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Research Article

Comparative Study of Noise Removal Techniques

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Abstract

This paper studies the concept of noise, how noise is added to an image and various noise removal techniques. This paper contributes a comparative analysis of noise removal techniques such as 'salt & pepper noise', and 'gaussian noise'' with reference to original image. For experimental purposes, initially we observed the original image with respect to following parameters: mean, variance, entropy etc. Then we observed the image after adding different types of noise and lastly we have observed which noise removal technique is suitable for which noise for denoising. We have performed this work on MATLAB.

Keywords: *Gaussian noise, Salt & Pepper noise, mean, median, Binary image*

1. Introduction

An image is a 2-D function that represents a measure of some characteristics such as brightness or colour of a viewed scene. It can be defined as two variable function f(x,y) where for each position (x,y) in projection plane, f(x,y) defines the light intensity at this point. There are two types of image: analog & digital image.

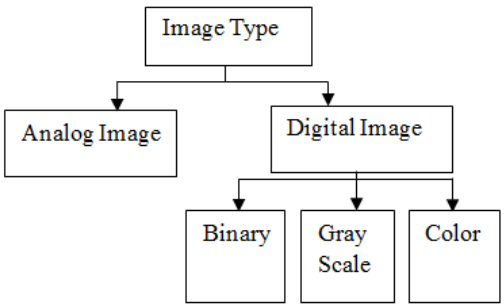

Figure 1: Types of Image

Analog Image: An image which is represented by continuous variation in tones.
Digital Image: A digital image is composed of picture elements called pixels. A pixel represents brightness at one point.
There are following differences between analog & digital image:

Table 1: Comparison between Analog & Digital Image

S.No	Parameter	Analog Image	Digital Image
1	Color	Less color	More color
2	Contrast	Low	High
3	Accuracy	Less	More accurate
4	Simulation	Difficult to simulate & design	Design & simulation is easy.

There are 3 types of coordinate system in image processing:

1) Cartesian Coordinate
2) Matrix Coordinate
3) Pixel Coordinate

Cartesian Coordinate system are used in mathematics where the point of origin is used(0,0). It is represented as shown in figure 1(a)

Matrix Coordinate system are used for matrix representation & display where the point of origin is (1,1). It is also known as row-column coordinate system. It is represented as shown in figure 1(b)

Pixel Coordinate system is used in digital image processing. It is represented as shown in figure 1(c)
In MATLAB, digital image is represented as matrices coordinate system for the manipulation of image matrix & for other reason we use pixel coordinate system.

2. Principle Sources of Noise

The variation between the real & captured image is called noise. Random variation of brightness or color information in an image is called noisy image. When an unwanted information is added to an original image which reduce the image quality then we say that a noise is present in an image. A noise can be defined as a process which affects the original image but not a part of original image. A noise can be introduced in an image by means of scanner, sensor or digital camera. The noise defiles the picture between their obtaining & transmission medium. When a noise is

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introduced in image then the useful information of image is lost. The noise in an image can be introduced during the capturing of image (due to movement of camera), due to sensor temperature, light level etc. In this paper we have discussed 3 different types of noise.

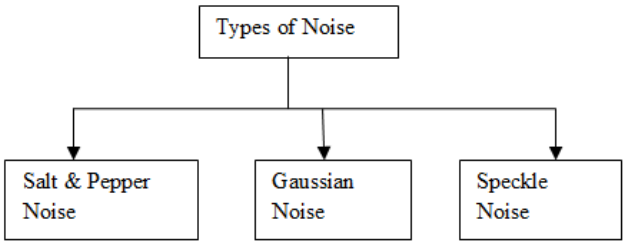

Figure 2: Types of Noise

Salt & Pepper Noise

It is also known as additive noise. Salt & Pepper noise is introduced in an image while capturing of images from camera. It contains arbitrary occurrences of black & white pixels in image data. So this type of noise is termed as additive noise. In this type of noise, an image that contain bright region has dark pixels and an image containing dark region contain bright pixel.

