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ANALYSIS OF MEDICAL CT IMAGES THROUGH WAVELET TECHNIQUES

V.Vijaya Basker[1], Lakshmi Rekha.R[2],M.K. Mishra[3]

[1]*Prof Sathyabama University Chennai*

[2,] *Asso. Prof. ,* [3]*Professor ,E.G.S Pillay Engineering College, Nagapattinam (T.N.),*

ABSTRACT

Nowadays medical diagnosis become very critical and various sophisticated techniques are used by the medical practioners due to lacking of time and techniques sometimes the practioners got confused due to variety of noise is embedded over the output images like x-rays, CT scan, MRI etc. So there is a requirement to introduce some good methodology which has less complexity and more accuracy. In the present paper we deals with de noising of medical images by threshold techniques in wavelet domain, the conventional threshold functions are presented based on wavelet transform and a new threshold function is proposed based on wavelet decomposition because This proposed threshold function has many advantages over soft threshold functions under MATLAB platform. The simulation results show that the proposed thresholding technique has better features in comparison with conventional methods. Using multi-resolution techniques, medical images are decomposed into various resolution levels, which is sensitive to different frequency bands. The most significant features for diagnostic medical images is to reduce noise which is generally found in medical images and make better image quality for good prediction of disease.

Keywords-Wavelet Thresholding, Wavelet transform, Image De-noising, PSNR, MSE

I. INTRODUCTION

There are various techniques and tests are there to detect the disease but due to noise which is created by machine or human. It is very difficult to locate an exact spot which is affected by disease, it may leads to misdiagnosis. The aim is to provide a technique using existing algorithm and introducing new algorithm for de-noising the medical images comparison of existing and proposed techniques and optimize the results which are very helpful for accurate diagnosis.

In the past few years, various researches is going on in the field of medical diagnosis the wavelets have emerged as a powerful tool for image processing. To achieve a good performance in this respect, a de-noising Algorithm has to adapt to identify the signal discontinuities. Wavelet transforms (WT) based schemes have proved to be effective, especially the non-linear threshold-based de-noising schemes.

We use Poisson, Gaussian, speckle and salt & pepper noises using wavelet transform. The performances of the various thresholding techniques with different wavelet methods are compared in terms of Peak Signal to Noise Ratio (PSNR) and the results are presented.

II. METHODOLOGY

A. Block Diagram of the De-noising Process

The de-noising of medical image can be done as shown in (Figure 1).

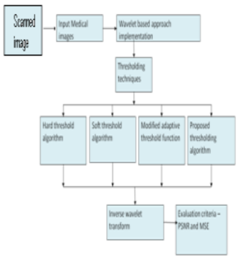

Fig.1 Block diagram of the de-noising process

The main objective of the proposed project is de-noising the input medical image. For this we chosen CT scanned image of brain which is shown in image (Fig 2) which is affected by noise. The input medical image is preprocessed.

Fig.2 Input CT scanned image of brain

The signal representation of input image is shown in (Figure 3(a)). The coefficient of the input image is analyzed. The plot of wavelet coefficients in (Figure 3(b)) suggests that small coefficients are dominated by noise, while coefficients with a large absolute value carry more signal information than noise.

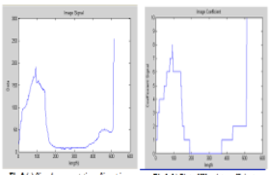

Fig.3 (a) Signal representation of input image Fig.3 (b) Plot of Wavelet coefficients

Canny edge detector is used to differentiate higher and lower intensity pixels and to preserve edge details (Figure 4)

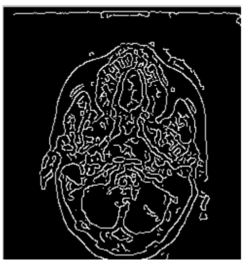

Fig.4 Edge detection using canny edge detector

B. Thresholding techniques

The Hard thresholding is defined as:

D (U, λ) = U for all

|U|> λ = 0 otherwise …1

The soft thresholding operator is defined as:

D (U, λ) = sgn(U)max(0, |U| - λ) …2

Adaptive thresholding is defined as follows:

$$w'_{j,k} = \begin{cases} \operatorname{sgn}(w_{j,k})\left|w_{j,k}\right| - \frac{t}{2}\left(1 - \exp(w_{j,k}^2\right), & \left|w_{j,k}\right| > t \\ 0, & \left|w_{j,k}\right| < t \end{cases} \quad ..3$$

Proposed thresholding is defined as follows:

$$w'_{j,k} = \begin{cases} \operatorname{sgn}(w_{j,k})\left|w_{j,k} - t\right| + \beta w_{j,k}, & \left|w_{j,k}\right| > t \\ 0, & \left|w_{j,k}\right| < t \end{cases} \quad ..4$$

Where sgn(*) is a sign function, $w_{j,k}$ stands for wavelet coefficients, $w\hat{}_{j,k}$ stands for wavelet coefficients after treatment, t stands for threshold value

C. Wavelet De-noising

Wavelets are mathematical functions that distribute data into different frequency components with a resolution matched to its scale. Wavelets have advantages over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes.

The **Haar wavelet** is a sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. The **Daubechies** wavelets, based on the work of Ingrid Daubechies, are a family of orthogonal wavelets defining a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. In applied mathematics, **symlet wavelets** are a family of wavelets. They are a modified version of Daubechies wavelets with increased symmetry.

