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Denoising and Compression of Medical Image in Wavelet 2D

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Abstract— Medical Images normally have a problem of high level components of noises. Image denoising is an important task in image processing, use of wavelet transform improves the quality of an image and reduces noise level. Here image is first loaded in biorthogonal wavelet and level 3 decomposition using Wavelet 2D transforms, then the level of soft threshold is selected for reducing the noise in the image. Hard threshold kills the procedure. Soft threshholding shrinks the coefficients above the threshold in absolute value. Here a mechanism is used in medical image compression and de-noising methods that are based on of wavelet decompositions without sacrificing clarity of original image. The mechanism describes horizontal, vertical and diagonal details. It is shown that, if noisy medical image can be taken using two mechanisms we can de-noise and compressed that medical image.

Keywords-*Wavelets, Image Processing, Medical Image, Image De-noising, Image Compression*
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I. INTRODUCTION

Image processing field is a huge one. It encompasses in the following areas: 1. Image Compression, 2. Image De-noising, 3. Image Enhancement, 4. Image Recognition, 5. Feature Detection, and 6. Texture Classification [1]. Wavelet-based techniques apply to all of these topics. Compression is the process of reducing large data files into smaller files for efficiency of storage and transmission. Data compression techniques are: a. Lossless data compression b. Lossy data compression. Lossless data compression is nothing but the original data can be reconstructed exactly from compressed data. Lossy data compression in which data after compression and then decompression retrieves a file that is not exactly as the original data as there will be loss of data. De-noising plays a very important role in the field of the medical image pre-processing. It is often done before the image data is to be analyzed. Denoising is mainly used to remove the noise that is present and retains the significant information, regardless of the frequency contents of the signal. It is entirely different content and retains low frequency content. The most important way of distinguishing information from noise in the wavelet domain consists of thresholding the wavelet coefficients. Mainly hard and soft thresholdings techniques are performed.

II. WAVELETS TRANSFORM

In most of the applications of image processing, it is essential to analyze a digital signal. If the data will be transformed into any other domain then the structure and features of the signal may be better understood. There are several transforms available like Fourier transform, Hilbert transform, Wavelet transform, etc. The wavelet transform is better than Fourier transform because it gives frequency representation of raw signal at any given interval of time, but Fourier transform gives only the frequency- amplitude representation of the raw signal but the time information is lost [5]. So we cannot use the Fourier transform where we need time as well as frequency information at the same time. Wavelets are mathematical functions that cut up data into different frequency components. The fundamental idea behind wavelets is to analyze the signal at different scales or resolutions, which is called multiresolution. The most important feature of wavelet transform is it allows multiresolution decomposition.

III. IMAGE DENOISING

An image is often corrupted by noise in its acquition and transmission. Image de-noising is used to remove the additive noise while retaining as much as possible the important signal features. In the recent years there has been a fair amount of research on wavelet thresholding and threshold selection for signal de-noising [2], because wavelet provides an appropriate basis for separating noisy signal from the image signal. The motivation is that as the wavelet transform is good at energy compaction, the small coefficients are more likely due to noise and large coefficient due to important signal features [1]. These small coefficients can be thresholded without affecting the significant features of the image.

315

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IV. BASIC MODEL OF COMPRESSION SYSTEM

Most of the compression systems [3] [4] are based upon reducing the redundant information present in the signal whether it is 1D signal or 2D signal like image. Sometime redundancy reduction process is performed over the transformed signal rather than the original signal itself. The redundancy depends upon the entropy of the signal. Redundancy reduction removes highly correlated data which is more in case of image due to much of the low frequency content in it. Discrete Wavelet Transform (DWT) has emerged as a popular technique for redundancy reduction [5]. DWT has high de-correlation and energy compaction efficiency. Non-significant information is removed from the data by this process but it is a non-reversible process electronically for review. An image that is decomposed by wavelet transform can be reconstructed with desired resolution. The most important feature of wavelet transform is it allows multiresolution decomposition. The procedure for this is a low pass filter and a high pass filter is chosen, such that they exactly halve the frequency range between themselves. This filter pair is called the Analysis Filter pair. First of all, the low pass filter is applied for each row of data, and then we obtain low frequency components of the row. As the LPF is a half band filter, the output data consists of frequencies only in the first half of the original frequency range. By Shannon's Sampling Theorem, they can be sub sampled by two, so that the output data contains only half the original number of samples, similarly the high pass filter is applied for the same row of data, and now the high pass components are separated, and placed by the side of the low pass components. This procedure is done for all rows [4].

