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An Adaptive Wavelet and Level Dependent Thresholding Using Median Filter for Medical Image Compression

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ABSTRACT:
Image compression is technique which used to minimize the size of the any file for ex graphic file or text file in such a manner so that its quality is not reduced and also information should be retained. Thus, reduce the size in such a manner that lost information during compression should not affect the data information. And critical information should remain intact. In this work, Discrete Wavelet transform is being used for image Compression but before applying any algorithm it's very important to remove noise or corrupted data from the image. Thus, in the proposed work DE noising is performed first and then wavelet decomposition applied along with level dependent Thresholding method for compression purpose. And after that Wavelet reconstruction method is used for reconstruction of original image. For performance measurement CR and PSNR are calculated.

INTRODUCTION:
Image compression is technique which used to minimize the size of the any file for ex graphic file or text file in such a manner so that its quality is not reduced and also information should be retained. Thus, reduce the size in such a manner that lost information during compression should not affect the data information. And critical information should remain intact. With the help of image compression the main motive is to reduce the size of file so that more data can be stored. As we Know memory is very much expensive and we need to manage and utilized in efficient manner so we need compression technique so that file size should be reduced till acceptance level and memory should also be utilized efficiently. Also the file whose size is small is efficient and easy to manage like in transferring, uploading or downloading. There are two types of image compressions that is Lossy Compression and Lossless Compression [1]. Lossy Compression is also known as irreversible compression.

It is one of the classes of data encoding methods which uses partial data discarding and in exact approximations. Lossy Compression technique is mainly used to reduce data size for transmitting, storage and for proper handling. In this technique the exact data cannot be reconstructed after compression that is why it is known as irreversible compression. Other is Lossless compression which is also known as reversible compression. This technique of image compression allows the original data to be recovered or reconstructed from compressed data. This method is mainly used where the information before compression and after decompression needs to be same. This is mainly used where the information is critical and needs to be intact. That is why it is known as reversible compression.

MATERIALS AND METHODS
1)Software Used:
The Research Methodology has been implemented with MATLAB 14b

2)Discrete Wavelet Transform:
It is a wavelet transform for which the wavelets are sampled discretely. The very important feature in DWT is that it captures both location and frequency information [2]. The Discrete Wavelet Transform can be implemented using Filters.

One Stage Filtering: Details and Approximations:
In a Signal there two types of content. One is Low frequency content and other is high frequency content. The important information or critical data always lies in low frequency part and other information like some characteristics; nuance or flavor lies in high frequency part. This can be explained by taking example of human voice. If the high frequency component is removed from human voice then the voice sounds in different manner but still it is easily depict able what exactly being said.

But if the low frequency component is removed then you would heard meaningless and not understandable voice. Similarly in the case of wavelet analysis also there are two components that are details and approximations. The details are high frequency, low scale components. And the approximations are low frequency, high scale components.[3][4].

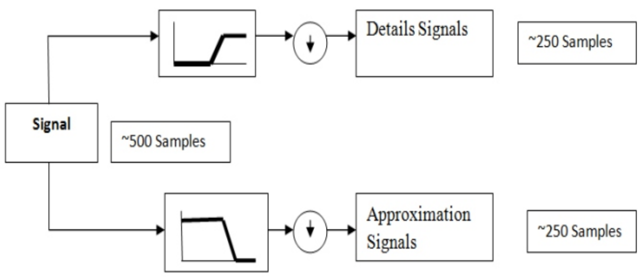

Figure 1: Signal Decomposition Using Down Sampling.

The above figure uses down sampling for decomposition of signal which produces DWT coefficients.

RECONSTRUCTION OF WAVELETS:

In above studies, decomposition or analysis operation was explained. But after processing the decomposed components/signals, they need to be combined back into its original signal state without any loss of any type of information. This way is called as synthesis or we can say reconstructions. Thus, for reconstruction or synthesis can be achieved using wavelet Coefficients. In wavelet analysis filtering and down sampling is used but for reconstruction consist of Up Sampling and filtering process. Up Sampling is a process in which signal length is increased by inserting zeros between the samples [5][6].

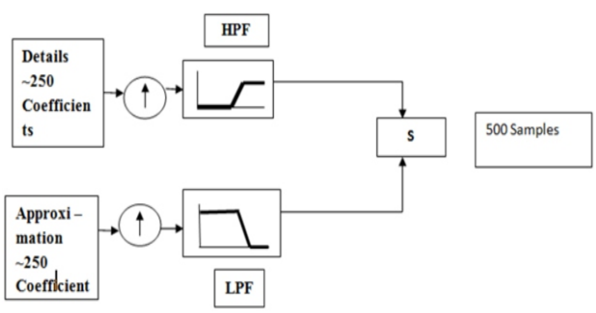

Figure 2: Reconstruction of Approximations and Details.

