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A Survey on IoT based Intelligent Fire Escape System

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ABSTRACT: The emergence of IoT luminaires has been tremendous in recent times. The major companies are also making a move to include IoT in their products. The main aim for making this project is to use the best technology to do the best possible thing i.e. to save lives. It is possible to save the loss of lives in the major disasters like fire, since fire is the most prone disaster to take place ahead of all other disasters.

There are technologies available for telling the escape route to the public trapped inside the building on fire, but they cannot tell about the exact location of the fire and can eventually lead to more casualties. There are also fire drills being carried out in the societies and the schools for educating the masses to respond to the emergency situations. But it is again not foolproof as it contains more human interaction since time elapses in noticing the fire and then informing the fire station about the fire. The camera installation at every place in the building is also possible in today's scenario, but it is not effective in case of power cuts, which happens in most cases of fire incidents in buildings.

The proposed system consist of modules, each containing a flame sensor, temperature sensor, gas sensor, a communication module for sending the information to the server about the intensity and the distance of the fire, the server calculates the exact information and informs-- the various agents regarding their actions to be performed. The agents include the customers gets notified about the presence of fire in the building, the fire station representative which gets the information about the exact locations and the intensity of the fire.

KEYWORDS: IoT; Disaster Management; LBS; navigation; escape system; Arduino; Maps;

I. INTRODUCTION

IoT is being used in India in all the fields but not in the Disaster Management, as yet. Fire is the most frequent disaster to take place in a building. To get out of the building on fire safely can be difficult at times, as you do not know about the location of the fire and you may encounter a fire on your route to exit. Also, some societies and localities provide fire education, but since it is not given to the most it is irrelevant as many people do not know how to react in emergency situations. Their companion (mobile phone) can help them to come out of the such life-threatening situation by informing them about the route to exit. For example, there is a fire breakout in a building near an exit and people are struggling to find a route to come out of the building since the guidance lights in the building are pointing to the same exit!!

The fire department also, needs to be informed by the people and also take time to find the location and the cause of the fire in the building. For example, there is a fire in a room of a large building. At first, a person must notice the fire as early as possible. Even after noticing the fire, he first leaves the building then informs the fire department about the fire. The firemen know about the building and the floor on fire but has to find the room on fire in order to put out the fire. Also, knowing the cause of the fire can prove helpful for them. This whole process can be done a lot quicker and more people and property can be saved from the fire.

Our system aims at performing the following tasks: Detect the fire in the building, Inform all the people in the building to evacuate by giving them appropriate directions, alerting the fire department about the intensity and the

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location of the fire. The project implements the fuzzy logic in the centralized server for calculating the distances of the fire from the various devices placed at specific locations in the building. Each device consist of the arduino uno board with flame detector, smoke detector, gas detector, temperature sensor. Location Based Services are used to find the people inside the building and inform them about the fire as soon as it is detected. E-mails will be sent to the people inside the building about a link containing the evacuation plan. Wired medium is used for communication among the various modules and with the centralized server.

II. RELATED WORK

LBS refer to mobile services. GPS technology is used for most different fields which is one the most obvious technology for LBS. Generally, LBS are based on wireless LDTs which are either terrestrial (a limited operational area) or spatial (Global navigation system). Mobile networks (GSM, GPRS, UTMS) are available everywhere but the positioning accuracy is rather low (100m and more). Terrestrial LDTs are represented by different methods to determine the position of the mobile device in the wireless communication operator's networks. It is based on computations done in the handheld device or by the network's LMC (Location Measurement Center). It is possible to determine the location with different methods for LBS. However, these methods have different accuracy level. Network Based-Hybrid, one of the two fields in LDTs. This technology uses the network of the operator to determine the location of the mobile device. All mobile telephone networks that are used and are built the same way: The network is organized in cells around the antennas of the BTS, which connect the user terminal to the global telephone network.[1][2].

ZigBee, a wireless sensor network which combines driver's display unit and signal transmitter, is considered to be one of the reliable applications. This network is composed of micro sensor nodes which have the ability to calculate. These nodes can monitor sense and collect information of different locations in the coach. Compared with other wireless technologies, ZigBee techinques has provide important of unique advantages are safe and reliable in data transmission, an easy and more flexible network configuration, low cost for equipments and Long- lasting batteries. The ZigBee Alliance is not pushing a technology; rather it is providing a standardized base set of solutions for sensor and control systems and The ZigBee Network Node is designed for battery powered or high energy savings. Thus, it has great development potential and a promising market application in the field of industrial control. By applying a wireless sensor network based on ZigBee to a train fire monitoring system, information such as temperature and relative humidity at any part of the train covered by the network could easily be collected, dealt with and analysed at any time.[3] The thermocouple temperature sensor is to monitor for fire conditions external and internal alarms, together with automatic operation of the alarm system in organization. When the temperature senses it triggers the alarm make the people alert and wake up who are present in the building. The carriage Controllers have associated with the LED batteries such that fire protection is maintained by indicating the color lights in the security manager. As a backup, the alarm also installed in the building[4]. A self-controlled smart system is proposed with microcontroller unit to control and integrate the information received from different sensors(the location, the severity and the breakout). It informs the fire services and the other users about the fire via messages and phone calls. It also put out the fire by releasing the extinguishing gas at the exact location of the fire[5]. No navigation for the users.

