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Image Denoising using Neural Network with SVM (Support Vector Machine) and LDA (Linear Discriminant Analysis)

Ahmad Ali Saihood

[#]Lecturer in Computer Centre, Thi-Qar University
Nassirya,Thi-Qar,Iraq

***Abstract*— the medical figure technology is become a much powerful component for number of applications such as diagnosis; research; and treatment. Medical figure like X-Ray; CT; MRI; PET and SPECT have small information about heart brain and nerves. All of These figures need to be exact and free from noise. To minimize noise plays an important role in medical imaging. The numbers of methods of noise removal such as filter and thresholding based on wavelet. Although this method does not produce good results but also have some limitations. Taking and analyzing the limitations of the previous method; our research presents neural networks as an efficient and robust tool for noise reduction [1,7]. In research; use Neural Network; SVM 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, Neural Network, SVM 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. Then 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.

The aim 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 United State America. 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. [8].

The paper describe as in section II shows medical image denoising. Section III tell about NN and section IV gives idea about LDA and section V discuss SVM. At last in section VI detailed about result and section VII about conclusion.

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. Therefore 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.

III. Neural Networks

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. [4,6].

IV. Linear Discriminant Analysis:

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

In PCA; then 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.

The discriminant analysis; two scatter matrices; called within-class (Sw) and between-class (Sb) matrices, are defined to quantify the quality[12].

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

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

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 technique. [13].

V. SVM

The Support Vector Machine (SVM) is a state-of-the-art classification method introduced in 1992 by Boser, Guyon, and Vapnik . The SVM classifier is widely used in bioinformatics (and other disciplines) due to its highly accurate; able to calculate and process the high-dimensional data such as gene expression, and exibility in modeling diverse sources of data .SVMs belong to the general category of kernel methods. The kernel method is an algorithm that depends on the data only through dot-products. This is the case; the dot product can be replaced by a kernel function which computes a dot product in some possibly high dimensional feature space. It has two advantages: First; the ability to generate non-linear decision boundaries using methods designed for linear classifiers. Then second; the use of kernel functions allows the user to apply a classifier to data that have no obvious fixed-dimensional vector space representation. Therefore prime example of such data in bioinformatics are sequence; either DNA or protein; and protein structure. Using SVMs effectively requires an understanding of how they work. When training an SVM the practitioner needs to make a number of decisions: how to preprocess the data, what kernel to use; and finally; setting the parameters of the SVM and the kernel [1]. Uninformed choices may result in severely reduced performance. We purpose to provide the user with an intuitive understanding of these choices and provide general usage guidelines.