MEDIAN FILTER:

Median filtering is a nonlinear type process which is very useful in reducing salt and pepper noise or for reducing random noise which occur while transferring the data through channel. The data bits get corrupted due to communication channel hence noise gets introduced in the data. As we know that edges are very important part in an image as they provide lot of information about the image [7]. Thus, median filter is capable and efficient that it preserves the edges while removing noise from the image. Any image processing technique will provide better results if the input is correct and not corrupted. In Digital Image processing it is very important that the processed image should be noise free otherwise it can affect overall result of image processing. In the proposed technique this is the major step for getting the improved result. The main criterion of median filter is to scan whole image element by element and replacing each element (pixels) with the median value of neighboring pixels. This scanning pattern is also known as window because like ways window it slides/scan element by element and replaces it with median value of its neighbor. At the time of window , it can encountered odd number of element entries then to find median is very easy that is the middle one would be the median. But if at the time of window, it encountered even number then there could be possibility of more than one median [8][9].

THRESHOLDING:

Thresholding is a procedure which takes place after decomposing a signal at a certain decomposition level. After decomposing this signal a threshold is applied to coefficients for each level from 1 to N (last decomposition level). This algorithm is a lossy algorithm since the original signal cannot be reconstructed exactly [3]. By applying a hard threshold the coefficients below this threshold level are zeroed, and the output after a hard threshold is applied and defined by this equation:

$$y_{hard}(t) = \begin{cases} x(t), & |x(t)| > \delta \\ 0, & |x(t)| \leq \delta \end{cases}$$

where x(t) is the input speech signal . An alternative is soft thresholding at level which is chosen for compression performance and defined by this equation:

$$y_{soft}(t) = \begin{cases} sign(x(t))(|x(t)| - \delta), & |x(t)| > \delta \\ 0, & |x(t)| \leq \delta \end{cases}$$

The Thresholding used in Research Methodology is Level Dependent thresholding. For implementing this Birge-Massart strategy is used [10]. The Strategy is used by the following wavelet coefficients selection rule: Let J0 be the decomposition level, m the length of the coarsest approximation coefficients over 2, and α be a real greater than 1 so:

1. At level J0+1 (and coarser levels), everything is kept.
2. For level J from 1 to J0, the KJ larger coefficients in absolute value are kept using this formula [11]

$$K_J = \frac{m}{(J_0 + 1 - J)^{\alpha}}$$

PROPOSED METHODOLOGY:

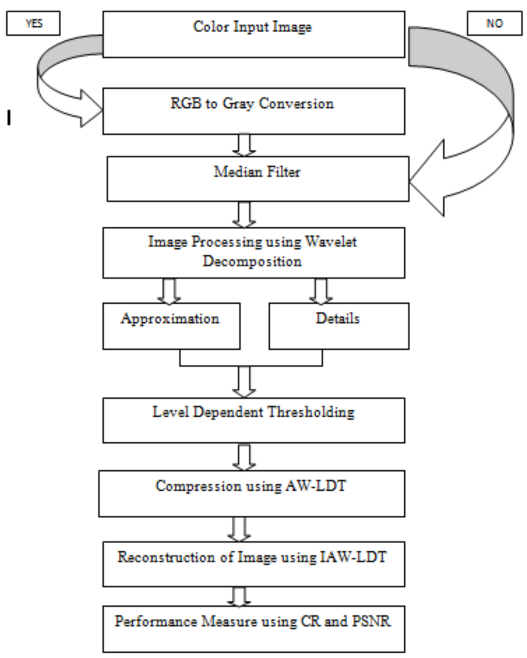

Figure 3 : Proposed Methodology

PERFORMANCE MEASURE PARAMTERS:

For evaluating the performance of image compression we need to calculate two important parameters.

- Compression Ratio
- PSNR

Compression Ratio: This is also known as data compression ratio. It is the terminology used to measure the reduction introduced in data representation size by any compression algorithm.

In Simple term it can be defined as ratio between uncompressed sizes of image to the compressed size of image. This will give us the compression ratio achieved. This is the measure used for verifying the capabilities of compression algorithm. There are so many algorithms present for data compression and compression ratio is major factor for measuring the performance.

