ISSN 2278-3083
Volume 8, No.6, November –December 2019
International Journal of Science and Applied Information Technology
Available Online at http://www.warse.org/ijsait/static/pdf/file/ijsait01862019.pdf
https://doi.org/10.30534/ijsait/2019/01862019

Image Noise Removal Techniques : A Comparative Analysis

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ABSTRACT

In recent years, the digital images use has increased dramatically in various domains in life such as scientific, medical, military and other, for several reasons including the data didn't loss quality during copying or transfer, the ability to modify or correct the images later easily, ability to display images on electronic and digital devices and other features. Digital images are exposed to the different types of noise during capture, storage or other factors that affect their quality, so it is necessary to remove these noises with preserving the image as much as possible. The removal of noise from images is a major task in the field of image processing, because it affects the quality of the image and leads to the loss of some of its important information through the impact of noise on it. To remove the noise in the images, different image filtering techniques are used. In this research, the main challenge was to conduct analytical study on the work of filters mean, medium, weiner2 used to remove the types of noise proposed in this research, such as salt and pepper noise, speckle noise, Poisson noise (shot noise), Gaussian noise. The study will explain the causes of these types of noise and their impact on the images, in addition to how to remove them from the images will also be a comparison between the types of filters and their ability to remove noise according to specific criteria.

Key words: Noises, Gaussian noise, Salt & Pepper noise, Speckle noise, Poisson Filters.

1. INTRODUCTION

The image processing branch is one of the branches of computer science, where the section is concerned with the process of improving images, or fragmentation of important parts of images or extract features and other. Due to the great development in the field of information technology and its equipment, the images taken by this technology has become a source of interest for many and the search for the best image and more accurate demand of many, so there are several ways to process and improve images in case of noise or any other effects.

Image processing is a set of calculations on the images the purpose is improve the images and eliminate noise, with preserve the edges of the images and the objects edges in the images as much as possible and prevent noise effect when removed [1].

Digital images are exposed to different types of noise due to errors in noise during its acquisition and transmission and due to blurring artifacts, which does not reflect the real density of the real scene. There are many sources that cause noise affect to the image, depending on how the image is created, for example (if the image is read from the film, the film's surface will be a source of noise), the film may be damaged and there will be noise, Or as a result of using the scanner itself, electronic transmission of image data can generate noise [2].

After researching and reading studies interested in the subject of noise and how to remove them using many types of filters. We found it necessary to conduct an analytical study with practical application to know which performance from filters is the best in noise removal and its ability to preserve images. In this research, selected four types of noise and added to the images in three sequential percentages 1%,5%,10%.These types of noise were removed using three types of filters namely mean, median, wiener2.After removing the noise from the images, the filters performance was analyzed according to the following criteria: mean square error (MSE), mean absolute error (MAE), peak signal-to-noise ratio (PSNR). when seeking in the results of the practical application to this research, , we found that the performance of the median filter was the best in removing Gaussian noise, then the filter will give Winer the best performance in removing the rest of the noise types.

[3] Discussed in his paper different noise such as salt and pepper, Poisson noise and other different filtering techniques are available for Reduce image noise. The main objective of this research is to remove certain species of the noise that affects the image quality. In this research, different types of nonlinear filters were used, and the filter ratio was measured on these criteria: SNR, MSE, PSNR and SSIM.

[4] pointed out in this paper, a non-linear filtering algorithm suggests that called (CMF) to reduce or remove the Salt and Pepper noise which causes white and black spots on the original image. The experiments display that the CMF

algorithm reconstructs a high-quality image in comparison with the standard median filter in term of the mean square error (MSE) as a quality valuation parameter.

[5] Focuses of his paper is to compare the noise techniques of images applied in the automatic detection of skin cancer. Suggest in his research restoring a damaged image. The paper briefly explains the sounds in the image as well as five famous filters to eliminate noise in an image. In this paper four noise, salt, pepper, poison and spike are added to the skin cancer and then removed using a medium adjustment filter, medium filter, medium conditioning filter, Gaussian smoothing filter, Wiener to compare the best performance.

[6] Discussed, different techniques are used to remove noise from the image. Noise removal technology depends on the behavior and type of noise. The noise model determines the noise type of its advantages and disadvantages as well.
[7] Discuss noise removal technology. As image obtained after the transmission is often corrupted, so before using it in applications it must be processed. This paper reviews noise models and classification of image de-noising techniques.
[8] Pointed out to the noise reduction techniques are used to improve image quality as well as maintain authenticity. This paper also focuses on the advantages and disadvantages of different methods such as linear and nonlinear filtering techniques.

