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A NOVEL RESTORATION SCHEME OF AN IMAGE USING WIENER FILTER

P.P.Patro*, C.S.Panda

* PG Dept. of Computer Science and Applications Sambalpur University, jyoti vihar, Burla Odisha, India,768109 (M.Phil Student).

PG Dept. of Computer Science and Applications, Sambalpur University, jyoti vihar, Burla Odisha, India,768109 (Faculty).

ABSTRACT

Image play a very important role in every aspect of life and it play a vital role in the area of research of digital image processing. This paper describes type of image and type of noise that can effect an image .It also evaluates the cause of noise in an image. Ever filter has its own property and it must be effective for a specific type of noise.so here we have taken wiener filter as our restoration filter and used various noise to show which noise can be effectively reduced by wiener filter Wiener filter applies an effective noise reduction technique i.e. it uses statistical knowledge of the noise field. The transfer function of the Wiener filter is chosen to minimize the mean square error using statistical information on both image and noise field. The choice of window size of Wiener filter also r depends upon the noise variance of image.

KEYWORDS: Noise, blurring, filter, de-blurring, PSNR(Peak signal to noise ratio), SNR(Signal to noise ratio), MSE(Mean square error).

INTRODUCTION

The most important sensor of humane body is vision system .The Image processing deals with the image i.e. to produce the appropriate processed image for various applications in day-to-day life. It play vital role in many field such as astronomy, medical image and image for forensic laboratories. Image used for this aspect must be noise free. So noise detection and its reduction play an important role in all aspect of life.

An Image is a two-dimensional function $f(a, b)$, where a and b are spatial coordinate, and f is the amplitude at any pair of coordinates (a, b) which is also called intensity or grey value of image. When spatial coordinate and amplitude all are in finite discrete quantities, then the image is called digital image [1].

TYPE OF DIGITAL IMAGE

Binary Image: Binary Image [2] contains only two possible values for each pixel, that may be either 1 or 0. In binary image we need 1 bit per pixel.

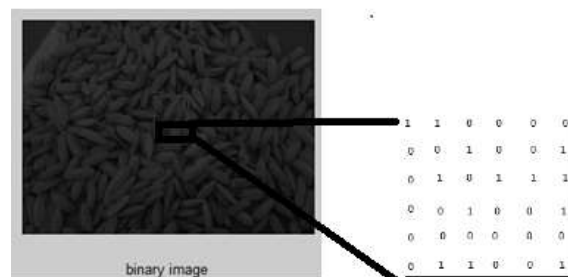


Fig-1: Example of Binary Image

Grey scale Image: A grey scale image is represented by 0 to 255 pixel value, where 0 is the extreme lowest value which gives a black colour as an output and 1 is the pick value which makes the pickles into white. In grey scale image each Pixel in the image can be shown by eight bits, that it exactly of one byte.

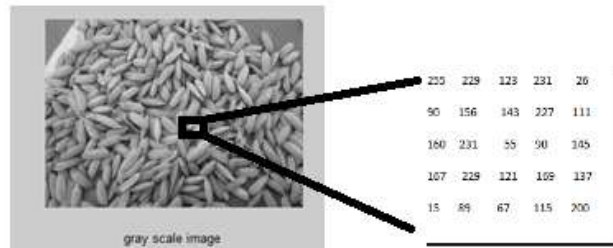


Fig-2.Example of grey scale image

RGB Image: A RGB image is described by the quantity of red, green and blue value in an image. In each of the component has a range from 0-255, this means that this gives a total of 256³ different possible colour value.

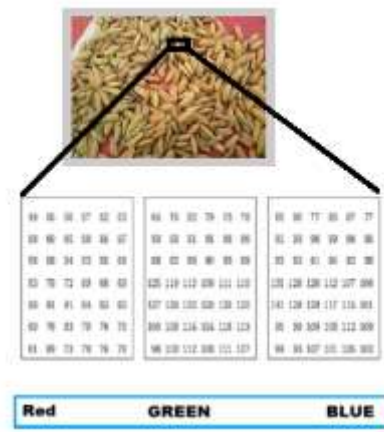


Fig-3: Example of RGB Image

Noise Model: Noise is an unwanted signal or information which destroys image quality and causes degradation in image quality[3]. A digital image is corrupted by noise during image acquisition or during image transmission. An image is affected by variety of reason such as environmental condition during image acquisition or quality of sensing element themselves. During acquisition of image the camera lenses, sensor temperature and light level are major factor of degradation or creation of noise in image. we can define noise in an image

$$g(x, y) = f(x, y) * h(x, y) + n(x, y) \tag{1}$$

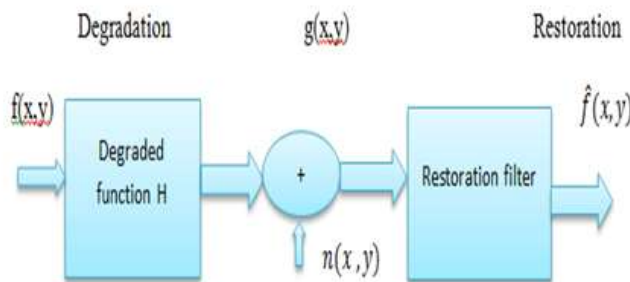


Fig-4: Restoration process of an Image

Here $f(x, y)$ =Original pixel value
 $g(x, y)$ =noisy/contaminated pixel value
 $\hat{f}(x, y)$ =Restored pixel value

$$\begin{aligned} \text{Since } f(x, y) \neq \hat{f}(x, y) & \quad 2 \\ e(x, y) = |\hat{f}(x, y) - f(x, y)| & \quad 3 \end{aligned}$$

