Volume 2, Issue 5, May 2012 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Enhancement of Chest X-Ray images Using Filtering Techniques

G.N.Sarage
#Research Scholar Singhania University Pacheri Bari
Enail :- govind_sarage@yahoo.com

Dr Sagar Jambhorkar
#Research Guide Singhania University Pacheri Bari
Email :- sjambhorkar@yahoo.com

Abstract— **X-ray image is never the correct representation of the object under observation; it is always ruined by degradations during acquisition and within the imaging system itself. These include noise, blurring and distortion. Noise removal is an important and challenging issue in medical image processing. Various filtering techniques have been developed to solve the noise removal problems, but most of them require deep expert knowledge to design appropriate image filters. These filtering techniques have their own assumptions, advantages and disadvantages. This paper proposes mean and median filtering techniques for the removal of noise from the X-ray medical image. Proposed method applied for noise removal problems. In terms of statistical quantity measures such as MSE, RMSE, PSNR, AD, the results show the superiority of the proposed method.**

Keywords— **Medical Imaging, X-Ray, Image Filtering, De-Noising, Statistical Measurement.**

I. INTRODUCTION

Medical imaging systems detect different physical signals arising from a patient and produce images. An imaging modality [1] is an imaging system which uses a particular technique. Some of these modalities use ionizing radiation, radiation with sufficient energy to ionize atoms and molecules within the body, and others use non-ionizing radiation. Ionizing radiation in medical imaging comprises x-rays and γ-rays, both of which need to be used prudently to avoid causing serious damage to the body and to its genetic material. Non-ionizing radiation, on the other hand, does not have the potential to damage the body directly and the risks associated with its use are considered to be very low. Examples of such radiation are ultrasound, i.e. high-frequency sound, and radio frequency waves [2].

Medical imaging systems, for example, take input signals which arise from various properties of the body of a patient, such as its attenuation of x-rays or reflection of ultrasound. The resulting images can be continuous, i.e. analog, or discrete, i.e. digital; the former can be converted into the latter by digitization [1]. Noise is unwanted fluctuation in the pixel values of an image. It results in a degradation of the image quality. The challenge is to obtain an output image that is an accurate representation of the input signal, and then to analyze it and extract as much diagnostic information from the image as possible. The principal sources of noise in digital images arise during image acquisition (digitization) and/or transmission. The performance of imaging sensors is affected by a variety of factors, such as environmental conditions during image acquisition, and by the quality of the sensing elements themselves. For instance, in acquiring images with a CCD camera, light levels and sensor temperature are major factors affecting the amount of noise in the resulting image. Images are corrupted during transmission principal due to interference in the channel used for transmission [1]. For example, an image transmitted using a wireless network might be corrupted as a result of lightning or other atmospheric disturbance.

Medical imaging [1, 2] involves a good understanding of imaging medium and object, physics of imaging, instrumentation, and often computerized reconstruction and visual display methods. Though there are a number of medical imaging modalities available today involving ionized radiation, nuclear medicine, magnetic resonance, ultrasound, and optical methods, each modality offers a characteristic response to structural or metabolic parameters of tissues and organs of human body [1, 3].

X-ray radiography is the simplest form of medical imaging with the transmission of X-rays through the body which is then collected on a film or an array of detectors. The attenuation or absorption of X-rays is described by the photoelectric and Compton effects providing more attenuation through bones than soft tissues or air. The diagnostic range of X-rays is used between 0.5A and 0.01A. A wavelength which corresponds to the photon energy of approximately 20Kev to 1.0Mev. In this range, the attenuation is quite reasonable to discriminate bones, soft tissue and air. In addition, the wavelength is short enough for providing excellent resolution of images even with sub mm accuracy. Shorter wavelengths than diagnostic range of X-rays provides much higher photon energy and therefore less attenuation. Increasing photon energy makes the human body transparent for the loss of any contrast in the image.

II. TYPE OF NOISE

Noise is always present in images to some extent. Different types of noise [1, 3] can be identified according to their origin. Any imaging device must use a finite exposure (or integration) time, which introduces stochastic noise from the random arrival of photons. Optical imperfections and instrumentation noise (for example, thermal noise in semiconductor devices) can result in further noise. Sampling causes noise due to aliasing of high-frequency signal components, and digitization produces quantization errors. Additional noise can be introduced by communication errors and compression.

