A STUDY TO IMPROVE THE QUALITY OF IMAGE ENHANCEMENT BASED ON DIFFERENT FILTERING DESIGN TECHNIQUES

Vivek Singh Rathore[1], Vivek Dubey[2], Santosh varshney[3]

[1, 2, 3]Computer Science & Engineering, LNCT (Indore), India

rathorvivek93@gmail.com, vivekdubey22@gmail.com, varshneysantosh@yahoo.com

Abstract

In this paper we are doing study of digital filter on three types of noise such as Salt and Pepper (SPN), Gaussian noise, Speckle (SPKN). Different noise variance will be removed between 10% to 60% by using different types of filter as median and High pass digital filter. Filter techniques are mainly used for de-noising, smoothness and sharpening of images and extracting the useful information for the analysis for image processing The same concept is applied to the different images and they are compared with one another. The study is proposed with the help of Mean Square Errors (MSE) and Peak-Signal to Noise Ratio (PSNR).So as to choose the appropriate noise for different filtering methods for any image. Results are simulated on MATLAB R2007b.

Keywords: *Different images, image noise, Filter, Unsharp masking, PSE and MSE*

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1. INTRODUCTION

Image processing is the most important technique that used into improves the quality of image enhancement. Digital image processing has helped in the access to technical data in digital, services of computers in terms of speed of processing the data and the possibilities of big storage. Several studies can also take the benefit of it such as technical diversity of the digital image processing and maintaining the accuracy of the original data. Noise is removable using iterative median and High pass filter in spatial domain which requires much less processing time than removal by frequency domain Fourier transforms [1].The objective of image enhancement is to improve the quality of image.

An enhancement algorithm is one that yields a better quality image for the purpose of some particular application which can done by either suppressing the noise or increasing the image contrast. Image enhancements algorithms are employed to emphasize sharpen or smoothen the image features for display and analysis. The high pass and high-boost filter will work on high-frequency components of images. Image enhancement techniques emphasize specific image features to improve the visual perception of an image [2].Filtering technique can not remove more than one noise at the same time.

1.1 Spatial Domain Method

A spatial domain method is an image operation where each pixel value is changed by a function of the intensities of pixels in a neighbourhood. Spatial domain is a simple manipulation of neighbourhood pixels

2. IMAGE NOISE

Image noise represents unwanted information which degrades the image quality to enhance the quality we use filtering. Noise is defined as process (n) which adds with original image(s) and affects the acquired image (o).

$$o(i\ ,\ j)=s(i\ ,j)+n(i\ ,j) \quad (1)$$

Noise may be appears in image from different-different source. The digital image acquisition process, which converts an optical image into a continuous electrical signal that is then sampled, is primary process by which noise appears in digital image. There are several ways through which noise can be introduced into an original image, depending on types of noise.

2.1 Types of Noise

There are three different types of noise

- Salt and Pepper Noise
- Gaussian Noise
- Speckle Noise

2.1.1 Salt and Pepper Noise

Salt & pepper noise is random combination of black & white intensity value. We can ensure that image containing noise have dark pixels in bright regions and bright pixels in dark regions is salt and pepper [3]. This type of noise can be caused by dead pixels, analog-to-digital converter errors, bit errors in transmission, etc. This can be eliminated in large part by using some short of filtering technique.

$$P(x) = \begin{cases} P1, & x=A \\ P2, & x=B \\ 0, & \text{otherwise} \end{cases} \quad (2)$$

Where: p1, p2 are the Probabilities Density Function (PDF), p(x) is distribution salt and pepper noise in image and A, B are the arrays size image. Salt & Pepper are called impulsive noise.

2.1.2 Gaussian Noise

Gaussian noise is useful for modelling process which introduce noise caused by conversion of optical into an electronic one this type of noise is also called the random variant impulse noise or normal noise is randomly occurs as white intensity values[3]. Gaussian distribution noise can be expressed by:

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$$P(x) = 1/ (\sigma\sqrt{2\pi}) * e(x-\mu)2 / 2\sigma 2 \; -\infty < 0 < \infty \quad (3)$$

Where: P(x) is the Gaussian distribution noise in image; μ and σ is the mean and standard deviation respectively.

2.1.3 Speckle Noise

Speckle noise is added in the image it is also called multiplicative noise, multiplicative noise is a undesired artifact that limits the interpretation of optical coherence of different images it is dynamic by nature. Speckle noise in conventional radar results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element [4]. It increases the mean gray level of a local area .The distribution noise can be expressed by:

$$J = I + n*I \quad (4)$$

Where, J is the distribution speckle noise image, I is the input image and n is the uniform noise image by mean □ and variance v.

