

Real-Time Fire and Smoke Detection for Open Space Surveillance

Rahul D. Dhotkar
M.Tech (CSE) Scholar,
Department of CSE,
Government College of
Engineering, Amravati-444605,
India

R. V. Mante
Asst. Professor Department of
CSE, Government College of
Engineering, Amravati-444605,
India

P. N. Chatur, PhD
HOD Department of CSE,
Government College of
Engineering, Amravati-444605,
India

ABSTRACT

Artificial neural network is used for analyzing and training the sensed data which is gathered by different channels. In this paper we use different combinations of techniques to detect smoke and flame detection algorithms in a video. The past sensed data cannot respond quickly and fire and smoke may not capture quickly. The region partitioning technique is proposed, which will increase the accuracy and also reduce test data so that rather than using a whole frame in a video it uses only a part of that frame. The flame characteristics are used for normalization data while we are processing. The use of neural network in combination with image processing can improve the accuracy and also help to predict the data. In improvement the wrong alarm problem is decreased. The double band method is used to detect fire. The region which we are analyzing for detecting fire and smoke is calculated directly so that it can reduce computational time.

Keywords

Artificial Neural Network, Flame Detection, ImageProcessing.

1. INTRODUCTION

With the development of economy, the number of large high buildings is increasing with cities. Generally, for the more complex and high density populated area, there were high load of fire and intensive staff, so the major property damage and heavy casualties like huge economy loss and may be a lot of death will be easily caused if fire happens in these places, it has a bad social impact. So difficult technical problems of fire finding and alarm are urgently solved to obtain more valuable time for extinguish and evacuation. In large rooms and buildings, conventional fire detectors can hardly detect characteristic parameters of fire like smoke, temperature and flame in the very early time of fire, and cannot meet the demand of early fire detection in these places. Compared to conventional fire detectors, video fire detectors which have many advantages, such as quick response, long distance of detection, large protection area et al, are particularly applicable to large rooms and high buildings.

But most of present methods for video fire detection have high rates of wrong alarms. Researchers all over the world have done a lot of work on this new technique. Up to now, most of methods make use of the visual features of fire flame or smoke including color, textures, geometry and motion. Yamagishi and Yamaguchi [1, 2], Celik et al. [3], Chen et al. [4] used color information to segment flame regions. Liu and Ahuja [5] and Yuan et al. [6] do Fourier coefficient analysis to flame contours. Ugur et al. [7], and Dedeoglu et al. [8] propose temporal and spatial wavelet method to analyse flame. Compared to flame, the visual characteristics of smoke like region and grads are less trenchancy, and smoke is harder to be differentiated from its disturbances. So the extraction of smoke features becomes more

complicated. In the study of Xiong et al. [9], they thought smoke and flames were both turbulent phenomena, the shape complexity of turbulent phenomena might be characterized by Dimensionless edge/area or surface/volume measure. Yuan [10] gave an accumulated model of block motion orientation for smoke detection. Toreyin et al. [11] extracted the edge blurring feature of smoke in domain. There are few studies on video fire detection that can detect both flame and smoke. In Ho [12] actually recognize flame and smoke individual with different models. Chen et al. [4] and Çelik et al. [13] establish a color model to recognize fire flame and smoke. Generally speaking, most of studies of video smoke detection focus on greyish smoke from the smouldering phase, while few on black smoke produced with fire flame. With the high growth of present market demand, video fire detection techniques that could detect both fire flame and smoke fog will be applied to more scenes will certainly be the development trend in the future.

2. APPROACH

Since fire is a complex but unusual visual phenomenon, from this I can decide a multi-feature-based approach for algorithm. The hope and the goal of such an algorithm are to find a combination of features whose mutual occurrence leaves fire as their only combined possible cause. Fire has distinctive features such as color, motion, shape, growth, smoke behavior and edges of smoke and flame. For this project I focused on features such as color, motion and edges, hope to include also additional feature analysis in future work. To reduce the total computational load, the first step of our algorithm is to perform frame differencing to get idea where motion occurred and extract the images from the given video that are captured by surveillance camera. The regions of the video which are moving are fed to a fire color classification algorithm. There are a number of different ways of finding fire colored region. In [14], the authors used a mixture of Gaussian in the RGB color space to classify pixels as being fire or not. In [15], pixels whose color landed in a specific segment of the HSV color space were classified as being fire flame colored. So the decision is to use a multilayer perceptron, like [16], to classify pixels as being fire colored or not. Spatial clustering and analysis is performed on the pixels that get classified as being fire colored. The next stage involves grabbing a short 50 to 100 frame sequence of the video focused and each of these moving fire-colored regions. These short video sequences are then fed to a module which performs texture analysis it. So that target region is being fire or not is to be observed.

