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Novel Technique for Fire Detection

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Abstract
Fire is one of the major disaster which can leads to many losses, such as financial losses or loss of life. So it is becomes more important to detect occurrence of fire at early stages. Now a days, sensor based fire detection system are becomes one of the important invention in automatic fire detection technology. But there are some drawbacks in this sensor based detection system such as false alarm and large response time taken by the system. A novel approach which based on video processing is described in this paper to overcome drawbacks of traditional fire detection methods. This paper proposed the algorithm for flame detection which uses video processing technique. Current work gives attention on development of two algorithms which are used for flame detection. The study carried out to focus early detection of fire using two properties of flame that are motion and shape which can be achieved by edge detection algorithm and motion detection algorithm. Algorithm is developed by using open source software named as Open CV.

Keywords **–** Edge detection, Flame, Image, Open CV, Motion detection.

I. Introduction

Fire can be referred as one of the disasters where damage can be prevented, if compared with other natural disasters such as earthquake and hurricanes. But because of the speed and distractive force of fire, it constitutes more than one serious problem. For the purpose of reducing these problems, the fire is desired to be controlled at its initial stage. At the same time, it is very difficult to identify the fire at its initial stage and hence controlling of such hazards is delayed.

By considering all these possibilities, developments of a reliable system which can detect an occurrence of fire at early stage become very important. Now a day's automated fire detection systems are consists of number of sensors, which detects various parameters of fire such as temperature, smoke etc. However, these sensor based automated system are not able to detect fire at early stage as it require some input to sense which is one of the most considerable disadvantage. In case of fire it may be CO2 gas or smoke or temperature. For these conservative fire detection systems, it is important that these input parameters reaches to the sensor on time, so that alarm is fired. For the purpose of this sensing, sensors have to be placed at appropriate locations and the system needs some specific level of these inputs to sound alarm. But this is not the best way to ensure a timely response when safety is concern, as lot of damage might have happened by then. One more disadvantage with these sensors is that these are not suitable for open spaces. There may be lot of chances of false alarm.

Due to rapid development in video processing techniques, traditional fire detection methods are replaced by vision based systems. Moreover video processing based flame detection system offers several advantages. The first important advantage is that installation cost is lower as the system uses CCTV camera. Second is that response time is faster as it does not have to wait till the product of combustion (Input required for sensor) reaches the sensor. At the same time, in case of false alarm, confirmation can be done from the room by person without rushing to location of fire.

This paper proposes the simple algorithm for flame detection using video processing. Aim of this paper is to utilize advance techniques of video processing for flame detection and resulting good model with the help of two algorithms of fire detection which are edge detection and motion detection. And The advantages of video based system over traditional fire detection systems.

II. Overview Of Fire Detection

Fire has number of features such as color, motion, shape, smoke and growth etc. For detection of fire these feature are used. During the occurrence of fire, smoke and flame both can be seen. As per Gaurav et. al [3] 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[4] divided the fire detection algorithm into two algorithms which are flame detection and smoke detection. Tareyin et. al [6]

uses extracted features such as motion, flickering, edge blurring region from a video, using wavelet transformation and background subtraction for determination of smoke. Kandil et. al [1] and Liu et.al[5] use shape and color features to detect occurrence of fire. According to Blagojevice et. al[7] fire has three phases normally, growth, steady burning and decay. These phases are based on temperature of fire. It is assumed that produced output image captured by image capturing device is in RGB format. These R, G, B elements are considered separately which can be used for color detection.

2.1 Edge Detection

Edge detection is an algorithm which is based on variation in color of images. This method compares the color difference between present image and previous image and gives edge based on it. From this algorithm, shape of flame is determined.

From the work [3], we get (1), (2) and (3) which gives the formula for finding the edge of the image.

To detect vertical edge,

$$Ex_{x,y} = |P_{x,y} - P_{x+1,y}| \qquad \forall x \in= 1, N-1;\ y \in 1, N$$

(1)

To detect horizontal edge,

$$Ey_{x,y} = |P_{x,y} - P_{x,y+1}| \qquad \forall x \in= 1, N;\ y \in 1, N-1$$

(2)

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

$$Ex_{x,y} = |2xP_{x,y} - P_{x+1,y} - P_{x,y+1}| \qquad \forall x, y \in= 1, N-1$$

(3)

2.2 Motion Detection

Motion detection is the algorithm which recognize occurrence of any moveable change in the video. It is done by analyzing two sequential images or frames of a video. This analysis is mainly based on the concept on finding difference in the image.

Frame difference is mainly done to find out occurrence of any movement in the video. This is performed by comparing two consecutive images. Ko et. al [8] put a simple formula for calculating the frame difference,

$$DiffF = |B_n[k,l] - X_n[k,l]|$$

(4)

$$B_n[k,1] = a|B_n[k,l] + (1-a)X_n[k,l]| \quad \text{if } DiffF < t$$

$$= X_n[k,l] \quad \text{else}$$

(5)

Where, B_n is background intensity in the n[th] frame at the location *k,l* , whereas $X_n[k.l]$ is the intensity value of that same n[th] frame at same location. *DiffF* is the frame difference which determines the difference between present image and the previous image by using (4). α is a weight value whose value is varying between 0 and 1. *t* is the threshold value which should be mentioned.

