National Conference on Engineering Innovations and Solutions (NCEIS – 2018)
International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2018 IJSRCSEIT | Volume 4 | Issue 6 | ISSN : 2456-3307

A Survey on Early Fire Alarming Using Smoke Detection

Megha K S[1], Meghashree[2], Shilpa B L[3]
[1]Information Science, VVIET,Mysuru,Karnataka, India
[2]Information Science, VVIET, Mysuru, Karnataka, India
[3]Computer Science, Assistant Professor,VVIET, Mysuru, Karnataka, India

ABSTRACT

Nowadays, fire accidents can result in disastrous personal injury and destructive damage which causes both economical and ecological damage.
This paper presents a survey on smoke detection method for early fire-alarming system based on video processing. The fundamental approach of smoke-pixel judgment is composed of two decision rules. The first one is chromaticity based static decision rule and the second rule is diffusion based dynamic features decision rule. The first rule depends on the grayish color of smoke and dynamic rule is based on the spreading attributes of smoke. Experimental results show that the above two analysis provides lower rate of false alarm. These analyses are used in many of the applications like ships, tunnels and to identify the forest fires.
Keywords: Smoke detection, Video processing, Feature Extraction

I. INTRODUCTION

Our eyes and our brain are capable of extracting detailed information far beyond what can be described in text and, it is this ability we want to replicate in the "seeing computer", so a camera replaces the human eye and video replaces human brain. The main goal is to analyze the image with the purpose of first finding objects of interest and then extracting some parameters of these objects.

From a long-run, the fire accident normally causes economical and ecological damage and also it risks the people's life. To keep-off from fire tragedies, many fire detection techniques have been evolved, most of them are based on particle sampling, temperature sampling in addition with the traditional method. The drawbacks of traditional method are as it won't give some information about burning process, fire location, size, and growing rate and so on. Hence they are not reliable because of energy emulsion of bi-products, so this leads to the false alarm rate[1]. To get reliable information, we have to use the visual-based approach, the alarm system is used to alert about fire[2]. In many of the situations, smoke detection will offer more early alarm than the flame detection. It can be avoided by using two methods one is static analysis and the next one is dynamic analysis which reduces the false alarm rate. The fire detected by the static analysis is verified by using the dynamic analysis as to confirm it as a real smoke or not. In static analysis, these smoke pixels will be verified by using dynamic diffusion in dynamic analysis[3].

II. SMOKE DETECTION METHODS

The basic plan of smoke pixel decision is composed of two decision rules:

1. Static analysis 2.Dynamic analysis

Static Analysis: The smoke is generally displayed in grayish color during the burning process. Grayish

color is divided into two regions; they are light gray and dark gray. This suggests the three components R, G, and B of smoke pixel are equal or so. Hence, these grayish colors can be explained by the intensity (I) component of HSI color model [4][5]. The intensity of light gray lie between the ranges of L_1 and L_2 and the intensity of dark gray lie in the ranges of D_1 and D_2 of gray level regions.

By the chromatic analysis, the condition

$R \pm \alpha = G \pm \alpha = B \pm \alpha$ and $L_1 \leq I \leq L_2$ and $D_1 \leq I \leq D_2$, these can be used as one of the decision factor for recognizing the smoke. The values of α, L_1, L_2, D_1 and D_2 depend on the statistical data of experiments. The typical value of α ranges from 15 to 20, typical value of dark-gray ranges from 80 (=D_1) to 150 (=D_2) and 150 (=L_1) to 220 (=L_2).

Three decision rules for extracting smoke pixels from an image are deduced in the following:

Rule 1 : $R \pm \alpha = G \pm \alpha = B \pm \alpha$

Rule 2 : $L_1 \leq I \leq L_2$

Rule 3 : $D_1 \leq I \leq D_2$

If (Rule 1) AND [(Rule 2) OR (Rule3)] = TRUE

Then smoke - pixel

Else not smoke - pixel

If the above condition is satisfied, then the smoke is real, else not smoke-alias[3].

