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Detection Of Fire Using Morphological Process In Real Time - Datacenter Application

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Abstract Detection of smoke and fire can considerably mitigate the economic and ecological costs linked with a fire disaster. An intelligent fire detection system is proposed that exploits a Neural Network in order to aggregate the features of fire. In addition, robust fire feature detection algorithms are implemented which consider dynamic and static characteristics of fire. In the proposed method, fire is detected in the real time applications using neural network and spatio-temporal algorithm. Experimental result on real time camera shows that the proposed fire detection system has robust performance on the detection of the existence of fire which shows the effectiveness of the proposed fire detection system.
Keywords—Neural Network, Spatio-Temporal algorithm, Image Processing, Fire alarm.

I. INTRODUCTION

In this modern world, the leading hazard is the fire which threatens people's property and life. Thus the early warning on timely and accurate alarm of fire is an important concern. As it is a real time application, false alarm affects the entire building management security system(BMS).

Nowadays in datacenter, fire detection is performed using sensors. However there is an entire CCTV (Closed Circuit TV) surveillance provided in the highly secured datacenter areas. Two distinct protections provide to obtain a cent percent security.

The sensor senses and activates the fire alarm when it crosses the permissible limit. The limit on temperature is dependent on space and time, the designer can find out the details from the international fire codes. The sensed fire signal sends to Building Management System (BMS) thereby activating the fire alarm as well as fire mode fans located in the respected fan room.

At the same time, CCTV sends the signal to the Building Management System located in the control room through the servers. The control person in the control room monitors the datacenter in the continuous manner in order to spot out the malicious activities.

Now it's a time to optimize the cost as well as establishing the latest technology to obtain the highest security in the datacenter.

By effectively using the CCTV (Closed Circuit TV) surveillance camera, the detection of fire is performed in this proposed method. This method helps to predict the fire accurately and activates the fire alarm.

A. Contributions

The main aim of this project is to detect the fire on the real time basis. In this method, the fire shape, color and texture are trained using neural network. Using neural network, the predefined video sequences are employed to train the feature of fire. Once the camera is initialized, it is trained with neural network and released the input video. Frame size can be varied from camera to camera. The received sequence is converted into YCbCr from RGB. YCbCr technique is used for color codes. The spatio-temporal analysis and morphological process are involved to extract the fire. Once it is extracted, fire alarm signal releases to the Control room.

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B. The Sections Of The Paper

The paper consists of different sections:

In the next section, color space is investigated, together with advantages about color space. A detailed study of morphological process, spatio-temporal algorithm and neural network, and are shown in section 3, 4 and 5 respectively. Section 6 explains about the fire detection flowchart. Section 7 explains about Fire detection Algorithm and its steps. Simulation results are presented in Section 8. Results and Conclusions are drawn in Section 9 and 10 respectively.

II. SELECTION OF COLOR SPACE

A color model or color space is a specification of a coordinate system and each subspace within the system where every color is denoted by a single point. It is a method to specify, create and visualize color. As a human, we define a color by its attributes of brightness, hue and colorfulness. But a computer describes a color using the amounts of RGB color phosphor emission which requires matching a color. A printer estimates the specified color with respect to the reflectance and absorbance of cyan, yellow, magenta and black inks on the printed paper. Thus, a color is usually indicated using three parameter or co-ordinates. These parameters/ co-ordinates describe the location of the color inside the color space being used. They hang on what color space is being used whereas they do not convey us what the color is.

Color space plays a vital role to recognize flames in fire surveillance. The Most flame pixels have red, orange and yellow color components. The comparative study on the detection rates and false alarm rates proves YCbCr is the best color space. Thus, the selection of YCbCr color spaces is realistic in fire surveillance task.

Y′ - Luma component

CB - Blue-difference Chroma components.

CR - Red-difference Chroma components.

YCbCr is used in video systems. It is a scaled and an offset type of the YUV color space. The range of Y is defined as 16–235; Cb and Cr are defined as a nominal range from 16–240. The equations to convert from RGB to YCbCr [10] are:

Y = 0.257 R + 0.504 G + 0.098 B + 16

Cb = –0.148 R – 0.291 G+ 0.439 B + 128

Cr = 0.439 R – 0.368 G – 0.071 B + 128 and

R = 1.596(Cr – 128) + 1.164(Y – 16)

G = 1.164(Y–16) – 0.391(Cb – 128) – 0.813 (Cr – 128)

B = 2.018(Cb – 128) + 1.164(Y – 16)

The above equations have been used to generate the logic in color conversion module.

