International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June-2018 www.irjet.net p-ISSN: 2395-0072

A Review on Different Techniques of Fire Detection for Emergency Management

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Abstract - *Lately, eruption of fire is considered as a major concern which generally results in severe casualty to human and their properties and also causes rigorous destruction to nature. In recent years, this kind of incident greatly increases. However, various control units are available to deal with the situation but after the event and sometimes the situation goes out of hand. There are mixed techniques that have been developed by researchers in order to provide prevention system against the disaster caused by fire. But the real time execution of all those fire retardant techniques is not up to the mark. So, a prevention technique is required which can efficiently detect the outbreak of fire. In the proposed system, a method is developed to enhance flame luminance using Chromaticity Pigmentation through which fire can be detected with high level of accuracy.*

Key Words: Fire Detection, Alarm, Color Detection, Color Models, Image Processing.

1. INTRODUCTION

Outbreak of fire causes heavy damage not only to the environment but also various human and animals lose their life in these incidents. To deal with such incidents, various techniques based on fire detection and prevention system were developed. However, it is difficult to cope with the situation of fire outbreaks, especially before the accident. Even though, various investigate has been performed by the researchers to address the concern regarding the issue. Some researches has exploited the technique of wireless sensor network to perceive the situation but to detect any incident related to fire using physical equipment is something very unreliable. Since the key problem of this system is its energy utilization which let the sensor to detect temperature in every small interval of time. Traditionally, A detection technique was also developed which was based on point based fire. The basic approach of that model is the value of temperature which is fixed at particular interval. Although, temperature based models are limited to its implementation as it takes time to detect fire. Increase in temperature will increases the intensity of fire. So, to detect the eruption of fire at early stage is impossible with this technique. Nowadays, systems to detect fire through videos are taken into consideration which doesn't require any proximity with the spot to detect the incident. Various techniques were exploited by the researchers to develop a fire detection system to resolve the issue but still lagging somewhere. There are various small devices of indoor fire detection available in the market but having less accuracy. Some researchers worked on smoke detection but the false acceptance rate of these systems are higher and generates false alarm.

Fig. 1.1 Fire Detection Device [9]

Fig. 1.2 Smoke Detection [10]

2. LITERATURE SURVEY

2.1 Review on existing systems:

Angelo Gonzalez et al. [1] proposed a method by inducing Convolutional Neural Network to detect fire in the shown images. The approach used was SFEwAN-SD (Simple Feature Extraction with FCN AlexNet, Single Deconvolution). The system which has been proposed is a fraction of Unmanned Autonomous Vehicle (UAV) system which was used to detect and examine wildfire. The model which has been induced in this paper is Caffe Framework and examined 500 various images of fire to verify the system. The technique exploited two different approaches of CNN which are amendment of

AlexNet and convolution series. The overall accuracy verified by the system which has been proposed in this paper to detect fire in image is 94.76%.

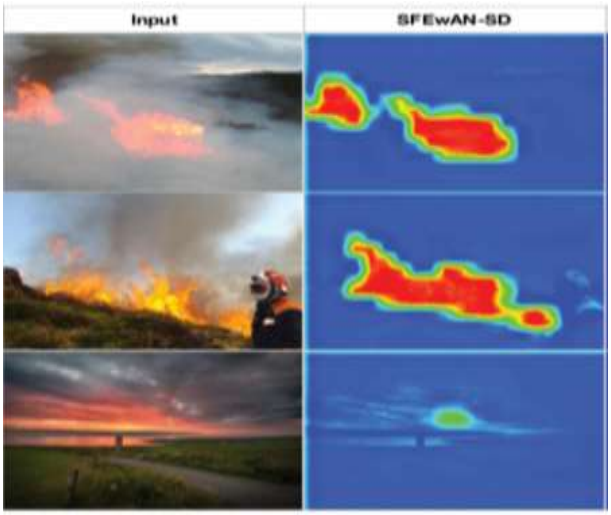

Fig. 2.1.1 Initial Two Rows for Positive Samples & Third Row Is For Negative Image [1]

