Performance Comparison of Various Filters for Removing Gaussian and Poisson Noises

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Abstract- :**Digital image are prone to a variety of noise. Noises like Gaussian noise, Poisson noise. To obtain significant results, Filters like Averaging filters, Median filters, Weiner filter have been proposed to remove noise from Images .This paper deals with comparison of various filters for noise removing by accounting Peak Signal to Noise Ratio and Root Mean Square Error as performance parameters. This paper proves that wiener filter is effective for Gaussian noise and Poisson noise Results of this paper have been simulated on MATLAB.**

Key Words:Average filter, Median filter, Wiener filter, Poisson noise, Gaussian noise, PSNR ,RMSE**.**

1. INTRODUCTION

The area of digital image processing related to processing of digital images by using digital computer [1]. Denoising of image is an essential part of image reconstruction process.Noise gets introduced during acquisition, transmission, & reception and storage & retrieval processes. Noise may be classified as substitutive noise (impulsive noise like salt and pepper noise ,impulsive noise etc), additive noise like Gaussian noise and multiplicative noise like speckle noise. The important property of image denoising model is that it Should completely remove noise with preserving edges. Basically the image quality is measured by the peak signal to noise ratio (PSNR) and root mean square error (RMSE) [2]. However, in this paper first image is taken and some noise is added to image to make it as noisy image and then noisy image is decomposed by filters. It becomes very important to denoise the image before applying to different applications [3].The principle approach of image denoising is filtering. Filters used to remove noise are averaging filters, median filters, wiener filter.

1.1 MEDIAN FILTER

The median filter is non-linear filter. It remove noise effectively as well as preserving sharp edges. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve noise. itsimply replaces each pixel value by the median of the intensity level in the neighborhood of the pixel [1]. It proves to be best in removing salt and pepper noise .it is a order statistics filter .instead of taking the mean ,rank of pixel values in the window ,take the n^{th} order value

1.2 AVERAGING FILTER

Average filter or mean filter is simple and easy to understand.it perform smoothing of images (i.e reducing variation of intensity between one pixel and the next). Average filter replaces each pixel by the average of pixel in a square window surrounding these pixels. larger window can remove noise more effectively, but also blur image

1.3 WIENER FILTER

Wiener filter is a linear filter. It provides linear estimation of a desired signal sequence from another related sequence [4]. Wiener filter provide solution for stationarysingals in finding signal estimation problems. It provides successful results in removing noise from images .Wiener filter is based on statistical approach.

2. NOISE

Noise is an result of error in image acquisition process that results in pixel values that do not reflects true intensities of Real pictures . Noises used in this paper are

2.1 GAUSSIAN NOISE

Gaussian noise is a statistical noise. It is evenly distributed over the whole image. The probability density function (PDF) Of Gaussian noise is equal to that of the normal distribution ,also known as Gaussian distribution

$$P(z) = 1 / (\sqrt{2\pi\sigma})\ \pi e^{\frac{-(z-\mu)^2}{2\sigma}} \text{.........(1)}$$

2.2 POISSON NOISE

Poisson noise or Shot noise is a type of electronic noise which can be modeled by a Poisson process . Shot noise results from discrete nature of electric charge . Shot noise may be dominant when the finite number of particles that carry energy is sufficiently small so that uncertainties due to the Poisson distribution, which describes the occurrence of independent random events. The magnitude of shot noise increases according to the square root of the expected number of events, such as the electric current or intensity of light. But since the strength of the signal itself increases more rapidly, the *relative* proportion of shot noise decreases and the signal to noise ratio (considering only shot noise) increases anyway.

3. PARAMETRIC DESCRIPTION

The performance parameters are most important criteria to justify the simulation results. Peak signal to noise ratio (PSNR) and mean square error (MSE) are considered parameters . the quality of denoised image is measured by :

$$PSNR = 10 \log_{10}\left(\frac{R^2}{MSE}\right)$$

Where R is maximum value of pixel present in an image and MSE is the mean square error between original and denoised image with M*N size
.

$$MSE = \frac{1}{M*N}\sum_{i=1}^{M} \sum_{j=1}^{N}[x(i,j) - y(i,j)]^2$$

Where , x(i , j) is original image and y(i , j) is denoised image .RMSE is defined as :

RMSE =sqrt(MSE)

4. IMPLEMENTATION

Step 1: Read an RGB image and convert it into gray scale image

Step 2: Make it noisy by applying Gaussian and Poisson noise.

