Image Compression Algorithm for Different Wavelet Codes

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Abstract: - This paper represents the wavelet techniques used for compression of gray scale and true color images. Image compression methods is applied on the EZW has been successfully implemented to provide high compression rates maintaining ratio can be reached to good quality of the image with different level wavelet codes.

Keywords:-Low Pass Filter, High Pass Filter, Mean Square Error, Peak Signal Noise Ratio , Embedded Zero tree Wavelet

I. INTRODUCTION

The wavelets are chosen based on their shape and their ability to analyze the signal in particular examples. A wavelet analysis is perfect reconstruction, which is the process of reassembling a decomposed signal or image into its original form without loss of image data. To achieve a high compression rate, it is often necessary to choose the best wavelet and decomposition level, which will play an important role in compressing the images. EZW algorithm is designed to use for different wavelet codes.

The next section is about wavelet transform and EZW algorithm is explained how it is used encoding and decoding process for the high quality of the image. Experimental results are in section III of PSNR and MSE with different wavelet codes. Concluding remarks are given in section IV.

II. PROPOSED ALGORITHM

A. *WAVELET TRANSFORM*

The important feature of wavelet transform is it allows multi resolution decomposition [2]. An image that is decomposed by wavelet transform can be reconstructed with desired resolution. It consists of two methods for extracting the frequency range between themselves.

- Low Pass Filter (LPF)
- High Pass Filter(HPF)

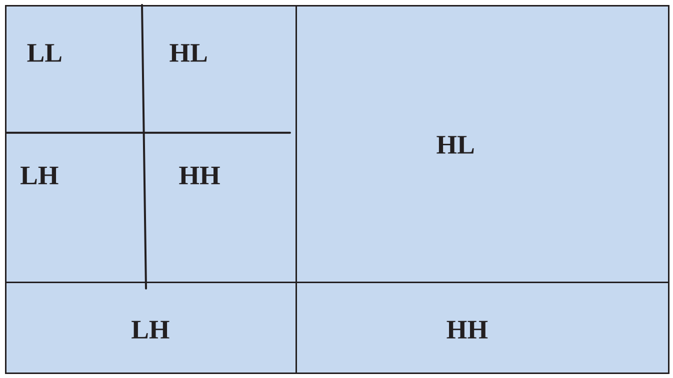
This filter pair (LPF, HPF) is called Analysis Filter pair. The filtering is done on Rows & Columns.

Rows (Procedure):-

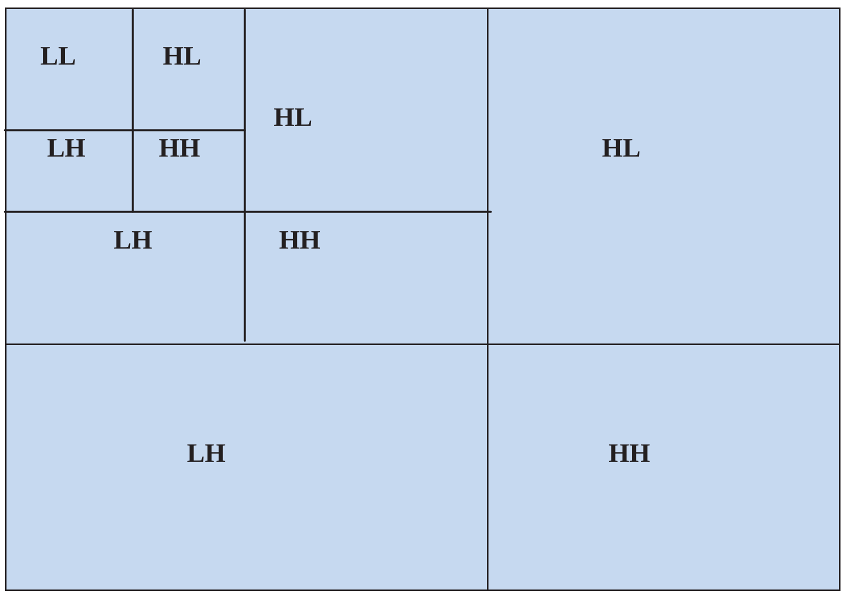
- ✓ The low pass filter is applied for each row of data, and then we get low frequency components of the row. As the LPF is a half band filter, the output data consists of frequencies only in the first half of the original frequency range. By Shannon's Sampling Theorem, they can be sub sampled by two the output data contains only half the original number of samples.
- ✓ 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 is done for all rows.