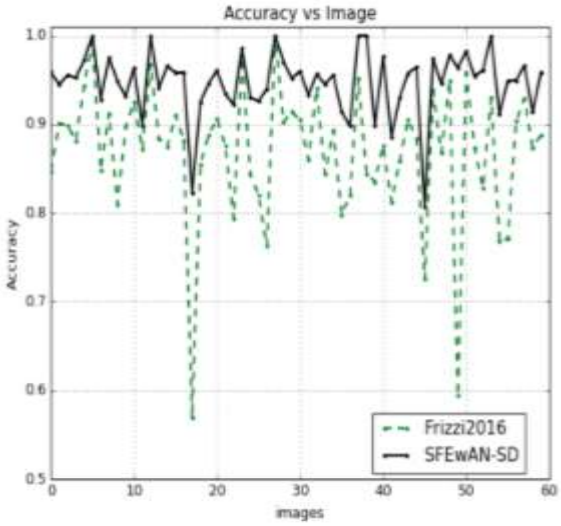

Fig. 2.1.2 Accuracy Graph for 60 Images [1]

Shruti Gupta et al. [2] proposed a system to detect any calamity by exploiting the functionality of WSN i.e. wireless sensor networks. The system further have used an algorithm of LEACH i.e. Low Energy Adaptive Clustering Hierarchy to sustain the communication among the defined nodes. The overall system which has been projected in this paper relied on the value of preset temperature. The technique used in the paper executed when the temperature reached to its preset threshold value which was sensed by the induced sensors and the extracted information processed through the LEACH algorithm.

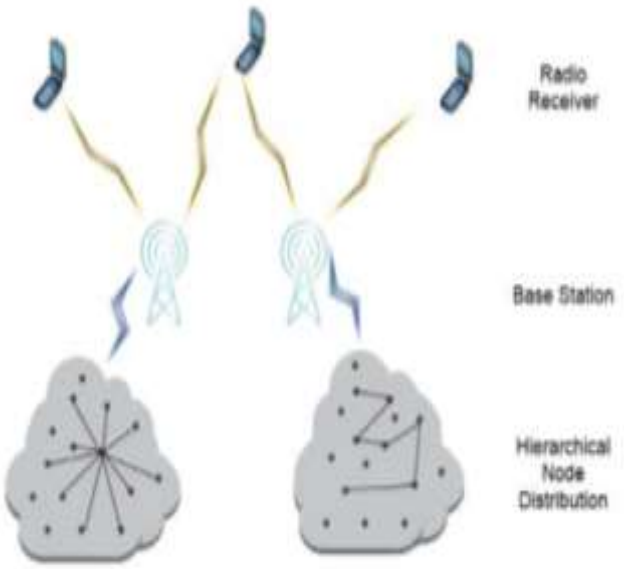

Fig. 2.1.3 Architecture Diagram of WSN [2]

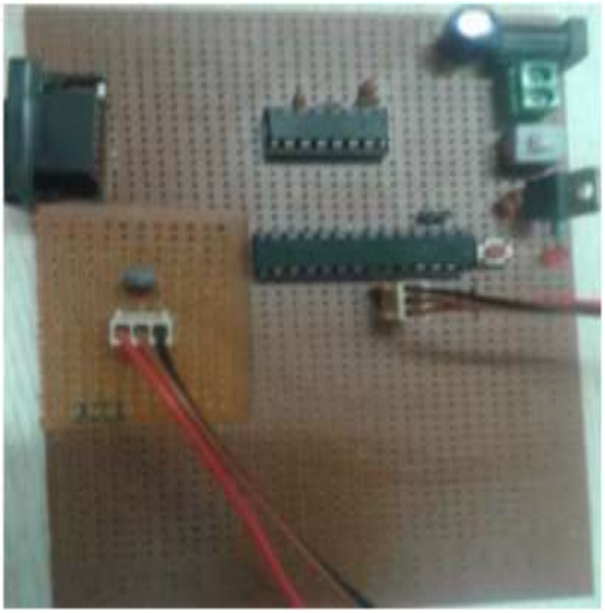

Fig. 2.1.4 Physical Architecture of Simulation Model [2]

Kuang-Pen Chou et al. [3] developed a system which exploited feature extraction method which is based on blocks to examine the local data of assorted regions to reduce computational data. System relied on the concept to extract the features obtained from a fire block including its color, source immobility and its disorder. Basically, the system which has been proposed extracts the feature from videos of fire and recognized various features for the detection of fire. System used both global and local extraction of features from the acquired video to identify fire and enhance the rate of error.