An IPS system being used in the critical environment must have the following important features:

- The system must be on an ad hoc basis without any requirement for pre-setup platform such as cabling, electricity power supply and permanent devices installed in a fixed located
- The system must be portable and flexible without any requirement on location for installation.
- The system must be integrated with position tracking and communication capability in real time.
- The system must be controlled remotely.[8]

Wi-Fi and Cloud Technologies is used for detecting fire, gas leakage, or smoke and informs the owner about the hazards in the house by integrating the information received from the various servers[7]. Pedometry and indoor mobile Augmented reality can be used for evacuating the building in the emergency situations by recommending the best way out of the building in terms of time for evacuation. GPS and Wi-Fi based positioning system used for better understanding and communication within the network[9].

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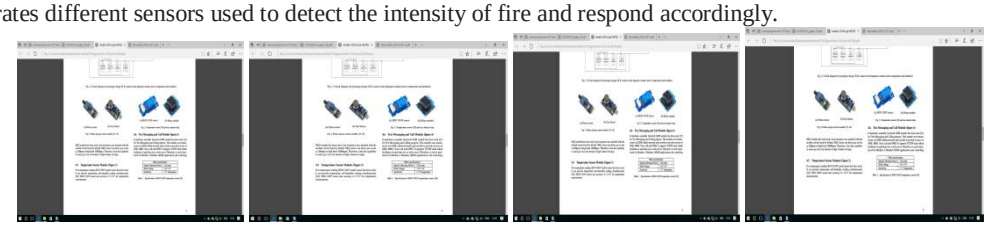
A prototype consisting of vehicle mounted units is proposed for vehicle platforms and portable units for dismounted personnel, where the vehicle mounted unit has 100-200 meters diameter of cover range and the portable unit with 50-100 meters diameter of cover range[6].

	One Hop	Two Hop
Network cover range	200m x 200m	400m x 400m
Data Transmission capacity	24kbps	24kbps
Positioning accuracy	10 cm	25 cm
Target tracking accuracy	20 cm	50 cm

Table 1 shows UWB cover ranges and accuracy of positioning and target tracking[6]

III. PROPOSED SYSTEM

The Proposed work is to provide people an overview of intensities of fire at different places, and also suggest a path to follow for safe evacuation of people. The setup consist of Arduino Uno, flame sensor, gas sensor, temperature sensor and Zigbee module. Technologies used are location based services, Zigbee. Arduino uno is used for providing interface between sensors and server. Figure 1 illustrates different sensors used to detect the intensity of fire and respond accordingly.

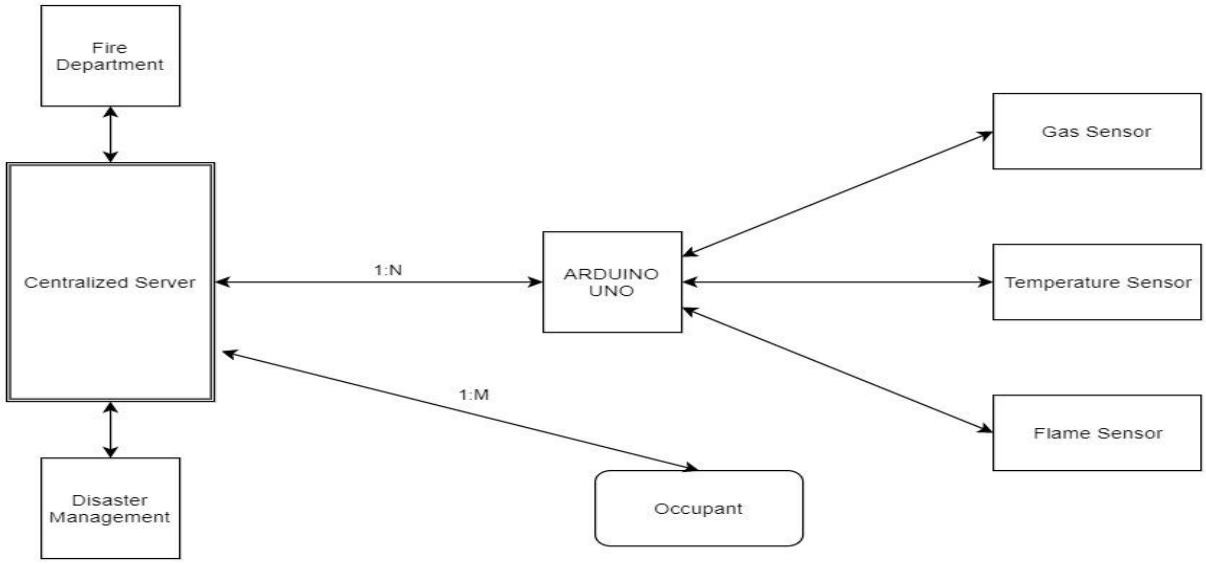


a b c d

(a) Flame sensor (b) Gas sensor (c) Temperature sensor (d) One channel relay

Figure 1: Different types of sensors[5]