Step 3: Noisy image is then converted into denoisy image by applying different types of filters.

Step 4: Calculate PSNR and RMSE to check the performance of filter and denoised image.

Step 5: Denoised image having high PSNR and low RMSE.

5. SIMULATION RESULTS

A gray scale image is taken as reference image.two type of noises i.e. Gaussian noise, Poisson noise are added to the image.Denoising is performed using three filters i.e. Median filter, Averaging filter, Wiener filter. Results are shown through comparison among them. Comparison is made on the basis of parameters like PSNR and RMSE.

Fig-1: Original image

Fig-2: Noisy image: Gaussian noise with mean=0 and variance 0.01

Fig-3: Noisy image: Poisson noise

Fig-4: De-noised image by Median filter for Gaussian noise.

Fig-5: De-noised image by wiener filter for Gaussian noise

Fig-6: De-noised image by Average filter for Gaussian noise

Fig.7: De-noised image by Median filter for Poisson noise

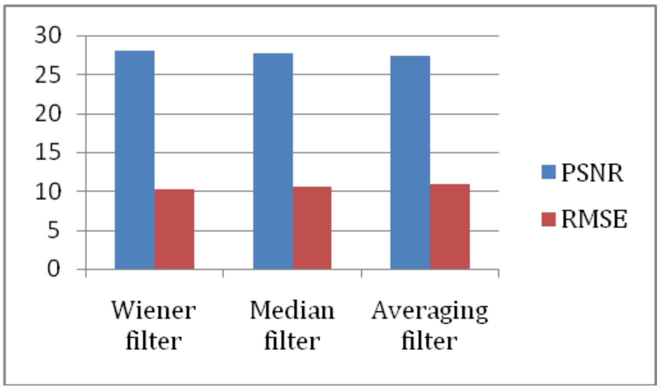
Fig-8: De-noised image by Wiener filter for poisson noise

Fig-9: De-noised image by Averaging filter for Poisson noise

6. RESULTS

FILTERS	PSNR	RMSE
Wiener filter	28.00	10.18
Median filter	27.66	10.58
Averaging filter	27.41	11.07

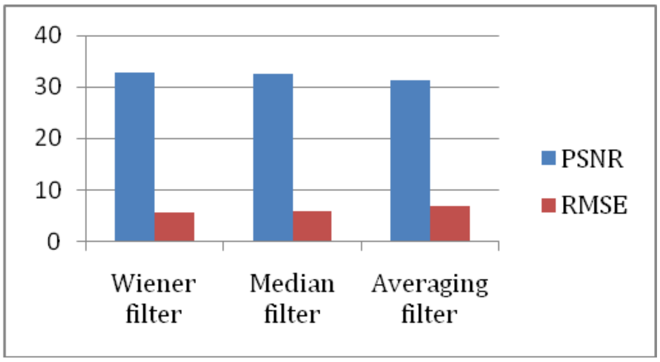
Table-1: COMPARISON OF PSNR AND RMSE FOR GAUSSIAN NOISE DENOISED BY FILTERS



The graph is plotted for PSNR an RMSE values resulting from different filters. This graph shows that wiener filter is more efficient for removing Gaussian noise,but the performance of median filter is also good enough for Gaussian noise.

FILTER	PSNR	RMSE
Wiener filter	32.89	5.79
Median filter	32.59	6.04
Averaging filter	31.27	6.95

Table-2: COMPARISON OF PSNR AND RMSE FOR POISSON NOISE DENOISED BY FILTERS



The graph is plotted for PSNR an RMSE values resulting from different filters. This graph shows that wiener filter is more efficient for removing Poisson noise ,but the performance of median filter is also good enough for Poisson noise.

7. CONCLUSION

In this paper, we have implemented the above mentioned filters in Matlab to recover the image degraded by Gaussian noise and Poisson noise . Wiener filter performs better in removing Gaussian noise as well as Poisson noise than other filters. Median filter also provide better results for Gaussian noise and Poisson noise. In this paper PSNR and RMSE has been used as comparison parameters. Results have been simulated on MATLAB 2013.

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