FIRE DETECTION FOR SURVEILLANCE OF FOREST USING IMAGE PROCESSING

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Abstract - *Fire outbreak is a common issue and the damage caused by these types of incidents is tremendous toward nature and human interest. The main causes of outbreaks in rural areas are agricultural burning and conversion of forests to croplands, burning forests to improve hunting, and arson. Due to this, the need for an application for fire detection has increased in recent years. The proposed algorithm works on rule-based color model which are specified based on luminance and chrominance contents present in an image. YCbCr color space effectively separates luminance from chrominance compared to other color spaces like RGB. The proposed algorithm separates fire flame pixels and also isolates high temperature fire center pixels by taking into some of statistical parameters of fire image in YCbCr color space like mean and standard deviation. In this algorithm four rules are defined to separate the true fire region from the fire image. Two rules are defined for segmenting the fire region and other two rules are defined for segmenting the high temperature fire center region in fire image. The results are obtained and tested for a 50 images and achieves 98.83% of higher true fire detection rate and less false detection rate. The proposed methods can be used for real time forest fire detection with moving camera or UAV.*

Keywords: Fire detection, image processing, RGB color model, standard deviation.

1. INTRODUCTION

A fire alarm is very useful for security reasons. To reduce the loss of life and the property from fire, an early warning is an imperative. Presently almost all the fire detection system uses sensors. For high precision fire detection systems, large numbers of sensors are required in the case of outdoor areas. The sensors also need a frequent battery charge which is impossible in a large open space. Sensors detect fire if and only if it is close to fire. This will lead to damaging of sensor. Computer vision-based systems replaces conventional fire detection systems, due to rapid development of the digital camera technology and video processing. The performance of the fire detection system depends on the fire pixel classifier which generates major areas on which rest of the systems operates. Thus, a precise fire pixel classifier is needed with a high true detection rate and less false detection rate. However, four rules are specified for fire pixel classification. Fire pixels classification can be considered both in gray scale and color video sequences. Many rules have been proposed for detection of fire in an image. Each method gives a robust result for specified set of images. However, results may be varying due to image orientation, size, contrast and color. In non-documented images, detecting fire is more challenging because of variation in fire size, position and color.

2. OBJECTIVE

Fire detection system is the most important component in the surveillance system to discover fires early in their development when time will still be available for the safe evacuation of occupants. Fire has been one of the major disasters, even though it is so important to fulfil certain activities in day-to-day life. Fire disasters will cause severe damage to human properties and cause terrible mental and physical injuries. Traditional method also plays a significant role in protecting the safety of emergency response personnel. Property loss can be reduced and downtime for the operation minimized through traditional method because control efforts are started while the fire is still small. The Fire detection systems provide information to emergency responders on the location of the fire, speeding the process of fire control.

3. MODEL FOR FIRE DETECTION

In order to create/derive the color model for fire, we analyzed several images having fire. Since the color of fire is generally closer to red and has high illumination, we can use property of fire to derive the required color model.

3.1. RGB COLOR MODEL

A fire images can be explained by using its color properties. There are three different parts of color pixels: Red, Green and Blue (RGB). The color pixel can be removed into these three individual elements R, G and B, which is used for color detection. RGB color model is used to detect red color details in image. In terms of RGB values, the corresponding inter-relation between R, G and B color channels: Red>Green and Green>Blue. The combined condition for the captured image can be written as: Red>Green>Blue. In fire color detection Red should be more stressed then the other color component, and hence R becomes the domination color channel in an RGB image for fire. This imposes the condition for R as to be over some predetermined threshold value Red Threshold value (RTH).

Conditions for fire colors in image are summarized below:

Condition1: R > RTH

Condition2: Red> Green > Blue.

