

Internet of Things Technology for Intelligent Fire Emergency Response System

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Abstract— Prevention of fire and fire risk level control difficulty are increased day by day. Fire-fighting and monitoring situations are very serious today. Public security keep on insisting in increase of technology in firefighting and monitoring. They give special attention to improve the science and technology in resisting fire disasters. They are concerned about the application of new technology such as IoT and wireless sensor network in fire-fighting and monitoring field.

Key words: Fire, Fire-Fighting, Wireless Sensor Network

I. INTRODUCTION

The main characteristics of sensor nodes include: small physical size, low cost, limited processing power, low battery capacity and short-range communications. A Wireless Sensor Networks consist of huge number of sensor nodes and is a set of hundreds or thousands of micro sensor nodes that have capabilities of sensing, establishing wireless communication between each other and doing computational and processing operations. Wireless sensor network is a network in which a large number of sensors are deployed and data is collected from them and send to a particular system for processing.

In this project, we designed an IOT based fire alarming system to help detect fire as soon as possible and save precious human lives. The system will use several sensors to detect any symptoms of fire. The sensors will be placed on proper places after doing surveys on the building for its vulnerable places of fire. After choosing the best places for placing the sensors, the sensor will be activated. The data collected by sensors will be sent to microcomputer. All the sensors will be controlled centrally by Raspberry Pi microcomputer. Intelligent algorithm is used to decide when to start alarm for fire. At the same time the system will send SMS using GSM module to the nearby fire service station informing them of the incident. The system will also inform the location of the fire to the administrator.

II. LITERATURE SURVEY

Fire and its accidents have been the subject matter of many studies in the literature. Researchers have attempted to determine reliable indicators of fire by analyzing certain variable parameters of fire. They discussed the latest technology that can help to reduce catastrophic accidents caused by fire. They designed the whole system and evaluated its effectiveness as well as scalability. With the improvement of sensor technology, the system will become more efficient and useful. If this system can be successfully integrated in every factories, then it is hoped that the loss of life and property due to the fire accidents will reduce remarkably and the country's economy will not be stumbled by such tragic accidents.

III. MOTIVATION

Conventional fire detectors are costly and they are not suitable for open spaces. Moreover they highly produces false alarms and often detects fire when it's too late. So it is needed to develop an efficient low cost fire detection system with negligible response time. But this project has a great potential to meet these requirements.

The new modern fire response system is based on wireless sensor network in combination with Internet of Things. Because of modern advanced technology, the system minimize the losses due to fire. Sensors detects the fire condition and transfers the data to the system. Fire brigade and building owners can do the interactions with the system. All the data from the sensor nodes located in the buildings are provided to the users. The historical data reference from building data base server provides final useful response mechanisms. The users can communicate with the system through different ways to monitor and control the environment and get more information about it.

IV. OBJECTIVE

The main objective of this work is to design an intelligent fire emergency response system that provides real-time surveillance, monitoring and automatic alarm by the following:

- a) Analysis and calibration of temperature sensor and smoke sensor.
- b) Development of program to convert the analog output of the sensor to equivalent digital form in the microcontroller.
- c) Development of visual warnings to indicate fire detection with the help of LCD and GSM module.
- d) Development of audio warnings to indicate the presence of fire.
- e) Implementation of the IoT function for fire monitoring in wireless sensor network.

V. METHODOLOGY

The block diagram of proposed work is shown in Fig 1. The system performs four major operations, which can be classified in their order of occurrence as,

- 1) Sensing.
- 2) Monitoring.
- 3) Alerting.
- 4) Automatic safety precautions.
- 5) Manual control.

