Comparative Performance Analysis of Gaussian Denoising using Spatial Filter

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Abstract: Median filter performs better than median filter. It preserves the edges but at higher noise levels, it still contains some amount of noise and restored image is over smoothed. Average PSNR of Median filter is lower than the mean filter. This shows that performance of median is better than mean filter.Weiner (Adaptive filter) filter perform better than all the filters. It preserves the edges and also restored the better quality image in its visual appearance so we find that adaptive filter preserves the more significant details, texture, edges of an original image from the noisy image. Based on all the experimental results it can be seen from tables, graphs and images the adaptive filter has the higher PSNR value and the lower MSE value provides better performance in both PSNR and visual quality of an image out of all the three filters.

Keywords: weirner, filter, denoising

I. INTRODUCTION

Noise is the undesirable information that degrades the image quality or can say noise is an undesirable by-product of image that adds extraneous information and represents unwanted information which degrades image quality and is not a part of image. An undesirable information often gets added to images when they are processed, compressed and stored due to which degrades image quality and becomes an obstacle to image analysis and figuring out image features. Noise means, pixels within picture present different intensity values rather than correct pixel values. The original meaning of noise was unwanted sound, unwanted electrical fluctuations in signals caused noise. Noise has low as well as high frequency components. The distortions of images by noise are common during its acquisition, processing, compression, transmission etc. In acquisition process of digital images, optical signal is converted into electrical signal and then into digital signal and this conversion process introduces noise in digital images. Images sent from the sender end may not be same at the receiving end, often corrupted with noise as each step in the conversion process experiences fluctuations, caused by natural phenomenon, and each of these steps adds a random value to intensity of a given pixel.

Image processing refers to processing digital image by means of digital computer. Image Processing is a strategy to change over a picture into computerized shape and perform a few operations on it, keeping in mind the end goal to get an improved picture or to concentrate some helpful data from it. In Image Processing, we input data in picture form and yield might be a picture or attributes connected with that picture. It is among quickly developing innovations today, with its applications in different parts of a business.

II. LITERATURE REVIEW

Detection of edges is an important problem in image processing. Due to addition of noise in original image, intensity value of edges change which may result shifting of edges from their original positions or it may also result missing or false edge problems. There are many edge detection techniques available in image processing such as Sobel and Prewitt detectors which work well for certain alignment or position and does not work for the detecting edges which are blur and noisy. Linear filters are smoothing filters which helps in reducing noise level but these filters also blur edges. Derivative masks of some sort of smoothing filters act as linear operators which help to extent in detecting edges **[1]**. Image Denoising is an important step to be taken before analyzing image data and extracting information from that data. In this paper various denoising algorithms are studied to examine a beneficial denoising technique. Normally spatial filters reduce the amount of noise to certain extent but they are not able to prevent the images from blurring and missing edge problem. A great work was done in this field to overcome the problem of blurring edges as various nonlinear filters like weighted median, ranking non-linear and relaxed median have been developed. Mean filter is optimal linear filter for removing Gaussian noise by calculating mean square error as in case of weiner filter. The wiener filtering method needs prior knowledge about the spectra of the noise and the original signal and it works well only in case the signal is stationary [2].

Image denoising was performed on four types of noise i.e. Gaussian noise , Salt & Pepper noise, Speckle noise and Poisson noise was performed by using Mean, Median and Wiener filter . Results of all the filters were compared and analyzed which filter performs better for which type of noise. By de-noising all noisy images by all filters and it is concluded that the performance of the Wiener Filter is better than Mean filter and Median filter for denoising for all Speckle, Poisson and Gaussian noise and the performance of the Median filter is better than Mean filter and Wiener filter for de-noising Salt & Pepper noise. One of the most popular methods is wiener filter. Weiner filter performs better in wavelet domain **[3]**. The wavelet transform has become a popular tool in many applications, including image processing, especially in removing noise from images. This paper presents a modified Donoho's (1995) thresholding for denoising images. The simulation results showed that modified thresholding is superior in terms of PSNR compared to Donoho's thresholding. Weiner filter gives best result in wavelet domain [4].

