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An Efficient Technique of Image Noising and Denoising using Neuro Fuzzy and SVM

Jyoti Sharma[1] and Mrs.Rupinder Kaur[2]

[1] *Mtech (Computer Science)Student of RIMT-IET Punjab,India*
[2]*Assistant Professor in Computer Science RIMT-IET,Punjab,India*

Abstract:- **Medical imaging technology is becoming an important component of large number of applications i.e. diagnosis, research, and treatment. Medical images are X-Ray, MRI, PET, CT and SPECT have minute information about heart brain and nerves. These images need to be accurate and noise free. Noise reduction plays the vital role in medical imaging. There are various methods of noise removal like filters, wavelets and Thresholding are based on wavelets. These methods produced good results but still have some limitations. The limitations of the previous methods are Considering and analyzing our research presents neuro fuzzy and SVM as an efficient and robust tool for noise reduction. In this paper, the proposed research use both mean and median statistical functions for calculating the output pixels of training patterns of the neural network and fuzzy provide promising results in terms of PSNR and MSE.**

Keywords:- **Image De-noising, PSNR, Fuzzy Logic, SVM.**

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.

The 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.

MEDICAL IMAGE DE-NOISING

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 features of image. There are many de-noising techniques have their own problems. Therefore, Image de-noising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. Therefore different algorithms are used depending on the noise model. Noise reduction is very important; as various types of noise generated limits the effectiveness of medical image diagnosis [7, 8].

SUPPORT VECTOR MACHINE (SVM)

It is primarily a classifier in which Width of the margin between the classes is the optimization criterion, i.e. empty area around the decision boundary defined by the distance to the nearest training patterns. These are called support vectors. The support vectors change the prototypes with the main difference between SVM and traditional template matching techniques is that they characterize the classes by a decision boundary. This decision boundary is not just defined by the minimum distance function. The concept of (SVM) Support Vector Machine was introduced by Vapnik. The objective of any machine that is capable of learning is to achieve good generalization performance, given a finite amount of training data. The support vector machines have proved to achieve good generalization performance with no prior knowledge of the data. The principle of an SVM is to map the input data onto a higher dimensional feature space nonlinearly related to the input space and determine a separating hyper plane with maximum margin between the two classes in the feature space. The SVM is a maximal margin hyper plane in feature space built by using a kernel function. This results in a nonlinear boundary in the input space. The optimal separating hyper plane can be determined without any computations in the higher dimensional feature space by using kernel functions in the input space. There are some commonly used kernels include:-

a) Linear Kernel

K(x, y) = x, y

b) Polynomial Kernel

K(x, y) = (x. y+1) d

SVM Algorithm

i. Define an optimal hyper plane.
ii. Extend the above definition for non linear separable problems.
iii. Map data to high dimensional space where it is easier to classify with linear decision surfaces.

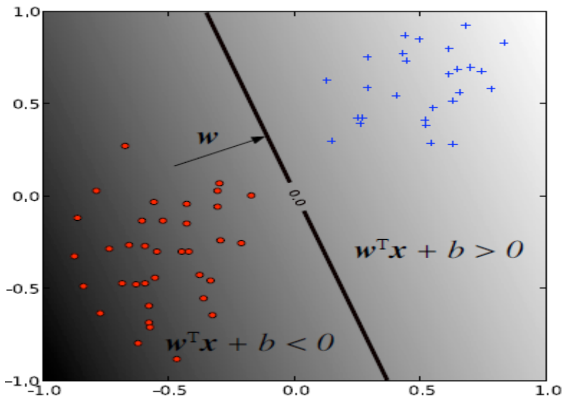

Figure 1

II. Literature Review

A lot of research has been done in the field of image de-noising but yet the area of image de-noising, especially for the medical images remains to be a hot area of research. Stress has been laid to summarize the concept of different authors who has worked in this field.

Ms S. Hyder Ali, Dr. (Mrs.) R. Sukanesh, Ms. K. Padma Priya (2001)[10] proposed a new type of thresholding neural networks(TNN) with a new class of smooth non-linear thresholding functions being the activation function. Unlike the standard soft thresholding functions the new non linear thresholding functions were infinitely differentiable. The TNN based space-scale adaptive noise reduction algorithm exhibited much superior then the soft thresholding.TNN can be further used to produce over effective learning algorithms for various applications.