A. Periodic Noise

This arises typically from electrical interference, especially in the presence of a strong mains power signal during image acquisition [1, 3]. It is spatially dependent and generally sinusoidal at multiples of a specific frequency. It is recognizable as pairs of conjugate spots in the frequency domain, and can be conveniently removed either manually or by using a notch (narrow band reject) filter/frequency domain filter.

B. Gaussian Noise

Gaussian noise [1, 2, 3] has a probability density function, or normalized histogram, given by

$$p(a) = \sqrt{1/2\pi\sigma^2}\ \exp(\ -\ (a-\mu)^2\ /\ (2\sigma^2)\ )$$

where a is the gray value, μ is the average gray value and σ is its standard deviation. Approximately 70% of its pixel values are in the range [(μ − σ), (μ + σ)]. It is a particularly attractive model since it can be analytically integrated, which may explain its over-use. It also conveniently has the same spectral shape in the frequency domain[1, 3]. Gaussian noise comes from many natural sources, such as the thermal vibrations of atoms in antennas (referred to as thermal noise or Johnson noise) and black body radiation from warm objects.

It is often incorrectly assumed that Gaussian noise is necessarily white noise. However, neither property implies the other. Being Gaussian refers to the way gray values are distributed, while the term “white” refers to the lack of correlation between pixel values, and this randomness results in all frequencies being present in the same amounts, i.e. a flat power spectrum. Gaussian white noise is a good approximation of many real-world situations and generates mathematically tractable models.

C. Impulse and salt paper noise

Another common form of noise is data drop-out noise, commonly referred to as impulse noise or salt-and-pepper noise. Here, the noise is caused by errors in data transmission. Corrupted pixels are either set to the maximum value or to zero, giving the image a “salt and pepper” like appearance. Unaffected pixels remain unchanged. The noise is usually quantified by the percentage of pixels which are corrupted.

D. Speckle Noise

Although Gaussian noise and speckle noise [3] can appear superficially similar in an image, they are a result of different processes and require different approaches for their removal. Whereas Gaussian noise can be modeled by random values added to the pixel values of an image, speckle noise is modeled by random values which are multiplied by the pixel values. Speckle noise is a some major problem in radar application.

III Filtering Techniques For Noise Removal.

a. Mean Filtering:-

Mean filtering can be achieved by convolving the image with a $(2K + 1 \times 2L + 1)$ kernel where each coefficient has a value equal to the reciprocal of the number of coefficients in the kernel. For example, when $L = K = 1$, obtain

$$w(k, l) = \begin{Bmatrix} 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \end{Bmatrix}$$

referred to as the 3 × 3 averaging kernel or mask. Typically, this type of smoothing reduces noise in the image, but at the expense of the sharpness of edges [1]. Examples of the application of this kernel are seen in Figure 1(b–c). Note that the size of the kernel is a critical factor in the successful application of this type of enhancement. Image details that are small relative to the size of the kernel are significantly suppressed, while image details significantly larger than the kernel size are affected moderately. The degree of noise suppression is related to the size of the kernel, with greater suppression achieved by larger kernels.

b. Median Filtering

Median filter, which replaces the value of a pixel by the median of the gray levels in the neighborhood of that pixel (the original value of the pixel is included in the computation of the median). Median filters are quite popular because, for certain types of random noise, they provide excellent noise-reduction capabilities, with considerably less blurring than linear smoothing filters of similar size.

Median filters [1, 3, 5] are particularly effective in the presence of *impulse noise*, also called *salt-and-pepper noise [3]* because of its appearance as white and black dots superimposed on an image. The median, j, of a set of values is such that half the values in the set are less than or equal to j, and half are greater than or equal to j. In order to perform median filtering at a point in an image, first sort the values of the pixel in question and its neighbors, determine their median, and assign this value to that pixel. For example, in a 3*3 neighborhood the median is the 5^{th} largest value, in a 5*5 neighborhood the 13th largest value, and so on. In general, median filters do not have the same smoothing characteristics as the mean filter [1, 3, 5].

Features that are smaller than half the size of the median filter kernel are completely removed by the filter. Large discontinuities such as edges and large changes in image intensity are not affected in terms of gray-level intensity by the median filter, although their positions may be shifted by a few pixels. This nonlinear operation of the median filter allows significant reduction of specific types of noise. For example, "pepper-and-salt noise" may be removed completely from an image without attenuation of significant edges or image characteristics [5].

