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A FAST AND EFFICIENT VISION BASED APPROACH FOR DETECTION OF FIRE IN REAL TIME SCENARIO

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ABSTRACT

Fire is a huge serious disruption which leads to economic and environmental losses. So it is necessary to detect occurrence of fire at early stage. Alarm is not issued unless particles reach the sensors to activate them and requires large response time. Also, infrared and ultraviolet sensors which are commonly used produce many false alarms. With the help of computer vision techniques, it is possible to get better results than conventional systems because images can provide more reliable information. In this paper OpenCV library is used to process video images more accurately with fast speed. Also an innovative approach is proposed, which is based on video processing to overcome drawbacks of sensor based fire detection methods. The main consideration in this proposed technique is that, it is based on three algorithms mainly used for flame detection & they are motion detection algorithm, edge detection algorithm and colour detection algorithm. It is observed that this approach based on three techniques gives better results then existing fire detection techniques.

KEYWORDS: Edge detection, Flame, Image, Motion detection, OpenCV.

INTRODUCTION

Fire is one of the few affliction in which damage can be interrupted or reduced, when compared to other natural disasters such as earthquakes and hurricanes. Fire can lead to major losses in various aspects, The fire could be put out by a method to detect fire by the authority ,before it would become out of control. Detecting the fire earlier is the most important thing to control the fire before it would become a big disasters . In traditional fire protection System, sensors are the keys to detect fire occurrence and make the decision accordingly. In market the available sensors are smoke detector, flame detector, heat detector and etc., but these sensors take quite large time to response. The vital requirement is to place these sensors carefully at various locations, and they are not suitable for open spaces as products of combustion tend to spread away which can reduce the detection.

This paper focuses on detection of fire in sequences of images. Fire has differentiate, multispectral signatures, for its detection several of which have been utilized to devise different methods. In this dissertation, the algorithms for fire flame detection using video processing will be explained. A vision based methods were based on difference of colour, motion detection of
fire flame pixel and edge detection also. By identifying colour, motion and edge, which is generated because of fire pixel and the moment detection of flame .To, reduce false alarms in fire detection, this vision based technique is used and algorithms of this system are very useful for detection of colour motion of fire. In fire detection system able to monitor large and open spaces .The fire algorithms can detect an active fire with the best fire detection algorithm so that fires can be prevented and contained with minimal or no damage to facilities.

LITERATURE SURVEY

Reducing the fire damage, the fire should be exhausted when it is in small amount .However, as long as there is fuel the fire grows naturally .Small amount of fires are difficult to see, and that's why the fire are spotted too late This can be remedied by the use of fire and smoke detectors, which can detect fire using which is emitted from the fire as well as the fire itself. A brief review of major research work carried out in the field of fire flame detection and various algorithms which are used in this paper are given below.

Tian Qiu, Yong Yan, Gang Lu, [1] proposed An Auto adaptive Edge-Detection Algorithm for Flame and Fire Image Processing. The identification of flame or fire edges is the process of identifying a region between the area where there is thermo chemical reaction and those
without. After the flame characteristics are analyzed, a new flame edge-detection method has been

developed and evaluated in comparison with conventional methods. Experimental results have demonstrated that the algorithm developed is effective in identifying the edges of irregular flames. The advantage of this method is that the flame and fire edges detected are clear and continuous. The vision based system provides Pedro Santana, Pedro Gomes, and Jos´e Barata [2] presented the early fire detection which is given to the challenges related to the actual deployment of the computer vision system. Mostly, for improved accuracy subtraction of background is performed, an attentive mechanism is employed to study a computationally expensive frequency analysis of potential fire regions; a model for object detection and tracking was proposed and integrated with the purpose of reducing the false alarm rate in a model-based way.

Suzilawati Mohd Razmi, Nordin Saad, Vijanth Sagayan Asirvadam [3] explained Vision-Based Flame Detection: Motion Detection & analysis of fire, in this paper vision-based flame detection is mainly discussed using motion detection. As a result, for the future work, algorithm for fire-colour pixel should be combined with motion and edge detection to build a flame detection system. The technique proposed in this paper is to perform the motion detection first, followed by the identification of the flame based on fire colored pixel and then to use edge detection to detect the colour variances and the shape of flame.

