УДК 614.842.4:004.94

ИСПОЛЬЗОВАНИЕ ИНФОРМАЦИИ ПОЖАРНЫХ ИЗВЕЩАТЕЛЕЙ В РЕЖИМЕ РЕАЛЬНОГО ВРЕМЕНИ ПРИ РАБОТЕ ПОЖАРНОГО РАСЧЕТА В ВЫСОТНЫХ ЗДАНИЯХ

Шу Сюэмин, доцент
тел. +86-1062796981, shuxm@mail.tsinghua.edu.cn

Ву Джинжин
тел. +86-18522288295, wu-jj16@mails.tsinghua.edu.cn

Танг Шиян
тел. +86-13520756279, 1007939330@qq.com

Ху Джун
тел. +86-18810654098, hujun18810654098@126.com

Отдел инженерной физики, Институт Исследований Общественной Безопасности,
Университет Цинхуа, Пекин, Китай, 100084

Гуан Джингфу
тел. +86-13225607610, guanjinfu@gsafety.com

Отдел инженерной физики, Институт Исследований Общественной Безопасности,
Университет Цинхуа, Хэфэй, Китай, 230000

В случае возникновения пожара в здании необходимо собрать как можно больше полной информации о горящем здании. Имея такую информацию, пожарный расчет может своевременно выехать к месту происшествия для подавления огня на ранней стадии.

Использование технологии IoT (Internet of Thing – Интернет вещей) позволяет в режиме реального времени контролировать координаты и текущее состояние противопожарного оборудования, такого как пожарные гидранты, дымовые извещатели, извещатели пламени, собирать информацию о состоянии конструкций зданий и расположения очага возгорания. Аналитическое моделирование дает возможность спрогнозировать характер распространения пожара, местоположение пострадавших людей и пожарных-спасателей. Такая информация может быть полезной спасателям в ходе ликвидации пожара, значительно повышая эффективность пожаротушения и спасения.

Проведен ряд исследований по обнаружению пожаров в высотных зданиях, включающих технологию динамической оценки полей пожарного риска в процессе реагирования, систему локализации персонала в высотных зданиях и сетевые пожарные технологии. Указанные технологии могут помочь руководителям тушения пожара производить разведку на пожаре и спасение людей, и уже апробированы в одном из пожарных подразделений Китая.

*Ключевые слова***:** пожарная сигнализация, пожарная сигнализация в режиме реального времени, IoT, Интернет вещей, динамика пожарного риска, пожарный расчет.

(Поступила в редакцию 28 сентября 2017 года)

ЛИТЕРАТУРА

1. Cao, Gongli. Assessment for the fire risk of high-rise building based on FAHP-FCE mode / Gongli Cao // M. S. thesis (in Chinese), Zhejiang University, China, March, 2013.
2. Zhang, Lining. High-rise building fire risk evaluation and intelligent alarm system research / Lining Zhang // M. S. thesis (in Chinese), Beijing Institute of Technology, China, May, 2015.

APPLICATION OF FIRE DETECTORS' REAL-TIME ALARM INFORMATION FOR HIGH-RISE BUILDING FIRE COMMAND

Shu X.M., Wu J.J., Tang S.Y., Hu J., Guan J.F.

Purpose. Once a building fire broke out, it is imperative for the fire department to collect the burning building's comprehensive information as much as possible. With these information, fire brigades are able to be dispatched and rush into the fire scene to eliminate fire at early stage.

Methods. Using IoT technology, we can achieve the monitor`s position and running state of the fire-fighting equipment such as fire hydrants, smoke detectors, flame detectors in real time, and grasping the structural information of the building and the location of the fire source. By simulating the trend of fire spread, the location of the trapped people and firefighters can be inferred. This information can provide reasonable suggestions for on-site command, which will greatly improve the efficiency of fire fighting and rescue.

Findings. Using real-time information of fire IoT facilities, we can improve the efficiency of fire fighting and fire rescue significantly.

