Analysis of Image Compression using Wavelets

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ABSTRACT

In this paper significant features of wavelet transform in compression of images, including the extent to which the quality of image is degraded by the process of wavelet compression and decompression is being studied it has been found that maximum improvement in picture quality with higher compression ratio is achieved by wavelet based image compression In this paper examined a basic concept of wavelets; wavelet transform and discrete wavelet transform and also deliberate the principle of image compression and image methodology. The objective is to select the appropriate mother wavelet during the transform stage towards compression the gray image and the quality of reconstructed image has been estimated in terms of image quality metrics PSNR and CR and also computes compression ratio at different level of decompositions of DWT. Haar, Daubechies and Biorthogonal, Coiflets and Symlet wavelet have been applied to an image and their qualitative and quantitative analysis results has been compared in terms of PSNR values, MSE and compression ratios. In this paper going to reduce the size of gray image with maintain good picture quality, this property is helpful to storage and transmission of data over internet.

Keywords

Peak signal noise ratio (PSNR), compression ratio (CR), mean square error (MSE), DWT, threshold

1. INTRODUCTION

In recent year's research in computer graphics has perceived considerable activity focused on the use of wavelets, as in many other disciplines**. [1]**Wavelets are mathematical tool for systematic decomposing function as they allow a function to be described in terms of a coarse overall shape, plus details from broad to narrow range irrespective of whether the function of interest is an image wavelet, after an elegant technique for representing the levels of detail existing. Although wavelets have their roots in approximation theory and signal processing, they have currently been applied to many problems in computer graphics. These graphics application include image editing, image compression and image querying etc. as well. In the present era image processing has emerged significantly and is widespread in research area in computer graphics, as image processing is technique for analysis and manipulation of image and also improves a quality of an image. Image processing in computer is used to change the nature of image. **[2]**The ideas of multiple levels of resolution or so called "level of detail" when wavelet moved from a mathematical analysis tool to a practical computation tool and they were rapidly put to use in computer graphics. The introduction of wavelets to signal and image processing has provided a very flexible tool for engineering so as to create innovative techniques for solving various engineering difficulties. **[3]**Nowadays, in internet and multimedia technology much information is being accessed having a large amount of data and it requires more storage space in disk. In many different fields, digitized image are replacing conventional analog image as photograph and medical image or x-rays. The size of data required to explain images greatly show transmission and makes storage excessively costly. The information confined in the image must therefore be compressed by extraction of merely visible elements, which are then encoded. The unprocessed image heavily consumes very important resources of the system; uncompressed image requires large memory to store the image and large bandwidth to transmit the image data and are incapable to handle a current technology and also economically it has very hard processing so, the solution to this problem is to compress the information and storage space and transmission is reduction of redundancy and irrelevancy. Redundancy reduction aims at removing duplication form of image and irrelevancy reduction omits parts of the signal that will not be noticed by human visual system.

A basic aim of image or data compression is to reduce the size of original image (the bit rate for transmission) or storage while maintaining an acceptable image quality. Data compression is the technique to reduce the redundancies. Image compression research's objective is to contract the number of bits (size) and represent an image by removing the correlation either between neighboring pixels (aka spatial) or between different color and spectral bonds (aka spectral).

2. IMAGE COMPRESSION TECHNIQUE

The main task of image compression algorithm is reduction of redundant and irrelevant information**. [4]**Image compression in lossless manner can be reconstructed exactly without any change in the intensity values as Image compression can be lossy or lossless. -Lossy compression methods especially when, used at compression low bit rates with the distortion of the reconstructed image and then lossy encoding for image is generally achieved using transform encoding methods. In lossy compression, the original signal is exactly reconstructed from the compressed data. In a lossy compression scheme, the image compression algorithm should achieve a balance between compression ratio and image quality .In any data compression scheme three basic steps are involved: transformation, quantization and encoding. Wavelet based compression is a one type of transform-based compression. In general, transform based compression is done according to the scheme shown in fig-1 .For wavelet based compression, a wavelet transform and its inverse are used for the transform and inverse transform, respectively.