LL	**HL**
LH	**HH**

(a) I st level



(b) 2nd level



(c) 3rd level

Figure 1 Different Wavelet Decomposition Models

Column (procedure):-

The low pass filter and high pass filter is applied for each columns of data. 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. 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 [8].

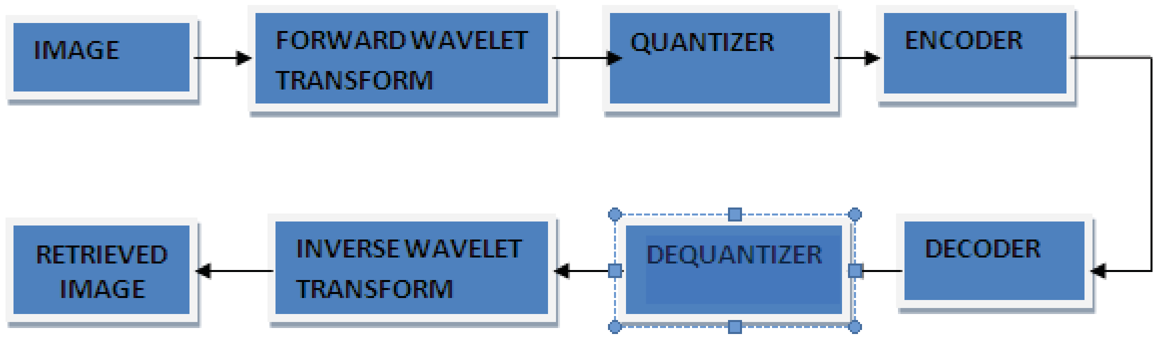


Fig 2.Block diagram for image compression

One of the most important characteristics of DWT is multiresolution decomposition by using the block diagram of the image compression.

- ✓ An image is considered and forward wavelet transforms applied on the image then the image is decomposed,
- ✓ The decomposed image is given to the quantizer .The quantizer approximates the continuous set of values in image data with finite set of values.
- ✓ After that data can be encoded using entropy coder to give additional compression.
- ✓ Next is the decoder that carries decoding process reading the unique code bits sent in place of bit data.

The de quantizer were dequantizes the decoded data bits then finally the inverse transformation is the process of retrieving back the image data from the obtained image values

To determine the effect of the choice of the wavelet filter order, we compare the performance of some known wavelet families see from table 1

S.NO	Wavelet Families	Description
1.	Haar Wavelet	It is based on a class of orthogonal matrices whose elements are 1,-1, or 0 multiplies by power of . The drawback of the wavelet is not continuous & not differentiable.
2.	Daubechies Wavelets	This family is based on orthogonal, and characterized by a maximal number of vanishing moments are supported scaling wavelet functions, which generates an orthogonal multiresoultion analysis and the wavelet function is psi and denoted as db1. It is impossible to obtain an orthogonal supported wavelet that is either symmetric or asymmetric except for Haar wavelets.
3.	Coif lets	It is same as daubechies wavelet and maximal number of vanishing moments and the scaling function form 2N-1 moment equal to 0. And this general wavelet function has 2N moments equal to 0. The two function support of length 6N-1.
4.	Symlet	They are based on least asymmetric and maximum number of vanishing moments. They are called as symmetric wavelets.
5.	Biorthogonal wavelet	They are denoted as bior wavelet, compression wavelet use biorthogonal instead of orthogonal i.e. rather than having one scaling and wavelet function, there are two scaling functions that may generate different multiresolution analysis, and accordingly two different wavelet functions used in the analysis and synthesis.
6.	Reverse Biorthogonal	It is based on reconstruction and decomposition scaling filters. This wavelet has vanishing moments on decomposition for analysis and vanishing moment for the reconstruction of synthesis. It is denoted as rbio
7.	Discrete FIR Meyer wavelet	It is based on symmetric, orthogonal and biorthogonal. It is

		denoted as dmey

Table 1: Different wavelet codes

B. MAGE COMPRESSION ALGORITHM

An EZW encoder is specially designed to use with wavelet transforms [1]. The is based on progressive coding to compress an image into bit stream with increasing accuracy then more bits are added to a bit stream image will be more detailed.

