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A Survey on Improved Edge Detection for Flame and Fire Image Processing

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ABSTRACT
Edge detection process is used in image processing application to obtain the information from images. Flame and fire image processing is to judge the boundary between area of fire and nonfire region. Basically it is image based flame monitoring technique which is necessary for early fire detection, fire evaluation and determination of flame and fire parameter. There are many edge detection methods have been proposed over by many researchers. Some researchers use flame and fire edge detection process for different application. Different researchers developed their algorithm for getting better results. The features about edge detection of flame and fire images still not getting in some methods, hence researchers developed new one for improving the performance. In this paper we give brief review of few published methods related to the flame and fire image processing.

Keywords:- Image processing, edge detection, feature extraction, flame/fire image edge analysis.

I. INTRODUCTION

Fire is a serious phenomenon that is out of control in space and time and due to that it will causes serious loss of life and property once it happened. This detection of fire/flame more accurately and rapidly is a current research topic. To study the combustion efficiency and pollutant emission quantitative flame monitoring is important in fossil fuel fired combustion system, particularly in power generation plant[3].There are many conventional flame detector systems that are based on optical sensing, ionization current detection and thermocouple [12].These traditional flame detector system used in many places, uses smoke,temperature,photosensitive characteristic to detect fire, but they are not applicable in large place, harsh environment or outdoor environment [1].
Image based system can detect uncontrolled fire at an early stage before they turn into disasters. The advantages of fire detection technology based on video image are, detection techniques are intuitive, image can save more scene information through color and texture which is helpful for fire detection method greately.Beacause of this system it is convenient for people to verify record or query the fire with saved video monitor screen. Hence it has higher reliability [1].

Edge detection is the important step in flame and fire image processing. It is necessary to identify flame edges. Flame edges are useful for quantitative determination of range of flame characteristic parameter such as shape, size. location and stability. Also flame edges can reduce the amount of data processing and filter out unwanted information such as background noise within image. Edge detection can segment group of flame which is convenient for multiple flame monitoring in some industrial furnaces where multiburner system is used. This timely determination of flame edges can trigger a fire alarm and provide the fire fighter with information on fire type, combustible substances exterior of flame. This is useful for identification of real and false fire alarm [12].

Section I of this paper gives the information of fire, necessity of fire detection, importance of image based system and importance of edges in fire detection. Section II gives the brief literature of flame edge detection methods. Different algorithms and methods developed by researchers are described in this section .Section III give a concluding remark based on the literature

II. RELATED WORK

For classification of burning properties of material, numbers of tools are available eg. Cone calorimeter, ignitability apparatus etc. The data which can be measure using these tools include Heat release Rate (HRR), time taken by sample to ignite at a particular incident. These techniques are unavailable to fire researchers when unnecessary fire breaks out, the only tool available at an unwanted fire scenario may be a video camera and hence flame properties such as flame height ,flame color can be determine from image. In such a case video based fire detection system is useful in order to

detect the fire correctly, it is important to eliminate false signal by preprocessing the digital image.

There are numerous methods are present for edge detection such as classical method, Gaussian based method, color edge method which uses vector valued image function, contextual method which uses adaptive edge detection approaches, wavelet based method. Different researchers use different methods for edge detection depending on their performances. Some of the methods and algorithms for edge detection for flame and fire image processing are reviewed in this paper.

Byoung Chul Ko,Kwang-Wo Cheong,Jae-Yeal Nam proposed Fire Detection Based on Vision sensor and support Vector Machine[2]. It is based on wavelet transform and support vector machine. This method uses color feature of fire which can detect the fired colored pixel and nonfired colored pixel. The generated wavelet coefficients are applied to the support vector machine which is then used for final fire pixel verification. This method tries to reduce the number of false alarm. Support Vector Machine (SVM) has good performance but require additional computation time depending on feature dimension.

To reduce the computation time another method was proposed by Najuan Yang, Huiqin Wang, Qianyuan Zhang, Zongfang [3].Adaptive flame Detection Algorithm is based on support vector machine which is an effective data classification tool and it can efficiently classify the fire flame from the suspicious region. Support vector machine (SVM) is nothing but the structural risk minimization principle which gives attention to both training error and generalization ability. Its function is to calculate the dependency relationship of input and output vector according to the given training sample, then estimated and evaluated unknown input vector. This method is based on kernel function. This method extracts the feature from flame image and use these feature to form the training sample input. After getting training sample they select kernel function and train the support vector machine with kernel function for obtaining the information of support vector which give new kernel function. Hence new kernel function is obtained, and then they again train the support vector machine with this new kernel function. As kernel functions are modified in this method still it is time consuming [3].