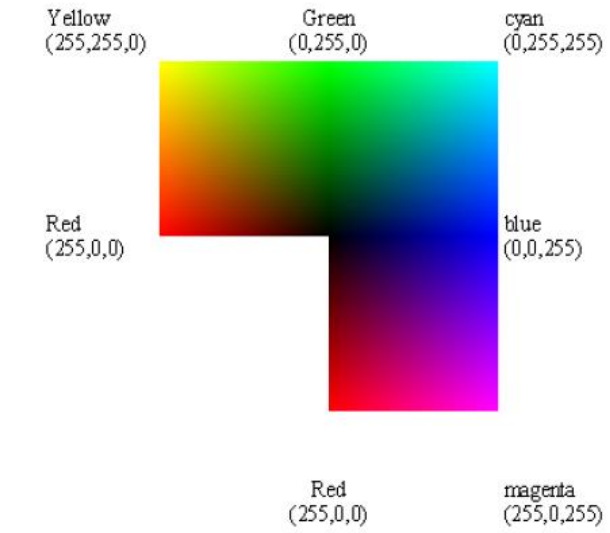

Fig 2.1: RGB Color Model

It is impractical to process the image in RGB color space, since it requires high bandwidth. To overcome this, RGB color space is converted into YCbCr color space.

III. MORPHOLOGICAL PROCESS

Edge detection is an image processing technique which is used to find out the boundaries of objects within images. The boundary is detected by discontinuities in brightness. The morphological process helps to identify, analysis and description of the smallest unit of the structure.

Sobel Edge detection is a discrete differentiation operator which calculates the gradient at each point in an image for the intensity changes. This operator consists of a pair of 3×3 convolution masks.

To obtain the disc shape, Morphological Opening process is used which helps to smooth the object's contour, removes thin protrusions and disrupts narrow isthmuses.

To remove the small structure, Morphological Closing process is employed which helps to smooth the contour's sections, blending long thin gulfs and narrow breaks, seals the contour gaps and removes small holes.

Opening of a set A by structured element B, denoted by A o B, is defined by

$A \circ B = (A \ominus B) \bigcirc B$

This operation has a capacity to form regular regions of similar size to the original image while removing small regions and peaks.

Similarly, Closing of a set A by B, is

$A \bullet B = (A \bigcirc B) \ominus B$

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Therefore, the opening of A by B is the erosion of A by B, followed by a dilation of the result by B.

IV. SPATIO-TEMPORAL ANALYSIS

The term 'spatio' means changes with respect to space parameter. The term 'temporal' means changes with respect to time parameter. The flame's shape changes continuously and irregularly, due to the burning material and the air flow direction. This analysis is used to discriminate between fire-like colored object and real fire. The total spatio-temporal energy is estimated by averaging the individual energy pixels in the block.$E_{block} = (1/N_b) \sum_{x,y} E(x,y)$
where E(x,y) is the temporal variance of the spatial energy of the (x,y).

$$E(x,y) = \frac{1}{N} \sum_{t=0}^{N-1} (E_t(x,y) - \bar{E}(x,y))^2$$

where E_t is the spatial energy of the pixel and $\bar{E}$ is the average value of this energy.

V. NEURAL NETWORK

Neural network is employed to train the video sequence with predefined video sequence. Conditional statement like if-then statement is used here to find out the fire detection. Comparing the input variables with the conditions, thereby it produces the output variable.

To detect the fire, flame shape and color are given as the input nodes and providing the hidden conditions, the neural network determines whether the compared frame processed is fire or not.

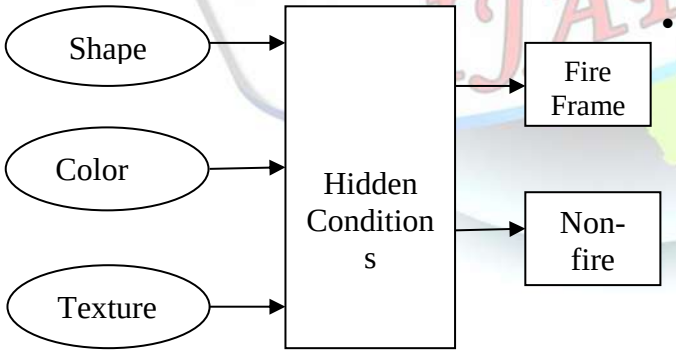

Fig 1. Neural Network Scheme

The steps followed by neural network are: the network sets used in the rules: Compare the input variables with the hidden functions on the basis part to obtain the functional values of each linguistic label. Combine (usually multiplication or minimum) the membership values on the basis part to obtain the firing strength of every rule. Generate the qualified consequent of every rule which depends on the firing strength of the signal. Accumulate the skilled consequents to produce a output.