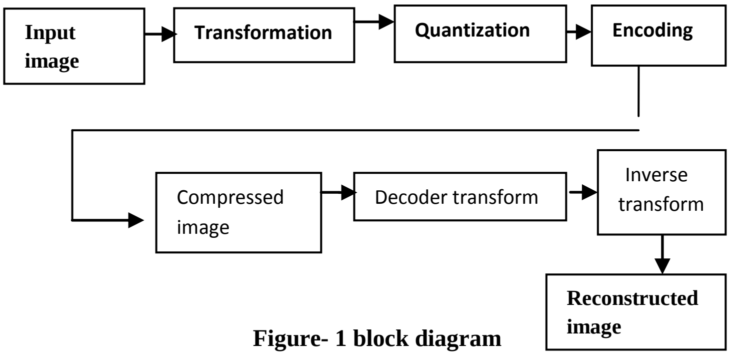


Figure- 1 block diagram

3. WAVELET IN IMAGE COMPRESSION

Wavelet transforms has now, developed as one of the most important and powerful tool for signal representation. Nowadays, it has been used in image processing, data compression, and signal processing. Wavelets are tool for decomposing signals such as images, into an order of increasing resolutions. The wavelet transforms, particularly those for orthonormal and biorthogonal wavelets with finite support, have emerged as a new mathematical tool for multiresolution decomposition. Wavelet transforms are used for the compression and noise reduction in image in order to improve the quality of an image and this is accomplished through a reversible wavelet decomposition followed by selective suppression of undesirable noise components by reconstructing the image from wavelet. Wavelets are a mathematical tool for changing the coordinate system in which we represent the signal to another domain that is best suited for compression. **[5]** Wavelet transform is a two dimensional time frequency signal analysis method; it also represents an image as a sum of wavelet function with different locations of scales and localization properties in the time and frequency domain. Important properties of wavelet in image compression leads to efficient implementation, and useful in avoiding dephasing in image processing and allows fast algorithm and degree of smoothness. Analysis by wavelet transformation can be observed as a decomposition of the given signal of sub band, constituting a filter bank of band pass filters, with width linearly increasing as a function of frequency. This method provides a spectral analysis of the signal .Wavelet based coding is more robust under transmission and decoding errors. **[6]** Wavelet coding scheme at higher PSNR with compression ratio avoid blocking artifacts and they are better matched to the human visual system characteristics. Wavelet is scalable as the transform process can be applied to an image as many times as required and thus decoding errors, and also facilitates progressive transmission of images, wavelets provides an efficient decomposition of singulars prior to compression, wavelet compression is very efficient at low bit. Thresholding is one of the most commonly used processing tools in wavelet signal processing. It is widely used in noise reduction signal and image compression, and sometimes in signal recognition. For high value of threshold, the loss of information is more and for low value of threshold loss of information is less. The selection of threshold should be low, but for the low value of threshold there is negligible compression of data. The small values of the DWT coefficients retain little of the picture. Therefore they can up to a limit, can be neglected. Certainly some details of the picture are consequently lost after applying the threshold but the question is to what extent the human eye can detect the differences between the original and the reconstructed image. Wavelet transform divides the information of an image into approximation and detail subsignals. The approximation subsignal shows the general trend of pixel values and other three detail subsignal as show the vertical, horizontal, and diagonal details or changes in the images.