Matlab Algorithm to add 'Salt & Pepper'noise in an image.

Step1: Read an image into a variable in_img.
Step2: Convert the image obtained in step 1 into a gray scale image, g_img.
Step3: Add 'salt & pepper' noise to the image , g_img, using imnoise() function.
Step4: The resultant noisy image is obtained in noise_img.

Gaussian Noise

It is also an additive noise. In this type of noise random values are added to an image matrix. Gaussian noise is introduced by random fluctuations in signal. It is a static noise.

Matlab Algorithm to add 'Gaussian' noise in an image.

Step1: Read an image into a variable g_img.
Step2: Convert the image obtained in step 1 into a gray scale image, gr_img.
Step3: Add 'gaussian' noise to the image , gr_img,with zero mean & different values of variance using imnoise() function.
Step4: The resultant noisy image is obtained in gnoise_img.

3. Need of Filtering Techniques

Filtering is the process of transformation of pixel intensity values to reveal certain image features. Some image filtering techniques are:

- Mean Filter
- Median Filter
- Wiener Filter etc.

These filtering techniques are applied on corrupted image to improve contrast, remove noise and detect known patterns. Smoothing of image is directly proportional to size of filter.

Smoothing α size of filter

Mean Filter

This type of filter is used to smooth a signal in an image. This is a linear low pass filter. It works on the concept of windowed filter. In this type of filter, center value of window is replaced with the average value.

Basic Concept

5	2	6
4	1	5
1	1	2

Unfiltered Value

*	*	*
*	3	*
*	*	*

Mean Filtered Value

Figure 1: Mean Filter with window size 3*3

Matlab Algorithm to remove 'Salt & Pepper' and 'Gaussian ' noise an image

Step1: Read the noisy image that is corrupted with salt & pepper noise and Gaussian noise.
Step2: Define a mask.
Step3: Apply the mask obtained in step 2 on the images obtained in step1 using imfilter() function.
Step4: Resultant image.

Median Filter

It is also a type of smoothing an image. In this type of filtering technique, first the intensity values are arranged in ascending order and central pixel is replaced with median value.

Basic Concept

Ordered List

1	1	1	2	2	4	5	5	6

5	2	6
4	1	5
1	1	2

5	2	6
4	2	5
1	1	2

Figure 2: Median Filter with selected median value 2.

Matlab Algorithm to remove 'Salt & Pepper' and 'Gaussian ' noise an image

Step1: Read the noisy image that is corrupted with salt & pepper noise and Gaussian noise.
Step2: Define a mask.
Step3: Apply the mask obtained in step 2 on the images obtained in step1 using medfilt2() function.
Step4: Resultant image.

4. Experimental Results

Quantitative Results: In this paper we have take an image over which we have applied different type of noise and then filtering technique is used to removed unwanted signal from noisy image. Table I,II & III shows different results which we observed during experiment.

Table 2: PSNR in dB between noisy & filtered image

S.No	Filter	Salt&Pepper	Gaussain
1	**Mean**	36.1107	35.7574
2	**Median**	22.4175	20.0523

Table 3: Mean Squared error Between Original & Filtered Image

S.No	Filter	MSE
1	Mean (Salt & Pepper noise)	-2.6405
2	Mean (Gaussian noise)	-6.2172
3	Median (Salt & Pepper noise)	-1.1685
4	Median(Gaussian noise)	-1.2944

