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Segmentation Using HED And Analyze AMFE Feature Of Flame Suspected Area By Using Wavelet Transform

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***Abstract*— This paper proposes that a video which is to be converted into 'n'number of frames. A flame is to be detected from each frame based on the Amount of the Movement of the Flame Edge (AMFE) for detecting the fire with the characteristic of the flame edges constant motion. Fire and Flame images are highly affected by noise which is removed by using Gaussian filter. Firstly, background update has to be done to extract moving regions. And then the suspect area of similar flame color will be identified from the moving regions based on HSI color model. Finally, the paper construct curve of the AMFE of the flame suspect area, and make use of the local maxima of the wavelet coefficient of the high frequency components to detect whether there is flame in the video sequence with the application of wavelet transform on this curve. The experimental results prove the accuracy and the effectiveness of this method.**

Keywords— AMFE, HSI color model, Suspect area.

I. INTRODUCTION

Fire is a kind of common natural disasters, which will cause a serious threat to the safety of lives and property. Because of the uncertainty and variety of the fire, the traditional fire detection technology based on the sensor is easy to be affected by environment, such as the area, humidity, dust, gas flow and so on, which results that this technology not detect a fire accurately and also have a poor real-time performance. In recent years, with the video monitor being widely utilized and the increasing improvement of digital image processing technology, video-based fire monitoring has become increasingly better.

Several issues in the fire and flame image are it is highly sensitive to noise and the detected edges are not continuous and it lacks clarity. It is difficult to detect the coarse and superfluous edges in a fire

and flame image. There are several classical edge detection techniques such as Roberts, Prewitt, Sobel and Canny. By using these techniques the longer edges are not accurately detected.

To overcome these issues Gaussian filter is used to remove the noise in the fire and flame images and auto-adaptive algorithm is used to find the longer edges in the fire and flame images.

A flame detection method based on brightness and color features of the fire edge regions has been proposed. To extract flame suspect area with the help of brightness information, and then classify the suspect area to detect flame using support vector machine(SVM). This algorithm has high recognition rate, but with higher computational complexity. Wavelet transform is applied in the one dimensional and two dimensional space to analyze flame flicker frequency and the changes of pixel value which reduces false positives caused by single use of moving regions and color. Based on this the paper which proposes a flame detection method based on the Amount of Movement of the Flame Edge(AMFE) that is the unique feature of early detection.

II. RELATED WORK

Several approaches have been proposed in literature for edge detection in fire and flame image processing.

Tian Qiu and Yong Yan et al[1] have proposed the algorithms for fire and flame detection. The algorithm called auto-adaptive edge detection is used to detect the fire and flame edges. This method detects the main edge of the object in an image rather than all the edges. The edge detected by the presented method is continuous and long enough.

Tian Qiu and Yong Yan et al [2] have developed new flame detection algorithm in fire and flame image processing to detect the flame images. This algorithm is effective in identifying the edges of complex and irregular flames in noisy images. It is fast and convenient flame edge detection method lays a good foundation for subsequent quantification of flame parameters and 3D flame reconstruction and visualization.

Turgay and Huseyin et al [3] have proposed two models based on luminance and on the chrominance. For the luminance model, concepts from Fuzzy logic are used in luminance model and made the classification more effectively in fire, flame and fire like colored objects. The differences between fire and non-fire pixels are achieved by chrominance model. The fire pixel classification can be made combining the mask derived from fuzzy logic with the chrominance model.

Byoung and Sun Jey et al [4] have proposed a fire-flame detection method using fuzzy finite automata (FFA). The shape of fire flames continuously changes with respect to time, so that the variables in FFA are time-dependent and irregular. It achieve more robust for similar cases such as shadows, rapid changes in color and motion when compared to other methods.

Vibin [5] have proposed an approach for forest fire detection using image processing technique. The proposed algorithm uses RGB and YCbCr color space to classify the fire pixel in an image. The proposed method has both higher detection rate and lower false alarm rate. This algorithm is easy to compute and it can be used for real time forest fire detection.

Byoung C K [6] have proposed to extracts flame suspect area eith the help of brightness information, and then classify the suspect area to detect flame using support vector machine (SVM). This algorithm has high recognition rate, but with higher computational complexity.

B.UgurToreyin [7] have proposed that Wavelet transform is applied in the one-dimensional and two-dimensional space to analyze flame flicker frequency and the changes of pixel value, which reduces false positives caused by single use of moving regions and color, but has low recognition rate on rapid shaking objects with similar flame color.

