A STUDY ON DIFFERENT TYPE OF NOISE AND NOISE FILTERING METHOD

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ABSTRACT: *Digital images play a major role in day to day life. It is mostly used in different applications such as in medical filed (magnetic resonance imaging, and computer tomography), satellite television and also in areas of research and technology such as geographical information systems and astronomy. Sometimes an input image may be unfortunately corrupted with noise either during acquisition, transmission, or taking image from camera/sensors or retrieval from storage media. This paper discusses various type of noises like Gaussian noise, Salt and Pepper, Speckle noise and Poisson noise, etc and also discuss the result after applying median filter on different images corrupted by different noise and analysis the performance of median filter.*

KEYWORDS- Digital Image Processing, Types of image, Image Noise, Filters, MSE, PSNR

1. INTRODUCTION

An image is a picture, photograph or any other form of 2D representation of any scene.[23] An image is denoted by two-dimensional function F(a, b).Where a and b are spatial plane or coordinate, and the amplitude of F at any pair of coordinates (a, b) is called the gray level of the image at that point or intensity of the image at that point. When a, b and the amplitude values of are all predetermined discrete quantity, and this image called the digital image. A digital image is set of a finite number of elements, in which each element has a certain value and location. These elements of digital image are known as pixels, image elements, picture elements or pels. Noise in Image is disorganized discrepancy of brightness or color information in images. It can be produced due to sensor and circuitry of a scanner or digital camera or time of transmission of digital image or bad environmental condition. In image processing, noise lessening and restoration of image is probably enhancing the quality of an image. Digital image is inclined to a variety of noise which affects the quality of image. The main purpose of de-noising the image is to restore the detail of original image as much as possible[11]. The criteria of the noise elimination problem depend on the type of noise by which the image is corrupting. Different approaches for reduction of noise and image enhancement have been considered, each of which has their own limitation and advantages.

2. TYPE OF NOISE

Image distortion is most pleasance problems in image processing. Image distorted due to various types of noise such as Gaussian noise, Poisson noise, Speckle noise, Salt and Pepper noise and many more are fundamental noise types in case of digital images. In This section different type of noise are discussed.

Gaussian noise: in digital images, Gaussian noise arises during acquisition stage. The sensor has inherent noise due to poor illumination level and its own temperature or electronic circuit temperature. It is also called as electronic noise because it arises in amplifiers or detectors. The magnitude of Gaussian Noise depends on the Standard Deviation (sigma). Noise Magnitude is directly proportional to the sigma value. Gaussian Noise is a statistical noise having a probability density function equal to normal distribution.[12]

Salt-and-pepper noise: Salt-and-pepper noise is a form of noise sometimes seen on images. It is also recognized as impulse noise. This noise can be caused by sharp and abrupt disturbances in the image. It presents itself as thinly occurring white and black pixels. An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions.[9]. An effective reduction method for this type of noise is a median filter[1] or a morphological filter.[2] For reducing either salt noise or pepper noise, but not both, a contra harmonic mean filter can be effective.[3]

Shot noise: The dominant noise in the brighter parts of an image from an image sensor is typically that caused by statistical quantum fluctuations, that is, variation in the number of photons sensed at a given exposure level. This noise is known as photon shot noise.[6] Shot noise has a root-mean-square value proportional to the square root of the image intensity, and the noises at different pixels are independent of one another. Shot noise follows a Poisson distribution, which except at very low intensity levels approximates a Gaussian distribution. In addition to photon shot noise, there can be additional shot noise from the dark leakage current in the image sensor; this noise is sometimes known as "dark shot noise"[6] or "dark-current shot noise[13]

Film grain: The grain of photographic film is a signal-dependent noise, with similar statistical distribution to shot noise.[17] If film grains are uniformly distributed (equal number per area), and if each grain has an equal and independent probability of developing to a dark silver grain after absorbing photons, then the number of such dark grains in an area will be random with a binomial distribution. In areas where the probability is low, this distribution will be close to the classic Poisson distribution of shot noise. A simple Gaussian distribution is often used as an adequately accurate model. [11]

Film grain is usually regarded as a nearly isotropic (non-oriented) noise source. Its effect is made worse by the distribution of silver halide grains in the film also being random.18]

3. DIFFERENT TYPE OF FILTER FOR REMOVING NOISE

Image filter changes the appearance of an image or part of an image by altering the shades and colors of the pixels in some manner. Filtering is used to attain noise reduction and interpolation. Filtering image data is a typical process used in almost all image processing systems. Filters are used to remove the disturbance which was added into image during the transmission or taking the image by cameras or sensors.