LL	HL
LH	HH

1st level

LL	HL	HL
LH	HH	
LH		HH

2nd level

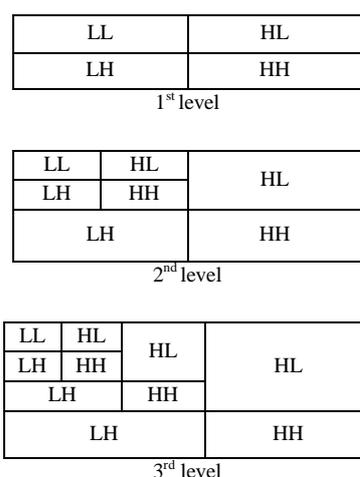| LL	HL	HL	HL
LH	HH		
LH		HH	
LH			HH

3rd level

Fig 1 – wavelet decomposition

Next, the filtering is done on each column. as a result we get four bands of data, each labeled as LL (low-low), HL (high-low), LH (low-high) and HH (high-high).The LL band can be decomposed once again in the same manner, thereby

producing even more sub bands[4]. This can be done up to any level, thereby resulting in a pyramidal decomposition as shown above the LL band at the highest level can be said as most important, and the other bands are of lesser importance, the degree of importance decreases from the top of the pyramid to bottom.
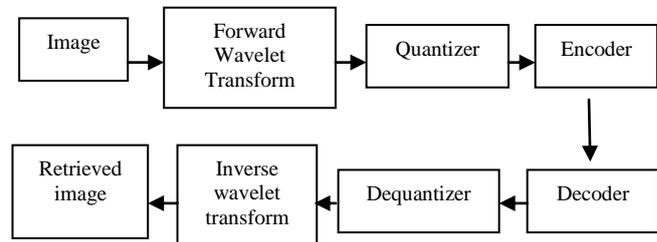
Fig -2: Block diagram for image compression

V. DENOISING IN WAVELET 2D

For generating MATLAB code to reproduce GUI-based 2-D decimated wavelet denoising at the command line. We have taken an medical image named "eczema" and the file type is jpeg. To perform the operation in the Wavelet 2-D–De-noising tool, First of all denoise the selected medical image before enable the File > Generate Matlab Code (Denoising Process) operation.The next instruction as given below:

1. Enter wavemenu at the MATLAB command prompt.
2. Select Wavelet 2-D.
3. Load the Noisy SinSin example indexed image. Using the default biorthogonal wavelet and level 3 decomposition, click De-noise.
4. In the Select thresholding method drop-down menu, select the default Fixed form threshold and soft options. Use the default Unscaled white noise. Set the thresholds by level for the horizontal, diagonal, and vertical coefficients as follows:

   Level 3 — 4
   Level 2 — 4
   Level 1 — 8
5. Generate the MATLAB code with File > Generate Matlab Code (Denoising Process).
6. Save the function in a folder on the MATLAB search path for executing code.

VI. COMPRESSION IN WAVELET 2D

We can generate MATLAB code to reproduce GUI-based 2-D decimated wavelet compression at the command as well as in the Wavelet 2-D --Compression tool [6][7]. We must first compress our medical image before we can enable the File > Generate Matlab Code (Compression Process) operation.

