Research on Forest Fire Image Recognition System in Northeast Forest Region Based on Machine Vision

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Abstract. As a large forest region in Northeast China, forest fire prevention has always been an important matter concerned by Heilongjiang Province. The emergence of fire, the damage to the ecology and environment is inestimable. Therefore, it is particularly important to use the intelligent image recognition technology to monitor the forest fires in northeast China in real time to ensure that the forest areas in northeast China are not damaged by fire. In fact, in the field of forest fire prevention, many scholars at home and abroad have done a lot of forest fire research, mainly in the field of forest fire monitoring, a lot of research and practical application. The forest fire detection and recognition system based on machine vision can effectively reduce the impact of forest fire, reduce the loss, and improve the real-time and accuracy of forest fire recognition.

Keywords: Forest fire · Machine vision · Fire recognition

Northeast forest region is the largest natural forest region in China. This area is very rich in forest resources, forest area of nearly 700 million mu, in the national forest area of more than one-third, the amount of wood savings more than 3 billion cubic meters, in China's total wood savings of more than 33% [1]. At present, most of the defense schemes used in fire monitoring in northeast China are human normal patrol, UAV and satellite monitoring. Subject to the influence of the changeable seasonal climate and the imperfect monitoring technology and high monitoring costs and other factors, the real-time monitoring and early warning of forest fire prevention can not be better achieved by the human ground patrol forest protection, remote control UAV patrol and satellite monitoring.

With the continuous improvement of image and pattern recognition technology, it has become more and more important to use video image recognition technology to distinguish forest fire in forest fire prevention and prevention, and it has become a very important research trend for image video recognition of forest fire [2]. In view of the northeast forest safety protection, the researchers of our country have carried out special research and actual monitoring of the northeast forest fire prevention. However,

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due to the high cost of key control equipment, high area and narrow coverage, and the influence of seasonal climate in northeast China, the timeliness and monitoring distance of the monitoring system are insufficient. In view of the above problems, this project is committed to the study of forest fire image recognition and classification in the northeast forest region, and to build an intelligent real-time fire monitoring platform in the northeast forest region, which is of great significance for strengthening the protection and restoration of forest resources in the region.

Forest fire image recognition system plays an important role in forest fire prevention in northeast China. Its two main functions are to identify the physical properties of fire and smoke in time and to solve forest problems by studying the system. In order to ensure the accuracy and efficiency of forest image recognition system in northeast China, technical problems such as fire, light, seasonal weather and the influence of various interference factors on the system should be considered in system design. The forest fire recognition system in northeast China mainly adopts pattern recognition technology.

1 Image Pattern Recognition Technology

1.1 Dynamic Change Feature Extraction

Smoke produced by forest fires tends to rise or move under the influence of air currents. With the increase of smoke volume, the shielding range becomes larger and the thickness of smoke increases [3]. The whole process is changing, and the pixels in the video image are changing. The approximate range of forest fire can be judged by the displacement change of video pixels. Generally speaking, according to the comparison between the original image and the current image, the larger the overlap area of contrast, the greater the similarity value of the determined image. Usually, image area signal-to-noise ratio formula is used to calculate. The SNR formula of image area is:

$$SNR = 10LOG10\left[\frac{\sum_{I-1}^{M}\sum_{J-1}^{N} G(I,J)^2}{\sum_{I-1}^{M}\sum_{J-1}^{N}[G(I,J)-F(I,J)]^2}\right] \quad (1)$$

In the SNR formula, I and J respectively represent horizontal rows and vertical columns in the image where the pixels in the image are located, M and N respectively represent the total number of horizontal rows and vertical columns in the computed pixel range, G (I, J) is the original image, and F (I, J) is the compared image. The larger the SNR value is, the higher the overlap degree of the image is.

