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Image Compression and De-noising using Discrete Meyer Wavelet Technique

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***Abstract*-The main objective is to examine the still image format lossy compression and de-noising using Discrete Meyer Wavelet Technique. The compression and de-noising is implemented in software using MATLAB2012b version Wavelet Toolbox and 2-D DWT technique. The purpose is to analyze compression and de-noising using wavelet family such as Discrete Meyer. The experiments and simulation is carried out on image .jpg formats.**

This research work highlighting compression and adding 'Salt & Pepper' noise and de-noising. The scope of the work involves Compression, De-noising and image clarity and to find the effect of the threshold levels, to find out energy retained (Image Recovery) and lost, to find PSNR and MSE.

The wavelet differs from each other in PSNR and MSE. This method is compared and classified in terms of its efficiency at different threshold values. Therefore, the image recovery is good and clarity, but the percentage of compression and retaining the energy is different. In order to quantify the performance of the de-noising, a 'Salt & Pepper' noise is added to the image and given as input to the de-noising algorithm, which produces an image close to the original image.

Index Terms: **Peak Signal to Noise Ratio (PNSR), Mean Square Error (MSE), Two Dimensional Discrete Wavelet Transform(2D-DWT).**

I. INTRODUCTION

The key technology in the field of communication and multimedia application is digital image compression. Many techniques have been developed to make the storage and transmission of images economical. In the past several years number of attempts has been made to apply Discrete Wavelet Transform (DWT) techniques for digital image compression and de-noising. Compression makes it possible for creating file sizes of manageable, storable and transmittable dimensions. For example 4 MB image will take more than a minute to download using a 64kbps channel, whereas, if the image is compressed with a ratio of 10:1, it will have a size of 400KB and will take about 6 seconds to download. In other words we can say that compression is minimizing the size of bytes of a graphic file without degrading the quality of image. The applications such as digital camera, video conference, video on demand, audio broadcasting etc. are widely used with the development of network and multimedia communication technology.

II. LITERATURE SURVEY

A literature survey, or literature review, is a proof essay of sorts. It is a study and review of relevant literature materials in relation to a selected topic. The literature review is important because: It describes how the proposed research is related to prior research in statistics. It shows the originality and relevance of the research problem. It justifies the proposed methodology. It demonstrates the preparedness to complete the research. Different authors have worked with image compression technique, image de-noising technique, 'salt & pepper' noisy image de-noising technique and have measured one or more image quality parameters. Due to the great innovation of display and information technology, the stringent requirement of data capacity is drastically increased in human life. This trend makes a significant impact on storage and communication evolution. The data compression technique is extensively applied to offer acceptable solution for this scenario. Some images like satellite images or medical images have very high resolution, such high resolution images have large file size and computation time required to process such high quality images is more. Hence compression of image and video is required. The image can be compressed using lossy compression techniques.

In the lossy image compression[2, 3] technique, the reconstructed image is not exactly same as the original image. Different image compression techniques are suggested by the researchers, but the technique with high data compression with low loss is always preferred because of the advancement in internet, world has come very close and can afford and avail the services such as medical, education etc., remotely. Data compression is the key in giving such fast and efficient communication. It has made large impact on service sector to provide best services to all sections of society. High coding efficiency is the measurement parameter for the performance of data compression system.

III. RESEARCH WORK LIMITATIONS

This work carried out on image compression, compressed image de-noising and 'salt & pepper' noisy image de-noising. In this work the observation is on few limitations

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which are: this work concentrate for testing using 'jpg' standard format 256 x 256, gray scale image.

IV. PREVIOUS EXISTING SYSTEM

Image compression has become an important process in today's world of information exchange. We can compress image either by using lossy or lossless compression algorithms. For lossy compression technique, many sophisticated standards have been intensively developed such as JPEG and JPEG2000 for still image and MPEG-4 for multimedia communications and high end video application, respectively [4-11].

- JPEG is a commonly used method of lossy compression for digital images, particularly for those images produced by digital photography. The degree of compression can be adjusted, allowing a selectable trade-off between storage size and image quality. JPEG typically achieves 10:1 compression with little perceptible loss in image quality.
- JPEG 2000 is an image compression standard and coding system. The code stream obtained after compression of an image with JPEG 2000 is scalable in nature, meaning that it can be decoded in a number of ways, JPEG2000 uses DWT. It produces 20% improvement in compression in comparable with JPEG format.
- MPEG-4 is a method of defining compression of Audio and Visual (AV) digital data. It provides improved coding efficiency.