Application field of research. Used in the field of fire detection, monitoring, early warning and fire emergency rescue.

Conclusions. We have completed several fire detection researches on high-rise building, such as dynamic fire risk mapping technology in fire dispatching, personnel localization system inside high-rise buildings and fire networking technology. These technologies can help fire commandersconducting in fire rescue and fire distinguish, and it has already been applied in one fire brigade in China. Summary of the article is made, evaluation and recommendations are given, perspectives of further research are proposed.

Keywords: fire detection, real-time fire alarm information, Internet of Thing, dynamic fire risk, fire command.

(The date of submitting: September 28, 2017)

Introduction. Fire safety has been a major problem that can't be ignored and must be faced in China. More and more high-rise buildings have been constructed and some of them break out of fire in metropolis cities, such as the CCTV Tower Fire (Beijing, 2009), Jiaozhou Road Fire (Shanghai, 2010), Dynasty Wanxin building Fire (Shenyang, 2011), and so on. According to an incomplete statistics, from 2004 to 2010, the number of China's high-rise building fire accidents is more than 100,000. 607 of them are of very serious high-rise building fire accidents, which caused 4181 deaths, 4844 disabilities, andthe direct economic losses is 1.45 billion yuan in total [1]. Skyscraper fire is one of the most technical fire suppression challenge for the modern fire departments. A highly organized and cooperated fire brigade is necessary to suppress or extinguish the fire.

The fire building's information. The fire building's information, including real-time, dynamic information and static information. All the information is required for the fire command to dispatch the firefighters. When firefighters arrive at the fire scene, the most important information is shown as below:

(1) the location of burning building;
(2) the horizontal coordinate of fire source and its layers in the building;
(3) the number of trapped people and their locations;
(4) the locations of fire hydrants;
(5) whether other hazards are happening in the building;
(6) the fire spread rate;
(7) the best path to attack the fire.

All the decisions need to be made within 30 seconds after fire brigade arrive in the fire scene. So, the information above is critical to support fire commander to make decision on fire rescue scene.

The smart fire fighting system. In fact, fire detectors installed in high-rise buildings can provide so much important information for the fire commanders to make accurate decision. Fire detectors can detect whether fire broke out in its' coverage area easily. And it can continuously figures out how many rooms have caught fire and measures the fire spread rate. If some sensors are installed on hydrant water, they can detect real-time water pressure, and fireman can correctly decide which fire hydrant to be connected. And, if we have detected each person's location in the building, we can properly infer how many people are trapped in fire and their locations after fire-fighters rush into the fire scene. In this way, the firefighters can implement a rapid life rescue.

Using networking technology, the smart fire fighting system can grasp the running state of building's fire fighting equipment in real time. As shown in Figure 1, in the command center, it can get the information of the detector in entire floor, the position and operation of the fire fighting equipment. Once one of the sensors breaks down, it will b shown on the interface. Once the detector alarms, the alarm position could be determined immediately.

