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An Internet of Things Based Fire Detection and Fire Alert System

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Abstract **-** Fire accidents cause huge amount of death and injuries to people every year. Life of people is the most important thing which requires more protection and care at any situations. In many situations, the number of death and injuries can be reduced by providing proper alerts regarding fire accidents to the occupants of the building. To prevent from the fire related damages in buildings it is needed to provide effective fire detection and fire alert system. The proposed work presents an IoT based fire detection and fire alert system that contains a voice system and alarm facility. When any of the fixed fire sensors on the floor detects the fire, the system will provide an alarm in the building and location of the building will be sent to the fire Station with a notification sound. The notification sound is used to intimate about the occurrence of the fire accident to the fire fighters, then they can locate the fire affected building by using the location information. Using the information from the voice system users can take path for escape from the fire affected building.

Keywords- Internet of Things, Fire Detection, Voice System, Alert System

I. INTRODUCTION

An IoT (Internet of Things) is a technology which enables communication between devices over the Internet. In simple terms, an IoT can be defined as the collection of devices such as laptops, vehicles and home appliances which are embedded with software, sensors, and actuators. Interaction among those devices is possible through the connectivity between them. The IoT is a relationship that connects people to things and things to things [12]. An IoT is a widely used technology because it provides Machine to Machine communication which reduces human entrance during the communications between devices. The proposed work uses IoT technology in order to provide communication between the building affected by fire and the fire station. In the fire affected building, it would be better if there is a person who will guide the people to take exit by providing information about the fire affected area in the building, which is not possible in such situation. So instead of allocating such guide, the proposed system contains voice system which will do the job of providing information about the fire affected location. By using this information occupants can make a safe exit from the building.

This paper is organized as: Section II contains the discussion on related work. Section III includes the explanation of proposed work and the functioning of components used under the topic of methodology. Section IV provides the information about the experimental results and the performance analysis of the proposed system. Section V involves the conclusion and future scope of the proposed system.

II. RELATED WORK

This section discusses some of the surveys related to fire detection and fire alert system.

RaviKishore Kodali and Suyerroju, presented the system that can detect smoke, flame and flammable gas. When fire hazard occurs, the system sends location coordinates of the dangerous location to the nearest fire station. In this system we are using ESP32 Microcontroller which is useful for low power applications, MQ5 sensor is used to detect flammable gas, MQ2 sensor is used to detect smoke and Flame sensor is used to sense the flame [1]

Sheila Abaya, Ejay Cabico, Rommel Diaz, Hiro Kojima, presented the work that explains when the device detects high degree of fire, a signal will sent to the microcontroller that will send code to the GSM. Then GSM will send a notification wirelessly to the pre-designed map, located in the nearest fire station. This will trigger the map and turn on the LED on the map which is an indication where there is a fire [2]

S.R.Vijayalakshmi, S.Muruganand, presented the work which explains wireless sensor network for early detection and monitoring of fire in that area using low rate and low power sensors.MSP430 Microcontroller are used to process

and implement the best algorithm which has low cost and low power consumption [3]

Huiping Huang, Shide Xiao, Xiangyin Meng,Ying Xiong, provided system that can detect fire, leakage of gas or thieves intrusion and send alarm message remotely to the house owner's mobile. When temperature sensor senses high temperature or gas sensor senses the combustible gas, the system will send encoded alarm [4]

Haibing Hu Gang Wang Qixing Zhang Jinjun Wang Jun Fang Yongming Zhang, presented the system that is used to determine and implement the fire detection that detects the fire and reduce the false primitives by using the wireless network (WSN) and GSM based communication [5]

Mr.C.Santhana Krishnan, Assistant Professor(Sr.G),Akhilesh Galla (Student), Naveen Arlapalli (student), presented a work that explains, Survey on implementation of fire detection system using ZigBee networks. This design is used for transmitting the fire information to long distances within the building by using ZigBee network [6]

KB Deve, GP Hancke and BJ Silva, presented the model which explains the system of Design wireless multi sensor fire detection and alarm system based on ARM. It is used to develop a universal fire detection which has low cost and low false alarm rate[7]

Yeon-sup Lim1 provided a studied about fire detection and rescue support framework with wireless sensor networks is presented. This system consists of fire detection sensor network, information gathering layer, middleware and escape support system which all make use of wireless sensor technology for fire detection and rescue system [8]
Ahmed Imteaj , provided a system is an IoT based fire alarming and authentication system which is capable to detect fire and can provide the location of the affected region and also provided a confirmation of the fire suspecting system to avoid any false alarm [9]