Compression Ratio = (Size of an Uncompressed Image) / (Size of a compressed Image)

For ex: There is 20 MB file and we need to compress this file into 10 MB then the compression ratio would be 20/10 = 2 It is also defined as ratio of number of Zeros of the current decomposition level to the number of coefficients.

PSNR: The full form of PSNR is Peak Signal to Noise Ratio.

It is also one of the important parameter used in image processing. It is an engineering terminology. It is defined as Maximum possible power which signal has to the power of noise which has affected the image and its representation. Logarithmic decibel scale is used for its expression. It is one of the parameter used for measuring the quality of image after image processing. That means how much data is present in the image and how much noise is introduced after image processing. In my work compression is done thus, this parameter is required to be calculated. PSNR is defined by using MSE that is Mean Square Error.

MSE is defined as:

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

The PSNR is defined as:

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \end{aligned}$$

Mean Square Error and PSNR Formula [12]

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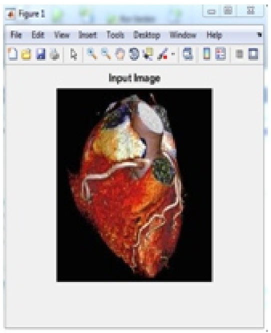
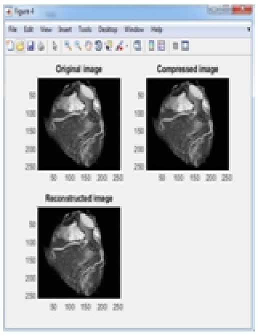
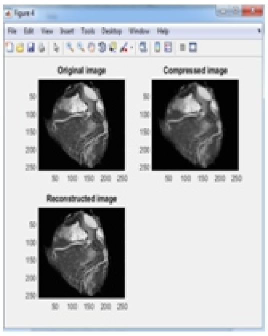
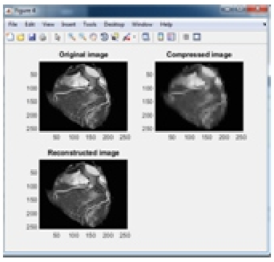
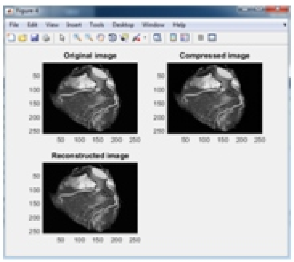
RESULTS AND DISCUSSION:

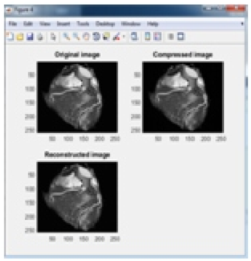












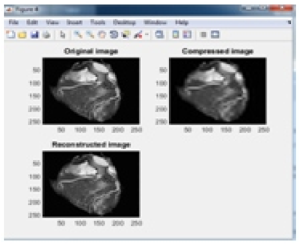
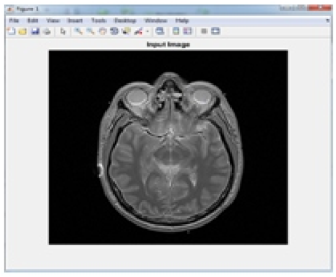
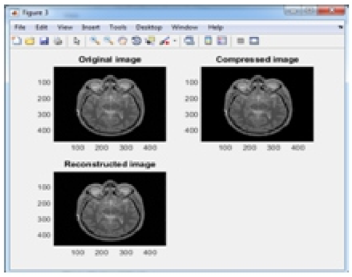
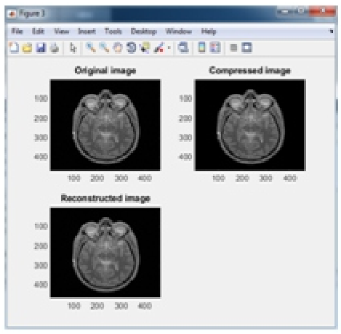


Figure 4: Original, Compressed and Reconstructed Images obtained from color image as input with ' Haar' and bior4.4' 1 for 1st, 2nd and 3rd level of decomposition respectively.