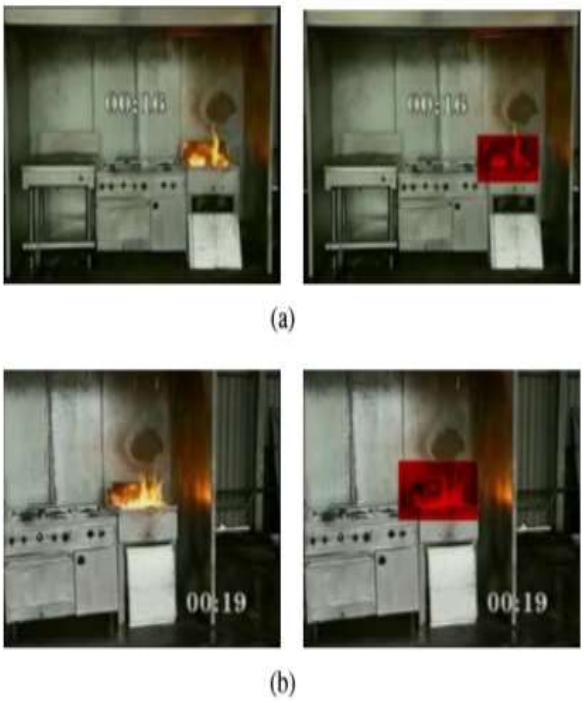

Fig. 2.1.5 Fire Reflection on Metal at Different Scenarios [3]

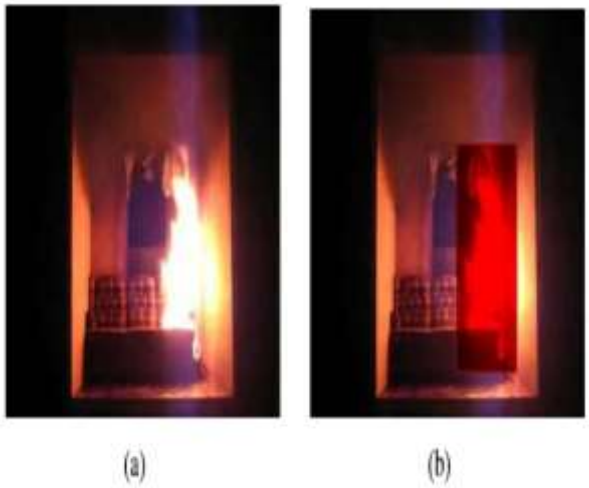

Fig. 2.1.6 Fire Detection in Dark Space [3]

Rubayat Ahmed Khan et al. [4] proposed a system base on the technique of video processing. System extracted various features like color and spatiotemporal characteristics to recognize the area of fire. Pixels of color usually appear in a fire is extracted by exploiting the rule of RGB. As the pixels extracted from fire are dynamic in nature, for this, the projected system exploited foreground technique. The system which has been proposed stated the accuracy of 97.7% obtained after executing the result.