At the present time, it has been used in image processing, data compression, and signal processing. The wavelet transform uses non-periodic, non-smooth and finite support basis functions (i.e., Haar, Daubechies, Coiflet...) thus, allowing a much more meaningful representation through multi-resolution analysis. The Discrete Wavelet Transform (DWT) can be applied by a perfect reconstruction filter bank, a low-pass filter and the corresponding high-pass filter, known as analysis filters. Discrete wavelet transform (DWT) algorithms have now become standards tools for processing of signals and images in several areas of research. **[9]**The advantage of DWT over existing transforms, such as Discrete Fourier Transform (DFT) and DCT is that the DWT can perform a multiresolution analysis of a signal with localization in both time and frequency domain. **[7]**The Discrete Wavelet Transform (DWT)can be interpreted as signal decomposition in a set of independent spatially oriented frequency channels. The discrete wavelet transform of signals produces a non-redundant image. Discrete Wavelet Transform(DWT) which is based on sub-band coding is found to yield a fast computation of wavelet transform, it is now easy to implement and, it also reduces the computation time and resources required. **[8]** The signal is passed through two complementary filters and emerges as two signals, approximation and details this is called decomposition or analysis. Discrete Wavelet Transform (DWT) can be efficiently used in image coding applications because of their data reduction capabilities. **[9]** DWT has some properties, which makes it a better choice for image compression than DCT, especially for images of higher resolutions. DWT have higher de-correlation and energy compression efficiency so, DWT can deliver better image quality on higher compression ratios. Localization of wavelet functions, both in time and frequency gives DWT potentiality for good representation of images with lesser coefficients. Thus, DWT represents an image on different resolution level.

In this paper studied the performance of different types of wavelet function with different size of resolution image and proposed the most appropriate wavelet function that can perform optimum compression for a given type of image by performing wavelet analysis on images using wavelet transform and implementing in an image the compression system and highlighted the advantage of this transform method. deliberate in this paper the important features of wavelet transform in compression of images, including the extent to which the quality of image is degraded by the process of wavelet compression and decompression and checks the results in terms of image quality metrics PSNR and also computes compression ratios at different level of decompositions of DWT. Haar, Daubechies and Biorthogonal wavelets have been applied to an image and results have been compared in the form of qualitative and quantitative analysis in terms of PSNR values, MSE and compression ratios. To analyze the performance of the wavelet function with images the lost amount of data in the compressed image is calculated by their respective compression ratio and image quality is measured using Peak Signal Noise Ratio (PSNR). The effects of different wavelet function, image contents and compression ratio estimate the picture quality. A very competent image compression scheme is proposed based on discrete wavelet transform.

4. MEASURE OF IMAGE QUALITY

Standard distortion measure are mean square error (MSE) and **[4]** peak signal to noise ratio (PSNR) between the original and compressed image version. PSNR parameter is one of the parameter that can be used to image quality, PSNR parameter is often used as a bench mark level of similarity between reconstructed image and the original image. Larger PSNR will produce better image quality, usually expressed in decibels (db), The PSNR is defined as,

$$\boldsymbol{PSNR = 20 * log_{10} (\frac{255^2}{MSE})}$$

The known and most often used objective measures of the quality of a compressed image is mean square error (MSE) and peak signal to noise ration are based on error measures in the L^2 Norm, these measure signify quality by a single number which is an aggregate measures of compression error at all image pixels A low value of MSE means lower error, and as seen from the inverse relation between the MSE and PSNR.

$$\boldsymbol{MSE = \frac{1}{m, n} \sum\sum (X_{i,j} - Y_{i,j})^2}$$

Where X is original image, Y approximation of decompressed image and m, n are dimensions of the image.

4.1 Compression ratio

The compression ratio is one of the quantitative parameters to measure the performance of compression method. Compression ratio is defined as -

Compression ratio (CR) = $\frac{orignalimagesize}{compressedimagesize}$

The compression ratio is used to measure the capacity of image data compression by comparing the size of the original image against compressed image. Compression ratio (CR) as the ratio of the number of nonzero elements in original matrix to the number of nonzero elements in updated transformed matrix.

5. WAVELET TRANSFORM

The uses of Wavelet Transform is in image processing such as image compression, edge detection, noise removal .Wavelets are mathematical tool for altering the coordinate system in which we represent the signal to another domain that is appropriate for compression. Wavelet based coding is more robust under transmission and decoding errors. Wavelets are device for decomposing signals such as image, into an order of increasing resolution. A wavelet transform can be used to decompose a signal into component wavelets. Wavelets have great advantage of being able to separate the time details. Wavelet is a small wave whose energy is focused in time and all these function are created from a single function called mother wavelet by dilations and translation in time domain. Wavelet produces a natural multi resolution of every image including the all-important edges. **[10]**Wavelets are signals which are local in time and scale and generally have an irregular shape. A wavelet is a waveform of effectively limited period that has an average value of zero. The term wavelet comes from the fact that they integrate to zero and they wave up and down across the axis. A signal can be decomposed into many shifted and scaled representation of the original mother wavelet. Wavelet compression methods **[11]** have produced superior objective and subjective results. Meanwhile wavelet consists of function with both high frequencies and low frequencies, large smooth areas of an image may be represented with very few bits. The wavelet transform decomposes signals over dilated and translated functions called *wavelets*. Mathematically, the wavelet is a function of zero average, having the energy concentrated in time:

$$\int_{-\infty}^{\infty} \psi(t) = 0$$

In order to be more accurate in extracting time and frequency information, a family of Wavelets **[12]** can be Constructed from a function ψ (t), also known as the 'Mother Wavelet', in a finite interval. 'Daughter Wavelets' $\psi_{u,s}(t)$ are then formed by translation with a factor u and dilation with a scale parameter$s$:

$$\boldsymbol{\psi_{u,s}(t) = \frac{1}{\sqrt{s}} . \psi\left(\frac{t-u}{s}\right) \; OR \quad h_{a,b}(t) \; \frac{1}{\sqrt{a}} h\left(\frac{t-b}{a}\right)} \quad \text{….. (1)}$$

Wavelet transform **[13]** have gained significant attention in recent times due to their suitability for a number of important signal and image processing tasks including image coding. The principle behind the wavelet -transform, as elaborated is systematic or ordered decomposing of an input signal into a series of successively lower resolution references signals and their associated detail signals, at each level. The references signal and detail signal comprises of the information needed to reconstruct the reference signal at the next higher resolution level. The wavelet transform plays an extremely vital role in image compression. Wavelet transformation is an essential coding technique for both spatial and frequency domains. Where it is used to distribute the information of an image into approximation and detail sub signals. Wavelet transform represents an **[14]** image as a sum of wavelet function with different location and scales and any decomposition of an image into wavelets involves a pair of wave forms, one to represent the high frequencies corresponding to the detailed part of an image (wavelet function) and one for the low frequencies or smooth part of an image (scaling function). Wavelet transform performs a multi resolution **[15]** image analysis and the result of multi resolution analysis is simultaneous image representation on different resolution (& quality) levels. Wavelet transform is powerful because of its multi resolution decomposition technique, this technique allow wavelets to de-correlate an image and concentrates the energy in a few coefficients. The wavelet transform, where the basis function is obtained from a single prototype wavelet by translation and dilation **[16]** Where $a \in R^+, b \in R$ for large a, the basis function becomes a stretched version of the prototype wavelet that is a low frequency function, while for small as the basis function becomes a contracted wavelet, that is a short high frequency function, the wavelet transform (WT) is defined as

$$X_w(a,b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} h^* \left(\frac{t-b}{a}\right) x(t) dt \ldots\ldots\ldots (2)$$

Wavelets are modifiable and hence can be designed to suit the individual application. Its generation and calculation of discrete wavelet transform is well suited for a digital computer. A wavelet in the sense of discrete wavelet transform is an orthogonal function which can be applied to a finite group data. The wavelet transform is executed in the discrete time domain by the discrete wavelet transform and the discrete wavelet transform can be implemented by passing the signal through a combination of low pass and high pass down sampling by a factor of two thus, obtaining a single level of decomposition and multiple of the wavelet transform are performed by repeating the filtering and down sampling operation on low pass branch outputs. The discrete wavelet transform which is based on sub band coding is found to yield a fast computation of wavelet transform **[17]**

5.1 Discrete wavelet transform

Let us examine the discrete wavelet transform, the translation and dilation /contraction parameters of the wavelet **[18, 19].**

$$h_{m,n}(t) = a_0^{-\frac{m}{2}}.h(a_0^{-m}t - nb_0),\ m,n \in Z, a_0 > 1,\ b_0 \neq 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

$$which\ corresponds\ to\ a = a_0^m and\ b = na_0^m b_0, \quad a_0 = 2, b_0 = 1$$