3. FILTER

Here the image filtering method is using 2D filter matrix, and the 2D image for every pixel of the image, take the sum of products where the current pixel is obtained by colour value or a neighbour of it, with the corresponding value of the filter matrix. Filtering method that remove the unwanted noise from image .The centre of the filter matrix has to be multiplied with the current pixel and get the new value, the rest elements of the filter matrix with corresponding neighbour pixels [6].

3.1 Median Filter

Median filter is a filtering technique that is non-linear by nature which changes the intensity value of image. Median filter is spatial filter, which change the variance of intensity of image. It is uses 2D filter to calculate the new pixel value of original image [5]. To apply the mask means to centre it in a pixel, calculating the brightness of pixel and determining which brightness value is the median value.

There are number of steps to in median filter to calculate the new pixel value in processing image.

- The neighbourhood pixels of the pixel in the original image which are calculated by the mask are stored in the ascending or descending order.
- The median of the stored value is computed and is chosen as the pixel value for the processed image.

3.2 High-Pass Filtering

High-pass filtering is a method that is used to high light the essential details through high frequency components. High-pass filter is a spatial filter, it is used for image sharpening and smoothing [6]. Spatial mask which perform image sharpening using following equations:

$$1/9 \times \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

High-pass= original – low-pass (5)

The resulting signal value should be zero that implies the sum of all the weight is zero.

3.2.1 High-Boost Filtering

High-boost filtering is used to emphasis the quality of image. High-boost is based on high frequency which can build after removing the low frequency component basically high-boost filtering is used for getting smoothing and sharpening of image [7]. In high-boost filter input image f(m, n) is multiplied by an amplification factor A. Thus the high-boost expression can be represented by following equations:

High-boost = A x original – Low-pass (6)

Adding and subtracting 1 with amplification factor A, we get

High-boost = (A-1) x original + original – Low-pass

Finally we get

High-boost = (A-1) x original + High-pass (7)

3.3 Unsharp Masking

Unsharp masking is a technique where amplification factor is equal to one it is work like high-pass filter but when amplification factor is greater than one then part of the original image is added back to the high pass filtered image[8]. This technique is used for typically for edge enhancement. The following steps to perform unsharp masking given below:

- Filter the image.
- Subtract the result obtained from step 1 from the original image.
- Multiply the result obtained in step 2 by some weighting fraction.
- Add the result obtained in step 3 to the original image.

Mathematically, the unsharp masking operation is given by

Original’ = original + □□[Blur - original] (8)

4. PROPOSED METHODOLOGY

In proposed methodology, we are combining the different filtering techniques into single one. There are three different noise source as possible noises are salt and peppers, Gaussian and speckle noise will be added to original image here we want to improve the quality of image enhancement. The noise will be common for the median filter it is used for de-noising then to improve the quality of image through high-boost filtering. At last three outputs are generated we select the appropriate output and compare with the original image; if match found then we conclude the following noise is appropriate for median as well as high-boost filtering.

Simulation result will be carried out using any images, here one image is chosen for demonstration. The performance evaluation of the filtering operation is quantified by the PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) PSNR is most commonly used to measure the quality of reconstruction of noisy image[9]. The signal in this case is the original data, and the noise is the error introduced by compression MSE measures the average of the squares of the errors. The error is the amount by which the value implied by the estimator differs from the quantity to be estimated by some expressions:

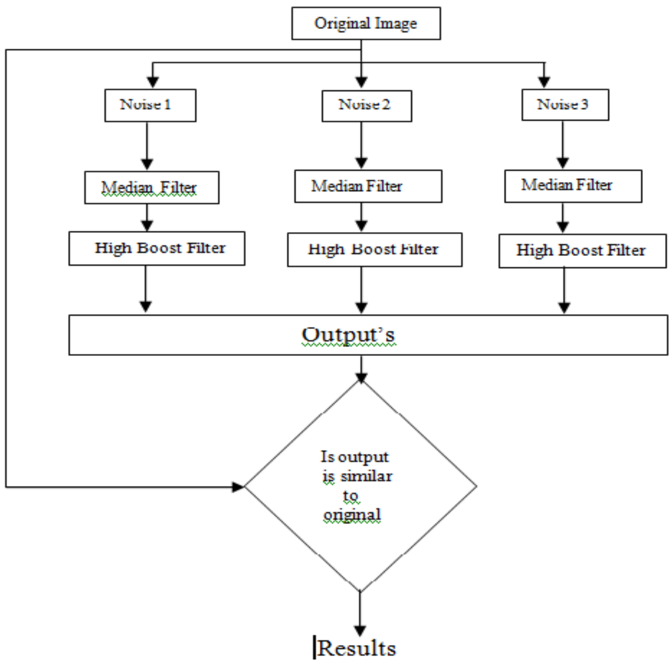


Fig1- Proposed Method

The MSE is calculated, Given a noise-free m×n monochrome image I and its noisy approximation K, MSE is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (9)$$

The PSNR is defined as:

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \quad (10)$$

Where, M and N are the total number of pixels in the horizontal and the vertical dimensions of image where I denotes the noise image and K denotes the filtered image.