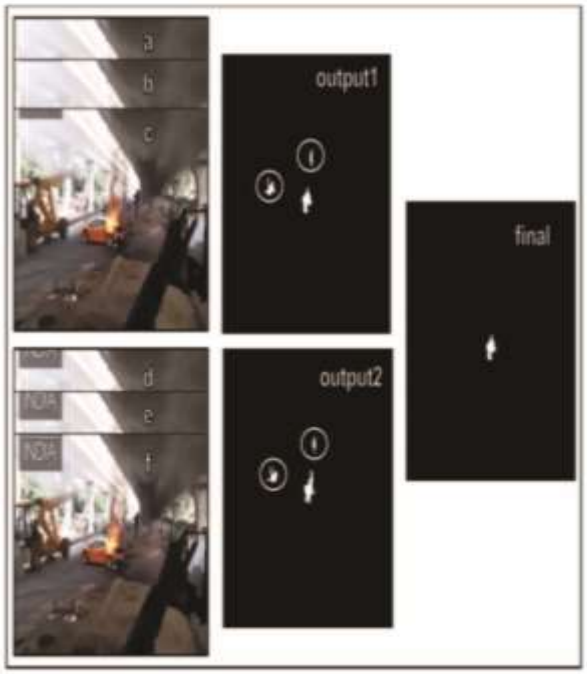

Fig. 2.1.7 "Output1" is the Result of Consecutive Frames A, B & C. "Output2" is the Output of (D), (E) and (F). "Final" is the Ultimate Output Where the Wrong Blobs are Eliminated and the True One is shown. [4]

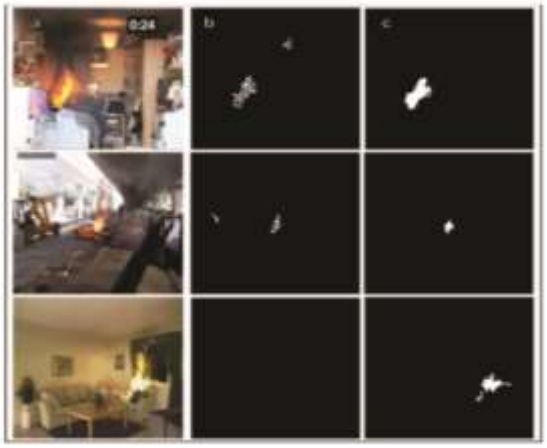

Fig. 2.1.8 Column (a) contains sample fire frames & Column (b) shows false regions in the first two instances while the last one got unobserved. [4]

Teng Wang et al. [5] proposed a system for indoor detection of fire by incorporated the characteristics of flame kinematics which was induced on the consecutively extracted video frames. Resemblances obtained from acquired video frames were also integrated in the system which has been proposed. The method which has been proposed is relied on the aim to avoid false alarm generation of fire detection. For this, comparable video frames which are in a row is considered under observation and proposed an approach, called a zone-based tracking algorithm.

Fig. 2.1.9 (a) Original RGB image (b) Detection result through RGB- HSI model [5]

Fig. 2.1.10 Detection result of Current Frame through RGB-HSI Model (d) Display of Changing Areas [5]

Nurul Shakira Bakri et al. [6] proposed a system which exploited the technique of image processing to classify the pixels of color. Technique which has been proposed in the system considered fire images as an input. System also used the image enhancement technique with models of RGB and YCbCr color with predefined scenario of dividing up the pixels of extracted image's color. The system verified their technique which has been proposed by examine 10 different images. So the concluded result of system which has been proposed in the system offered the accuracy of 90%.

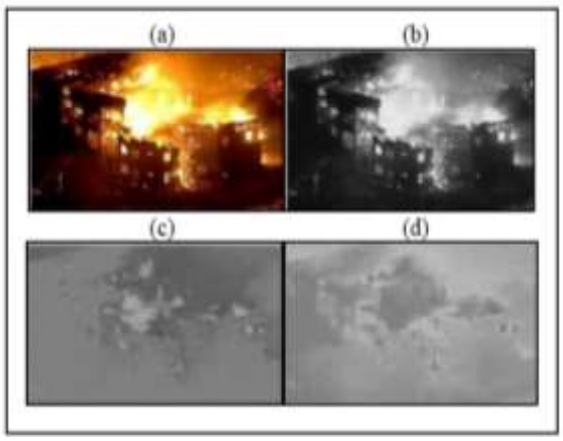

Fig 2.1.11 (a) Original image, (b) Y component, (c) Chrominance Blue, (d) Chrominance Red [6]