A. Properties of SVM:

1. Flexibility in choosing a similarity function

2. Sparseness of solution when dealing with large data sets

3. Ability to handle large feature spaces

4. Over fitting can be controlled by soft margin approach

VI Result Discussion

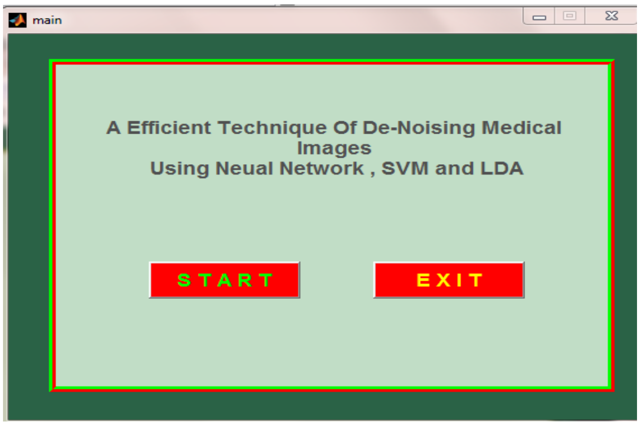

Figure 1: GUI front layout

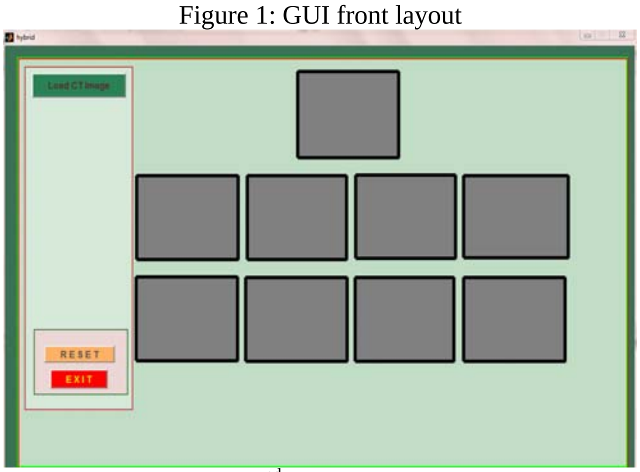

Figure 2: GUI 2nd layout to load CT image

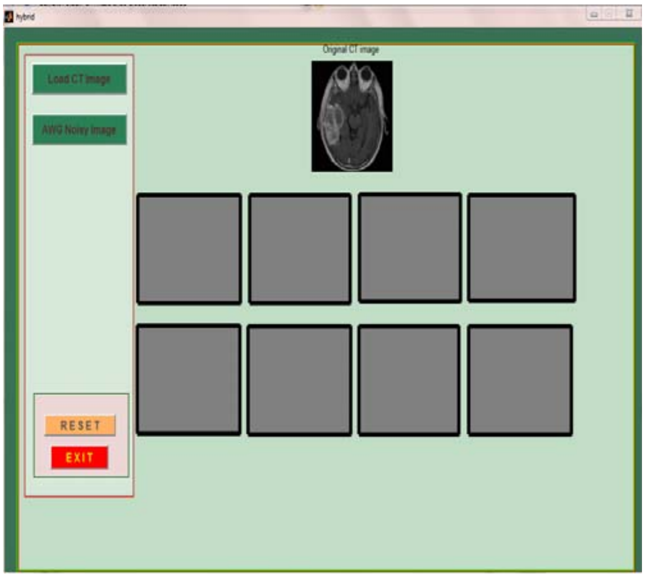

Figure 3: GUI layout after CT image

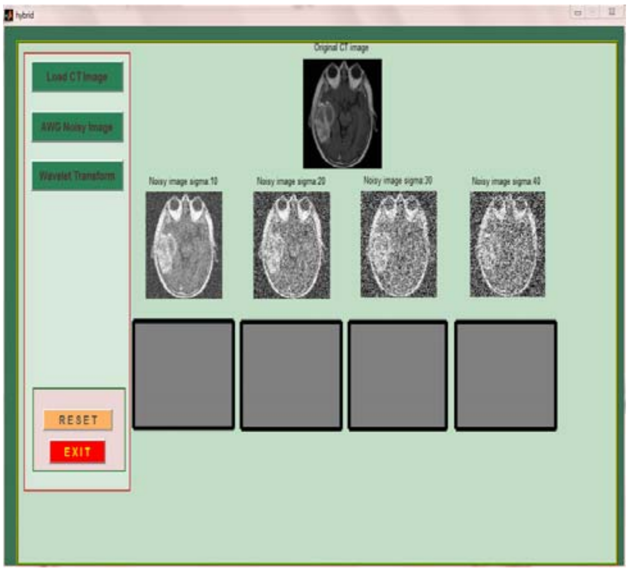

Figure 4: To load image with adding AWGN noise