The two dimensional discrete wavelet transform is basically a one dimensional analysis of a two dimensional signal if only operates on one dimension at a time by considering the rows and columns of an image in a separable fashion. An effective way to implement these, using filters was developed in 1988 by Mallat. The discrete wavelet transform of a finite length signal X (n) having N components, for example is expressed by an N×M matrix. In the discrete wavelet transform, an image signal can be analyzed by passing it through an analysis filter bank followed by a decimation operation. The DWT represents an image as a sum of wavelet functions, known as wavelets, with different location and scale. It represents the data into a set of high pass (detail) and low pass (approximate) coefficients. The input data is passed through set of low pass and high pass filters used. The output of high pass and low pass filters are down sampled. The output from low pass filter is an approximate coefficient and the output from the high pass filter is a detail coefficient. The high pass filter, which resembles to a differencing operation, extracts the detail information of the signal. After filtering the image produce a sub image ,we have divided the image into four bands denoted by LL, LH, HL, and HH after one level decomposition, It means a one-dimensional discrete wavelet transform (1D DWT) to decompose each image tile into high and low sub image . A two dimensional decomposition is achieved by applying the 1D DWT along the horizontal and vertical axes of the image tile. This results in four sub band images; low sub band image (LL), high sub band image (HL), low sub band (LH), and high sub band image (HH). Hence LH signal contain horizontal elements similarly, HL and HH contain vertical and diagonal elements respectively.

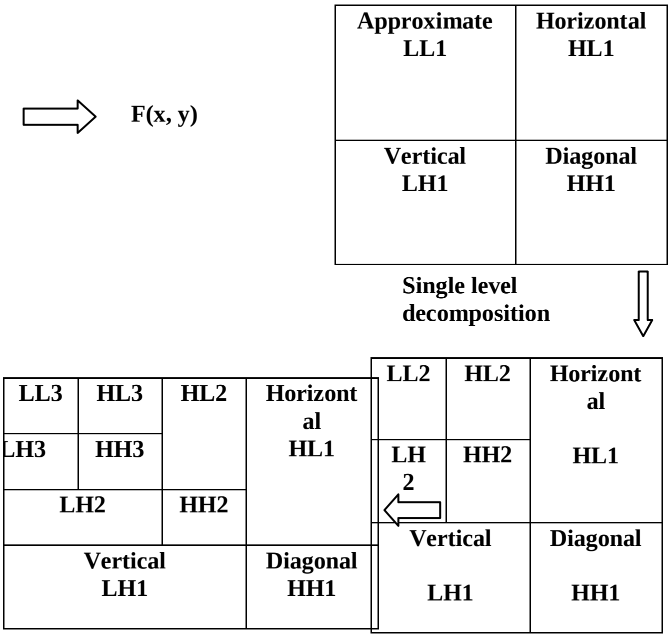


Figure -2

The number of decompositions decides the resolution of the lowest level in wavelet domain. If we use larger number of decompositions, we will be more effective in resolving important DWT coefficients from less important coefficients thus; the quality of compressed image depends on the number of decompositions. The HVS is less sensitive to removal of smaller details **[20]**.

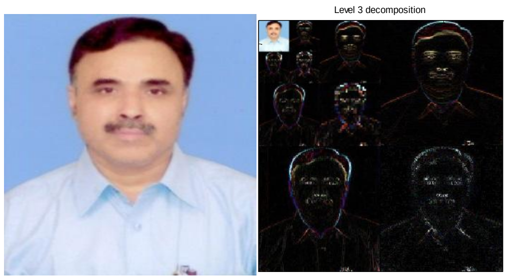


Figure – 3 Original image decomposition at 3rd level using wavelet

After decomposing the image and representing it with wavelet coefficients, compression can be achieved by ignoring all coefficients beneath some threshold. In our experiment, compression is achieved by wavelet coefficient thresholding, using a global positive threshold value. All coefficients below some threshold are neglected and compression ratio is computed. Shows in Figure reconstructed image Lena (512*512) for 1 to 5 level of decomposition it can be realized that image quality is improved for a larger number of decompositions on the other hand , a larger number of decompositions causes the loss of sition is required to attain balance between image quality and computational complexity.