V. PROPOSED METHOD

Proposed system consists of lossy image compression, compressed image de-noising and 'salt & pepper' noisy image de-noising technique is used to improve overall compression ratio. The lossy techniques is tested using method Discrete Wavelet Transform (DWT) and using Discrete Meyer(dmey) Wavelet. Examining the results of image quality by PSNR & MSE.

A. *Problem Definition*

Surveillance application requires the data to be in the more compressed form as well as maintaining the quality of image. Development of an image compression technique [12-14], which provides an improved compression ratio and also maintains the quality of image, is the required one. Efforts are made to enhance the compression ratio by the combination of lossy image compression. But the technique with high data compression with low loss is always preferred.

B. *Methodology*

In this research work, first the image is compressed, reconstructed and de-noised using DWT technique. Comparing the results at threshold values and PSNR & MSE to find out the quality of image, adding 'salt & pepper' noise to original image and de-noising.

C. *Research Objective*

The main objective of this work is:

- Image Compression using Discrete Wavelet Transform and tabulate PSNR and MSE for different values of threshold using wavelet Discrete Meyer (dmey).
- Adding 'salt & pepper' noise to original image and to tabulate PSNR and MSE by adding different percentage of noise to original image and de-noising using DWT.

D. *Research Work Merits*

- Image compression reduces the size of an image file without causing major degradation to the quality of the image, results in effective utilization of time, memory and bandwidth.
- Compressed images are very easy to handle through network, easy to download and easy to upload
- Wavelet-based coding is more robust under transmission and decoding errors, and also facilitates progressive transmission of images
- It has the ability to pack most information in fewest coefficients
- It has been implemented in single integrated circuit
- Wavelets provide an efficient decomposition of signals prior to compression
- It minimizes the block like appearance called blocking artifact that results when boundaries between sub-images become visible.
- DWT helps in the multi resolution analysis of the data

E. *Simulation Tool Used*

Simulation tool used is MATLAB 2012b. The MATLAB high-performance language for technical computing integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

VI. IMAGE COMPRESSION AND DECOMPRESSION

A. *Decomposition*

The image split into four bands denoted by LL, HL, LH and HH after one-level decomposition "Fig.2c". Further decompositions can be achieved by acting upon the LL subband successively and the resultant image is split into multiple bands as shown in "Fig.1c", and "Fig.1d". In mathematical terms, the averaging operation or low pass filtering is the inner product between the signal and the scaling function (Φ) as shown in "Eq.(3)", whereas the differencing operation or high pass filtering is the inner product between the signal and the wavelet function (ψ)[19-22] as shown in "Eq. (3)".

Average coefficients,

$$C_j(k) = < f(t), \Phi_{j,k}(t) > = \int f(t), \Phi_{j,k}(t)\, dt \quad (1)$$

Detail coefficients,

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$$dj(k) = \langle f(t), \psi j, k(t) \rangle = \int f(t), \psi j, k(t)\, dt \quad (2)$$

The scaling function or the low pass filter is defined as

$$\Phi j, k(t) = 2^{j/2} \Phi (2^{j} t - k) \quad (3)$$

The wavelet function or the high pass filter is defined as

$$\psi j, k(t) = 2^{j/2} \psi (2^{j} t - k) \quad (4)$$

Where j denotes the discrete scaling index, k denotes the discrete translation index. The reconstruction of the image can be carried out by the following procedure. First, we will up sample by a factor of two on all the four subbands at the coarsest scale, and filter the subbands in each dimension. Then we sum the four filtered subbands to reach the low-low subband at the next finer scale.

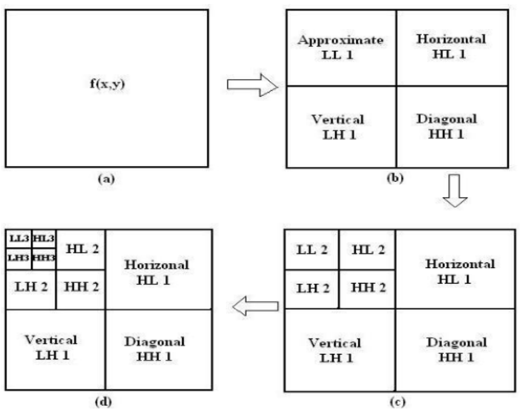
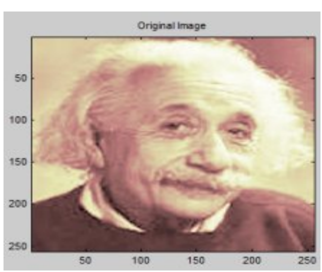
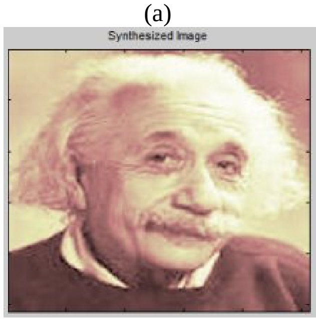


