Research on Large Space Fire Monitoring Based on Image Processing

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Abstract. Fire in large space buildings has the characteristics of rapid spread and easy to ignite, which makes it difficult to extinguish fire. Therefore, the research on fire safety prevention technology of large space buildings has strong practical significance and practical value. Fire image automatic monitoring technology is based on the advantages of image processing and the high-speed operation of computer language. This paper proposes a fire monitoring technology which uses the information of flame image to analyze and judge fire. It combines computer graphics, digital image processing and computer vision technology, and one new image-based fire detection and processing technology is studied from the aspects of flame morphology and flame color.

Keywords: Large Space Fire Monitoring, Image Processing, Technology

1. Introduction
As one of the most common serious disasters, fire has become one of the most frequent, destructive and influential disasters in China. In recent years, large space building fires occur from time to time. Therefore, large space building has become one of the key objects of fire protection. Accurate detection of fire and early warning are positive means to safeguard the fire safety of such buildings. At present, the common method of fire detection is to detect smoke, mild light and other parameters generated when a fire occurs. After signal processing and comparison, fire alarm signals are issued after judgment. With the development of modern image processing technology, the market of new image-based fire detection technology is speeding up, and it has gradually developed into two application branches of fire flame and fire smoke detection. Many detection algorithms have appeared in each application branch, showing a vigorous development momentum [1].

2. Recognition of fire image

2.1. Fire image recognition algorithms
Fire phenomena are complex and changeable, and many features in fire images are difficult to be described by precise mathematical formulas. Neural network has complex pattern classification ability and good multi-dimensional function mapping ability, which can be used to realize the non-linear mapping relationship between fire occurrence probability and corresponding flame characteristics. BP
algorithm is proposed to solve the optimization of weights of multilayer feed-forward neural networks, so BP algorithm usually implies that the topology of neural networks is a multilayer feed-forward network without feedback. BP network model includes its input and output model, action function model, error calculation model and self-learning model, as shown in figure 1 below [2].

![BP network model](image)

**Figure 1.** BP network model

The information of the neural network is distributed in the weight coefficient of the link, which makes the network highly fault-tolerant, and there is often noise or loss of input image in image recognition. Therefore, the neural network can better solve the problem of image recognition. In addition, the self-organizing and self-learning function of the neural network makes it show great superiority to the problem of image recognition.

2.2. **Fire image recognition basis**

The basis of fire recognition is the gray level, shape of the scene image, the change of the recognition target, and so on. It can identify the location of the fire, the size of the fire and other information. According to the graph theory, these features are quantified and normalized to be classifier recognition specimens. The criteria for fire discrimination include flame peak, flame change rate, propagation growth, edge dithering, relative stability and flame similarity, as shown in figure 2 below. In addition, there is other basis for selection, such as color feature extraction, image wavelet feature extraction, flame similarity, image hierarchy, image skeleton, flame continuity and so on [3].

![Criteria for fire discrimination](image)

**Figure 2.** Criteria for fire discrimination

3. **Digital processing method of fire image**

3.1. **Image acquisition**

When the environment is unattended and the monitoring system is enabled, the image acquisition system continuously collects the images of the detected environment, puts them into the reference image database, and constantly refreshes them to ensure the consistency of the background images
before and after the fire. When the fire signal is obtained by the control computer, the image acquisition system starts to collect the fire image and put the collected fire image into the fire image database, as shown in figure 3 below [4].

![Image acquisition process](image.png)

**Figure 3.** Image acquisition process

3.2. **Image pre-processing**

The image acquired after image acquisition is inevitably blurred due to the influence of noise such as illumination and current. Therefore, it is necessary to pre-process the image, remove the influence of noise and other factors before matching, and extract the point features of the image. At the same time, the noise in the image is usually expressed as high-frequency components, which need to be smoothed to reduce or eliminate. However, image smoothing often blurs the features of the image, so it is particularly important to adopt a reasonable smoothing method for image processing.

4. **Spatial location of fire**

4.1. **Principle of binocular stereovision**

The basic principle of binocular stereovision is to observe the same scene from two viewpoints in order to obtain perceptual images from different perspectives. The position deviation between image pixels is calculated by imaging geometry principle to obtain the three-dimensional information of the scene. This process is similar to the stereo perception process of human vision. The realization is to obtain two images of the same scene by two cameras with the same parameters and fixed positions, calculate the parallax of the same space point in two images, and then determine the depth information of three-dimensional space points. The acquisition of three-dimensional information from a single spatial point is shown in figure 4.
Figure 4. Acquisition of three-dimensional information principle

4.2. Software simulation of fire location algorithm
Firstly, since fire location algorithm recognition simulation needs to take a large number of fire images, it is necessary to install two cameras equipped with infrared filters to take a set of simulated fire pictures. Secondly, with the help of MATLAB programming language, a series of processing algorithm programs for fire flame are compiled, including M-function simulation files of enhancement, filtering, segmentation, feature point extraction, matching algorithm, etc. Thirdly, the above M functions are executed and the results are analyzed. Fourthly, all simulation m functions are synthesized and m function files of fire location algorithm are compiled. Fifthly, the M-function of fire location algorithm is implemented and the simulation results are analyzed. The location algorithm is based on the premise that the fire has been determined and the fire image has been accurately identified. If the extraction and location is not accurate, it will have a great impact on the three-dimensional location of the fire [5].

5. Conclusion
As a new fire detection technology, image-based fire detection technology is based on digital image processing and digital signal processing technology, algorithm and principle. In the process of flame image processing, pattern recognition technology plays an important role in the extraction of flame image features. At the same time, the theory and algorithm of computer vision is also the key technology of fire detection and recognition. The automatic fire detection and alarm system not only has great social benefits, but also has broad market prospects.

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