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Enhancing Fire Detection Process Using Video Surveillance By Multi Expert System

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***Abstract*—Many fire detection systems are existed but itrequires some specialize hardware use of this hardware make system costlier so there is need of an efficient and inexpensive system. The main intent of propose system is to recognize fire through video surveillance camera to reduce ecological and economical losses. Existing systems narrates a method which is able to detect fires by analyzing the videos acquired by surveillance camera. Most of the them are having performance issues so these paper introduce some novel idea to overcome these performance issues and enrich the fire detection process.**

Proposed system describe main novelty about fire detection: complementary information respectively based on color analysis, shape variation and motion analysis are combined by multiexpert system. With the use of multiexpert system the detection of fire is done in the fast way as well as in accurate manner. System uses various algorithms by means of inputting the computed attributes and outputting the decision regarding the fire's presence.

Keywords—Multiexpert system ,fuzzy logic, Video surveillance

I. INTRODUCTION

Several fire detection system are based on sensors like various crowded multi-storeyed building such as garment's factory, chemical industries etc. also it is use in extrinsic area like forest, farms etc. Sensors divine information about physical parameters such as temperature, smoke, flame based on all this parameter it can detect fire. Existing solutions are based on smoke sensor, temperature sensor, ultraviolet sensor, infrared sensor, etc. for detection of fire. Sensors detect its working methodology which is mainly focus on chemical properties of fire i.e. smoke ,temperature. Sensors should not be place away from fire sources. If the sensors is place away from the fire sources then it brings complexity and give false outcome. Cost of installation and maintenance is high especially for large area.

Fire is considered as one of the vital and indispensable Assets. Identification of flame and fire using the computerized monitoring methods such as the video surveillance system has a significant consideration over the last decade. A prior warning and instant action or real time fire detector system are the important prevention approach to evade much damage due to fire that affects ecological as well as economical environment. Video surveillance system is basically use for security reasons but we use this system simultaneously for fire detection ,so that no extra specialize hardware is required for this. It can be widely used at home, buildings, various industries, etc.

In the essence of many fire detection system based on the color variations. Different color models are used for fire detection such as RGB, HSI ,YUV models. Using RGB model fire pixels can be abide by RGB color space. [1]Mostly RGB color models is use for color analysis in fire detection process. In this model every color appears as its primary color like red, green, blue also its various shades can be effectively calculated. In RGB color space it takes three number to form RGB color ,the two digits hex number assigns to each its safe color . eg. For accompaniment the bright green in the form of decimal like R=0, G= 255(FF) ,B=0.This postulate 256 colors variation is the smallest possible quantity of color that can be assemble faithfully by any system .Using 256 color combinations calculate many different shades of color hence the RGB model can be preferred to the fire detection system. Exact portion of fire can be calculate using RGB color and other portion is discarded to get true positive results. Grayscale models carries only intensity information of an image in this the value of each and every pixel is a single sample it is in form of black and white it forms exclusive shades of grayspace. In grayspace variable form of black is at the faint intensity and white is at dark shade. Grayscale image gives the outcome of measuring light intensity of the each and every pixel in the given image they can be combine at ample color image.[1] Grayscale algorithm takes the normal image as input and gives outcome image is in the form of gray color. There are various algorithms are used for motion variation and shape analysis.[4] The flickering effect of fire can be easily detected through algorithms that are use for motion. In motion based model threshold value is main asset using this threshold value we can calculate the pixel position. we got the result by using absolute difference technique of each frame pixel. [4]Shape Identification technique is mainly based on ratio of height and width of an image. By thresholding technique we can evaluate shape of fire image and its variation ratio to reduce number of false outcome.

[8] Fuzzy logic is an logic to computing based on "degrees of truth" rather than giving the solution is in 'true or false' format. It checks all the simple possibilities for result to compute truth positive rate. For example: if we take the statement is , today is raining it might be 100% true if there is no sunlight and dark clouds, 80% true if there are clouds and

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0% true if all day is sunny. Different possibilities of simple statement is check to get the accurate results. Fuzzy logic has proved experimentally to be useful in expert system and applications of Artificial Intelligence (AI). All the three criteria i.e.motion ,shape and color of the proposed system has been verify under the FFA(Fuzzy Finite Algorithm).[8] Some default value can set for the fuzzy logic, then fuzzy logic takes results of three principles and deploy their predefined rules on that principles. It checks all possibilities outcome according to their predefined rules. Existing system uses all three basic parameters for fire detection but for effective results that means to reduce false positives ,it can be used . To increase the system performance fuzzy rules can be apply on the result set.

