Comparative Analysis of Wavelet Transformation for Fire and Smoke detection in Color Image

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***Abstract*— Smoke is first indication for fire and different image capturing are used for security purpose. Here we find smoke in capture image and present a comparative analysis for detecting best result for smoke presence in image. Various smoke detection method are available using wavelet but it still required more accuracy for conform that smoke present are not. Here we represent a comparative analysis of various wavelets and their 5 level and also use some noise which more refines the image for smoke detection. Here we use wavelet 5 levels for one image and their Energy level for different Noise like Gaussian Noise, Speckle Noise, Poisson Noise and Salt & Pepper Noise. All this are some noise removal techniques that are available for remove the image Noise. For comparative analysis take input as two images first without smoke and second with smoke image. In first segmentation image will convert the gray image and filter the image using media filter. This gray and filter image energy was calculated by different wavelet transform by different wavelet. A table of image energy with different wavelet and different Noise will present. And their comparative graph which show that which on is the best level for smoke detection. This process will further expended for different wavelet level and some more image. This paper will provide further some more accuracy and best result for smoke detection in image.**

INDEX TERMS— **Smoke Detection, Segmentation, Wavelet, Gaussian Noise, Speckle Noise, Poisson Noise and Salt & Pepper Noise.**

I. INTRODUCTION

Fire is an important part of our life. And second thing it also a destructive part of element. It may occur sometimes very big loss of properties, human life and environment effect. Many of the products have produce for fire and smoke detection system. It may play major role in life. In sometime this different conventional device are not effective controls fire accident cases. Sometimes these devices are save the life but sometime it may be fail. Because of that it totally dependent on place where it installed, environment and also for cover big area it required more devices. And also it cost effective.

Smoke is first indication of the fire case. There are many research activity are taken about this system. For image based fire detection various method use. In image processing wavelet transform are uses in previous paper for detect fire and smoke. And many of wavelet use for detect fire and smoke. But it still may require and generate a best result for detect smoke. If smoke is effectively detected. We say smoke is present in detected area image. Here we represent comparative analysis of wavelet transformation for various smoke detection method for more refine the result for smoke image.

In this method two image are used for in this paper for generate a comparative analysis. First image is without smoke and second is with smoke image. After that some pre-segmentation process image energy with different wavelet based are calculated. At this process all the Energy level with different Noise likes Gaussian Noise, Speckle Noise, Poisson Noise and Salt & Pepper Noise are use. Since this are some noise removal technique for remove noise from image. All the process generated table and graph will represent a best result for smoke presence in the image.

II. WAVELET

A wavelet approach a small wave, a wavelet is an oscillation that decays speedy. Wavelets include the dilations and translations of a single real valued feature function $\boldsymbol{\psi} \in \boldsymbol{L^2(R)}$ referred to as the reading wavelet (additionally called the fundamental wavelet or mother wavelet). Through dilation we mean a scaling of the argument**.**

Equivalent mathematical conditions for wavelet are:

$$\int_{-\infty}^{\infty} |\boldsymbol{\psi(t)}|^2 \; \boldsymbol{dt} < \infty \qquad \textbf{Eq. 1}$$

$$\int_{-\infty}^{\infty} |\boldsymbol{\psi(t)}|^2 \; \boldsymbol{dt} = \mathbf{0}\,; \qquad \textbf{Eq. 2}$$

III. DIFFERENT NOISE MODEL

Noise tells unwanted unused statistics in virtual digital images use. Noise generate undesirable effects together with artifacts, unrealistic edges, unseen strains, corners, blurred objects and disturbs heritage scenes. To reduce those undesirable results, earlier mastering of noise fashions is crucial for in addition processing. Virtual high digital noise may also generated from diverse types of sources consisting of charge Coupled Device (CCD) and Complementary Metal Oxide Semiconductor (CMOS) sensors. In some experience, points spreading function (PSF) and modulation transfer function (MTF) have been used for well-timed manner,

complete and quantitative mode analysis of noise fashions. Probability density function (PDF) or Histogram is likewise used to design and characterize the noise fashions.

a. Gaussian noise

Gaussian noise is normally statistical noise having a probability density function (PDF) which may be equal to that of the everyday distribution form, which is likewise known as the Gaussian distribution. In different phrases, the values that the noise can tackle are Gaussian-distributed. A unique case is white Gaussian noise, where in the values at any pair of instances are identically disbursed and statistically independent (and hence uncorrelated).[17] In verbal exchange channel trying out and modeling, Gaussian noise is used as additive white noise to produce additive white Gaussian noise.