Swarnadeep Majumder, Sean O'Neil, Ryan Kennedy, provided a system which is used to provide information to the occupants and emergency services of the location of the fire and to provide a real-time safe evacuation path through their mobile. This system localizes the fire instead of localizing people of affected area [10]

III. METHODOLOGY

From research on related works, it is found that most of the present systems on fire detection and fire alert are having few considerable issues. In some system there is no direct information is provided to the fire station. In some work the mobile phone is used for providing information about the location of fire in the building. In other system, proper alert facility is not provided. On considering these issues, the proposed work has an alarm facility upon the ignition and when the fire sensor provided in the system senses the occurrence of fire, an alarm sound will be provided. Then the latitude and longitude of the building is shared to the fire station for further evacuation process. In the building, the verbal commands about the fire affected area is provided and the preferable evacuation path is also provided for the evacuation of occupants in the building. People in the fire affected building identify the fire occurrence through an alarm sound which comes from the buzzer and the people uses the voice commands to identify where the fire has occurred in the building. By using this knowledge the occupants can avoid the fire affected area to get away from the fire affected building and further injuries to the occupants. On fire station, the location of the fire affected building is shared with notification sound to indicate where the fire occurs and to intimate about the occurrence of fire accidents. After reaching the fire affected building, the fire fighters will identify the fire affected areas in the building using voice instructions and can plan for further evacuation of people to vacate from the building. Also fire fighters will take proper actions to off the blazing fire.

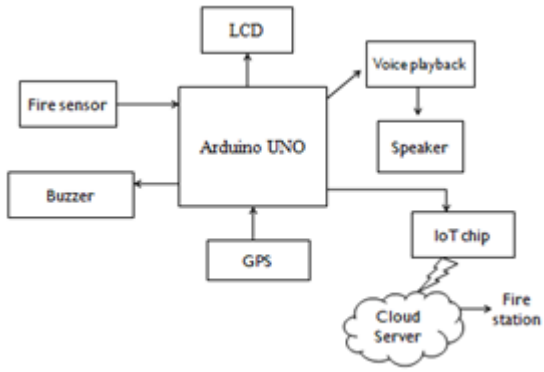

Figure 1.Architecture diagram of the proposed system

The proposed system contains Arduino UNO board, fire sensors, IoT chip, Voice playback, Speaker, GPS, Buzzer, and LCD.

A.FIRE SENSOR

Fire sensor is also referred as flame sensor which is useful in the detection of fire and it also responds to fire. In extremely hazardous environment, fire sensor works to reduce the risks associated with fire. A fire sensor contains an integrated circuit which is composed of a flame sensor to detect flame, power indicator to indicate the supply of power, flame detection indicator to indicate the occurrence of fire, potentiometer and comparator LM393. The fire sensor has a photo diode which receives a small amount of infrared light emitted by the fire. The fire sensor can detect the infrared light with a wavelength range from 700nm to 1000nm.The

fire sensor operates in 3.3v-5v.This fire sensor has a LED which blinks upon the detection of fire. The potentiometer in the fire sensor is used to adjust the sensitivity. Fire sensor makes use of comparator to detect fire. This fire sensor replies rapidly and more precisely than a smoke or heat detector. Fire sensors which are connected to the Arduino board become low when the fire gets detected. In the propose system, fire sensors are used to detect the occurrence of fire in the building.