1.2 LBP Texture Feature Extraction

LBP is a $3 \times 3 \times 3 \times 3$ window, which takes the center pixel as the threshold and compares the gray value of 8 pixels. If the peripheral pixel value is larger than the center pixel value, the position is binary 1. Otherwise, it is binary 0 [4]. Through this method,

an eight-bit binary can be obtained, which can be used as the value of the LBP of the center pixel of the window, and finally obtain the texture information of this area.

$$LBP_{(M,N)} = \sum_{L=1}^{8} S(I(L) - I(C)) * 2^L \tag{2}$$

Here, L represents the L pixel excluding the center point in the 3 × 3 window; I(c) represents the gray value of the center point, and I(L) represents the gray value of the L pixel point within the range. The formula of S (M) is as follows:

$$S(M) = \begin{cases} 1, \ M \geq 0 \\ 0, \ otherwise \end{cases} \tag{3}$$

By modifying the circular LBP operator, the range can be extended to any neighborhood, that is, the neighborhood radius can be extended to meet the requirements of texture features of different sizes in this way, so as to achieve gray scale and rotation invariance [3].

1.3 Smoke Classification Model Based on SVM

Support Vector Machine (SVM) is to establish the optimal classification surface to maximize the interval between two types of samples, and achieve the correct classification of positive samples and negative samples. The computational complexity is low, which is helpful to solve problems such as small sample learning, nonlinear and high-dimensional pattern recognition. A total of 5,544 forest fire smoke areas in all videos were selected as positive samples, while 1,470 typical non-smoke areas, including clouds, cars and pedestrians, were selected as negative samples. LBP features were extracted as the INPUT of SVM, and k-fold cross validation (K-CV) was used to obtain the optimal parameters of the model. The kernel function was set as radial basis kernel function (RBF), which mapped the data nonlinearly to the high-dimensional space and processed the nonlinear relations between features and their attributes. The penalty factor C is 100, and the coefficient γ is 0.001. 70% of the original samples were taken as the training set and 30% as the test set. The SVM classification model was trained and tested by using the optimal parameters. Then, the trained SVM classification model was used to classify the suspected smoke area and distinguish the smoke area from the non-smoke area. Classification algorithm evaluation index, accuracy rate M, recall rate N and F1, calculation formula is as follows:

$$M = \frac{T_M}{T_M + F_M} \tag{4}$$

$$N = \frac{T_M}{T_M + F_C} \tag{5}$$

$$F_1 = 2 \times \frac{M \times N}{M + N} \tag{6}$$

where, represents the number of image blocks predicted as smoke and actually as smoke; Represents the number of image blocks predicted to be smoke but actually non-smoke;

Represents the number of image blocks predicted to be non-smoke but actually smoke; M is the accuracy rate. For the prediction result, here represents the proportion of the sample predicted as smoke that is actually smoke. N is the recall rate, which represents the proportion of smoke samples accurately predicted as smoke [5]. Is the harmonic mean of accuracy rate and recall rate.

1.4 Technical Segmentation of Dynamic Images

By segmenting the image region, the quality of video recognition can be guaranteed more clearly. Image segmentation technology refers to the process of dividing the distribution points, boundary regions, textures, shapes and color features of an image into non-overlapping regions. Image segmentation is a key step in the process of image pattern recognition. This process provides a basis for the next step of image feature extraction. Because the color image contains a lot of information, it needs to carry on the complex segmentation operation. Generally speaking, in order to study the problem of low color attribute, we will use the technology of transforming color image into gray image, which greatly reduces the difficulty of replacement technology. The commonly used methods are region growth method, edge detection method, threshold segmentation method and so on [6] (Fig. 1).

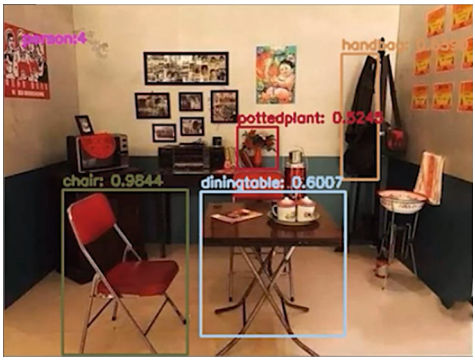

Fig. 1. The Python segmentation plot

2 Research Methods

The northeast forest area image acquisition system mainly realizes the operation of image processing algorithm on hardware circuit. With MATLAB image processing software, the recognition and separation of flame, smoke, temperature and other features of forest fire video images can be realized, and the pattern recognition technology of images can be used to identify the fire in northeast forest region, find the fire in time and display it in real time (Figs. 2 and 3).