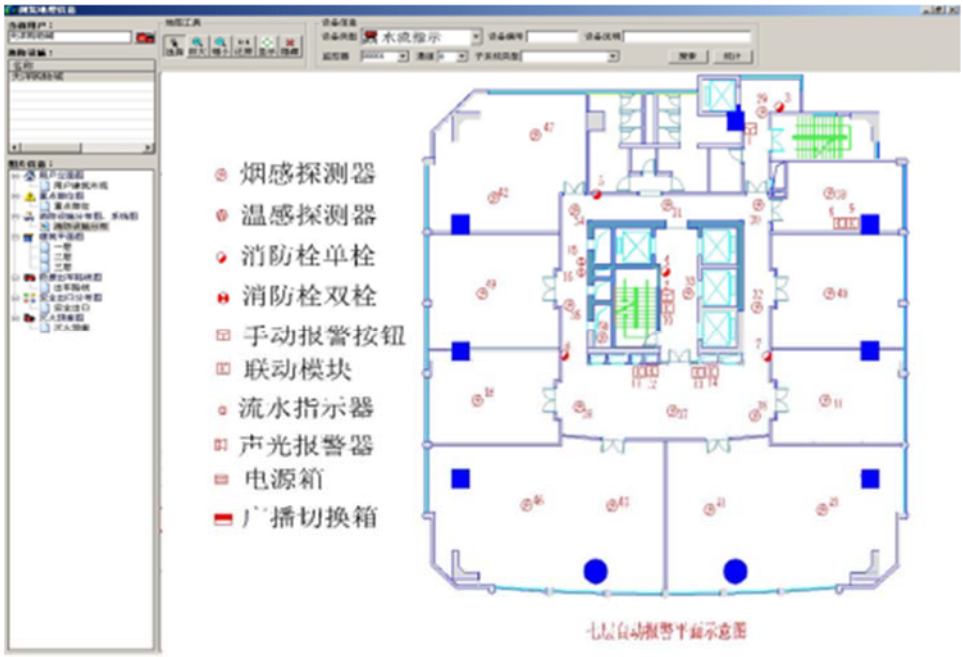


Figure 1. – The operation of the fire control facilities

Different colors represent different status of equipment. Where: blue represents the normal operation of equipment, gray represents the equipment is damaged, red represents the equipment have sent an alarm signal. Fire hydrant has two states: blue represents normal water pressure, gray represents the water pressure is too low or the fire hydrant is damaged. Escape channel has two states: green represents no danger, red represents a fire is happening.

Once the fire happens, the alarm system will generate the fire alarm map automatically. The map of the fire building location can help to determine the surroundings of the building, and help firefighters to determine the position of fire truck; the map of alarm floor and room location can help firefighters ensure the forward path. Even if firefighters are not familiar with the architecture, they can quickly enter and eliminate the fire.

