DWT, DKT and DCT Based Hybrid Transform Implimentation for Lossless Compression of RGB Color Image

Siddharth Sinha, Ayoush Johari

Abstract— High quality color image obliged expansive measure of space to store and extensive data transmission to transmit it. Because of impediments in data transfer capacity and away space, it is primary prerequisite to layers computerized color image. To meet this, various picture pressure procedures are created in last a few years. This research paper presents a peculiar Hybrid Wavelet Transform technique for Image compression using three orthogonal transforms. The concept of hybrid wavelet transform is to combine the attributes of two or more different orthogonal transform wavelet to attain the vitality of multiple transform wavelet. Proposed approach is to generate hybrid wavelet transform with three orthogonal transform using together which are Discrete Cosine transform, Discrete Wavelet transform and Discrete Kekre Transform. These all are lossy compression techniques. On several image simulation has been carried out. The experimental result has shown that hybrid transform wavelet performance is best as compared to transform wavelets. Here the hybrid of DWT, DCT and DKT provides the best result amongst the individual mentioned transforms.

Keywords— Image compression; Hybrid Wavelet Transform; Discrete Wavelet Transform; DWT; Discrete Cosine Transform; DCT; Discrete Kekre Transform; DKT

I. INTRODUCTION

The advent of high speed computing devices and rapid development in the field of communication has created a tremendous opportunity for various computer based image applications. The amount of data required to store a digital image is continually increasing and overwhelming the storage devices. Therefore it is required to store images using lesser number of bits than its original size. Image compression deal with this problem. It reduces the number of bits required to represent the image. Hence, reduction in file size allows more image to be stored in a given amount of memory space. It also reduces the time required for the image to be sent over the internet or downloaded from web pages. There are two types of compression methods: lossless compression and lossy compression. The lossless image compression preserves exact data of the original image [1]-[3].

The lossy compression will not preserve the absolute data content of the original image but preserves some specified level of image quality. It relies on the conception of compromising the accuracy of reconstructed image in order to reinforce the compression ratio.

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If the resulting distortion is endurable the increase in compression can be significant. Therefore lossy compression is frequently used as compared to lossless compression. The measure of image compression achieved is defined as compression ratio. Generally used lossy compression technique is Transform Coding such as Discrete Cosine Transform (DCT) used in JPEG and Wavelet Transform used in JPEG2000 [3]-[6]

Transform coding technique is based on modifying the transform of an image. Here, reversible linear transform is used to map image into a set of transform coefficients and then these coefficients are quantized and coded. In transform coding initially DCT was popular. It separates an image into different frequency component. Low frequency component provides high energy compaction as compared to high frequency component. Therefore they are discarded. Elimination of this high frequency component provides the transformed image with sparse low frequency component. Image reconstructed from these sparse low frequency elements is compressed image without ruining much data content in original image.

Since last two to three decades wavelet transform is adopted for enormous applications, often replacing widely used Fourier Transform. Traditional signal processing technique such as Fourier Transform are poorly suited for analysing signals which have sharp abrupt transitions superimposed on lower frequencies. Wavelet Transform provides an approach to analyse such data. An important property of wavelet is its Multiresolution capability which helps to view the image at different scales. Recently Hybrid Technique is in progression, in which one transform is combined with another transform to amalgamate the advantages of both transforms [5]-[8].

Initially Haar Wavelet were focused and widely used for compression. In recent literature wavelets of other orthogonal transforms have been introduced. These transforms include Walsh, DCT, Kekre, and Hartley Transform is proposed. The wavelet transform in various applications have performed better than their respective orthogonal transform [8, 18, 19].

The paper presents the inventive Hybrid Wavelet Transform genesis methodology, which generates Hybrid wavelet transform of any three orthogonal transform. So the concept behind using hybrid wavelet transform is to exploit the strength of both the transform wavelets. Here hybrid wavelet transform is generated using Discrete Walsh Transform (DWT), Discrete Cosine Transform (DCT), and Discrete Kekre Transform(DKT). The another objective of this paper is to enhance compression ratio so as to reduce the storage size of a image. For this a combination of three

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lossy compression method such as Huffman coding and run length encoding is used. Here Huffman coding is applied on symbols or runs rather than single symbol. This is referred here as Extended Huffman Compression. The experimental result convince that the hybrid wavelet transforms are better than their wavelet transforms and due to encoding a higher compression ratio is achieved [20, 21].

II. PROPOSED ALGORITHM

Proposed new method for color image compression and decompression utilizes the idea of producing hybrid wavelet transform from three orthogonal transforms DWT, DKT and DCT. Schematic outline of procedure took after is indicated in fig. 1 and 2.