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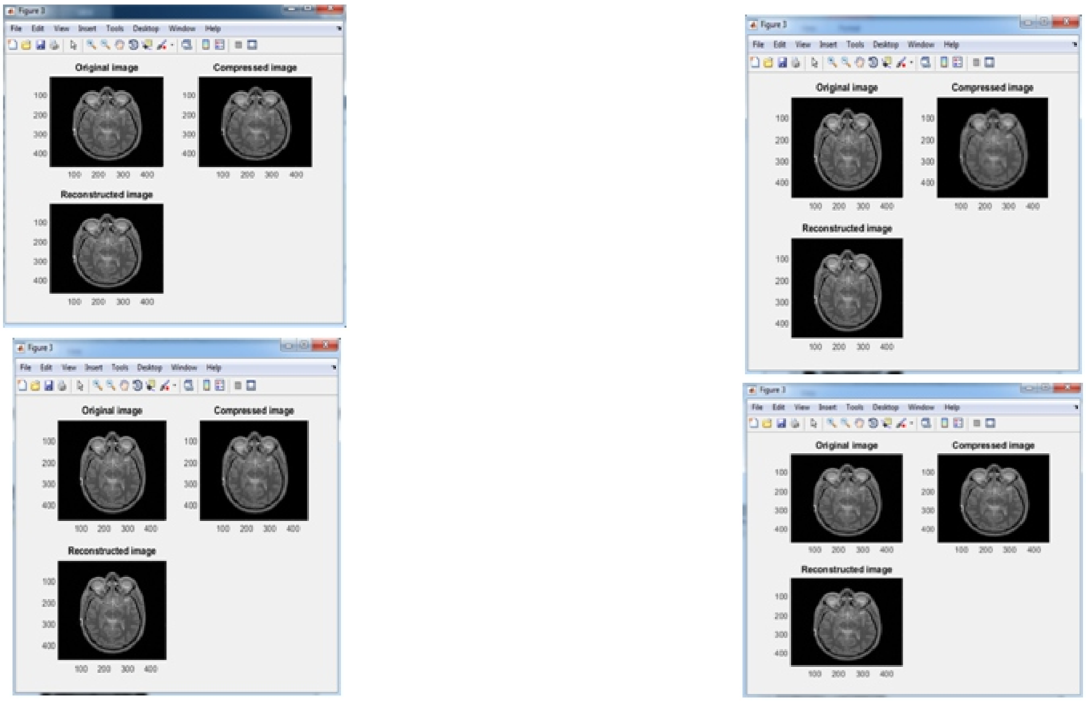

Figure 5: Original, Compressed and Reconstructed Images obtained from Gray image as input with ' Haar' and bior4.4' 1 for 1st, 2nd and 3rd level of decomposition respectively.

TABLE I: Compression Ratio and PSNR Achieved for Color Image

Wavelet	Decomposition Level	Thresholds	Compression Ratio	PSNR
HAAR	1	3 5 7 9	66.5833 72.8943 74.4736 74.8703	32.7243 32.7147 32.7031 32.6947
HAAR	2	3 5 7 9	91.0172 93.1519 93.6111 93.7149	32.6949 32.6588 32.6296 32.6115
HAAR	3	3 5 7 9	97.6883 98.2849 98.4024 98.4299	32.6168 32.5448 32.4990 32.4710
BIOR4.4	1	3 5 7 9	66.5619 72.8908 74.4720 74.8680	32.7259 32.7223 32.7183 32.7155
BIOR4.4	2	3 5 7 9	90.1992 92.5326 93.0307 93.1448	32.7130 32.6921 32.6732 32.6620
BIOR4.4	3	3 5 7 9	96.9202 97.7141 97.8715 97.9071	32.6694 32.6181 32.5796 32.5573

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TABLE II : Compression Ratio and PSNR Achieved for Gray Image

Wavelet	Decomposition Level	Thresholds	Compression Ratio	PSNR
HAAR	1	3 5 7 9	69.7623 75.7966 77.3874 77.7752	31.4034 31.3977 31.3886 31.3826
HAAR	2	3 5 7 9	91.1698 93.3036 93.7598 93.8657	31.3856 31.3558 31.3265 31.3089
HAAR	3	3 5 7 9	97.7069 98.3028 98.4203 98.4473	31.3215 31.2572 31.2075 31.1795
BIOR4.4	1	3 5 7 9	66.9047 73.2328 74.8146 75.2101	31.4040 31.4023 31.998 31.3979
BIOR4.4	2	3 5 7 9	90.5650 92.8110 93.2915 93.4027	31.3981 31.3819 31.3632 31.3515
BIOR4.4	3	3 5 7 9	97.2656 97.9710 98.1106 98.1421	31.3626 31.3149 31.2699 31.2489