III. Methodology

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 project, 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. Therefore for development of system following flowchart is involved.

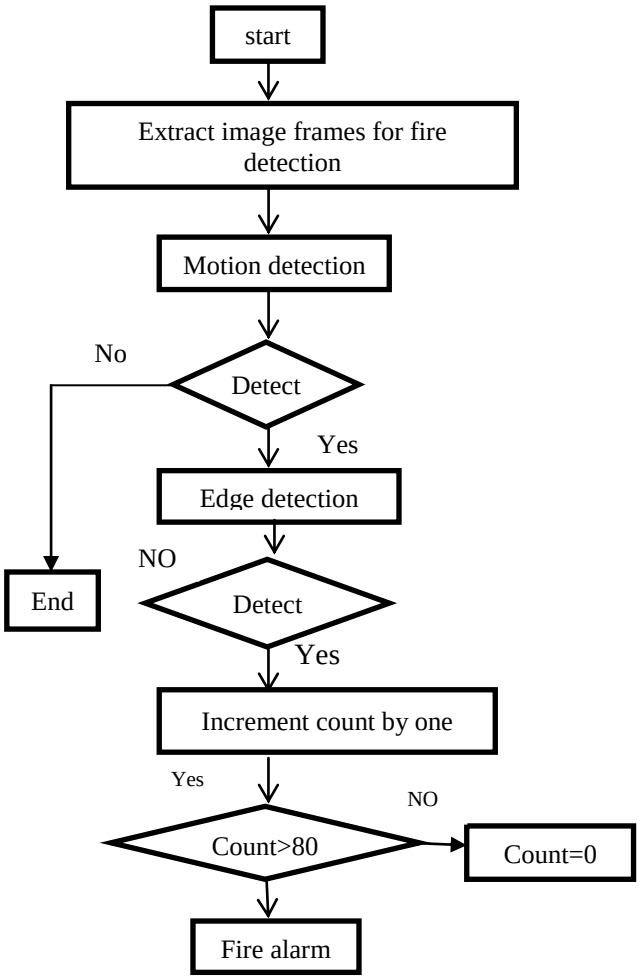

Fig 1: Proposed Flow Chart

This work perform on the basis of OpenCV software using image and video processing tool.

3.1 Edge Detection

Edge detection method is used to detect the color variance in an image. Block Diagram of Edge Detection System is as shown in following figure. Using OpenCV[8] and [9] an Edge Detection model is built based on this block diagram.

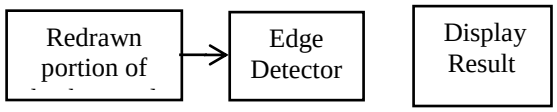

Fig. 2 Block Diagram of Edge Detection System

A redrawn portion of background is loaded into edge detection system. This detection system compares the color difference in the present image and provides image edges based on it. The output of this edge detection system provides a shape of the moving object. Flame has its particular pattern. If this pattern is detected by the system resulting figure will detects that current edge is of fire
From this edge detection algorithm one can recognize the shape of the flame. Therefore edge detection can be used to analyses shape of the flame or the fire.

3.2 Motion Detection

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 [8] and [9], a Motion Detector model is built based on this block diagram.

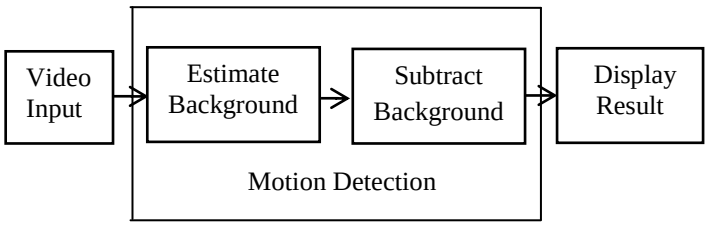

Fig 3. Block Diagram of Motion Detection System

A video input is loaded into the motion detection system. Then, a motion based system performs fire differentiation on the input video in two stages. System estimates the background image. This system uses first frame of the video stream as the background image. Than this background is subtracted from each video frame to produce foreground images. It only redraws the portion of background that is expos by moving object.

IV. Conclusion

The preliminary work of flame detection shows the simplest fire detection algorithm, which is free from the ordinary fire and smoke detection systems which are consisting of number of sensors. The objective of this work is to create a system which would be able to detect flame using images from a feed, such as a video feed. And to build the system which has good response time. The system was made to detect fire at its early stages. The system should not detect fire when there is none. For achieving this, system uses two algorithms named as motion detection and the edge detection. The work is become more effective by the use of OpenCV.

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