Figure 2: Block Diagram of the Proposed System



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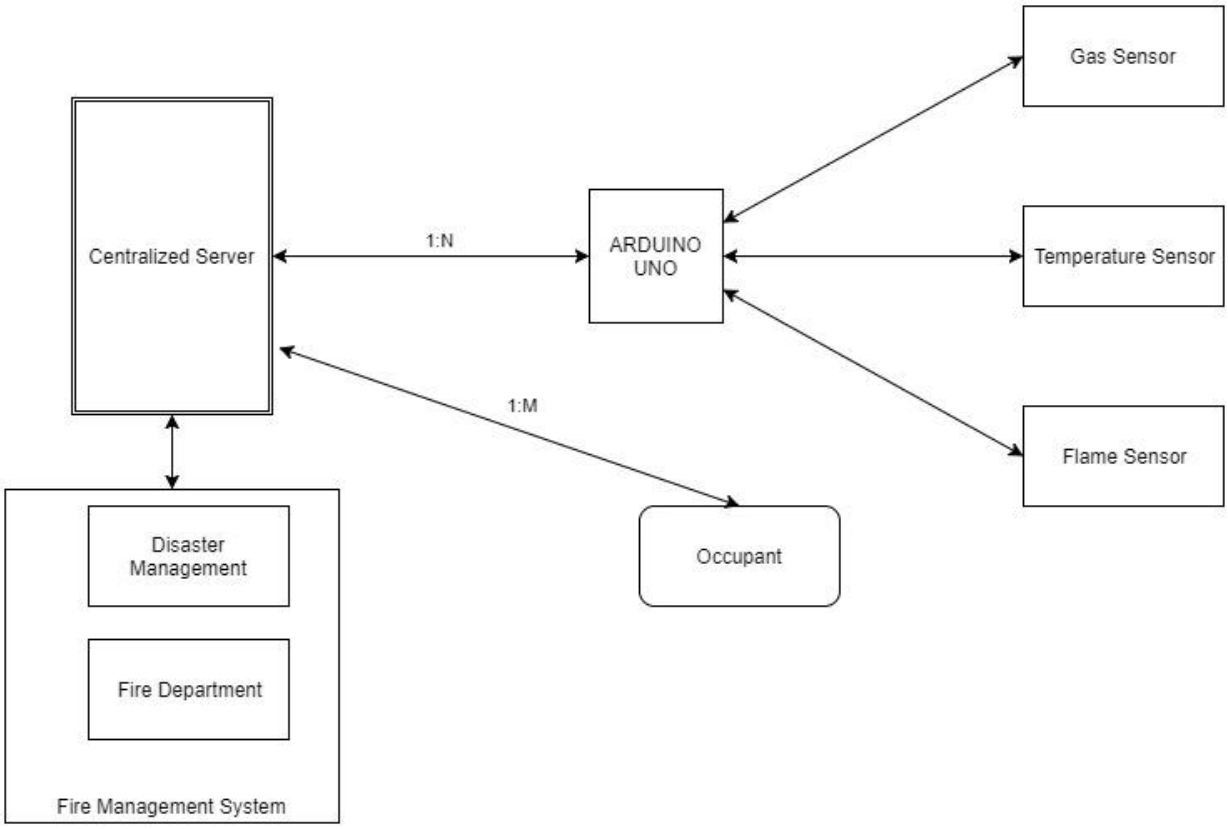

Different sensors are connected with Arduino Uno. The total no of Arduino Uno depends on area, efficiency and need. Thus, different Arduino Uno are connected with centralized server. Centralized server is used to receive data from sensors, and thus calculate intensities and give the result to the Fire Management System. Different occupants are then updated and given to occupants. It also shows navigation, and overview of fire estimation and occupants can also derive their own way based on data provided. The centralized server consists of a Database, a Map Server (for displaying and managing map operations), Logic Unit (for doing calculations) and Control Unit (for taking decisions).