The main objective of restoration filter is to optimised the error $e(x, y)$, because the less the error better the filter. Again Image restoration is a process where image De-blurring and noise suppression (filtering) take place.

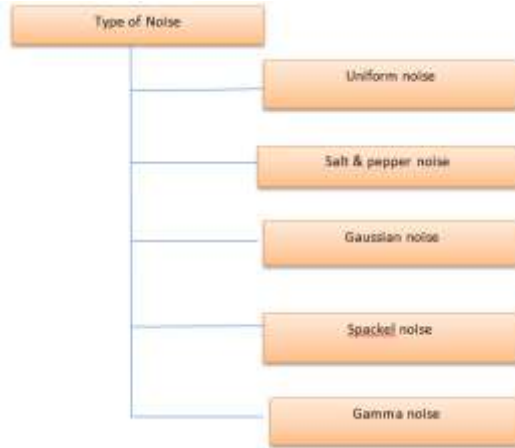


Fig -4: Noise Model

Every noise has its own characteristics and effect on the image to different extends. Generally our focus is to remove certain kind of noise by applying wiener filter and to find out which noise is best reduced by this filter.

Salt & pepper noise:The Impulse noise is also called salt and pepper noise. Black and White dots appears in the image .As a result it is called as salt-and-pepper noise [4]. Image having salt and pepper noise will have dark pixel in bright area that contain the extremely low value 0 and bright pixel in dark areas that contain the extremely high value 1. The noise arises in the image because of sharp and sudden change in image signal.

The PDF of impulse noise is given by

$$P(z) = \begin{cases} p_a & \text{for } z=a \\ p_b & \text{for } z=b \\ 0 & \text{otherwise} \end{cases} \quad 4$$



Fig-5: Original Image figure

Fig-6: salt & pepper noise with 0.2 noise variance

Gaussian noise: It is a statistical noise that has a probability density function (PDF) of the normal distribution also called as Gaussian distribution [4]. In this noise each pixel in the noisy image is the sum of the true value and a random Gaussian distributed noise value. The noise is independent of intensity of pixel value at each point. The PDF of Gaussian random variable is given by

$$F(g) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(g-m)^2}{2\sigma^2}} \quad 5$$

$F(g)$ = Gaussian distribution noise in image
 σ = Standard deviation
 m = mean value



Fig-7: Gaussian Noise with variance 0.2

Speckle noise: This noise can be modelled by random value multiplications with pixel values of the image and can be expressed as

$$J = I + n * I \tag{6}$$

Where, J is the speckle noise distribution image, I is the input image and n is the uniform noise image by mean 0 and variance v. This noise deteriorates the quality of images. This noise is originated because of coherent processing of back scattered signals from multiple distributed points.



Fig-8: Speckle noise with 0.02 variance

Image restoration: Image restoration [6] play a very important in noise reduction in an image. The main objective of restoration process is to extras noise pixel from the number of pixel in an image restoring the file detail of the image. Image restoration [6] is a process where image de blurring and noise suppression take place. Here by applying wiener filter we are going to restore some noise and examine their property.

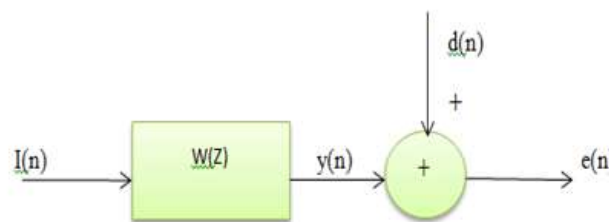


Fig-9: Image of wiener Filter

In the above I(n) and d(n) are discrete-time random signal. The filter output y(n) and e(n) is the estimation error. Here the input signal I(n) is passes through wiener filter w(z) and again the result is added with another signal d(n) to obtain a filtering error e(n) [7].

The wiener filter is expressed as

$$G(x, y) = \frac{H^*(x, y)}{H(x, y)^2 + s_n(x, y)} \tag{7}$$

Here H(x, y) = Degradation function

H*(x, y) = complex conjugate of degradation function

$S_n(x,y)$ = Power spectral density of noise
 $S_f(x,y)$ = Power spectral density of un degraded Image

For noise estimation a small filtering window is selected initially. Then the window size is changed or selected according to the amount of noise present in that picture which have to be noise free. Below a wiener filter is used for filtering of salt and pepper noise. Here also various masks having different size are used.