1. Enter wavemenu at the MATLAB command prompt.
   Select Wavelet 2-D.
2. Select File > Load > Image and load the eczema.mat indexed image from the

matlab/toolbox/wavelet/wavedemo folder. When the Loading an Image dialog appears, select No to load the grayscale image.

3. Select the bior3.5 wavelet, and set Level to 3.

4. Click Analyze, and then click Compress.

5. Using the default Global thresholding, set Select thresholding method to Bal.sparsity-norm (sqrt).

6. Click Compress.

7. File > Generate Code (Compression Process) generates the code.

8. Save the MATLAB program.

VII. EPERIMENTAL RESULTS

We actually use medical image into the Wavelet 2-D graphical tool except with all the details involved in multilevel image decomposition in command line in order to more easily display it. The results tell what percentage of the wavelet coefficients was set to zero and what percentage of the image's energy was preserved in the compression process. Here even though the compressed image is constructed from only about half as many nonzero wavelet coefficients as the original, there is almost no detectable deterioration in the image quality.

A. Generating MATLAB Code for De-noising

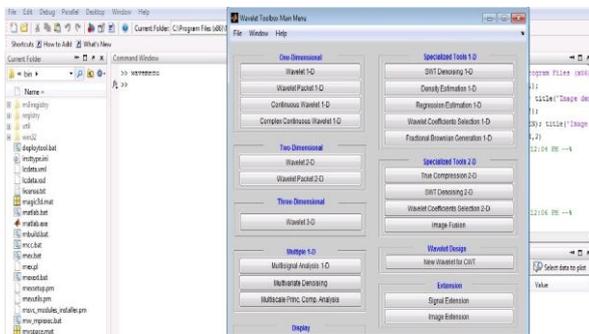1. Enter wavemenu at the MATLAB command prompt

Fig-3 wavemenu

2. Select Wavelet 2-D

Fig-4 Wavelet 2D

3. Load the Noisy SinSin example indexed image. Using the default biorthogonal wavelet and level 3 decomposition, click De-noise.
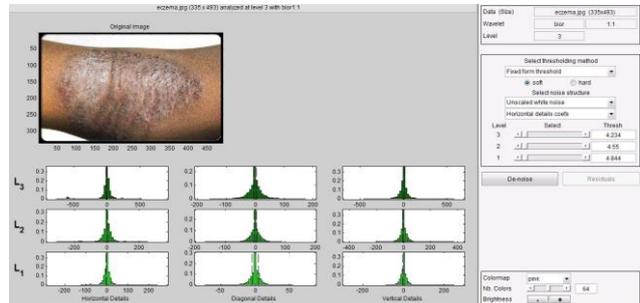

Fig-5

4. In the Select thresholding method drop-down menu, select the default Fixed form threshold and soft options. Use the default Unscaled white noise. Set the thresholds by level for the horizontal, diagonal, and vertical coefficients as follows:
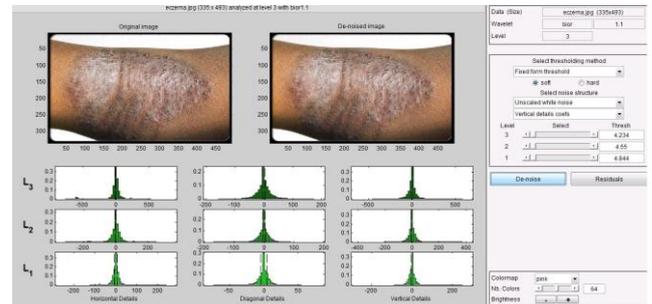
Level 3 — 4
Level 2 — 4
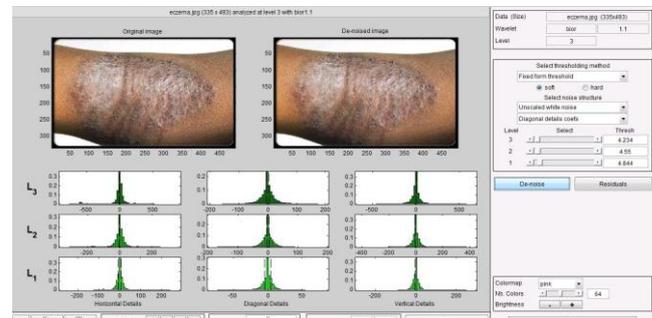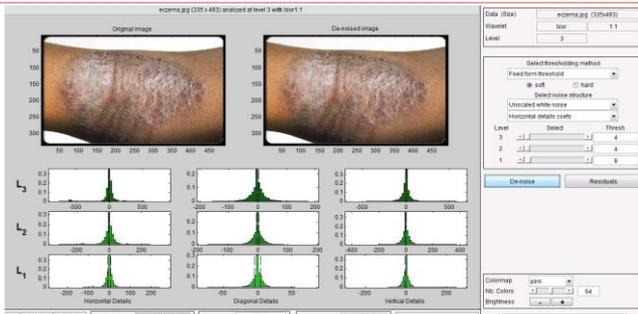Level 1 — 8

