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De-Noising of Medical Image Using Wavelets

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Abstract: **-- De-noising of images is an important task in image processing and analysis, and it plays a significant role in modern applications in different fields, including medical imaging and pre-processing for computer vision. This paper analysis various medical image using different wavelet transform. Particularly the discrete wavelet transform (DWT) is best suited for De-noising of medical image. To apply two dimensional DWT is applied to the image and the four different sub filters section are obtained. Each section has some threshold value based on the noise effect. The inverse DWT (IDWT) is applied and de-noise effect estimated. To apply various soft threshold techniques like, Visu Shrink, Sureshrink, Bayes Shrink, etc., are applied and results rare compared with state of art techniques. The physical parameters like, RMSE, MSE, PSNR, SNR etc.are compared.**

Keywords--: **MRI, DWT, IDWT, MSE**

I. INTRODUCTION

Image De-noising is any Digital image processing method which reconstructs an image from a noisy one. Its goal is to remove noise and preserve useful information from output image. It is used for medical image applications, remote sensing, satellite imaging and biomedical image processing. There are many techniques available in the image processing depending on the applications.

Medical images corrupted by Gaussian white noise are a major problem in image processing. Wavelet De-noising method has been a popular research work because wavelet de- noising scheme thresholds the wavelet coefficients arising from the standard discrete wavelet transform. The noise suppression method is as follows: Let x(t) be the original image and y(t) be the image corrupted with identically distributed zero mean, z(t) be a white Gaussian noise.

$$Y(t) = X(t) + \sigma_n \ Z(t) \qquad (1)$$

The methodology of the discrete wavelet transform (DWT) based image de-noising involves the following three steps 1. Transform the noisy image into orthogonal domain by 2D discrete wavelet transform. 2. Apply the threshold i.e hard or soft there sholding in the noisy detail coefficients of the wavelet transform 3. Inverse discrete wavelet transform (IDWT) is performed to obtain the de-noised image [1-3]. The contour let and wavelet techniques with dual tree complex and real and double density wavelet transform De-noising methods are performed on real ultrasound images and results were quantitatively non full stop are also .compared[4][5]. Images de-noising by TV, wavelet and AVREC methods. The proposed method is also compared with the total variation (TV) De-noising and wavelet there sholding methods[6].In this paper, the multi resolution structure and sparsity of wavelets are employed by nonlocal dictionary learning in each decomposition level of the. wavelets[7] ,which shows the various methods of the wavelet. The proposed method builds a nonlocal hierarchical sparse dictionary on the wavelet coefficients of a noisy image. The curve let based methods yield better results for CT images and the TV method is suitable for MRI images. Total variation method and Curve let transform method is also very effective for image De-noising. We use two types of curve let which are as follows: 1) curve let De-noising using hard there sholding 2) curve let De-noising using cycle spinning [8-12]. NL –means (NLM) algorithm and Median non - local means filtering (MNLM) i)The proposed method incorporates a median filtering operation indirectly in the nonlocal means (LM) method, which gives more robust estimation of the weights used to average the pixels in the medical images[13]. The neighboring wavelet there sholding idea was extended by Chen and Bui [14] into the multi wavelet scheme. In this method it was proved that neighbor multi wavelet De-noising outperforms the neighbor single wavelet De-noising [15]. Neelamani has proposed the For Ward D[16] method in which suppression the noises in the images efficiently. Many other noise removal techniques have also been proposed,viz. Mandal and Mukhopadhyay termed as ANDWP[17], EPRRVIN[18], GADI[19] and EKSI[20]. These filters perform excellent when applied to images corrupted with high, medium and low densities of noises.

