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A REVIEW ON VARIOUS FILTERS FOR REMOVING NOISE IN MEDICAL IMAGES

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Abstract— *The use of images in various fields such as education, medical has been increased nowadays. But the problem is that the noise enters to the image while data transmission is going on. Noise is a kind of disturbance occurs in the channel at the time of transmission. Then this noise is removed by using suitable noise removal mechanism which leads to the destruction of the information in the original information of the image. For ages researchers have been proposing several techniques that were used to remove the noise from the image. Image denoising is the process of recovering true image from the noisy image. This study has been conducted to have a review to the various types of noise, filters for denoising,*

Keywords—*Medical Images,Despeckle, Image denoising, Filters.*

I. INTRODUCTION

The image is made up of tiny dots which are known as pixels. More thousand pixels made a image. But in computer language, image is considered in the form of matrix. The image can be of two dimensional or three dimensional. The matrix is formed by using the location of pixels with respect to their horizontal and vertical position. In computer, the image is saved in the form of either digital image or analog image. The digital image is used for applying and analyzing the various computations and processing. If the image is in the form of analog image then first of all it is converted to the digital image so that it can processed by using computer technologies. Digital image is created by using discrete pixels which are made up of various brightness and colors [1].
Image, whether it is digital or analog image can get affected by the noise. Noise can be defined as signal in the image which is not part of the information. In other words it can be said that noise is a signal which enters to the image from outside and destroy the informative part of the image. Hum is the example of noise. Analog signals are more prone to noise whereas digital signals are less affected by the noise. Therefore it is always preferable to convert an analog signal to the digital signal. Each and every kind of data which travels over network whether it is image, sound or text always suffers from the noisy content. But when the noisy content crosses the limit defined in the form of threshold then it can fully destroy the data. This noisy content can be removed from the image by following a procedure i.e. firstly to detect the noise and then to apply various efficient noise removing mechanisms. Noise can never fully remove from the image but it is possible to decrease the effect of the noise in the signals [2].

The image denoising is specifically done to enhance the quality of the image by eliminating the noisy pixels from the image. The image denoising can be done by applying various available denoising techniques. Image denoising is similar to the image processing, because image processing is also done for enhancing the image quality and to extract more and more information from the image. The image can be affected by the noise in the following manners:

- Unwanted objects or spots can be seen in the image.
- The suffered image will phase loss of original data.
- The quality of the received image will be degraded in comparison to the original image.
- The original image can be lost fully if the level of the noise is increased by the value of the threshold.
- The image with noise cannot be re-sued anywhere.
- The noisy image will suffer from lack of visibility or quality [3].

II. TYPES OF NOISE IN MEDICAL IMAGES

Image can suffers from assorted types of noise some of them are listed as follows:

- Gaussian noise
- Salt and Pepper Noise
- Speckle noise

2.1 Gaussian noise

The Gaussian noise exist along with the probability density function i.e. PDF and also referred as Gaussian distribution. In this Gaussian distribution refers to the value that noise can take over. In order to calculate the PDF of Gaussian Filter following formulae is used and it is referred as $pg(z)$.[4]

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \dots\dots\dots\dots (1)$$

In above Equation z stands for grey level value of the image;
μ, stands for mean value.
σ, stands for standard deviation.
When the values at any pair are similar and statistically self-governing then such case us considered as special case in Gaussian noise. The source of the Gaussian noise in the image is Sensors disturbance because of weak signals of illumination and increase in the temperature etc.

2.2 Salt and pepper noise

It is commonly found noise in the images. This noise creates black and white pixels in the images that are created randomly at any position in the image. In order to remove this kind of noise from the image median filters and morphological filters are used. Another filter such as harmonic filters can also be used for removing this noise from the image but the backlog of harmonic filter is that it can only remove either salt or paper noise from the image [5]. Some other techniques such as dark frame elimination, interpolating of dark/bright pixels can be used to remove this noise. This noise sometimes also cause to the existence of fat tail or impulsive noise in the image. To recognize the salt and pepper noise from the image one can observe that the area with the dark color in the image will be consisted of light colored spots and the area with the dark color in the image will comprised of spots with the light color. The salt and pepper noise exist in the image in case when the image convergence takes place. The term spike noise is also used to refer the salt and pepper noise.

