ISSN:0975-9646

Amritpal Kaur et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3) , 2014, 3246 - 3249

Review On: An Efficient Technique of Noising and De-Noising Medical Images Using Neuro– FUZZY and LDA

Amritpal Kaur[#], Dr. Pankaj Kumar Verma[*]

[#]*Computer Science, Kurukshetra University*
Panchkula Engg. College ,Mouli, Panchkula, India
[*] *Associate Proff. And HOD of computer Science,*
Panchkula Engg. College ,Mouli, Panchkula, India

***Abstract*— Medical imaging technology is becoming an important component of large number of applications such as diagnosis, research, and treatment. Medical images like X-Ray, CT, MRI, PET and SPECT have minute information about heart brain and nerves. These images need to be accurate and free from noise. Noise reduction plays an important role in medical imaging. Various method of noise removal such as filters, wavelets and thresholding based on wavelets. Although these methods produced good results but still have some limitations. Considering and analyzing the limitations of the previous methods our research presents neural networks as an efficient and robust tool for noise reduction [1,7]. In our research we use Neuro –Fuzzy and LDA as the learning algorithm which follows the supervised learning. The proposed research use both mean and median statistical functions for calculating the output pixels results in terms of PSNR and MSE.**

Keywords:- Noising, De-noising, Medical images, Neuro-Fuzzy and LDA

I. 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 a two dimensional function of two real variables. Image= f(x, y) where, x and y are the spatial coordinates known as pixels and f is the amplitude. Before, processing an image is converted into the digital form. The digitization includes; sampling of images and quantization of the sampled values. Therefore after converting the 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, refers to the image plane itself; it is based on the direct manipulations of the pixels in the image.
2. Frequency domain: In frequency domain, image is processed in form of sub bands. All types of transformations are applied in frequency domain. e.g 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[1,2]. It allows a much 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 over two dimensions digital image processing may be modeled in the form of multidimensional systems. Therefore 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 (e.g. for human pathological investigations). Then measurement and recording techniques which are not primarily designed to produce images; such as electroencephalography (EEG), magneto encephalography (MEG), 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. And in the clinical context; "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 two modalities that utilize visible light imagery. And diagnostic radiography designates the technical aspects of medical imaging and in particular the acquisition of medical images[2,10]. The radiographer or radiologic technologist is usually responsible for acquiring medical images of diagnostic quality; although some radiological interventions are performed by radiologists. Radiology is an evaluation of anatomy; nuclear medicine provides functional assessment. Many of the techniques developed for medical imaging also have scientific and industrial applications. And medical imaging is often perceived to designate the set of techniques that non-invasively produce images of the internal aspect of the body. The case of ultra-sonography the probe consists of ultrasonic pressure waves and echoes inside the tissue show the internal structure. The case of projection radiography; the probe is X-ray radiation which is absorbed at different rates in different tissue types such as bone; muscle and fat. Therefore term noninvasive is a term based on the fact that following medical imaging modalities do not penetrate the skin physically. On the electromagnetic and radiation level; they are quite invasive. From the high energy photons in X-Ray Computed Tomography, to the 2+ Tesla coils of an MRI device; these modalities alter the physical and chemical environment of the body in order to obtain data[8].

A. MEDICAL IMAGES

1. X-ray : X-rays, for example, are often used to detect broken bones and some types of cancer.
2. Computer Tomography (CT) : Computed Tomography (CT) scans, also known as CAT (Computed Axial Tomography) scans; produce multiple cross-sectional images of the body by using special X-rays and computer enhancements. Technology creates an image many times more sensitive and detailed than a simple X-ray can produce.
3. Magnetic Resonance Imaging (MRI): MRI provides extremely detailed images of body tissue; organs; and bones without using X-rays or radiation. It uses two natural; safe forces: magnetic fields and radio waves.MRI is used to detect a wide range of conditions; including cancer; heart and vascular disease; strokes; and disorders of the joints.
4. Ultrasound: Diagnostic medical sonography; is a safe and painless imaging process. This uses high-frequency sound waves; without radiation; to generate images of the internal structures of the body.
5. Echocardiography: When ultrasound is used to image the heart it is referred to as an Echocardiogram. It allows physicians to see detailed structures of the heart, including chamber size, heart function, the valves of the heart [10].

