Research on Intelligent Fire Risk Perception System of High-rise Building Based on Big Data of Internet of Things

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Abstract: Due to the characteristics of high-rise buildings, such as dense personnel, complex structure and many combustibles, fire safety problems are more prominent. Aiming at the fire problem of high-rise buildings, based on the Internet of Things and big data technology, the intelligent fire risk perception system of high-rise buildings is studied. Through the functional modules of fire water monitoring system, intelligent electricity monitoring system and fire automatic alarm system, the hydraulic and water level of fire water, the current and voltage values of key nodes such as distribution cabinets, and the on-duty personnel in fire control room are mastered in real time, so as to grasp the specific location of fire in time and accurately, so as to realize the intelligent control of fire safety of high-rise buildings.

1. Introduction

With the rapid development of urban construction and the increasing number of high-rise buildings, high-rise building has become an important symbol of urban economic prosperity and development. However, due to the high-rise buildings have many floors, crowded, complex structure and function, fuel and other characteristics, its fire protection problem has been a worldwide problem[1]. Once a fire occurs, the energy supply and communication facilities will be destroyed, and the location of the fire cannot be accurately detected, resulting in the rapid spread of the fire. It is difficult to extinguish the fire and rescue personnel, which is easy to cause a large number of casualties and serious property losses[2]. Therefore, Research on high-rise building fire risk intelligent perception system is particularly important to improve the prevention and control of high-rise building fire.

In recent years, the construction of smart city and smart fire protection has developed rapidly, and the transformation and upgrading of fire protection work has become the focus of smart fire protection construction[3]. Based on the Internet of Things and big data technology, the intelligent monitoring system is used to monitor the working status of fire water, electricity facilities and sensing equipment in real time, and timely and accurately grasp the specific location and floor information of fire occurrence, so as to ensure the fire safety status of high-rise buildings, realize the intelligent perception of fire risk of high-rise buildings, and improve the timeliness, reliability and accuracy of fire alarm, reduce the frequency of fire occurrence, and improve the management level of urban fire safety.
2. Internet of Things and Big Data Technology

The Internet of Things was first presented in a speech in 1985[4]. Since the concept of the Internet of Things was put forward, the state has vigorously supported the development of the Internet of Things technology. While the Internet of Things technology has been vigorously developed, it has promoted the development of smart cities and smart fire protection[5]. The Internet of Things technology is an application based on the Internet and combined with various information sensor technologies. The Internet of Things technology has important characteristics, which can realize the barrier-free communication between things and things, and between people and things, making things feel and have certain perception ability. In addition, the Internet of Things technology enables the equipment to have the functions of self-feedback and intelligent control, so that the equipment can work independently. It uses the Internet as a medium for remote management[6]. Big data technology refers to the collection of data that cannot be captured, managed and processed by conventional software tools within a certain time range, and it requires new models to deal with massive data. Big data technologies include big data platforms and big data index systems. The technology can not only complete the collection, collation and storage of information data within the specified time, but also ensure the accuracy and integrity of information resources[7]. The fire department uses big data analysis technology to mine data. The attributes of fire accidents are analyzed and the inherent law of fire occurrence is explored[8]. This not only provides an accurate basis for fire safety management, but also provides technical support for fire information construction and fire management.

3. High-rise building fire risk intelligent perception system

Intelligent fire information acquisition system for high-rise buildings can realize information display and data monitoring of key units and display of real-time alarm monitoring data. By using the big data technology of the Internet of Things, functional modules such as fire water monitoring system, intelligent electricity monitoring system, and automatic fire alarm system are used to monitor the status of fire equipment and facilities, so as to detect and control hidden dangers in time. Deployment of fire Internet of Things terminal, remote monitoring of fire control host, security video and fire important facilities running state, realize centralized management.

3.1 intelligent fire water monitoring system

By collecting the parameters of the fire water system, the intelligent fire water monitoring system sends out real-time alarm information for the problems of insufficient pressure of the fire pipe network and insufficient liquid level of the high water tank to ensure the normal operation of the system. The device collects real-time data and uses professional detection devices (as shown in Figure 1) to detect the water level and water pressure of high water tank, fire pool, fire hydrant at the most unfavorable end and water spray in real time. The data changes of water level and water pressure are collected and sent to the server.

![Figure 1. Fire water level and water pressure monitoring device](image-url)
Fire safety management personnel can monitor the status of fire water supply system in real time, solve a series of safety problems caused by human factors, and improve the level of fire safety management and work efficiency.