The possibility density function P of a Gaussian random variable Z is given by:

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}} \quad \textbf{Eq. 3}$$

b. Speckle noise

Generally speak noise by human like a, speckle noise may be reduced via different multiple look processing or spatial filtering. Even as multi searching process is typically accomplished at some point of information acquisition degree, speckle discount by spatial filtering is finished at the picture after it is received. Irrespective of which method is used to reduce the effect of speckle noise, the appropriate speckle discount technique preserves radiometric information, the rims between special. The spatial filters are classified into two types of group together, i.e., non-adaptive and adaptive. Where each Non-adaptive filter use the complete parameters signal of image into attention and leave out the local homes of the terrain backscatter or the nature of the sensor. These forms types of filters aren't suitable for non-desk bound scene signal. Fast Fourier Transform (FFT) is example of these types of filters. Whereas we can say that other hand, adaptive filters accommodate create changes in nearby houses of the terrain backscatter as well as the character of the sensor. In those sorts of filters, the speckle noise is taken into consideration as being desk bound but the changes inside the suggest backscatters due to adjustments within the sort of goal are considered. Adaptive filters reduce speckles at the same time as preserving the edges (sharp comparison version). This types of noise called is a multiplicative noise. This types of appearance is look in coherent imaging machine together with laser, radar and acoustics etc,. Speckle noise it may be can exist similar in an image as Gaussian noise.

$$F(g) = \frac{g^{\alpha-1} e^{\frac{-g}{a}}}{\alpha-1! a^{\alpha}} \quad \textbf{Eq. 4}$$

c. Poisson noise

The presence of these types of noise is view because of the analytical nature of electromagnetic waves like a x-rays, seen lights and gamma rays. The x-ray and gamma ray assets emitted quantity of photons consistent with unit time. Those rays are injected in affected persons of their body frame from its source, in clinical x rays and gamma rays imaging systems. These resources are having random fluctuation of photons. Result accumulated photo has spatial and temporal randomness. This noise is also referred to as quantum (photon) noise or shot noise. This noise follows the Poisson sharing and is given as.

$$P(f_{(pi)}) = k) = \frac{\lambda^k{}_i e^{-\lambda}}{k!} \quad \textbf{Eq. 5}$$

d. Salt and Pepper noise

That is also known as information bead noise due to the fact analytical its drop the original data values. This noise is likewise referred as salt and pepper noise. However the image isn't always fully corrupted by way of salt and pepper noise rather than a few pixel values are modified in the photograph. Although in noisy picture, there's a potentiality of some neighbours does not perform change. This noise is visible in statistics transmission. Image pixel values are replaced by way of corrupted pixel values either most 'or' minimal pixel cost i.e., 255 'or' zero respectively, if variety of bits are 8 for transmission.

IV. PROPOSED METHODOLOGY

For the analysis of Detecting Smoke in various wavelet with use of noise removal technique figure 1 show that methodology of propose model. In figure show that first step two images are use one image is without smoke and second is with smoke image load this image in model. Second step it required smoke some segmentation process. Both of the images are converted into gray image. After convert gray image use some media filter for noise removal technique. And next step is calculating the energy by using different wavelet transform. Here use wavelet like db2, db4, db6, db8, db10, sym2, sym4, sym6, coif1, coif3, coif5, bior1.1, bior1.5, bior2.8, bior3.3, bior3.9, bior5.5, rbio1.1, rbio1.5, rbio2.4, rbio3.3, rbio3.7, rbio4.4, haar. By using this energy is calculated for different wavelet. Result will give the energy of without smoke image and smoke image. It required not the smoke image and maintains table data. If we use the different image repeat the same process for energy calculation. And after that next step is required compare the energy of smoke and without smoke image. If energy is level is different with smoke and no smoke image message the display the smoke is detected in image. And if energy level difference is less then message is display smoke is not detected. And final last step stop the process.