Nicholas True [4] proposed a computer vision based fire detection using a combination of various techniques to detect fire in video data. First, where there is movement, the algorithm locates regions of the video.According to H.C. Muller and A.Fisc1ier Multi Sensor based Fire Detection (MSbFD) systems are one of the important systems for current, developments in automatic fire detection technology [5]. As per there discussion this system also takes time to response and cannot be used for open space. So as discussed above traditional fire detection method has lots of disadvantages, so new vision based fire detection system is immersing now a. Firstly, the installation cost is lower, as this system is based on cameras, and industries are mostly equipped with CCTV for surveillance. Secondly, the response time is faster as it does not have to wait till the product of combustion to reach the sensor [6] subsequently, in case of false alarm, confirmation can be done by personnel from a control room without rushing to the location of fire. Although there already exist different methods for fire detection via video processing, flame and smoke are two major features used in the related research work.

Computer Vision based fire detection is potentially a useful technique explained a Che-Bin Liu
and Narendra Ahuja [7] ,number of surveillance cameras being installed, a vision based fire detection capability can be incorporated in existing surveillance systems at relatively low additional cost. Vision based fire flame detection offers advantages over the traditional methods in fire detection. Experiments show that his algorithm detects fire with very high accuracy, both in single images & image sequences.

According to S.P. Kale, S. B. Somani [8] The aim of this paper is to develop an automated and fast responding system based on the video image to detect an occurrence of the fire. In this paper out of different properties of fire, author use only selected properties of fire to perform fire detection. That are edge detection and fire detection .That can give more distinct results in the detection of fire. As per Gaurav et. al [9] as the fire increases its intensity, smoke and flame will be visible. So for fire detection, both smoke and flame needs to be analyzed.

Han et. al [10] divided the fire detection algorithm into two algorithms which are flame detection and smoke detection. For fire and flame detection, two main methods can be seen from the results from the research. The first method color is use to fire in movement. The second would be to analyze the flicker caused by a flame. The first method was employed by Y. Le Maoult [11] and Phillips et al [12], who used a color scheme near the infrared. This scheme used the color scheme of fire, and analyzes it through movement. If an object with a color similar to the color scheme was detected in the video feed, it would be assumed to be fire.

The second method, analysis of the flicker of the flame, was employed by Toreyin et al [13]. Toreyin et al used the wavelet analysis, which is detecting wave that oscillates, based on both time and space. This allows the system to be able to detect something like fire, of which the edges flicker in and out. Phillips et al had a system which utilizes color information, which was then processed and had the motion of the flame filtered out.

METHODOLOGY

In Figure1 the basic system block diagram is shown. The system has basic blocks in any detection application. As cameras are located on surveillance area, this technique is applied for safety purpose. The main function of video processing system is to analyze video sequences to detect unusual or abnormal activities. Activity detection is a very crucial component of video processing systems for

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activity based analysis of processing videos. Detection of fire activities uses computer vision techniques on video sequences to detect is fire at early stage in surrounding environment.

Figure1: ***System Block diagram***

At first, the frames are captured from the image acquisition devices- camera, and then image frames are extracted from given video for fire detection purpose. If fire is seen then detect fire coloured region, moving region detection and edge detection.

The proprietary Fire Detection algorithm is able to detect and identify a nearly unlimited number fire sources while avoiding false alarms from hot spots in the scene, the three algorithms discussed are given in brief are as follows

\A. Motion Detection

Motion detection allows for an organism to detect motion across its visual field. Motion detection is used to detect any occurrences of movement in a video. Block Diagram of Motion Detection System is as in following figure. Using OpenCV model, a Motion Detector model is built based on this block diagram. A video input is loaded into the motion detection system. Then, motion based Background storage uses the first frames of the video stream to store the background image .It subtracts the background from each video frame to produce foreground images and only redraws the portion of the background that is revealed by the moving objects. The background storage unit provides background for the entire processing.The background is the outcome of the background storage unit where there is no fire. Then, the threshold is the output of background subtraction, where it shows the difference between original captured frames with estimated background. Finally, the result shows an original image, with a bounding box, where this bounding box is to show that there is a motion inside this area.

Figure2: ***Motion Detection***

B. Edge Detection

Edges generally occur on the boundary between two different regions in an image. So it has fundamental importance in digital image processing. Prior classical operators like Robert, Prewitt, and Sobel etc were used but they didn't give satisfactory result as they all are highly sensitive to the noise so detects false and unsharp edges. In 1986, John F. Canny proposed a new edge detection algorithm; known by this name "Canny edge detection Algorithm". It is widely considered to be the standard edge detection algorithm in the industry. The aim of John F. Canny was to find such an algorithm for edge detection provides good detection good localization and minimal responses.