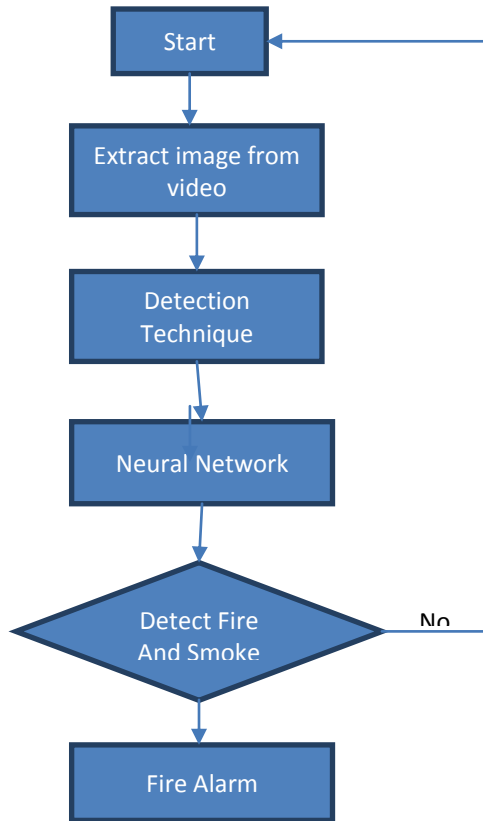


Fig 1. State diagram of detection of smoke

3. RESEARCH METHODOLOGY TO BE USED

3.1 Edge Detection

The Edge detection is use to detect theparticular position in an image where the pixel brightness changes drastically, more formally or dis continuously. The point in image where brightness changes drastically are arranged into a set of curved line segments term is called edges. The problem of finding unorganized one dimensional signals is called step detection, similarly finding an unorganized signals over time is called change detection. Edge detection is fundamental tool in image processing and computer vision, particularly in the area where feature is used. Edge detection is widely used in operation where we want to find the pattern or processing in image. The main reason is to use Edge detection for forming the outline of an object. An edge is boundary between the background and the object in the image. Also, to identify area between overlapping object. This means that if the edges in image can be identified accurately, all of the object can be located and basic property such as area, perimeter and shape can be measured. Since computer vision involve the identification and classification of object in an image, edge detection is an essential tool. In fire and flame detection the edge detection used to find particular pattern and shape of flame. So that it can distinguish between the actual fire and another source of light such as streets light, vehicles light etc.



Fig. 2 (A) Original image.



Fig. 2(B) Image after applying edge detection.

Fig.2 (a) shows the original frame i.e. frame 1 and the Fig. 2 (b) which is the result of the detected edge of this image. The edge detection system compares the drastic color change in the image and provides an image with black and white color space where high intensity area is filled with white color and less intensity area is filled with black color. The intensity difference is categorized using a global intensity threshold which is separately calculated for each image by MATLAB/Simulink, the output will provide a design of the fire flame. Thus, the edge detection can be used to analyze color detection of fire flame [17].

3.2 ColourDetection

A fire is an image can be described by using its color characteristics. The color pixel can be extracted into the individual elements as R, G and B, which can be used for color detection. Noda et al. [18] have used R and G elements and find out that there is a co-relation between G/R ratio and temperature change, whereas temperature increases, G/R ration also increases. So, due to this, colour of flame can provide useful information to guess on the temperature of a fire and also fire phase. In terms of R-G-B values, this fact corresponds to the following inter-relation between R, G and B colour channels: $R > G$ and $G > B$. The combined condition for the fire flame region in the captured image is $R > G > B$. Besides, R should be more useful than the other components, because R becomes the dominating colour channel in an RGB image of flames. This imposes another choice for R as to be over some pre-determined boundary value, RT. However, lighting conditions in the background may affect the saturation values of flames resulting in similar R, G and B values which may cause non flame pixels to be considered as flame colored [22].

