Research and Simulation of Flame Recognition Algorithm Based on BP Network

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Abstract

In this paper, a flame segmentation algorithm is obtained by the constraint between the three component models RGB, HSI and YCbCr. The image is transformed into a binary image of the object through morphological processing. The filter template is used to transform an image into three binarized target images with different details, and then extract the features of the image. Finally, the feature vector is sent to the trained BP neural network for flame determination.

Keywords

Flame split, Filter template, Feature extraction, BP neural network.

1. Introduction

Fire, as a common major disaster, seriously threatens people's lives and property safety. How to effectively monitor the source of fire has always been the focus of people's research. The traditional indoor flame monitoring method uses smoke alarms and temperature sensors to monitor the smoke concentration and temperature in real time, but this has great limitations on distance and detection field. And the monitoring sensitivity is not high, easy to be interfered. Sensitivity requires more sensors, which wastes space and needs to invest a lot of financial resources. With the widespread use of monitoring systems, digital image processing technology has made a great breakthrough in flame monitoring. Through real-time analysis of the collected images, it has the characteristics of wide monitoring range, rich information features and short warning response time. The existing fire detection methods are mainly divided into: based on the feature model and based on the learning model. The former mainly achieves the purpose of fire monitoring by analyzing the characteristics of flame and smoke and summarizing the characteristics of fire area; and the latter is to obtain the best good judgment through the classifier model with learning ability, through continuous statistical analysis of input parameters and constantly correcting parameters.

2. Flame split

The main purpose of flame splitting is to segment the target area, that is, to segment the suspected flame area. The algorithm for target segmentation mainly includes threshold method, region growing method, segmentation method based on edge detection, and so on. For the segmentation of dynamic targets such as flame, there are corresponding dynamic segmentation methods, such as Vibe dynamic detection, optical flow method, frame difference method, and gradient motion algorithm. Because there is no change in the main part of the flame when it burns, only the flashing part of the flame tip can be extracted, and the flame prospect is not ideal. The traditional image segmentation algorithm based on RGB-HIS color model is susceptible to scene brightness, illumination, and similar color interference with flame. This paper adds YcCbCr color model for image segmentation analysis. In the YCrCb color model, Y represents luminance information, Cb represents a blue component of chrominance, and Cr represents a red component of chrominance. In the flame, the proportion of red component is larger than that of blue component, so the difference between Cr component and Cb component of flame image and non-flame image should be large, which can be used as the criterion for segmentation of target image:

$$C_r(x,y) - C_b(x,y) \geq \alpha \tag{1}$$

Through a large number of experiments, it is found that when α is 35, the effect of segmentation is ideal. At the same time, according to the traditional RGB-HSI color model constraints:

$$\begin{cases} R(x,y) > G(x,y) \\ G(x,y) > B(x,y) \\ R(x,y) > 150 \\ S \geq ((255 - R(x,y)) \times 0.267) \\ C_r(x,y) - C_b(x,y) \geq 35 \\ 0.299R(x,y) + 0.587G(x,y) + 0.144B(x,y) \geq 180 \\ \dfrac{R(x,y)}{R(x,y)+G(x,y)+B(x,y)} \geq 0.34 \end{cases} \tag{2}$$

Through the above image segmentation, and the contour of the flame is outlined by the closed operation of the morphological image processing, and then the image is removed from the target area by the opening operation. Scattering, and finally filling the holes in the target area by area filling, the experimental results are as Fig1:

(a) (b) (c)

Fig. 1 (a) is the original image, (b) is Is the result of image segmentation, (c) is the the result of morphological filtering

Considering that the size of flame will affect the effect of morphological processing: too small flame, too large template may lose the details of the flame edge, affecting the value of the back eigenvector. We processed the same image with three different template sizes. The results are shown in Fig2:

(a) (b) (c)

Fig2 (a) is small template, (b) is medium template, (c) is large template

From the experimental results, we can see that the flame region can be better segmented by the segmentation algorithm in this paper. For multi-flame region, after processing the previous steps, the connected region with the largest area is taken as the flame target area.