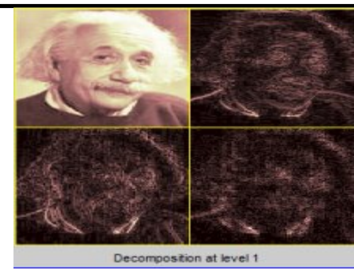
Fig.1. DWT Decomposition: a) Original Image b) One Level Decomposition c) Two Levels Decomposition. d) Three Levels Decomposition.



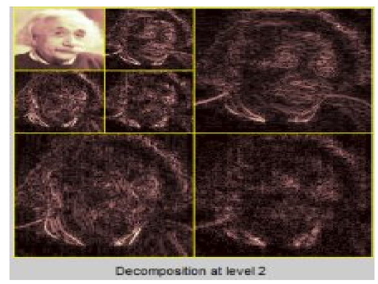
(a)



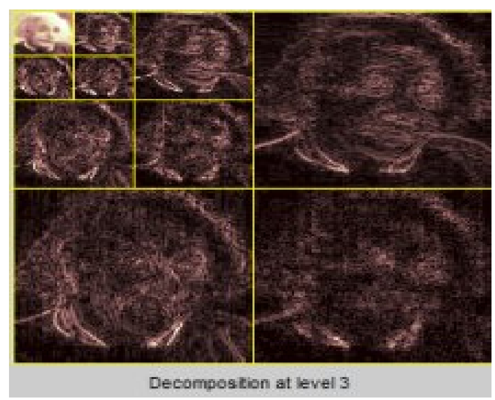
(b)



(c)



(d)



(e)

Fig. 2. Decomposition Approximations: (a) Original Image (b) Synthesized Image (c) Decomposition Level 1 (d) Decomposition Level 2 (e) Decomposition Level 3

The decomposition [21] experiment is conducted using Haar wavelet has two functions “wavelet” and “scaling function”, such that there are half the frequencies between them. They act like a low pass filter and a high pass filter, a typical decomposition scheme. The decomposition of the signal into different frequency bands is simply obtained by successive high pass and low pass filtering of the time domain signal. This filter pair is called the analysis filter pair. First, the low pass filter is applied for each row of data, thereby getting the low frequency components of the row. But since the low pass filter is a half band filter, the output data contains 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 now contains only half the original number of samples. Now, the high pass filter is applied for the same row of data, and similarly the high pass components are separated.

B. Image De-noising

Let us now consider the representation of a digital image. A 2-dimensional digital image can be represented as a 2-dimensional array of data s(x, y), where (x, y) represent the pixel location. The pixel value corresponds to the brightness of the image at location (x, y). The image s(x, y) is blurred by a linear operation and random noise n(x, y) is added to form the degraded image w(x, y) [1, 21]. This is convolved with the restoration procedure g(x, y) to produce the restored image z(x, y).

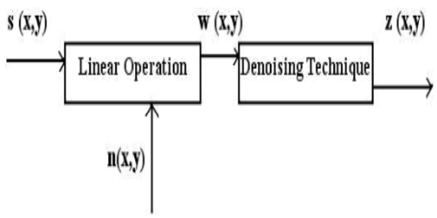


Fig. 3. De-noising Technique

The "Linear operation" shown in Figure is the addition or multiplication of the noise n(x, y) to the signal s(x, y). Once the corrupted image w(x, y) is obtained, it is subjected to the de-noising technique[15-18] to get the de-noised image z(x, y).

C. Compression Ratio

Compression ratio (CR) is defined as,

$$\frac{\text{Original Image File size}}{\text{Compressed Image File size}}$$

Higher the compression ratio, reconstructed image is more compressed and the quality of image degrades.