IV. Experimental Analysis and Discussion

The proposed algorithms have been implemented using MATLAB. The performance of various noise removal approaches using mean and median filters are analyzed and discussed. The measurement of noise removal from X-ray medical image is difficult to measure. There is no common filtering algorithm for the noise removal from the medical image. The statistical measurement could be used to measure enhancement of the X-ray medical image. The Mean Square Error (MSE),Root Mean Square Error (RMSE), Peak Signal-to-Noise Ratio (PSNR) and Average Difference(AD) are used to evaluate the enhancement performance .The MSE,RMSE, PSNR and AD are provided in the table 1.

S.No	Filtering Method	MSE	RMSE	PSNR	AD
1	MEAN 3x3	216.88	14.73	24.77	0.11
2	MEAN 5X5	239.42	15.47	24.34	0.11
3	MEDIAN FILTER	253.60	15.92	24.08	0.48

STATISTICAL MEASUREMENT	FORMULA
Mean square error (MSE)	$\sum \frac{(f(i,j) - F(i,j))^2}{MN}$
Root Mean Square Error (RMSE)	$\sqrt{\sum \frac{(f(i,j) - F(i,j))^2}{MN}}$
Peak Signal to Noise Ratio (PSNR)	$20 \log_{10} \frac{255}{RMSE}$
Average Difference	$\frac{\sum\sum f(i,j) - F(i,j)}{MN}$

Table-1. Picture quality measures

Here, *f* (i, j) is noisy image, *F (i, j)* is enhanced image. The noise image and filtered images of the X-ray obtained by various filtering techniques are shown in figure 1. If the value of MSE, RMSE and AVERAGE DIFFERENCE is high and the values of PSNR are low then the enhancement approach is better. The table 2 shows the performance analysis of the proposed approaches with the regard to X-ray medical images for breast cancer detection. It was observed from the figure-1, figure-2 and table-2 that the proposed Median filter removes the pepper noise better than the other mean filters.

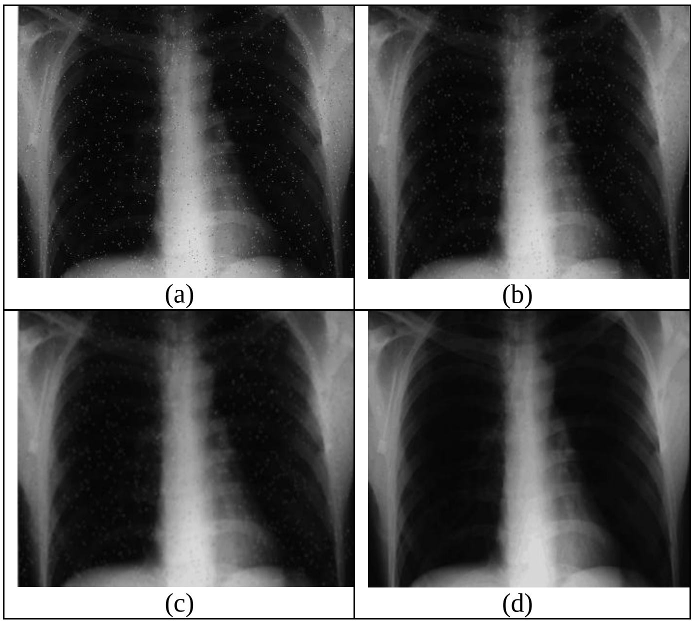

Fig1. Output images of the filtering methods (a)Noisy image (b) mean filter 3x3 (c) mean filter 5x5 (d) median filter