D. Parameter estimation

PSNR is defined via the mean squared error (*MSE*). Given a noise-free *m*×*n* monochrome image *I* and its noisy approximation *K*, *MSE* is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad ...5$$

The PSNR (in dB) is defined in equation 6:

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \quad ...6$$

Here, MAX_I is the maximum possible pixel value of the image.

III. EXPERIMENTAL RESULTS

While using existing techniques and proposed techniques we optimise the Selection of thresholding is very important in denoising images. It is very sensitive because often the result of such output might be so close or nearly the same as that of the input with noise still present in the output signals.

The setup is as follows:

1. The processed input image is taken.
2. We step through the thresholds from 0 to 16 with steps of 2 and at each step denoised the noisy images by thresholding methods with that threshold.
3. For each threshold, the MSE of the denoised signal is calculated as shown in (figure 5).
4. Repeat the above steps for different orthogonal bases namely, Haar, Daubechies, symlet (table 1).

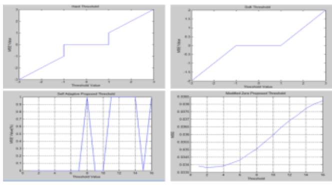

Fig.5 Plot of MSE against Threshold values

The wavelet decomposition of an image is done as follows as shown in(Fig 6): In the first level of decomposition, the image is split into 4 sub-bands, namely the HH, HL, LH and LL sub bands. The HH sub-band gives the diagonal details of the image; the HL sub-band gives the horizontal features while the LH sub-band represents the vertical structures. The LL sub-band is the low resolution residual consisting of low frequency components and it is this sub-band which is further split at higher levels of decomposition.

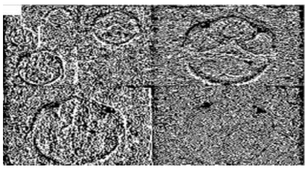

Fig.6 Wavelet decomposition

Technique	Hard Threshold	Soft Threshold	Adaptive Threshold	Proposed Threshold
Haar	0.66	1.58	1.38	1.38
Db2	0.93	1.57	1.37	1.33
Db4	0.94	1.58	1.38	1.38
Db8	0.95	1.59	1.39	1.33
Sym	0.94	1.55	1.35	1.37

Table.1 Threshold with denoising technique in MSE

For performance evaluation of the proposed algorithm, Mean square error (MSE) and Peak signal to noise ratio (PSNR) are adopted as shown in table 2.

Wavelet based Technique	Hard Thresholding		Soft Thresholding		Adaptive Thresholding		Proposed Thresholding	
	MSE	PSNR (dB)	MSE	PSNR (dB)	MSE	PSNR (dB)	MSE	PSNR (dB)
Haar	$3.39*10^4$	1.11	$0.70*10^4$	7.22	$0.09*10^4$	25.5	$0.08*10^4$	26.4
Db2	$3.40*10^4$	1.00	$0.71*10^4$	7.11	$0.19*10^4$	25.4	$0.10*10^4$	25.9

Db4	$3.30*10^4$	1.70	$0.67*10^4$	7.90	$0.03*10^4$	25.9	$0.02*10^4$	26.8
Db8	$3.29*10^4$	2.11	$0.60*10^4$	8.01	$0.01*10^4$	26.0	$0.01*10^4$	27.1
Sym	$3.32*10^4$	1.21	$0.68*10^4$	7.73	$0.05*10^4$	25.7	$0.03*10^4$	26.6

Table.2 Comparison of all methods based on MSE and PSNR

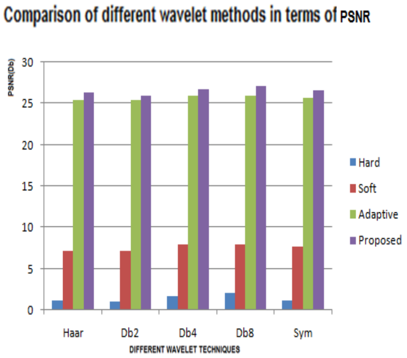

Fig.7 Comparison of different wavelet techniques in terms of PSNR

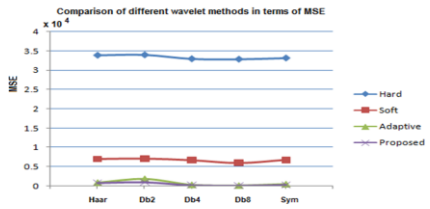

Fig.8 Comparison of different wavelet techniques in terms of MSE

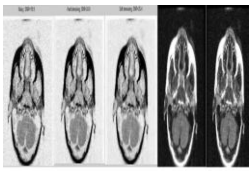

Fig.9 Stimulated results

(a) Noisy image (b) Hard (c)Soft (d)Adaptive (e)Proposed

Comparison chart for PSNR (dB) values vs. different wavelet techniques is shown in figure 7. Comparison chart for MSE values vs. different wavelet techniques is shown in figure 8. The stimulated de-noised output images for various thresholding techniques are shown in figure 9. From the chart, it is shown that the Proposed Db8 wavelet thresholding method have high PSNR value & low MSE value when compared with other wavelet methods.

IV. CONCLUSION

This paper presents improved algorithm for de-noising of medical images for early detection and diagnosis of diseases. It is based on thresholding and wavelet analysis. The algorithm has been applied to medical images of CT scanned image of brain from the standard Database. For performance evaluation of the proposed algorithm, Mean square error (MSE) and Peak signal to noise ratio (PSNR) are adopted. Experimental results shows that the proposed algorithm yields significantly provide better image quality.

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