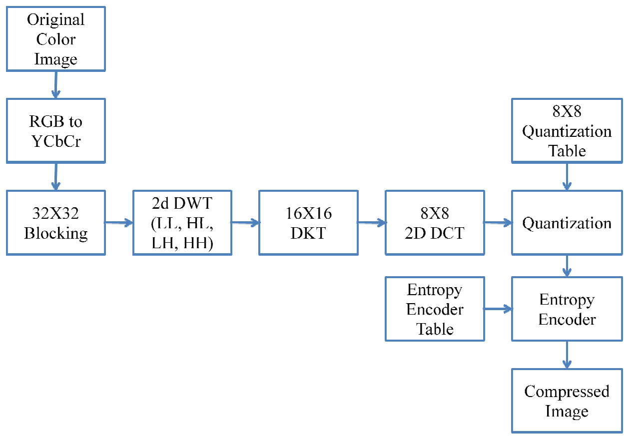

Fig. 1.Proposed Image Compression Algorithm Based on Hybrid Wavelet Transform

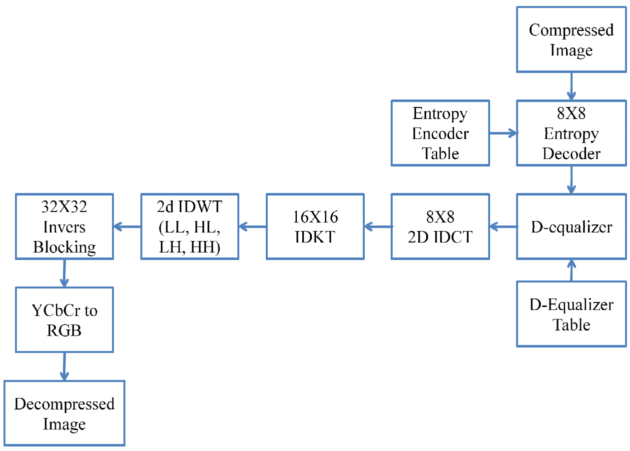

Fig. 2.Proposed Image Decompression Algorithm Based on Hybrid Wavelet Transform

A. Color Image Compression

Fig. 1. demonstrates the proposed method for color image compression and fig. 2. demonstrates its decompression system to recoup the first picture. To compress 256x256 color picture first RGB color picture is factorized into its Luma part (Y), Blue deference (Cb) and Red deference (Cr) of croma segments. The transformation of RGB color picture into YCbCr is performed by utilizing following equations [19].

$$Y' = 16 + 65.481 * R' + 128.553 * G' + 24.966 * B' \tag{1}$$

$$C_B = 128 - 37.797 * R' - 74.203 * G' + 112.0 * B' \tag{2}$$

$$C_R = 128 + 112.0 * R' - 93.786 * G' - 18.214 * B' \tag{3}$$

Every removed part is first obstructing into 32x32 pick cells. Every 32x32 pick cell square is then transformed through 2d DWT and changed over into LL, LH, HL and HH parts of size 16x16 pick cells. Here LL speaks to the estimate picture, LH speaks to even subtle elements, HL speaks to vertical points of interest and HH speaks to askew points of interest of every 32x32 piece of picture. Here LH, HL and HH subtle elements are supplanted by zero and LL points of interest are utilized for further process [20].

Every LL points of interest of the 16x16 pick cell size are currently gone through 16x16 DKT. The playing point of the Kekre's transform network is that it don't need of size having whole number force of 2. It ought to be of any size NxN. In DKT network all inclining and upper askew components are 1 while; all lower corner to corner components with the exception of the components just underneath the slanting are zero. Kekre transform network of size 6x6 is indicated beneath for instance.

$$\text{DKT Matrix } (16x16) = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ -5 & 1 & 1 & 1 & 1 & 1 \\ 0 & -4 & 1 & 1 & 1 & 1 \\ 0 & 0 & -3 & 1 & 1 & 1 \\ 0 & 0 & 0 & -2 & 1 & 1 \\ 0 & 0 & 0 & 0 & -1 & 1 \end{bmatrix} \tag{4}$$

The DKT transformed LL details of size 16x16 are now re-blocked in to 8x8 size of pick cells. 2d DCT of size 8x8 is now implemented in to each 8x8 DKT transformed LL details [21]. The DCT transform equation can be expressed as:

$$D_{DCT}(i,j) = \frac{1}{\sqrt{2N}} C(i)c(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} P(x,y) * \cos\left(\frac{(2x+1)i\pi}{2N}\right) \cos\left(\frac{(2y+1)i\pi}{2N}\right) \tag{5}$$

Each 8x8 DCT elements are compressed through Quantization means dividing by some specific 8x8 matrix which is called Q_{matrix} and rounding to the nearest integer value as shown in equation (6).

$$D_{quant}(i,j) = round\left(\frac{D_{DCT}(i,j)}{Q_{matrix}(i,j)}\right) \tag{6}$$

Here Q_{matrix} is decided by the user to keep in mind that it gives Quality levels ranging from 1 to 100, where 1 gives the poor image Quality and highest compression ratio while 100 gives best Quality of decompressed image and lowest compression ratio [18]. The standard Q_{matrix} can be shown as equation (7).

$$Q_{matrix} = \begin{bmatrix} 16 & 11 & 10 & 16 & 24 & 40 & 51 & 61 \\ 12 & 12 & 14 & 19 & 26 & 58 & 60 & 55 \\ 14 & 13 & 16 & 24 & 40 & 57 & 79 & 56 \\ 14 & 17 & 22 & 29 & 51 & 87 & 80 & 62 \\ 18 & 22 & 37 & 56 & 68 & 109 & 103 & 77 \\ 24 & 35 & 55 & 64 & 81 & 104 & 113 & 92 \\ 49 & 64 & 78 & 87 & 103 & 121 & 120 & 101 \\ 72 & 92 & 95 & 98 & 112 & 100 & 103 & 91 \end{bmatrix} \tag{7}$$

The quantized information is encoded by number juggling encoding system. All encoded groupings are currently spare in a content organization, which demonstrates less obliged plate space to be store then unique picture. This encoded content document might likewise transmit, which will oblige less channel space and will be decompressed on the accepting side.