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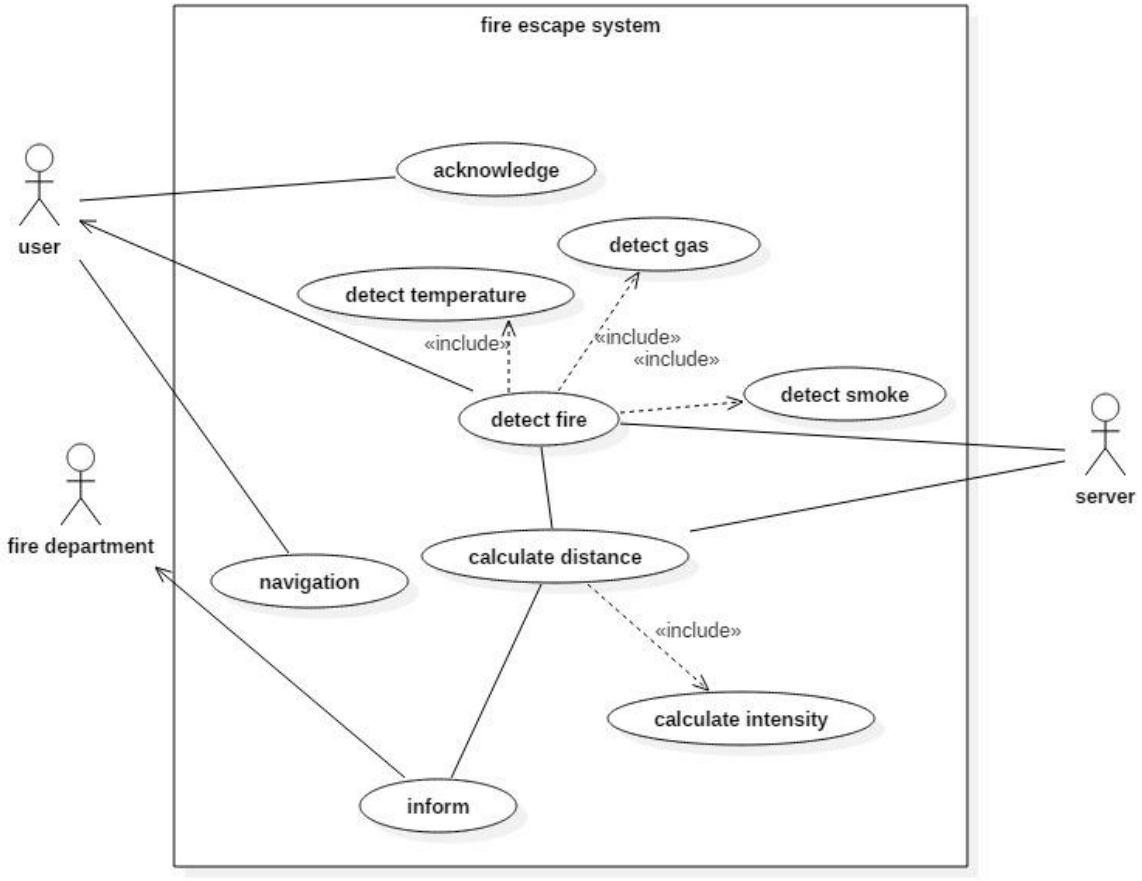
IV. ANALYSIS

Figure 3: Use case Diagram of the proposed system



In Figure 3, the actors involved are user, fire department and server. User is an actor who is trapped inside the building, Fire department is informed by centralized server when it detects fire with the help of the sensors. The job of centralized server is to take the values from different sensors and calculate intensity, location and proximity.

Figure 4 shows the list of activities that are to be performed. It begins when the sensors detect fire and then it calculates its intensity, location and proximity of fire. It then sends the updated map to the users present inside the building. It also provides navigation to exit safely on the basis of calculated intensities, location and proximity. It also provides user to choose any other path, thus providing flexibility. It also informs the fire emergency services immediately.

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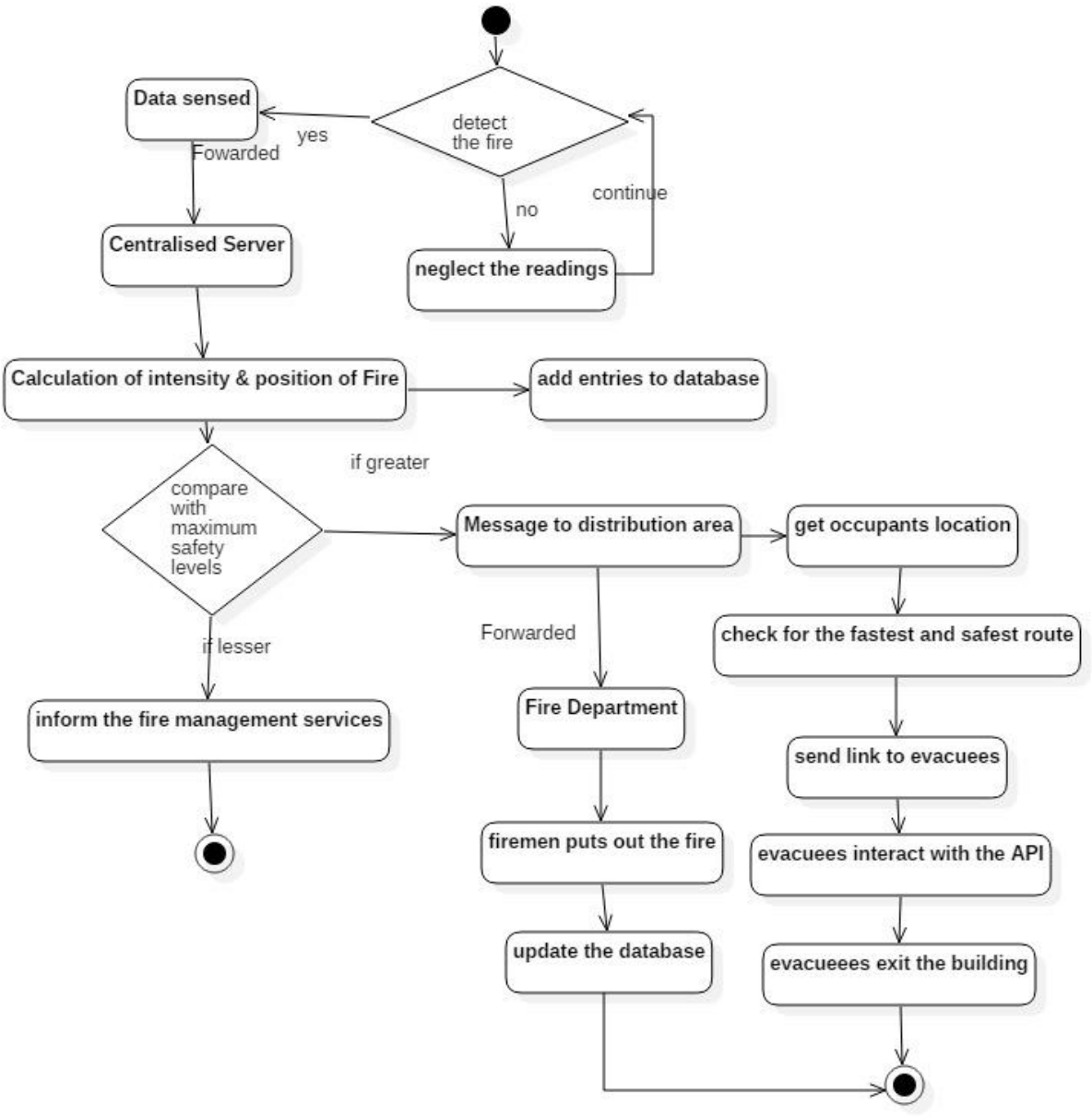
Figure 4: Activity Flowchart of the Proposed System



