"FIRE AND SMOKE DETECTION USING IMAGE PROCESSING"

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ABSTRACT: *Fire is one of the major disasters. Fire is the visible effect of the process of combustion. At various places such as offices, hospitals, schools, colleges, industries, etc sudden fire may initiate and spread which can cause losses such as financial losses or loss of life. The losses due to fire are not recoverable. 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 new approach which based on image processing is described to overcome drawbacks of traditional fire detection methods. The aim of the system is to early detection of fire apart from preventive measures to reduce the losses due to hazardous fire. The images will be further processed by using the image processing. The proposed system uses RGB and YCbCr color models. A system which can efficiently detect fire after the image of the area has been captured by a camera. Fire is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat and light. The light parameter and colour of flame helps in detecting fire. When a fire breaks in the area under consideration, the corresponding fire region in the input video frame will be segmented which covers the fire. For a fire pixel Y(x, y) >= Cr(x, y) >= Cb(x, y), where a non-fire pixels don't satisfy this condition, where (x,y) is spatial location of a fire pixel. When a certain number of pixel (say 10 to 20) in an image satisfy condition of a fire pixel a fire alarm will go on. Such system can be useful for detecting forest fires where we can't put sensors at each location.*

***Keywords*:** Image Processing, Color Models

1. INTRODUCTION

Fire is one of the major disasters 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. So that, to overcome this drawbacks of traditional Fire detection methods, a new system is design which is called smoke and fire detection system using image processing. Current system of fire or smoke detection use electronic sensors which use radiation heat to detect smoke or fire by detecting change in temperature. In such systems the main drawback is sensors can't cover outdoor area or large area such as forests, petrochemical refineries, sawmills etc. where we can't install sensors over a large area. Installing electronic sensors is not feasible in such locations. Secondly, the other

drawback is of time, heat radiation or smoke should reach sensor before sensor can detect it.

Vision based fire detection is potentially a useful technique. With the increase in the 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 detection offers advantages over the traditional methods. It will thus complement the existing devices. Each fire detection method is better suited to a distinct environment. Vision based fire detection has the following advantages over the other methods. First, it has fast response to fires. Like the radiation based method, it detects fires as soon as they appear in sight. Second, it directly senses the location of fire (in 2-D), not just radiation which comes from its general vicinity. Last, but not least, it is capable of analyzing existing images or image sequences so that it can be used for Multimedia database retrieval. Line of sight visual methods like this complement other methods that use associated cues of smoke and heat. Hence this approach of fire and smoke detection is very helpful in outdoor locations which cover large area and where it is not feasible to put electronic sensors.

2. BACKGROUND HISTORY

There are several research have been done in this area. This include by Ti Nguyen, in (2013) developed a method that extract color and motion from video sequences to detect fire. The result of this was able to produce a method which has the ability to perform the region growing segmentation to identify color pixels in the scene and then identify fire region. The methodology used are YCBCR color space model and region growing technique which compares all unallocated neighboring pixels to the region [4].

In (2012) a method suggested by Punam with the uses of RGB color model and background subtraction method. This method does have two major advantages which are modes computational load and fast processing but greatly effects the quality of the fire detected. In (2012) a method presented by Jareerat which uses HSV and YCbCr color model with conditions to separate brightness of the fire from the background and ambient light. Meanwhile research by Wenhao and Hong (2012) extracted flame objects by iterative adaptive threshold techniques [4].

While in (2012), Tian Qiu proposed an algorithm which worked on edge detection for a similar purpose which is to detect fire. In this algorithm the fire was detected by identifying the area between thermo chemical and the non-thermo reaction. Result of this experiment shows that edge of the fire was able to be detected clearly and non-stop. In (2012), contra to Petro presented a real-time algorithm which works on the background subtraction method. An algorithm which was based detection and tracking was used with the objectives to reduce false alarm rate of fire which frequently happen with the traditional electronic methods. In (2013), Lei and Liu used frame differences, median filters and Bayes classifier to detect flame. In (2010), Celik proposed an algorithm which divided in two parts, which are color modeling and background registration [4]. Mehdi Torabnezhad proposed another method that used image fusion technique to detect smoke. In this method, combine visual and thermal information to improve the rate of fire detection.

