ISSN:0975-9646

A Hybrid Technique for Medical Image Denoising using NN, Bilateral filter and LDA

Rupinder Pal Singh, Varsha Varma, Pooja Chaudhary
Computer science engineering, Punjab Technical University

Abstract-Medical imaging technology is becoming an important component of large numbers of applications such as diagnosis, Treatment and research. Medical images like CT, X-Ray, MRI, PET and SPECT have minute information about heart, nerves and brain. These images need to be more accurate and free from distortion or noise. Noise reduction or removing plays an important role in medical images. Various methods of noise removal such as: wavelets, filters and thresholding based on wavelets. Although these types of methods produced good results but still have some drawbacks or limitation Considering and analyzing the limitations of the previous methods our research presents neural networks as an efficient and robust tool for noise reduction. In our research we use neural network as the learning algorithm which follows the supervised learning. In this paper Bilateral filter is defined for its effectiveness in edge-preserved image Denoising. Bilateral filter improves the Denoising efficiency, preserves the fine structures and also reduces the Rician noise. The LDA analyzing the limitations or drawbacks of the previous methods with proposed work. The proposed research use both mean and median statistical functions for calculating the output pixels results in terms of PSNR, MSE, And Mean SSIM.

Keywords-Noising, De-noising, Medical images, NN, Bilateral filter And LDA.

1. INTRODUCTION

Image processing is a form of signal processing for which the input is an image such as a photograph or video frame and the output of image processing may be either an image or the image parameters. Image is defined as two dimensional function of two real variables. Image f(x, y) where f is amplitude to any pair of co-ordinates(x and y) are the spatial coordinates known as pixels, image elements and picture values. In image processing the image is converted into the digital form. The digitization involves sampling of an images and quantization of sampled values. Afterthen converting of image into bit information the processing is performed. The processing technique may be image enhancement; image reconstruction and image compression. Image is processed in two ways:

1. Spatial domain: Spatial domain is defined as to enhance the image plane itself; it is based on the direct manipulations of the pixels in the image. These technique are worked on the gray level mapping. Where mapping is used to enhance the image.

2. Frequency domain: Till now, all the domains in which we have analyze the signal. We analyzing with respect to time. But in the frequency domain we do not analyze signal with respect to time, but with respect of frequency. image is processed or categorized/decomposed in form of sub bands. All types transformations are applied in frequency domain. For instance(DWT, DFT etc).

Therefore the purpose of image processing is divided into five groups:

1. Visualization: Observe the objects that are not visible.
2. Image Sharpening and Restoration: To create a better image.
3. Image Retrieval: Seek for the image of interest.
4. Measurement of the Pattern: Measure various objects in an image.
5. Image Recognition: Distinguish the objects in an image.

It is the use of computer algorithms to perform image processing on digital images. It is a field of digital signal processing; digital image processing has many advantages over analog signal processing. It allows much more wider range of algorithms to be applied to the input data and can avoid problems such as the build- up of noise and signal distortion during processing. Images are defined in f(x,y) two dimensions digital image processing may be modeled in the form of multidimensional systems. So that digital image processing allows the use of much more complex algorithms. Medical imaging is the technique and process used to create images of the human body for clinical purposes and diagnosis (medical procedures seeking to reveal; diagnose or examine disease) or medical science. Therefore imaging of removed organs and tissues can be performed for medical reasons; such procedures are not usually referred to as medical imaging. A discipline and in its widest sense; it is part of biological imaging and incorporates radiology; nuclear medicine; investigative radiological sciences; endoscopy; medical thermography; medical photography and microscopy (for instance: human pathological investigations).After Then the measurement and recording techniques which are not primarily designed to produce images; such as magneto encephalography (MEG), electroencephalography (EEG), Electrocardiography (EKG) and others; but which produce data susceptible to be represented as maps; can be seen as forms of medical imaging .Radiation exposure from medical imaging in 2006 made up about 50% of total ionizing radiation exposure in the USA. Therefore in clinical context;[7] "invisible light" medical imaging is generally equated to radiology or "clinical imaging" and the medical practitioner responsible for interpreting (and sometimes acquiring) the images is a radiologist. Then "Visible light" medical imaging involves digital video or still pictures that can be seen without special equipment. The Dermatology and wound care are in two modalities that utilize visible light imagery. And the diagnostic radiography designates the technical aspects of the medical imaging and in particular the acquisition of medical images.