Rajesh Kumar Rai, Trimbak R.Sontakee (2002)[12] conducted a study on various thresholding techniques such as Sure Shrink, Visu Shrink and Bayes Shrink and determine the best one for image de-noising .Wavelet de-noising attempts to remove the noise present in the signal while preserving the signal characteristics, regardless of its frequency content. It involves three steps: a linear forward wavelet transform, nonlinear thresholding step and a linear inverse wavelet transform. Wavelet thresholding is a signal estimation technique that exploits the capabilities of wavelet transform for signal de-noising. It removes noise by killing coefficients that are insignificant relative to some threshold, and turns out to be simple and effective, depends heavily on the choice of a thresholding parameter and the choice of this threshold determines, to a great extent the efficiency of de-noising.

S.Zhang, E.Salari (2005)[5] presented a neural network based de-noising method implemented in the wavelet transform domain. In this method, a noisy image is first wavelet transformed into four sub bands, then a trained layered neural network is applied to each sub band to generate noise-removed wavelet coefficients from their noisy ones. The de-noised image is thereafter obtained through the inverse transform on the noise-removed wavelet coefficients. Simulation results demonstrate that this method is very efficient in removing the noise. Compared with other methods performed in wavelet domain, it requires no a priori knowledge about the noise and need only one level of signal decomposition to obtain very good de-noising results.

SME Sahraeian, F. Marvasti, N Sadati (2006)[6] proposed a new method based on the wavelet transform. in this method an improved TNN were introduced by utilizing a new class of smooth non linear thresholding functions as the activation function. This approach introduced best threshold in the sense of minimum MSE mean square error. TNN obtained thresholds were employed using a cycle spinning based technique to reduce the image artifacts. This method outperforms other established wavelet denoising techniques in terms of PSNR and visual quality.

Yongjian Chen, Masatake Akutagawa, Masato Katayama, Qinyu Zhang and Yohsuke Kinouchi(2007)[2] proposed a novel filter by applying back propagation neural network (BPNN) ensemble where the noisy signal and the reference one are the same. The neural network(NN) ensemble filter not only well reduces additive and multiplicative white noise inside signals, but also preserves signals' characteristics. It is proved that while power of noise is larger, the reduction of noise using NN ensemble filter is better than the improved ε nonlinear filter and single NN filter, and compared with the improved ε nonlinear filter, degradation of the capability for reduction of noise by NN ensemble due to the increase of noise power is much suppressed. Furthermore, it presented the relationship between noise reduction and bandwidth of noises. The performance of the NN ensemble filter is demonstrated in computer simulations and actual electroencephalogram (EEG) signals processing.

Masakuni Oshiro, Toshihiro Nishimura(2009)[13] conducted study on a Multi-Layer Back-Propagation Neural Networks (MLBPNNs) with the Epanechnikov fuzzy function and proposed to reduce the speckle, and while at the same time, enhance the lesion boundaries of the UltraSound(US) image. The main goal of the proposed method is to improve the quality of US image so as to improve the quality of the humans interpretation and the computer systems auto-edge detection. In order to automatically detect the lesion boundary by a computer system, an edge enhancement is required. Evaluating the simulation results by Peak Signal to Noise Ratio (PSNR), Normalized Mean Square Error (NMSE), Detail Variance (DV), and Background Variance (BV), the proposed method demonstrates an increased performance of reducing the speckle and enhancing the edge. The proposed method has higher PSNR than conventional methods and can remove the speckle sufficiently, so that tumour boundaries of real US breast tumor image could be preserved and detected.

Tanzila SABA, AMJAD Rehman, Ghazali Sulong(2010)[11] presented an novel approach based on the Cellular neural networks(CNN) to de- noise an image even in the presence of very high noise. Image De-noising was devised as a regression problem between the noise and signals solved using CNN. The noises are detected with surrounding information and removed. The proposed algorithm exhibited promising results from qualitative and quantitative point of view. Experimental results of the proposed algorithm exhibit high performance in PSNR and visual effects in color image even in the presence of high ratio of the noise

Dr. T. Santhanam, S. Radhika(2011)[4] explored the possibility of using an Artificial Neural Network(ANN) for image classification followed by the suitable filter classification for the removal of a specific type of noise. In this method the Multilayer perceptron(MLP), Back propagation neural network(BPNN), Probabilistic Neural network(PNN) are used to classify the noise in an image as non Gaussian white noise, Gaussian noise and salt and pepper noise. Then these noise inputs are given to MLP, BPNN, and PNN which identifies the suitable filters for the noise removal.

