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A METHOD OF FIRE DETECTION SYSTEM BASED ON IMAGE PROCESSING

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ABSTRACT

This paper uses digital image processing technology to enhance image effects through preprocessing operations like graying, filtering, denoising, and histogram equalization. The suspicious fire area is processed using threshold segmentation and edge detection. Pattern recognition technology is crucial for flame image extraction, and computer vision theory is key for fire location. This system effectively eliminates interference from distance and light intensity, improving recognition accuracy and enhancing fire detection. Hence, this analysis shows better results interms of accuracy and efficiency.

Keywords: Image Processing, Fire Detection, Image Segmentation, Image Information Processing System

1. INTRODUCTION

Accurate detection of fire and early warning are positive measures to protect the fire safety of such buildings. Among all kinds of disasters, it has become one of the major disasters that threaten public safety and even national social development. Among many kinds of disasters, the direct loss caused by fire is about 5 times that of earthquake, second only to drought and flood, and the frequency of fire is the first among all kinds of disasters [1]. Therefore, it is the key research content in the technical field of fire prevention and control to monitor it effectively in real time and minimize the loss caused by fire. The fire monitoring system based on image processing is a kind of automatic fire monitoring and alarm system, which takes computer as the core and combines photoelectric technology and computer image processing technology. If it is judged that a fire has occurred, the alarm signal will be transmitted to the command center in time. Among them, the accuracy of fire image feature recognition greatly affects the reliability of system discrimination. Through the understanding and analysis of fire image information in the process of fire occurrence, the fire can be quickly detected and linked with fire fighting. However, using digital image processing technology and using the image characteristics of fire flame can solve the fire detection problem[2].

The general image processing system consists of hardware and software. Hardware is mainly composed of Image collection system, digital computer and control processing. After a series of operations such as denoising, image enhancement, image extraction, feature recognition, etc., the computer uses neural network to judge whether the fire has occurred or not. Generally speaking, the larger the sampling interval, the fewer pixels, the lower the resolution, the worse the image quality and the smaller the required storage space. On the contrary, the smaller the sampling interval, the more pixels in the obtained image [3]. Based on the color characteristics of flame, the collected image is transformed into HSI space through color space, and the region similar to flame hue is separated from the whole image in hue H component diagram, which is considered as "suspicious" flame region. Especially, when the combustibles on initial fire are isolated, the flame will extinguish itself. If the ventilation is insufficient, the fire may be extinguished by itself, or it may continue to burn at a very slow combustion speed under the control of ventilation and oxygen supply conditions.

The color of each pixel in the image is determined by the red, green and blue components stored in the corresponding position. In Cartesian coordinate system, RGB model can be represented by a cube. In order to realize corrosion and expansion, mathematical morphology puts forward the concepts of target and structural elements [4]. The inspected or processed image is called the target image. In order to determine the structure of the target image, it is necessary to examine the relationship among each part one by one, and acquire the live video through the camera. Then, through a series of image preprocessing methods, the interference factors such as noise are eliminated and the image information is enhanced. The gray scale is still continuous, so it can't be processed directly by computer. Such an image needs to be quantized, that is, the gray scale of pixels is converted into discrete integer values. The area, centroid and area shape information corresponding to adjacent frames are subtracted to obtain the largest area change, the whole movement, the shape change and the edge contour similarity. The software body of digital image processing is the

core of the system. Firstly, the digital image is segmented, and then the objects in the image are identified or classified by using the image characteristics [5].

Fire alarms are present in a lot of buildings, industrial parks and workplaces. These fire alarms are usually based on sensors which detect certain characteristics of fire such as smoke, radiation, or heat. However, these fire alarms depend on the fire particles reaching the given sensor. Apart from the inherent disadvantage in the delay in detecting the fire due to the time taken for particles to reach the sensor, these alarms are basic and do not provide crucial information such as intensity, location and the size of the fire. Many of the places with a fire alarm system also have a surveillance system [6].

These surveillance cameras can be incorporated in the fire detection process using object detection. This has become an important area of research. The object detection is based on image processing. Vision based fire detection systems have several advantages [7]. Already installed surveillance cameras can be used for this and if they are not present, CCD (Charged Coupled Devices) cameras can be installed which are fairly inexpensive. The most important advantage is the detection time because vision-based systems do not require smoke or heat to diffuse. Another advantage is the area covered. If the camera is placed at a vantage point, it can cover a lot of open space which is a very big improvement from conventional sensors which are better in confined spaces.