In this paper section II is dedicated for literature survey where as section III describes the proposed technique in detail. Section IV evaluates the performance of the system and section V concludes the paper with some possible future extension.

II. LITERATURE SURVEY

Up till now, video observations is largely utilized in business and security areas such as traffic monitoring and transportable applications. [2]Video fire detection has also becomes an important topic in the field of fire detection. Automatic detection of fire in pictures and videos is critical for prior fire detection, which may solve several problems. Previous systems which warn about fire, makes the use of particle sensor along with the optical sensors. These system does not sense the fire until the fire properties like smoke, heat actually reach to sensors, and they usually don't provide any further report related to fire like its location, its size and the temperature of fire. Hence, with the activation of fire alarm, the supervisor of the system himself needs to go to the location and assure about the presence of fire.[3] So to overcome these faults ,video surveillance came into consideration .These system offers various benefits. First of all, they make use of preinstalled cameras which are already monitoring various places like hospitals, offices etc. Secondly, detection of fire is done in very less time. Third, for detecting a fire for huge area it acts as high volume sensor instead of conventional small area point to point sensors.

[3] This paper describes the methodology about use of color and motion information which is extracted from video frames to detect fire .The approach is based on the region growing to identify color pixels in frame and moving pixel based on correlation coefficient .But it does not give any specification about shape parameter.[7] This paper explains the method for real time fire detection system based on the two main steps first is color detection and second is motion variation .The motion detection is implemented by using the displacement and vibration properties of flame. It uses YCbrcr color space to detect fire color .It uses intersection algorithm. [9] this paper give brief idea about probabilistic membership function of visible features and fuzzy finite automata is used for fire flame detection.[9] FFA uses capability of automata with fuzzy logic that deals with the uncertainty in computational systems .Probabilistic membership function is used to eliminate false positives. But to improve the performance it needs to be modify membership functions of features and model architecture. [10]this paper narrates the use of wireless sensor network for data gathering to be used as raw input data. System was developed using five functions of fire such as temperature ,smoke ,light ,humidity and distance .It uses two processes for fire detection such as fuzzification and defuzzification. In which fuzzification is a process in which crisp inputs are converted two fuzzy inputs and defuzzification converts fuzzy output to crisp output. But system does not possess that much power and due to use of sensors it becomes costlier. [2]System describes about color identification, under home video surveillance system is used for automatic fire detection and warning system to recognize fire and inform concerned people accordingly. The system uses RGB color space for the fire detection approach. [4]This paper is associated with the color and motion based parameters which are used for detecting the fire. Color can be detected using HIS model.[5]Explains about color and motion identification, Hidden Markov Models are used to model the ordinary motion and color cues of fire and flame in video sequences by processing the data recorded using a common camera. [4]It is used to differentiate flame flicker process from motion of flame colored moving objects .Supervised Machine learning related algorithms ,such as Support Vector Machine (SVM) and Neural Network(NN) are trained on a data set of extracted features from video data and ground truth. Color feature and contour feature are considered and modeled with the temporal characteristics .Color feature and contour feature are considered but there is no any pixel identification using RGB value is used. [6] It introduces shape identification , for fire detection. It uses RGB space for color detection. It set threshold value to obtain the segment flame region and removing fire-like-color region from the original image and get the resulting image[8] This system narrates the Fuzzy Logic and Horus fire detection algorithm. Algorithm is used to detect fire which consists of three different steps: firstly, horus removes the background by a basic motion detection technique Background Binary Map (BBM) is the output of that algorithm .Second is the Fuzzy Fire Search (FFS) which processes only the pixel classified as foreground in the BBM that is to find a set of pixel potentially classifiable as fire and last step is the Motion Dynamic Test (MDT) in this analyzing the motion of the fire colored areas detected by FFS to reduce false positives .But the cons of this system is that the Horus performances decline slowly as the detection conditions degrade. [1]In this system color analysis ,shape variation and motion analysis are combined by multi expert system .Small changes in design pattern gives drastic change in result .Even if the system is made of working simultaneously its computational load is adjust with low cost embedded system. But it was not powered to identify harmless fire.

