802.15.4 network protocol, Linux based RaspberryPI, and ESP8266 Wi-Fi transceiver. The system can be easily transported, repositioned and expanded. Benefiting from multithreading feature of ContikiOS and executing the tasks in parallel, the system a short response time, which is critical for fire detection.

According to the test results, the system responds to the changes in temperature and prompts a warning/alarm message in approximately 4 seconds. Most of the fire detection systems proposed in the literature are focused on coal mines and forests due to the high ignition risk in coal mines and wide spreadable fires in the woods. Generally, WSN consists of a sink node and multiple source nodes which create large quantity of data collecting and transmitting area [1]. Normally, library fire risks occur because of vandalism, arson and natural causes. More than 70 percent of all library fires are incendiary in origin. Other fires originate in malfunction of heating plants, in problems with mechanical or electrical systems, in the operations of contractors or from lightning [2]. In [3], the WSN devices use smoke, humidity and temperature sensors and communicate on

Mesh Network using MICA-Sensor Motes to detect fire. In the study of WSN devices also use GPS technology.
All data is directly sent to the base station and stored in a database. From a web browser the users can access the collected data. As another study, the uses ad-hoc and multi-hop network which is aimed to detect wild fires on mountains and send alarm message using a shortest path algorithm. TinyOS is chosen as operating system in There are other approaches to detect fire except thermocouple sensors which uses photo detectors, in [6]. Study [7] uses TinyOS for fire detection, but as a difference with our study, we preferred Contiki operating system. TinyOS is not supported anymore and most of the new devices are not ported to Tiny OS. On the other hand, Contiki OS supports new features and technologies such as 6LoWPAN. Also, TinyOS supports partial multithreading while Contiki OS supports multithreading using Protothreads. Currently, in IoT solutions, Contiki OS has 15% of the users where TinyOS only has 9.2% [8].

As a result, it seems that ContikiOS is moIn this study Atmel AVR IRIS XM2110 motes and MDA100CB sensor cards are used with Contiki operating system to measure temperature and to detect fire. In ContikiOS side, UDP broadcasting and IPV6 are used and ContikiOS based software is coded in C. ESP8266 is coded in C/C++ via Arduino Core used to measure indoor temperature with DHT11 sensor re promising to satisfy todays needs in the solutions. In ContikiOS side, UDP broadcasting and IPV6 are used and ContikiOS based software is coded in C. ESP8266 is coded in C/C++ via Arduino Core used to measure indoor temperature with DHT11 sensor. An application is coded in Java and run in RaspberryPI to store and compare the indoor and outdoor temperature values. For sending data to sink node, star topology is selected. The sink node collects all data and sends them to RaspberryPI via a serial connection. In our future studies, it is planned to use multi-hop network and RPL-UDP feature of ContikiOS with more developed user interface. In addition, to reduce software complexity and development time, the software can be developed using model driven techniques.

Smart Apparatus For Fire Evacuation – An Iot Based Fire Emergency Monitoring And Evacuation System
Author: Swarnadeep Majumder,Sean O'neil
Year: 2018
According to the National Fire Protection Agency, 14,500 highrise fires occur every year causing 40 deaths and 520 injuries per year on average [1]. Many of these deaths and injuries can presumably be avoided if evacuees had knowledge of the location of the fire and a solid exit strategy. In an age of IoT devices, there are no such commercial products available to address this problem. We have developed a technology that can be used as a smart fire defense guidance system. The goal is to inform occupants and emergency services of the location of the fire and provide a real-time safe path of evacuation. It proposes to use a mesh network of smart fire alarms and path planning algorithms to provide these essential services.

In this paper, we propose a novel IoT based fire defense system where the focus is on localizing fire instead of localizing people. Our assessment reveals that information regarding the location of a spreading fire would be incredibly helpful to victims and fire responders alike. Moreover, this technology can be implemented easily to existing fire alarm systems and can be an invaluable asset for firefighters in locating the origin of fire during times of emergency. This paper is organized into the six sections that follow. Section II describes the background of this project, briefly mentions previous work done on this topic and explores the need for such a product in the current market. Section III talks about the theoretical ideas behind the design of system.

Consecutively, Section IV details the implementation of this approach and functionality of the working prototype. The technology and methods that make up the S.A.F.E. system are well understood and widely used however they have not been leveraged together in this way before or for this application. This problem does not require technologies like indoor localization that are complicated, expensive, and underdeveloped. An overarching goal of this project was to prove that effective smart fire evacuation can be realized with developed, inexpensive, and well understood technologies like those aforementioned.

At a small scale, the prototype successfully proved this assertion to be true. Although this is by no means a final implementation, it gives a good sense of how a larger, more realistic system similar to this could function. We hope that technologies like these are explored and tested in the future by the scientific and engineering communities to develop a more suitable fire defense system. The MATLAB script, upon getting the input from Python, developed an occupancy grid matrix of the building where the system was installed. The Occupancy grid matrix can be generated using vectors as inputs in MATLAB's robotics package. The occupancy grids of the map used for the prototype.Internet-of-Things interconnected devices are transforming the typical building to be safer, healthier, and more efficient.

Home Fads A Dedicated Fire Alert Detection System Using Zigbee Wireless Network
Author- Mohd Faris Mohd Fuzi, Alif Faisal Ibrahim, Mohammad Hafiz Ismail, Nur Syakira Ab Halim.
This paper describes the development of innovative low-cost home dedicated fire alert detection system (FADS)

using ZigBee wireless network. Our home FADS system are consists of an Arduino Uno Microcontroller, Xbee wireless module (Zigbee wireless), Arduino digital temperature sensor, buzzer alarm and X-CTU software. Arduino and wireless ZigBee has advantages in terms of its long battery life and much cheaper compared to the others wireless sensor network. There are several objectives that need to be accomplished in developing this project which are to develop fire alert detection system (FADS) for home user using ZigBee wireless network and to evaluate the effectiveness of the home FADS by testing it in different distances and the functionality of heat sensor. Based from the experiments, the results show that the home FADS could function as expected. It also could detect heat and alarm triggered when temperature is above particular value. Furthermore, this project provides a guideline for implementing and applying home FADS at home and recommendation on future studies for home FADS in monitoring the temperature on the web server.ZigBee wireless networking, 802.15.4 is a standards-based technology for remote monitoring, control and sensor network application.

Improving Smart Home Security; Integrating Logical Sensing Into Smart Home

Author- Arun Cyril Jose, Reza Malekian

The paper explains various security issues in the existing home automation systems and proposes the use of logic based security algorithms to improve home security. The work classifies natural access points to a home as primary and secondary access points depending on their use. Logic based sensing is implemented by identifying normal user behavior at these access points and requesting user verification when necessary.

User position is also considered when various access points changed states. Moreover, the algorithm also verifies the legitimacy of a fire alarm by measuring the change in temperature, humidity and carbon monoxide levels, thus defending against manipulative attackers. The experiment conducted in this paper used a combination of sensors, microcontrollers, Raspberry Pi and ZigBee communication to identify user behavior at various access points and implement the logical sensing algorithm. In the experiment the proposed logical sensing algorithm was successfully implemented for a month in a studio apartment. During the course of the experiment the algorithm was able to detect all the state changes of the primary and secondary access points and also successfully verified user identity 55 times generating 14 warnings and 5 alarms.

X. CONCLUSION

This Project will be helpful to identify the fire and protect the place by giving the signal to control room with spot location so it can extinguish easily. This project can be used in all places for example colleges, Schools, and Malls etc.

Fig.10 Model Diagram.

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