International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 8, Issue 2, March - April 2019 ISSN 2278-6856

Intelligent Fire Rescue System

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Abstract: Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording physical conditions of the environment and organizing the collected data at the central location. WSNs measures the environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on. Detecting isolate safe areas is significant for various applications of event detection and disaster monitoring since valuable real-time information can be provided to save people who are trapped in isolate safe areas. Centralized method detects isolate safe areas via discovering the holes in an event area but results in detection delay, so distributed isolate safe area detection method is implemented that starts scanning from the potential isolate grids to discover all the isolate safe areas effectively.

Keywords: Sensor networks, isolate safe area, area detection, rescue.

1. INTRODUCTION

Wireless sensors play an important role in Internet of Things to collect data and information of physical environment and objects possible. Sensors have the capability of sensing, computation and communication that is emerging all over the world. Different kinds of sensors within the sensor network are capable of gathering large amount of information such as temperature, humidity and light intensity, at any time, any place, and under any circumstances. Sensor networks are widely implemented to monitor surrounding environment and detect events in military fields, national security, traffic control, health, environmental monitoring, industry, disaster prevention and recovery [1]. The sensor network play an important role in Intelligent Fire Rescue System.

At a moment's notice, a fireman is ready to perform his job functions such as rescuing people from a burning building, fighting fires and providing emergency medical assistance. But sometimes they fail to rescue as there is no way to find exact location of trapped people.

Intelligent Fire Rescue System can be used in various fields to carry out rescue operation more safely and timely, as finding the location of trapped people is the key of rescue. The system detects fire according to abnormal temperature and smoke intensity sensed by sensors and triggers alarm to inform people and fire-fighters, and generates real time fire maps to find the location of trapped people to help them get most efficient route. Evacuation within buildings is done through Web or mobile application service [5]. In the system, user's login to the application once they know there is fire around and sends details like his location, floor number and 'Help Me' message to the fire department. The fire department uses this information to calculate the shortest path for the trapped person using effective algorithm. This shortest path is sent to the user's application and the fire fighter to perform rescue operation.

2. RELATED WORK

Event detection of wireless sensor networks has been widely studied by researchers.

In Ref. [1], detection of isolate safe areas to save trapped persons is discussed through a centralized detection method and a distributed detection method, respectively. The centralized version is easy to be implemented however, its response delay is longer than the distributed method.

In Ref. [2], a fire rescue architecture with Fire-Net is proposed. The system requirements including accountability of fire-fighters, real-time monitoring, intelligent scheduling, resource allocation, Web-enabled service and integration are widely discussed. Implementation challenges of this system are also addressed in this work.

In Ref. [3], a cellular-automata-like algorithm and an averaging consensus algorithm are proposed specifically for the fire detection and also for localization with sensor networks. When fire is detected in the network, the algorithm notifies all its neighbouring sensor nodes rapidly. Then, the algorithm predicts the parameters of the circle surrounding the fire detected location. The proposed method can detect the fire rapidly and monitor extension of fire in real-time manner. Also, every live sensor has the information of the fire outbreak and extension.

In Ref. [4], algorithms are proposed to detect the event boundary and faulty sensors. The proposed algorithms can be used to the outlier detection and regional data analysis.

In Ref. [5], an IOT-based intelligent fire emergency response system with decentralized control that can intelligently guide evacuees which is based on the location and time of fire to minimize the loss of human life is discussed. This system can reduce casualties by determining the point of occurrence of a disaster in a building to prevent directional confusion, so it does provide the emergency lights and inappropriate evacuation guidance.

In Ref. [6], designing and evaluating a wireless sensor network using multiple sensors for the early detection of house under fires is discussed. In addition to this, it uses the Global System for Mobile Communications (GSM) to avoid false alarms. To test the results of our fire detection system, we have simulated a fire in a smart home using the Fire Dynamics Simulator and language program. The simulation results showed that our system is able to detect fire early, even when a sensor is not working, while keeping the energy consumption of the sensors at acceptable level.

In Ref. [7], a distributed method of dynamic event region detection is been studied. Dynamic Markov random fields are used for the model of the spatio temporal relationship of the evolving regions. To improve the performance loss of conventions, the quickest change detection methods, whose work uses the system dynamics to predict the field evolution and proposes the distributed event region detection algorithm using mean field approximation approach. A hybrid detection scheme is also been introduced to improve the performance for rarely occurred events.

3. METHODOLOGY

Before moving on to the methodologies we see what is isolate safe area. An isolate safe area is a continuous area which is surrounded by a dangerous area. We assume safe grids located at boundary of the whole monitored area cannot be a grid of an isolate safe area.