Liu [8] uses color information and structural features to extract flame suspect area using Fourier transform to classify the suspect area using Fourier coefficients. This algorithm also has high recognition rate, but it is very strict to the environment. Yamagishi H[9] have developed Contour fluctuation data processing method to detect flame using a color camera.

Section I of this paper is a background introduction. Section II discusses a brief literature review of flame edge-detection methods. Section III describes Existing work. Section IV(1) describes HSI color model. Section IV(2) explains Flame suspect area extraction. Section IV(3) describes Features of the amount of movement of the flame edge. Section IV(4) shows analysis of AMFE feature via Wavelet Transform. Concluding remarks and a scope for further research are given in Section V.

III. EXISTING WORK

Fire and flame colored images are converted into grayscale image. There are several edge detection methods in fire and flame image processing. They are Sobel edge detection, Roberts edge detection, Prewitt edge detection, Canny edge detection. The basic edges are detected by using canny operator and then generating the edge map using auto-adaptive edge detection. Gradient method is used in computing algorithm for calculating frequency of the image which results only in the combination of High-Low and Low-High components. The major concern is that, there is no possibility of achieving high end of frequency.

IV. PROPOSED WORK

Fire and flame images are highly affected by Gaussian noise due to high temperature in the image. In pre-processor, the Gaussian noise is removed by using Gaussian filter. The proposed work consists of that Red Green Blue (RGB) colored video frame is converted into Hue Saturation Intensity (HSI) model. Intensity measures for the different color components in the image and used to change color in an image. And then, to identify the amount of moving flame and to analyse the Amount of the Movement of the Flame edge(AMFE) features of the flame suspect area using Wavelet transform. Hence Wavelet transform method is used to achieve high frequency component which is a diagonal component.

In proposed work, first convert video file into n number of frames and then select any one frame for filter process. If that video is affected by Gaussian noise, then that noise should be removed by using Gaussian filter. Finally compute peak signal-to-noise ratio (PSNR) between images. This ratio is often used as a quality measurement between the original and a compressed image. The Mean Square Error(MSR) and the Peak Signal to Noise Ratio(PSNR) are the two error metrics used to compare image compression quality.

To compute PSNR: PSNR = $10\log_{10}\frac{R^2}{MSE}$

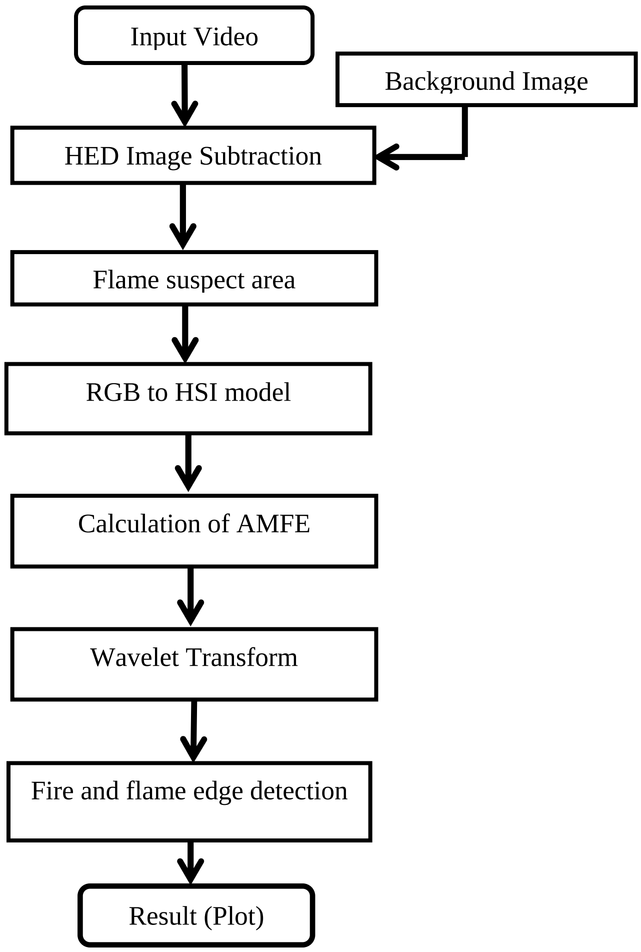

Fig.1 Functional Architecture

A. HSI Color Model

HSI color model is more suitable to human eyes for perception of scenery. The Hue, Saturation and Luminance components of flame color have its specific range in the HSI color model.