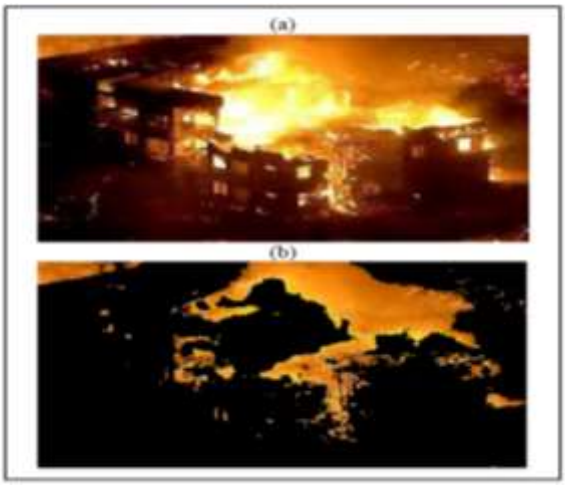

Fig. 2.1.12 (a) Contrast Enhanced Image, (b) Fire Pixel Detection [6]

Oxsy Giandi et al. [7] developed a technique in a system called fire predictor and fire appearance detector. In the system which has been proposed, fuzzy system technique was employed on fire detector and fire predictor illustrated the concentration of gas leak & generates an alarm on emergency. The system of fire detection proposed in the paper is in the form of model only. It has been stated that fuzzy system exploited various sensors to observe temperature, humidity, gas and smoke in the technique to measure fire symptoms. Basic task of fuzzy in the system is to observe data acquired by the sensors in intervals. Though the system based on gas concentration utilized LPG data for the prevention system against any gas explosion. The smoke and CO data was extracted with temperature and humidity sensor which is employed under fuzzy system used to calculate the fire appearances. Since, the data monitoring is not shown in real time because the parse of the serial data in MFC cannot read the data quickly.

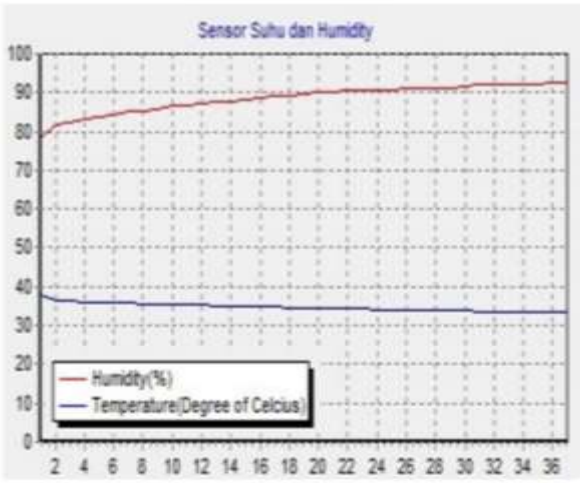

Fig. 2.1.13 Gas Leak Simulation (1) [7]

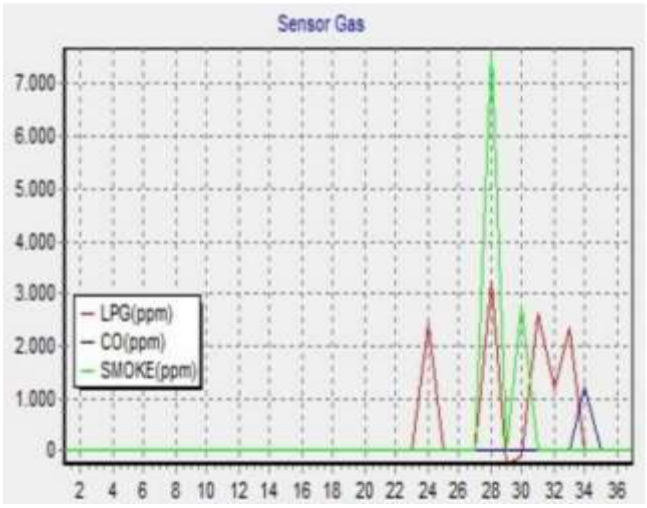

Fig. 2.1.14 Gas Leak Simulation (2) [7]