II. ON THE WAVELET DE-NOISING:

Discrete wavelet transforms (DWT) have attracted more and more interest in biomedical image noisy reduction (De-noising), storage and retrieval [2]. De-noising of images using wavelet is very effective because of its ability to capture the energy of a signal in few coefficients at various resolutions [7-10]. For traditional images, the wavelet transform yields a large number of small coefficients and a small number of large coefficients. In De-noising, orthogonal sets with a single mother wavelet function have played an important role. Due to merits of the localization of time-frequency characteristics and flexibility of choosing diverse methodologies; wavelet based restoration approaches have been considered for many applications of medical images and firmly established as a powerful De-noising tool [2-5]. When used on images, DTW can be interpreted as 2D signal decomposition in a set of independent, spatially oriented frequency channels. The image in a spatial domain passes through two complementary filters and emerges in the frequency domain as coefficients of average and of details. The decomposed components could be assembled back into the original image domain without loss of information (Inverse Discrete Wavelet Transform - IDWT). The decomposed components could be processed before the image reconstruction, in order to improve the image or be used as a key for retrieving it in the image [6-8]. Generic De-noising procedures using DWT involve three steps: (i) wavelet decomposition, (ii) threshold of coefficients related to noise in the wavelet domain and (iii) reconstruction by inverse wavelet transform into the spatial domain [9,10]. In the wavelet decomposition step, an image is decomposed into a sequence of spatial resolution images using DWT. In these, a given j level of decomposition can be performed resulting in 3j+1 different frequency bands of low (L) and high (H) components of the original image, namely, LLj , LHj , HLj and HHj , as shown in Fig. 1 [7].

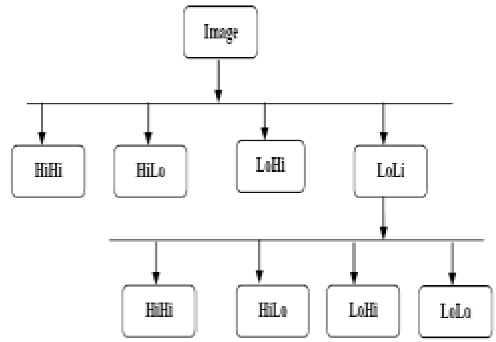


Fig 1: Image Decomposition using wavelet Transform.

LL = Horizontal low and Vertical low frequency component. LH = Horizontal low and Vertical high frequency component. HL = Horizontal high and Vertical low frequency component. HH = Horizontal high and Vertical high frequency component.

III. INPUT IMAGE:

Experiments are conducted on several gray scale medical images like X -Ray, MRI, Ultrasound, CT scan of resolution 512X 512, then speckle noise is added at different noise levels σ= .01, .02, .04.

We select a wavelet Haar or Db3. Haar transform decomposed the discrete signal into two subsignals half of its length. Daubechies wavelet has set of scaling functions which are orthogonal. It is useful in noise removal as high frequency coefficient spectrum reflect all high frequency changes.

IV. THERE SHOLDING:

There sholding is the simplest method of image De-noising .In this from a gray scale image, there sholding can be used to create binary image. There sholding is used to segment an image by setting all pixels whose intensity values are above a threshold to a foreground value and all the remaining pixels to a background value. There sholding is mainly divided into two categories:

4.1 ***Hard There Sholding:***

Hard threshold is a "keep or kill" procedure and is more intuitively appealing. The transfer function of the Hard there sholding is shown in the figure. Hard there sholding may seem to be natural. Sometimes pure noise coefficients may pass the hard threshold and this there sholding method is mainly used in medical image processing.[6-7]

4.2 *Soft There Sholding:*

Soft threshold shrinks coefficients above the threshold in absolute value. The false structures in hard there sholding can be overcomed by soft there sholding. Now a days, wavelet based De-noising methods have received a greater attention. Important features are characterized by large wavelet coefficient across scales in most of the timer scales.[6]

V. PERFORMANCE PARAMETERS:

There are two performance parameters are used to measure the reconstructed image using proposed CIM.

One is PSNR (peak signal to noise ratio) and second is Mean square error (MSE). Mean Square Error (MSE) is the cumulative difference between the compressed image (I_2) and original image (I_1). Small amount of MSE reduce the error and improves image quality.

