Comparative Performance Analysis of Salt and Pepper Denoising using Spatial Filter

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Abstract - An image has been often corrupted by different kinds of noises when it is processed, compressed and stored which degrades its quality and becomes an obstacle to image analysis and extraction of image features. Efficient noise suppressing image de-noising technique is still a big challenge in image analysis and processing. Image Denoising refers to the recovery of a digital image that has been contaminated by noise so that the visual quality of an image is of high quality and used effectively for analysis. In spatial domain filtering technique filters can tackle the denoising problems without affecting the significant features of an image and gives us better results in restoring an image. Low image quality is an obstacle for effective feature extraction, analysis, recognition and quantitative measurement so this paper present practical aspects of various types of filter that have been used for suppression of noise. Experiment was performed on 12 standard test images that have been corrupted by different Gaussian noise levels and result has been compared in terms of peak signal-to –noise ratio (PSNR),mean squared error (MSE) to quantify the performance of denoising techniques.

Keywords: *PSNR, spatial, filters*

I. INTRODUCTION

Image processing refers to processing digital image by means of digital computer. Example: The acquisition process for digital images convert optical signals into electrical signals and then into digital signals and is one process by which noise is introduced in digital images. Each step in the conversion process experiences fluctuations, caused by natural phenomenon, and each of these steps adds a random value to resulting intensity of a given pixel. So, images sent from sender end may not be same at the receiving end, often corrupted with noise.

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 Image has been often corrupted by different kinds of noises when they are processed, compressed and stored which degrades its quality and becomes an obstacle to image analysis and extraction of 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.

Noise is defined as process (n) which affects the acquired image (g) and is not part of the initial signal (f) and so noise model can be written as

$$g(i,j) = f(i,j) + n(i,j)$$

Image noise is random (not present in the object imaged) variation of brightness or color information in images.

II. RELATED STUDY

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 den**o**ising 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 den**o**ising 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 5^{th} 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.

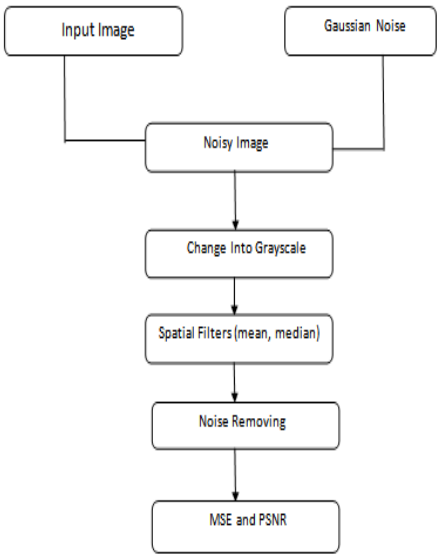


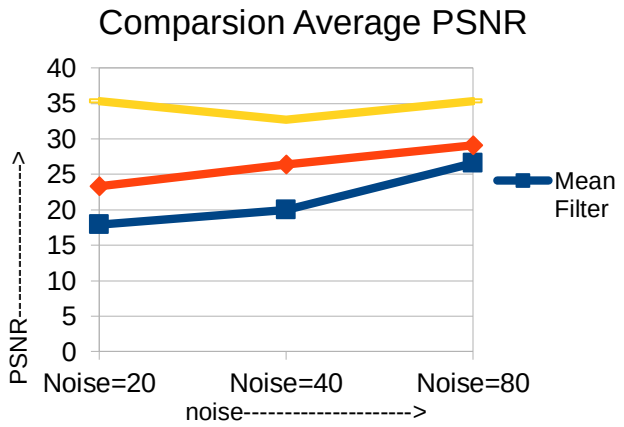
Figure 1.1 Flow chart of the proposed methodology

IV RESULTS

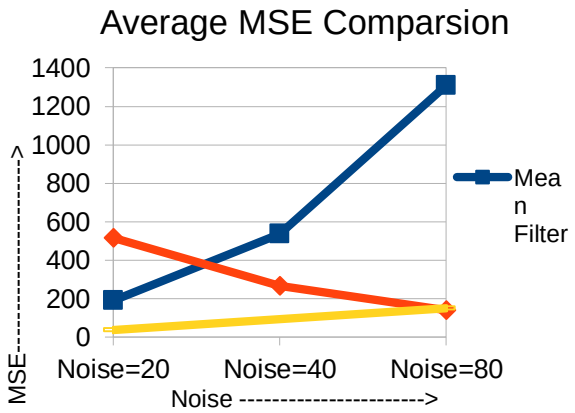
This section of the paper shows the comparison of the result with proposed and existing approach. For evaluating the performance of denoising technique we used the important evaluation factors called peak signal-to-noise ratio (PSNR) in decibles (dB) and mean square error (MSE).

MSE (Mean Square Error): MSE (Mean Square 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 denoised image is better if it has lower MSE value.

PSNR (Peak signal-to-noise ratio): The PSNR is the peak signal-to-noise ratio, in decibels, between two images. The PSNR ratio is used as a quality measurement between the original image and restored image. The quality of denoised image is better if it has the higher PSNR value.



Graph 1.1: Comparison between Mean, Median and adaptive filter PSNR



Graph.1.2: Comparison between Mean, Median and adaptive filter MSE

V. REFERENCES

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