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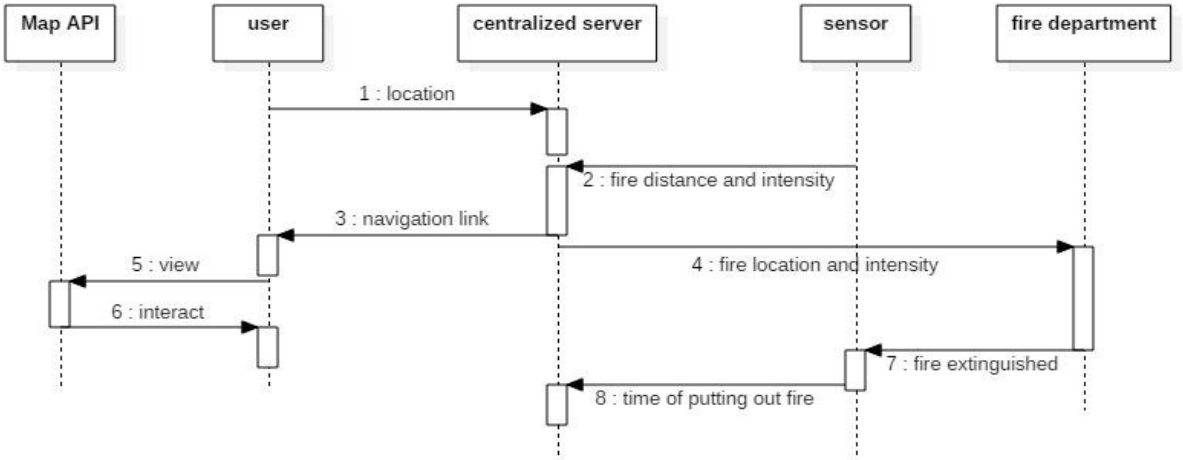

Figure 5: Sequence diagram when intensity of fire is greater than the maximum safety level

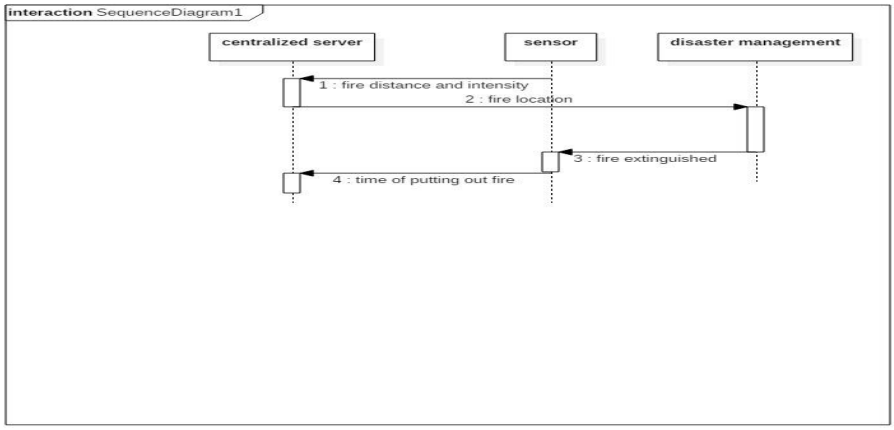

Figure 6: Sequence diagram when intensity of fire is less than the maximum safety level

Figure 5 shows when fire with very high intensity is detected. It shows the sequence of activities that are to be performed. Initially, user's location is fetched and if it is within fire affected area, then updated navigation is sent to that user.

Figure 6 shows sequence of activities that are performed as far as centralized server is concerned. When this server detects fire, it immediately informs fire dept so that effect of fire can be minimized.