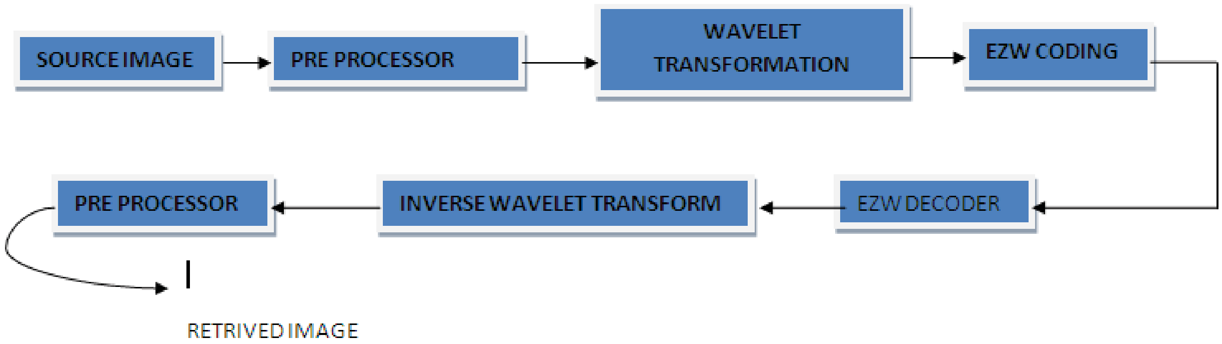


Figure 3.Block diagram for EZW

The wavelet transform uses filter banks for the decomposition of preprocessed image [3]. The EZW encoder encodes the decomposed image by recognizing the priority of decomposed image pixel. The coding algorithm includes the first step to determine the initial threshold, if we choose bit plane coding then initial threshold T_0 will be $T_0=2^{[\log(\max((U^{(x,y)}))]}$. MAX (U(X, Y)) is the maximum coefficient with this threshold [4]. We analysis peak signal to noise ratio and mean square error by using this coding algorithm.

The **encoding process** is done using two passes. The dominant pass generates any one of four possible combinations are significant positive (SP), significant negative (SN), isolated zero (IZ) and zero tree root (ZR). Subordinate pass where the coefficients are encoded as 0 or 1 depending on the current threshold [7].

The **decoding process** is done using two passes. The decoding unit reconstructs the values by identifying the symbols as positive, negative, zero tree and isolated zero tree. Inverse transformation is the process of retrieving back the image data from the obtained image values. The image data transformed and decomposed under encoding side is rearranged from higher level decomposition to lower level with the highest decomposed level been arranged at the top Fig3 shows the reconstruction of the obtained decomposed component [6].

```
// main loop
Threshold = initial_threshold// assigning the initial value to the threshold
do {
dominant_pass(image);//using dominant pass encoding and decoding process to the image
subordinate_pass(image);//using subordinate pass encoding and decoding process to image
threshold = threshold/2;// divided by two with threshold
} while (threshold>minimum_threshold)//until get minimum threshold from present threshold
```

III. EXPERIMENT AND RESULT

The test set for this evaluation experiment image randomly selected from the internet. Matlab 7.0 software platform is use to perform the experiment. The PC for experiment is equipped with an Intel P4 2.4GHz Personal laptop and 2GB memory. Star image size is 256*256 using haar wavelet code