Dynamic Analysis: The smoke spreads out in the way of diffusion process, in the dynamic analysis. Usually airflows affect the smoke's shape, moving speed and moving direction of smoke particles. Reliability of smoke detection can be improved by considering the growth rate and disorder of smoke which can be involved as the decision factor for judging the smoke. Since airflows make the shape of smoke to be changed at any time, a novel disorder measure, the ratio of circumference to area for the extracted smoke region, is introduced to enhance the combination of smoke. The following decision rule can be used to detect the smoke.

If (SEP / STP) ≥ STD

then real smoke

else not smoke

In the rule, the parameter SEP denotes sum of circumstances of smoke regions segmented. STP is the number of smoke pixels extracted and STD means a disorder threshold that differentiates from other smoke like objects. SEP/STP denotes the disorder measurement of smoke. In addition to the disorder-based decision rule, the growth rate is also necessary condition for improving the reliability of the smoke detection. As a result of diffusion process, which exist in smoke, the smoke region eventually increases in the image sequence. The increment rate of the extracted smoke pixels by the chromatic decision rule is defined as

$$\Delta A_{d\,i} = \frac{d\,A}{d\,t} = \frac{A_{\,i+k} - A_{\,i}}{t_{\,i+k} - t_{\,i}} \quad (1)$$

Where A_i = smoke area at the interval between i+k and time i

In the digital image processing, the area can be represented with the pixel quantity and the time interval will be replaced by the frame number.

So, equation 1 is deduced to

$$\Delta A_{\,d\,i} = \frac{d\,P}{d\,t} = \frac{P_{\,i+k} - P_{\,i}}{(i+k) - i} \quad (2)$$

Where p_i =number of i-th frame

ΔA_{d_i} = ratio of pixel quantity obtained by frame difference between the frame i and the frame i+k to the frame number k.

To get more reliable growth rate measure, an average growth rate is adopted and defined as follow:

$$\overline{\Delta\,A_{\,d_{\,1}}} = \frac{1}{n}\sum_{i=1}^{n} \Delta\,A_{\,d\,i} \quad (3)$$

Where n=number of iteratively measuring the growth rate, $\overline{\Delta A_{d_1}}$ = average growth rate.

Hence, growth rate based decision rule in the dynamic characteristic is described as,

If NUM ($D_1 < \overline{\Delta A d_1} < D_2$) $> N_d$

then smoke
else not smoke

Where D_1 and D_2 are low bound and high bound thresholds of growth respectively.N_d= threshold of checking times.

If the checking times of that the average growth-rate is between D_1 and D_2 are larger than N_d , it is regarded as the real smoke otherwise not a real smoke[3].

III. SMOKE DETECTION FLOW DIAGRAM

The smoke detection algorithm is as follows:

1. The presented smoke detection algorithm is dedicated for implementing for implementing an early alarm for feasible fire disasters.
2. Firstly the captured images which are in sequences are fragmented based on the frame difference[6] and thus the fragmented images are used as candidates for examining whether it is a real smoke or not by using chromatic analysis.
3. To verify and conclude that the extracted pixels are smoke, dynamic characteristics including growth-rate and disorder are utilised.
4. Finally as the real smoke is validated, a smoke alarming is given[3].