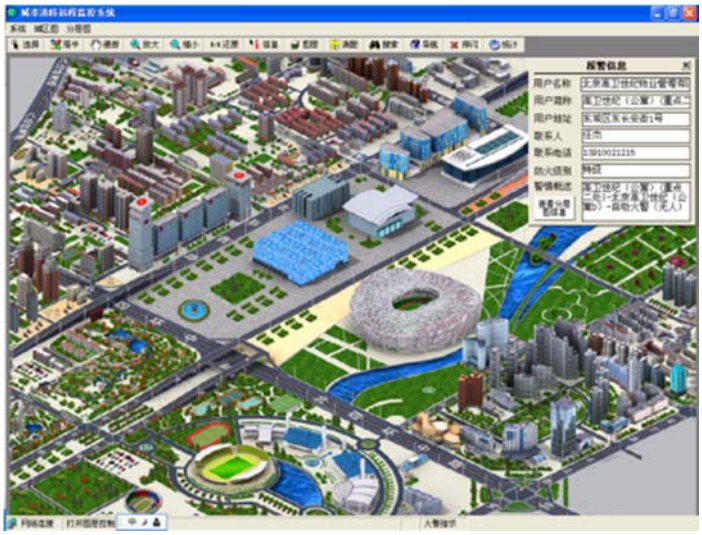


Figure 2. – Fire location information

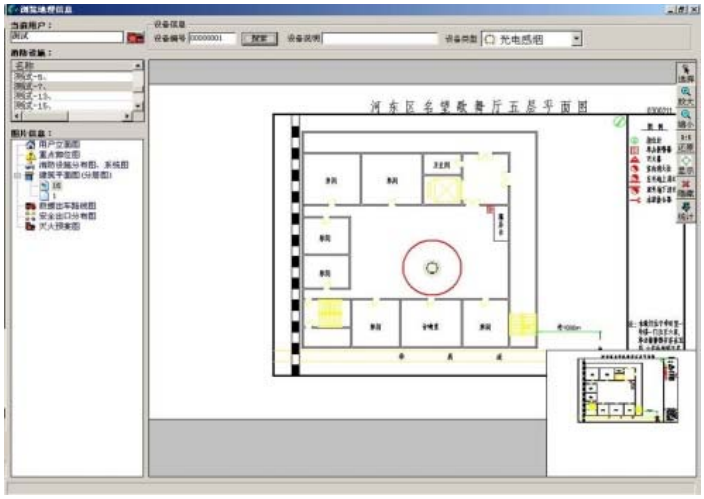
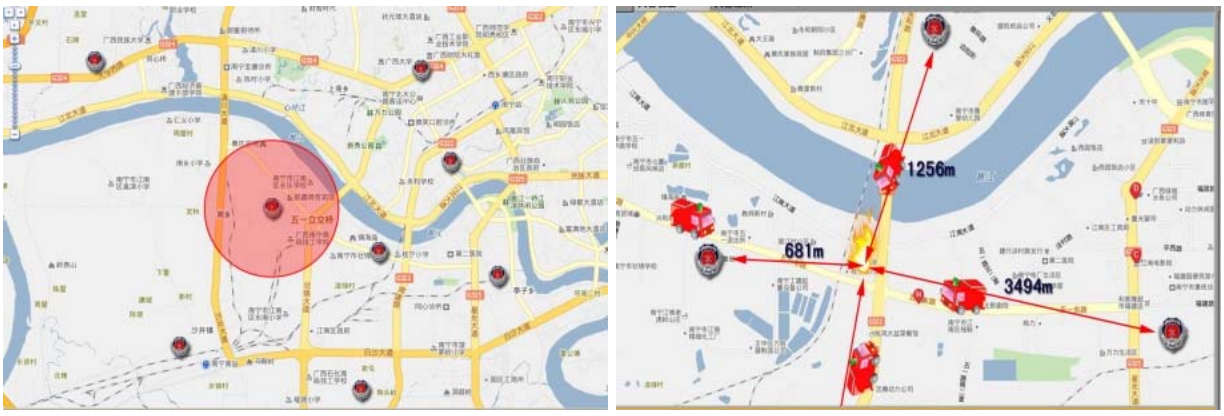


Figure 3. – Alarm floor and room location information

When the command center receives the alarm information, the alarm system can generate the deployment map of the surrounding fire force automatically. This map includes the number and location of the fire stations surrounding the fire, firepower of each station, the distance between the fire station and fire site. According to this map, the command center can release dispatch instruction to squadron.



(a) (b)

Figure 4. – (a) Fire station information, (b) Distance of fire station and fire source

We should pursue the process control rather than some point control for high-rise building fire [2]. According to the three-dimensional structure of the building and the order of alarm time, the smart fire fighting system can predict the direction and range of the flame and smoke, and then determine the fire fighting strategy and escape path.

Figure 5. – Smoke spread map

Once the smoke alarm response, the smart fire fighting system can be transferred out of the floor plan. According to the response of the detector state, we can make a reasonable judgment on the spread of the fire. The deep yellow zone represents the room which on fire, and the light yellow zone represents the area where is likely to be on fire in a short period of time. Once the flame spreads to the fire zone, the fire shutter will automatically start to prevent the flame from spreading. With the development of the fire, the red area indicates the area where the detector has failed, suggesting that the area has high risk. If the rescue team arrives at the fire scene, the fire fighting route can be displayed on the system, leading firefighters enter the fire scene safely.