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V. DESIGN

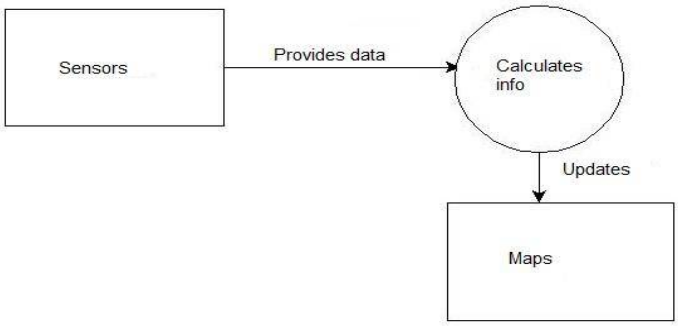

Figure 7: DFD Level 0

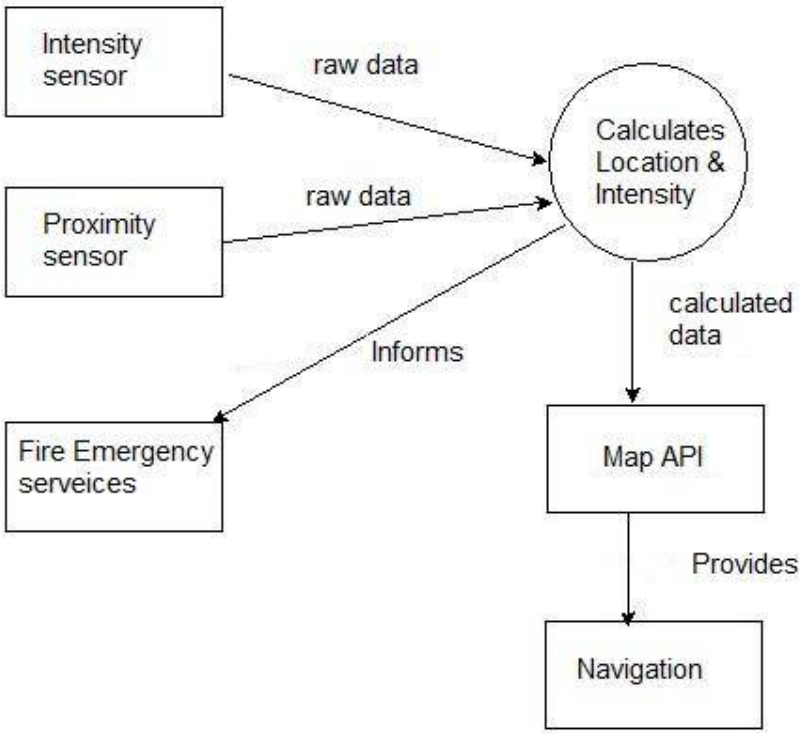

Figure 8: DFD Level 1

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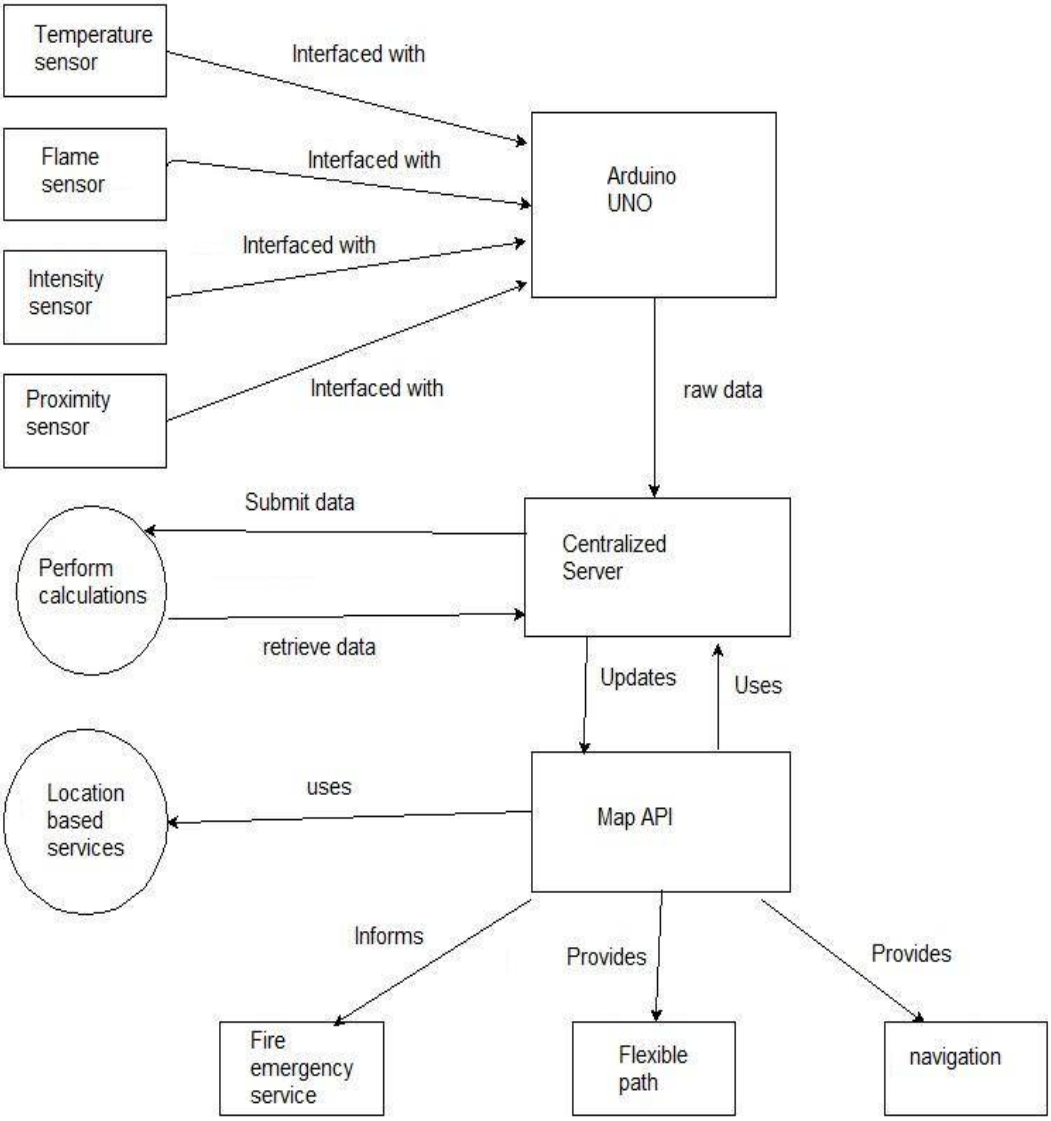