Khan Muhammad et al. [8] proposed a system based on images to detect fire by exploiting the technique of CNN (convolutional neural networks). The system which has been proposed in the paper relied on the basic idea of Google Net architecture. System utilized the deep learning architecture to detect flames as early as possible. The system which has been proposed in the paper used 68457 images from various dataset. Among those, 62690 frames are from Dataset1. The proposed system shown below,

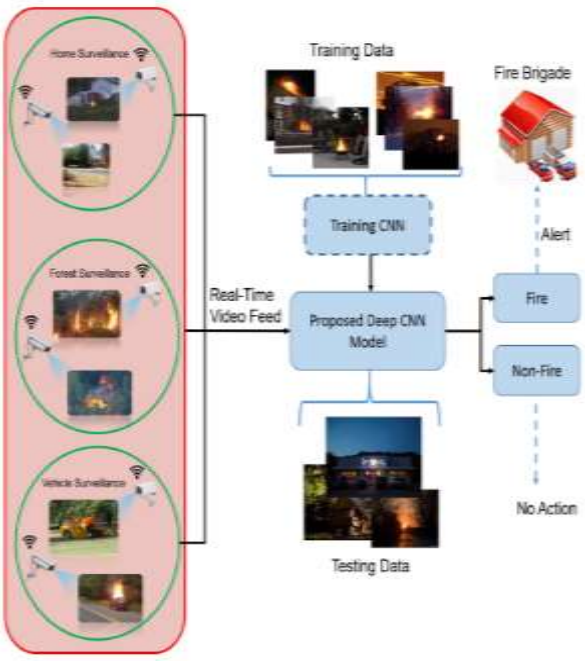

Fig. 2.1.15 Flame Detection in Surveillance videos using Deep CNN [8]

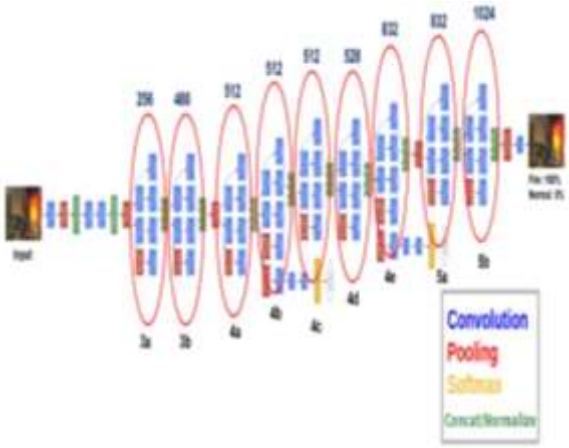

Fig. 2.1.16 Architectural Overview of Deep CNN [8]

3. PROBLEM IDENTIFICATION

Various techniques were developed in order to resolve the issues came across during fire detection. The system which has been proposed in the base paper [6] is relied on the conversion of RGB to YCbCr (Yellow, Chroma Blue, Chroma Red) color space. The formula used for the conversion is

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.2568 & 0.5401 & 0.0979 \\ -0.1482 & -0.2910 & 0.4392 \\ 0.4392 & -0.3678 & -0.0714 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix}$$

The technique which has been illustrated is not suitable for high brighten flame luminance and the obtained rate of conversion is bit lower than the requirement. Overall accuracy obtained should be enhanced as the circumstances of the incident may vary. The technique used in the system is failed to detect fire in the kind of image shown below, as it has low intensity.

Fig. 3.1 Fire with Low Flame Intensity

4. CONCLUSION AND FUTURE SCOPE

Those systems which have been proposed are not efficiently executed to detect the fire at real time. So, the system which is proposed is able to enhance flame luminance using chromaticity pigmentation that also enhances the accuracy or true acceptance rate. It increases the specific color pixel that relies on flame intensity which provides better level of accuracy. The current proposed concept of enhancing flame luminance using chromaticity pigmentation can be implemented for the detection of fire based calamities which would be effective for remote areas as well as indoor hazardous accidents.

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