The formulae for determining HSI model:
Hue value can be determined by,
H=H/(2*pi); where H is an Angulo.
Saturation value can be calculated by,
S=1-3.*(num./den);
where, num=min(min(R,G),B);
den=R+G+B;
Intensity value can be obtained by,
I=(R+G+B)/3;

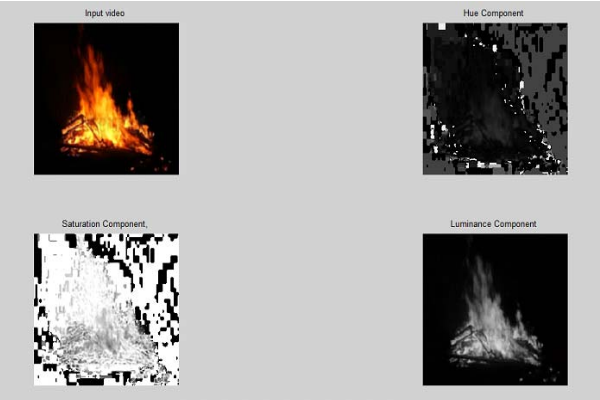

Fig.2 HSI Color Model

From this intensity value we have to calculate the amount for that suspected flame by converting it into binary image and the output as the position of the white pixels. Based on this the flame suspect area can be extracted from moving regions.

B. Flame Suspect Area Extraction

We need to extract the suspect area of similar flame color before analyzing AMFE feature, which will make the analysis of the AMFE feature is more targeted because it is not needed to analyze AMFE future if there is no moving regions in video images or there is no suspect area of similar flame color in moving regions.

The extraction of the flame suspect area is divided into two parts. First of all, we need to update the background image to extract moving regions using background difference. And then the flame suspect area will be extracted from the moving regions based on HSI color model and morphological image processing methods.

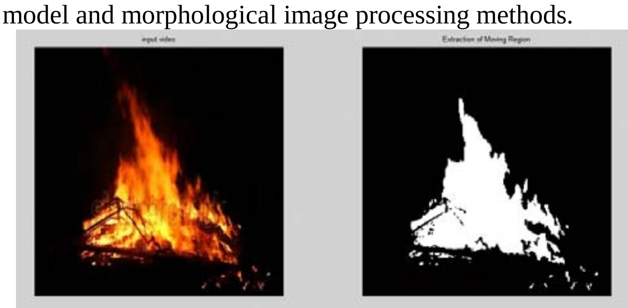

Fig.3 Extracting Moving Region

1) Background Update and Extraction of Moving Region

Moving region is determined by background estimation and update. Now, if we have two adjacent frames In, In+1 and background image Bn of n-th frame. Firstly. We get inter-frame difference image D1 by using the difference between two adjacent frames and get background difference image due by using the difference between the current frame and background image, which are described by:

$$D_l(x,y) = |I_n(x,y) - I_{n+1}(x,y)| \qquad (1)$$
$$D_h(x,y) = |I_n(x,y) - B_n(x,y)|$$

And then we can get binary images F_l and F_h by processing the above two difference images, that is:

$$F_l(x,y) = \begin{cases} 1, & D_l(x,y) > T_l \\ 0, & \text{else} \end{cases} \qquad (2)$$

$$F_h(x,y) = \begin{cases} 1, & D_l(x,y) > T_h \\ 0, & \text{else} \end{cases} \qquad (3)$$

Finally, we can get moving region image Y_n via and operation between F_l and F_h , that is :

$$Y_n = \begin{cases} 1, & F_l(x,y) \text{ and } F_h(x,y) \neq 0 \\ 0, & \text{else} \end{cases} \qquad (4)$$

2) Extract Flame Suspect Area Based on HSI Color Model

The common color model has RGB and HSI. Where H, S, and I respectively represent the Hue component, the Saturation component, and the Luminance components of flame color have its specific range in the HSI color model, based on which flame suspect area can be extracted from the moving regions. The steps are

Step 1: Flame suspect area is extracted from the moving regions by,

$$g(x,y) = \begin{cases} f(x,y) & ((H_{min} < H(f(x,y)) < H_{max}) \\ & (S_{min} < S(f(x,y)) < S_{max}) \\ & (I_{min} < I(f(x,y)) < I_{max})) \\ 0 & \text{else} \end{cases}$$

Where, g(x,y) is flame suspect area image, f(x,y) is moving region image in the HSI color model, H_{max}, H_{min}, S_{max}, S_{min}, I_{max} and I_{min} are 6 thresholds. The range of values of H, S and I are $H \in [0,60]$, $S \in [0.2,1]$, $I \in [0.5,1]$.

Step 2: Morphological image processing methods such as continuous opening and closing operations are used to smooth the edge of the suspect area, by eliminating isolated points.