2. DIGITAL IMAGE NOISE

Noise refers to visual distortion. The noise is like small colored pixels, and sometimes resembles the pills you might see in film photography. You may notice more noise in images taken in low light situations. Noise can distort the visual details of the image, making it blurred and uncomfortable for the eye.
Noise is known as undesirable or unhelpful information added to the image from various sources that may be due to fluctuation of electrical signals, weather or motion during filming [9] [10].

There are many types of Noise are following [11]:
- Amplifier noise (Gaussian noise).
- Salt-and-pepper noise.
- Speckle noise.
- Poisson noise (shot noise).

A.Gaussian noise
This type is also known as electronic or white noise one of the most common noise types. It is frequent to find it with other types of noise. This reason because some image corrupted with the addition of several types of noise. This noise affects the whole image, because each pixel is corrupted in the image. it is a correlated noise by nature because being electronic, affects the three channels[1].
B. Salt-and-pepper noise
Salt and pepper noise are defined as dark points and bright points added to the image [12]. This type of noise can occur due to bad weather, bit errors in transmission, etc.

C. Speckle noise
Speckle is a noise type that minimizes fine detail and edge definitions and limits the accuracy of contrast in the image. This granular noise is originally found in active radar, synthetic aperture (SAR) radar, medical ultrasound and CT images of optical coherence. This type of noise distorts ultrasound images, making medical diagnosis difficult Reducing this noise is a very important process [13].

D.Poisson noise (shot noise)
Poisson noise or shot noise is a type of electronic noise that occurs when the finite number of particles that carry energy, such as electrons in an electronic circuit or photons in an optical device, is small enough to give rise to detectable statistical fluctuations in a measurement [14].

2.1 IMAGE DE-NOISING

Noise reduction very important task in image processing because of the need for image analysis. It is important to preserve the details of the image when removing the noise so that the edges and edges of the objects remain clear. There are several ways to remove noise from images which is linear and nonlinear. Linear methods are quick to eliminate noise, but do not preserve images compared to nonlinear methods that preserve images and their details [15].

A.Median filter
Intermediate filter is a nonlinear digital filtering technique, often used to eliminate image blurry. The intermediate filter is used to handle digital images, because under certain conditions, it preserves edges while removing noise. The average filter is useful for removing salt and pepper noise while maintaining the edges [15].

B. Mean filter
Is a simple linear filter which a spatial filter, simple sliding window replaces the value of the center in the window with an average of all pixel values in the window. The nucleus, usually square but can be any shape.
The filter calculates the average value of the damaged image in a given area, and the pixel density value is replaced by the average value. This filter is also called the average. A mean filter is useful to remove salt and pepper noise from the image [16].

C.Weiner2
Wiener a kind of linear filters works with images adaptive type images adaptive have high frequencies and many details. Variance can be used to identify sharp details such as edges and classify in to different regions, when the variance is large, this filter gives the image less smoothing. Therefore, wiener can preserve edges and other high frequency parts of an image. Also, it produces minimum mean square error [18].
Wiener filter is characterized by the following [11]:
- Assumption: signal and (additive) noise are stationary linear random processes with known spectral characteristics.
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- Requirement: the filter must be physically realizable, i.e. causal (this requirement can be dropped, resulting in a non-causal solution).
- Performance criteria: minimum mean-square error.

(1) below in appendix, the median filter is better than the other filters used to remove Gaussian noise depending on the value of PSNR, taking into consideration that the noise ratio is 1%.

Table 1:. Comparative Results at Noise Level 1%

Filter Name	Gaussian Noise			Salt and pepper Noise			Poisson Noise			Speckle Noise		
	MSE	***MAE***	***PSNR***	***MSE***	***MAE***	***PSNR***	***MSE***	***MAE***	***PSNR***	***MSE***	***MAE***	***PSNR***
Median filter	162.13	552903	26.03	2777	641851	13.7	748.3	772159	19.3	1394.1	949502	17
Wiener filter	311.3	904872	23.2	2118	1215651	15	668.3	1086338	20	1114	1172716	18
Mean filter	192.4	769597	25.3	2724	1105828	14	979	990775	18.2	1486	1146447	16.4

3.SIMULATION RESULTS

We are applying this method to 10 images by adding four types of Noise Gaussian noise, Poisson noise, Speckle noise and Salt & Pepper noise, and apply three ratios 1%,5%,10% of noise then De-noised image using Mean filter, Median filter and Wiener filter and comparisons among them using Matlab program version R2010a. For example the fireman's picture was put to illustrate how the noise effect on the images and the work of the filters on each type of noise.