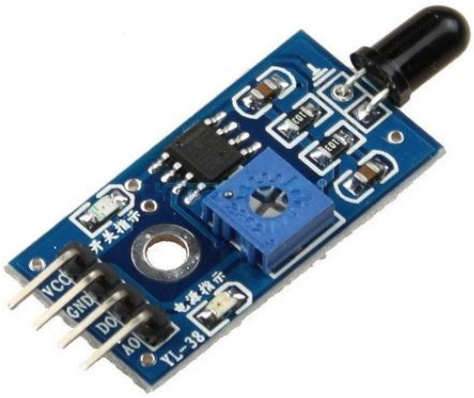

Figure 2.Fire Sensor

B.ARDUINO UNO

The Arduino UNO board is a microcontroller board which is based on the AT mega 328 chip. It uses AVR controller (8bit). The main controller of the proposed system is the Arduino Uno which can control, transmit, and receive signals for the whole Operating System [13]. It supports embedded high speed flash memory. It consist of 14 digital pins (0-13) in which 0^{th} & 1^{st} pins are for transmitter(tx) and receiver(rx), 6 analog pins (A0-A5), 16MHZ crystal oscillator, USB programming interface, a power jack, an ICSP header and a reset button. The 14 digital pins and 6 analog pins on the UNO either can be used as input or output using pin mode function and digital Write() and digital Read() functions are used for read and write operations. Arduino has an integrated software environment which has a cross compiler, a debugger on a serial monitor to execute the programs. The Arduino integrated development environment kit (Arduino IDE) can be downloaded from Arduino.cc. In Arduino IDE we can select board types, ports for executing the programs and after the successful uploading of program in the controller, hardware part will produce the output. The Arduino UNO is programmed using embedded c program. Arduino UNO gets started by simply connecting it to a computer with USB for 5v power requirements or powers it with an adapter for 12v power requirements or a battery. In this proposed system fire sensor, GPS are connected as input devices to the Arduino board and LCD, buzzer, voice playback, IOT chip are connected as output devices.

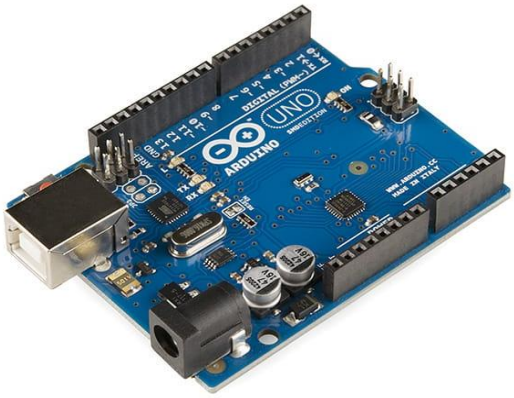

Figure 3.Arduino UNO ATmega328

C.GPS

Global positioning system is used to determine the ground position that is location information of an object. It makes use of signals sent by satellites in space and ground stations on earth to accurately determine its position on earth. GPS receiver module uses USART (Universal synchronous asynchronous receiver transmitter) for the communication with microcontroller. The information such as latitude, longitude, altitude, time etc is received from the satellite in the form of NMEA (National Marine Electronics Association) string. Then this string will be parsed to get the information that we need. In the proposed system, when fire sensor senses the fire, location coordinates (latitude, longitude) will be sent from GPS to the microcontroller.

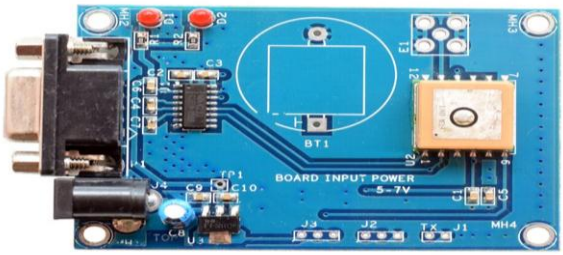

Figure 4. GPS Receiver

D.IOT CHIP

The ESP8266 Wi-Fi module is a self contained Soc with integrated TCP/IP protocol stack that can give any microcontroller access to Wi-Fi network. It is a low cost Wi-Fi module. ESP8266 uses serial transceiver (TR/RX) to send and receive data and serial command to query and change configuration of Wi-Fi .It only requires two wires(TR,RX) for communication between microcontroller and Wi-Fi module. In the proposed system it is used to transmit the location co-ordinates to the fire station through the cloud server when the fire sensor detects fire. At fire station this location information is provided with a notification sound.

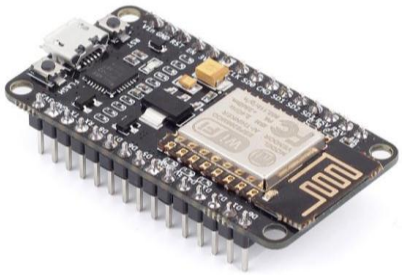

Figure 5. ESP8266 Wi-Fi module

E.VOICE PLAYBACK

APR9600 is a low cost, high performance voice recording and playback system which is compatible with Arduino. It requires 12v amount of power supply for its functioning and operations. It contains a power amplifier chip which is used to amplify the audio and enhance volume. It provides high quality of sound with low noise level. In this voice playback, the recorded sound can be retained even after power supply is removed from the module. Depending on the fire sensor which detects fire, the corresponding voice information will be played through the speaker.