Yazeed A. Al-Sbou (2012)[3] presented neural network as a noise reduction efficient and robust tool. In this research the BPNN is used as a learning algorithm. This approach includes using boh mean and median stastical functions for calculating the output pixels of the NN. This uses a part of degraded image pixels to generate the system training pattern. the output of the proposed approach provided a good image de-noising performance which exhibits a promising results of the degraded noisy image in terms of PSNR, MSE and visual test.

Considering and analyzing the drawbacks of the previous methods we propose a new improved Neuro-Fuzzy and SVM approach to de-noise the medical images. This approach includes using boh mean and median stastical functions for calculating the output pixels of the Neuro-Fuzzy and SVM. This uses a part of degraded image pixels to generate the system training pattern. Different test, images noise levels and neighborhood sizes are used. Based on using samples of degraded pixels neighborhoods as input, the output of the proposed approach provided a good image de-noising performance which exhibits a promising results of the degraded noisy image in terms of PSNR, MSE and visual test.

III. METHODOLOGY

Flow chart

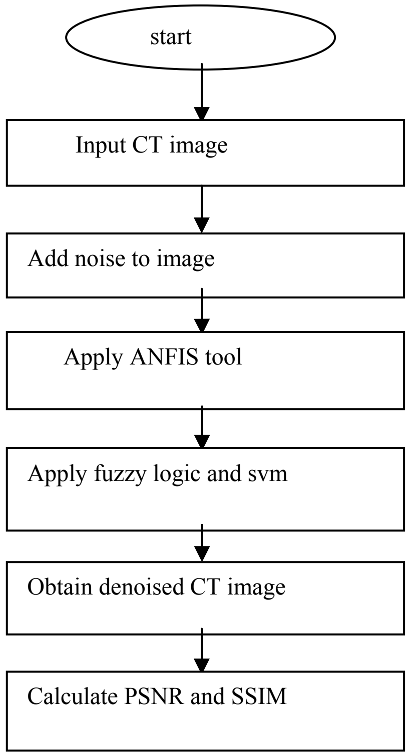

Figure 2

Step1: Take a medical image as input.

Step2: Pre-processing will be done:

Image will be de-noised by using iterative bilateral filter.

For simulation ,we will use the MR image of the brain with with intensity values in the range 0-255. and image will be artificially corrupted by noise.

Parameters PSNR and SSIM will be calculated.

Step 3: After preprocessing the work will be done using the neuro-fuzzy and SVM i.e proposed method. Then SVM will be applied.

Take sample image and noised image in dataset of svm.

Train noised image according to denoised image.

Case1:The more closer pixels,the images are similar.

Case2:The more space between pixels,the images are not similar.

Adaptive Neuro-Fuzzy Inference System(ANFIS),which are available in Fuzzy logic toolbox of MATLAB software will be used to denoise the image.

De-noised image will be obtained by reducing MSE.

Parameters will be calculated,by setting the parameters of SVM.

Step4: The quantitative analysis will based on the standard metrics like Peak Signal –to-noise ratio and Structural Similarity Index Matrix.

IV. Results

Comparison between previous work and proposed work on the basis of PSNR and SSIM.