6. METHOD FOR IMAGE PROCESSING

An intensity image is a data matrix whose values have been scaled to represent intensities. An image is defined as a two – dimensional function i.e. A matrix, $f(A, B)$ where A and B are spatial coordinates and the amplitude of f at any pair of coordinates (A, B) is called the intensity or gray level of the image at the point. They have values in the range [0,255] and [0, 65535] **[21, 22].** Process of wavelet image processing is performed as follows: an input image is taken by the computer, and discrete wavelet transform is performed for decompose the image in different level then after, the compressed images are reconstructed into an image similar to the original image by applying discrete wavelet transform. Thus images are compressed and reconstructed using Various discrete wavelet transform are used in step by step namely daubechies, haar, biorthogonal and coiflets and symlets observer how various mathematical properties such as symmetry, vanishing moments and orthogonality differ the results of compressed results. Quantitative analysis measuring reconstructed images by using PSNR value, MSE and compression ratio at different decomposition of levels.

Wavedec2 performs the decomposition of the image for the given desired level (N) with the given desired wavelets (wname). wavedec is a two dimensional wavelet analysis function [C, S] = wavedec2(X, N, wname) returns the wavelet decomposition of the matrix X at level N using are the decomposition string 'wname' output are the decomposition vector C and the corresponding book keeping matrix S. here the image is taken as the matrix X, and after compressed image, then reconstruct the image using inverse wavelet transform. Since the whole purpose of this paper was to compare the performance of image quality (PSNR) and compression (CR) using different wavelets, and here we try the perfect reconstruction after processing the original image. The whole process of DWT based image compression has been performed to get the desired results of the proposed work. The work has been done in MATLAB software. The steps involved in compressing, decompression and reconstructed of image are:-

1. Read the image form computer (image dimension 512 × 512, 256 × 256, &128 × 128)
2. Apply 2D discrete wavelet transform (2D-DWT) using various wavelets and decompose the image from 1-level to 5 –level. (Using 2D wavelet decomposition with respect to a dwt computes the approximation coefficients matrix CA and detail coefficient matrixes CH, CV, CD (horizontal, vertical & diagonal respectively) which is obtained by wavelet decomposition of the input matrix).
3. We have applied compression process with desired wavelets and compressed image.
4. Reconstruct an estimate of the original image by applying the corresponding inverse transform. Because applied inverse transform and reconstructed image after decomposition process and compressed image (respect original image).
5. Calculate compression ratio , mean square error and peak signal noise ratio values for corresponding different wavelets are apply for corresponding reconstructed images.
6. The same process is repeated for different resolution of images and compares its performance.

7. RESULTS ANALYSIS

In this experiment taken results analysis using standard type gray image like Lena, cameraman and bird and its resolution is 512×512, 256×256 and 128×128. And apply the mother wavelets like Haar wavelet, Daubechies wavelet, Coiflet wavelet, Biortogonal wavelet and Symlet wavelet. Results are observed in terms of Peak Signal noise ratio (PSNR) and compression ratio (CR). Image decomposition by using DWT and then after image reconstructed by using inverse discrete wavelet transform (IDWT). And image decomposition and reconstructed analysis a results in different level of decomposition, threshold value and with wavelet family. The higher PSNR value is better quality of compressed or reconstructed image. Typical values for lossy compression of an image are between 30 and 50 dB and when the PSNR is greater than 40 dB, then the two images are indistinguishable.