3. Feature extraction

The feature extraction is performed by using the flame segmentation area obtained in the previous section. In order to improve the operation speed of the algorithm and improve the real-time performance, this paper adopts feature extraction of static images, including color, circularity, and texture features.

3.1 Color feature

Color is the most basic feature of the flame. In the step of image segmentation, a color filter has been performed, so the color of a single pixel no longer has significant features, but the color distribution can be reflected by solving the average color of the entire target image. . This feature is also called the color moment of the image:

$$M = \frac{1}{N}\sum_{i=1}^{N} H(p_i) \tag{3}$$

N represents the total number of pixels and H(pi) represents the H component of the pixel in the image.

3.2 Circularity feature

The circularity reflects the regularity of the object. The contour of the flame is often complex and irregular. The circularity can distinguish the flame from the regular target of the sun. The circularity can be used for the circumference of the target area. The square is the square of the area to define:

$$C = \frac{L^2}{S} \tag{4}$$

The area of the target area can be measured by the number of pixels, and the circumference of the target area can be measured by the number of pixels of the image edge, but in order to describe the circularity more accurately, the circumference is calculated by the 8-chain code.

3.3 Texture feature

The texture feature is a feature that distinguishes the flame from other interferences. The commonly used texture feature extraction algorithms include local binary mode and gray level co-occurrence matrix. In this paper, the gray level co-occurrence matrix is selected as the texture feature extraction algorithm. Based on the gray level co-occurrence matrix, four statistical components of energy (E), entropy (H), correlation moment (C) and moment of inertia (I) are calculated as texture features. The energy reflects the degree of image grayness distribution and the degree of texture thickness. Entropy indicates the complexity of the image texture, and the correlation moment reflects the correlation between pixels. Combining the above characteristics, finally determining the feature vector as

$$X = [M \quad C \quad E \quad H \quad COR] \tag{5}$$

4. Recognition based on BP neural network model

The BP neural network is a feedforward neural network based on backpropagation. It uses forward propagation output processing results and uses backpropagation to correct the accuracy of the output. The operation of a neural network involves two steps:

(1) Training learning phase: Provides a series of input data and expected output data to the neural network. Through numerical calculations, the node weights are continuously adjusted until the desired output can be generated from a given input.

(2) Prediction phase: Forecasting unknown samples with a trained network.

5. Simulation results and analysis

The images used in the simulation experiments in this article are partly from the Internet, and some of them come from the flame video they shot, a total of 400 pictures, including flames, books, the sun and other interference. Of these, 350 were used for training and 50 were for testing. The experimental results show that the correct recognition rate of 50 pictures is 90%, and the error function curve is as shown:

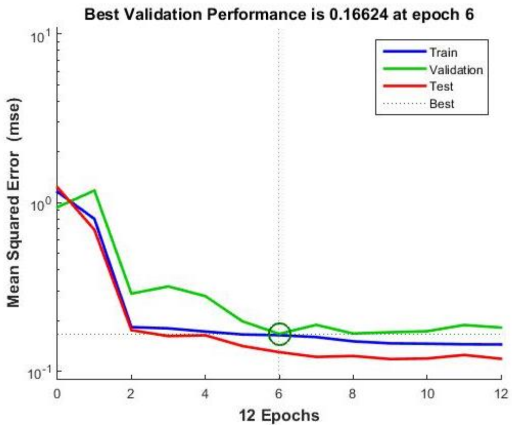

Fig3 Error function curve

It can be seen from the error curve that the convergence speed is faster, but the adjustment curve appears to be over-fitting. It is found that the number of samples collected in this paper is not enough relative to the number of feature vectors, and a slight over-fitting phenomenon occurs. The result of the picture recognition rate not in the training sample is not high enough. The solution is to use the flame database publicly provided by the laboratory to eliminate the over-fitting phenomenon by training a large number of samples.

6. Conclusion

In view of the traditional incomplete, inaccurate and poor real-time flame segmentation, this paper extracts the flame features based on the flame target segmentation algorithm of three color spaces, and processes the target edge information through multiple morphological processing templates. Extracted, and finally sent multiple feature vectors of the sample into the BP neural network for learning, and finally achieved the purpose of prediction. If the number of samples is sufficient, the recognition rate of this article will increase a lot.

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