Edge detection is important step often the precursor and lays a foundation for other processing, because the flame edges form a basis for the quantitative determination of a range of flame characteristic parameters like shape, size, location, and stability. The amount of data can be reducing and filter out unwanted information such as background noise within the image is possible by using flame edges. A new flame edge-detection method has been developed by Tian Qiu [1] and evaluated in comparison with conventional methods. Liu explained an algorithm for early fire detection and tested it on video clips. Jiang and Wang also demonstrated an improved canny edge detector which was used to detect moving fire regions in large space fire images. Although every methods has its own advantages for the given tasks, such as fire detection or shape reconstruction in a difficult background, or help to detect an early fire and trigger a fire alarm, they have some limitations. For instance, some fire flame edges detected are unclear, discontinuous, or do not well match the actual shape of flame. For the purpose of detecting the flame's size and shape and, consequently, the geometric characteristics, it is

necessary to attain the clear, continuous and, closed edge of the flame.

Edge detection is an analysis based on the color contrast of an image. As this method is insensitive to change in overall illumination level, it is widely used in image interpretation. Equation (1), (2) and (3) show how to find the edge of an image.

To detect vertical edges,

$$Exx,=|Px,y-Px+1,y|\ \forall x\in=1,N-1;\ y\in1,N \quad (1)$$

To detect horizontal edge

$$Eyx,=|Px,y-Px,y+1|\forall x\in=1,N;\ y\in1,N-1 \quad (2)$$

Combining equation (1) and (2), new equation (3) that can detect vertical and horizontal edges together is formed.

$$Exx,=|2xPx,y-Px+1,y-Px,y+1|\forall x,y\in=1,N-1 \quad (3)$$

C. Colour Detection

A computer screen produces colours based on the varied combinations of red, green and blue phosphor emission required to form a colour. Typically colour is represented by three coordinates or parameters. The location of the colour in the colour space is exemplified by these parameters. Colour space conversion is defined as the transformation and description of a colour from one source to another. Normally, colour space conversion is performed while converting an image that is represented in one colour space to another colour space, with the objective of making the translated image appear as similar as possible to the original. The commonly used colour spaces are RGB, CIE *XYZ*, CIE YUV, CIE L*a*b*, YCbCr and HSV. In the proposed intelligent system, the images in RGB colour space are converted to *XYZ* colour space. Block Diagram of Colour Detection System is as in following figure. Using Opens model, a Colour Detector model is built based on this block diagram

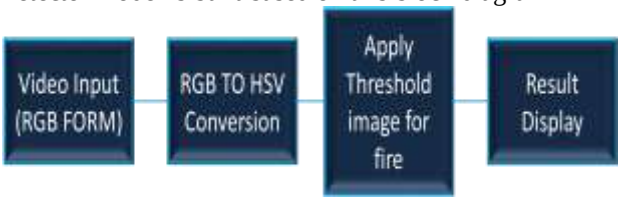

Figure:3. ***Colour Detection***

Video sample is loaded into color detection system. The input for color detection system is in the form of RGB, system convert this in to HSV format. Threshold values for the fire are loaded in to the system, as par the threshold values color detection system display result only if the fire is detected. So color detection system provides final result of the total fire detection system. In order to create a color model for fire, we have analyzed the different fire samples. HSV color space is chosen, because of its ability to separate illumination information from chrominance more effectively than the other colour spaces. For RGB colour space in order to detect possible fire-pixel it can be transformed into HSV colour space and analysis can be performed with rule. However the rules fall short in coming up with a single quantitative measure which can indicate how likely a given pixel is a fire pixels.

Fire has very distinct colour characteristics, it is the most powerful single feature for finding fire in video sequences. Based on tests with several images in different resolutions and scenarios, it is reasonable to assume that generally the colour of flames belongs to the red-yellow range. Some Lab experiments show that this is indeed the case for hydrocarbon flames, which are the most common type of flames seen in nature. Other types of flames, such as blue liquefied petroleum gas flames, are not considered in this system since they do not represent the typical flame seen in a surveillance or catastrophe scene.

D. Experimentation

In this paper combination of three methods of fire detection gives better results as compare to traditional method. By using these three algorithms the chances of false alarm and early stage detection is achieved. Motion detection and edge detection is carried out using OpenCV. For edge detection color detection is become helpful. In this dissertation to develop and demonstrate a new and unique system for achieving effective coding aims of minimizing false alarm. The system is based on real time operating. As the process is in real time so we required high processing speed Software. MATLAB having the image processing tool but processing speed of MATLAB is too less for real time application. To detect such a real time activity, INTEL introduces an OpenCV which has a high speed processing speed about 30 frames per second, which is more than enough for real time application so we are using OpenCV platform.