2.3 Speckle Noise

Each and every image capturing device whether it is camera, X-Ray machine or any other device suffers from various kind of noise. for example, the X-Ray images acquired by X-Ray capturing machine suffers from poisonous noise whereas the ultra sound images suffers from speckle noise. Speckle noise is a method which decreases the quality of an image with back sprinkled wave appearance which starts from various microscopic diffused reflections that crosses the internal objects [6]. It becomes difficult for the user to differentiate the informative part of the image while examining the image. Speckle noise is also known as multiplicative noise. The coherent imaging systems such as laser, acoustics mostly suffers from speckle noise. This noise originates from random interference among coherent returns. Speckle noise follows a gamma function that is defined in equation below:

$$F(g) = \frac{g^{\alpha-1}}{(\alpha-6)!\, a^{\alpha}} e^{-\frac{g}{a}} \dots\dots (2)$$

In this equation the variance α=2 and a and g defines the gray level.

2.3.1 Need for Descpeckling

The speckle noise is referred as a leading source of noise in images. And it becomes necessary to eliminate it without affecting the original information of the image. The main motive behind despeckling the images is as below:
By despeckling the images the boundaries and the objects of the image get clearer [7].
Despeckling is a part of the image pre-processing such as image segmentation and registration. It enhances the speed and accuracy of the process.

III. FILTERS FOR DENOISING

Generally to eliminate the noisy signals from digital images, the filters are used purpose fully. Filtration is one of the major mechanisms that is widely acceptable to denoising and processing the images. Filters are applied to the noisy image in order to obtain the enhanced [8], noise fewer images. Various filters have been developed and the selection of the filters relies upon some parameters like format of the information located in image, purpose of filters for implementation etc [9]. filters are capable to eliminate the unwanted noisy content from the digital images. Filters can be categorized as follows:

- Filtering without detection
- Filtering after detection
- Hybrid filtering.

3.1 Filtering without Detection

Filtering without detection refers to the application of filters to the image without detecting the noisy signals from it [10]. It utilized the masking window to revolve and scan the full digital image. Following formulation is used for evaluating the mask window size:

$$\frac{(2N+1)}{2} \ldots\ldots (3)$$

In equation , N is used for representing the positive value of integral numeral. The masking process initiates from top left corner of the window and ends at bottom right corner of the window. In this way all of the pixels in the window scanned effectively.

3.2 Detection followed by Filtering

In this filtration process the detection of the noisy signal is performed and then the filtration is applied to the content. The working of this is divided into two phases. In first phase the noise detection is applied to the image and after detecting the noisy signals second step is processed for removing the noisy content from image. The filtration is applied by using the masking. It traverses the image and scans each and every pixel of the image [11].

3.3 Hybrid Filtering

Hybrid filtration refers to the integration of two or more filter mechanisms. The methods for this collaboration can be selected by using various quality parameters such as type of noise, nature of the object which suffers from the noise i.e. image. Hybrid filtration is considered as a complex filtering process due to the indulgence of multiple mechanisms.

3.4 Other filters

3.4.1 Adaptive median filter (AFM)

AFM is an abbreviation for Adaptive Median Filters. These types of filters are usually implemented for denoising in image. Adaptive median filters are preferred over mean filters. Main advantage of adaptive median filters is that it does not affect the desired information while eliminating the noisy content from it. Therefore, this type of filter is used to prevent the edges of image. This filter is usually implemented in advanced form of applications. Adaptive mean filters are comparatively good than ordinary median filters. Spatial filters are used in it to determine the noisy content in the image. To identify the contaminated pixels, the comparison is performed between adjacent pixel values [12].

3.4.2 Vector median filter (VMF)

VMF or Vector median filters are used to improve the median filters. Usually for multi-variant data, these filters are implemented. In these types of filters an observation window is used which is represented as:

$$\Omega = \{x_1, x_2, \ldots\ldots, x_N\} \ldots\ldots (4)$$

To calculate the output generated by the median filter, the mathematical formula is represented below:

$$X_{VM} = argMin \sum \|x - x_i\|^2 \ldots\ldots (5)$$

In above equation, || || represents the LP norm. Main advantage associated with this technique is that it has fast processing speed but this technique can only be implemented over those images in which less noisy content exist. This filter performs very well on the impulsive noise [13].

3.4.3 Gaussian Filters

Gaussian filters are implemented to eliminate the noisy content from image. In order to eliminate the noisy content from image, the Gaussian function is implemented which is as followed:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}} \ldots\ldots (6)$$

Here, σ depicts the standard deviation of distributed function. It is considered that it has 0 mean values corresponding to it.