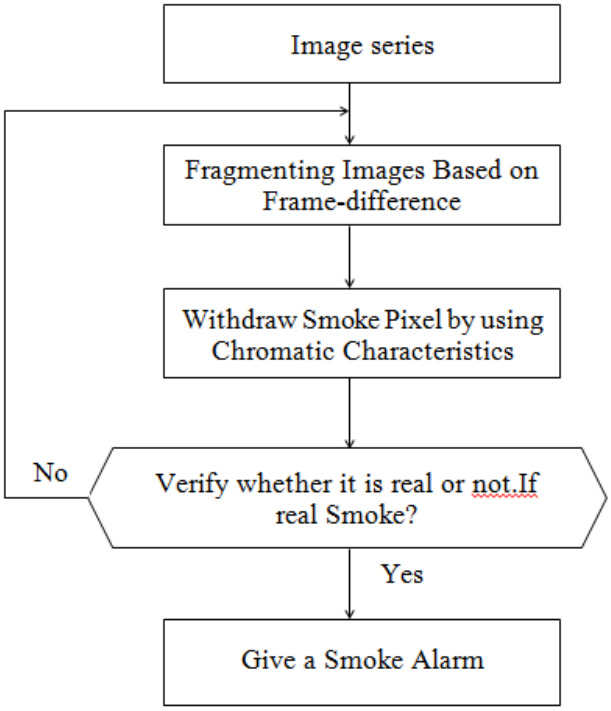

Figure 1. Smoke Detection Algorithm

IV.APPLICATIONS OF STATIC AND DYNAMIC ANALYSIS

Generally the static and dynamic analysis for smoke detection for early alarm is attractively used for the important military, social security, commercial applications and to identify forest fire and so on[7].

Some of the applications are described below

1. Static and dynamic analysis is used as one of the method for identifying the forest fire in forest fire monitoring system which is based on the digital image processing approach[8].
2. In ship, for early smoke detection inside the ships engine room. They use system CCTV system for capturing the images, and to judge whether the smoke is read or not they use the above described two analyses[9].
3. A fire in road tunnels is very dangerous as it can lead to loss of life. It is very essential to detect the fire as earliest to suppress them. For identifying the smoke, they use static analysis as one of the methods[10].

4. Massive tsunami, volcano, fire and terrorism cause property damage. For smoke detection at the earliest, they use CCTV's for capturing the image, for identifying it as a real smoke they use static analysis as one of the method[11].

V. CONCLUSION

After doing the survey on smoke detection method for early fire alarming system based on video processing. Both the static and dynamic analysis is used to verify it as areal smoke or not. The smoke pixels are extracted by using chromatic rule of static analysis and it is further verified by using diffusion rule of dynamic analysis.

One drawback of static analysis is if the surrounding is in gray color then this may leads to false alarm, so to overcome this drawback, dynamic analysis is used and these analysis are cost effective and it is having more advantages than the traditional methods.

VI.REFERENCES

[1]. Phillips Iii, Walter, Mubarak Shah, and Niels da Vitoria Lobo."Flame recognition in video." Pattern recognition letters 23.1-3 (2002): 319-327.

[2]. Chen, Thou-Ho, Ping-Hsueh Wu, and Yung-ChuenChiou."An early fire-detection method based on image processing." Image Processing, 2004.ICIP'04.2004 International Conference on.Vol. 3.IEEE, 2004.

[3]. Chen, Thou-Ho, et al. "The smoke detection for early fire-alarming system based on video processing." Intelligent Information Hiding and Multimedia Signal Processing, 2006. IIH-MSP'06. International Conference on.IEEE, 2006.

[4]. Chen, Thou-Ho, Cheng-Liang Kao, and Sju-Mo Chang."An intelligent real-time fire-detection method based on video processing." Security Technology, 2003.Proceedings.IEEE 37th Annual 2003 International Carnahan Conference on.IEEE, 2003.

[5]. Foggia, Pasquale, 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 25.9 (2015): 1545-1556.

[6]. Yang, Ou."Moving object detecting method in video." IEEE Aerospace and Electronic Systems Magazine 23.1 (2008): 18-20.

[7]. Healey, Glenn, et al. "A system for real-time fire detection." CVPR.Vol. 93. 1993.

[8]. Surit, Surapong, and WatcharaChatwiriya."Forest fire smoke detection in video based on digital image processing approach with static and dynamic characteristic analysis." Computers, Networks, Systems and Industrial Engineering (CNSI), 2011 First ACIS/JNU International Conference on.IEEE, 2011.

[9]. Bistrović, Miroslav, JasminĆelić, and DomagojKomorčec."Computer Vision Application for Early Stage Smoke Detection on Ships." Pomorskizbornik 52.1 (2016): 63-80.

[10]. Noda, S., and K. Ueda."Fire detection in tunnels using an image processing method." Vehicle Navigation and Information Systems Conference, 1994.Proceedings., 1994. IEEE, 1994.

[11]. Ha, Changwoo, GwanggilJeon, and JechangJeong."Vision-based smoke detection algorithm for early fire recognition in digital video recording system." Signal-Image Technology and Internet-Based Systems (SITIS), 2011 Seventh International Conference on.IEEE, 2011.