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Fire disaster evacuation and response system using the Internet of Things

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ABSTRACT

Buildings nowadays have become compound and augmented, all around the world. Present-time buildings all around the globe have become complicated & enlarged. Seeing the structural definition of buildings nowadays, safe and fast evacuation through emergency exits at times blackouts due to fire, collapsing of buildings, earthquakes or old buildings need to be possible but have become complex and leads to a problematic situation. An Industrial fire is a type of disaster in industries which involves a holocaust which occurs in industrial areas. Fires in industries often occur together with outbreaks. They are most likely to occur in places where there is a lot of inflammable objects present. This paper suggests a Fire Disaster evacuation, response system using the Internet of Things (IoT) based that can control directional guidance intelligently according to location of a disaster with help of sensor networks to attend the problems of the existing response systems during fire disasters. The proposed system has different sections, each one of them contains a temperature, flame, smoke sensor, and a communicating channel for transferring the data to the server about the location of the fire, the server receives the data and sends the actions to be performed to the far devices. The subscribed users get notified about the fire and temperature of the area, the fire department also gets all the information about the location and temperature in the area.

Keywords— *Evacuation system, Internet of Things, Fire detection, BLYNK cloud service*

1. INTRODUCTION

Fire disaster happens in buildings due to negligence and change in environmental conditions. This possess a threat to the residential and industrial areas and may results in death and damage of property. Accordingly, the fires should be found as soon as possible so that threats like these can be avoided. Finding the fire before it causes havoc is the biggest issue in fire detecting systems. In wireless fire detection systems, the system sometimes doesn't detect a fire due to failure of one or more sensors. In traditional fire disaster response systems, the exit guides which are used helps people to evacuate through the nearest exit and not the safest passage it doesn't take the location of the fire in consideration. According to a few surveys it takes above half an hour or more to evacuate when a fire is detected in the building. Fires are one of the most common and frequently occurring disaster, and the problem should be addressed asap so that the loss of life and property can be saved before any greater damage is caused and also reduce the financial loss impact overall. In most of the cases, it is found that fire accidents are comprehended when more than half of the damage is already been done. However, Internet of Things (IoT) has given everyone a method to build applications and top standard systems for industries by providing the growing pervasiveness of the wireless sensor network with radio frequency identification devices (RFID), mobiles and other sensor devices. Internet of Things applications can be found in most of the industries with a diversity of application for the smart homes, travel transportation and smart buildings, retail, personal care and health, construction, agriculture, and more. Evacuation guidance used at present is tedious because it uses exit signs to guide the evacuees during a fire. The fumes generated contains liquid, solid particles and poisonous gases, very menacing for the human body. Inhaling fumes is the root of most deaths during this disaster. Elevators often fail during a fire, trapping the occupants. IoT technology combined with WMSN (Wireless Multi-media sensor network), information fusion technology, fire proof beds, and the automatic safe haven proposal will pass all the above-defined barricades.

The flame sensor is used in your heating devices when the gas ignites the gas furnace enters into a process where either a surface igniter or spark ignites the gas. First, the gas starts burning which produces, current. The flame sensor measures this quantity in micro amps. After a time, if we don't clean and maintain the flame sensor, the sensor can malfunction due to carbon building on it or oxidation taking place. There are a lot of disadvantages in the available fire monitoring, detection, and alarm system. Few of the disadvantages are small surveillance capacity, poor reliable in detection, simple human-computer interface system, non-flexible network interface system and slow response time.

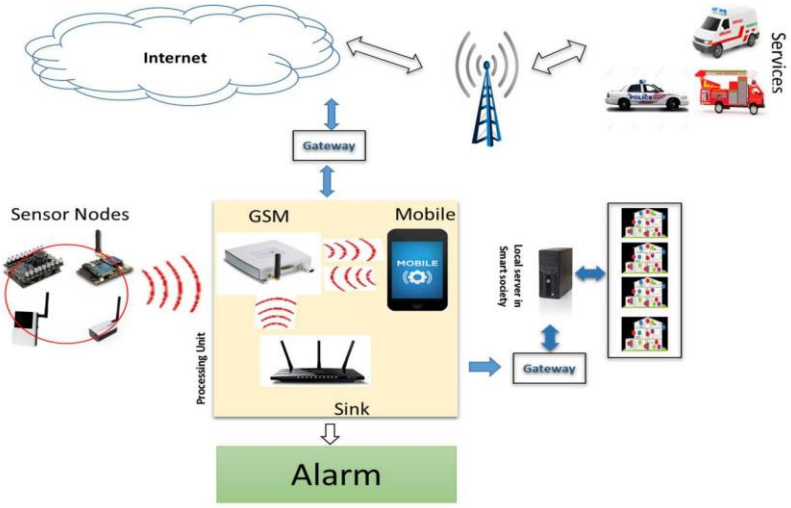

Fig. 1: Model of IoT based smart home to prevent any outbreak of fire

The fire monitoring system currently in use has false negative responses and false positive responses are high in number. The rate of occurrence of problems in these systems are large and the time delay in detection is serious. It is necessary to form a system to overcome these problems and satisfy the requirements of the user. The wireless system price and performance are not good compared with the wired system. Even though the advantages of wireless are many. Some of which is the fast speed of installation, less power consumption, application places are wider and small damages to the buildings. The wireless system is a simple, low cost, short delay, and flexible network structure. It could meet all the requirements of the user.

