# DWT BASED HYBRID IMAGE COMPRESSION FOR SMOOTH INTERNET TRANSFERS

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**ABSTRACT — The image compression is very necessary and popular technique in course of saving the memory on the local disc or to speed up the internet transfers. The discrete wavelet transform (DWT) has already been proved as the best image compression algorithm. The DWT technique decomposes the image matrix into various sub-matrices to create a compressed image. The new compression technique will be developed by combining the most effective and fast wavelets of DWT technique for image compression. The quality of the new image compression technique will be evaluated using the peak signal to noise ratio (PSNR), mean squared error (MSE), compression ratio (CR) and elapsed time (ET). Also, the new techniques would be compared with the existing image compression techniques on the basis of the latter mentioned parameters.**

***Keywords – Image compression, DWT compression, decomposed matrix, wavelet transform***

## 1. INTRODUCTION

Compression is the process of reducing the size of a file or of a media such as high-tech graphical images etc, by encoding its data information more efficiently. By doing this, there is a reduction in the number of bits and bytes used to store the information. Therefore, a smaller file or image size is generated in order to achieve a faster transmission of electronic files or digital images and a smaller space required for downloading. Compression basically employs four types of redundancy in the data: **Temporal, Spatial, Spectral, Psycho-visual**. Compression is done by using compression algorithms that rearrange and reorganize data information so that it can be stored economically. By encoding information, data can be stored using fewer bits. This is done by using a compression/decompression program that alters the structure of the data temporarily for transporting, reformatting, archiving, saving, etc.

Compression reduces information by using different and more efficient ways of representing the information. Methods may include simply removing space characters, using a single character to identify a string of repeated characters or substituting smaller bit sequences for recurring characters.

Some compression algorithms delete information altogether to achieve a smaller file size. Depending on the algorithm used, files can be greatly reduced from its original size. The rapid development of high performance computing and communication has opened up tremendous opportunities for various computer-based applications with image and video communication capability. However, the amount of data required to store a digital image is continually increasing and overwhelming the storage devices. The data compression becomes the only solution to overcome this. Image compression is the representation of an image in digital form with as few bits as possible while maintaining an acceptable level of image quality [1]. In a lossy compression scheme, the image compression algorithm should achieve a tradeoff between compression ratio and image quality. Higher compression ratios will produce lower image quality and vice versa. Quality and compression can also vary according to input image characteristics and content. Traditionally, image compression adopts discrete cosine transform (DCT) in most situations which possess the characteristics of simpleness and practicality. DCT has been applied successfully in the standard of JPEG, MPEGZ, etc. DCT which represent an image as a superposition of cosine functions with different discrete frequencies. The transformed signal is a function of two spatial dimensions and its components are called DCT coefficients or spatial frequencies. Most existing compression systems use square DCT blocks of regular size. The image is divided into blocks of samples and each block is transformed independently to give coefficients. To achieve the compression, DCT coefficients should be quantized. The quantization results in loss of information, but also in compression. Increasing the quantizer scale leads to coarser



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quantization, gives high compression and poor decoded image quality. The use of uniformly sized blocks simplified the compression system, but it does not take into account the irregular shapes within real images.However, the compression method that adopts DCT has several shortcomings that become increasing apparent. One of these shortcomings is obvious blocking artifact and bad subjective quality when the images are restored by this method at the high compression ratios. The degradation is known as the "blocking effect" and depends on block size. A larger block leads to more efficient coding, but requires more computational power. Image distortion is less annoying for small than for large DCT blocks, but coding efficiency tends to suffer. Therefore, most existing systems use blocks of 8X8 or 16X16 pixels as a compromise between coding efficiency and image quality.[4]The Discrete Wavelet Transform (DWT) which is based on sub-band coding, is found to yield a fast computation of Wavelet Transform. It is easy to implement and reduces the computation time and resources required. The main property of DWT is that it includes neighborhood information in the final result, thus avoiding the block effect of DCT transform. It also has good localization and symmetric properties, which allow for simple edge treatment, high-speed computation, and high quality compressed image.

Wavelets begin with Haar wavelet, the first and simplest. Haar wavelet is discontinuous, and resembles a step function. It represents the same wavelet as Daubechies db1

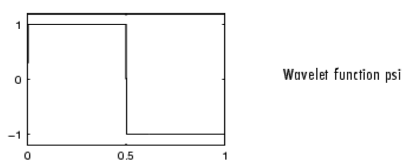


**Figure1.1: Haar Wavelet Function Waveform**

Built by I. Daubechies at the request of R. Coif man. The wavelet function has 2*N* moments equal to 0 and the scaling function has 2*N*-1 moments equal to 0. The two functions have a support of length 6*N*-1. General characteristics: Compactly supported wavelets with highest number of vanishing moments for both phi and psi for a given support width.