3.4.4 Butterworth Filter

Butterworth filter helps in maintaining the flat and static output response. The Butterworth LPF operates somewhat in similar manner to the ideal filter without few steps discontinuous model. In Butterworth filter the transfer function with 'n' order and predefined cutoff frequency locus at a distance I0 from the origin can be described with the help of following mathematical equation [14].

$$H(a,b) = \frac{1}{1 + [\frac{I(a,b)}{I_o}]\text{^}2n} \ldots\ldots (7)$$

$$I(a,b) = (a^2 + b^2)^{1/2} \ldots\ldots (8)$$

IV. RELATED WORK

Rajesh Mohan R, (2016) [1], developed a novel approach to get rid of speckle noise in microwave images by combining the spatial and frequency domain methods. At initial stage the wiener filters was applied in spatial domain as a pre-processing mechanism and soft thresholding wavelet transform was implemented in frequency domain. Then logarithmic transformation was applied by considering the multiplicative model to filtered image. The standard deviation equation was utilized corresponding to each decomposition level. The performance parameters such as PSNR and SSIM was evaluated and it was observed that the proposed work produced quie qualitative results.

Mr. Hitesh, (2016) [2], Addressed the issue of speckle noise in medical images such as X-Rays, ultrasound images etc. the existence of speckle noise in medical images can couse the alterations in original information. The proposal of this study was to remove the speckle noise by using wavelet and counterlet transform individually. The contrast between two of the proposed technique had been derived on the basis of different performance metrics such as PSNR, SNR, MSE and CC. **Milind Kumar V. Sarode, (2011) [3]** developed models to remove the speckle noise from digital images by using various filters. The satellite images and Synthetic Aperture Radar had been used for simulation purpose. The proposed models were capable to preserve the information of structured region. The proposed model under this study automatically gathered the noise related content from the image and hence proved better than the traditional noise removal methods which were failed to collects the noise variance from the images.

Alenrex Maity (2015) [4], this study was conducted with a view to had a review to the noise in digital images and it was discussed under this study that the noise is a variation in the image that occurs randomly and effects the originality of information in that image. This noise can be of various types such as impulsive noise, Gaussian noise, uniform noise, speckling noise etc and is described in this work. The focus was laid on speckle noise and it was explained as the variations that happen due to environmental effects. The radar images, satellite images and medical images are found highly affected by speckle noise. Numerous techniques had been developed to remove the speckle noise from the images. This paper addressed various speckle noise removal methods along with their advantages and disadvantages to generate a comparison.

T.Ratha Jeyalakshmi (2010) [5], author described the existence of speckle noise in medical images and developed a mathematical morphological image cleaning algorithm for despeckling the images. This technique was based on the approach given by Richard Alan Peter II. This technique utilized various reconstruction mechanisms to develop the features of the images that have been lost due to the existence of the speckle noise in the image. It also used the arbitrary construction elements to perform the morphological operations.

Nishtha Attlas, (2014) [6] this work was a review study that specifically organized to have overview to the concepts of noising and denoising of digital images. The center of the study was to review the various approaches that are specifically used for reducing the speckle noise form ultrasound images. A demonstration was given in this by considering the wavelet transform based methods to enhance the visual quality of the image. It was concluded that the discrete wavelet transform technique is more reliable for reducing the noise in both cases window based and region of interest based.

Jyoti Jaybhay, (2015) [7] denoising a process that reduces the effect of noisy signal from echo mages. Denoising comprised of various methods. Filtration is one the method that is used in denoising of the image. Some of the filters are median filters, frost filters, adaptive mean filters, wiener filters etc are widely used and generate effective results. All of these filters behave differently with the variation in the variance of speckle noise. This study defined the various noise removal filters and analyzed the performance of filters by using metrics like ASNR, FOM, MSE, PSNR and SSIM.

K.M. Sharavana Raju, (2013) [8], this study generated a noise removal mechanism by using different filters on medical and radar images. The proposed technique was able to enhance the performance of the existing filtration technique for reducing the speckle noise from the images. The implementation had been evaluated by analyzing the various statistical metrics like SNR, Peak Signal to Noise Ratio, RMSE, CC. At last the image with best statistical results is displayed along with the name of the filters that generated such qualitative results.

Karamjeet Singh, (2017) [9], projected a hybrid denoising mechanism with an objective to collect the local and non local features of the image. The proposed work was divided into three phases. The first phase comprised of local statistics as filters which reduced the effects of speckle noise at initial stage, then in second phase, bilateral filters were applied to reduce the speckle noise from the image at second level. At last phase, the diffused edges of the image had been created by using the post-processing methods

V. CONCLUSION

The image denoising is one of the most prominent field for research work. lot of work had been done by numerous authors in this field and some of the work is still going on to resolve the various issues regarding the different kind of noise removing techniques. On the basis of the related work that has been represented in this study it is concluded that the speckle noise and Gaussian noise is quite difficult to remove from the image. Various authors provide different mechanism in direction to solve this issue but lacks somewhere such as lowest PSNR etc. Hence it can be said that in future such a mechanism can be developed which can remove the speckle noise and Gaussian noise from the image without degrading the originality or quality of the information of the image.

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