2. METHODOLOGY

In our proposed method we are using a flame detector using an infrared object sensor when it detects the fire the response system is activated, and the buzzer is used to sound the alarm, the location or room of each sensor is encoded so that the people and the fire department are notified about the whereabouts of the fire. The temperature of the fire is monitored using an integrated temperature sensor (LM35).

The temperature sensor along with smoke sensor is used to prevent any false alarms by monitoring the temperature of the area one can also know the progression of the fire. The location of the fire is also encoded so that the fire department can use Google maps to find the location of the building and navigate their way quickly.

Arduino based security system using RFID – The system designed as shown in figure 1, is a security-based system for industries.

The system contains the following components: Arduino UNO R3 Board-Arduino board, this acts as the central processing unit of the system it controls all the other devices. It reads the input from the RFID tag reader where the RFID tag reader gets the input from an RFID tag which can be a card or a key-chain or any other material, this tag contains a unique 12 bit alphanumeric unique code at the serial port. This is used to identify who all have evacuated the building and who all are still in the building.

2.1 NodeMCU Wi-Fi Module (ESP8266)

A Wi-Fi module contains SOC, it has an integrated TCP/IP protocol, which provides any micro-controller access to the Wi-Fi network. Power Supply Transformers/Battery adapter/9V high watt battery. SPDT Relay Coil Single pull double through relay for the purpose of AC appliances (ON and OFF).

2.2 Sensors

2.2.1 Thermistor Sensors (LM35): It is an integrated temperature sensor, it is highly efficient and calibrated, some of its attributes is that it doesn't get heated much and it has low linear impedance. It gives an analog output and the output voltage is directly proportional to the temperature in Celsius. The output range of this device is -50 degrees to +150 degree Celsius.

2.2.2 IR Object Sensor/Flame sensor: This sensor detects flame by detecting IR radiation from the flame it has a threshold when the threshold is crossed it triggers the circuit by sending data that a flame is detected.

2.2.3 Smoke/Gas Sensors (MQ2) Gas Sensor -This sensor is usually packed in a plastic cage which is usually 25mm thick and 150mm in diameter (to be contd.) This device is useful for gas leak/smoke detection. These devices are small in size, it works on the principle of Non-Dispersive Infrared (NDIR), to detect carbon dioxide in the air.

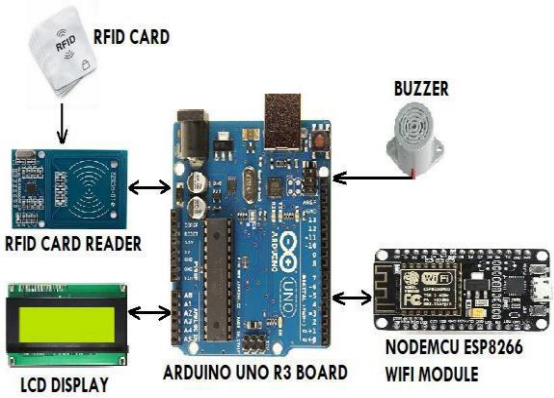

Fig. 2: System architecture of assembly point 1-arduino based security system using RFID

In our proposed method, we used these sensors mentioned above and calibrated the threshold for each sensor. The sensor reads the data from the environment, if the data obtained is higher than the set threshold, then the sensor sends the signal that the fire is detected.

3. IMPLEMENTATION

(a) Radio Frequency Identification (RFID) technology is implemented, it uses RFID tags as a component in a solution set. The tags have a chip embedded which carries an electronic product code or EPC number it points to the additional data or the contents of the package. The RFID readers can read the tags from a certain distance and doesn't need a line of sight or any physical contact between the reader and the tag.