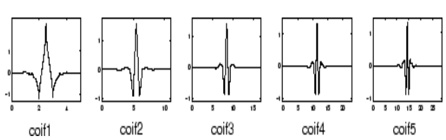


**Figure1.2: Coiflets wavelet families**

Daubechies wavelet based on work of Ingrid daubechies defined by daubechies. Daubechies wavelet defined the discrete wavelet transform. A wavelets act as a mathematical tool to extract information from different kinds of data such as audio signal and images comparing with discrete cosine transform (DCT) , DWT provide more advantages and excellent coding gain for image processing applications. The DWT use a frame-based computation concept which the image can be separated into many files where a Larger file size can avoid the blocking artifacts. The advantage of DWT where the frame-based computation concept introduces a higher compression rations and directly avoiding blocking artifacts. Daubechies wavelets transform is used to remove the edge problem.

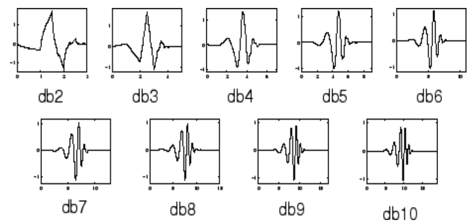


**Figure 1.3: Daubechies Wavelets Transform**

## 2. LITERATURE REVIEW

Many researchers have worked for the analysis of image compression application but there is still some room for improvement in cases where data compression is necessary due to huge requirements of storage and time, especially in problems of information transmission. Sandeep kaur et.at. (2013) In their paper "Comparative Analysis Of Haar And Coiflet Wavelets Using Discrete Wavelet Transform In Digital Image Compression " Images require substantial storage and transmission resources, thus image compression is advantageous to reduce these requirements. The objective of this paper is to evaluate a set of wavelets for image compression. Image compression using wavelet transforms results in an improved compression ratio. Wavelet transformation is the technique that provides both spatial and frequency domain information. This paper present the comparative analysis of Haar and Coiflet wavelets in terms of PSNR, Compression Ratio and Elapsed time for compression using discrete wavelet transform. Discrete wavelet transform has various advantages over Fourier transform based techniques.DWT removes the problem of blocking artifact that occur in DCT.DWT provides better image quality than DCT at higher compression ratio. Noor Huda Ja'afar et.al. (2013) in their paper "Distributed Arithmetic Architecture of Discrete Wavelet Transform (DWT) with Hybrid Method" This paper presents the design and implementation of distributed arithmetic (DA) architectures of three-dimensional (3-D) Discrete Wavelet Transform (DWT) with hybrid method for medical image compression. Due to the separability property of the multi-dimensional Haar and Daubechies, the proposed architecture has been implemented using a cascade of three N-point one-dimensional (1-D)Haar/Daubechies and two transpose memories for a 3-D volume of N×N×N, suitable for 3-D



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medical imaging applications. The architectures were synthesized using VHDL and G-code and implemented on field programmable gate array (FPGA) single board RIO (sbRIO-9632) with Spartan-3 (XC3S2000). Experimental results and an analysis of the area, power consumption, maximum frequency, latency, throughput as well as the subjective test are discussed in this paper. Oussama GHORBEL et.al.(2012) in their paper "Images Compression in WSN: Performance Analysis" With the recent technological advances in wireless communications, integrated digital circuits; development of wireless sensor networks has been enabled and become dramatically feasible. WSNs are large networks made of anumerous number of sensor nodes with sensing, computation, and wireless communications capabilities. Many various routing, power management, and data dissemination protocols have been designed for wireless sensor networks (WSNs) dependent on both the network architecture and the applications that it is designed for. Image compression is one such technology that has been used in WSN domains and then developed to reduce image size and used by WSN applications. Multimedia networked applications have become more and more feasible over WSNs. PreetiAggarwal et.al. (2010) In their paper “Performance Comparison of Image Compression Using Wavelets” focused on how the Fractal image coding takes the long time in its computation due to block searching and matching. So, to overcome this, they used the combination of fractal and wavelet in order to reduce this computation time. They proposed an improved fractal image algorithm based on the wavelet sub-tree. This algorithm proposed improved fractal image compression technique in wavelet domain with thresholding value, which reduces the encoding time effectively. S.M.Ramesh and et.al. (2010)In their paper titled “Medical Image Compression Decomposition for Prediction Method” offers a simple and lossless compression method for compression of medical images. Method is based on the wavelet decomposition of the medical images followed by correlation analysis of coefficients. The correlation analyses are the basis of prediction equation for each sub band. Predictor variable selection is performed through coefficient graphic method to avoid multi co linearity problem and to achieve high prediction accuracy and compression rate. Sindhu M et.al. (2009)In their paper titled “Images and its compression techniques- A Review” gave the review of types of images and its compression techniques. They recommended some general guidelines to choose the best compression algorithm for an image.