The choice of filter is determined by the nature of the task performed by filter and behavior and type of the data. Filters are used to remove noise from digital image while keeping the details of image preserved is a necessary part of image processing. Filters can be described by different categories first is Filtering without Detection and second one is Detection followed by Filtering. In Filtering without Detection window mask is moved transversely the observed image. The size of mask is $(2N+1)/2$, in which N is a any positive integer.[13] In this the centre element is the pixel of concern. When the mask is start moving from left top corner to the right bottom corner of the image, it perform some arithmetic operations without discriminating any pixel of image and in Detection followed by Filtering, In this process firstly it recognized the noisy pixels in image and then filters those pixels of image which contain noise. There is also a mask which is moved across the image and performs some arithmetic operations to detect the noisy pixels of image. Then the filtering process is performed only on noisy pixels and keeping the non-noisy pixel of image intact.

4. FILTERING TECHNIQUES

There are mainly two more popular filtering techniques first is Linear Filters and second is non linear filtering process. Linear filters are used to remove certain type of noise. Gaussian or Averaging filters are suitable for this purpose. These filters also tend to blur the sharp edges, destroy the lines and other fine details of image, and perform badly in the presence of signal dependent noise [5]. In recent years, a variety of non-linear median type filters such as rank conditioned, weighted median, relaxed median, rank selection have been developed to overcome the shortcoming of linear filter.

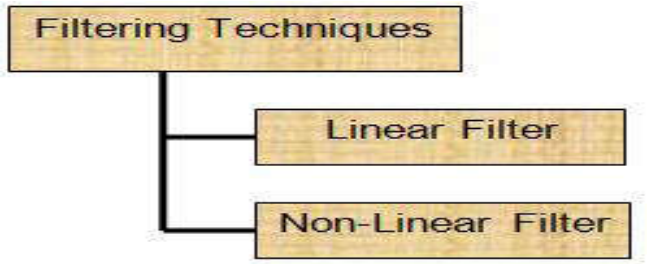

Figure1.1 Classification of filtering technique

Different Type of Linear and Non-Linear Filters: There is different type of linear and non linear filter which were used to denoise the image. Most popular is mean and median filter. Basics of both filters are discussed below and also discuss the benefits of filters.

Mean Filter: The mean filter is a simple spatial filter also called sliding-window filters and it reinstates the center value in the window through the average mean of all the pixel values in the window. There are some advantage of mean filter such as it is Easy to implement and used to use to remove the impulse noise but also has disadvantage that is it remove some details of image while denoising process, It does not successfully preserve details of image.[2]

Median Filter: It is non-linear filter which is based order statistics. It is effortless to implement method of smoothing images. Median filter is used for tumbling the intensity variation between one pixel and the other pixel. In this filter, in this filter centre pixel value is not replace with image with the mean of all neighboring pixel values of image, but it replaced with the median value of all pixels. Then the median is calculated by first sorting all the pixel values into ascending order and then replace the pixel being calculated with the middle pixel value. If the neighboring pixel of image is to be considered contains an even numbers of pixels, than the average of the two middle pixel values is used to replace. [2]

5. ALGORITHM OF PROPOSED MEDIAN FILTER

The algorithm for the median filter is as follows:

Step 1. Select a two dimensional window W of size 3*3. Assume h at the pixel being processed is Cx,y.

Step 2. Compute Wmed the median of the pixel values in window W.

Step 3. Replace Cx,y by Wmed.

Step 4. Repeat steps 1 to 3 until all the pixels in the entire image are processed.

Some merits of median filter are discussed here. It is easy to implement and Used for de-noising different types of noises. There are some demerits of filter are. Median Filter tends to remove image details while reducing noise such as thin lines and corners and Median filtering performance is not satisfactory in case of signal dependant noise. To remove these difficulties different variations of median filters have been developed for the better results.