Table 4: Mean Squared error Between Salt &Pepper noise & Filtered Image

S.No	Filter	MSE
1	Mean	0.1254
2	Median	2.9344

Table 5: Mean Squared error Between Gaussian Noise & Filtered Image

S.No	Filter	MSE
1	Mean	0.1360
2	Median	5.0587

Figure 3: Original Image

Figure 4: Salt & pepper noise with noise density 5%

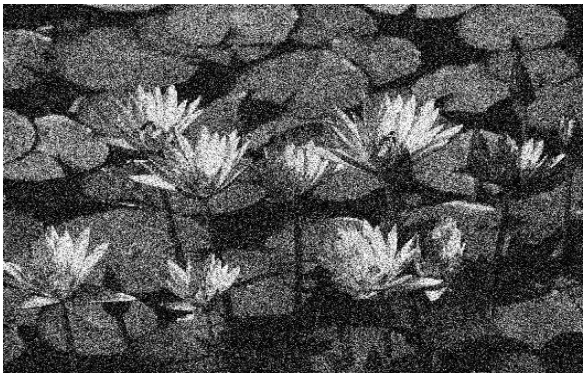

Figure 5: Gaussian noise with zero mean and σ=0.05

Figure 6: Remove salt & pepper noise using mean filter

Figure 7: Remove gaussian noise using mean filter

Figure 8: Remove salt & pepper noise using median filter

Figure 9: Remove gaussian noise using median filter

Table 6: Comparison of Salt & Pepper noise and Gaussain noise

S.No.	Parameter	Salt & Pepper	Gaussian
1	**Basic Idea**	Random occurrence of black & white pixel	Random valued added to image.
2	**Source of Noise**	Due to sharp & sudden changes of image signal.	Caused by random fluctuation of signal.
3	**Probability Density Function**	P(z)= Pa for z=a Pb for z=b 0 otherwise	P(z)= $\left(\frac{1}{\sigma\sqrt{2\pi}}\right) * exp(-\frac{(z-\mu)2}{2\sigma2})$
4	**Type**	Additive	Additive
5	**Present**	In camera images	In Medical Images

Table 7: Comparison of Mean & Median Filter

S.No.	Parameter	Mean Filter	Median Filter
1	**Type**	linear filter	Non linear
2	**Compatability**	Good to remove Gaussian noise	Good to remove salt & pepper noise
3	**Advantage**	Used to remove impulse noise	Used to remove any kind of noise
4	**Disadvantange**	Does not preserve details of image	Preserve edge in image.

References

Gonzalez, R.C. and R.E. Woods, *Digital Image Processing*, Reading, Massachusetts: Addison-Wesley, pp 716.

D. Maheswari et. al.(2010) , Noise removal in compound image using median filter *(IJCSE) International Journal on Computer Science and Engineering*, Vol. 02, No. 04, pp 1359-1362

Suresh Kumar, Papendra Kumar, Manoj Gupta, Ashok Kumar Nagawat, (2010) Performance Comparison of Median and Wiener Filter in Image De-noising, *International Journal of Computer Applications* (0975 – 8887) Volume 12– No. 4.

Yao Wang Polytechnic University, Brooklyn, NY11201 http://eeweb. poly. edu/~yao.

Parminder Kaur and Jagroop Singh. (2011). A Study Effect of Gaussian Noise on PSNR Value for Digital Images *International Journal of Computer and Electrical E ngineering*.Vol. 3, No.2, pp 1793-8163.

Rafael C. Gonzalez,(2011) , Image Restoration and Reconstruction, in Digital Image Processing, 3rd ed. India: Pearson Prentice Hall, pp. 322-330.

D. Maheswari et. al.(2010) Noise Removal In Compound Image using Median Filter. *(IJCSE) International Journal on Computer Science and Engineering* Vol. 02, No. 04, pp 1359-1362.

C. Mythili and Dr. V.Kavitha. Efficient Technique for Color Image Noise Reduction, The Research Bulletin of Jordan ACM,Vol.II(III)

Amit Agrawal and Ramesh Raskar(2009), Optimal single image capture for motion deblurring. In *Proc. IEEE Conference on Computer Vision and Pattern Recognition*, pp 2560-2567.

Pawan Patidar and et al. (2010) Image De-noising by Various Filters for Different Noise in *International Journal of Computer Applications* (0975 – 8887) Volume 9– No.4.