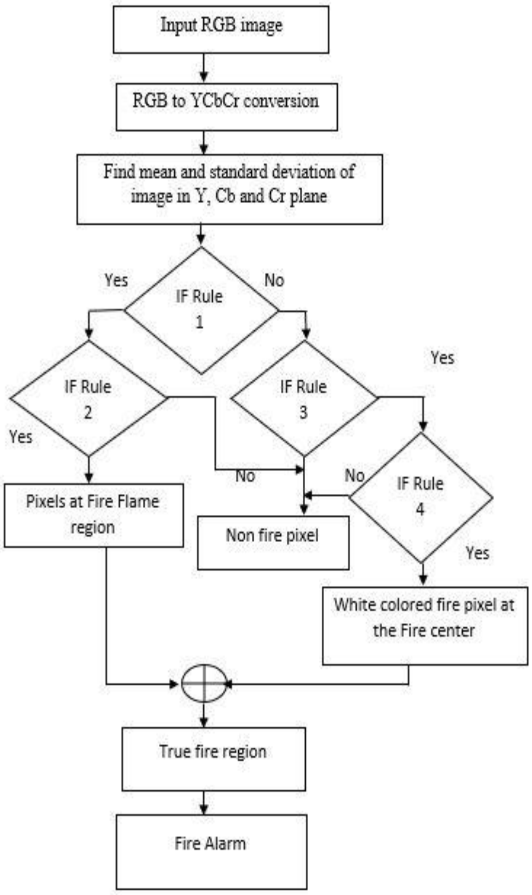

Fig.- Flow chart of proposed algorithm for fire detection using image processing.

3.2. YCBCR COLOR MODEL

In RGB color space it is not possible to separate a pixel's value in to intensity and chrominance. The chrominance can be used in modeling color of the fire rather than modeling its intensity. This provides a very effective representation for fire pixels. So, there is a need for transforming RGB color space into one of the color spaces where the separation between intensity and chrominance is more discriminate. Based on the above subjects we choose YCbCr color model for the classification of fire pixels and also conversion from RGB to YCbCr color space is linear.

This parts deals with the proposed fire pixel classification method. It uses YCbCr color space. Because YCbCr color space separates luminance from chrominance information. The 'Y' is Luminance component, 'Cb' is the Chrominance blue component and 'Cr' is the chrominance red component. The range of 'Y' is [16 235]. The range of 'Cb' is [16 240] and 'Cr' range is [16 240].

Using mean of the image, one can find the standard deviation of the image in Y, Cb and Cr plane. New method uses standard deviation of Cr plane.

$$Y_{mean} = \frac{1}{MXN}\sum_{x=1}^{M}\sum_{y=1}^{N} Y(x,y)$$

$$Cb_{mean} = \frac{1}{MXN}\sum_{x=1}^{M}\sum_{y=1}^{N} Cb(x,y)$$

$$Cr_{mean} = \frac{1}{MXN}\sum_{x=1}^{M}\sum_{y=1}^{N} Cr(x,y)$$

$$Cr_{std} = \sqrt{\frac{1}{M\ X\ N}\sum_{x=1}^{M}\sum_{y=1}^{N}(C_r(x,y) - C_{r_{mean}})^2}$$

M×N : Total number of pixels in the input image.

Rules are made to detect the fire in fire image. It uses

YCbCr color space in order to separates chrominance information from luminance information. Totally four rules are made Rule I and Rule II are used for the segmentation of fire flame region. Rule III and Rule IV are used for the segmentation of center fire pixels (high temperature region).

Finally, the image showed by satisfying Rule I & Rule II and the image showed by satisfying Rule III & Rule IV are added to get the true fire image.

Rules are listed below:

Rule1:

$AI\ (x, y) = \{$

$I(x, y), if\ Y(x, y) > Cb(x, y)$

$0, Otherwise$

I(x,y) representing the input RGB Image.

Y(x,y) and Cb(x,y) are luminance and chrominance Blue

values at different special locations (x,y).

AI(x,y) is the pixel which satisfying RULE I.

Rule2:

$AII\ (x, y) = \{$

$AI\ (x, y), if\ Y(x, y) > Ymean\ , Cr\ (x, y) > Crmean$

$0, Otherwise$

Rule 3:

$AIII\ (x, y) = \{$

$I(x, y), if\ Cb(x, y) \geq Y(x, y) > Cr\ (x, y)$ $0, Otherwise$

Rule 4:

$AIV\ (x, y) = \{$

$AIII\ (x, y), if\ Cr < \tau\ Crstd$

$0, Otherwise$

"τ" is a constant

4 .RESULT

Analysis is carried out using more than hundreds of images. This fire parts consists of flame like objects such as red colored car, sun, red rose, red leaves etc. The proposed method effectively segments fire flame and the high temperature fire center (white colored region) with high detection rate and low false detection rates.