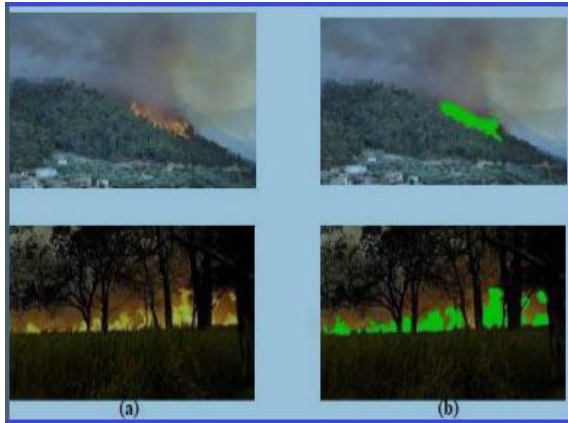


Fig. 3 Original RGB images [19] are given in column (a), and corresponding fire region manually segmented in column (b).

3.3 Motion Detection

Motion detection is used to detect the change of motion in a continuous video frames so that it can be calculated the fire flame extraction in other hand it will also detect the expansion of flame so that it can detect fire intensity. The change in background and the object that changing its points is known as object is moving from one spot to another. It is important to detect the motion of fire so that it can distinguish between constant light and the fire flame which change its position in video stream [20]. The first step is to compute the binary frame difference map, by threshold the difference between two consecutive input frames. At the same time, the background difference map is generated by comparing the current input frame with the background frame stored in the background buffer. The binary background changeable map is used as primary information for moving pixel detection. In the second step, according to the frame changeable map of past several frames, pixels which are not changing position for a long time are considered as relevant background in the background registration. This step maintains an updated background buffer and background registration map indicating whether the background information of a pixel is present or not. In the next step, the binary background difference map and the binary frame difference map are used combine to create the binary changeable pixel map. If the background registration map shows that the background information of a pixel is present, the background difference map is used as the initial binary moving pixel map. It is done by analyzing a difference between two consecutive images [21].



Fig.4(A) motion of first flame.



Fig.4(B) motion of second flame

4. BAYESIAN NEURAL NETWORK

The Bayesian network is a probabilistic approach for relationship between unmatched variables. It is a class of model known as artificial neural network. Bayesian learning neural network helps to come closer to realize an optimal and robust result in classification problems. It also helps to use a probabilistic approach for proper treatment of uncertainties. It has main features in image processing such as image segmentation, optimal and robust result, probabilistic approach with proper treatment of ambiguity. Bayesian network is used to modeling knowledge in computational biology.

Bayesian learning of neural networks could take us another step closer to realizing optimal and robust results in classification problems. It also allows a fully probabilistic approach with proper treatment of uncertainties. But, of course, the key question is: does the averaging help? The answer, in principle, is yes. More to the point, we have found the answer to be yes, in practice in effect, a comparison of 100 single neural networks with the Bayesian average over all of them. A study of these distributions reveals that the area under the ROC curve (the plot of the signal efficiency vs. background efficiency) is larger for the “Bayesian-average network” than for any one of the individual networks, which is an indication that the averaging helps. A large number of points is needed so that one can abstract a subset of (several Hundred) networks that are approximately statistically independent.

A BNN-based method has following main features:

- Image Segmentation.
- Optimal and Robust Result.
- Probabilistic Approach with Proper Treatment of Uncertainties.
- Prediction for future cases.

5. CONCLUSION

In this paper a technique which is helpful to detect the fire and smoke in an open space where the fire safety as well as ground patrol is discussed. The use of neural network in this method is because of classification and prediction of the data so that it can detect fire and smoke before it will go in extreme condition.

In fire and smoke images recognition method the criteria is decided according to the flame and smoke features. Then the data is input to neural network so that it can calculate undergoing data for prediction. This method will surely reduce the false alarm problem and result come before it will under process.