2. PREVIOUS WORK

Various research papers related to medical image Denoising are studied and discussed in this section. Medical image Denoising are widely used in today era's. These technology are easily diagnose the diseases which are might be in human body. Following are the previous paper which is represents the different methods of medical image Denoising:-

R.Riji, Jeny Rajan, Jan Sijbers, Madhu S.Nair, **"Iterative bilateral filter for Rician noise reduction in MR images"** An iterative bilateral filter for filtering the Rician noise in MR images. This filter the denoising efficiency and preserves the edge feature and fine structures in the images. It also removes the bias due to rician noise. In this paper PSNR and Mean structural similarity index matrix used to enhance and better quality of MR images.

Abha Choubey, Dr. G.R.Sinha, IEEE Member, Siddhartha Choubey**,"A Hybrid Filtering Technique in Medical Image Denoising: Blending of Neural Network and Fuzzy Inference**" In this paper, the Additive white Gaussian Noise from the CT images and improves the quality of the CT images. This work is comprised of three phases are preprocessing, training and testing. Hence, the denoised and the quality enhanced CT images are obtained in an effective manner.

Sandeep dubey, Fehreen hasan, Gaurav shrivasrava, **"A hybrid method for image denoising based on wavelet thresholding and RBF network"** In this paper, a hybrid based method on multi scale wavelet edge detection was used for achieving a better Denoising quality. PSNR was set to achieve the target and visual quality.

Vivek Singh Bhadouria, Dibyendu Ghosal, Abul Hasan Siddiqi **"A new approach for high density saturated impulse noise removal using decision-based coupled window median filter"** A new decision based algorithm has been proposed for removal the corrupted pixels in the image. This algorithm has been found to be able to remove the salt and pepper noise. The algorithm found better PSNR, image enhancement,SSIM.

3. NOISE

Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Image noise is regarded as an undesirable by-product of image capture. And although these unwanted fluctuations [7] became known as "noise" by analogy with unwanted sound they are inaudible and actually beneficial in some applications such as dithering. The characteristics of the noise depend on its source. Filter or the operator which best reduces the effect of noise also depends on the source . Many image-processing packages contain operators to artificially add noise to an image.

Different types of noise present in images which is given below:

Amplifier Noise: The standard model of amplifier noise is Gaussian ,additive, independent at each pixel and independent of the signal intensity. In colour cameras where more amplification is used in the blue colour channel as compare to green or red channel. there can be more and more noise in the blue channel. The Amplifier noise is the major part of the "read noise" of an image sensor during acquisition. That's of the constant noise level in dark areas of the image.

Gaussian Noise: Gaussian noise is the statistical noise that has own probability density function equal to that the normal distribution which is also called as the Gaussian distribution. one of the Another words, value of that the noise can take on are Gaussian-distributed. The special case is white Gaussian noise in which the values at any pairs of times are statistically independent and uncorrelated. In some of applications Gaussian noise is the most commonly used as additive white noise to yield additive white Gaussian noise. If white noise sequence is a Gaussian sequence then it's called a WGN (white Gaussian noise sequence).

Salt and Pepper Noise: An image containing salt-and-pepper noise will have dark pixels in the bright regions and bright pixels in dark regions. That type of noise can be caused by dead pixels during analogue to digital converter, transmission bit. That can be reduces or eliminated in large part by using dark frame subtraction and by interpolating around bright/ dark pixels. This noise is named for the salt and pepper appearance of an image take on after being degrades by this type of noise.

Speckle Noise: That type of noise is granular noise that inherently exists in and degrades the quality of the active radar and SAR(synthetic aperture radar) images. Speckle noise is the conventional radar results from random fluctuations in return signal from an object that is no bigger than a single image-processing element. It is increases the mean grey level of local area. Speckle noise is caused by signals from the gravity-capillary ripples, beneath, image of the sea waves, elementary scatterers, and manifests as a pedestal image.