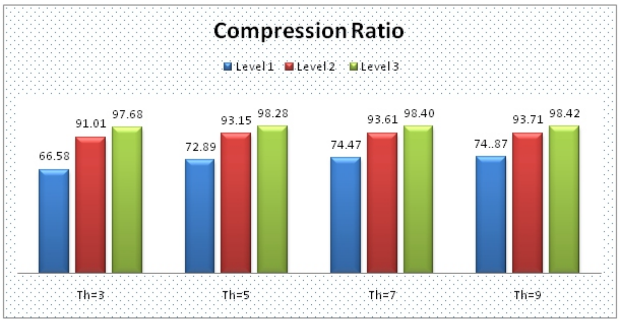

Figure 6: Comparison of CR with 'haar' for various levels for Color Image

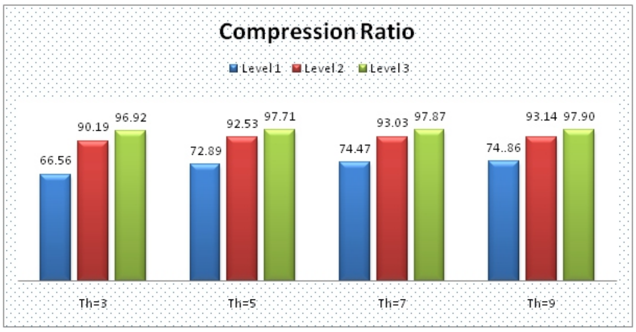

Figure 7: Comparison of CR with 'Bior4.4' for various levels for Color Image

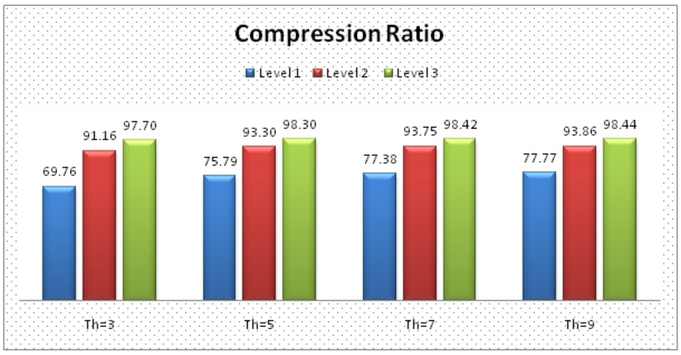

Figure 8: Comparison of CR with 'haar' for various levels for Gray Image

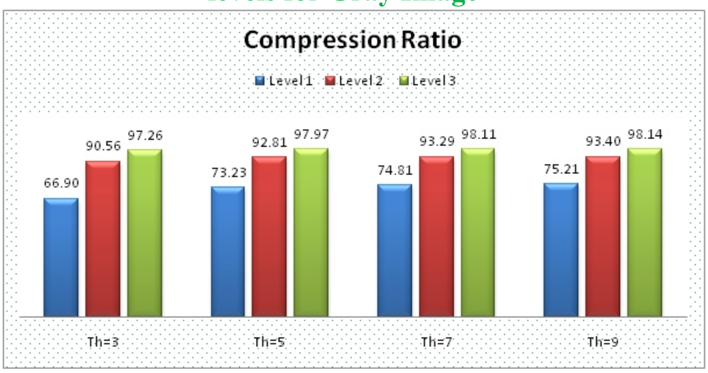

Figure 9: Comparison of CR with 'Bior4.4 for various levels for Gray Image

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CONCLUSION:

Here in the proposed work we had implemented and performed an analysis of different wavelet families with various levels of decompositions using AW-LDT based image compression. It has been observed that if the Denoising is performed on the image before putting any image compression algorithm then the results would be better. In the proposed Scheme Denoising is performed using Median filter so that image used for compression should be noise free. The Image obtained after Denoising is compressed using Adaptive wavelet level dependent Thresholding and also decompressing the image on the basis of wavelet reconstruction technique. Simulation results shows that when the CR is much high, at that state level quality of image is less when compared to the less CR level. However, it has given that the Haar wavelet has being performed well in terms of compression ratio and bi-orthogonal has been performed better with quality of image after reconstructing the image from the compressed image. Thus, we obtained better results from this technique.

FUTURE SCOPE:

The work is here defined using Denoising and wavelet decomposition approach to perform Image compression. The work can be improved in terms of

•In this work, gray Scale and RGB color image is used for analysis and compression. In future further technique can be analyzed to perform image compression on large images with multiple dimensions like 4 dimensional.
For ex: medical ultrasound.

•In this work, Compression results are obtained by wavelet compression method. In future some optimization techniques like Genetic algorithm, Fuzzy Logic can be applied on the results for optimizing the results.

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