D. Peak Signal to Noise Ratio

Peak Signal to Noise Ratio (PSNR) is defined as,

$$PSNR=10\log_{10}\left(\frac{255^2}{MSE}\right) \qquad (5)$$

PSNR should be as high as possible, low value of PSNR means the quality of image is poor.

E. Mean Squared Error

Mean Squared Error (MSE) is defined as:

$$MSE = \frac{\sum_{M,N}[I_1(m,n)-I_2(m,n)]^2}{M*N} \qquad (6)$$

The large value of MSE indicates that image is of poor quality.

F. Thresholding

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. Global thresholding is performed to convert the entropy image into binary image

VII. ALGORITHMS

A. Image Compression

Step 1: Start
Step 2: Read input image
Step 3: Input image to be converted into RGB to Gray and 256 × 256 format
Step 4:Standard format input image is applied to threshold value and Wavelet, results in DWT based compressed image and compare original image and compressed
Step 5:Evaluate compression ratio, retain energy, PSNR and MSE
Step 6:Repeat the same process for different threshold values and wavelet
Step 7: End of the process

B. Image De-noising

Step 1: Start
Step 2: DWT compressed image is applied to IWT and set threshold value and wavelet
Step 3: Call the function of De-noising and set threshold values, results in reconstructed (de-noised) image
Step 4: Evaluate PSNR and MSE for original image and de-noised image
Step 5: Repeat the same process for different threshold values and wavelet
Step 6: End of the process

C. Adding 'Salt & Pepper' to the Original Image

Step 1: Start
Step 2: Read input image
Step 3: Input image to be converted into RGB to Gray and 256 × 256 format
Step 4: Apply 'Salt Pepper' to the original image and evaluate the PSNR and MSE for original image and noisy image
Step 5: End of the process

D. Noisy Image De-Noising

Step 1: Start
Step 2: add 'Salt Pepper' to original image.
Step 3: Apply noisy image to Inverse Wavelet Transform (IWT) and set threshold value and wavelet
Step 4: Call the function of De-noising and set threshold values. Results in reconstructed image obtained
Step 5: Evaluate PSNR and MSE for original image and de-noised image
Step 6: Repeat same process for different threshold values and wavelet
Step 7: End of the process

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VIII. EXPERIMENTAL RESULTS

The research work concentrated on lossy image compression and image de-noising using DWT technique and adding 'salt & pepper' noise to the original image and de-noised using DWT by the wavelet Discrete Meyer and for different threshold values, comparing the results with different image quality parameters like Compression Ratio, energy retain, PSNR and MSE.

A. Image used for Testing

This work carried out for any gray scale 'jpg' image in standard format (256 x 256). The entire project work implemented by 'Einstein.jpg' image.

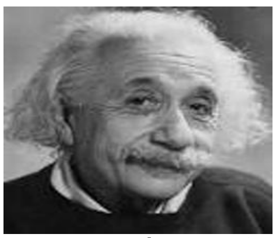

Fig. 4. Gray Scale Einstein Image, File Type 'jpg', 256x256 Resolution

B. Result Analysis for DWT Based Image Compression

The Discrete Wavelet Transform (DWT) based image compressed carried out by wavelet 'Discrete Approximation of Meyer'. The result analysis of wavelet for different threshold values and decomposition level-2 are tabulated below:

Table 1 shows the Discrete Meyer wavelet image compression and comparing the result between original image and compressed image for different image quality parameters for different threshold values.

TABLE 1. RESULTS FOR DISCRETE MEYER WAVELET IMAGE COMPRESSION

Threshold	PSNR	MSE	Retain Energy	No.of Zero's	Compression Ratio	Global Threshold
1	57.4389	0.1173	99.9996	75.00	54.3108	38.15
2	52.0103	0.4093	99.9984	88.79	67.0551	168.4
3	49.0969	0.8006	99.9969	93.16	73.0979	368.6
4	47.1494	1.2535	99.9951	95.05	76.6723	1087
5	45.7075	1.7472	99.9931	96.05	79.0409	2375
6	44.6213	2.2436	99.9910	96.56	80.6755	3218
7	43.7237	2.7587	99.9889	96.93	81.8802	4343
8	42.9394	3.3048	99.9866	97.24	82.8742	10620