4. RICIAN NOISE

Rician noise degrades images in both qualitative and quantitative senses, interpretation and feature detection. The bias due to rician noise reduces delectability in low SNR MRI. Consequently, it is highly desirable to develop filtering methods that remove this noise. The rician noise can be estimated from the image and a simple correction scheme is provided to reduce the bias. Rician noise introduces a bias into MRI measurements that can have a significant impact on the shapes and orientations of tensors in diffusion tensor magnetic resonance images. This is the less problem in structural MRI, because this bias is the signal dependent and it does not seriously impair tissue identification or clinical diagnoses.

EFFECTS OF RICIAN NOISE:

1. The rician noise is significant impact on the shapes and orientations of tensors in diffusion tensor magnetic resonance images.
2. Due to rician noise images suffer from a contrast values and signal dependent bias.

5. MEDICAL IMAGE DE-NOISING

The arrival of digital medical imaging technologies such as positron emission tomography (PET), magnetic resonance imaging (MRI), computerized tomography (CT) and ultrasound Imaging has revolutionized modern medicine. Today numbers of patients no longer need to go through invasive and often dangerous procedures to diagnose a wide variety of illnesses. The widespread use of digital imaging[8] in medicine today the quality of digital medical images becomes an important issue. To achieve the best possible diagnosis it is important that medical images be clear, sharp and free of noise and artifacts. The technologies for acquiring digital medical images continue to resulting in images of higher and higher resolution, improve and quality, removing noise in these digital images remains one of the major challenges in the study of medical imaging, because they could mask and blur important subtle features in the images. The many proposed de-noising techniques have their own problems. Image de-noising is still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. Noise modelling in medical images is greatly affected by capturing instruments; data transmission media; image quantization and discrete sources of radiation. Therefore different algorithms are used depending on the noise model. Then most of images are assumed to have additive random noise which is modelled as a white Gaussian noise. Medical images such as magnetic resonance imaging (MRI) and ultrasound images have been widely exploited for more truthful pathological changes as well as diagnosis. They suffer from a number of shortcomings and these includes: acquisition noise from the equipment; ambient noise from the environment; the presence of background tissue; other organs and anatomical influences such as body fat; and breathing motion. Noise reduction is very important; as various types of noise generated limits the effectiveness of medical image diagnosis.

6. NEURAL NETWORK

Artificial neural networks are composed of interconnection artificial neurons (programming constructs that mimic the properties of biological neurons). The Artificial neural networks may either be used to gain an understanding of biological neural networks or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real biological nervous system is based on highly complex artificial neural network algorithms attempt to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view. Good performance (for instance as measured by good predictive ability; low generalization error); or performance mimicking animal or human error patterns can then be used as one source of evidence towards supporting the hypothesis that the abstraction really captured something important from the point of view of information processing in the brain. Others incentive for these abstractions is to reduce the amount of computation required to simulate artificial neural networks; so as to allow one to experiment with large networks and train them on larger data sets. the Application areas of ANN include system identification and control (vehicle control, process control), and decision making (backgammon, chess, racing), pattern recognition (radar systems, face identification, object recognition), financial applications, sequence recognition (speech, gesture, handwritten text recognition), medical diagnosis, data mining (or knowledge discovery in databases, "KDD"), game-playing, e-mail spam filtering and visualization.

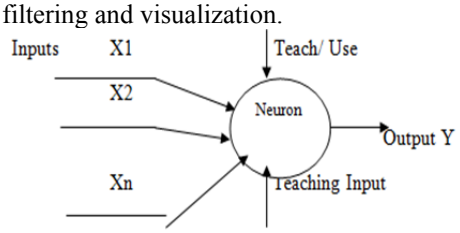


Figure1. Neural Network

7. BILATERAL FILTER

Bilateral filtering is a technique to smooth images while preserving edges. The use of bilateral filtering has grown rapidly and is now it is used in image processing applications such as image denoising, image enhancement etc. Several qualities of bilateral filter are enlisted below which explains its success:

- It is simple to formulate it. Each pixel is replaced by a weighted average of its neighbors.
- It depends only on two parameters that indicate the size and contrast of the features to preserve.
- It is a non-iterative method. This makes the parameters easy to set since their effect is not cumulative over several iterations .