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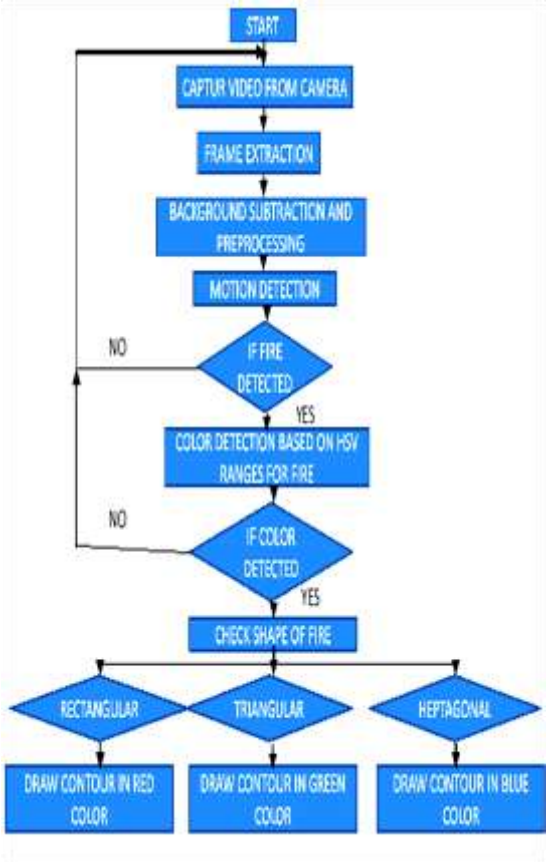


Figure:4 ***Flow chart***

E. Hardware

a. 5 Mega Pixel USB 2.0 Webcam

The INTEX Night Vision USB 2.0 webcam is used for experimentation.

The features of Webcam are:

- Webcam having excellent quality.
- True plug and play, Easy USB interface. Their most popular use is the establishment of video links.
- Permitting computers to act as video phones or video conference stations.

b. Software Used

1. Microsoft visual studio C++ 2010 express edition.
2. OpenCV 2.4.2

RESULTS AND DISCUSSION

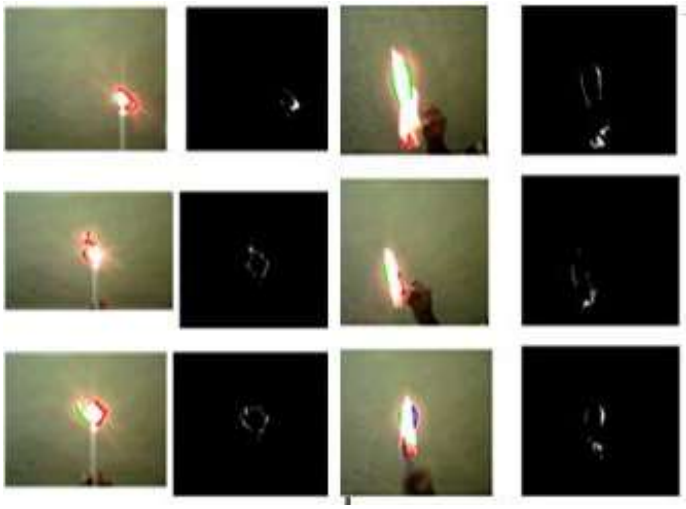
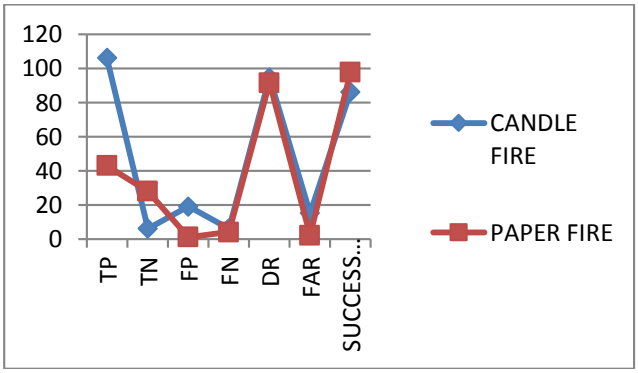


Figure:5 ***Result of fire flame detection by using candle & paper***

TABLE NO. 1
Performance comparisons of different fire detection methods on video sequences detailed

PARAMETER	METHOD OF [13]	METHOD OF [19]	PROPOSED METHOD
	DR	DR	DR
CANDLE FIRE	51.2	58.3	94.62
PAPER FIRE	87.5	79.2	91.48

GRAPH I
Qualitative analysis of candle and paper fire



CONCLUSION

The previous work for fire flame detection shows that most of the systems use sensors. As per the vision based system are concern uses simple fire detection algorithm which are unable to robustly detect fire. The main objective of propose work is to develop such a system which would be automatically

detect fire with high processing frame rate. This work introduces three fire detection algorithm, motion based, color based and edge based which is totally free from sensor. The system also has good response time. Hence system gives better system performance.

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