3. SYSTEM DESIGN

3.1 Basic Idea

For fire detection, in order to create Y, Cb, Cr components from a obtained RGB Image we shall use color space transformation equation to transform each RGB pixel in corresponding Y Channel, Cb Channel, Cr Channel pixel to form a corresponding Y, Cb, Cr image. YCbCr color space, Y′ is the luminance component (the "black and white" or achromatic portion of the image) and CB and CR are the blue-difference and red-difference chrominance components, will be chosen intentionally because of its ability to separate illumination information from chrominance more effectively than the other color spaces. In YCbCr color space and analysis can be performed. For a fire pixel Y(x, y) >= Cr(x, y) >= Cb(x, y), where a non-fire pixels don't satisfy this condition, where (x, y) is spatial location of a fire pixel. When a certain number of pixel (say 10 to 20) in an image satisfy condition of a fire pixel a fire alarm will go on. Such system can be useful for detecting forest fires where we can't put sensors at each location.

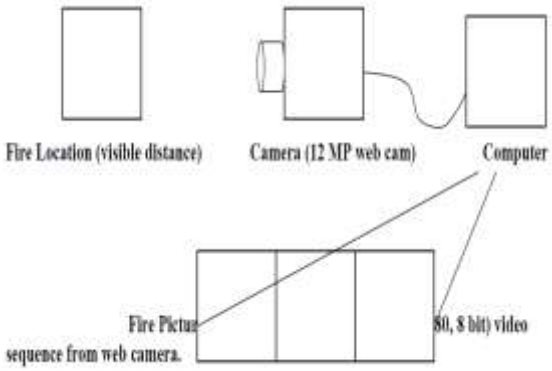

Figure 3.1: Basic Working of System

The propose fire detection system based on light detection. This system uses color models with given conditions to separate color. The system will trigger an audible alarm and provide visual images of the fire as a green box superimposed over the image of the fire. There is a big trend to replace conventional fire detection techniques with computer vision-based systems. This analysis is usually based on two figures of merit; shape of the region and the temporal changes of the region. The fire detection performance depends critically on the performance of the flame pixel classifier which generates seed areas on which the rest of the system operates. The flame pixel classifier is

thus required to have a very high detection rate and preferably a low false alarm rate. The flame pixel classification can be considered both in gray scale and color video sequences.

3.2 Working Methodology

For fire detection, image processing is a technique in which any image captured by camera is taken for processing, processing in term comparing that image with the sample images. A manually segmented fire set is used to train a system that recognizes fire like color pixels. The training set like fire images color model are used for the fire detection system. The main concept involves:-Color recognition. For the purpose of image processing camera is used.

3.2.1 Colour Models For Fire And Smoke

There are various color spaces such as RGB, HSV, HIS, YCbCr, YIQ, YUV and so on. There are some characteristics using the YCbCr as the color space:
1) Separates the brightness and chrominance effectively.
2) We can directly get the YCbCr through linear transformation from RGB space, hence the computational efficiency is relatively high [9].
3) Color characteristics are confined to two values: Cb and Cr, hence computations are reduced.

As we selected YCbCr model, we have to calculate values of brightness and saturations.

The steps involved are:-

1. RGB Band Separation

Each pixel is represented by three values, the amount of red, green and blue. Thus an RGB color image will use three times as much memory as a gray-scale image of the same pixel dimensions. RGB image consists of 3 matrices overlapping each other. First one determines the red value, second determines the green value and third determines the blue value.

2. Brightness and Saturation Calculation

In the image-based fire detection system, the interference of the background image can be regarded as an important factor that causes the ultimate false alarm. Therefore, accurately extracting the flame image from the scene image is particularly important. The color in the image can be expressed in three- color components including R (red), G (green) and B (blue). The Red saturation is Cr = R / (R + G + B), Blue Saturation is Cb = B / (R + G + B) and the average brightness is Y = 0.22 * R + 0.587 * G + 0.114 * B

3. Smoke detection

Smoke detection is a very important step in fire detection. Generally, methods for detecting fires using cameras combine smoke detection methods and flame detection methods. Smoke detection method use color and motion information to detect smoke from digital images [12]. As most of the objects that catch on fire first start giving a smoke, if we are able to detect smoke in an early period, we could prevent fire. Also smoke detection will help us curbing false alarm situation. Smoke has a peculiar color, high in blue saturation. Hence we use YCbCr color model [9].

In order to create a colour model for fire and smoke, we have analyzed the images which consist of fire or smoke samples. Each pixel is represented by three values, the amount of red, green and blue. Thus an RGB color image will use three times as much memory as a gray-scale image of the same pixel dimensions. YCbCr colour space is chosen intentionally because of its ability to separate illumination information from chrominance more effectively than the other colour spaces.