C. Feature Of The Amount Of Movement Of The Flame Edge

Here, we find that flame edge motion characteristic can be determined by AMFE. Hence this paper defines AMFE as the number of pixels that change from the fire to non-fire or from non-fire to fire in the flame suspect area of two adjacent frames. Which means the AMFE for the current frame is calculated by the number of pixels that have above changes between the previous frame and the current frame. The binary area constituted by these pixels is called an edge motion region and the corresponding binary image is called a flame edge motion region.

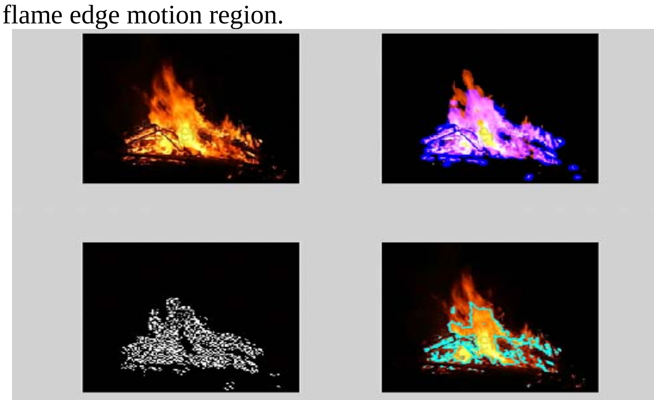

Fig.3 Fire and Flame Edge Detection

Algorithm I: Calculation of AMFE

for i = 2 : N do
$K_i = 0$
$J_i = S_i$ AND S_{i-1}
$B_i = S_i$ OR S_{i-1}
$M_i = B_i - J_i$
for (x,y) $\in M_j$ do
if f(x,y) = 1
$K_i = K_i + 1$
end if
end for
return K_i
end for

Where, J_i is AND operation binary image between two adjacent frames, B_i is OR operator binary image between two adjacent frames, M_i is flame edge motion binary image.(x,y) is coordinate of the pixels in M_i and the corresponding f(x,y) is pixel value (which is 0 0r 1). And K_i represents the valuethe current frameurrent frame.

D. *Analysis Of AMFE Feature via Wavelet Transform*

The difference of AMFE of fire between adjacent frames is larger, curve Q must have irregular mutation. Wavelet transform is applied to analyze the location and the degree of changes for its good time-frequency localization analysis capability. Because flame has an obvious AMFE feature caused by edge motion, its wavelet coefficient of the high-frequency components should be near zero. Based on this, we can detect flame by the number of local maxima of the wavelet coefficient of the high-frequency components within a certain range [250 , 1500].

Based on the experimental results, this paper which defines the absolute values of the wavelet high-frequency coefficient of the AMFE of fire to be [250,1500] range.

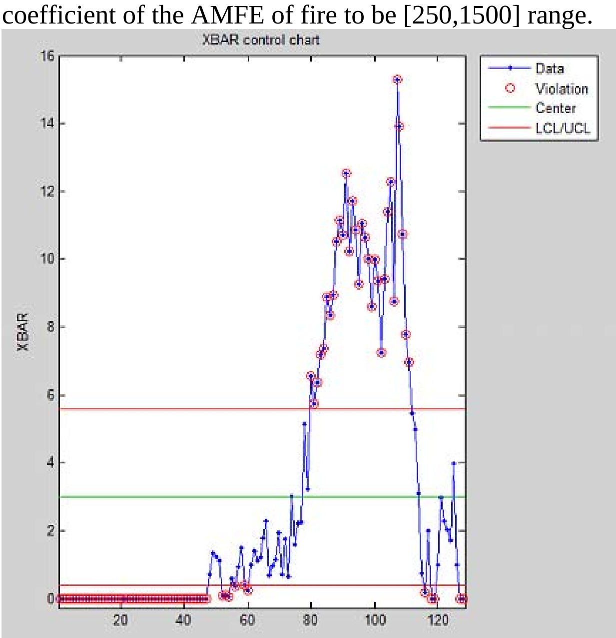

Fig.4 AMFE Curve of Flame

V. CONCLUSIONS

Based on the AMFE feature caused by the characteristic of the flame edge's constant motion, this paper proposes a flame detection method. This method extracts a flame suspect area based on the HSI color model, and then constructs curve for AMFE of the flame suspect area. And then wavelet transform is applied on this curve to analyze the location and the degree of the changes in the curve of AMFE. Finally, the number of absolute values, in [250 , 1500] range, of the high frequency coefficient of 20 frames is utilized to make flame detection. Experimental results prove that this flame detection method is accurate and effective.

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