VI. PROCEDURAL FLOWCHART

The below flowchart shows the procedure to detect the fire: Refer Fig.2.

VII. FIRE DETECTION ALGORITHM

This subsection covers the steps involved in the fire detection process.

- Step 1:- Camera is initialized to monitor the datacentre.
- Step 2:- Camera sequence is trained with predetermined fire sequence using Neural Network.
- Step 3:- Background Subtraction is employed to identify the moving object in the captured video.
- Step 4:- YCbCr Color Space: It converts the RGB color code to YCbCr color code to reduce the bandwidth. It provides very less false alarm rate.
- Step 5:- Morphological Process is used to extract the fire space from the camera sequence.
- Step 6:- Compare the extracted sequence with the preset threshold value from the trained sequence, to estimate the frame which is affected with fire or not.
- Step 7:- If the frame is affected with fire, then send message to BMS.
- Step 8:- Repeat the process again from step 1.

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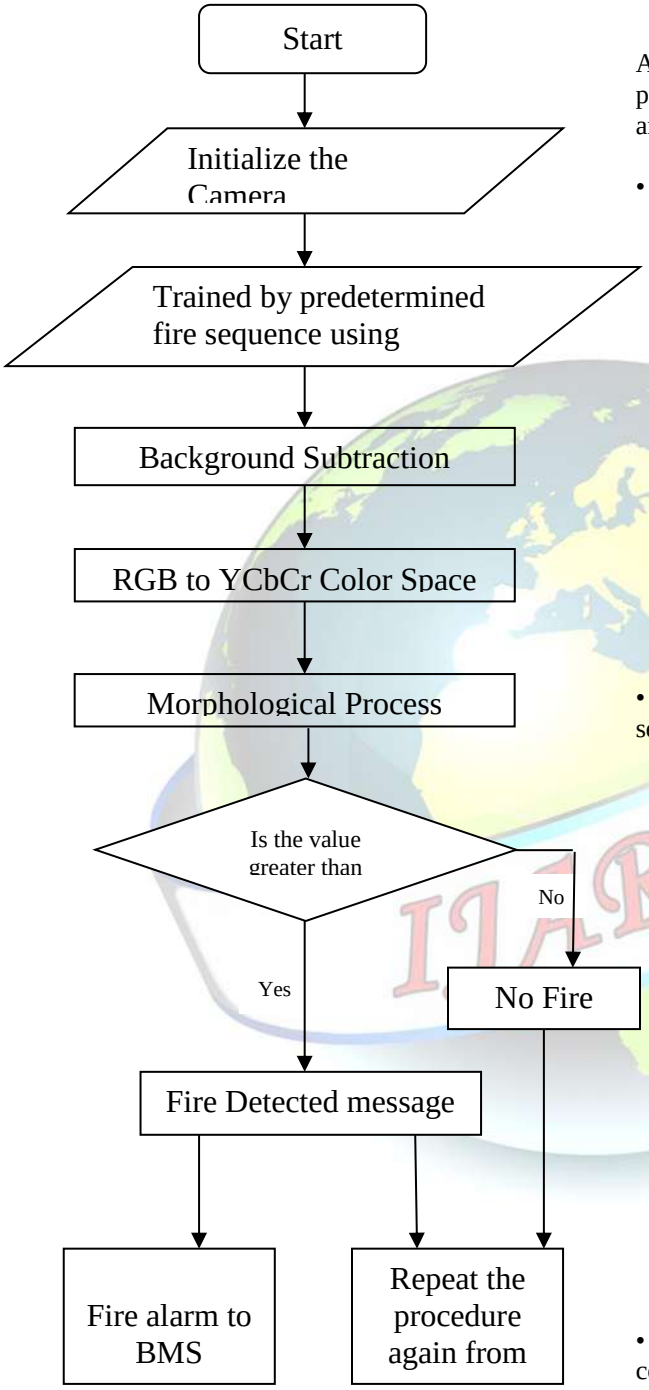

Fig 2. Flowchart

VIII. SIMULATION OUTPUT

Algorithm steps for fire detection using morphological process and neural network is given here. The detection steps are as follows.

• Initialization the camera.