Sample image having fire is taken as input and the RGB conversion of the image is done. After converting the image into RGB, the YCbCr rules are applied as mentioned above. Based on the fire condition, fire detected image is obtained as final result result is shown as in Fig-2, Fig-3 and Fig-4.

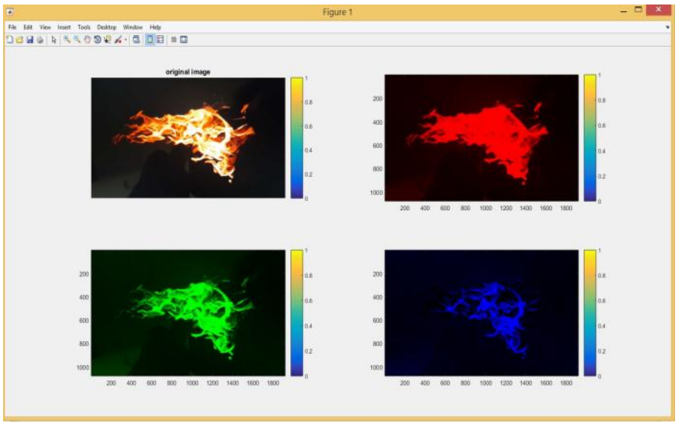

Fig-2. Converting the image into RGB

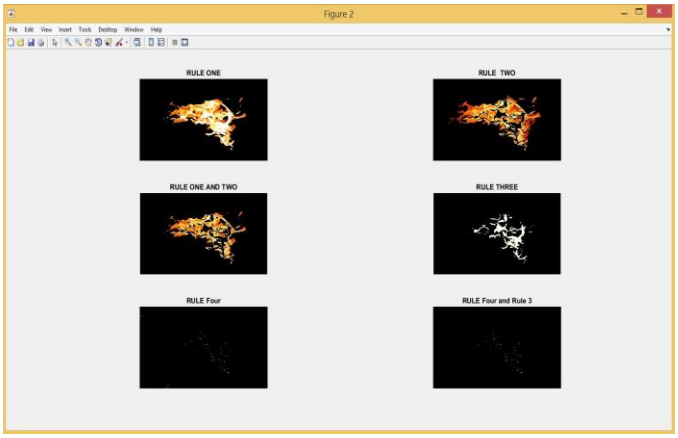

Fig-3 Applying YCbCr rules

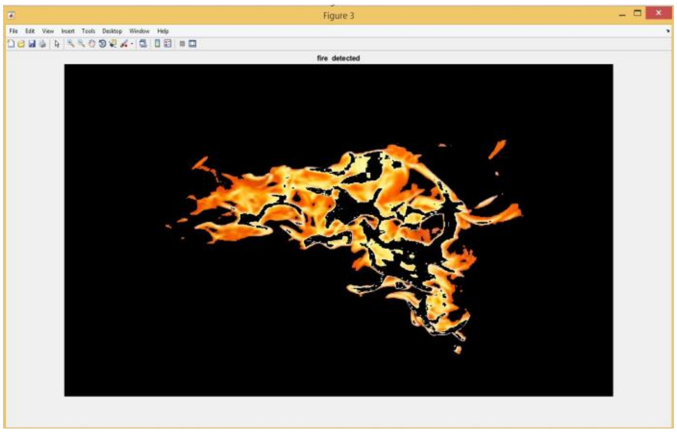

Fig-4. Detected fire image

5. CONCLUSION

In this project, image processing based fire pixel classification using YCbCr colour space is proposed. The proposed method not only separates fire flame pixels but also separates high temperature fire centred pixels. It uses four rules to classify the fire pixels. Computational complexity of the proposed system is very less, hence it can be used for real time forest fire detection. The proposed system achieves 89% fire detection rate and 12% false alarm rate. Future work that can be added to this project may be to decrease false alarm using some of the methods such as motion detection, area dispersion to increase the efficiency of fire detection and reduce false alarm.

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