A Simplified Approach of Denoising Watermarked Images

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ABSTRACT

Image denoising is one important part of image enhancement in the field of image processing. Now a days many applications of modern digital world are based on digital images and hence quality of digital images are matter in all applications. The goal of image denoising is to remove the unwanted noise from the image. There are various methods of image denoising. Which method is best to denoise the image is still a challenge for researcher. This paper compare different denoising filter based techniques for denoising the image. Gaussian noise, Salt and Pepper noise and Speckle noise are being considered and all the three noises are reduced using mean filter, Wiener filter and Median filter. The implementation result shows the comparison and the performance of different types of filters to denoise the noised image. Mean square errors and PSNR are used as performance metrics.

Keywords-Noise, denoising, filters, Salt and Pepper noise, Mean filter, Median filter.

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1 INTRODUCTION

A very large portion of digital image processing is devoted to image restoration. This includes research in algorithm development and routine goal oriented image processing. Image restoration is the removal or reduction of degradations that are incurred while the image is being obtained [1]. Degradation comes from blurring as well as noise due to electronic and photometric sources. A noise is introduced in the transmission medium due to a noisy channel, errors during the measurement process and during quantization of the data for digital storage. Each element in the imaging chain such as lenses, film, digitizer, etc. contributes to the degradation. Image denoising is often used in the field of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed. There are many schemes for removing noise from images. In common there are two types of image denoising model, linear model and nonlinear model. Generally linear model are being considered for image denoising, the main benefits of using linear noise removing models is the speed and the limitations of the linear models is the models are not able to preserve edges of the images in an efficient manner Non-linear models can preserve edges in a much better way than linear models but very slow.

2 IMAGE NOISE

Image noise is random variation of brightness or Color information in images, and is usually an aspect of electronic noise. It can be produced by the sensor and circuitry of scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Image noise is an undesirable by-product of image capture that adds spurious and extraneous information. Digital image noise may occur due to various sources. During acquisition process, digital images convert optical signals into electrical one and then to digital signals and are one process by which the noise is introduced in digital images. Due to natural phenomena at conversion process each stage experiences a fluctuation that adds a random value to the intensity of a pixel in a resulting image [2]. In general image noise is regarded as an undesirable by-product of image capture.

The types of Noise are following:-

- Amplifier noise (Gaussian noise)
- Salt-and-pepper noise
- Shot noise (Poisson noise)
- Speckle noise

A. Gaussian Noise

Gaussian noise is statistical in nature. Its probability density function equal to that of normal distribution, which is otherwise called as Gaussian distribution. In this type of noise, values of that the noise are being Gaussian-distributed. A special case of Gaussian noise is white Gaussian noise, in which the values always are statistically independent. For application purpose, Gaussian noise is also used as additive white noise to produce additive white Gaussian noise. Gaussian noise is commonly defined as the noise with a Gaussian amplitude distribution [3], which states that nothing the correlation of the noise in time or the spectral density of noise. Gaussian noise is otherwise said as white noise which describes the correlation of noise [2].

B. Salt and Pepper Noise

Salt & pepper noise model, there is only two possible values a and b. The probability of getting each of them is less than 0.1 (else, the noise would greatly dominate the image). For 8 bit/pixel image, the intensity value for pepper noise typically found nearer to 0 and for salt noise it is near to 255. Salt and pepper noise is a generalized form of noise typically seen in images [4]. In image criteria the noise itself represents as randomly occurring white and black pixels. Salt and pepper noise occurs in images under situations where quick transients, such as faulty switching take place. This type of noise can be caused by malfunctioning of analog-to-digital converter in cameras, bit errors in transmission, etc.

D. Speckle Noise

Speckle noise is a type of granular noise that commonly exists in and causes degradation in the image quality .Speckle noise tends to damage the image being acquired from the active radar as well as synthetic aperture radar (SAR) images. Due to random fluctuations in the return signal from an object in conventional radar that is not big as single image-processing element. Speckle noise occurs [6]. Speckle noise increases the mean grey level of a local area. Speckle noise is more serious issue, causing difficulties for image interpretation in SAR images .It is mainly due to coherent processing of backscattered signals from multiple distributed targets.

3 TYPES OF FILTER

A Mean Filter

Mean filter comes under linear filtering scheme. Mean filter is also known as averaging filter. The Mean Filter applies mask over each pixel in the signal. Each of the components of the pixels comes under the mask are being averaged together to form asingle pixel that‟s why the filter is otherwise known as average filter. Edge preserving criteria is poor in mean filter. Mean filter is defined by
Mean filter =

$$(x_1 \dots\dots x_n) = \frac{1}{N}\sum_{i=1}^{N} x_i \quad \dots\dots\dots\dots(3.1)$$

Where (x1 ….. xN) is image pixel range. Mean filter is useful for removing grain noise from the photography image [7]. As each pixel gets summed the average of the pixels in its neighborhood is found out, local variations caused by grain noise are reduced considerably by replacing it with average value.