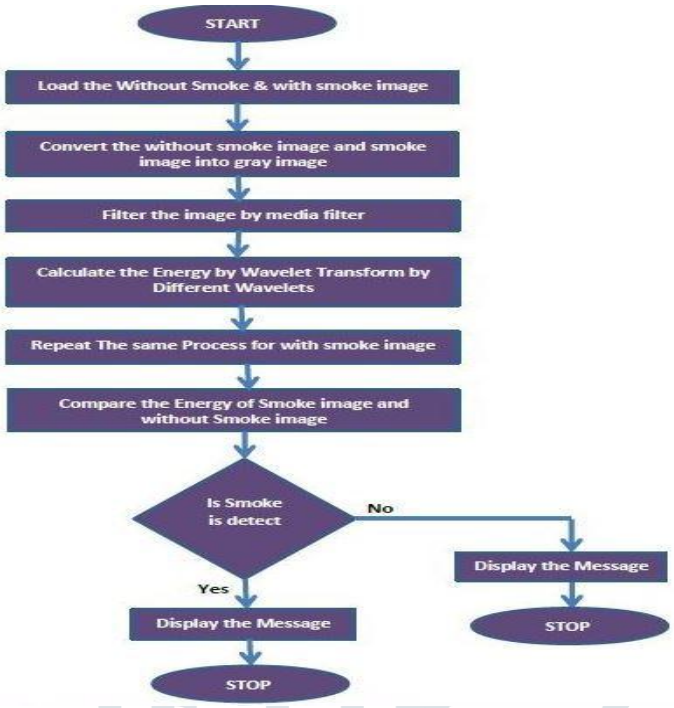

Figure 1: Methodology of comparative Analysis Smoke Detection

(a)  (b) 

Fig. 2. Input Image: (a) Without Smoke image, (b) Smoke Affected image,

Table 1: Noise affected image energy at Wavelet level 5

Wavelet	Gaussian Noise image Smoke	Speckle Noise image Smoke	Poisson Noise image Smoke	Salt & Pepper Noise image Smoke
db2	1.578	0.92216	0.60153	0.99542
db4	1.2303	0.7163	0.4667	0.87875
db6	1.0576	0.63854	0.43432	0.77599
db8	0.88902	0.53477	0.36557	0.70307
db10	0.7427	0.45054	0.30431	0.67851
sym2	1.5751	0.92631	0.60491	0.98873
sym4	1.3281	0.76435	0.49071	0.89909
sym6	1.0997	0.62379	0.39856	0.81612
coif1	1.4563	0.85721	0.56173	0.93804
coif3	0.84898	0.50502	0.33562	0.72262
coif5	0.62915	0.3882	0.26768	0.58236
bior1.1	1.8227	1.0978	0.72452	1.1255
bior1.5	1.4759	0.93409	0.66718	1.0867
bior2.8	1.3493	0.84508	0.58688	1.1038
bior3.3	4.3374	2.6388	1.8679	2.8199
bior3.9	2.4008	1.5455	1.1126	1.8755
bior5.5	0.90044	0.46656	0.25655	0.67592
rbio1.1	1.8129	1.0955	0.73071	1.1217
rbio1.5	1.1797	0.63518	0.37279	0.86246
rbio2.4	1.0679	0.59909	0.37345	0.78227
rbio3.3	1.502	0.92352	0.62846	1.1125
rbio3.7	0.94453	0.52426	0.32289	0.77569
rbio4.4	1.2982	0.7824	0.53295	0.89961
haar	1.8315	1.1002	0.72798	1.1309