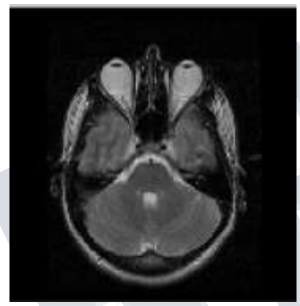
$$MSE = \sum_{m=0}^{M}\sum_{n=0}^{N}\frac{[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

PSNR is the measurement of the peak error between the compressed image and original image. The higher the PSNR contains better quality of image. To compute the PSNR first of all MSE (mean square error) is computed.

$$PSNR = 10 \log log_{10}\left[\frac{MAX_i^2}{MSE}\right]$$

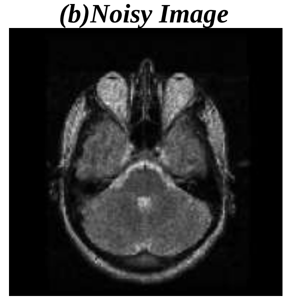
VI EXPERIMENTAL RESULTS

In this paper, experiments are conducted on four different gray scale medical images. Like, Ultrasound, MRI, X-Ray, CT scan of resolution 512 X 512 at different speckle noise levels, σ = .01,.02,.04. Haar and db3 wavelet transforms are applied for De-noising respectively. Different PSNR and MSE values are calculated at different level of speckle noise on each medical image at soft and hard there sholding levels by applying these Haar and db3 wavelets one after another and then comparison is made from the tables given below showing the PSNR values at each level which shows the better wavelet. It is clear from the tables below that db3 wavelet is better than haar wavelet for the purpose of De-noising in the medical images. When speckle noise is added , σ = 1,.02,.04 in all type of image, PSNR is calculated. De-noising is performed at speckle noise σ=.01, on MRI images by using Haar and db3 wavelets at soft threshold, the best PSNR value is calculated that is 41.47 db and 41.721 db respectively.

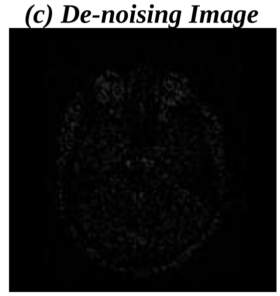


(a)Original Image

(b)Noisy Image



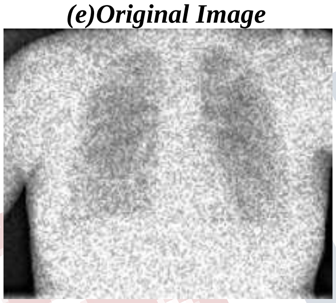
(c) De-noising Image



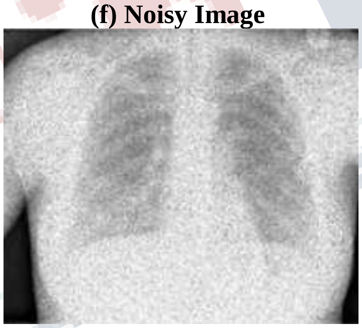
(d) Difference Image

In this computation (a) is original MRI image and (b) is image has speckle noise of level .04 and in (c) image is enhanced by soft there sholding using haar wavelet at one decomposition level and so PSNR is calculated 36.18 db.(d) is the difference between original image and de-noising image and the remaining noise in the image.

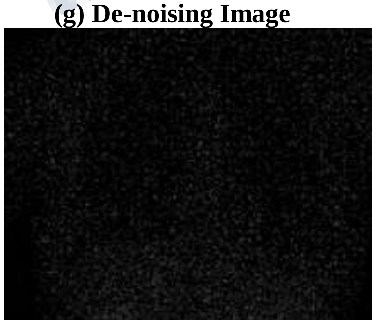
(e)Original Image



(f) Noisy Image



(g) De-noising Image



(h) Difference Image

In this computation (e) is original X ray image ,(f) is image is noisy having speckle noise .03 ,(g) is the image de-noising at hard threshold by using db3 filter at first decomposition level and thus PSNR is computed 29.02 db,(h) is the difference image ,remaining percentage of noise than the original image in the de-noising image.

V. CONCLUSION:

In this paper, De-noising of different medical images like, MRI, Ultrasound, X-ray, CT scan is performed using haar and db3 wavelets at both soft and hard threshold levels and the peak signal-to-noise ratio(PSNR) is calculated. After De-noising by these two wavelets, PSNR values are compared and it is found that db3 wavelet is more efficient than haar wavelet for removing the certain level of speckle noise in the medical images and also it enhances the visual quality of the medical images. It helps to select the best wavelet transform for the De-noising of particular medical image and it will also help in effective diagnosis.

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