During acquisition of an image, from its source, noise becomes integral part of it, which is very difficult to remove. Various algorithms have been used in past to denoise images. Image denoising still has scope for improvement. In this paper we present a new image denoising algorithm based on combined effect of wavelet transform and median filtering. The algorithm removes most of the noisy part from the image and maintains the quality. The level of wavelet decomposition is restricted to three. The performance of this combined filter is measured on the basis of measuring parameters Peak Signal to Noise Ratio (PSNR) and Root Mean Square Error (RMSE) [5]. Spatial filtering algorithms are studied and their performance is compared to solve the problem of interference in the signal or weal signal problem. The least mean square (LMS), normalized LMS (NLMS) and Recursive least square (RLS) adaptive algorithms for spatial filtering are studied. In the spatial filtering algorithms, LMS, NLMS, RLS have a good effect of suppressing interference, LMS algorithm is simple, stable and easy to achieve. But its convergence speed is slow. NLMS algorithm is the improvement of LMS algorithm. RLS algorithm has the advantages of fast convergence and small steady-state error, but its algorithm complexity is obviously higher than LMS and NLMS algorithm, its application has also been limited. Compared with the LMS algorithm, the NLMS algorithm establishes the relationship between the step factor and the input signal at every time, and the convergence speed and stability of the algorithm are improved. RLS algorithm works best, produced the deepest depression, its convergence speed is very fast and steady-state error is very small [6].

This paper introduces a new technique based on nonlinear Minmax Detector Based (MDB) filter for image restoration. The Centre Weighted Mean (CWM) filter has got a better average performance over the median filter, where CWM is the special case of WM filter and WM is an extension of median filter. To prove the efficiency of the proposed MDB schemes, the new proposed MDB scheme is compared with the existing ones. In this proposed algorithm, center pixel is taken as the test pixel, if pixel value is more than max value then pixel is corrupted and replaced by median value. The graph in this paper signifies as the noise level in images increase, percentage of noise attenuation by CWM filter decreases. CWM filter does not work well for high level of noise where, the proposed MDB filter work efficiently for higher level of noise even. MDB filter, the proposed scheme gives superior performance as compared to the existing schemes when Salt and Pepper impulse noise is considered [7]. Wavelet image denoising has been widely used in the field of image noise. After taking into account the objective and subjective results of the noise image, this paper presents a new image denoising method. Firstly, this method decomposes the noisy image in order to get different sub-band image. Secondly, we remain the low-frequency wavelet coefficients unchanged, and after taking into account the relation of horizontal, vertical and diagonal high-frequency wavelet coefficients and comparing them with Donoho threshold, we change them and make them enlarge and narrow relatively. Thirdly, we use soft-threshold denoising method to achieve image denoising. Finally, we get the denoising image by inverse wavelet transform. According to the result of experiment, this method as compared to soft-threshold denoising method has a higher PSNR and visual effects [8].

An image is often corrupted by noise in its acquisition and transmission. Removing noise from the original image is still a challenging problem for researchers. In this work new approach of threshold function developed for image denoising algorithms. It uses wavelet transform in connection with threshold functions for removing noise. SNR is efficiently improved **[9]**.There has been an increasing interest in the use of autonomous underwater vehicles for ocean exploration. Side scan sonars are usually installed on these vehicles to survey the seafloor and there is need to transmit side scan sonar images over an acoustic low bandwidth channel which requires the use of compression techniques. This paper introduces a wavelet based method for compressing side scan sonar images. Wavelets are an adequate choice because their intrinsic properties suit side scan sonar images. Wavelet based results yield high compression rates. Wavelet-based compression boosts side scan sonar imaging by reducing noise without smoothing important details **[10]**.

III. PROPOSED METHODOLOGY

Following are the steps which are followed in the proposed methodology.

1. Input an 2D image (m by n)
2. Pre-allocate another matrix with zeros as boundary elements (m+2 by n+2)
3. Copy the input matrix into pre-allocated matrix

4. Form a window matrix of size 3 by 3 and slide the window as the elements processed.
5. a) Now, In case of mean take mean of elements, find its mean value and if mid element of window is corrupted, then replace the mid element of window with the resulting mean value.

b) In case of median sort elements in ascending order, find median value. Here 5th element will be the median then if mid element of window is corrupted, and then replace the mid element of window with the resulting median value.

6. Convert the image into an Image of 0-255 color range type.
7. Display the Image without noise.

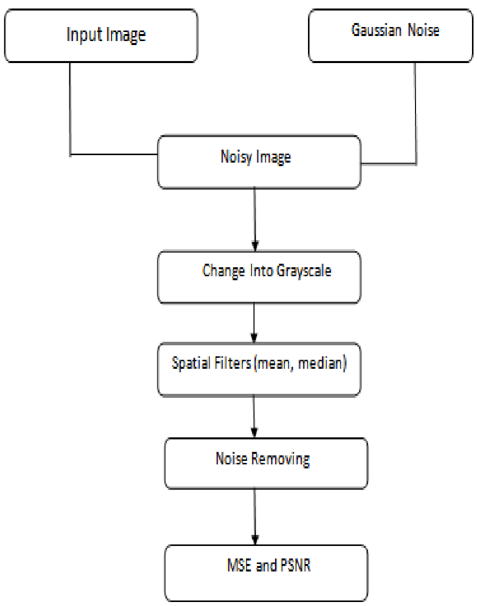

Figure 1.1 Flow chart of the proposed methodology.