Fig-6 Horizantal

Fig-7 Diagonal

Fig-8 Vertical

5. Generate the MATLAB code with File > Generate Matlab Code (Denoising Process).

B. Generating MATLAB Code for Compression

1. Enter wavemenu at the MATLAB command prompt.
2. Select Wavelet 2-D.
3. Select File > Load > Image and load the eczema.mat indexed image from the matlab/toolbox/wavelet/wavedemo folder. When the Loading an Image dialog appears, select No to load the grayscale image.
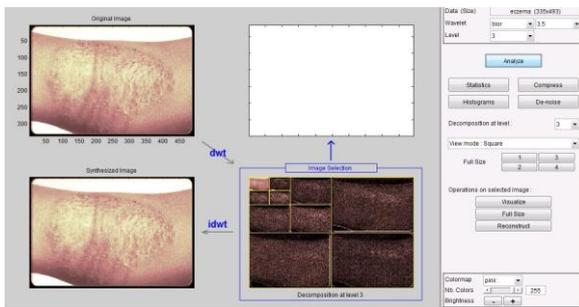4. Select the bior3.5 wavelet, and set Level to 3.

Fig-9

5. Click Analyze, and then click Compress.
6. Using the default Global thresholding, set Select thresholding method to Bal.sparsity-norm (sqrt).
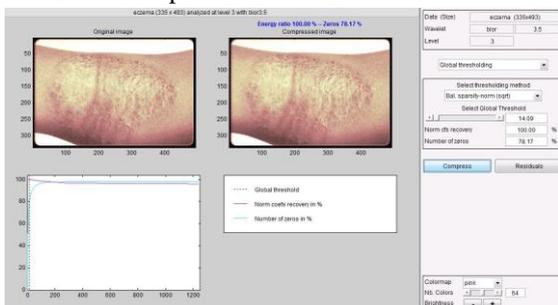7. Click Compress

Fig-10

8. File > Generate Code (Compression Process) generates the code.

9. Save the MATLAB program
10. Save the compressed image from the Wavelet 2-D - - Compression tool.

CONCLUTION

In this paper we have taken a medical image for de-noising and compression in Wavelet Toolbox specially Wavelet 2D in MATLAB using step by step. As a result we get the compressed image (energy ratio=78.17%) as well as noise free in vertical, horizontal and diagonal details and got energy ratio.. After doing this there is almost no detectable deterioration in the image quality. The statistics displayed in the above figure are related to the displayed image but not to the original one. Usually this information is the same, but in some cases, edge effects may cause the original image to be cropped slightly. To see the exact statistics, we can use the command line functions to get the desired image and then apply the desired MATLAB statistical function(s).

FUTURE WORK

In future work, we can denoise a medical image using different wavelets. We can do that making a different wavelet by us to get more and more noise free and compressed image.

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