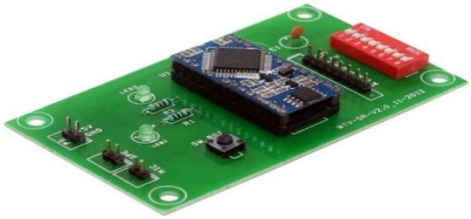

Figure 6. Voice Playback Module

F. SPEAKER

Speaker is an output device, which is useful to produce an audio output that can be heard by the listener. It has a transducer which converts the electromagnetic waves into sound waves. The speaker which is connected to the voice playback will play the sound which is already recorded or stored in voice playback module. In proposed system, the sound from the speaker will give the instructions in the form of verbal commands upon the detection of fire using which occupants can identify the location of fire.

Figure 7. Speaker

G.BUZZER

Buzzer is an output device, which is used to provide an audible identification or alert that can be heard by the users. It is also called as Beeper. It is a signalling device used to alert the people. In the proposed system buzzer provides an alarm sound to alert the people when the fire sensors sense the fire in the building. By using the alarm sound, users will get prior knowledge about the fire occurrence.

Figure 8.Buzzer

H. LCD

LCD is an output device which is used for display purpose. Liquid Crystal is used in LCD to produce visible image or text. In proposed system, 16x2 LCD is used, which is a very basic module. In 16x2, 16 represents sixteen columns and 2 represents two rows. 16x2 LCD modules are preferred over other display modules such as seven segments and other multi segments LEDs. Because LCDs are economical and easily programmable. A 16x2 LCD display is capable of displaying 16 characters per line and there can be 2 such lines. These LCD make use of registers for storing the commands and data. In proposed system, LCD which is connected to the Arduino UNO is used to display the informations such as fire monitoring.

Figure 9.LCD

I.FIRE SENSOR AND ARDUINO INTERFACING

In the proposed fire detection system three fire sensors are connected to the Arduino board. When any of the fire sensors detect fire, the signal will passed to the controller. On receiving this signal from fire sensor, Buzzer which is connected to the Arduino UNO gets turn on and provides alarm sound in the fire affected building to indicate the occurrence of fire. The digital output pin of the fire sensor is

connected with the digital input pin of the controller that is output of the fire sensor is given as input to the controller.

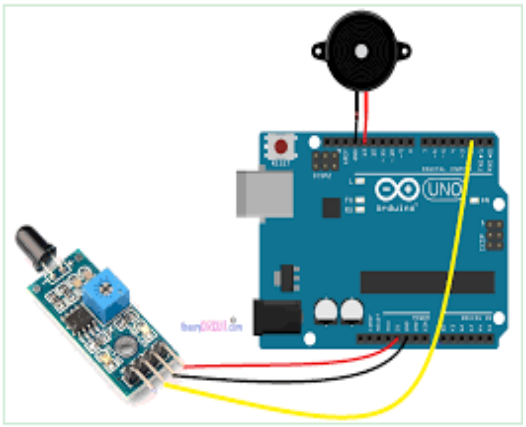

Figure 10. Interfacing of fire sensor and buzzer with Arduino

J.GPS AND ARDUINO INTERFACING

In the proposed work, GPS receiver which is connected with Arduino UNO will send the latitude and longitude of the fire affected building to the controller. This information will be sent to the fire station through an IoT chip. This coordinates will be updated in the cloud server. This location information is sent to the fire station. The information will be displayed on the web page with a notification sound to provide intimation to the fire fighters about the occurrence of fire accidents.

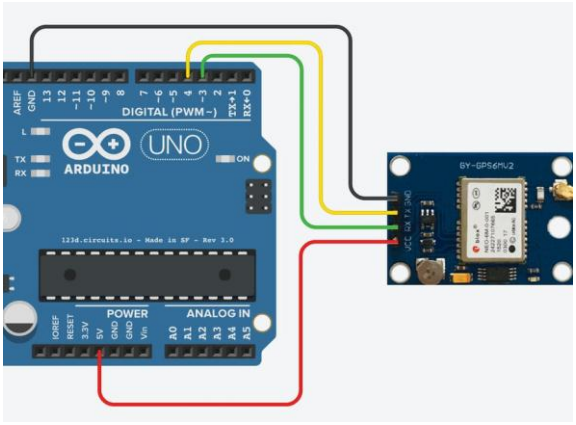

Figure 11. Interfacing of GPS with Arduino

K.VOICE PLAYBACK AND ARDUINO INTERFACING

In this work, the voice playback module which is connected with Arduino UNO will play the recorded voice through the speaker upon the fire detection in the building. Voice commands are recorded in the voice playback system according to the location of fixed FireSensor during the installation of the system.