Firstly discuss table 1 results (Lena, 512×512) image decomposition from 1 to 5 levels, first level of decomposition see figure (4) is with threshold value is 10 so higher PSNR value is 41.3808 in biorthonal wavelet and CR is 62.0230 in daubechies wavelet if fixed level of decomposition, analysis in maximum threshold value is 50 then experiment results reconstructed image quality higher PSNR value is 33.8448 and CR 73.2715. In these terms second level of decomposition threshold value is 10 so higher PSNR value is 40.2040 in biorthogonal wavelet and CR is 72.6217 in daubechies wavelet, if threshold value is increasing 50 so higher PSNR value is 31.7445 biortogonal wavelet and CR 89.3182 in symlet wavelet. In same pattern increasing a level of decomposition in third level so higher PSNR value 39.8889 and CR is 73.8534 threshold value is 10 and increasing threshold value is 50 so higher PSNR value is 31.0813 in biorthogonal and CR is 92.4467 in symlet wavelet. In forth level decomposition so higher PSNR value is 39.8349 in biortogonal and CR 73.2648 symlet wavelet if threshold value is 50 so PSNR value is decreasing 30.8923 in biortogonal wavelet but CR is increasing is 92.7389 in symlet wavelet. In fifth level of decomposition so higher PSNR value is 39.8215 in biortogonal wavelet and CR is 73.6396 in daubechies wavelet, if threshold value is 10 and set the threshold value 50 so higher PSNR value is 30.8560 or CR92.6569 is higher results by symlet wavelet.

Original image 512×512

Figure-4

Error image reconstructed image

1st level PSNR 41.3808 & CR 50.2130

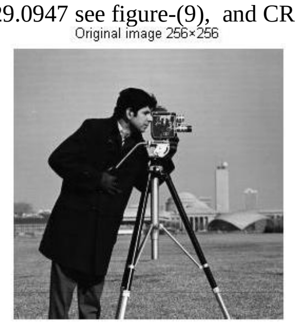
Figure-5

Reconstructed image **Error image**

Figure-6

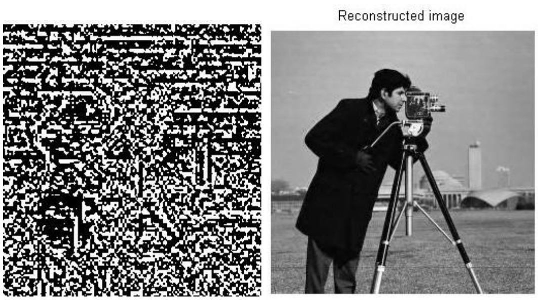
5th level PSNR 29.2624 & CR 92.6569

Observed table2 results in second step image cameraman (256×256) with same parameter uses in above. Image decomposes in first level and reconstructed image see figure (8).so analysis result in higher PSNR value is 40.8303 biortogonal wavelet and CR is 54.3823 in haar wavelet with threshold is 10, if analysis in maximum threshold value is 50 so reconstructed image quality is higher PSNR value is 30.7780 biortogonal and CR is 70.1437 symelet wavelet, if increasing level of decomposition is 2nd with threshold value is 10 so higher PSNR value is 39.6648 in biortogonal and CR is 65.4419 Haar wavelet if threshold value is 50 so higher PSNR value is30.2695 and CR 84.9209. if level 3rd and threshold value 10 so higher PSNR value is 39.4033 in biortogonal wavelet and CR is 67.1143 in haar wavelet, and threshold value is 50 so higher PSNR value is 29.1135 biortogonal wavelet and CR is 87.9029 in coiflet wavelet and next level is 4th in higher PSNR value in threshold value is 39.3498 in biortogonal wavelet and CR is 67.3401 haar. The maximum level in our results analysis is 5th level in higher PSNR value is 39.3498 in biortogonal wavelet and CR is 67.3584 in haar wavelet, and threshold value is 50 then higher PSNR value is 29.0947 see figure-(9), and CR is 88.5361.