However, the bilateral filter is not parameter-free. Therefore set of bilateral filter parameter has important influence on bilateral filter's behavior and performance. The parameters are window size w standard deviation σd and σr. In the case of noise removal; the parameters have to be adapted to the noise level during the bilateral filter adapts itself to the image details content.

8. LINEAR DISCRIMINANT ANALYSIS (LDA)

Linear Discriminant Analysis (LDA) is a well-known scheme for featureextraction and dimension reduction. It has been used many more of applications involving high-dimensional data, such as face recognition and image retrieval.Linear discriminant Analysis(LDA) is a techniques used for data classification and dimensionality reduction.

In the PCA the location and the shape of the original data sets changes when transformed to a different spaces whereas LDA doesn't change the location but only tries to provide more class separability and draw decision between the given classes.

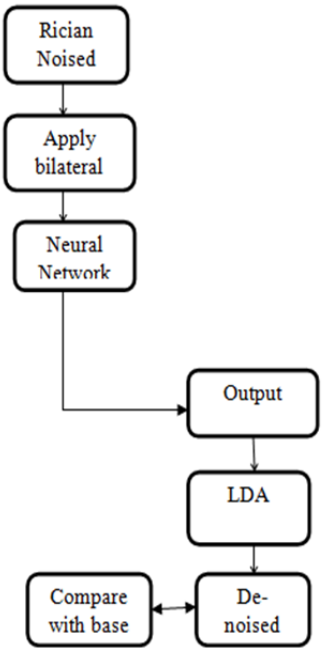
In discriminant analysis, two scatter matrices, called Sw (within-class) and Sb (between-class) matrices are determined to quantify the quality.

$S_w = \sum_{i=1}^{k} \sum_{x \in \Pi_i} (x - m_i)(x - m_i)^T$ and $S_b = \sum_{i=1}^{k} n_i (m_i - m)(m_i - m)^T$, where

$m_i = \frac{1}{n_i} \sum_{x \in \Pi_i} x$ is the *mean* of the *i*th class, and $m = \frac{1}{n} \sum_{i=1}^{k} \sum_{x \in \Pi_i} x$ is the *global mean*.

9. PROPOSED APPROACH

In this thesis, a new method is proposed for better quality of medical image. The proposed work is based on bilateral filter, LDA and Neural Network technique. There are many phases are as following:-



Phase 1:- The input image is loading from the database of the MATLAB. This is done for getting the input image pixel value in the workspace of the MATLAB.

Phase 2:- After getting noised image, the bilateral filter is apply to reduce the rician noise. The bilateral filter is defined for its effectiveness in edge-preserved image Denoising. Neural network is used to reduce the MSE and increase the value of PSNR or Mean SSIM.

Phase 3:- LDA is linear Discriminant analysis is well-known scheme for feature extraction and dimension reduction. This is used to compare the results between proposed and previous work.

10. RESULTS AND DISCUSSION

In this phase, present results are better and valuable of the experiments to corroborate the success of the proposed model.

PSNR:- The following figure shows the PSNR of previous and proposed work. This is used to reduce the noise and increase the quality of image.

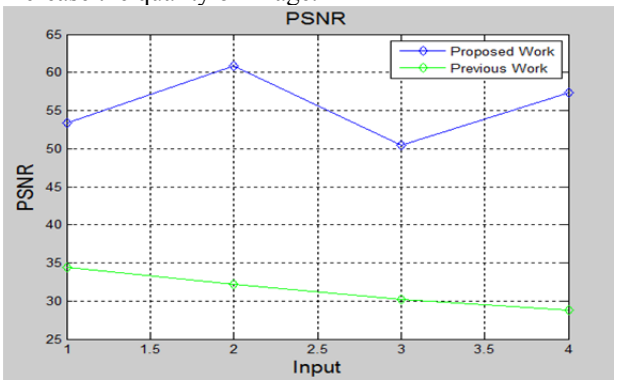


Figure2. PSNR of Previous work and proposed work

Figure 3 represents the values of PSNR in the form of noise image and denoised image.