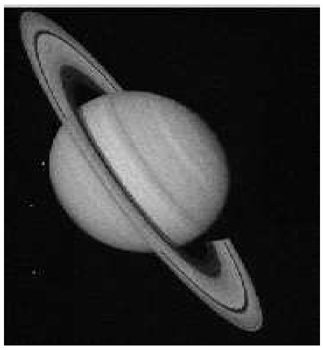


Fig2- Original image

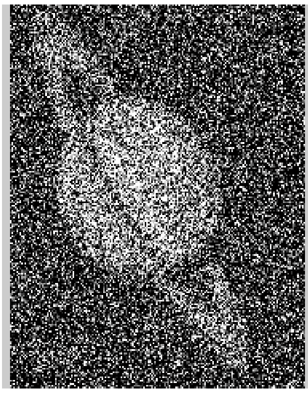


Fig3- Noisy Image 1 **Fig4**- Noisy Image 2

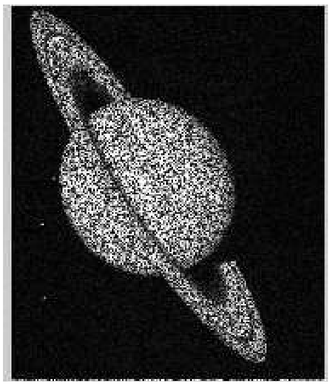
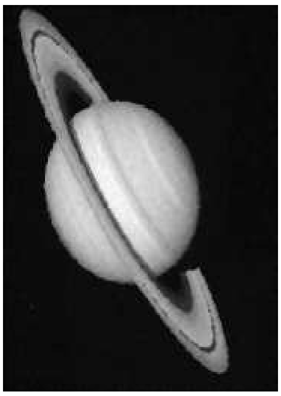


Fig5- Noisy Image 3

There are three different noisy images are generated, In first noisy image where original image is affected by salt & peppers , second affected by Gaussian noise and similarly third is affected by speckle noise. The output of median filter for all noisy images given below where first output generated after removing salt & peppers by median filter, second output comes after removing Gaussian and respectively third output after removing speckle noise by median filter.



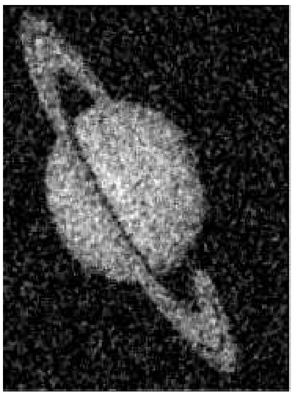


Fig6- Filter Image 1 **Fig7**- Filter Image 2

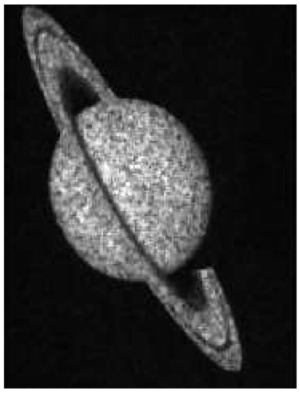
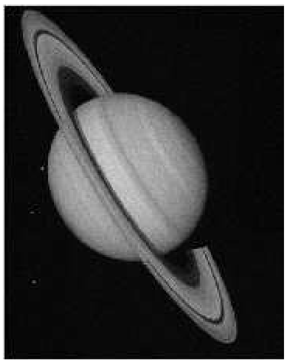


Fig8- Filter Image 3



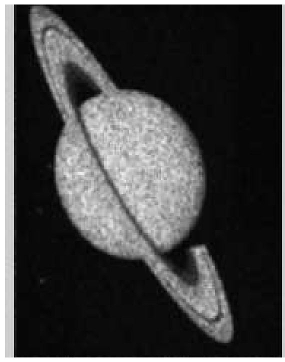


Fig9- Original Image **Fig10**- Unsharp mask

CONCLUSIONS

In this paper, we are proposing different noise source, median filter and high-boost filter for improving the quality of image enhancement. It is concluded that the median filter is best for salt and pepper noise here we are also calculating PSNR and MSE for noisy image then high-boost filter for smoothing and sharpening, it is remove the low-pass frequency and enhance the quality of image. Unsharp masking is perform the edge enhancement

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