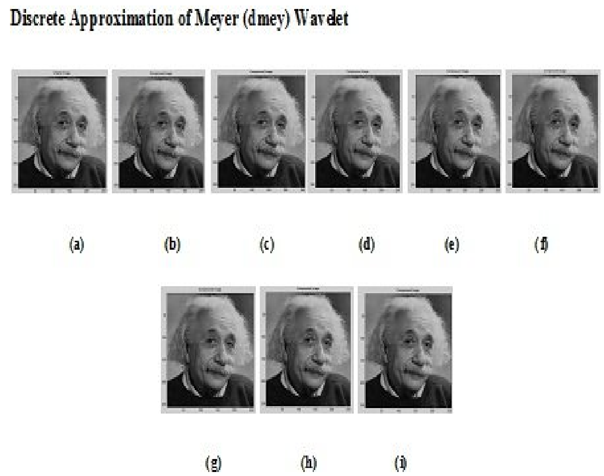

Fig. 5. Image Compression by Discrete Meyer Wavelet: (a) Original Image (b) Threshold = 1 (c) Threshold =2 (d) Threshold = 3 (e) Threshold = 4 (f) Threshold = 5 (g) Threshold = 6 (h) Threshold = 7 (i) Threshold = 8

C. Result analysis for DWT based Image De-noising

The DWT based image de-noising (Reconstruction of image) carried out by wavelet 'Discrete approximation of Meyer'. The result analysis of each wavelet for different threshold values is tabulated below:

TABLE 2. RESULTS FOR DISCRETE MEYER WAVELET IMAGE DE-NOISING

Threshold	PSNR	MSE
1	42.7812	3.4274
2	42.7796	3.4286
3	42.7782	3.4298
4	42.7781	3.4299
5	42.7018	3.4906
6	42.4565	3.6935
7	42.1221	3.9891
8	41.7284	4.3676

Table 2 shows the Discrete Meyer wavelet image de-noising and comparing the result between original image and compressed image for different image quality parameters and threshold values.

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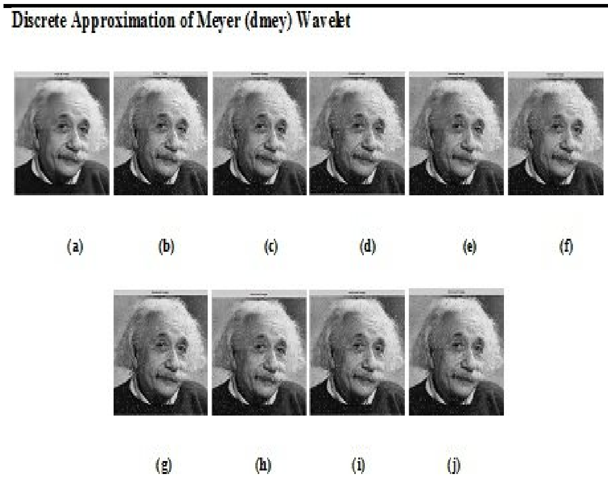

Fig. 6: Image de-noising by Discrete Meyer wavelet: (a) Original image (b) Threshold = 1 (c) Threshold = 2 (d) Threshold = 3 (e) Threshold = 4 (f) Threshold = 5 (g) Threshold = 6 (h) Threshold = 7 (i) Threshold = 8

D. Result Analysis for Adding 'Salt & Pepper' to Original Image

The process of adding different percentage of 'salt & pepper' noise to the original image as shown below:

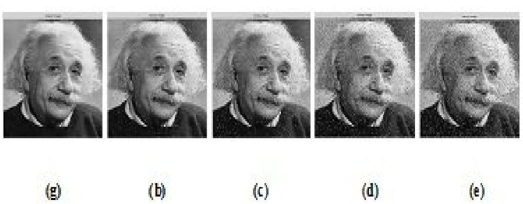

Fig. 7. 'Salt & Pepper' Noisy Image: (a) Original Image (b) Noise = 1% (c) Noise = 2% (d) Noise =4% (e) Noise = 6%

TABLE 3. RESULTS FOR ADDING 'SALT & PEPPER' TO ORIGINAL IMAGE

Percentage of noise added (%)	PSNR	MSE
1	25.0463	203.4448
2	22.0130	409.0547
4	18.9575	826.6618
6	17.3783	1189.20

Table 3, shows the adding 'salt & pepper' noise to the original image and comparing the result between original image and compressed image for different Image Quality parameters and threshold values. From the above table PSNR is higher for adding less noise to the original image and quality of the image is better, when increasing percentage of noise PSNR reduces. Similarly MSE is less for lower percentage of noise adding to the original image and higher for when increasing percentage of noise adding to the original image.