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III. PROPOSED SYSTEM

Below section proposed Detailed methodology used in Fire Analysis and Detection. Dynamic methodology to detect fire from live videos. Step by step examination has been presented with in depth procedure of algorithms implemented. System overview has been presented in figure 1 below

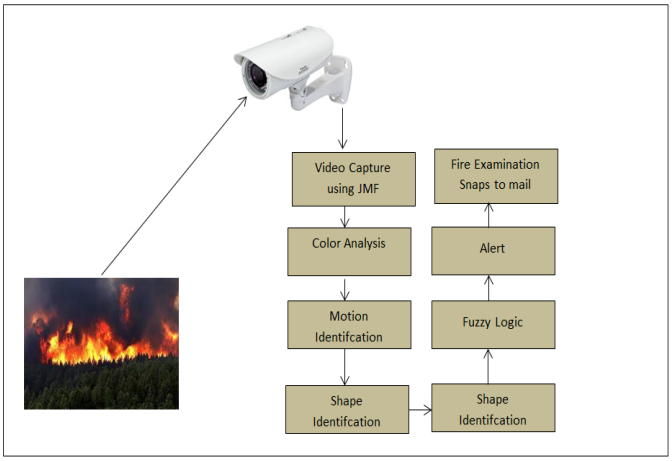

Fig. 1: System Overview

Step 1: Initial step in setting up system with hardware deployment. Webcam has been used in capturing images. A third part API JMF has been used to grab live images. Images captured are still and stable .Furture frame grabbing is been done on video to capture images in JPEG format set fro specific interval. Finally data is been ready for examination and detect if any fire occurance.

*Step 2:*Information from previous step is been feed to fire color identification step. A heuristic analysis is been done converting image into gray scale using mean value for RGB for pixels. This values are been compared to threshold of brightness and finally get fire color. Threshold is been set to 180.Each and every pixel which is above threshold value are been counted as fire pixel and taken for final examination. If fire frame found is above threshold then the images is been marked as fire frame. This is been analyzed buy algorithmic procedure from procedure 1 below mentioned

ALGORITHM 1: Color component with Gray scale &Binary threshold

// Input: Video Frame **F**
// Output: Fire detected image

Step I:Initiate
Step II: set Image path.
Step III: Height and width of Image**F** (L*W).
Step IV: FOR **i**=0 to W.
Step V: FOR **j**=0 to H.
Step VI: Get a Pixel at (i, j) as number.
Step VII: Translate pixel integer value to Hexadecimal (R, G,B) B.
Step VIII: **AVG**=(R+G+B) /3
Step IX: **IFAVG**>**T**
Step X: Pixel at (i,j) is FIRE
Step XI: **ELSE**
Step XII: Pixel at (i, j) is NOT FIRE
Step XIII: End of inner for
Step XIV: End of outer for
Step XV: Stop

*Step 3:*Shape examination has been done in this step .core technique used in shape identification is coaxil difference analysis. System continuously checks for ratio of fire pixel identified in previous step. This examination is been done with application of equation 1 and 2. Shape vector has been generated from this difference matching matrix.

$$MAT(x) = \sum_{i=1}^{N} V(i,j)/WIDTH \quad \text{(1)}$$

$$MAT(y) = \sum_{i=1}^{N} V(i,j)/HEIGHT \quad \text{(2)}$$

Where,
MAT(x) – Morphology vector related to X axis.
MAT(y) – Morphology vector related to Y axis.
V(i,j) – Pixel at position i and j
TI – Number of pixels in the image

Step 4: This step fire motion analysis has been for Every T interval of time. Fractional difference in between current frame and past frame is been examined. Numerical values generated help in detection firer motion. Threshold values are been computed with vector and this procedure is been depicted din figure 2

The algorithm 2 clearly indicates the details of this step as follows.

Algorithm 2: Motion Detection in Fire

// Input: Time **T**, Frame $\mathbf{F_c}$, Frame $\mathbf{F_p}$, Threshold Fire pixels $\mathbf{T_h}$
// Output: Motion of fire
Step 0: **Start**
Step 1: **WHILE** (TRUE)
Step 2: for each time **T**
Step 3: $F_p \rightarrow F_c$
Step 4: compute pixel positions of $\mathbf{F_p}$ in vector $\mathbf{V_p}$
Step 5: compute Pixel positions of $\mathbf{F_c}$ in an vector $\mathbf{V_c}$
Step 6: IF MATH.ABS(DIFF ($\mathbf{V_p} - V_c$) >$\mathbf{T_h}$)

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Step 7 Tag Frame for Fire
Step 8: **END IF**
Step 9: **END WHILE**
Step 10: Stop