Algorithm for Restoration by wiener filter:

- STEP 1: Take an original image.
- STEP 2: Convert the image into grey scale image.
- STEP 3: Create noised image with various density.
- STEP 4: Create Wiener filter of different mask size.
- STEP 5: Compute the mean and standard deviation.
- STEP 6: Compute the PSNR,SNR , MSE of that image.
- STEP 7: Show the Restored image.
- STEP 8: End of the process.

PERFORMANCE PARAMETER: For comparing original image and uncompressed image, we calculate following parameters.

MSE(Mean square error): The most frequently used image quality measures are deviations between the original and processed images of which the mean square error(MSE)[8]. The effectiveness of the algorithm stands in minimizing the mean square error. If $F(X, Y)$ is the original clean image, $G(X, Y)$ is the corrupted image and $\hat{f}(X, Y)$ is the de-noised image then MSE is given by

$$MSE = \frac{1}{MN} \sum_{X=1}^M \sum_{Y=1}^N (f(x, y) - \hat{f}(x, y))^2 \tag{8}$$

SNR(Signal to noise ratio): SNR(Signal to noise ratio):It is one of the most important statistical parameter for measurement of quality of an image [9]. Signal-to-noise ratio is defined as the measurement of signal power to noise power of a corrupted signal. When the ratio of SNR is higher, it indicates more noise in an image.

SNR is calculated as
$$SNR = \frac{P_{signal}}{P_{noise}} \tag{9}$$

PSNR(Peak signal to noise ratio): PSNR[10] is the ratio between maximum possible power of a signal and the power of distorting noise which affects the quality of its representation. Larger PSNR indicate a smaller difference between the original uncorrupted image and the de-noised image. This is the most widely used objective image quality/distortion measure. The main advantage of this measure is ease of computation. PSNR is calculated using

$$PSNR = 20 \log_{10} \left(\frac{f_{max}}{\sqrt{MSE}} \right) \tag{10}$$

Where, $F_{max} = 255$ for an 8-bit image.

RESULT: all the above discussed noise are restored by wiener filter and the result are analysis.

Table1: A Comparative table for PSNR, SNR, MSE of Noise variance 0.02

Noise	PSNR	SNR	MSE
Salt & pepper noise	22.2217	16.6339	2.4326
Gaussian noise	20.0422	14.4544	106.5223
Speckle noise	22.6421	17.0542	68.1277



Fig-10: Restoration of salt & pepper noise of variance 0.02 using wiener filter



Fig-11: Restoration of Gaussian noise of variance 0.02 by using wiener filter



Fig-12: Restoration of Speckle noise of variance 0.02 by using wiener filter

CONCLUSION

In this paper, we have discussed different types of image and different type of noise occur in an images during image acquisition or transmission. Light is also thrown on the causes of these noises and their major sources. In the fourth section we describe about wiener filter and its techniques that can be applied to de-noise the images. Experimental results presented, insists us to conclude that wiener filter performed well for salt & pepper noise. Where as it's performed worst for Gaussian noise.

REFERENCES

- [1] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 2nd ed. Prentice-Hall India, 2005.
- [2] A. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, First Edition, 1989.
- [3] "Digital Image Processing" S Jayaraman, S EsaKkirajan, T VeeraKumar, Tata McGraw Hill, 2009
- [4] A novel approach to noise reduction for impulse noise and Gaussian noise" P. Krishnapriya, Mr. S. Sanjeev Kumar, IJETAE, International Conference on Information Systems and Computing, vol.-3, January 2013
- [5] Dainty, J.C. 1971. Detection of images immersed in speckle noise. *Optica Acta*, Vol. 18, No. 5, pp.327-339.
- [6] S. Akkoul, R. Lédée, R. Leconge, C. Léger, R. Harba, S. Pesnel, S. Lerondel, A. Lepape, L. Vilcahuaman, "Comparison of image restoration methods for bioluminescence imaging," in *ICISP 08*, Cherbourg, France, 2008, vol. 5099, LNCS, pp. 163–172
- [7] Yen-Hsiang chen, Shanq-Jang Ruan, Tom Qi, "An Automotive Application of real time adaptive wiener filter for noise cancellation in a car environment," *IEEE*, 2012, 4673-2193
- [8] B. Widrow and S.D. Stearns, *Adaptive Signal Processing*, Englewood Cliffs, NJ: Prentice-Hall, 1985
- [9] Z. Wang and A. C. Bovik, "Modern image quality assessment," *Synthesis Lectures on Image, Video, and Multimedia Processing*, vol. 2, no. 1, pp. 1–156, 2006.
- [10] A. Hor'e and D. Ziou, "Image quality metrics: Psnr vs. ssim," in *Pattern Recognition (ICPR)*, 2010
- [11] *20th International Conference on*. IEEE, 2010, pp. 2366–2369.