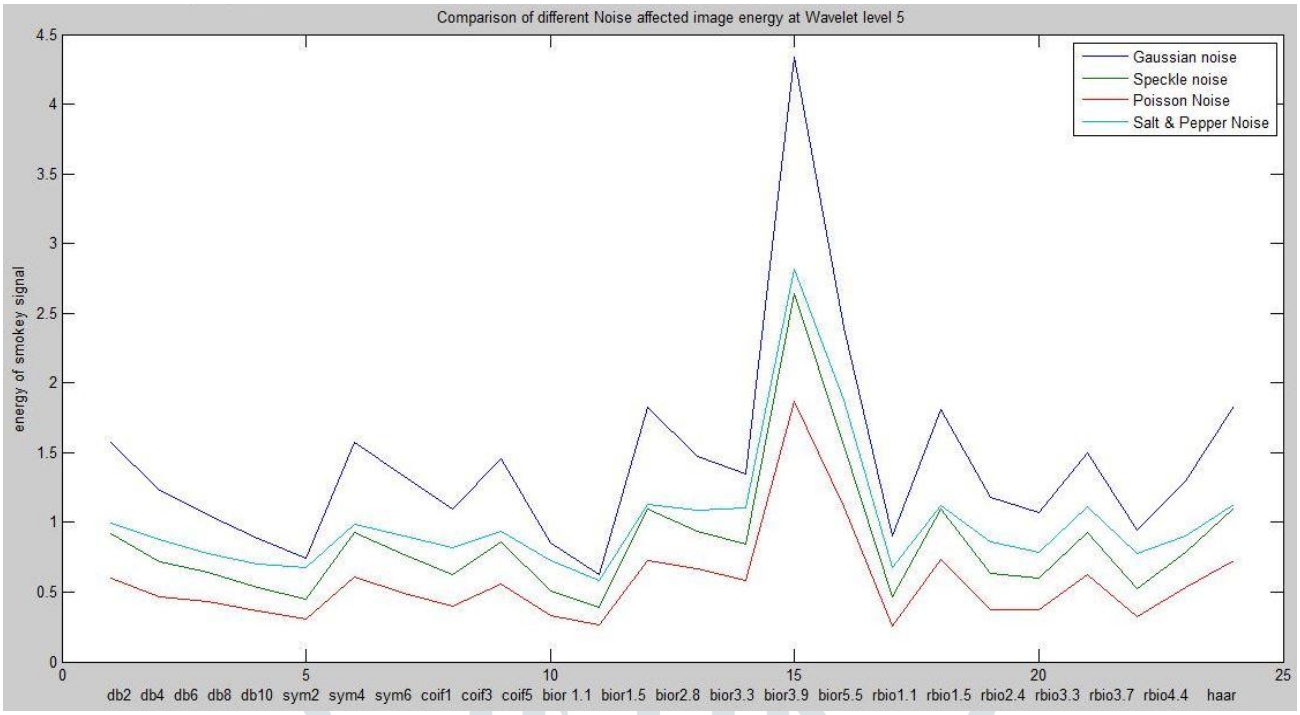

Fig. 3. Comparative Graph for different Noise affected image at Wavelet level 5 :

V. RESULT & DISCUSSION

Comparative graph show that Energy of smoke signal with apply different noise first Gaussian Noise, Speckle noise, Poisson Noise and Salt & Pepper Noise. And perform at different wavelet transform like db2, db4, sym2, coif1, haar etc. here graph show that energy of smoke level is higher in Gaussian Noise 4.3374 at bior3.3 and measure of other Noise like Speckle Noise again at bior3.3 energy level is 2.6388 this is the higher level of energy for Speckle. In Poisson Noise energy of smoke level is again higher 1.8679 in bior3.3 and using Salt and Pepper Noise energy level is again higher in bior3.3 and energy level is 2.8199. This analysis use wavelet level 5 for the comparative analysis. All this comparative analysis is based on for two images. Where first image is without smoke and second is with smoke image. Second with smoke image energy level is calculated after apply different noise technique. The resultant graph shows that best energy level for smoke detection.

Graph representation is best technique for any comparative analysis. Because of graphical representation show detail visual analysis report for different wavelet with apply noise removal technique. So this is best way to show the comparative analysis of different wavelet.

VI. CONCLUSION

This Wavelet Analysis is based on different wavelet with different noise removal technique for comparison of smoke energy in image. In our result its show that use different noise like Gaussian, Speckle, Poisson, Salt & Pepper analysis based on the various smoke detection wavelet technique available on previous research paper. As various previous researches that show Wavelet Transformation is the best technique for detecting smoke. Here we use wavelet like db2, db4, sym2, coif1, haar etc. In tabulation data various energy level show that different wavelet based energy with different noise removal technique. These analyses perform on wavelet level 5 for different wavelet. In Graphical representation show at Gaussian noise with wavelet bior3.3 is give higher level of energy efficiency for smoke detection. A comparison and graphical representation is the best way to for find higher level energy. It may be we get more accuracy for result for further if we test this process use for different images with different time slot with different location.

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VIII. BIOGRAPHIES

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