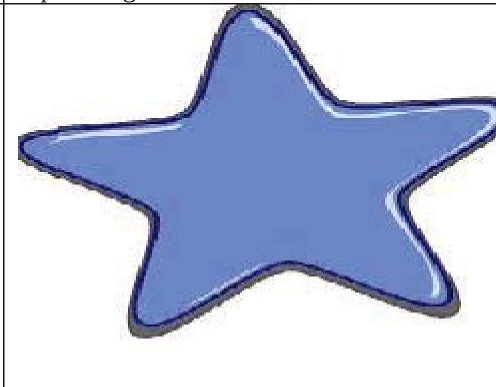
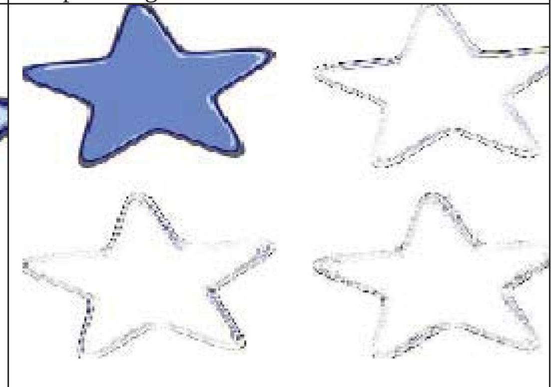
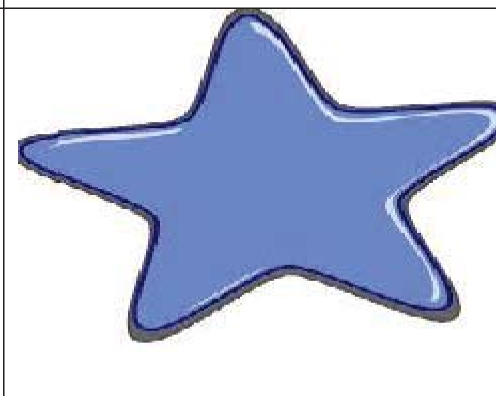
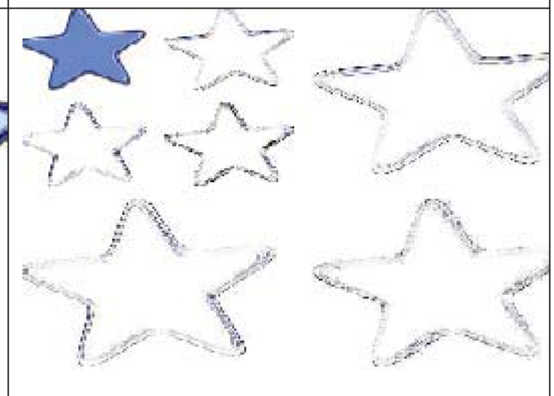
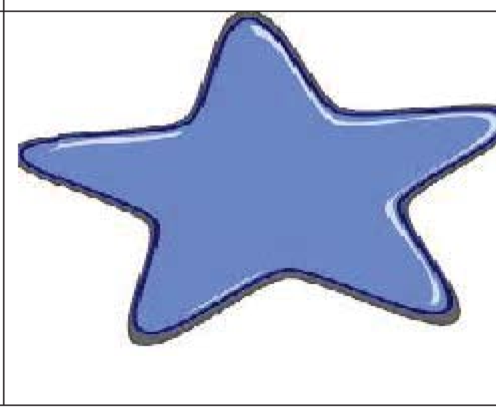
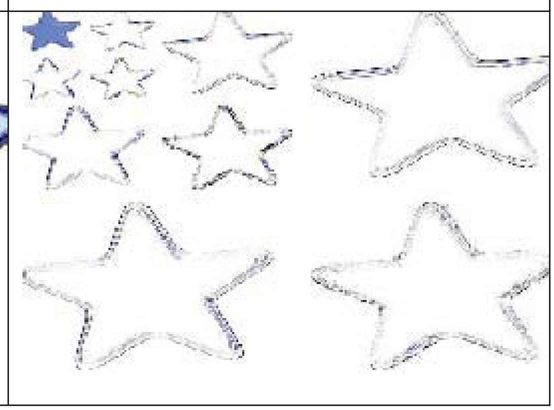
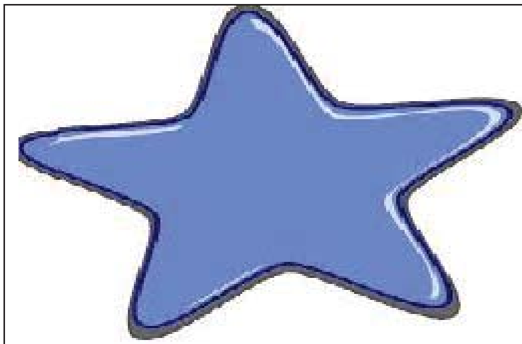
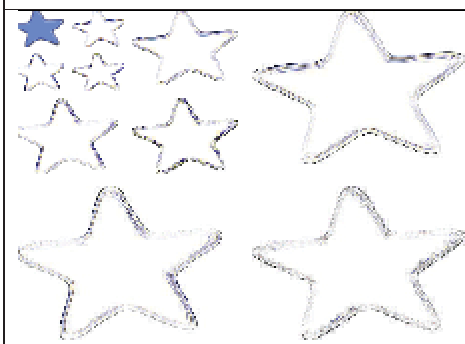
Method	Input Image	Output Image
EZW 1st Level		
2nd Level		
3rd Level		

