

A Survey on Vision Based Fire Detection in Videos

Nandhini Mohan*, S. Padmavathi**

*(Department of Computer Science and Engineering, Amrita Vishwa Vidyapeetham, Coimbatore-641112)

** (Department of Information Technology, Amrita Vishwa Vidyapeetham, Coimbatore-641112)

ABSTRACT

Computer vision techniques are largely used now a days to detect the fire. There are also many challenges in judging whether the region detected as fire is actually a fire this is perhaps mainly because the color of fire can range from red yellow to almost white. So fire region cannot be detected only by a single feature color many other features have to be taken into consideration. This paper is a study of the recent techniques and features extracted by different existing algorithms .

Keywords— Flame feature, Probabilistic model, Spatio-Temporal patters, Accumulated Motion Mask, Accumulated Intensity Template.

I. INTRODUCTION

Fire detection causes a huge loss to human life and property, hence early detection of fire is very important. One of the fast way of detection is the vision based fire detection. Traditional methods like sensor based methods have many disadvantages : they have transmission delay, they are applicable mainly for indoor regions and cannot be used for outdoor regions to monitor a large area. While vision based fire detection has many advantages: a large area can be monitored, the exact location of the fire can be located and can be fabricated along with the surveillance camera.

II. COMPARITIVE STUDY

A. COLOR CONTEXT ANALYSIS BASED EFFICIENT REAL-TIME FLAME DETECTION ALGORITHM

In this paper [Huan. Li, Shan. Chang, Lipng. Shao] designed a novel algorithm for fire detection in video for the industrial application which they named as Color Context Analysis based Efficient Real-time Flame Detection Algorithm (CCAFDA). The algorithm uses flame detection context based dynamic feature row vector and optical flame feature area vector to select the flame region in a frame. In this algorithm only flame feature area of each frame is considered and not the pixel features of the entire pixels in each frame. The algorithm scans pixels of the frame selectively which reduces the computational cost. But there are some conditions that need to be satisfied for the algorithm to function properly. One of the important condition among them is that, the flame should be stable and symmetrical in nature and the flame will not be extinguished suddenly.

The main idea of the CCAFDA algorithm is that the position of the flame of the furnace will be

concentrated over a particular region and hence there is no need to scan each pixels of each frame to get the fire region. In order to get the flame region initially the whole pixels of the first frame are scanned and when the flame region is detected the next flame onwards only the scanning is done in the detected region.

The area of the flame region is checked in each frame and if the area goes down below the desired threshold which may be because the flame has extinguished then an alarm is produced that makes the workers alert. Each time when the flame area goes down below the threshold then for the next frame scanning is done for the entire image to detect the new flame region. The main advantage of this algorithm is that only the optimal flame area is scanned in each frame except for the first frame and hence it reduces the computational time and increases efficiency.

B. A PROBABLISTIC APPROACH FOR VISION-BASED FIRE DETECTION IN VIDEOS

In this paper [Paulo Vinicius Koerich Borges and Ebroul Izquierdo] have proposed a probabilistic model for detecting the fire. The method proposed is applicable in surveillance application and aim of this paper is not identifying the fire pixel but to determine if fire is present in the video. Here frame-to-frame changes of features are analyzed for detecting the fire in a video. The initial step is creating a potential fire region and then the features are extracted from this region. The features described in this paper are color, surface coarseness, randomness of area size, boundary roughness and skewness. For a fire region the randomness of area size is large as compared to the non fire region. The variance is the factor that describe the surface coarseness property of fire. The fire region show

more amount of surface coarseness than non fire region and this is because of the rapid change of pixel value in the fire region.

While in case of skewness the fire region shows high negative value in the red channel. The values of each of these features are evaluated for different regions that is fire and non fire regions to determine the threshold value for each of them. And then based on this threshold value the Bayes classifier recognizes whether the detected region is a fire or not.

The main advantage of method used in this paper is that the features used are simple statistical features of fire and hence allows fast processing.

C. A NOVEL WAY FOR FIRE DETECTION IN VIDEO USING HMM

In this paper [Jian Ding and Mao Ye] have concentrated their work to complex environment where the burning of fire is more irregular. The first step in this method is detecting the candidate region, the candidate region refers to the common region resulting from both motion region and fire colored pixel region. For motion extraction background subtraction is used and all the process is done in RGB color space.

The second step was arranging the control points to get the flickering character of burning fire, these are the points along the contour regions of the candidate area. By setting a threshold value the control points are checked that it belongs to fire area or a non fire area.

The third step was Spatio-Temporal pattern feature extraction. For this the whole video is considered as a volume V , then the control point is represented as long tube T and these tubes are segmented into several observation cubes, whose length, width and height are L, W and H respectively. The average value of the Red channel is calculated for each cuboid that gives the sequence $\{\tau_1, \tau_2, \dots, \tau_w\}$. Two channel wavelet decomposition is operated on this sequence and only the high frequency part of the result is considered. The final observation sequence obtained at the end of this step is $\{O_1, O_2, \dots, O_T\}$.

The final step in this paper is Flame Flickering model by HMM. Here the final sequence obtained in the previous step is used for training the HMM parameters. Recognition of each control points from the boundary of the candidate region are done and finally a threshold value is obtained which helps in distinguishing the fire and non fire points.