II. 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, many 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 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 sharp; clear; and free of noise and artifacts. The technologies for acquiring digital medical images continue to improve; resulting in images of higher and higher resolution 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, many proposed de-noising techniques have their own problems. Image de-noising 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 [7,8].

A. WAVELET TRANSFORM

Noise reduction using the wavelets is performed by first decomposing the noisy image into wavelet coefficients that is approximation and the detail coefficients. Then by selecting a proper thresholding values that detail coefficient are modified based on the thresholding function. Finally the reconstructed image is obtained by applying the inverse wavelet transform on modified coefficients. Basic procedure for all thresholding methods is [6]:

1. Calculate the Discrete Wavelet Transform (DWT) of the image.
2. Threshold the wavelet components
3. Compute the IDWT to obtain the de-noised image.

DWT of image signal produces a non-redundant image representation; which provides better spatial and spectral localization of image formation; compared with other multi scale representations such as Gaussian and Laplacian pyramid recently; Discrete Wavelet Transform has attracted more and more interest in image de-noising. The DWT can be interpreted as signal decomposition in a set of independent; spatially oriented frequency channels. Therefore signal S is passed through two complementary filters and emerges as two signals; approximation and Details. It is called decomposition or analysis. Components can be assembled back into the original signal without loss of information. These processes are called reconstruction or synthesis.

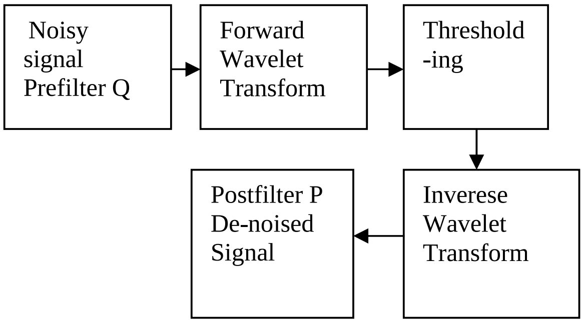

Figure 1: wavelet based de-noising

B. Discrete Wavelet Transform

Mathematical manipulation; which implies analysis and synthesis; is called discrete wavelet transform and inverse discrete wavelet transform. Image can be decomposed into a sequence of different spatial resolution images using DWT. Therefore in case of a 2D image; an N level decomposition can be performed resulting in 3N+1different frequency bands namely; LL; LH; HL and HH . The sub-image a1 is formed by computing the trends along rows of the image followed by computing trends along its columns. Therefore the same manner; fluctuations are also created by computing trends along rows followed by trends along columns. Then next level of wavelet transform is applied to the low frequency sub band image LL only. Therefore Gaussian noise will nearly be averaged out in low frequency wavelet coefficients. And only the wavelet coefficients in the high frequency levels need to be threshold [9].

III. Linear Discriminant Analysis:

Linear Discriminant Analysis (LDA) is a techniques used for data classification and dimensionality reduction.

In PCA, the shape and the location 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 within-class (Sw) and between-class (Sb) matrices, are defined to quantify the quality[12].

$$s_W = \sum_{i=1}^{k} \sum_{x \in ni} (x - m_i)(x - m_i)^T \text{ and } s_b = \sum_{i=1}^{k} n_i (m_i - m)(m_i - m)^T \quad (1)$$

$$\text{where } m_i = \frac{1}{n_i} \sum_{x \in ni} \text{ , x is the mean of the ith class ,and } m = \frac{1}{n} \sum_{i=1}^{k} \sum_{x \in ni} \text{, xis global mean}$$

IV. Artificial Neural Networks And Fuzzy Logic

Artificial neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons). Therefore 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. Therefore real; biological nervous system is 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 (e.g. 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. Other 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 larger networks and train them on larger data sets. And application areas of ANNs include system identification and control (vehicle control; process control); game-playing and decision making (backgammon, chess, racing), pattern recognition (radar systems; face identification; object recognition); sequence recognition (gesture; speech; handwritten text recognition); medical diagnosis; financial applications; data mining (or knowledge discovery in databases; "KDD"); visualization and e-mail spam filtering[4,6].