B Median Filter

Like the mean filter, the median filter considers each pixel in the image in turn and looks at its nearby neighbours to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighbouring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value [8]. (If the neighbourhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.)

4 IMPLEMENTATION AND EXPERIMENTAL RESULTS

4.1 Implementation of Watermarking Embbeding Process

For this process firstly the colour image is read and converts it into a gray scale host image and 2-D, 3-level DWT (Discrete Wavelet Transform) is applied to the image. In case of two-dimensional image, after a DWT transform, the image is divided into four corners, upper left cornerof the original image, lower left corner of the vertical details, upper right corner of the horizontal details, lower rightcorner of the component of the original image detail (high frequency). You can then continue to the low frequencycomponents of the same upper left corner of the 2nd, 3rd inferior wavelet

transform. In the same manner 2-D, 3-level DWT isalso applied to the watermark image which is to be embedded in the host image. For this Haar wavelet is used. Then technique alpha blending is used to insert the watermark in the host image. In this technique the decomposed components of the host image and the watermark are multiplied by a scaling factor and are added. Since the watermark embedded in low frequency approximation Component of the host image so it is perceptible in nature or visible.Alpha blending: formula of the alpha blending the watermarked image is given by
WMI=k*(LL3) +q*(WM3)
WM3 = low frequency approximation of Watermark, LL3 = low frequency approximation of the original image, WMI=Watermarked image, k, q-Scaling factors.

After embedding the cover image with watermarkimage, 3-level Inverse discrete wavelet transform isapplied to the watermarked image coefficient to generatethe final secure watermarked image. Fig. 5.1 showswatermark embedding process.

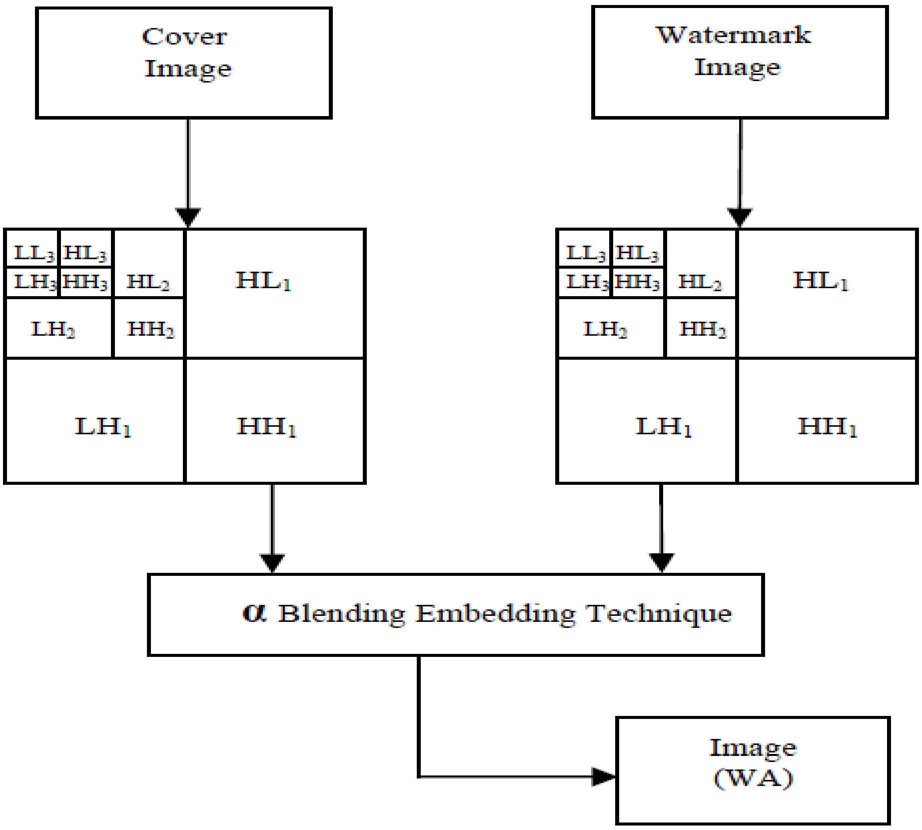

Fig -4.1 DWT Watermark embedding technique

Test images

Fig -.2 Puppy.jpg

Fig -4.3 Hwak.jpg

Table4 .1 Test images size and dimensions

TEST IMAGE	Puppy	Hwak
SIZE	19.9 KB	69KB
DIMENSIONS	256×245	445×379

To test the performance of i use puppy as cover image and hawk as watermarking images result is shown below.