3.2 Smart electricity monitoring system

From 2016 to 2020, the number of high-rise building fires increased year by year. The analysis of the causes of fires found that the fires caused by electrical factors accounted for a relatively high proportion[9]. Therefore, it is particularly important to prevent the occurrence of electrical fires in high-rise buildings. Smart electricity monitoring system (shown in Figure 2) can conduct real-time online monitoring and statistical analysis of the main factors that cause electrical fires. It can realize real-time detection of residual current and voltage of key nodes such as distribution cabinet and terminal distribution box, collect data changes of current and voltage, and send them to the server. After the transformer collects data, the data is sent to the platform (shown in Figure 3). The server establishes a real-time connection with the equipment and receives data. In order to facilitate the safety management personnel to use the mobile terminal, they can timely grasp the state of potential electrical safety hazard existing in the line, judge the causes of the fault, and timely eliminate the potential electrical fire safety hazard.

![Figure 2. Architecture of smart electricity monitoring system](image)

![Figure 3. Real-time distribution data](image)

According to different load types and time periods, the abnormal warning and power-off values of each circuit current are set, the overtemperature phenomenon is monitored in real time (as shown in Figure 4), and the warning and power-off values are set. When the system monitoring temperature reaches the set value, the warning or power-off is carried out. Set leakage current warning and power...
off value, when the system monitors leakage current is higher than the set value, start trip protection.

Figure 4. Real-time monitoring of distribution overtemperature data

3.3 Fire automatic alarm cloud monitoring system

With the development of artificial intelligence technology and sensor technology, automatic fire alarm cloud monitoring system is developing towards network and intelligence. Based on the technical idea of the Internet of Things application, a variety of networking methods such as mobile network are used to connect the decentralized front-end sensing equipment controller into a network. The alarm information and operation status information of the front-end sensing equipment in the networked building are collected in real time. The various hidden dangers of fire facilities are found in time, and the relevant rectification is urged to reduce the fire risk.

3.3.1 Video information linkage system

Through intelligent image analysis technology, the video information linkage system judges the on-duty personnel in the fire control room. When there is a long time of unattended operation, the system will automatically save the video, automatically warn information (as shown in Figure 5), and report the information to the responsible person to avoid staff lazy phenomenon and improve work efficiency.
3.3.2 Video fire alarm

Fire image is a signal that contains information such as object strength, shape and position. Fire image detection technology can usually be divided into image flame detection technology and image smoke detection technology according to different detection objects and recognition algorithms. The tasks of image pattern recognition detection technology include image segmentation, feature extraction and image recognition. Image segmentation divides the collected images, and completes the image segmentation operation by analyzing the segmented images. The feature extraction extracts the flame characteristics through transformation or screening, which lays a good foundation for flame recognition and fire alarm. Image recognition Data analysis and image recognition of some valuable non-featured objects constituting the image are performed by imaging instruments to determine whether they are flames, thereby image recognition and fire hazard alarm[10] (as shown in Figure 6).

![Figure 6. Video fire monitoring](image)

3.3.3 Fire warning and prevention system

1) Abnormal alerts. When the data collected by the monitoring system exceeds the set safety value, the system will issue warning information in time, carry out key warnings, push fire alarm and fault information to the platform, and deal with the situation, so as to view the fire safety management personnel.

2) Alarm disposal. The warning information is divided into fault information and fire information. When the system sends the warning information, it needs the staff to identify and determine whether there is fire. If there is a fire, after the alarm occurs, the duty personnel can receive and dispose in real time, upload alarm information to solve the situation, start the fire treatment plan, control the
development of fire. If there is no fire, need to judge the system false alarm or equipment failure, false alarm and failure related procedures. Lay the foundation for later management and experience summary.

4. Conclusions
1) Based on the Internet of Things and big data technology, through functional modules such as fire water monitoring system, smart electricity monitoring system and automatic fire alarm system, the working state of fire facilities is monitored in real time, so as to realize the intelligent perception of high-rise building fire risk and reduce the frequency of fire occurrence.

2) The fire water monitoring system monitors the water pressure of the fire hydrant and the water level of the fire pool in real time. The warning information is pushed in real time and processed in time to ensure the normal operation of the system. The fire water level and water pressure monitoring device are used to collect real-time data, collect the data changes of water level and water pressure, and display the changes of water level and terminal water pressure in real time.

3) The intelligent power monitoring system monitors and analyzes the electrical fire factors, realizes the real-time detection of the residual current and voltage of the key nodes such as the distribution cabinet and the terminal distribution box, and collects the data changes of current and voltage, sends the data to the platform, and automatically generates the power safety report, so that the safety personnel can find the hidden danger of power consumption in time, and effectively prevent the occurrence of electrical fire accidents.

4) Automatic fire alarm system includes video information linkage system, video fire alarm and fire early warning and prevention system. The video information linkage system judges the on-duty personnel in the control room through intelligent image analysis technology. The fire image is segmented by video fire alarm, and the flame characteristics are extracted to recognize the fire image. When the data collected by the monitoring system exceeds the set safety value, the fire warning and prevention system will issue alarm information, push fire alarm, fault information to the platform, and deal with the situation. If the alarm occurs, the duty personnel can receive and dispose in real time, and upload the alarm information to solve the situation.

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