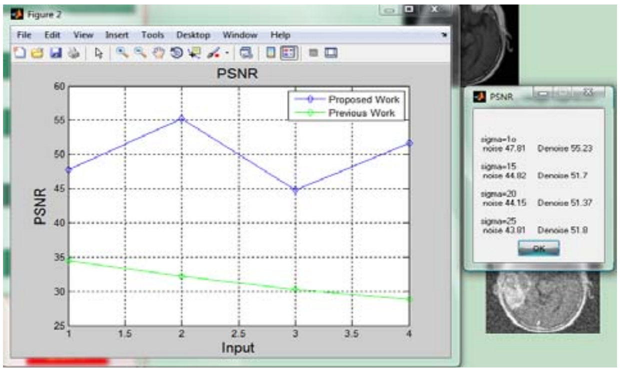

Figure 3

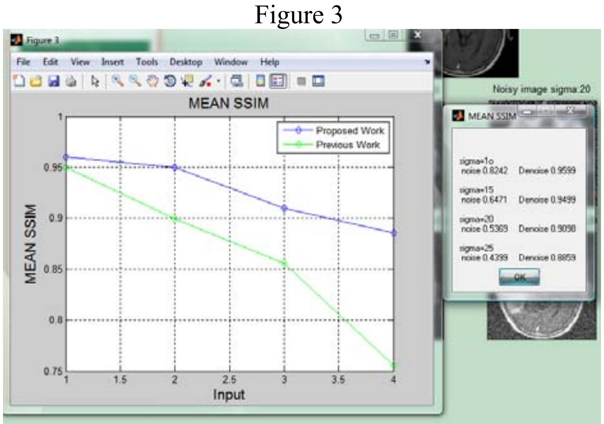

Figure 4

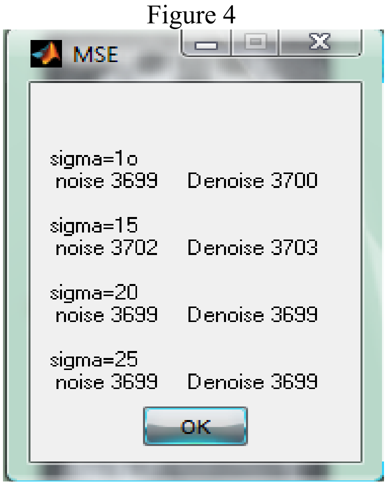

Figure 5

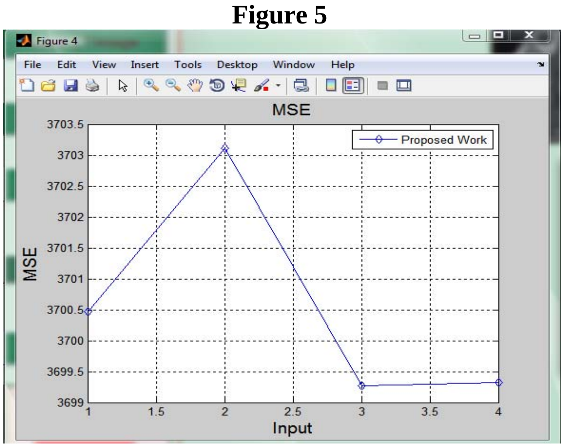

Figure 6

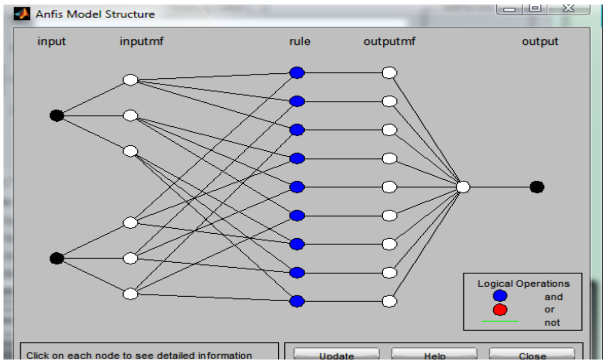

Figure 7

V. Conclusion

In this paper, we propose the neuro fuzzy and SVM as a tool for image de-noising and enhancement. ANFIS and SVM will be used. The evaluation will also include both mean and median functions. The evaluation will be based on the PSNR, MSE. The proposed approach i.e., improved technique for medical image de-noising using Neuro Fuzzy and SVM will exhibit outcomes of noise reduction and image quality improvements, with different noise levels, which will qualify it to be suitable for image processing and de-noising. This thesis is limited to applying medical image noising an denoising to single image.We can extend our research to work on the different medical images simultaneously.Also in future parameters like by enhancing the number of pixels quality can be considered.As we can also extend this work for the infinite number of users.We can further apply new formulas or algorithms for the enhancement of PSNR and SSIM.The proposed algorithm can be implemented on different tools.

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