## 3. PROBLEM FORMULATION

Compression is the process of reducing the size of a file by encoding its data information more efficiently. By doing this, the result is a reduction in the number of bits and bytes used to store the information. A smaller file size is generated in order to achieve a faster transmission of electronic files and a smaller space for its downloading.

With the increasing demand of manipulations, storage and transmission of the images, great effort has been made to develop the compression algorithms that can provide better compression ratio. Many new schemes such as curve lets, ridge lets, wavelets etc have been used for image compression but most of them suffered from the problems of computational complexity, choice of the filters involved and so forth. Still it is a challenge for researchers to improve the compression ratio of compression algorithms, smaller size of the encoding file, and improved quality of the decompressed images. This work focuses on developing a new algorithm based on fractal image compression.

## 4. EXPERIMENTAL DESIGN

Our first goal in this project is the image compression. Various compression schemes have been studied under the first objective. The major compression schemes evaluated under the preliminary study for this research are DFT (Discrete Fourier Transformation), DCT (Discrete Cosine Transformation) and DWT (Discrete Wavelet Transformation) because of their popularity and effectiveness.[10, 11] For images, the JPEG images are taken into account as it preferred DWT over DCT or DFT. [12, 13] In DFT, execution time is lower and it provides lower compression as compare to the other techniques. In DCT is simple compression algorithm, because computation count in this algorithm is limited, hence provides lower compression ratio. DWT on the other hand, is complex and computation count is very high and it provides higher compression ratio as compared to later two and also proven to be more effective. In wavelet transform system the entire image is transformed and compressed as a single data object rather than block by block as in a DCT based compression system. It can provide better image quality than DCT, especially on higher compression ratio. [10] After preliminary study of literature based on these compression techniques we evaluated that DWT with HAAR Wavelet is the best performer among all other compression techniques available in our selection in terms of compression ratio and elapsed time. Finally, the decision is made to use DWT for its effectiveness and robustness over DCT and DFT.[10, 11]

**Algorithm 1 DWT Algorithm**

1. The image is broken in smaller parts, say 8x8 pixels
2. Working from left to right, top to bottom, the DWT is applied to each block
3. Each block is compressed through quantization
4. The array of compressed blocks that constitute the image is stored in a drastically reduced amount of space.



ISSN: 2278 – 7798 

5. When desired, the image is reconstructed through decompression, a process that uses the inverse discrete wavelet transform (iDWT).

## 5. IMAGE COMPRESSION USING DWT

When a image has been processed of the DWT, the total number of transform coefficients is equal to the number of samples in the original image, but the important visual information is concentrated in a few coefficients. To reduce the number of bits needed to represent the transform, all the subbands are quantized. Quantization of DWT subbands is one of the main sources of information loss. In the JPEG2000 standard, the quantization is performed by uniform scalar quantization with dead-zone about the origin. In dead-zone scalar quantizer with step-size $\Delta_j$, the width of the dead-zone is $2\Delta_j$ as shown in Figure below. The standard supports separate quantization step-sizes for each subband. The quantization step size $\Delta_j$ for a subband $j$ is calculated based on the dynamic range of the subband values. The formula of uniform scalar quantization with a dead-zone is

$$q_j(m,n) = \text{sign}(y_j(m,n)) \left\lfloor \frac{|W_j(m,n)|}{\Delta_j} \right\rfloor$$

where $W_j(m,n)$ is a DWT coefficient in subband $j$ and $\Delta_j$ is the quantization step size for the subband $j$. All the resulting qunantized DWT coefficients $q_j(m,n)$ are signed integers.

After the quantization, the quantized DWT coefficients are then use entropy coding to remove the coding redundancy.