To implement this thesis we have used two images of puppy and hawk. Dimension of puppy image is 256X256 and size is 19.9 kb,Dimension of hawk image is 445X379 and size is 69 kb respectively. Fig. 5.2 and 5.3 shows the test images and table-5.1 show dimensions and size of test images.For embedding of watermark in the original image the selected value of scaling factor k is 0.98 and of q is 0.09.

4.2 Adding Noise

After performing the watermarked operation two types of noise is added to the original image one by one We see that Noise in imagescauses degradation in image quality. So theinformation associated with the images is damagedas we said earlier. It is must be restore the imagefrom noises for acquiring maximum informationfrom images. As a remedy, the quality and theinformation from the noised image can be retrievedusing different types of filters i.e. mean filter, median filter . The performance analysis of different filter for different types of noises is checked by Mean Square Error (MSE) value and Peak to Signal Noise Ratio (PSNR) value.



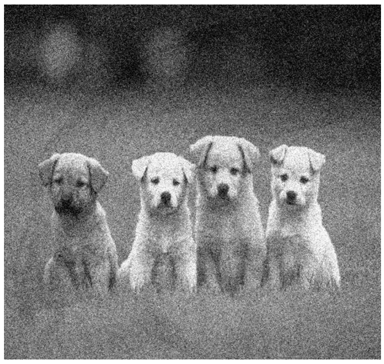

Fig -4.4 watermarked. Jpg   Fig 4.5 -Salt and pepper noise   Fig 4.6 -Gaussian pepper noise

4.3 Implementation of mean filter:

The pixel values of an image "test.jpg" are read into theprogram by using the function imread(). This image is converted into grayscale image by using function rgb2gray() and then resize the given image into a size of size 256× 256 by using function imresize().after that all the two types of noise are added into the image one by one and by using the function imnoise().A n1×n2 weight matrix is initialized. Selecting a n1× n2 window over the 256× 256pixel matrix, the weighted sum of the selected window is computed. The result replaces the center pixel in the window. Final action is performed by using function filter2 () that computed the final image after denoise the given image. The salt and pepper noise density used in the experiment is 0.02, 0.04, and 0.06. Gaussian noise variance used in the experiment is 0.02, 0.04, and 0.06. MSE and PSNR value are calculated for all the input image. Table 5.2 shows the result of mean filter for denoise the image from salt and papper and Gaussian noise when mask is 3*3 is used.

Fig 5.7 -Salt and pepper noise with image density 0.02, 0.04 and 0.0.6

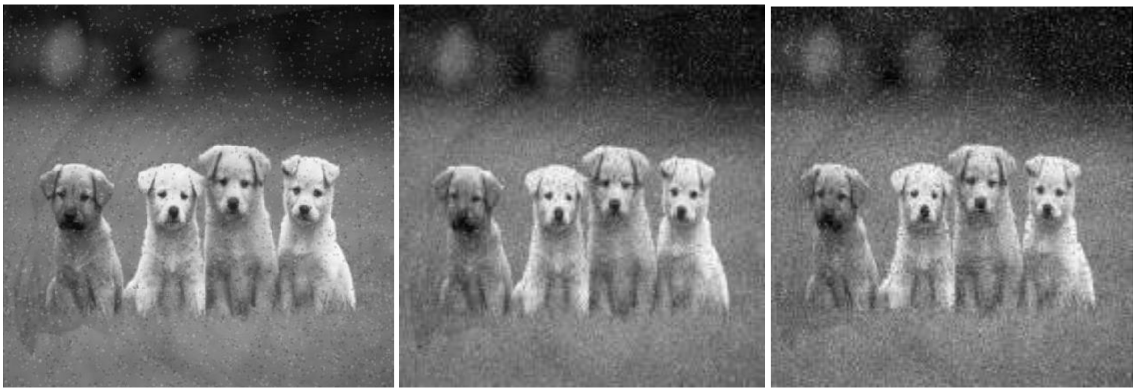

Fig 4.8 – De-noised images after applying mean filter on salt and pepper noise

Table 4.2:- Mean Filtering For Different Noise Types of Noises

DIFFERENT NOISES	MSE	PSNR
Salt & pepper noise (0.02)	0.0055	52.0380
Salt & pepper noise (0.04)	0.0105	45.5259
Salt & pepper noise (0.06)	0.0158	41.4823
Gaussian noise(0.02)	0.0088	47.3035
Gaussian noise(0.04)	0.0088	47.2914
Gaussian noise(0.06)	0.0089	47.2403

From the results we obtained, it shows that the salt and pepper noise affected image is effectively denoised with mean filter so we get low MSE and high PSNR value compared to other filtered noise and mean filter shows average removal of noise for Gaussian noised images.