2. LITERATURE SURVEY

V. Sherstjuk, M. Zharikova and I. Sokol, et.al [8] presents the fire monitoring and detecting system for tactical forest fire-fighting operations based on a team of unmanned aerial vehicles, remote sensing, and image processing. The idea of such a system and its general parameters and possibilities are described. Functions and missions of the system, as well as its architecture, are considered. The image processing and remote sensing algorithms are presented, a way for data integration into a real-time DSS is proposed. The results of experimental research of the prototype system are presented. The combination of multi-UAV-based automatic monitoring, remote sensing and image processing techniques provides required credibility and efficiency of the fire detection.

X. Wan, J. Cai, S. Luo, Z. Tian, L. Zhang and X. Xia,et.al [9] multi-sensor detection system is combined with image recognition process. Image recognition is utilized to help the fire detection, when the decision from the multi-sensor system is uncertain or the data is not available/faulty. Image features are extracted by using machine learning methods. Then, the Gaussian classification method is applied to detect the specific fire case. Images from real environments are used to evaluate the proposed method. In addition, we investigate and discuss the detection results when the training data is adequate or inadequate, which verifies that the image-based fire detection scheme combined with multi-sensor system can achieve better accuracy. Smart fire detection systems should be able to detect the fire and trigger the automatic alarm at an early stage. It should also trigger the automatic fire extinguishing system and broadcast the fire alarm under different fire conditions. Due to the strict detection accuracy requirement of the fire detection system, most of the modern smart fire detection systems are based on multi-sensor, or image/video surveillance system to reinforce its fast reaction and high reliability in the action process.

M. Kataev and E. Kartashov, et.al [10] proposes an algorithm for detecting forest fires from RGB images obtained using an unmanned motor glider (UMG). The algorithm includes several stages related to finding and subtracting the background, highlighting the fire area in the RGB color space. The proposed algorithm has been tested on images of forest fires. The article proposes a variant of the flight of an unmanned motor glider in such a way as to continuously monitor large spaces for several hours. The results of calculations are presented, showing that the proposed method allows one to find areas of the image occupied by fire and can be used in automatic systems for monitoring forests from fires.

X. Wan, J. Cai, B. Zhang, X. Xia, J. Han and K. Yan, et.al [11] propose to combine the multi-sensor detection system with image recognition. When the decision from the multi-sensor system is uncertain or the data is not available/faulty, images are used to assist the fire detection process, which could make the whole system more robust and reliable. We are aiming at extracting important features from the images by using machine learning methods. Then, different classification methods will be applied to detect the fire conditions. We make use of the existing images collected from real environments to evaluate the proposed approach. In addition, we investigate and discuss the detection results using different classification methods, which verifies that the image-based fire detection scheme combined with multi-sensor system can achieve better efficiency and accuracy.

Y. Cheng and B. Li,et.al [12] introduces the methods of image segmentation, including threshold segmentation, clustering segmentation and edge detection segmentation. Secondly, according to a need to extract a road image for image segmentation, and achieved very good results. Finally, this paper mainly analyzes the application of image segmentation in digital image processing. It is found that image segmentation has good application in automatic

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license plate recognition, biomedical engineering, remote sensing engineering and fire prevention and detection. At present, the widely used pattern recognition technology is realized by image segmentation technology. Based on this, this paper mainly studies the application of image segmentation technology in digital image processing.

3. METHODOLOGY

In Fig.1 block diagram of a method of fire detection system based on image processing is observed.

The Image collection system transmits the collected fire sequence images to the computer, and the computer extracts the features of the images through image processing technology, and then judges and recognizes the fire images. It includes image model building, preprocessing, image segmentation, feature extraction and pattern recognition. In the image preprocessing part, the spatial image processing method is mainly adopted, and the input image is preprocessed by combining the dual-band theory. There are many preprocessing techniques, which have different processing methods for different noises. The main preprocessing includes filtering, image enhancement, image restoration and reconstruction. According to the processing characteristics (frequency domain or spatial domain), the enhancement technology can be divided into frequency domain enhancement and spatial domain enhancement. The use of color moments is simple and effective, which can represent all the color distributions in an image. Moreover, because the color distribution information is concentrated in the low-order moment in most cases, it can fully meet the needs of the system by calculating the low-order moment. The collected and compressed data are read out from SDRAM and transmitted to the upper computer through PCI bus. The related contents can be deleted or added at the later stage of recording. The camera can continuously and continuously detect and record the scene in real time.