**Algorithm 2 Hybrid compression using db5 and db8**

1.) Image Acquisition
2.) Image decomposition level 1 using db5
3.) Image decomposition level 2 using db5
4.) Compression Image
5.) Image decomposition level 2 using db8
6.) Image decomposition level 2 using db8
7.) Re compression image matrix

Aslo, various dubechies and Coiflets coefficients of discrete wavelet transform have been survey under this research project. The research project focuses on the performance of the contenders being evaluated in the proposed model. The dubechie coefficients being evaluated under the research projects are db1, db2, db4, db5, db8 and a combination of db5 and db8. Also the coiflet coefficients has been tested with coif1, coif2, coif3, coif4 and coif5. The best coefficient after all of the experiments is the new combination of db5 and db8.

## 6. RESULTS

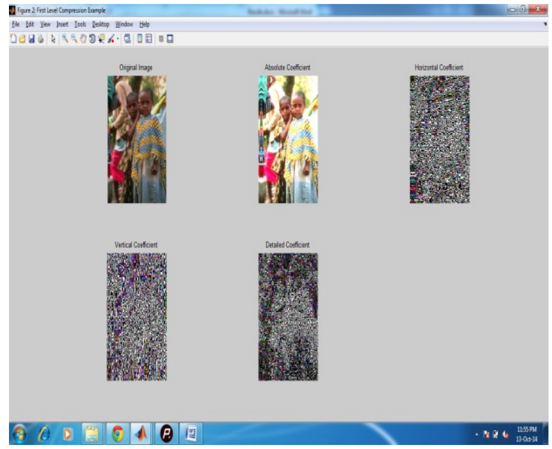

**Figure 6.1: The first-level compression**

Figure 4 shows the multiple levels of two-level image decomposition based image compression techniques. The DWT after first level decomposition is showing the original image, first level compression, second level compression and the decompression and reconstruction of the images.

In this figure 1$^{st}$ level of compression is done.We are taking a original image.Then we are calculate the absolute horizontal , vertical and detailed coefficient.

Figure 4: shows the multiple levels of the first-level decomposition. The first-level decomposition using DWT breaks the image into the four parts: Absolute Coefficient, Horizontal Coefficient, Vertical Coefficient and Detailed Coefficient. The colored image has been broken down into four parts, from where, the absolute coefficient will be picked for the second-level decomposition.

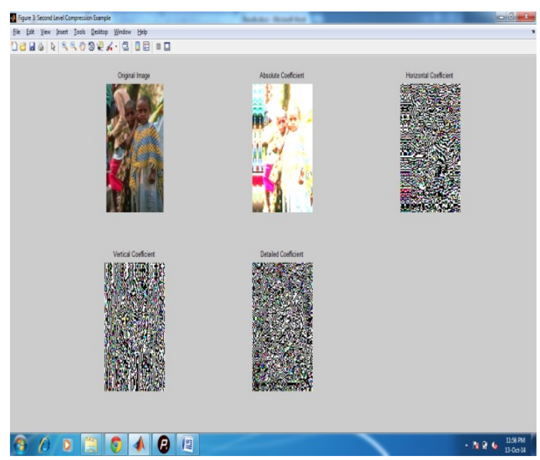

**Figure 6.1: The second-level compression**

In this figure 2$^{nd}$ level of compression is done. We are taking a original image.Then we are calculate the absolute horizontal , vertical and detailed coefficient.

Figure 5: shows the multiple levels of the second-level decomposition. The second-level decomposition using DWT, like first level, breaks the image into the four parts: Absolute Coefficient, Horizontal Coefficient, Vertical Coefficient and



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Detailed Coefficient. The absolute coefficient obtained from first-level decomposition of the colored image has been broken down into four parts, from where, the absolute coefficient will be picked for the final image decomposition.

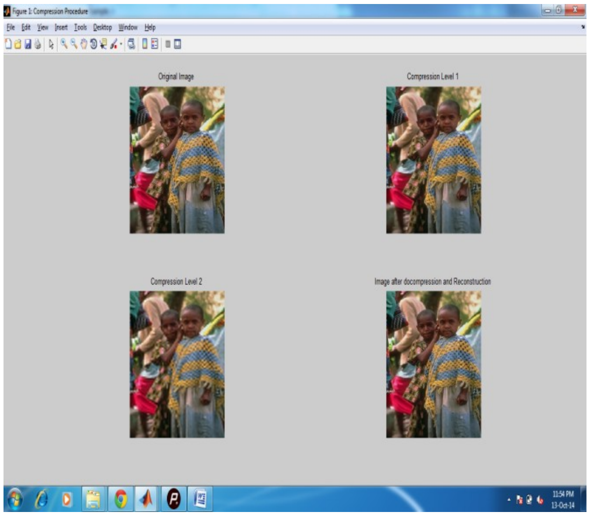


**Figure 6.3: DWT Compression in action**

In this result we are taking an original image. Then compressing original image at 1st and 2nd level. After then Decompression is done and we are reconstruct the image using daubeshies and coiflet techniques.