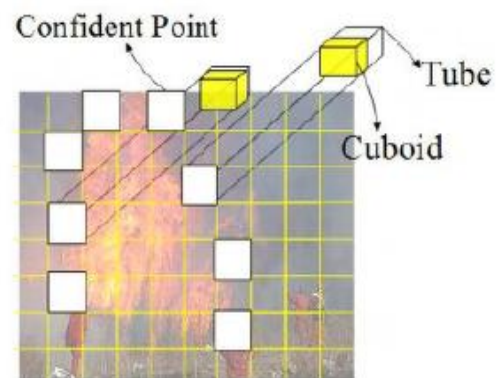


Fig.1. Arrangement of control points around the contour regions of fire. The above figure is taken from [3].

In this paper apart from the motion and color features of fire they have used the flickering properties of fire for identifying the fire region in a video.

D. SPATIAL- TEMPORAL STRUCTURAL AND DYNAMIC FEATURES FOR VIDEO FIRE DETECTION

In this paper [Hongcheng Wang, Alan Finn, Ozgur Erdinc and Antonio Vincitore] Spatial-Temporal features of fire is extracted for fire detection and is designed for surveillance application. There are mainly three modules involved in the detection of fire: Pixel- Level processing, Blob-Level Feature Extraction and SVM classifier. The initial stage is similar to that described in the previous paper. Here the blob regions are formed from Motion Extraction and Hot Spot Detection. For motion extraction unlike from the simple background subtraction frame differencing method Adaptive Gaussian Mixture model is used here. Hot spot detection is done in HSI model where the high intensity regions are segmented. The common of both the regions that is the Blob region is found by connected component analysis. The next step Spatial – Temporal feature extraction is done from this blob region. The Spatial – Temporal feature include both Spatial – Temporal structural feature and Spatial – Temporal contour dynamic feature.

In Spatial- Temporal Feature extraction the blobs obtained are observed for a period of time T , through this period of time the statistics of motion and structural patterns of blob are obtained. For this purpose two patterns are generated: Accumulated Motion Mask (AMM) and Accumulated Intensity Template (AIT). These patterns captures two important properties of fire i.e. flickering pattern and ringing structure of flame. For Accumulated Motion Mask, the motion mask is obtained from background subtraction method and it captures the flickering properties of fire. Accumulated Intensity Template is

found by averaging the intensity region of the motion mask for a particular interval of time and it captures the ringing structure of flame which occurs due to the temperature variations in different regions of fire.

For obtaining the spatial-temporal contour dynamic features, from the intensity fire blob region that was obtained in the initial stage, the contour regions and contour points are found. Then the spatial-temporal contour dynamic features are computed from FFT of spatial contour points and Eigen- projections of FFT coefficients over time. Finally for the classification SVM Classifier is used which is mainly used for a two class problem.

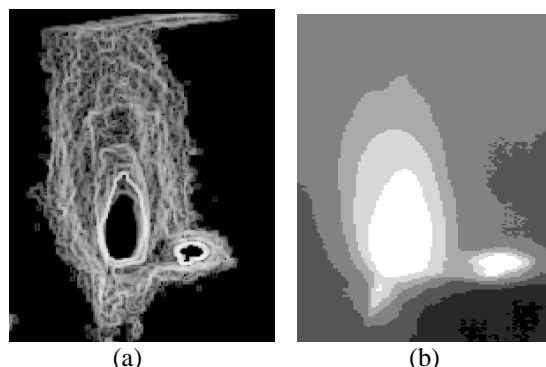


Fig2. Spatial-Temporal feature extracted. (a)Flickering pattern and (b) ringing structure of flame.

The flickering pattern and ringing structure of fire is given in fig2, which is from [4]. In this paper the blob features extracted are more robust and are effective in rejecting the false alarms.

TABLE 1 : COMPARITIVE ANALYSIS

Paper Title	Method Used	Features Used	Merits/ Demerits
Color Context Analysis based Efficient Real-time Flame Detection Algorithm	Fixing the optimal flame area	Color and motion	Only the flame region is scanned hence computational time is reduced. While demerit is that the method is purely based on color, can be used only for industrial application
A Novel Way for Fire Detection in The Video Using Hidden Markov Model	Wavelet decomposition	Motion area, color, flickering characteristics	Control points are automatically selected which reduce the computational complexity.
A Probabilistic Approach for Vision-Based Fire Detection in Videos	Frame to frame changes of features describing flame area	Color, area randomness, boundary roughness, surface coarseness, skewness	Statistical features are extracted here that allows very fast processing
Spatial-Temporal Structural and Dynamics Features for Video Fire Detection	Global Spatial-Temporal feature extraction	Color, motion, edge blurring, texture, Flickering properties, temporal dynamics of flames	Tracking of blob or contour points are not required here.

III. CONCLUSION

All the papers discussed in this survey have used different features for describing the fire some of them uses simple features like surface coarseness, skewness, area change etc while some of them have

used the structural features to detect the fire region. In the proposed method we planned to use both statistical features and Spatial –Temporal features of fire which can further improve the fire detection

method and false alarms can be reduced since both features are equally important.

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