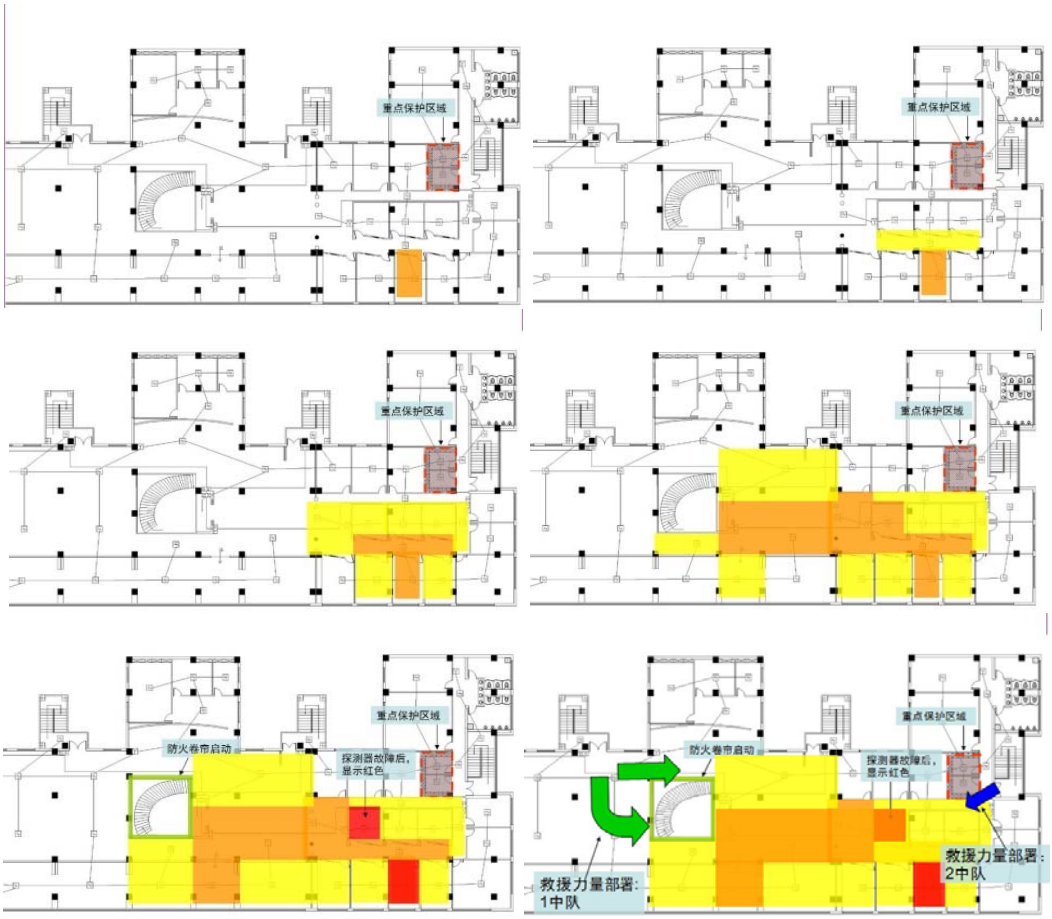


Figure 6. – Fire spread map and optimized rescue path

Conclusion. The real-time data of fire service facilities is of great significance to fire fighting and rescue operations. On the one hand, we know the operation of the fire facilities and repair the failure facilities on time. On the other hand, once the building is on fire, we can predict the spread of smoke and flames, that can help the fire commander's conducting on fire fighting and rescue operations.

We have completed several fire detection researches on high-rise building, such as dynamic fire risk mapping technology in fire dispatching, personnel localization system inside high-rise buildings, fire networking technology. And these technologies have already been applied in some fire brigade in China.

Acknowledge. The authors appreciate the support by the National Science & Technology Pillar Program during the 13th Five-year Plan Period (No. 2017YFC0806607).

REFERENCES

1. Cao Gongli. *Assessment for the fire risk of high-rise building based on FAHP-FCE mode*. M. S. thesis (in Chinese), Zhejiang University, China, March, 2013. (chn)
2. Zhang Lining. *High-rise building fire risk evaluation and intelligent alarm system research*. M. S. thesis (in Chinese), Beijing Institute of Technology, China, May, 2015. (chn)