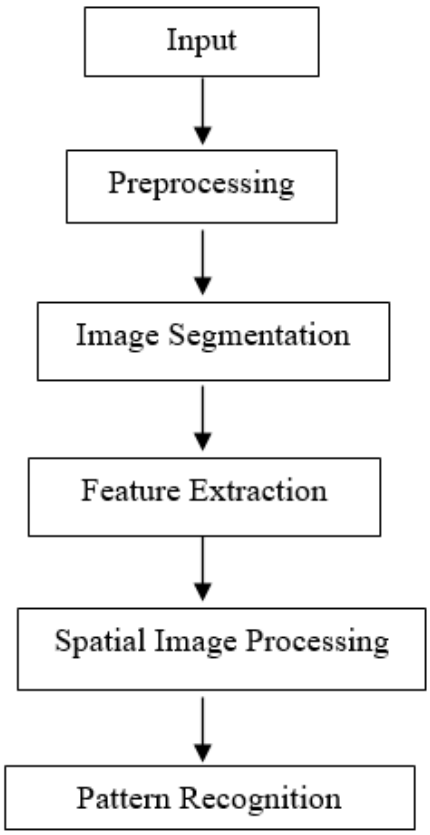

Fig.1: Block Diagram of A Method Of Fire Detection System Based On Image Processing

4. RESULT ANALYSIS

In this section performance analysis of method of fire detection system based on image processing is observed.

Table 1 : Performance Analysis

Parameters	Existing System	Proposed System
Accuracy	87.3	91.5
Efficiency	89.8	95.9

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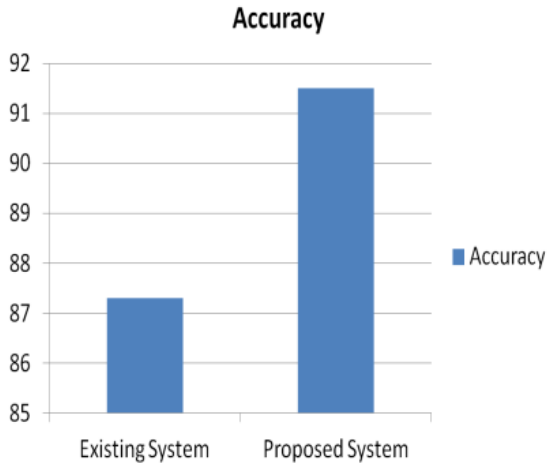

Fig.2: Accuracy Comparison Graph

In Fig.2 accuracy comparison graph is observed between existing system and proposed system.

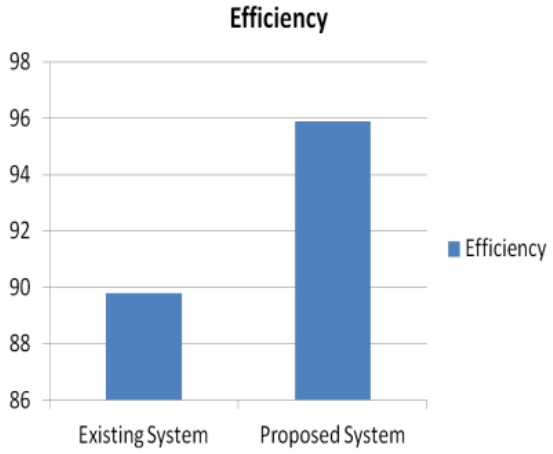

Fig.3: Efficiency Comparison Graph

Graphical representation of efficiency is observed in Fig.3 between existing system and proposed system.

5. CONCLUSION

Fire detection technology based on image processing uses digital image processing to overcome shortcomings in previous monitoring technology, such as small monitoring range and high false alarm rate. Open and close operation are used to process binary fire images, eliminating small objects and smoothing suspicious flame boundaries. Pre-processing alarm method reduces image processing time, enhances fire judgment accuracy, and reduces false alarm rate. Pattern classifiers are used to recognize suspicious areas in image sequences, improving recognition accuracy by analyzing area variation, edge contour similarity, overall movement, and shape variation. Hence, the fire detection system based on image processing achieves better results interms of accuracy and efficiency.

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