The concept of Fuzzy Logic (FL) was conceived by LotfiZadeh; a professor at the University of California at Berkley; and presented not as a control methodology; but as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership. And this approach to set theory was not applied to control systems until the 70's due to insufficient small-computer capability prior to that time. Therefore Professor Zadeh reasoned that people do not require precise; numerical information input; and yet they are capable of highly adaptive control. And if feedback controllers could be programmed to accept noisy; imprecise input; they would be much more effective and perhaps easier to implement. The U.S. manufacturers have not been so quick to embrace this technology while the Europeans and Japanese have been aggressively building real products around it. In this context, FL is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple; small; embedded micro-controllers to large; networked; multi-channel PC or workstation-based data acquisition and control systems. This can be implemented in hardware; software; or a combination of both. And FL provides a simple way to arrive at a definite conclusion based upon vague; ambiguous; imprecise; noisy; or missing input information. Therefore FL's approach to control problems mimics how a person would make decisions, only much faster[13].

V. CONCLUSION

Medical imaging technology is becoming an important component of large number of applications such as the diagnosis research and treatment. It enables the physicians to create the images of the human body for the clinical purposes. Medical images like X-Ray, CT, MRI and PET, SPECT have minute information about the heart brain and nerves. These images suffer from a lot of short comings including the acquisition of noise from the equipment, ambient noise from the environment and the presence of background tissue; other organs and anatomical influences such as body fat and breathing motion. Noise reduction therefore becomes very important. The main techniques of image de-noising are filters wavelets and neural networks. The LDA based approach is a powerful and effective method for image de-noising. Considering and analyzing the drawbacks of the previous methods we propose a new improved LDA approach to de-noise the medical images. This approach includes using boh mean and median stastical functions for calculating the output pixels of the NN. . In this research, we studied the existing methods of image de-noising, understand the limitations of the existing techniques and describe an efficient technique to reduce the noise. Regarding this, we will work on the Neuro – Fuzzy and Linear Discriminant Analysis (LDA).

ACKNOWLEDGMENT

Thanks to my Guide and family member who always support, help and guide me during my dissertation. This paper dedicated to my loving father, who always guide and help me.

REFERENCES

[1] Abuzoum Mohamed Saleh *"Efficient analysis of medical image de-noising for MRI and Ultrasound Images"*, (2012).

[2] Akutagawa Mastake, ChanYongjia, Katayama Masato, Yohsuke Kinouchi, Qinyu Zhang,*"Additive and multiplicative noise reduction by back propagation neural network"*, Proceedings of the 29th Annual International Conference of the IEEE EMBS Internationale, Lyon, France August 23-26, 2007 IEEE(2007).

[3] Al-Sobou Yazeed A. (2012) *"Artificial neural networks as an image de-noising tool"* World Appl. Sci. J., 17 (2): 218-227, 2012

[4] Dr. T.Santhanam, S.Radhika, *"Applications of neural networks for noise and filter classification to enhance the image quality"*, IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 2, September 2011 (IJCAI 2011).

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

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

[7] Gupta Manoj, KumarPapendra, KumarSuresh (IJCA-2010) *"Performance comparison of median and the weiner filter in image de-noising."*

[8] KaurJappreet, KaurManpreet, KaurManpreet, KaurPoonamdeep *"Comparative analysis of image de-noising techniques."* (IJETAE2012)

[9] Leavline E.Jebamalar Sutha S, Singh D.Asir Anton Gnana (IJCA-2011) *"Wavelet domain shrinkage methods for noise removal in mages."*

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

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

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

[13] Toshihiro Nishimura, Masakuni Oshiro, *"US Image Improvement Using Fuzzy NeuralNetwork with Epanechnikov Kernel"*, 978-1-4244-4649-0/09/ ©2009 IEEE