Fig. 2. The original picture of the fire

Fig. 3. Fire division diagram

3 Research Content

The fuzzy C-means clustering algorithm based on unsupervised learning was used to segment forest fire images. In view of the problem that the fuzzy C-means clustering algorithm could not solve nonlinear segmentation, an improved fuzzy C-means clustering algorithm, namely the kernel fuzzy C-means clustering algorithm, was proposed to segment forest fire images.

Aiming at the problem that the initial clustering center of the kernel fuzzy C-means clustering algorithm is difficult to determine, an intelligent algorithm is used to optimize the kernel fuzzy C-means clustering algorithm to overcome its deficiency in image segmentation.

Whale optimization algorithm has excellent performance in intelligent optimization algorithm, has a strong ability to search for optimization, this topic will make some improvements to the whale optimization algorithm, and design experiments to prove the improved whale optimization algorithm in performance. Then the improved whale optimization algorithm is used to optimize the kernel fuzzy C-means clustering algorithm to obtain more accurate segmentation threshold and higher segmentation efficiency. The intelligent real-time fire monitoring platform in donglin forest area is realized by using MATLAB and Visual C++ software.

Donglin forest fire intelligent real-time monitoring platform is composed of acquisition front end, processing algorithm and carrier. Among them, the front end of collection is to install a camera to collect video images, and then carry out image processing or

video image information processing. The intelligent monitoring of forest fires in northeast China is realized by using image feature extraction technology and classification technology through real-time monitoring of forest areas in northeast China to identify whether there are forest fire characteristics in the monitoring area (Fig. 4).

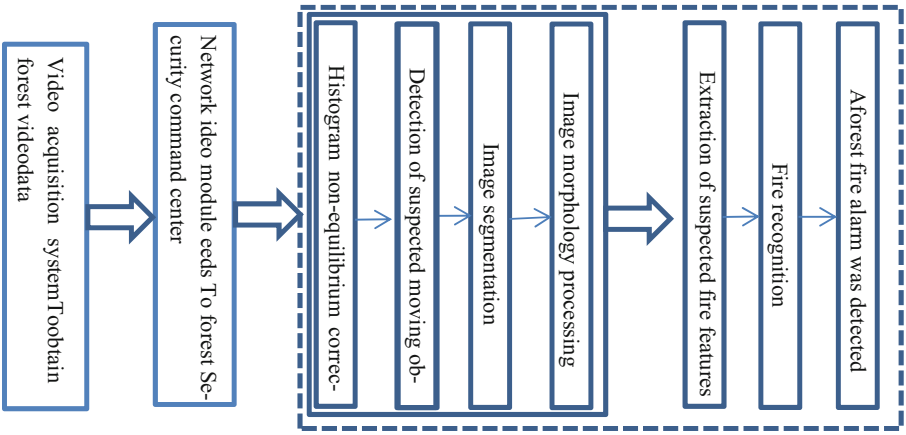

Fig. 4. Map of fire monitoring function module in Northeast Forest Area

Forest fires do great harm to human beings and ecological resources. The prevention and monitoring of forest fire has been paid great attention to all over the world. Video image monitoring and recognition based on visible distance is an important new research direction in forest fire prevention field. The forewarning of forest fire concerned by researchers of various countries has strong practical significance. Based on the research of image processing and pattern recognition technology, a forest fire automatic recognition and detection system applied to forest video surveillance system is proposed. At the same time, the image features are extracted by image preprocessing and motion sensing segmentation, and then the technical analysis, algorithm design and the judgment process of MATLAB simulation experiment are systematically carried out by image classifier recognition technology.

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