The rules defined for RGB colour space in order to detect possible fire-pixel or smoke-pixel candidates can be transformed into YCbCr colour space and analysis can be performed. However the rules fall short in coming up with a single quantitative measure which can indicate how likely a given pixel is a fire pixel. The implicit fuzziness or uncertainties in the rules obtained from repeated experiments and the impreciseness of the decision variable can be encoded in a fuzzy representation. This provides a way to express the output decision in linguistic terms.

The single output decision quantity expressed as a number between zero and one will then give the likelihood that a pixel is a fire-pixel or smoke pixel. As will be shown later in the paper, this fuzzy output is also capable in better discriminating fire and fire-like colored objects.

4. DETECTION OF POTENTIAL FIRE REGIONS

Because there is no fire in the most time, the background image of the camera is usually consistent. In order to improve the image processing speed of the system, the paper introduces the method of the current image and reference image for subtraction [8].In order to achieve the purpose of detecting fire, a threshold is set for Cb and Cr values. Studying various test images, a range of values are selected for Cb and Cr which are possibly fire regions. All those pixels which satisfy the threshold are termed as suspicious regions. This segmented image also consists of some noise.

5. EXTRACTING FIRE FLAMES

The flame color and color distribution is the basis for the identification of fire. Through the analysis of a large number of test images, it is found that humans observe an image and determine whether there is a fire, mainly based on the color of the image. In order to create a colour model for fire and smoke, we have analyzed the images which consist of fire or smoke samples. Each pixel is represented by three values, the amount of red, green and blue. Any flame can be divided into part 3 including the outer flame, the inner flame and the flame core. According to the temperature, the one of outer flame is the highest, followed

by the inner flame, and the flame core is the lowest, this result in the gray of the flame image shows a certain distribution law. From the inside to outside, the color of the flame the trend which it change from white to red; from the edge to the outside, the red of the flame fades continuously [8]. Therefore, the flame color features can be used to determine and extract whether there are suspicious areas in the surveillance system, it is the most original features of the fire. Smoke is the early sign of most of the fires. Smoke detection is important and necessary for monitoring air pollution; their effects on human health as well as on nature. Therefore it is mandatory to use good smoke detection method. Smoke sensors used for detection has transport delay of smoke from fire to sensor whereas in video smoke detection system, transport delay of smoke would not occur. Traditional smoke detectors do not provide information about location of fire, burning degree and size of the fire. Also they require a close proximity to the smoke. With the use of video smoke detectors, these problems can be overcome; therefore video smoke detection is more effective and it is a good choice for small area as well as large open space such as forest fires and petrochemical refineries.

6. SUMMARY & DISCUSSION

The traditional approach for fire detection is based on using Smoke detector, Temperature Induction or Light Intensity. But all these methods have got limitations. They are not sensitive and the response time is high. The results of these methods depend solely on the performance of the sensors which require frequent maintenance. In Ionization smoke detector if the smoke reaches the ionization chamber then only it can be detected. These available techniques are slow and cannot detect the fire in the early stage. The application of Image processing in fire detection will make use of high brightness and color characteristic of fire flame. The recent captured frame will be compared with the reference frame to obtain a value and is compared with the threshold value and results are produced. The use of this mentioned technique will also help to detect even the small fire, whereas the conventional techniques fail at these places.

Smoke detectors works mainly on two principles: Optical and Ionization. In optical smoke detectors, LED acts as a light source and at a distance from LED we have a photo detector. In absence of smoke, light reaches the detector without any decrease in intensity. When smoke enters the room, some light is scattered by smoke particles and hence light intensity reaching the detector is less and thus the alarm is triggered. Optical smoke detector has a very high response time. Ionization smoke detector uses radioactive isotope americium-241 to detect smoke. But Ionization smoke detector is rejected as it is more prone to false alarm. All these are not a reliable tool to detect fire and smoke. Even when fire is detected, it is detected in a very late stage where any precautionary measures will prove futile (waste) [2]. It has to be carefully placed in various locations.

In vision based fire detection system, there are three major features for fire: Color pixel, moving pixels and shape. The fire pixel can be classified as both in grayscale and color video sequences. Most of the fire detection system works on color video sequences. It is assumed that the image capturing device produces its output in RGB color format, and these color information is used as a pre-processing step. During an occurrence of fire, smoke and flame can be seen. As the fire intensity is increases smoke will be visible.

7. CONCLUSION

also used to decrease false alarm rate. Fire and Smoke were detected however there is a room for environment to this method. If other parameters such as spectral feature and time intensity parameter are also added, the false alarm will be reduced to a great extent. A specific process of fire and smoke detection is presented which can be used in work areas like banks, server rooms, data centers etc. to prevent or at least stop fire at an early stage.

8. REFFERENCES

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