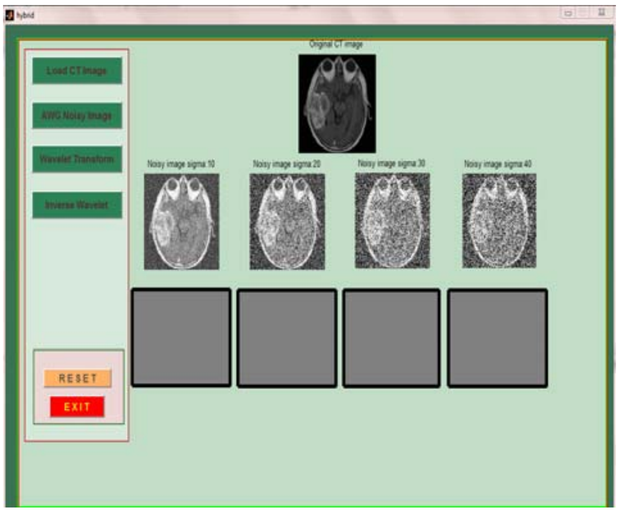

Figure 5: After loading noise image

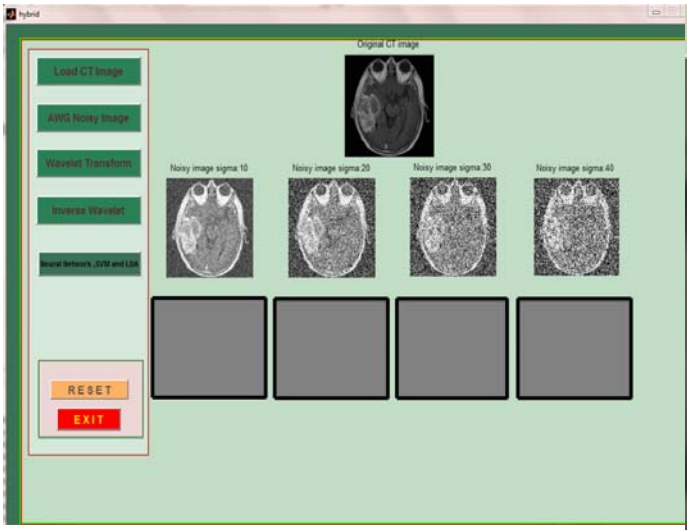

Figure 6: To perform NN, SVM and LDA

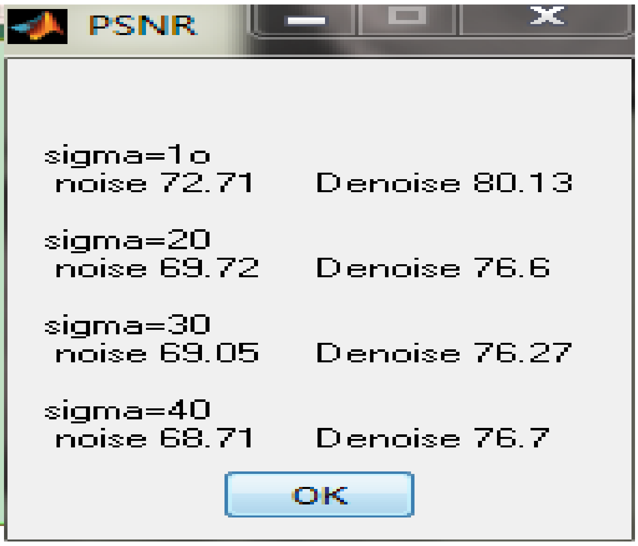

Figure 9: PSNR value with different noise level

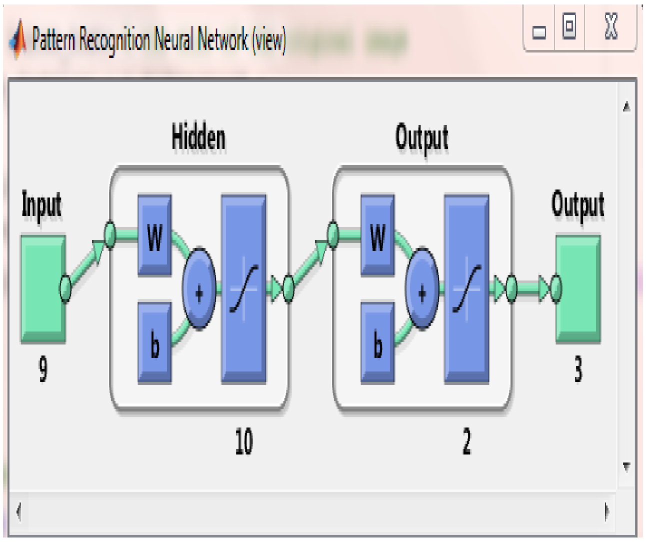

Figure 7: Neural Network view

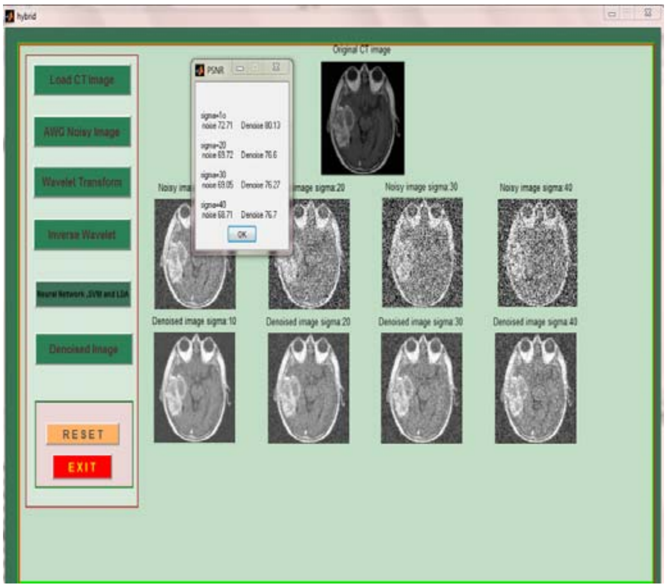

Figure 10: last GUI layout with PSNR value

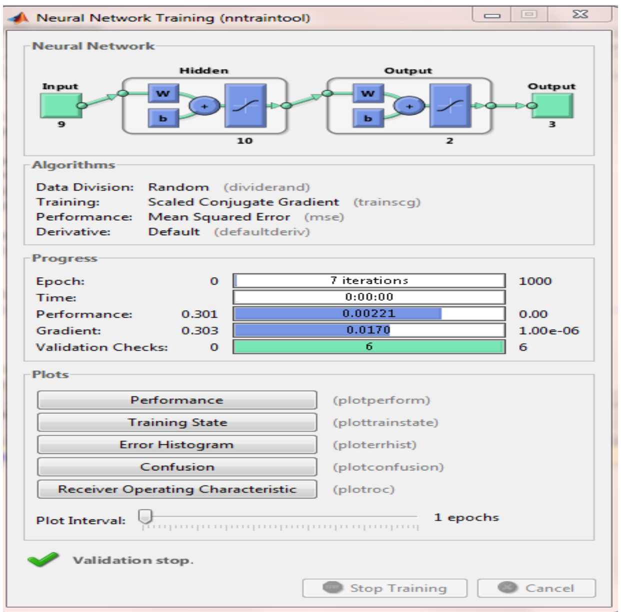

Figure 8: Performance analyze by using NN

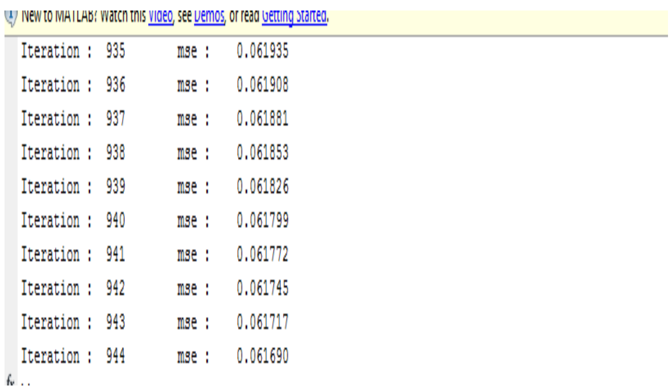

Figure 11: image of iteration value in command window

The above figure shows that the result of above techniques which is discuss. Figure 9 show the PSNR with different sigma value. These PSNR values come by using NN, SVM and LDA. This PSNR values better than previous PSNR value of different technique.

VII. Conclusion

Medical figure technology is becoming an important component of large number of applications such as the diagnosis research and treatment. 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 PSNR value to show that denoising is good by using NN, SVM and LDA technique.

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