TABLE I. CENTRALIZED:

To discover isolate areas, an m *n matrix *A* (m rows and n columns) is created to make help for the processing. The matrix element of a safe grid is set as 0, and the matrix element of dangerous grid (affected by the event) is set as -1. The basic idea is to mark each grid either safe or isolate safe. Since safe grids on the boundary must be a part of a safe area, it must start to process all grids on the boundary, then move to the inner grids next to boundary grids until the center is reached. If the current processing grid which is safe has a processed safe neighboring grid, the neighbor's area id is used to mark the current grid otherwise, a new area id is used to mark it. This way through centralized method it is possible to discover isolate safe areas and dangerous areas.

TABLE II. DISTRIBUTED:

To shorten the response delay of isolate safe area detection, we design a distributed method to discover isolate safe areas during the in-network processing of event queries. In order to discover isolate safe areas as early as possible, we also process along the reporting tree from the bottom to the top. For each internal node, its responsibility is to discover isolate safe areas within the sub-area it covers. Here, an isolate safe area within a sub-area means that any grid of this isolate area cannot be located at the boundary of the sub-area. The grids at the boundary have a chance to be merged with grids in its adjacent subareas, thus whether it is an isolate safe area or not and its range cannot be determined at the current stage; so these will be saved for the current node's ancestor to judge. When an internal node discovers an isolate safe area within its sub-area, it will send the report of the isolate safe area to the base station directly instead of sending along the reporting tree, thus guaranteeing the isolate safe areas can be reported immediately.

4. SYSTEM DESIGN

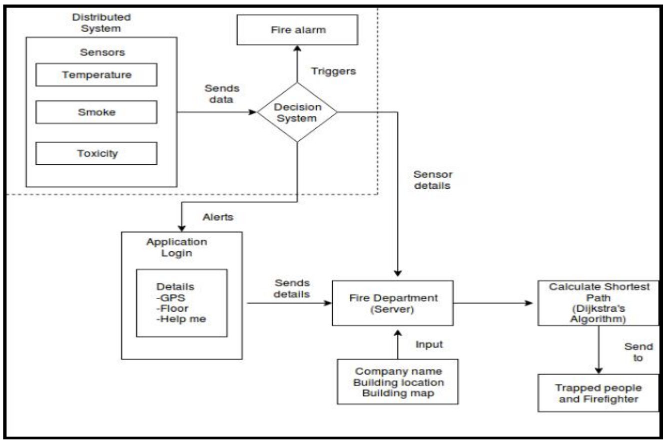

Figure 1: Architecture Diagram

1.2 SENSORS:

A sensor is a device that detect events or changes in its environment. The term input device in the definition of a Sensor means that it is part of a bigger system which provides input to a main control system. The following are the types of sensors.

4.1.1 TEMPERATURE SENSOR:

A Temperature Sensor, senses the temperature i.e. it measures the changes in the temperature. The changes in the Temperature correspond to change in its physical property like resistance or voltage.

4.1.2 SMOKE SENSOR:

A smoke sensor is a device that senses smoke, typically as an indicator of fire. These are housed in plastic enclosures, shaped like a disk.

4.1.3 TOXICITY SENSOR:

Toxic gas sensors are micro fuel cells, designed to be maintenance-free and stable for long periods. The simplest form of electro-chemical toxic sensor comprises two electrodes: sensing and counter, separated by a thin layer of electrolyte. These sensors sense the fire using the above three sensors and sends it to the Decision system.

1.3 DECISION SYSTEM:

The Decision system, makes a decision according to the information sent by the sensors about the fire. After acknowledgement of fire, it triggers Fire Alarm and also alerts about the fire detected to the Application logins for their safe rescue. It also sends these sensor details to the Fire Department server so that they can help to avoid the loss of life.

1.4 FIRE ALARM:

Once the information about the fire is sent by the Decision system, an alarm is triggered so that people in the building know about the fire detected.

1.5 USER APPLICATION:

This is an application program made available to the people present in the building. This application must be installed in every person's mobile who are in the building and must also register to the application by providing basic information asked while registration. This information about the people is sent to the Fire Department.

1.6 FIRE DEPARTMENT:

The Fire Department has information about the people in the building provided by them while registration and when it learns about the fire in the building it calculates the safe path for the trapped peoples rescue. It also makes fire-fighters available to rescue those in danger safely from the building.

1.7 ROUTE CALCULATION:

A safe and shortest path is calculated to rescue the people from the building. This calculated path is sent to the fire-fighters as well as to the trapped people for their safe rescue from the building.

5. CONCLUSION

Our focus centers on providing real-time and accurate information for the rescue missions when dangerous events take place. We are finding the most efficient route for the rescue of trapped people. The system is able to detect fire with the help of sensors and it triggers alarm to inform the people and also notifies the fire-fighters. The Fire department acts as server to calculate the shortest path. Evacuation within the buildings is done through Web or mobile application service.

The purpose of Intelligent Fire Rescue system is to increase the safety through emergency responders and building occupants by increasing the fire protection during fires and similar emergencies which is done through various aspects by the system where knowing the location of trapped people is the uniqueness of the system. For better understanding, the needs of the fire services, designers and code officials can work together to streamline fire service emergency operations within the built environment.

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