Fig 4.The above figure shows Decomposition level

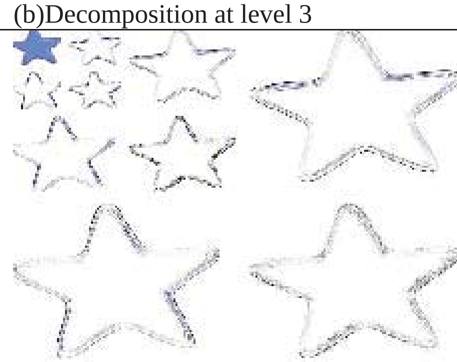


input image

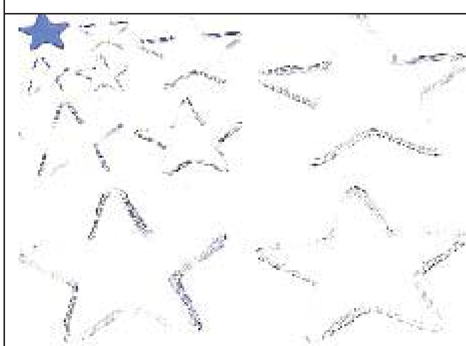
(b)Decomposition at level 3



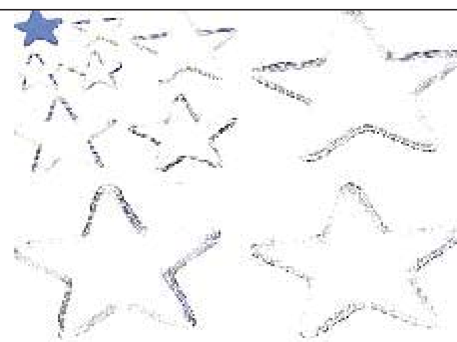
(c) haar



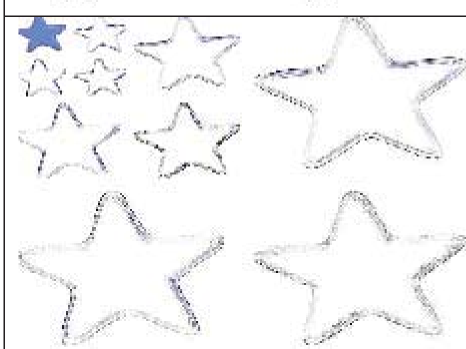
(d) db



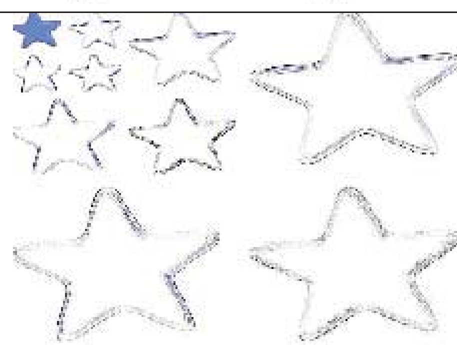
(e)sym



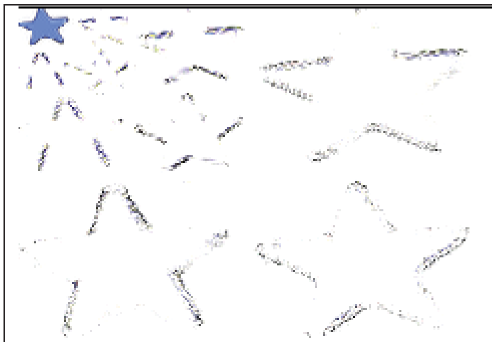
(f)coif



(g) bior



(h)rbio



(i)dmey

Fig 5.The above figure shows that EZW compressions using different wavelet codes

The PSNR and MSE values for the images compresses by the EZW method using different wavelet transforms [5] are tabulated in Table 2 & Table 3