Step 5: Fuzzy Analysis is has been applied in this step eliminating false costiveness by implementing fuzzy logic. This step all three values generated from previous steps are been feed to fuzzy analysis system. Color ,motion, shape the received values are been tagged in range of 0-1 and based on this range match false positive values are reduces. Fuzzy values are as depicted below
So by using the Fuzzy crisp values, which are divided in between the ranges as follows

- ✓ VL – 0 TO 0.2
- ✓ L -- 0.21 TO 0.4
- ✓ M-- 0.41 TO 0.6
- ✓ H -- 0.61 TO 0.8
- ✓ VH --0.81 TO 1.0

In examination any frame whose means values of all parameters are between range of H and VH high and very high that fire frame is been considered as relevant then only fire alarm is been triggered. Frames under all other ranges like low, medium or very low are false positive values and hence discarded.

IV. RESULTS AND DISCUSSIONS

System has been designed and developed on java platform with neat beans IDE. To analyze authenticity of system has been tested as mentioned below.

System has been tested with publicly available dataset from link http://mivia.unisa.it/datasets/video-analysis-datasets/fire-detection-dataset/ .

Different types of the images are been set to identify the fire by our system as shown below.

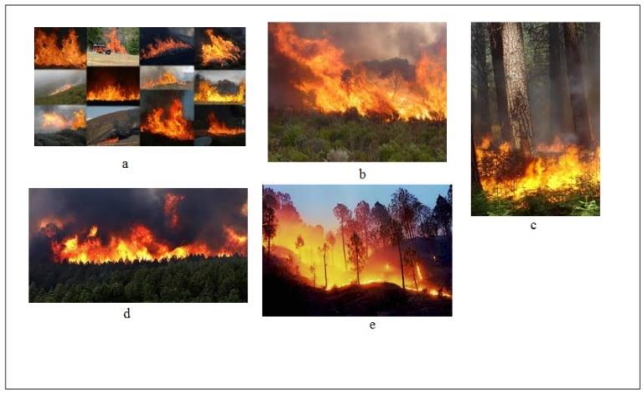

Figure 2. Different types of the images are been set to identify the fire by our system

Figure 2: (a) and (b) images shown detection of fire and they are taken from the datasets. (c) and (d) (e) images showing the detection of fire which are collected form the live streaming the videos from our camera.

Each Time fire is been detected to evaluate system authenticity MRR is the parameter used in evaluation .the best evaluation parameter used for system evaluation in accordance to human for betterment of system.

In MRR rank value is been given to image from value I-IV depending on perfection. I rank 1 is given fire detected image then it designates rank as 1, for 2 it designates rank as ½, then 1/3, ¼ ,1/5 and finally 0.

Finally mean rank is been computed using MRR equation used for so is as given below

$$R = \sum_{i=1}^{n} 1 /(Ranki) \quad \text{_____(3)}$$

$$MRR=R/N \quad \text{_____(4)}$$

Where n – Number of sample images

MRR is calculated for different types of image for the set of 20 numbers, Then got output for MRR is been recorded in the below table1.

Test No	Image Type	MRR
1	building	0.78
2	Corridor	0.87
3	forest	0.86
4	office	0.79

TABLE 1 : Recorded MRR

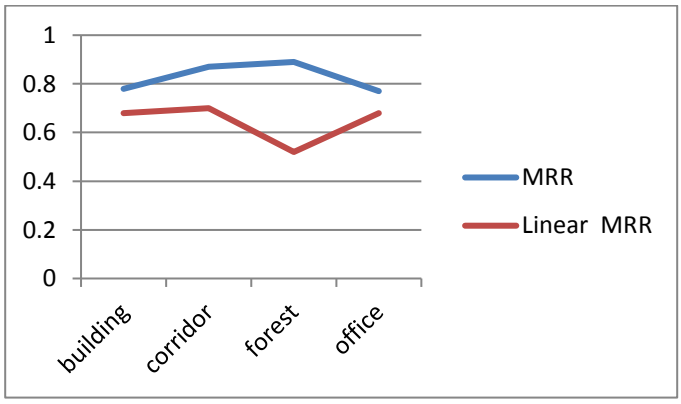

Figure 3: MRR for Different Images type

In above figure proposed system in fir examination yields overall average MRR of 0.79 which can be termed as best detection for video surveillance on other hand comparison of system with proposed methodology as presented in [11] our

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approach is found to be best on parameters like accurateness and efficiency results have been presented in table below

Fifty Images	Multi-Expert	ROI
TP	57	55
TN	8	4
FP	2	2
FN	0	0
accuracy	91	94
efficiency	92	83

TABLE 2 : Comparison Table

Here,

- True positive = correctly detected
- False positive = incorrectly detected
- True negative = correctly eliminated
- False negative = incorrectly eliminated

Accuracy and Efficiency can be given by Following Equations

Accuracy = TP/ (TP+TN)*100%
Efficiency = (TN+TP/TN+TP+FN+FP)*100%.