E. Result Analysis for Added 'Salt & Pepper' Image De-noising

The DWT based 'salt & pepper' noisy image de-noising (Reconstruction of image) carried out by wavelet 'Discrete approximation of Meyer'. The result analysis of each wavelet for different threshold values are tabulated below:

TABLE 4. RESULTS FOR DISCRETE MEYER WAVELET 'SALT & PEPPER' NOISY IMAGE DE-NOISING

Threshold	PSNR	MSE
1	23.1924	314.0353
2	23.1067	319.3494
3	23.0511	320.2607
4	23.0052	325.0413
5	22.9731	330.4560
6	22.8109	332.0812
7	22.7405	334.8726
8	22.6239	336.1079

Table 4 shows the Discrete Meyer wavelet 'salt & pepper' noisy image de-noising and comparing the result between original image and compressed image for different Image Quality parameters and threshold values.

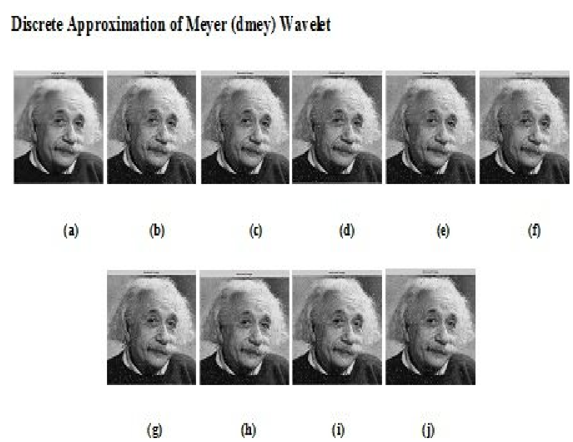

Fig. 8. Discrete Meyer Wavelet 'Salt & Pepper' Image De-noising: (a) Original Image (b) Noisy Image (2%) (c) Threshold = 1 (d) Threshold = 2 (e) Threshold = 3 (f) Threshold = 4 (g) Threshold = 5 (h) threshold = 6 (i) Threshold = 7 (j) Threshold = 8

This work carried out on lossy image compression and de-noising using Discrete Wavelet Transform (DWT) technique. The compressed and de-noised image compared by two parameters, Peak Signal to Noise ratio (PSNR) and Mean Square Error (MSE). If the PSNR is higher and MSE is lower, results is lower compression ratio and de-noising for these values gives the quality of the image is high. If MSE increases the image quality decreases.

IX. CONCLUSION

The scope of project is image compression and de-noising using Discrete Wavelet Transform of wavelet family Discrete Meyer. The experiments and simulation is carried out on .jpg format images using MATLAB.

Concentrated on the Image compression and de-noising by DWT technique. Results shown the values for percentage energy retained, percentage number of zeros, Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). These values were calculated for a range of threshold and decomposition level-2 values on the image. The energy retained describes the amount of image detail that has been kept; it is a measure of the quality of the image after compression. The number of zeros is a measure of compression. A greater percentage of zeros implies that higher compression rates can be obtained. A higher value of PSNR implies the image quality is improved and lower value of PSNR implies image is not clarity. A higher value of MSE the image is very poor and for lower value of MSE image is better.

To obtain higher compression rates change the threshold values. When threshold level is higher provides better compression but more energy loss. To change the energy retained and number of zeros values, a threshold value is changed. When threshold values are changed i.e. increased, energy lost but having good compression rate. The threshold is the number below which detail coefficients are set to zero. The higher the threshold value, the more zeros can be set, but the more energy is lost.

Adding 'salt & pepper' noise to original image at decomposition level 2, it is found that the wavelet having for lower threshold value image is clarity & as threshold value increases the quality of image decreases.

REFERENCES

[1] Priyadharshini.S, Gayathri.K, Priyanka.S and Eswari.K "Image De-noising Based On Adaptive Wavelet Multiscale Thresholding Method", *International Journal of Science and Modern Engineering (IJISME),* Vol. 1, Issue-5, April 2013.

[2] Anil Kumar katharotiya, Swati Patel and Mahesh Goyani "Comparative Analysis between DCT & DWT Techniques of Image Compression", *Journal of Information Engineering and Applications,* Vol. 1, No.2, 2011.

[3] Anitha S "Image Compression Using Discrete Cosine Transform & Discrete Wavelet Transform", *International Journal of Scientific & Engineering Research,* Vol. 2, Issue 8, August 2011.