6. SIMULATION RESULT

Matlab software is used to simulate the median filtering process. There are some parameters which are used to analysis of performance of methods. The most common parameter is PSNR and MSE. Parameters are given below

Mean Square Error (MSE): The MSE is the cumulative square error between the encoded and the original image defined by:

$$MSE = \frac{1}{mn}\sum_{0}^{m-1}\sum_{0}^{n-1}\|f(i,j) - g(i,j)\|^2 \quad \text{.....(1)}$$

Where, f is the original image and g is the uncompressed image. The dimension of the images is m x n. Thus MSE should be as low as possible for effective compression.

Peak signal to Noise ratio (PSNR): PSNR is the ratio between maximum possible power of a signal and the power of distorting noise which affects the quality of its representation. It is defined by:

$$PSNR = 20\log_{10}\left(\frac{MAX_f}{\sqrt{MSE}}\right) \quad \text{.....(2)}$$

Where MAXf is the maximum signal value that exists in our original "known to be good" image.

Bit per Pixel (BPP): It is defined as number of bits required to compress each pixel. It should be low to reduce storage requirement. Signal to Noise Ratio is defined by the power ratio between a signal and the background noise. Both noise and power must be measured at the same points in a system, and within system with same bandwidth.

here some output images are shown below. In first figure noisy Lena image took as input image and second is filtered image after appling median filter.similaraly



Figure1.2 Original noisy lena image and filtered image

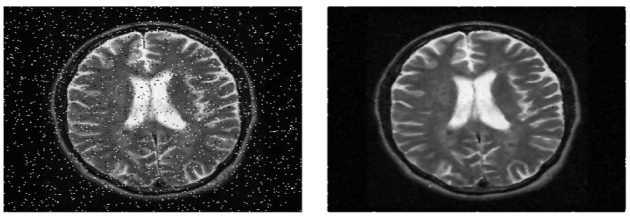

Figure1.3 Original noisy medical image and filtered image

In output image we can see that after applying median filter we get the good quality image with minimum noise effect.

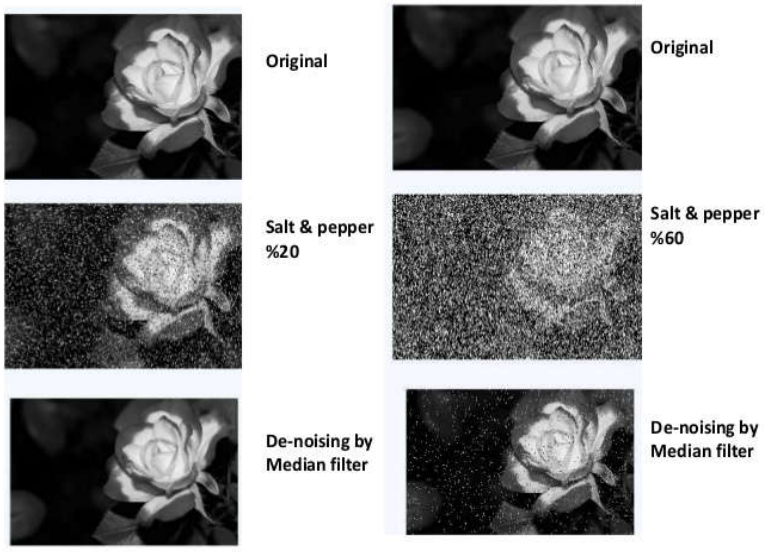

Figure1.4 Original flower image with different density of noise and denoised image

In figure 1.4 flower image take as input image and then different density of salt &pappers noise(20 % and 60%) applied on input image. Now on this noisy image median filter is applied and we can see that in both cases filtering process gives better result. Visual Quality of image is good with 60% of density of noise and get better psnr and mse by using median filter.

7. CONCLUSION

Enhancement of a noisy image is necessary task in digital image processing. Filters are used best for removing noise from the images. In this paper we describe various type of noise models and filters techniques. Filters techniques are divided into two parts linear and non-linear techniques. After studying linear and non-linear filter each of have limitations and advantages. In the filtering schemes, filters are recommended to separate a corrupted location. The decision to apply which particular filter is based on the different noise level at the different test pixel location or performance of the filter scheme on a filtering mask.