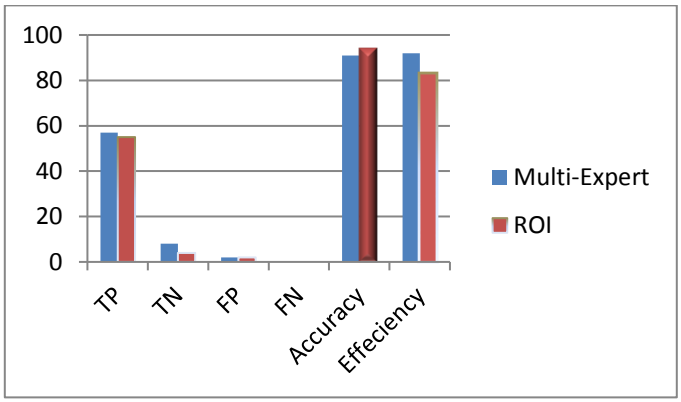

Figure 4: Comparison Graph

On mapping graph for all attributes As found in table 2 presented in figure 4 of proposed system performs in better with ROI technique. Multi-expert mechanism has been found to be best as compared to ROI.

V. CONCLUSION

In Above proposed System flame fire is been detected by examining image collected using surveillance camera. Gray scale ,shape color and motion are parameters used in fire detection . majorly techniques used in fire analysis are color detection, identification of shape, verification and fuzzy logic. System is been designed various methods used in fire detection using surveillance camera. It presents us facility to adjust system using different combination of video image processing. Proposed system provides us optimal technique for fire identification ,detecting accurate and real fire flames. Proposed system has found to best in terms of accuracy.

REFERENCES

[1]Pasquale Foggia, AlessiaSaggese and Mario Vento,"Real-time Fire Detection for Video Surveillance Applications using a Combination of Experts based on Color, Shape and Motion.",IEEE Transactions on Circuits and Systems for Video Technology,2015.

[2]Md.MahamudulHasan , M. AbdurRazzak,"An Automatic Fire Detection and Warning System Under Home Video Surveillance." IEEE 12th International Colloquium on Signal Processing & its Applicatios(CSPA),2016.

[3]Ti Nguyen-Ti1, Thuan Nguyen-Phuc2, Tuan Do-Hong3," Fire Detection Based on Video Processing Method", International Conference on Advanced Technologies for Communications (ATC'13),2013.

[4]Dattathreya1, Heegwang Kim2, Jinho Park2, Hasil Park2, and Joonki Paik2,"Fire Flame Detection Based on Color Model and Motion Estimation.", IEEE International Conference on Consumer Electronics-Asia (ICCE-Asia),2016.

[5]De Zhang ,Yahuni Wang, "Real Time Fire Detection Using Video SequencesData.",IEEE ,2016.

[6] Jing Shao, Guanxiang Wang, Wei Guo,"An Image-Based Fire Detection Method Using Color Analysis." International Conference on Computer Science and Information Processing (CSIP),2012.

[7]ResitDogan, M. ElifKarsligil,"Fire Detection Using Color and Motion Features in Video Sequences.",IEEE,2010.

[8]AutonioBuemi ,DavideGiacalone,FilippoNaccari,GiuseppeSpampinato," Efficient Fire Detection Using Fuzzy Logic.",International Conference on Consumer Electronics-Berlin,2016.

[9]SunJae Ham, ByoungChulKo, JaeYeal Nam,"Fire-Flame Detection based on Fuzzy Finite Automation.", International Conference on Pattern Recognition, 2010.

[10]PouyaBolourchi ,SenerUysal,"Forest Fire Detection in Wireless Sensor Network Using Fuzzy Logic.", Fifth International Conference on Computational Intelligence, Communication Systems and Networks,2013.

[11] " FIRE DETECTION ALGORITHM USING IMAGE PROCESSING TECHNIQUES ", Kumarguru Poobalan1 and Siau-Chuin Liew2, Proceeding of the 3rd International Conference on Artificial Intelligence and Computer Science(AICS2015), 12 - 13 October 2015, Penang, MALAYSIA