4.4 Implementation of median filter

The image processing toolbox in Matlab version 8.3.0.532 (R2014a) provides the medfilt2 () function to do median filtering on an image. The input image andthe size of the window are the parameters the function takes. As mentioned earlier, the image "test.jpg" is corrupted with salt and pepper, gaussian and a gaussiannoise with the imnoise ()function after loading the image using imread ().image corrupted with different noises are given to the function medfilt2 () formedian filtering. The window specified is of size 3×3.The salt and pepper noise density used in the experiment is 0.02, 0.04, and 0.06. Gaussian noise variance used in the experiment is 0.02, 0.04, and 0.06. MSE and PSNR value are calculated for all the input images. Table 5.3 shows the result of mean filter for denoise the image from salt and pepper, Gaussian noise.

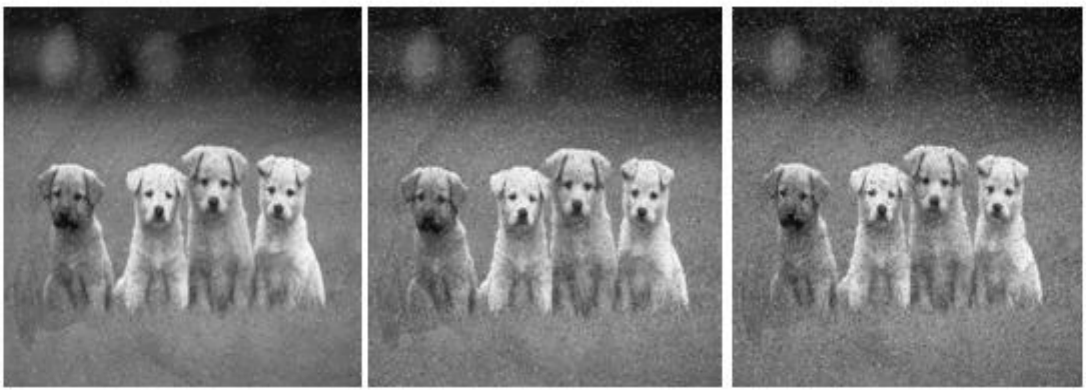

Fig 4.9 -Salt and pepper noise with image density 0.02, 0.04 and 0.06.

Fig 4.10 – De-noised images after applying median filter on salt and pepper noise

Table 4.3:- Median Filtering For Different Noise Types of Noises

DIFFERENT NOISES	MSE	PSNR
Salt & pepper noise (0.02)	3.4890	98.3284
Salt & pepper noise (0.04)	3.6492	97.8802
Salt & pepper noise (0.06)	3.8768	97.2751
Gaussian noise(0.02)	23..674	79.4411
Gaussian noise(0.04)	09.6389	88.1662
Gaussian noise(0.06)	3.08432	97.3622

From the results we obtained, it shows that the salt and pepper noise affected watermarked image is effectively denoised with median filter so we get low MSE and high PSNR value compared to other filtered noise and in case of gaussian noise median filter performed worst with highest value of MSE=23.674 and lowest value of PSNR. So it is observed that Median filter is not an appropriate filter for gaussian noise.

5 CONCLUSIONS AND FUTURE WORK

5.1 Conclusion:

In this thesis two types of noises namely Salt and Pepper and Gaussian had been added to the original watermarked clean “test.jpg” image. We observed that all noise causes degradation in the image quality which results in loss of information. The denoising of degraded image is performed using Mean and Median filter. Performance of denoising algorithms is measured using quantitative performance measures such as peak signal-to-noise ratio (PSNR), mean square error (MSE) as well as in terms of visual quality of the images.From the experimental results it can be concluded that for salt and pepper noise mean filter work well as compared to median filter and in case of Gaussian noise mean filter gives good results as compared to median filter. Overall result from our experiment shows that mean filter works well to remove the noise as compared to median filter.

5.2 Future work:

An ideal denoising procedure requires a priori knowledge of the noise. Since selection of the right denoising procedure plays a major role, it is important to experiment and compare the methods. As future research, we would like to work further on the comparison of the denoising techniques. Different watermarked techniques can also improve the result .If the noisedsignal is denoised by using the neural network, and then the rate of successful classification should determine the ultimate measure by which to compare various denoising procedures. Also we use fix mask value if we use different mask values this can also improve the performance of these algorithms.

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