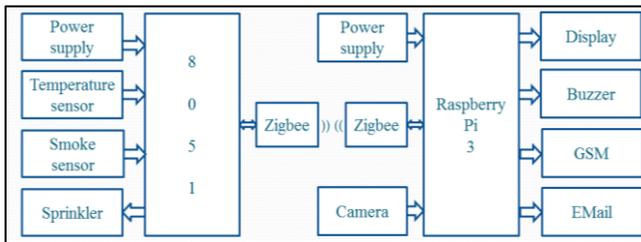


Fig. 1: Block Diagram of Methodology

A. Sensing

In this system we are using two sensors, a temperature sensor and a smoke sensor. Whenever there is leakage of the smoke particles reacts with the semiconductor inside the sensor and the sensor converts the respective physical quantity into an electrical signal, which can be read by an observer. The sensitivity of the sensors can be controlled and set to a desired range to get the optimum conversion of physical quantity. Here the output signal of the sensor will make the corresponding microcontroller pin as high.

B. Monitoring

The Ardu Cam MT9D111 will be used to capture the view of the situation which is 2 Megapixel optical lensed camera sensor module. The camera can capture in 4:3 format with RGB Bayer patterned color filter array. There are two frame rate, which are UXGA and SVGA. We will be using the SVGA frame rate as it consumes less data. The module has built in Xenon flash in it so that it can capture in both day and night time. The module has also auto focus system so that it can automatically set the range for the most perfect focusing. A Single Channel Relay module will be attached to Raspberry Pi, so that it can trigger the alarm whenever the fire detects.

C. Alerting

The microcontroller forms the heart of the proposed embedded system. The microcontroller will be continuously monitoring the two sensors and whenever the either of the sensors gets triggered the microcontroller gets the information about what type of accident has occurred. Once the microcontroller gets the information, it alerts the users and people in the surrounding environment using following methods namely:

1) Audio Signalling

Here we are using a piezoelectric buzzer as an audio signaling device. A piezoelectric element may be driven by an electronic circuit or any 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. In case of any accidents the microcontroller turns on the buzzer which produces audible sound signals, alerting the nearby people about the possible hazard by grabbing their attention.

2) Visual Display

The system uses a display to give a warning message about the possible accident that has occurred and allows the user to take the necessary safety precautions and control the hazard. The microcontroller will be programmed to display two separate messages one for the gas leakage and the other for the fire breakout. In the idle state it will display a

message indicating display a monitoring message indicating normal condition.

3) Alerting Message

A GSM modem interfaced with the Raspberry Pi gets the required command from the Raspberry Pi to send a predefined message in the form of an alerting SMS to a single or multiple users. A SIM will be inserted into the GSM modem which operates anywhere where the mobile network is available, which gives the necessary information about the type of accident has happened and the user can take the necessary actions to control the hazard.

The microcontroller has been programmed to send three commands to the GSM modem. In case of any hazards first, it will send a command to the modem to transmit a message. The communication with the administration and the system will be maintained by the GSM cellular connection for which SIM808 GSM module will be used in the system. SIM808 GSM module is the latest GSM module that has GSM, GPS and Bluetooth connectivity system. It can send and receive data from GSM, GPS and Bluetooth and can also act over AT commands. The GSM module will be connected with the Raspberry Pi 3 and it will send the location and snap.

4) Alerting Mail

An SMTP server is configured at the gateway to send regular e-mail updates regarding the WSN, and it is also used to send alarms in critical situations. Different techniques are currently used to address some of the challenges of WSNs. The emergence of modern protocols and radio communication technologies have increased the number of outdoor WSN deployments. The sensor networks are used in a variety of applications such as detecting fire accidents. The board Raspberry Pi 3 has built in wireless module in it that has both 802.11n wireless LAN and Bluetooth 4.1 including BLE feature by which we can both receive and transmit data wirelessly without any other partial device.

D. Automatic Safety Precaution

A sprinkler is a device that regulates the flow of a fluid by opening, closing or partially obstructing various passage ways. Sprinklers are technically pipe fittings. In an open sprinkler, fluid flows in a direction from higher pressure to lower pressure. Here the water valve issued to take out the fire if any by sprinkling water over it.