Fig 3. Camera Initialization

• Train the camera sequence with predefined fire video sequence using neural network.

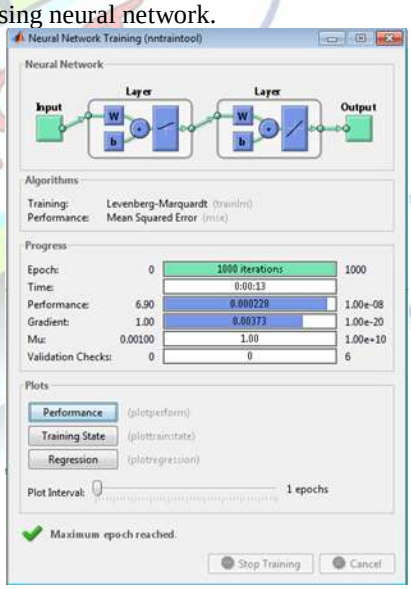

Fig 4. Neural Network

• Moving object is extracted from the frame sequence and is converted into YCbCr color space.

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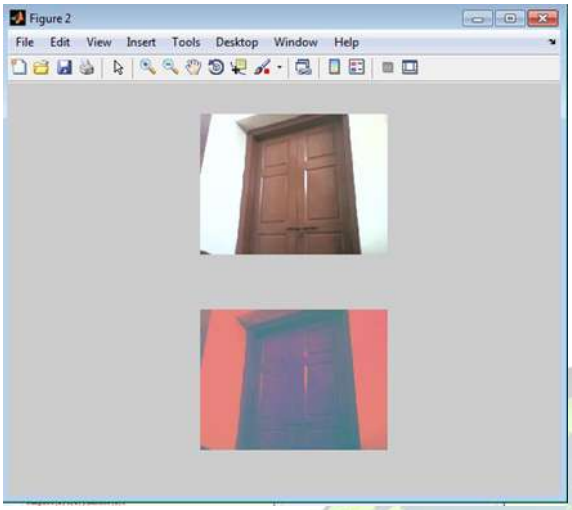

Fig 5. YCbCr Color Space

• The morphological process involved to compare the frames with the predefined frames. It compares the threshold value, of each frame. When the detected frame is high in threshold value, the decision making step send the fire signal.

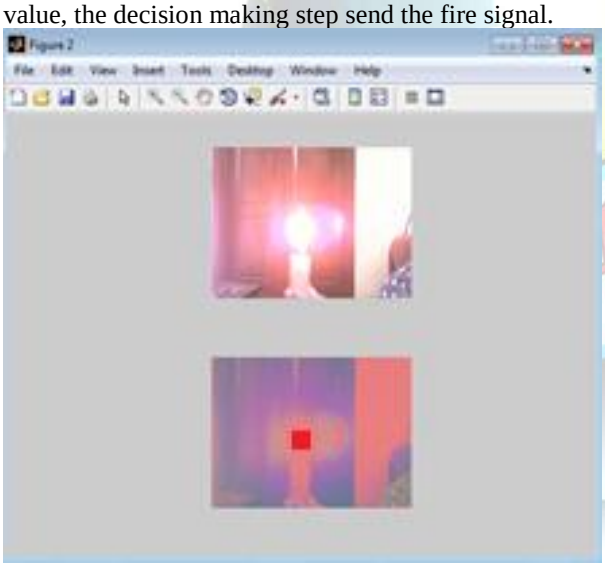

Fig 6. Fire Frame detected

• Once the fire frame is detected, fire alarm signal is directed to BMS

IX. RESULT

In this method, the simulations of the above implementation were done on the MATLAB. As this project is used in real time applications, online video frames are processed using camera. The frames are processed using morphological process. When a fire appear in the location, the morphological process analyses the video frames and it detects that it is a fire frame. Once it is detected, fire alarm generated and can be forwarded to BMS system located in control room. Compared to the earlier method, fire frames can be detected in fewer seconds.

X. CONCLUSION

A new approach for the real time detection of fire has been proposed based on the video processing. The new approach consists of morphological process and neural network. In order to differentiate the real fire and fire colored moving blocks, spatio-temporal algorithm is proposed.

This approach can be used in server rooms, datacenter, banks, etc. Since above mentioned rooms are highly secured, detection of fire in the preliminary stage is vital. Building Management System activates the fire mode fan belongs to the fire mode of the respective fan room.

As smoke precedes fire, the next attempt is to detect smoke. By combining these two detection process, fire/smoke can be determined in the preliminary stage itself.

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