Figure 9: DFD Level 2

Figure 7 shows the data flow diagram at level 0. Sensors act as input and it provides data and which is updated on maps.

Figure 8 shows data flow diagram at level 1. Sensors act as input and it provides data to centralized server. Centralized server then updates maps and also provides navigation and also provides flexible path.

Figure 9 shows data flow diagram at level 2. Sensors take the input and provides it to centralized server. Server then calculates proximity, intensities and updates it on google maps which uses location based services. Google maps only provides updated maps to those users which are currently in the building which is under fire. Users can use navigation provided or use their own flexible path based on the map provided.

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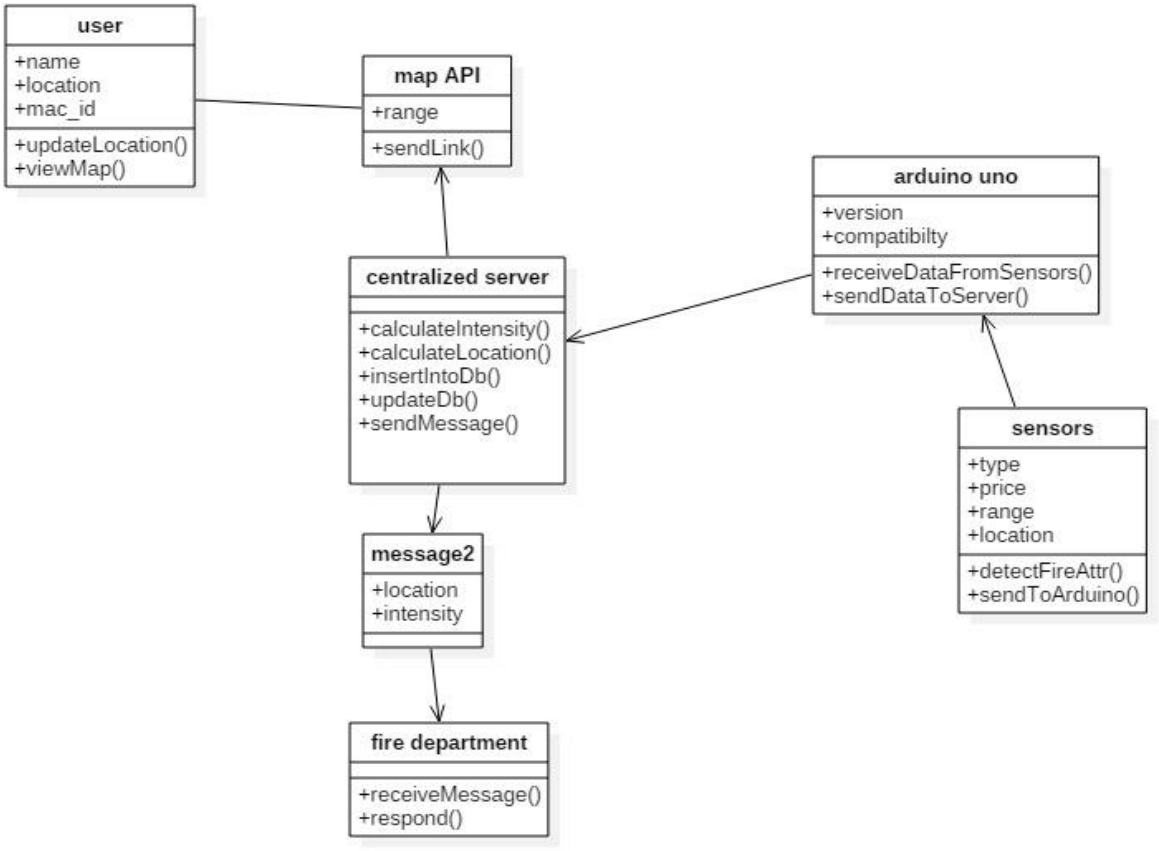

Figure 10: Class Diagram

In Figure 10, the classes present are Centralized Server, user, map API, fire dept, sensors, arduino uno, message. Centralized server is the center of this project. Second row contains all the attributes related to that class. Third row in class diagram are methods or operations that are to be performed regarding that particular class. Fire Dept is just a small module and it for this project, does not contain any attributes. It is because the action taken by them depends on fire dept itself and it cannot be predicated or premeditated.