Figure. 1: Original Image (Gray Level)

In Figure 3 in the appendix, we note the work of the three filters used in this research to remove the four proposed noise types. We Note from the images indicated in the fig 3 that the median filter was the best in removing the noise for the Gaussian noise and the Weiner filter gives the good performance to remove the rest noise.

4. RESULTS ANALYSIS

As shown in Table 1, 2,3 in appendix which includes result of MSE, MAE, PSNR we find that the Median filter is better than the rest of the other filters used in this research to remove the one type of noise Gaussian noise followed by the mean and wiener filters. As for the noise of salt and pepper and the spackle noise and Poisson noise, the wiener filter is the best in to removal these noises and according to the ratios referred to in tables. The results of the experiments were shown in table

The results of the experiments were shown in the Table 2 below, the median filter is better than the other filters used to remove Gaussian noise depending on the value of PSNR, followed by a good performance in removing the noise remaining types used in this research wiener filter taking into consideration that the noise ratio is 5%.

The results of the experiments shown in Table 3 below. The median filter was better than the other filters used to remove the Gaussian noise based on the PSNR value, followed by the mean filter in the removal of the Gaussian noise followed by a good performance in removing the remaining noise types used in this research. Considering that the noise rate is 10%.

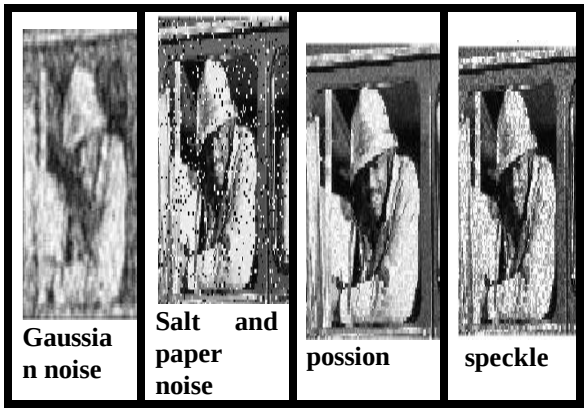

Figure.2: Adding noise ratio (0.5)

Table 2: Comparative Results at Noise Level 5%

Filter Name	Gaussian Noise			Salt and pepper Noise			Poisson Noise			Speckle Noise		
	MSE	***MAE***	***PSNR***	***MSE***	***MAE***	***PSNR***	***MSE***	***MAE***	***PSNR***	***MSE***	***MAE***	***PSNR***
Median filter	148	522330	26.4	2210.6	281858	14.7	186.2	396101	16.4	1386	945620	17
Wiener filter	231.9	701180	24.5	1114	390229	17.7	661.7	107303	10	1115	1180791	18
Mean filter	153.7	596778	26.2	1955	463635	15.2	971.9	979604	18.2	1466	1147561	16.4

5. CONCLUSION

We used the fireman image referred to in Figure.1. from type "JPG". Types of noise were applied salt and pepper noise, speckle noise, Poisson noise, Gaussian noise. They displayed in the Fig.2. These four types of noise removed using three types of filters median, mean, and wiener in the Fig. 3. The performance of median filter on Gaussian noise was best in removing this type compared to the other filters used in this research. Weiner filter achieved the best performance in removing the remaining three noise types**.**

5.1. FUTURE WORK

The need to find a way to remove the noise while preserving the edges of the image as much as possible, because the methods used in this research have removed noise, but by observing the resulting images we found that the edges have been affected and in some types of noises and after the application of the three filters affected by the quality of the image and distort the Image features.

Highlight a section that you want to designate with a certain style, then select the appropriate name on the style menu. The style will adjust your fonts and line spacing.

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Table 3: Comparative Results at Noise Level 10%

Filter Name	Gaussian Noise			Salt and pepper Noise			Poisson Noise			Speckle Noise		
	MSE	MAE	PSNR	MSE	MAE	PSNR	MSE	MAE	PSNR	MSE	MAE	PSNR
Median filter	188.1	565426	25.3	4044.8	1015624	12.06	2599.5	998799	14	3002	1015447	13.3
Wiener filter	326.1	787909	23	3180	990570	13.1	2049.8	968384	15.01	2355	966374	14.4
Mean filter	197	674422	25.1	3718.4	1002104	12.4	2402.1	967509	14.3	2453	972213	13.8