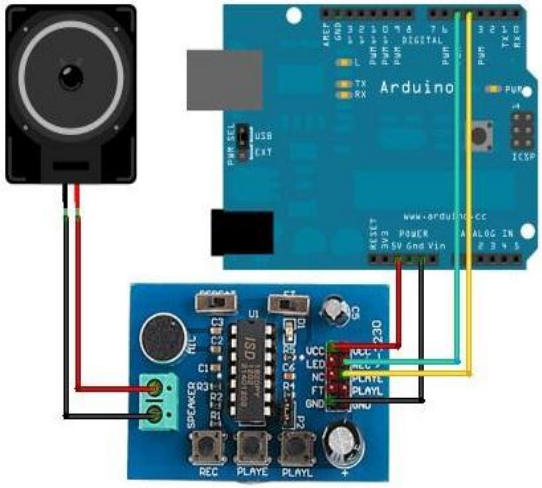

Figure 12. Interfacing of Voice playback module with Arduino UNO

IV. RESULTS AND DISCUSSION

Table 1. Experimental Results

Experiment number	Fire Sensor			Buzzer response	Voice system response	Decision
	1	2	3			
1	D	D	D	ON	ON	Fire
2	D	ND	ND	ON	ON	Fire
3	ND	D	ND	ON	ON	Fire
4	ND	ND	D	ON	ON	Fire
5	D	D	ND	ON	ON	Fire
6	D	ND	D	ON	ON	Fire
7	ND	D	D	ON	ON	Fire
8	ND	ND	ND	OFF	OFF	No Fire

D – Fire Detected
ND – Fire is Not Detected

Table 1 shows that the fire has detected during ignition, also buzzer and voice system gets turned on upon the detection of fire. Otherwise, the buzzer and the voice playback module will not provide any alerts. This prototype has three fire sensors and so there are eight possible results can be obtained. Results shows that, when any one of the fire sensors detect the fire, the buzzer will be turn on. When none of the fire sensor detects the fire, the buzzer will not get turn on and the voice playback module does not provide any information. In the existing system [11], mobile application is used for providing evacuation information to the occupants of the fire affected building. But in situation like fire accidents it is difficult for a person to use such mobile application and also it is not sure that whether all the occupants in the building are available with mobile. So the proposed system uses voice playback module for evacuation process.

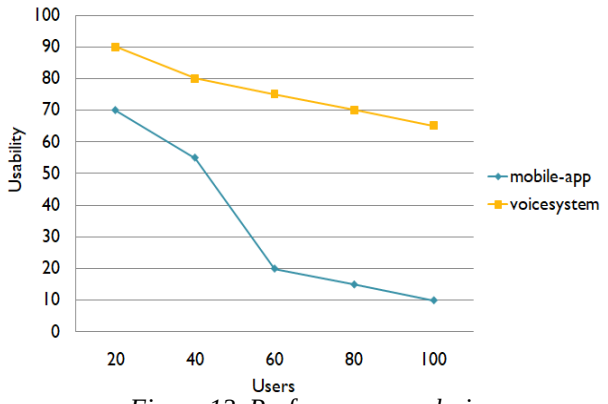

Figure 13. Performance analysis

Figure 13 shows a graph which represents the performance analysis of the proposed system. The first line from the top of the graph represents the usability of the voice system and the second line represents the usability of mobile app. From the graph, it is found that the usability of voice system is better than the mobile app. On considering a point from the graph, if the number of users is 60 then the chances for using the mobile app only 20 percentage whereas the chances for using the voice information will be 75 percentage upon the detection of fire.

V. CONCLUSION & FUTURE SCOPE

To reduce the uncertainty during fire accident, this fire detection and alert system based on IoT is designed. The main intention of the submitted work is to make the life of users to be safe during the occurrence of fire accidents in the buildings by providing a way for exiting from the affected area using the commands from the voice system. So the system effectively makes the life of the occupants safer. In addition we have considered this device to avoid people from rushing in the wrong way.

In future, the system can be improved by providing a way for finding the number of people still left in the building, after the occurrence of fire.

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