E. Manual Control

This system also works as a home automation system. Home automation is automation of the home, housework or household activity. Home automation may include centralized control of lighting, HVAC (heating, ventilation and air conditioning), appliances, and other systems, to provide improved convenience, comfort, energy efficiency and security. Home automation for the elderly and disabled can provide increased quality of life for persons who might otherwise require caregivers or institutional care.

The flowchart of a proposed system is shown in fig 2.

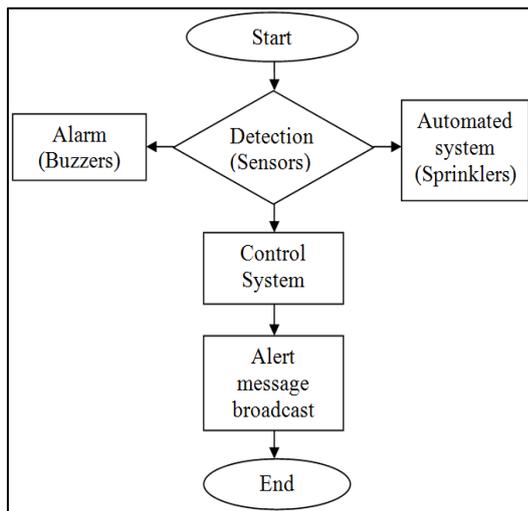


Fig 2: Flowchart of Methodology

VI. ADVANTAGES

- The system is easy to design because several components are interfaced to the microcontroller through the relay. It can be manually operated.
- The sensors automatically detect the presence of smoke or temperature and trigger the alarming and controlling mechanism.
- The system can be used to control several appliances in a building using GSM.
- The system has multiple functions like alerting, controlling devices during emergencies.
- This system combines the concept of home automation and alarm systems. So, it has many additional features.

VII. APPLICATIONS

- In high rise buildings or in multi storied buildings like apartments where evacuation process can be relatively slow, this system can be used to alert people during emergencies.
- It can be used in institutions like old age homes or hospitals, where a large number of people belonging to high risk groups are present.
- A home automation system integrates electrical devices in a house with each other. The user can control any electronic appliance interfaced with the system. User can open the doors of the house or any other enclosures for the guests even if he or she is not present at the spot. The user can alert the people inside the home using the vibrator and can turn off the mains supply just in case if he feels unsafe. Since, fire accidents occur at unanticipated magnitudes and condition it is better to have human control over the system.

VIII. RESULT & CONCLUSION

Large number of fire accidents has occurred because of the negligence shown in installing or maintaining alarm systems. In our project we have combined the concept of home automation, alarm as well as response system. This project is user friendly, as the user needs to have a basic knowledge of mobile operation. Our project is efficient one

as we can monitor the devices from far off places using GSM and webpage server with the help of a low cost circuit. The user can control a number of devices during such emergencies. The main objective of this project is to alert people and take safety measures during fire emergencies. Our project has a response mechanism which is used to alert people belonging to high risk groups, along with normal buzzer alarm.

Our long term goal to reduce catastrophic accidents caused by fire. We designed the whole system and evaluated its effectiveness as well as scalability. With the improvement of sensor technology, the system will become more efficient and useful. If this system can be successfully integrated in every public areas then it is hoped that the loss of life and property due to the fire accidents will reduce remarkably and the country's economy will not be stumbled by such tragic accidents.

IX. FUTURE WORK

As a part of future work a MIC can be connected which can be used to give voice commands and directions for evacuations during emergencies. The module can be connected to more complex equipment's, depending on the building or industry in which it is used. A remote warning handset or a vibrating pad can be developed which is always in contact with the person whom we want to alert during emergency situations.

The intelligent emergency evacuation system can also aid firefighting because it allows for a quick assessment of the exact location of the fire by integrating the intelligent and automated evacuation system with the central national emergency management agency. It reduces casualties and the time required for evacuation by guiding evacuees into dispersed detours that bypass the location of the fire.

Future studies will focus on expanding the applicability of this system to not only building disasters, but also various fields such as ocean vessels and evacuation within buildings, disaster safety through Web or mobile application services, and preventive actions for optimal disaster recovery.

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