REFERENCES

1. Leslie Stroebel; Richard D. Zakia (1995). The Focal encyclopedia of photography. Focal Press. p. 507. ISBN 978-0-240-51417-8.
2. Rohankar, Jayant (Nov 2013). "Survey on Various Noises And Techniques For Denoising The Color Image" (PDF). International Journal of Application or Innovation in Engineering & Management. **2** (11). Retrieved 15 May 2015.
3. Philippe Cattin (2012-04-24). "Image Restoration: Introduction to Signal and Image Processing". MIAC, University of Basel. Retrieved 11 October 2013.

4. Jun Ohta (2008). Smart CMOS Image Sensors and Applications. CRC Press. ISBN 0-8493-3681-3.
5. Junichi Nakamura (2005). Image Sensors and Signal Processing for Digital Still Cameras. CRC Press. ISBN 0-8493-3545-0.
6. Lindsay MacDonald (2006). Digital Heritage. Butterworth-Heinemann. ISBN 0-7506-6183-6.
7. Mehdi Mafi, Harold Martin, Jean Andrian, Armando Barreto, Mercedes Cabrerizo, Malek Adjouadi, "A Comprehensive Survey on Impulse and Gaussian Denoising Filters for Digital Images," Signal Processing, vol. 157, pp. 236-260, 2019.
8. Jump up to:[a] [b] [c] Rafael C. Gonzalez; Richard E. Woods (2007). Digital Image Processing. Pearson Prenctice Hall. ISBN 0-13-168728-X.
9. Alan C. Bovik (2005). Handbook of Image and Video Processing. Academic Press. ISBN 0-12-119792-1.
10. Linda G. Shapiro; George C. Stockman (2001). Computer Vision. Prentice-Hall. ISBN 0-13-030796-3.
11. Jump up to:[a] [b] [c] Charles Boncelet (2005). "Image Noise Models". In Alan C. Bovik (ed.). Handbook of Image and Video Processing. Academic Press. ISBN 0-12-119792-1.
12. Mehdi Mafi, Hoda Rajaei, Mercedes Cabrerizo, Malek Adjouadi, "A Robust Edge Detection Approach in the Presence of High Impulse Intensity through Switching Adaptive Median and Fixed Weighted Mean Filtering," IEEE Transactions on Image Processing, vol. 27, issue. 11, 2018, pp. 5475-5490.
13. A. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, First Edition, 1989.
14. Rafael C .Gonzalez and Richard E. woods, "Digital Image Processing", Pearson Education, Second Edition, 2005
15. K. S. Srinivasan and D. Ebenezer, "A New Fast and Efficient Decision-Based Algorithm for Removal of High-Density Impulse Noises," IEEE Signal Processing Letters, Vol. 14, No. 3, March 2007.
16. H. Hwang and R. A. Haddad"Adaptive Median Filters: New Algorithms and Results" IEEE Transactions on image processing vol 4. P.no 499-502, Apr 1995.
17. Nachtegael, M, Schulte, S, Vander Weken. Kerre, E.E.2005.Fuzzy Filters for Noise Reduction: The Case of Gaussian Noise. IEEE Xplore, 201-206 D, De Witte. V, 206.
18. Brian W. Keelan; Robert E. Cookingham (2002). Handbook of Image Quality. CRC Press. ISBN 0-8247-0770-2.
19. Suresh Kumar, Papendra Kumar, Manoj Gupta, Ashok Kumar Nagawat, "Performance Comparison of Median and Wiener Filter in Image De-noising" ,International Journal of Computer Applications (0975 – 8887) Volume 12– No.4, November 2010.
20. McHugh, Sean. "Digital Cameras: Does Pixel Size Matter? Part 2: Example Images using Different Pixel Sizes (Does Sensor Size Matter?)". Retrieved 2010-06-03.
21. R. N., Clark (2008-12-22). "Digital Cameras: Does Pixel Size Matter? Part 2: Example Images using Different Pixel Sizes (Does Sensor Size Matter?)". Retrieved 2010-06-03.
22. Wrotniak, J. Anderzej (2009-02-26). "Four Thirds Sensor Size and Aspect Ratio". Retrieved 2010-06-03.

23. Akansha Singh, K.K.Singh (2012). Digital Image Processing. Umesh Publications. ISBN 978-93-80117-60-7.