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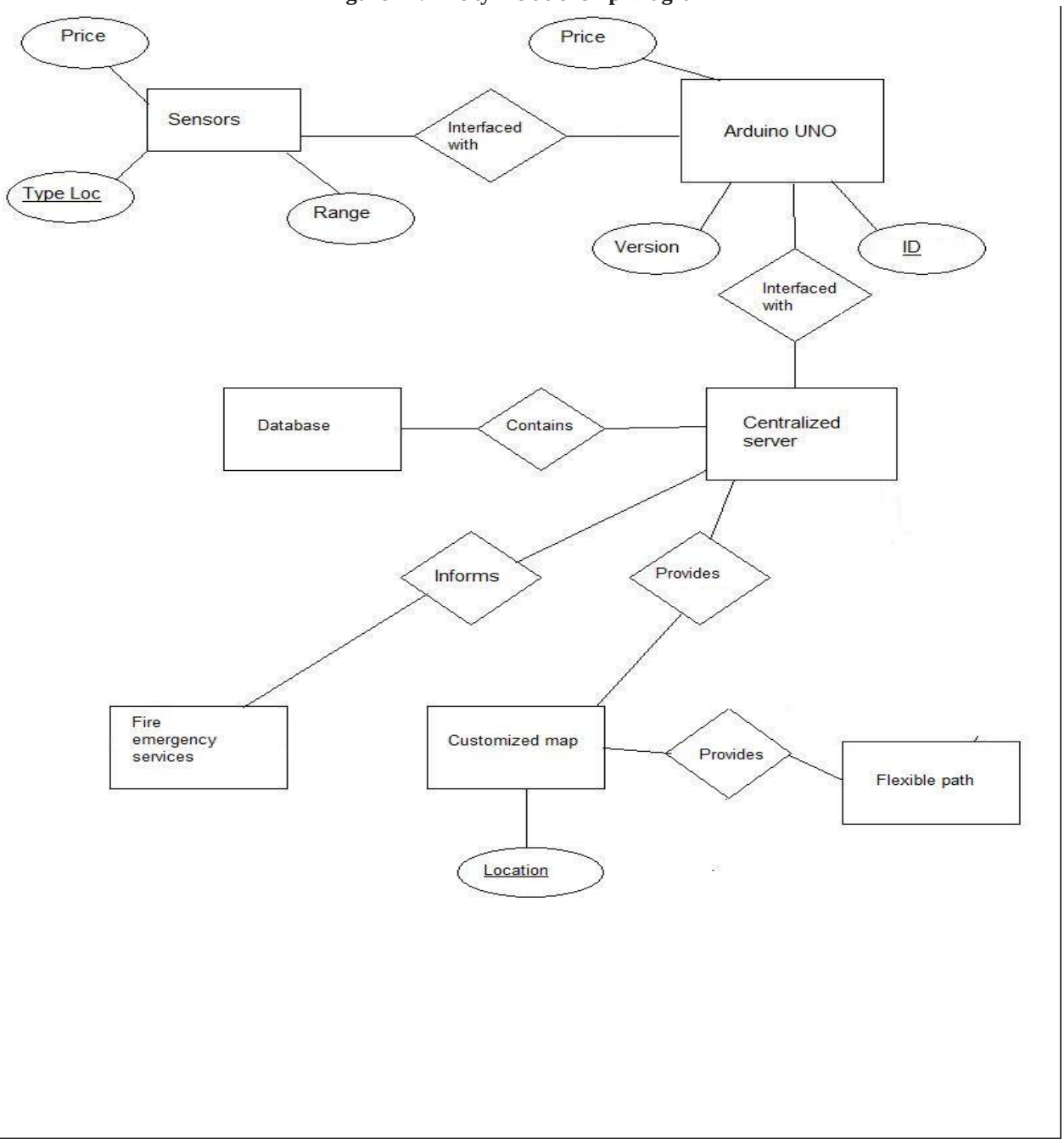
Figure 11: Entity-Relationship Diagram



Different entities present in the Figure 11 are Centralized server, Fire emergency services, sensors. Sensors have different attributes like range, version, etc. Sensors have relationship 'interfaced with' Arduino Uno. Thus centralized server is connected with two alternatives: navigation and flexible path. Anyone of these has to be chosen. It also informs Fire emergency services.

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VI. CONCLUSION

Our system removes many of the limitations of the existing system. It automates all the work from detecting the fire to informing the fire station to put out the fire, hence, doing it a lot quicker. Our system focuses mainly on evacuating the people from the building on fire so that there are less casualties. It also aims at controlling the traffic out of the building so as to avoid stampede. It will not put out fire by itself since only one methodology cannot be used nor it can prevent fire from spreading. But it also can be extended if Artificial Intelligence and Data mining is used. If the above technologies are used without restrictions, then it can serve many additional purposes like putting out fire and identifying the fire prone areas.

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