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IMPLEMENTATION AND COMARISION OF FILTER BASED DENOISING ALGORITHMS

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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.

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.

C.POISSON NOISE

Poisson noise is also known as shot noise. It is a type of electronic noise. Poisson noise occur under the situations where there is a statistical fluctuations in the measurement caused either due to finite number of particles like electron in an electronic circuit that carry energy, or by the photons in an optical device [5].

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 a single 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 =

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

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 WIENER FILTER

The main aim of the Wiener filter is to filter out the image that has been corrupted by noise. Wiener filter is based on a statistical approach. Desired frequency response can be acquired using this filter. Approaches followed by wiener filtering are of different angle. For performing filtering operation it is must to have knowledge of the spectral properties of the original signal and the noise [9], in achieving the criteria one can get the LTI filter whose output will be as close as original signal as possible.

C 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 EXPERIMENTAL RESULTS

Implementation is done by using Matlab version 8.3.0.532 (R2014a) with window 7(32 bit) operating system. The image hawak.jpg of dimension 445×379 is taken for experimental purpose as show in the Fig4.1. (a). after that three types of noise is added to the original image one by one We see that Noise in images causes degradation in image quality. So the information associated with the images is damaged as we said earlier. It is must be restore the image from noises for acquiring maximum information from images. As a remedy, the quality and the information from the noised image can be retrieved using different types of filters i.e. mean filter, median filter and Weiner 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.

 

(a) Original image (b)Gaussian noise

 

(c) Salt and pepper noise (d) Speckle noise

Fig.4.1 shows (a) original image (b) show image after adding Gaussian noise (c) show image after adding salt and pepper noise (d) show image after adding speckle noise.

DIFFERENT NOISES	MSE	PSNR
Salt & pepper noise (0.02)	0.0091	47.0404
Salt & pepper noise (0.04)	0.0150	41.9909
Salt & pepper noise (0.06)	0.0206	38.8366
Gaussian noise(0.02)	0.0103	45.7143
Gaussian noise(0.04)	0.0103	45.7586
Gaussian noise(0.06)	0.0100	46.0168
Speckle noise(0.02)	0.0092	46.9302
Speckle noise(0.04)	0.0148	42.1482
Speckle noise(0.06)	0.0202	39.0428

Table 4.1:- Mean Filtering For Different Noise Types of Noises

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 image and in case of speckle noise PSNR is low. So it is observed that Median filter is not an appropriate filter for Speckle noise.

DIFFERENT NOISES	MSE	PSNR
Salt & pepper noise (0.02)	21.6834	80.0598
Salt & pepper noise (0.04)	22.3498	79.7571
Salt & pepper noise (0.06)	23.3678	79.3117
Gaussian noise(0.02)	35.2430	75.2026
Gaussian noise(0.04)	19.9464	80.8948
Gaussian noise(0.06)	10.5511	87.2630
Speckle noise(0.02)	69.4452	68.4199
Speckle noise(0.04)	81.8475	66.7767
Speckle noise(0.06)	88.0020	66.0517

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

From the results we obtained, it shows that the gaussian noise affected image is effectively denoised with median filter so we get low MSE and high PSNR value compared to other filtered noise and median filter shows average removal of noise for Poisson noised image. And in case of speckle noise median filter performed worst with highest value of MSE and lowest value of PSNR. So it is observed that Median filter is not an appropriate filter for Speckle noise.

DIFFERENT NOISES	MSE	PSNR
Salt & pepper noise (0.02)	31.0133	76.4811
Salt & pepper noise (0.04)	36.1575	74.9464
Salt & pepper noise (0.06)	43.4047	73.1196
Gaussian noise(0.02)	44.9911	72.7606
Gaussian noise(0.04)	26.1523	78.1859
Gaussian noise(0.06)	14.9653	83.7679
Speckle noise(0.02)	83.6107	66.5636
Speckle noise(0.04)	100.5610	64.7176
Speckle noise(0.06)	109.5728	63.8594

Table 4.3: Wiener Filtering for Different Types of Noises

The obtained results shows that the Poisson noise affected image is effectively denoised with Wiener filter so we get low MSE and high PSNR value compared to other filtered noise and Wiener filter shows average removal of noise for salt and pepper noised image. But, when compared to gaussian noise, Salt and Pepper noise filtered images speckle noise shows high MSE and low PSNR values. From this we observed that wiener filter is not suitable for Speckle noised image.

5 CONCLUSIONS AND FUTURE WORK

The three types of noise namely Salt and Pepper, Gaussian and Speckle had been added to the original image "hawk". Filtering is done by mean, median and wiener filters. It has been observed that all noises causes degradation in the image quality which results in loss of information. 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. Implementation results confirmed that for salt and pepper noise, the mean filter work well as compared to median filter and wiener filter whereas Wiener filter and median filter works well for removing Poisson noise.

An ideal denoising procedure requires a priori knowledge of the noise. Since selection of the right denoising procedure plays a major role. As future research, performance of these algorithms can be improved by performing implementation with different techniques and images. If the noised signal is denoised by using the neural network, then the rate of successful classification of these denoising procedures would be improved. Also instead of using fix mask values, different mask values can also improve the performance of these algorithms.

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