[4] I. Daubechies, M. Defriese and C. DeMol, "An iterative thresholding algorithm for linear inverse problems with a sparsity constraint", *Commun. Pure Appl. Math.*, vol. 57, No. 11, pp. 1413–1457, 2004.

[5] W. Dong, L. Zhang and G. Shi, "Centralized sparse representation for image restoration," *in Proc. IEEE Int. Conf. Comput. Vis. (ICCV),* pp. 1259–1266 Nov. 2011.

[6] J. Mairal, M. Elad and G. Sapiro, "Sparse representation for color image restoration" , *IEEE Trans. Image Process,* Vol. 17, No. 1, Jan. 2008.

[7] M. Ahoron, M. Elad and A. Bruckstein, "K-SVD: An algorithm for designing over complete dictionaries for sparse representation", *IEEE Trans. Signal Process.,* Vol. 54, No. 11, pp. 4311-4322, Nov. 2006.

[8] R. Rybubstein, A. M. Bruckstein and M. Elad, "Dictionaries for sparse representation modeling", *Proc SPIC,* Vol. 98, No.6, pp. 1045-1057, Jun. 2010.

[9] K. Dabov, A. Foi, V. Katkovnik and K. Egiazarian, "Image de-noising by sparse 3-D transform-domain collaborative filtering", *IEEE Trans. Image Process.,* Vol. 16, No.8, pp. 2080-2095, Aug.2007.

[10] A. Danielyan, V. Katkovnik and K. Egiazarian, "BM3D frames and variational image deblurring," *IEEE Trans Image Process,* Vol. 21, No.4, pp. 1715-1728, Apr. 2012.

[11] Weisheng Dong, Lei Zhang, Guangming Shi and Xin Li, "Nonlocally Centralized Sparse Representation for Image Restoration", *IEEE Trans. On Image processing,* Vol. 22, No. 4, April 2013.

[12] M. Alptekin Engin and Bulent Cavusoglu, 'New Approach in Image Compression: 3D Spiral JPEG,' *IEEE Communications Letters,* Vol. 15, No. 11, November 2011.

[13] Bang Huang and Linbo Xie, "An improved LBG algorithm for image vector quantization," , *Compute Science and Information Technology (ICCSIT),* 3rd IEEE International Conference on, Vol. 6, No. , pp. 467, 471, 9-11 July 2010.

[14] Kiran Bindu, Anita Ganpati and Aman Kumar Sharma, "a comparative study of image compression algorithms", *International Journal of Research in Computer Science, eISSN* 2249-8265 Vol. 2, pp. 37-42. Issue 5, 2012.

[15] T. D. Bui and G. Y. Chen, "Translation invariant de-noising using multiwavelets", *IEEE Transactions on Signal Processing,* 46(12):3414-3420, 1998.

[16] S. G. Chang, B. Yu and M. Vetterli, "Adaptive wavelet thresholding for image de- noising and compression," *IEEE Trans. Image Process.,* Vol. 9, No. 9, pp. 1532–1546, Sep-2000.

[17] L. Sendur and I.W. Selesnick, "Bivariate shrinkage functions for wavelet- based de- noising exploiting inter scale dependency", *IEEE Transactions on Signal Processing,* 50(11), pp. 2744-2756, Nov 2002.

[18] D. L. Donoho and I. M. Johnstone, "De-noising by Soft Thresholding,", *IEEE Transactions on Information Theory,* Vol. 41, No. 3, 1995.

[19] L. Starck, J. Fadili and F. Murtagh, "The undecimated wavelet decomposition and its reconstruction", *IEEE Trans. Image Process,* Vol. 16, No. 2, pp. 297–309, February 2007.

[20] Pierrick Coupe, Pierre Hellier, Charles Kervrann and Christian Barillot "Nonlocal Means-Based Speckle Filtering for Ultrasound Images", *IEEE Transactions On Image Processing,* Vol. 18, No. 10, October 2009.

[21] B.B.S Kumar & P.S Satyanarayana "Compression and de-noising – Comparative analysis from still image using Wavelet Techniques", ISSN (PRINT): 2320 – 8945, Vol. 1, Issue -6, 2013.

[22] P. Chatterjee and P. Milanfar, Is Denoising Dead?, *IEEE Transactions on Image Processing,* Vol. 19, No. 4, pp 895-911, Apr. 2010.

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