IV RESULTS

In this work, various spatial domain filters for suppression of Gaussian noise are studied, analyzed and implemented those are median filter, bilateral filter and non- local means filter. To evaluate the quality of de-noised images we performed our experiments on 12 standard test images of size 256*256 have been corrupted by Gaussian noise of standard deviation (σ = 10,15,20,25,30). Performance quality metrics are used to measure the quality of an image objectively. Quality metrics which are used for comparison such as PSNR (peak signal-to-noise ratio) and MSE (mean squared error) are represented graphically.

Table 1.1: Comparison among mean, median and adaptive filter MSE

Noise Ratio	Mean Ratio	Median Filter	Adaptive Filter
Noise=20	160.41	630.23	234.34
Noise=40	168.23	123.34	113.01
Noise=80	189.23	234.23	151.38

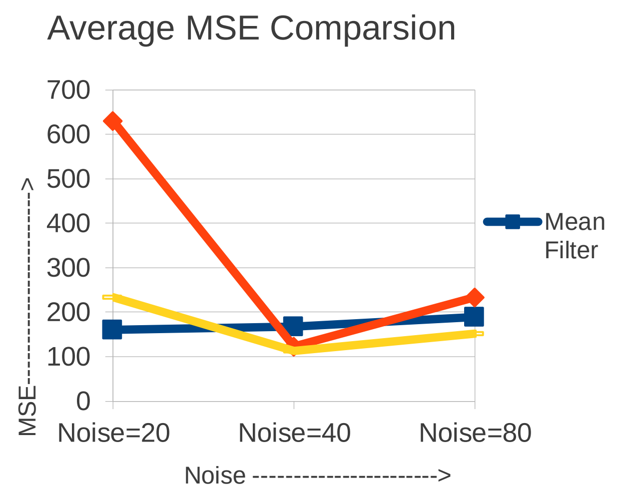

Figure 1.2: Graphical representation of Comparison of average MSE

Table 1.2: Comparison among mean, median and adaptive filter PSNR

Noise Ratio	Mean Ratio	Median Filter	Adaptive Filter
Noise=20	29.04	26.67	29.83
Noise=40	29.09	28.12	31.55
Noise=80	29.10	29.90	34.65

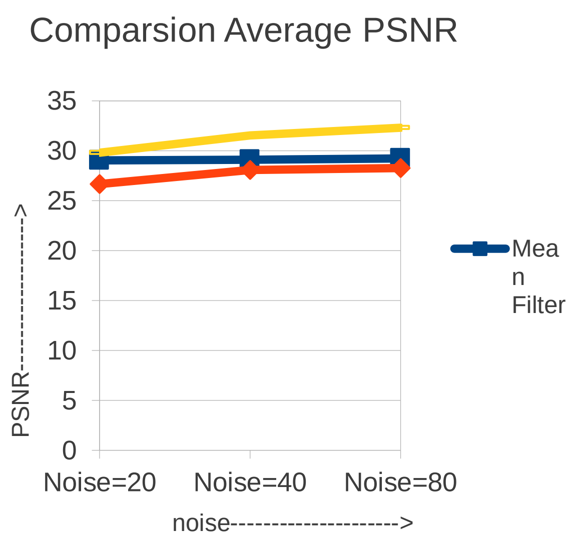

Figure 1.3 : Graphical representation of Comparison of average PSNR

The average PSNR and MSE values of all the 8 standard images are represented -in the table. The quality of restored image is better if it has the higher PSNR value. MSE (Mean squared error) represents the error between the original image and restored image. It is the sum of all squared value differences between the original and restored image divided by image size. The quality of restored image is better if it has the lower MSE value. The minimum MSE value and the higher PSNR value of non-local means filter shows the best performance at all the Gaussian noise levels.

V. CONCLUSION

In this work, we focus on image de-noising quality. There are various methods exist in the literature survey. Some of the filter based methods are studied, implemented and their performances are analyzed. Quality performance metrics results are represented in table and graphs.

Mean suppress the noise and widely used for its simple algorithm. The de-noised images still contain noise and also some detailed information such as edges in the images are lost.

VI. REFERENCES

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