**Table 6.1: Table of comparison of the coefficients**

| COEFFICIENT | COMPRESSION LEVEL | MSE | PSNR | COMPRESSION RATIO (CR) | MAE | RMSE |
|---|---|---|---|---|---|---|
| Db1 | 2-Level | 1.092 | 99.918 | 41.461 | 2.135 | 0.872 |
| Db2 | 2-Level | 0.973 | 99.935 | 46.143 | 1.994 | 0.759 |
| Db4 | 2-Level | 1.039 | 99.959 | 50.238 | 2.137 | 0.816 |
| Db5 | 2-Level | 1.021 | 99.996 | 52.841 | 2.120 | 0.805 |
| Db8 | 2-Level | 1.014 | 99.996 | 49.621 | 2.122 | 0.792 |
| Coif1 | 2-Level | 1.063 | 99.983 | 51.885 | 2.148 | 0.800 |
| Coif2 | 2-Level | 1.029 | 99.991 | 54.091 | 2.130 | 0.797 |
| Coif3 | 2-Level | 1.017 | 99.921 | 53.818 | 2.119 | 0.741 |
| Coif4 | 2-Level | 1.009 | 99.992 | 53.221 | 2.111 | 0.772 |
| Coif5 | 2-Level | 1.007 | 99.996 | 52.761 | 2.112 | 0.787 |
| Db5-Db8 | 2-Level | 0.823 | 99.998 | 58.123 | 1.928 | 0.741 |

**Table 6.2: Table of comparison of wavelets on the basis of compression ratio**

| COEFFICIENT | COMPRESSION LEVEL | SIZE BEFORE COMPRESSION | SIZE AFTER COMPRESSION |
|---|---|---|---|
| Db1 | 2-Level | 2359296 | 1224121 |
| Db2 | 2-Level | 2359296 | 1276170 |



ISSN: 2278 – 7798 

| | | | |
|---|---|---|---|
| Db4 | 2-Level | 2359296 | 1269732 |
| Db5 | 2-Level | 2359296 | 1255633 |
| Db8 | 2-Level | 2359296 | 1244795 |
| Coif1 | 2-Level | 2359296 | 978200 |
| Coif2 | 2-Level | 2359296 | 1088647 |
| Coif3 | 2-Level | 2359296 | 1185280 |
| Coif4 | 2-Level | 2359296 | 1246687 |
| Coif5 | 2-Level | 2359296 | 1170726 |
| Db5-Db8 | 2-Level | 2359296 | 923400 |

## 7. CONCLUSION

The aim of the proposed project is to design and implement a new compression algorithm using wavelet filters in unique and effective combination. The proposed compression technique has been decompose the image matrix and has been reproduce the compressed image. It has already been proved in number of researches that the wavelet transform techniques are very effective for image compression. The proposed technique has been compared with the existing ones on the basis of various existing techniques on the basis of peak signal to noise ratio (PSNR), mean square error (MSE), elapsed time (ET) and Compression Ratio (CR). The new technique has been the unique combination of the various wavelets used under the DWT in MATLAB simulator. In the future, the project has

been implemented using the MATLAB. The algorithm has been designed and the design has been revived and reviewed to build stronger, effective and lossless compression technique by keeping an eye over the image quality matrix. Additionally, the DWT coefficients have been evaluated for their performance with the proposed combination. The performance evaluation tells us about the best and worst performing coefficients among the all being surveyed under this research project. The dubechie coefficients being evaluated under the research projects are db1, db2, db4, db5, db8 and a combination of db5 and db8. Also the coiflet coefficients has been tested with coif1, coif2, coif3, coif4 and coif5. The best coefficient after all of the experiments is the new combination of db5 and db8.

## 8. FUTURE WORK

The proposed model has been proved itself as the best coefficient or combination of the coefficients among the other existing coefficients. It means the new coefficients can be carried forward for the future developments. The proposed model can be taken as a base for the future developments on the compression coefficients based on DWT. In the future, a new series of the coefficients may be also proposed based on the various mathematical or statistical computations as per the existing ones.

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ISSN: 2278 – 7798 

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