Table2: Initial different wavelet parameters

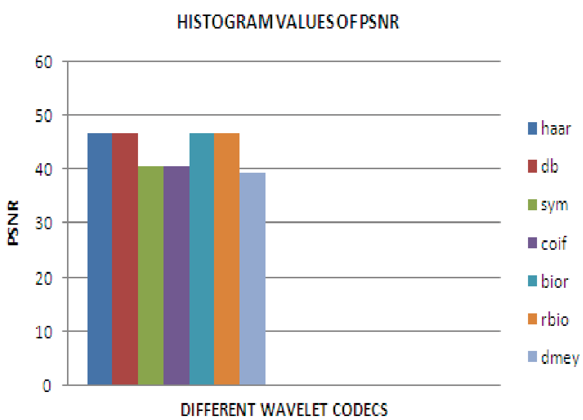
Compression Method	MSE	PSNR	Compression Ratio
haar	1.387	46.71	16.36
db-1	1.387	46.71	16.36
sym2	5.839	40.47	11.60
coif-1	5.536	40.7	11.54
bior-1.1	1.387	46.71	16.36
rbio-1.1	1.387	46.71	16.36
dmey	7.619	39.31	11.81

Table3: Final different wavelet parameters

Compression Method	MSE	PSNR	Compression Ratio
haar	1.387	46.71	16.36
db-5	6.274	40.16	11.64
sym8	6.452	40.08	11.18
coif-5	6.414	40.06	11.31
bior-6.8	6.29	40.14	10.83
rbio-68	6.262	40.16	11.49
dmey	7.619	39.31	11.81

Histogram Chart

Fig6: Table 2



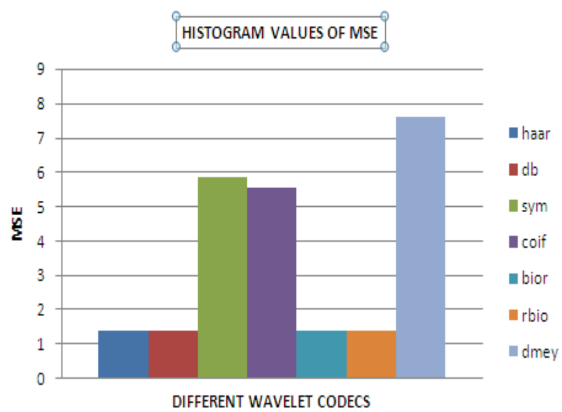
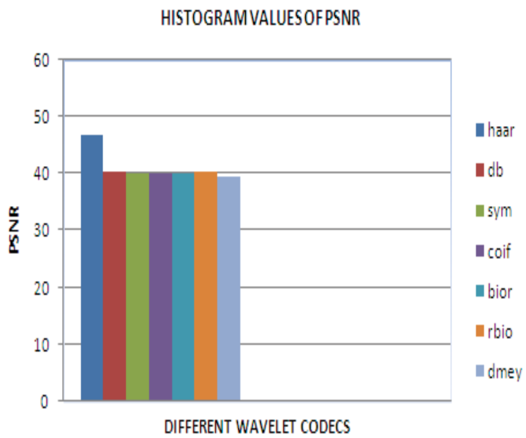
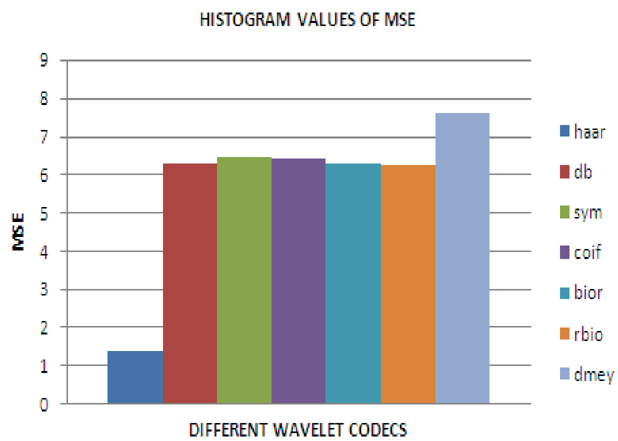


Fig 6: Table 3





IV.CONCLUSION

Image is considered and wavelet transform is applied on the image and decomposition is done. These properties of wavelet transform greatly help in identification and selection of significant and non significant coefficients amongst wavelet transform. Wavelet transform technologies currently provide the most promising approach to high quality image compression which is essential for many real world applications. Finally we get reduced bit stream and better scalability and high quality image.

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