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An Efficient Technique of Noising and De-Noising Medical Images Using Support Vector Machine

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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 methods 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. In our research we use SVM 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 and 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.

II. NOISE IMAGE

Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. The image noise is regarded as an undesirable by-product of image capture. And these unwanted fluctuations became known as "noise" by analogy with unwanted sound they are inaudible and actually beneficial in some dithering application. Therefore 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.

III. 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]. There are different techniques of de-noising from the medical image which given as:

a) Filter techniques
b) Wavelet techniques
c) Discrete Wavelet Transform

a) *Filter:*-In image processing filters are mainly used to suppress either the high frequencies in the image that is smoothing the image, or the lower frequencies that is enhancing or detecting edges in the image. The image can be filtered in frequency domain or in the spatial domain. In spatial domain there are two types of filters namely linear filters and non linear filters.

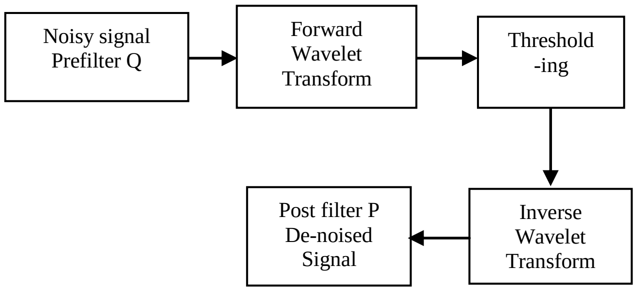

Figure 1: wavelet based de-noising

b) *Wavelet Transform:*-Noise reduction using the wavelets is performed by first decomposing the noisy image into wavelet coefficients that is approximation and coefficients. By selecting a proper Thresholding values that 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.

c) *Discrete Wavelet Transform:*-At last 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; DWT has attracted more and more interest in de-noising image. The interpretation of DWT 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. This is known as reconstruction or synthesis. 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. Hence, 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].

IV. METHODOLOGIES

The methodology has three phases:

1. **Preprocessing:** The CT image which is affected by the AWGN noise is transformed using multi-wavelet transformation.

2. **Training:** In the training phase the obtained multi-wavelet coefficients are given as input to the Support Vector Machine.
3. **Testing:** In the testing phase, the input CT image is examined using trained SVM and then to enhance the quality of CT image Thresholding is applied and then image is reconstructed.

The flowchart of the proposed work is as follows:

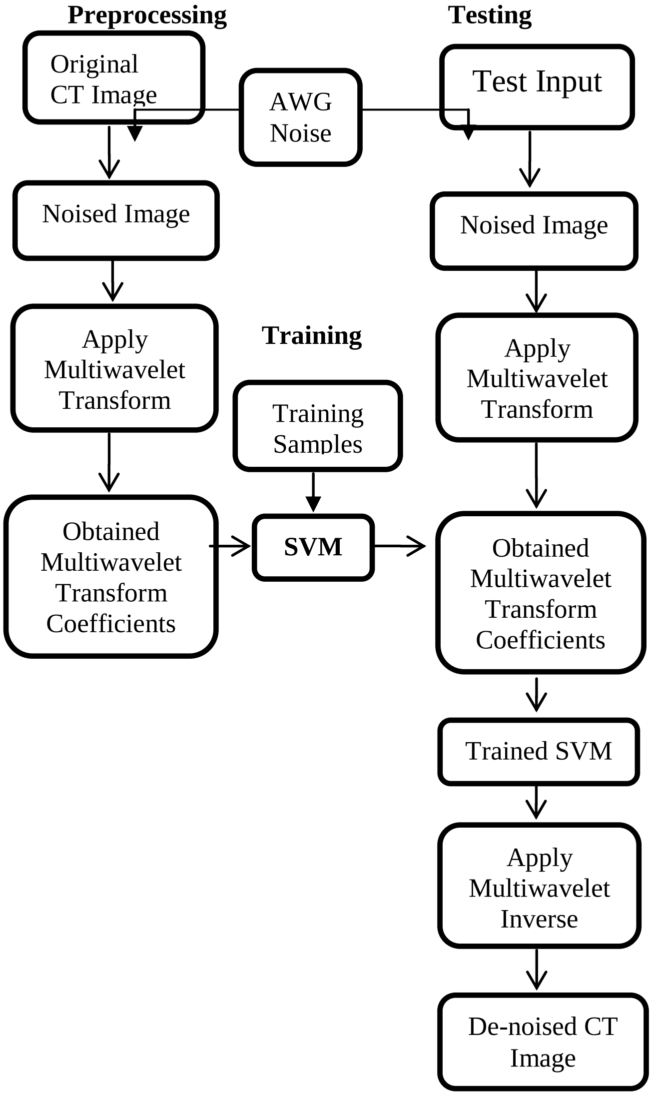

Figure 2: Proposed De-noising Technique

The methodology used is:-

Step 1: Code is developed to load original CT image in MATLAB and after that code is developed to add AWGN (Additive White Gaussian Noise) in CT image.

Step 2: Code is developed to apply Multiwavelet Transform on noised CT image. Thus we are obtained Multiwavelet Transform Coefficients.

Step 3: SVM code is developed and applied to check and enhance our result. Also SVM i.e., curve fitting tool present in MATLAB is used to check the accuracy of our work.

Step 4: Code is developed to perform Thresholding operation and then inverse Multiwavelet transform has applied.

Step 5: By using this mechanism noise is removed in better way than existing system.

The main methodology of thesis work is "SUPPORT VECTOR MACHINE".

V. 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.

VI. RESULTS

In the following figures, result of all the intermediate steps of the proposed algorithm is highlighted:

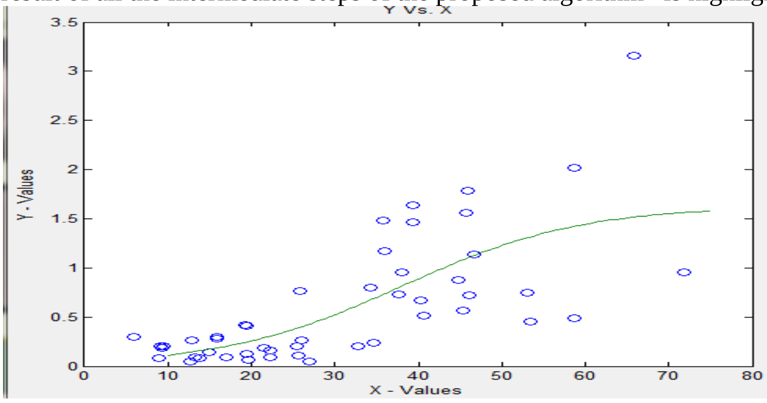

Figure 3: shows non linear classifier obtained by using SVM

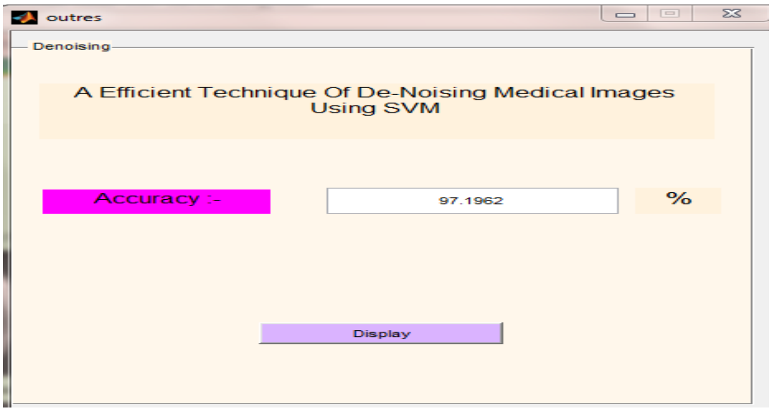

Figure 4: shows the accuracy of de-noised image by using SVM

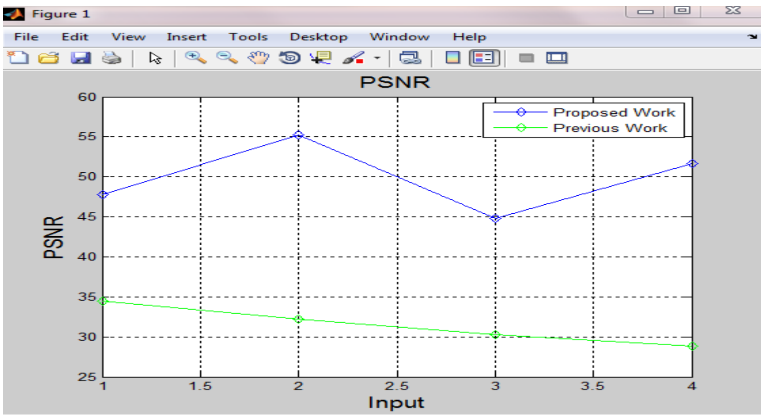

Figure 5: Comparison of proposed method and previous method

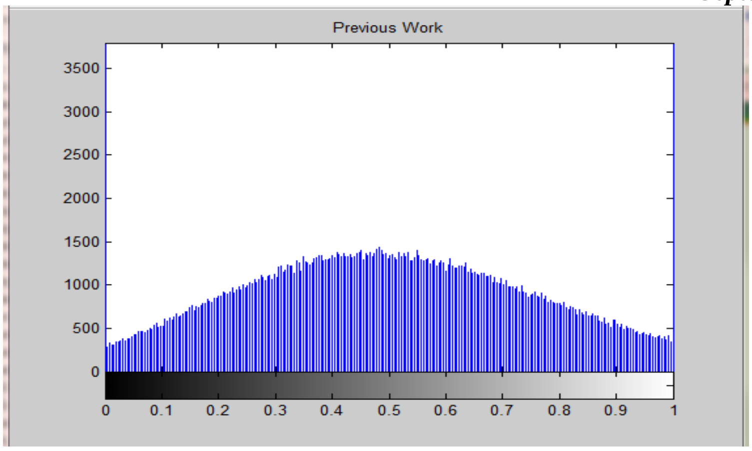

Figure 6: Graphical representation of previous method

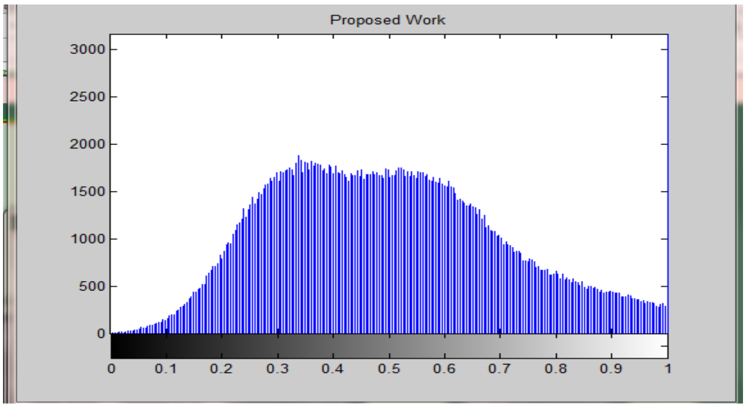

Figure 7: Graphical representation of proposed method.

VII. CONCLUSION

In this thesis, we implemented the support vector machine as a tool for medical image de-noising. The evaluation also includes both mean and median functions. The evaluation was based on the PSNR, MSE. The advantage of using Support Vector Machine is the use of kernels, absence of local minima, sparness of the solution and capacity control obtained by optimizing the margin. The proposed approach i.e., an efficient technique of noising and de-noising medical image using Support Vector Machine exhibit outcomes of noise reduction and image quality improvements, with different noise levels, is suitable for image de-noising. In future, Advanced Multiwavelet Transform technique can be used to produce better results.

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