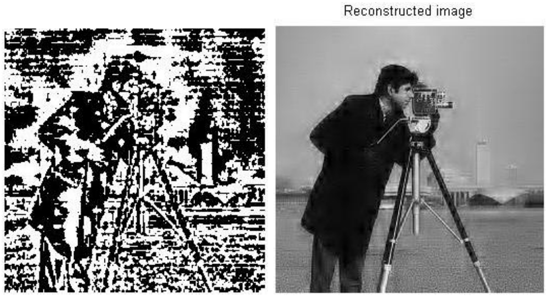
Original image 512×512

Figure-7



Error image **1st level PSNR 40.8303 & CR 43.8303**

Figure-8



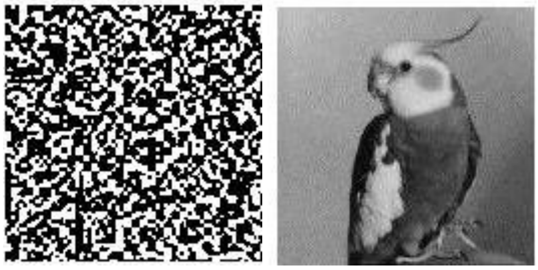
Error image **Reconstructed image**

5th level PSNR 29.0947& CR 88.5361

Figure-9

Results analysis in this section compressed image bird (128×128) according to table-3 & see figure (10, 11& 12). First analysis a results in 1st level of decomposition with 10 threshold value is 10 then higher PSNR value is 39.4709 in biortogonal wavelet and CR is 56.1429 in symlet wavelet, and threshold value is 50 so higher PSNR value is 31.0372 in symlet and CR is 71.7959 in symlet. If level is 2nd with threshold value is 10 so maximum PSNR value is 38.7952 in biortogonal wavelet and CR is 66.8246 in symlet wavelet, and threshold value is 50 then higher PSNR value 29.4690 in biortogonal wavelet and CR value is 86.0664 in symlet wavelet. Level is 3rd so maximum PSNR value is 38.5968 in biortogonal wavelet and CR is 68.3911 symlets wavelet , and threshold value is 50 so maximum PSNR value is 29.0432 biortogonal wavelet and CR is 89.4198 symelet . and level is 4th so higher PSNR value is 38.5323 in biortogonal wavelet and CR is 68.2006 in symelt wavelet, if threshold value is 50 so higher PSNR value is 28.8972 bioirtogonal wavelet and CR is 89.8436 symelet.

Figure-10



Error image **Reconstructed image**

1st level PSNR 39.4709 & CR 34.0830

Figure-11

Error image **Reconstructed image**

5th level PSNR 27.7636 & CR 89.4382

Figure-12

If this results analysis highest level of decomposition is 5^{th} level so higher PSNR value is 38.5289 biortogonal wavelet and CR is 67.7831in minimum threshold value is 10, and highest threshold value is 50so higher PSNR is 28.8829 biortogonal and CR is 89.4382 in symelet wavelet. We have analyzed the results between original image and reconstructed image; if we see the error image in above we can clearly see the large amount of data is lost but still we are getting higher compression ratio with respect to good picture quality in terms of PSNR value. This is main advantage of wavelet based image compression in this paper seen a large amount of data are losing in original image but also get good reconstructed image, after apply wavelets in the image compression method.

8. CONCLUSION

In this paper presented results are using standard image resolutions 512×512, 256×256 and 128×128, from a comparative study of different mother wavelets based image compression system. The effects wavelets function, number of decomposition, PSNR value, MSE value and compression ratio are examined. The final choice of mother wavelets in image compression application depends on image quality and compression ratio, and found that wavelet based image compression which prefers best wavelets, a suitable number of decomposition should be determined by means of image quality (PSNR value) and compression ratio (CR) results show that choice of wavelets depends on the method which is used for picture quality evaluation the objective measures such as PSNR and MSE do not correlate. Observed the results a wide range of wavelets with decomposition images and compressed the image different threshold value. Analyzed are different types of resolution images, if images decompose level by level increasing with respect of increasing a threshold value so images quality (PSNR value) is decreasing. Vice versa image compression ratio is increasing. If PSNR value is greater than 30 db so image quality better. Biortogonal wavelet is provides best visual quality in experiment results all type resolutions image with all desired level of decomposition. And all mother wavelets give higher compression ratio if increasing the number of decomposition. Its means all type wavelets produce a higher compression ratio in maximum level of decompositions. If want higher compression ratio with good image quality so all mother wavelets perform best results in 3^{rd} level of decomposition. The wavelet based image compression; a clear quality difference between them can be noticed. Reliability has helped the Police department to use this algorithm for a finger print reader. In hospitals to check images this method is been used. At both these places accuracy and quality is very essential.

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