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

Where, R is the maximum fluctuation in the input image data type. For example, if the input image has a double-precision floating-point data type, then R is 1. If it has an 8-bit unsigned integer data type, R is 255, etc.

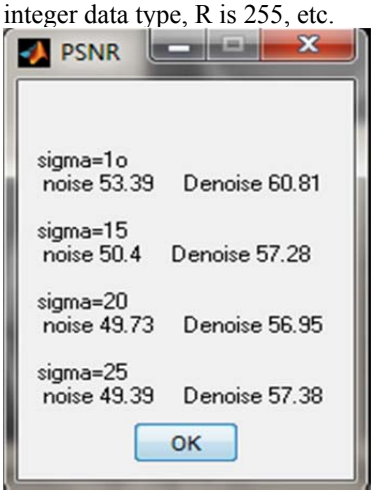


Figure3. Values of PSNR

MSE:- The MSE represents the cumulative squared error between the reconstructed and the original image. The working of MSE is lower the value of MSE, the lower the error.

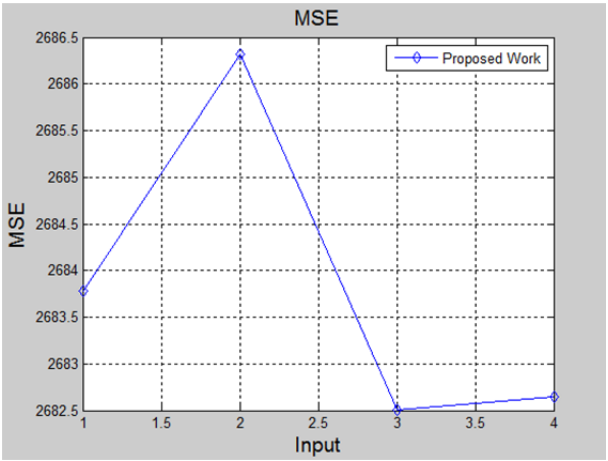


Figure4. MSE of Proposed work

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where,

M and N are the number of rows and columns in the input images, respectively.

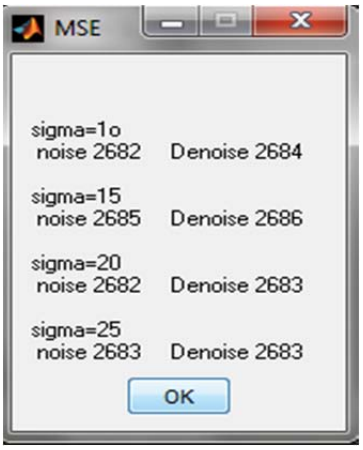


Figure5. Values of MSE

Mean SSIM: - The **structural similarity** (SSIM) index is a method for measuring the similarity between two images.

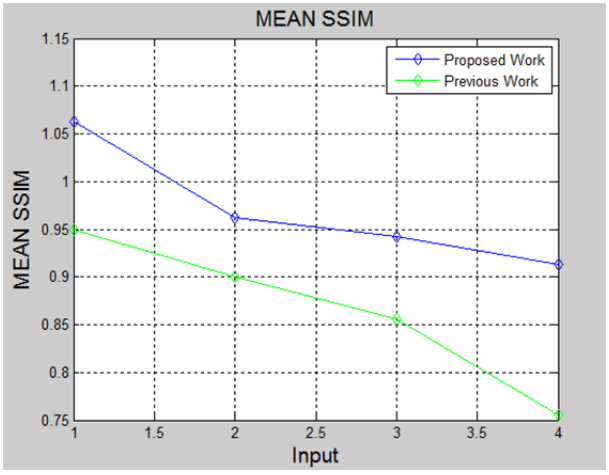


Figure6. Comparison of Mean SSIM between previous and proposed work

The structural similarity image quality method is based on the acquired that the image is an highly adapted for extracting structural information from the image, and after then, measure of structural similarity can provide a good approximation to perceived image quality.