6. REFERENCES

- [1] Yamagishi, H., Yamaguchi, J., 1999. "Fire Flame Detection Algorithm Using a Color Camera," Proceedings of 1999 International Symposium on Micromechanics and Human Science, Nagoya, Japan, pp. 255-260.
- [2] Yamagishi, H., Yamaguchi, J., "A Contour Fluctuation data Processing Method for Fire Flame Detection Using a Color Camera", IEEE 26th Annual Conference on IECON of the Industrial Electronics Society, Nagoya, Japan, pp. 824.
- [3] Celik, T., Demirel, H., Ozkaramanli, H., 2006. "Automatic Fire Detection in Video Sequences", Proceedings of European Signal Processing Conference (EUSIPCO 2006), Florence, Italy, September.
- [4] Chen, T., Wu, P., Chiou, Y., 2004. "An Early Fire-Detection Method Based on Image Processing," Proceedings of IEEE ICIP '04, pp. 1707-1710.
- [5] Liu, C. B., Ahuja, N., 2004. "Vision Based Fire Detection," In: Proceedings of ICPR 2004. Proceedings of the 17th International Conference on. 4, pp. 34.
- [6] Yuan, F. N., Liao, G. X., Zhang, Y. M., et al., 2006. Feature Extraction for Computer Vision Based Fire Detection, Journal of University of Science and Technology of China 36, p. 39.
- [7] Ugur, T. B., Dedeoglu, Y., et al., 2006. Computer Vision Based Method for Real-time Fire and Flame Detection, Pattern Recognition Letters 27, p.49.
- [8] Dedeoglu, N., Toreyin, B. U., et al., 2005. "Real-time Fire and Flame Detection in Video", Proceedings of IEEE 30th International Conference on Acoustics, Speech, and Signal Processing (ICASSP'05). Philadelphia, PA, USA. 2005.2(2), pp. 669-672.
- [9] Xiong, Z. Y., Caballero, R., Wang, H. C., Alan, M., Finn, Muhidin, A. L., Peng, P. Y., 2007. Video-based Smoke Detection: Possibilities, Techniques, and Challenges, IFPA, Fire Suppression and Detection Research and Applications - A Technical Working Conference (SUPDET), Orlando, FL.
- [10] Yuan, F. N., 2008. A Fast Accumulative Motion Orientation Model Based on Integral Image for Video Smoke Detection, Pattern Recognition Letters 29, p. 925.
- [11] Ugur, T. B., Dedeoglu, Y., Cetin, A. E., 2005. "Wavelet Based Real-time Smoke Detection in Video," 13th European Signal Process Conf. EUSIPCO2005, Antalya, Turkey.
- [12] Ho, C. C., 2009. Machine Vision Based Real-time Early Flame and Smoke Detection. Measurement Science and Technology 20, No.4.
- [13] Celik, T., Demirel, H., Ozkaramanli, H., 2006. "Automatic Fire Detection in Video Sequences," Proceedings of European Signal Processing Conference (EUSIPCO 2006), Florence, Italy, September 2006.
- [14] B. U. Toreyin, Y. Dedeoglu, U. G'ud'ukbay, and A. E. C, etin. Computer vision based method for real-time fire and flame detection. Pattern Recogn. Lett., 27(1):49-58, 2006. 1
- [15] J. Elbert and J. Shipley. Computer vision based method for fire detection in color videos.
- [16] W.-B. Horng and J.-W. Peng. Image-based fire detection using neural networks. In Joint Conference on Information Sciences. Atlantis Press, 2006.
- [17] Gaurav Yadav, Vikas Gupta, Vinod Gaur, Dr. Mahua Bhattacharya," Using Image Processing Based Techniques". Indian Journal of Computer Science And Engineering (Ijcse). Issn : 0976-5166 Vol. 3 No. 2 Apr-May 2012
- [18] S. Noda, K. Ueda (1994): Fire detection in tunnels using an image processing method, in Vehicle Navigation & Information Systems Conference Proceedings, pp. 57-62.
- [19] Forest fire images: <http://www.flickr.com>
- [20] TurgayCelik (2010): Fast and Efficient Method for Fire Detection Using Image Processing, ETRI Journal, Volume 32, Number 6.
- [21] B.C. Ko, K.H. Chong, J.Y. Nam (2009): Fire Detection based on vision sensor and support vector services, Fire Safety Journal, vol. 44, pp. 322-329.
- [22] T. Chen, P. Wu, and Y. Chiou (2004): An early fire-detection method based on image processing, in ICIP '04, pp.1707-1710.