Another method was developed by Zhong Zhang, Jianhui zhao, Dengyi Zhang, Cheng Zhang Qu, Youwang Ke, Bo Cai which is based on contour extraction[4].They proposed contour based forest fire detection using FFT and wavelet. Wavelet is used in this method to test whether pixel is belonging to the fire region or not and FFT is used to describe contour of fire area. The temporal wavelet is used to analyze Fourier descriptor that represents the variation of flame contour. This combine approach of wavelet and FFT can detect the fire than only using wavelet method. But this method performs well when fire increases and flickering frequency is described by whole shape of fire region. Qin Jiang and Qiang Wang proposed Canny Edge Detector Based on Adaptive Smoothing to avoid the large scale damage caused by fire occurring in large space building. It is based on adaptive automatic derivation of local threshold through modified canny operator. This algorithm uses boundary chain code which can extract dynamic flame characteristic in large space. This method detects flame edges but it is not suitable for fluctuated flame[5].

Tian Qiu,Yong Yan proposed Medial Axis Extraction Algorithm[6]. The flame whose shape is recognized as useful characteristic in the adjustment of combustion parameter. This method describes an algorithm Horizontally-cut Medial Axis to detect medial axis of an elongated flame. This method is useful for flame pattern recognition, quantification of flame parameter and validation of flame monitoring. It is applicable to advance flame monitoring and combustion diagnosis through digital imaging, leading to in-depth understanding and optimization of combustion process [6]. Liqiang Wang,Mao Ye,Jian Din,Yuanxiang Zhu proposed Hybrid Fire Detection using Hidden Markov Model and luminance map[7]. This method uses color feature of fire. It uses the fire flickering frequency to detect the fired colored object. Hidden Markove Model (HMM) based on spatiotemporal feature to detect the flame flicker process. This method reduces number of false alarm, but requires to analyze the texture for improving the recognition accuracy.

Tung xuan Truong,Jong-Myon Kim proposed Fire flame Detection in Video Sequences using Multi-Stage Pattern Recognition technique. This method is based on gaussian mixture model which detect moving region, fuzzy C-mean (FCM) algorithm which segment he candidate fire region from moving region based on color of fire and support vector machine which can distinguish between fire and nonfire region. Because of this multipattern recognition its computational time is more [8]. zhang xi, xu fang, Song Zheu , Mei Zhibin proposed Video Flame Detection Algorithm Based on Multi Feature Fusion Technique. In this method first fire region is extracted from image, and then boundaries of these regions will be taken out by Fourier coefficient. Finally using these Fourier coefficient and edge corrosion model to extract the feature of fire region and to recognize that [9].

Another method was developed by Wenhao Wang, Hong Zhou to improve the recognition accuracy [10]. Fire Detection based on Flame Color and Area deals with extraction of flame object based on the threshold of the area. This method can detect whether fire occurs from the fire flame color, fire

spreading characteristic information. Here contour extraction can be done which is based on threshold value and set theory. It deals with contour extraction and object could be located according to the contour. This method can achieve noise erosion and contour extraction [10].

Punam Patel and Shamik Tiwari proposed Flame Detection using Image Processing Technique. This method is based on dynamic feature such as fire, smoke, trees in the wind etc. and color model which detect fire pixel or nonfire pixel from image. It analyzes the shape of fired colored pixel in frame to detect the fire pixel in image. In short this method use combination of color, motion and area to detect the fire in sequence [11].To get the shape description of flame edge another algorithm is developed by Tian Qui and Yong Yan [12].An autoadaptive edge detection algorithm for flame and fire image processing can detect the superfluous edges of flame and remove the unrelated edges. It uses the autoadaptive feature to detect the clear and continuous flame edge so that fire region is detected. Here the threshold of detected edges should be autoadaptively adjusted to get the continuous edge.

This survey reveals that there are many methods and algorithms developed. Some method detects the flame based on flame color, someone extract flame contour, also detected the edges with parameter extraction. Different researchers developed their algorithm to give the best results, but still analyzing the texture, some geometric feature is the future challenge.

III. CONCLUSION

Flame images are special class of images. From the above literature it has been seen that there are many methods of detection of flame edges, each one has subjective pros and cons. Several unique features of flame is proposed by authors to identify flame edges. Edge detection is necessary because it can preserve important properties of flame and make the processing time shorter. The issues such as proper edge detection of flame edges, distinguish between fired colored and non fire color object, discontinuous edges of flame and detection of interference of fired colored object are the important factors to obtain the clear and continuous flame edges.

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