Figure7. Values of Mean SSIM

11. CONCLUSION

In this paper, we are implement neural network and LDA as a tool for medical image de-noising. The Bilateral filter is used to remove the rician noise. Bilateral filter preserving the edges and make a fine structure of an image. The proposed approach and de-noising medical image using linear Discriminant analysis exhibit outcomes of noise reduction and image quality improvements, with different noise level is suitable for image de-noising. The previous work or result is compare with proposed work and it shows improvement on the basis of PSNR, MSE and Mean SSIM.

ACKNOWLEDGMENT

Thanks to my Guide and family member who always support, help and guide me during my dissertation. Special thanks to my father who always support my innovative ideas.

REFERENCES

[1] R.Riji, Jeny Rajan, Jan Sijbers, Madhu S.Nair "Iterative bilateral filter for Rician noise reduction in MR images", Springer 2014.

[2] Abha Choubey, Dr. G.R.Sinha, IEEE Member, Siddhartha Choubey,'' A Hybrid Filtering Technique in Medical Image Denoising: Blending of Neural Network and Fuzzy Inference",IEEE 2011

[3] Sandeep dubey, Fehreen hasan, Gaurav shrivasrava "A hybrid method for image denoising based on wavelet thresholding and RBF network." International Journal of Advanced computer Research 2012.

[4] Vivek Singh Bhadouria, Dibyendu Ghosal, Abul Hasan Siddiqi "A new approach for high density saturated impulse noise removal using decision-based coupled window median filter" Springer 2013.

[5] R.Vanithamani,G.Umamahes-wari "Speckle reduction in ultrasound images using neighshrink and bilateral filtering" Journal of computer science 2014.

[6] M.Vijay, L.Saranya Devi "Image denoising by multiscale and joint bilateral filter in spatial domain" International journal of soft computing and engineering 2012.

[7] Monika Pathania, ParulPreet Singh "An Efficient Technique of Noising and De-Noising Medical Images Using Support Vector Machine", 3483-3486 Vol. 5 (3), 2014.

[8] Amritpal Kaur#, Dr. Pankaj Kumar Verma **"**Review On: An Efficient Technique of Noising and De-Noising Medical Images Using Neuro– FUZZY and LDA**"** Vol. 5 (3) , 2014, 3246 – 3249.

[9] E.Salari, S. Zhang ,"Image de-noising using neural network based non-linear filter in wavelet domain", 0-7803-8874-7/05/IEEE(2005)

[10] F.Marvasti, N.sadati, S.M.E Sahraeia, " Wavelet image De-noising based on neural network and cycle spinning" 1424407281/07/IEEE(2007).

[11] Manjón, J.V., Carbonell-Caballero, J., Lull, J.J., Garciá-Martí, G., Martí-Bonmatí, L., Robles, M.: MRI denoising using non-local means. Med. Image Anal. **12**, 514–523 (2008).

[12] Lysaker, M.; Lundervold, A.; Xue-Cheng Tai, "Noise removal using fourth-order partial differential equation with applications to medical magnetic resonance images in space and time," Image Processing, IEEE Transactions on , vol.12, no.12, pp.1579,1590, Dec. 2003.

[13] Aja-Fernández, S., Alberola-López, C., Westin, C.F.: Noise and signal estimation in magnitude MRI and Rician distributed images: a LMMSE approach. IEEE Trans. Image Process. **17**, 1383–1398 (2008).

[14] Mr. S. Hyder Ali, Dr.(Mrs.) R. Sukanesh, Ms. K. Padma Priya " Medical image de-noising using neural networks".

[15] Rehman Amjad, Sulong Ghazali, Saba Tanzila "An intelligent approach to image denoising", (JATIT 2005-2010).

[16] Sontakke Trimbak R, Rai RajeshKumar, "Implementation of image de-noising using thresholding techniques", IJCTEE.