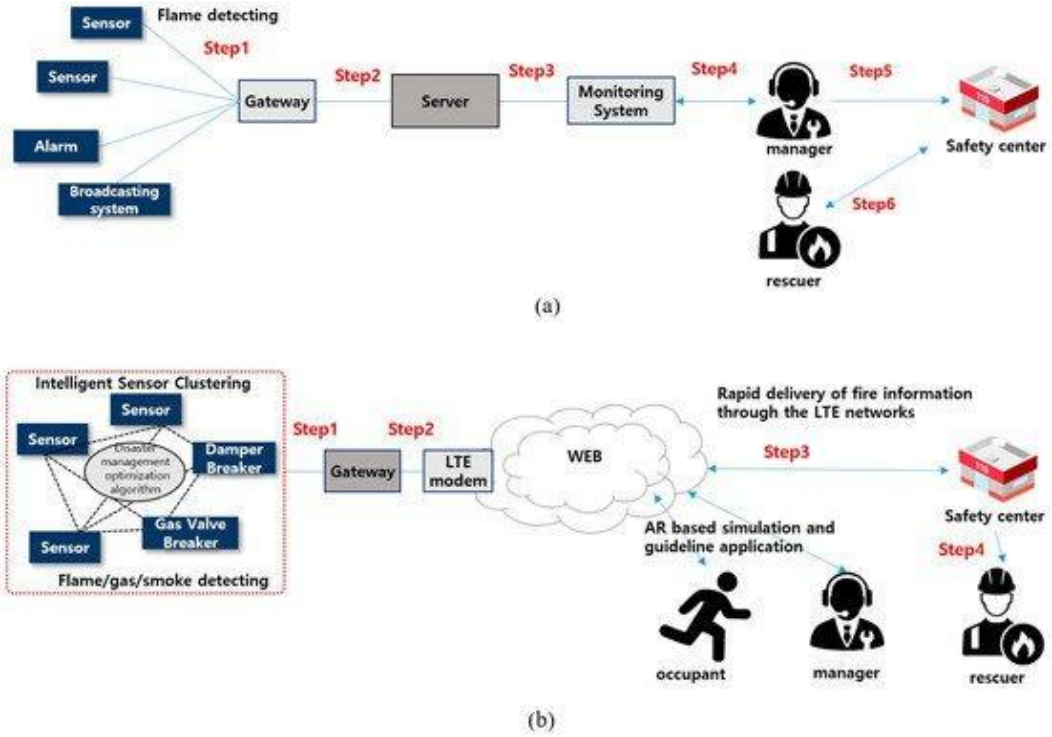

Fig. 3: Schematic diagram of existing vs. proposed system (a) Existing old system (b) Proposed new system

(b) The figure shows the basic schematic diagram of the already existing system and our proposed system.

(c) Smartphone Application Development: We are using an app which uses the internet to receive the data so that anyone at any place can receive the notification or alert and the details about the location and presence of the fire. The app shows the live monitoring of the temperature of the area and also it helps the fire department about the location of the building on Google maps so that they can use it to navigate to the building immediately. It also notifies people which all people have escaped the building and which all are still in the building with the help of RFID technology.

(d) Upload data to Blynk cloud: Blynk was designed as an application to the Internet of Things (IoT). Using this app, we can control the microcontroller or monitor it wirelessly, it can be used to display or store the data and many other things. There are three main components on this platform-:

- **Blynk Server**: It acts as a gateway for all the communications between the hardware and software. It has its own Cloud, Blynk Cloud or you can also use your own private server to keep the data secured. It can be used to control thousands of devices whether its Microcontroller or Microprocessor
- **Blynk App**: Using the Blynk app one can create interfaces and various widgets are provided along with it to create any project of your choice.
- **Blynk Libraries:** It helps to establish a communication with the Blynk server and processes the outgoing & incoming commands.

4. RESULTS AND DISCUSSION

Our proposed IoT based smart evacuation and response system can decrease the casualties during fire disaster by sending the details about the presence of the fire and also the location of the fire. It also used a light guide to the safest exit to prevent the people to go through the exit where the fire is generated or present. This proposed intelligent emergency response system can reduce the casualties of the disaster in industries to prevent the employees, industrial machines and infrastructure by providing appropriate evacuation guidance. This system uses light weighted protocols and cloud services so that the response is fast and the rescue operation can be done immediately. The location of the hazard is sent to the Blynk Cloud alone with other data such as temperature or the room in which the fire was generated then the Cloud communicates the data with the app sending all the data to the app via internet. Internet of Things is emerging nowadays it provides smart solutions in Smart Cities. This emergency response system it implemented using IoT standards which helps immediate rescue operation during fire disasters, it also sends the information needed to the public safety management. This prevents casualties and also controls the traffic while escaping from the building. This system can be made advanced if Artificial intelligence or Data mining is used.

5. CONCLUSION

So, to summarize our proposed system, we are taking help of IoT to monitor and send data via the internet to the app and respective public safety management, using IoT smart cities are becoming smarter. We are helping the people to evacuate the building immediately in case of a fire disaster. We are using guidance lights to help evacuees evacuate via the safest passage instead of the nearest passage. We are also notifying the fire department about the progress of the fire and the location of the fire so that they can plan accordingly also they get the location of the building so that they can easily navigate to that infrastructure using Google maps. They will also have the details of people who escaped the building and people who are still in the building. As we know half or more damage is already done before the fire is extinguished so this system helps people to escape quickly and safely preventing the loss of life and property.