Table 2. Experimental results and statistical measurements

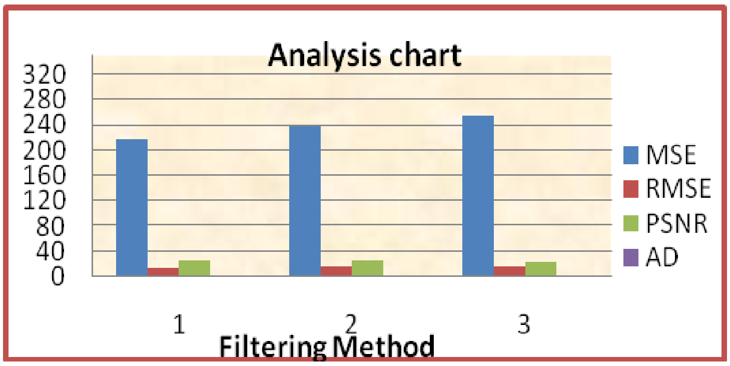

Fig 2 : Performance Analysis Chart

V. CONCLUSION

The performance of noise removing algorithms is measured using quantitative performance measures such as MSE, RMSE, PSNR and AVERAGE DIFFERENCE (AD) as well as in term of visual quality of the images. Many of the methods of mean filter fail to remove pepper noise present in the X-ray medical image, since the information about the variance of the noise may not be identified by the methods. Performance of all algorithms of mean and median filter is tested with X-ray image regard to breast cancer. The computational result showed that the median filter performed better than the various mean filters.

REFERENCES

[1]. Rafael C. Gonzalez University of Tennessee, Richard E. Woods. Digital image processing Third Edition 2008 .Pearson Education.

[2]. Rafael C. Gonzalez University of Tennessee, Richard E Woods, Steven L. Eddins. Digital image

processing using MATLAB. Fourth impression 2008 .Pearson Education.

[3]. Anke Meyer-Base. Pattern recognition for medical imaging 2004. Elsevier academic press.

[4]. Bernard Jahn. Digital image processing, fifth revised edition. Springer-Verlag Berlin Heidelberg New York.

[5]. Roger Bourne ,Fundamentals of Digital Imaging in Medicine by Springer-Verlag London Limited 2010.

[6]. Geoff Daugherty, Digital Image Processing for Medical Applications, Cambridge University Press 2009.

[7]. Atam P Dhawan, H K Huang, Day-Shik Kim. Principles And Advance Method In Medical Imaging And Image Analysis, World Scientific Publishing Co. Pvt. Ltd 2008.

[8]. Issac h Bankman Handbook of medical image processing and analysis, Elsevier Inc 2009.

[9]. J.C. Russ, The Image Processing Handbook (fifth edition), CRC Press, 2007.

[10]. Sankar Seramani, zhou Jiyan. "Denoising of MR images using non linear anisotrophic diffusion filtering as a preprocessing steps". http: // www.ijbst.org-a.googlepages.com /IJBST_1_1_17-21.pdf IJBST (2008), 1(1):17-21.

[11]. Tarek A Mahmoud, Stephen Marshall. Medical image enhancement using threshold decomposition driven adaptive morphological filter. 16th European Signal Processing Conference (EUSIPCO 2008), Lausanne, Switzerland, August 25-29, 2008.

[12]. Muhammad luqman bin muhd Jain. Enhancement of bone fracture image using filtering techniques. The International Journal of Video & Image Processing and Network Security IJVIPNS Vol: 9 No: 10 pp 49-54.

[13]. Vivian E Pera, Erica L. Heffer, Spatial second–derivative image processing: an application to optical mammography to enhance the detection of breast tumors. Journal of Biomedical Optics 8(3), 517–524 (July 2003).

[14]. Mrs firouz Abdullah Al-Wassai, Dr. N V Kalyankar. Arithmetic and frequency filtering methods of pixel based image fusion techniques. IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 3, No. 1, May 2011.pp 113-122.

[15]. Hadi sadoghi Yazdi, Farank Homayouni. Impulsive noise suppression of images using adaptive median filter. International Journal of Signal Processing, Image Processing and Pattern Recognition. Vol. 3, No. 3, September, 2010. Pp 1-12.

[16]. Mr. Salem Saleh, Dr V N Kalyankar. Removal Salt & Pepper noise from image by using adaptive median filter. International journal of advance research in Computer Science. Vol 2 No 2 Mar-Apr 2011. 431-434.

[17]. K. Arulmozhi ,S Perumal. Contrast improvement of radiographic images in spatial domain by edge preserving filter.

[18]. K balasubra-manian. Constrained PDF based histogram equalization for image contrast enhancement.

[19]. Jin-Hyuk Hong, Sung-Bae Cho, Ung-Keun Cho. A novel Evolutionary approach to image enhancement filter design : methods and applications. IEEE Transactions On Systems, Man, And Cybernetics—Part B: Cybernetics, Vol. 39, No. 6, December 2009.PP 1446-1457.

[20]. Andrzej Zadorozny and Hong Zhang . Contrast enhancement using Morphological scale space. Proceedings of the IEEE International Conference on Automation and Logistics Shenyang, China August 2009. pp 804-807.

[21]. C P Behrenbruch, S Petroudi, S Bond. Image filtering techniques for medical image post-processing: An Overview.

[22]. Kubler, Ron Kikinis. and Ferenc A. Jolesz . Nonlinear Anisotropic Filtering of MRI Data. IEEE TRANSACTIONS ON MEDICAL IMAGING. VOL. 1 I . NO. 2. JUNE 1992.pp 221-232.

[23]. P. Jagatheeswari, S. Suresh Kumar, M. Rajaram . A novel approach for contrast enhancement Based on histogram equalization followed By median filter. ARPN Journal of Engineering and Applied Sciences. VOL. 4, NO. 7, SEPTEMBER 2009.pp 41-45.

[24]. G. Vijaya, Dr.V.Vasudevan . Bilateral Filtering using Modified Fuzzy Clustering for Image Denoising. International Journal on Computer Science and Engineering (IJCSE). Pp 45-49.

[25]. Ambica Verma, Priyanka Gupta, Ramandeep Singh . Enhancement of ultrasound images using fuzzy sets and comparing the results of Radon and Fourier transforms. International Journal of Computer Sci ence and TechnologyIJCST Vol. 2, Iss ue 2, June 2011 pp 184-187.

[26]. Milindkumar V. Sarode, Dr. Prashant R. Deshmukh. Performance Evaluation of Noise Reduction Algorithm inMagnetic Resonance Images. IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 2, March 2011. Pp 198-202.

[27]. Dr. Samir Kumar Bandyopadhyay. Diagnosis of Breast Abnormalities in Mammographic Image. International Journal of Computer Sci ence and Technology IJCST Vol. 2, Issue 1, March 2011.pp 69-71.

[28]. K. Thangavel , R. Manavalan, I. Laurence Aroquiaraj. Removal of Speckle Noise from Ultrasound Medical Image based on Special Filters: Comparative Study. ICGST-GVIP Journal, ISSN 1687-398X, Volume (9), Issue (III), June 2009. Pp 25-32.

[29]. S.Kalaivani Narayanan and R.S.D.Wahidabanu. A View on Despeckling in Ultrasound Imaging.

International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 2, No.3, September 2009

[30]. Naglaa Yehya Hassan and Norio Aakamatsu . Contrast Enhancement Technique of Dark Blurred Image. IJCSNS International Journal of Computer Science and Network Security, VOL.6 No.2A, February 2006. Pp 223-226.

[31]. Mr. Salem Saleh Al-amri, Dr. N.V. Kalyankar. A Comparative Study for Deblured Average Blurred Images. International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010, 731-733.

[32]. D.Maheswari Dr.V.Radha .Noise removal in compound imageUsing median filter. International Journal on Computer Science and Engineering Vol. 02, No. 04, 2010, 1359-1362.

[33]. M. Jaya Manmadha Rao, S. Anuradha, Dr. KVVS Reddy. Impulse Noise removal in Digital Images. International Journal on Computer Science and Engineering Vol. 02, No. 07, 2010, 2345-2348.

[34]. Mrs. Preethi S.J , Prof. K. Rajeswari . Image Enhancement Techniques for Improving the Quality of Colour and Gray scale Medical Images. International Journal on Computer Science and Engineering (IJCSE). NCICT 2010 Special Issue. Pp 18-23.

[35]. B. D. Venkatramana Reddy, Dr.T.Jayachandra Prasad. Frequency Domain Filtering of Colour Images using Quaternion Fourier Transforms. IJCST Vol. 1, Issue 2, December 2010. International Journal of Computer Science and Technology. Pp 46-52.

[36]. Miss.Arti V.Gautam, Mr.D.M.Dakhane. Image Denoising Using Non Linear Filtering. International journal of advance research in computer science. Vol 2 no 3 May-Jun 2011. Pp 222-224.

[37]. Aswini Kumar Mohanty, Manas Ranjan Senapati, Saroj Kumar Lenka ,A novel Image mining Technique for Classification of Mammograms using Hybrid Feature Selection. International journal of advance research in computer science. Vol 2 no 3 May-Jun 2011. Pp 265-272

[38]. Sung Kon Oh, Jeyong Hyun Yoon , Yong Man Ro. Image enhancement with attenuated blocking artifact in transform domain. IEICE Trans Inf & Syst. Vol E85-D, No.1 January 2002.