B. Color Image Decompression

Decompression of the compressed color picture is accurate

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converse process as indicated in fig. 2. Encoded compressed content document is initially decoded by backwards usage of number juggling encoding, which is number-crunching deciphering. This decoded information is contrarily quantized by utilizing comparative Q_{matrix} as utilized as a part of compression methodology. Backwards quantization is executed as indicated in mathematical equation (8).

$$D_{dequant}(i,j) = Q(i,j) * D_{quant}(i,j) \qquad (8)$$

The de-quantized matrix is inversely transformed by using 8x8 2d-inverse DCT. The 2d-IDCT can be expressed as in equation (9).

$$P(x,y) = \frac{1}{\sqrt{2N}} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} C(i)c(j)D(i,j) * \cos\left(\frac{(2x+1)i\pi}{2N}\right) \cos\left(\frac{(2y+1)i\pi}{2N}\right) \qquad (9)$$

IDCT transformed 8x8 detail is now rearranged in to 16x16 matrix and transformed through IDKT by using Kekre's transform matrix of size 16x16. Now 16x16 inverse DWT transform is performed. Its output is in 32x32 pick cells size. This data is now regrouped in to single matrix by 32x32 inverse blocking.

Here we get back the color image components in the form if Y, Cb and Cr. Now these color components are reconverted in RGB color format to reconstruct the original color image, which is our decompressed color image.

III. MATLAB SIMULATION

This section shows the MATLAB simulation results of proposed method. This paper shows image compression and decompression results of eight well-known color images of size 256x256. All color images are first compressed through proposed Hybrid Wavelet Transform using DWT, DKT and DCT together. Compressed file is again decompressed and recovered lossless color image.

Here fig. 3 shows the original RGB color image of a couple. Its Luma component (Y), Blue deference (Cb) and Red deference (Cr) of Croma components are shown in fig. 4. These components of color image are processed through proposed color image compression method and encoded in to a text file. This file is decompressed through proposed decompression method and again reconstructed into Luma and Croma components. Fig. 5 shows these reconstructed components. Fig. 6 shows a compression between original color image and decompressed color image of couple.

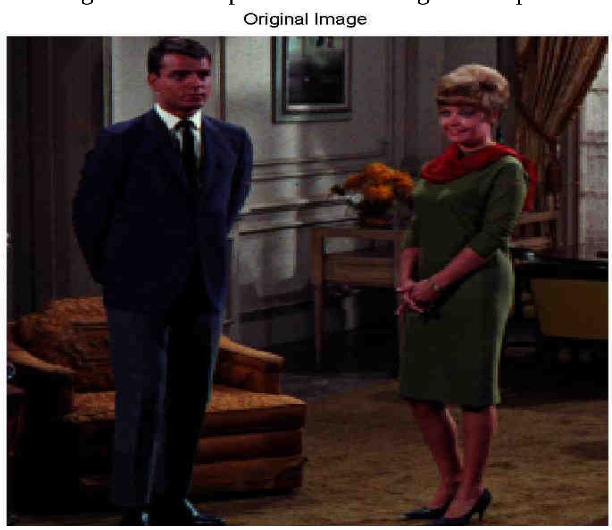

Fig. 3.Orignal RGB color image of couple

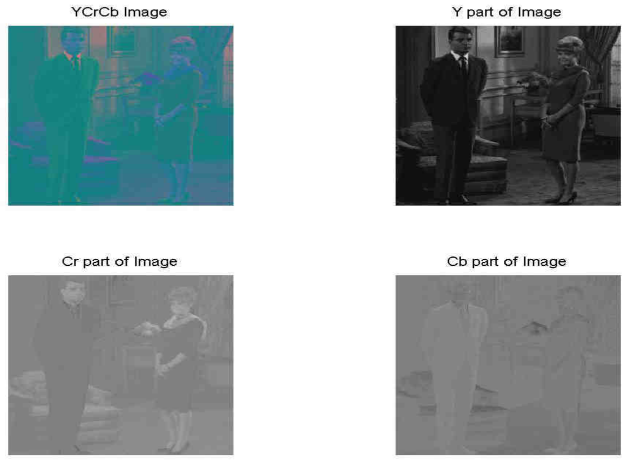

Fig. 4.Luma (Y), Croma Red (Cr) and Croma Blue (Cb) component of couple image before compression

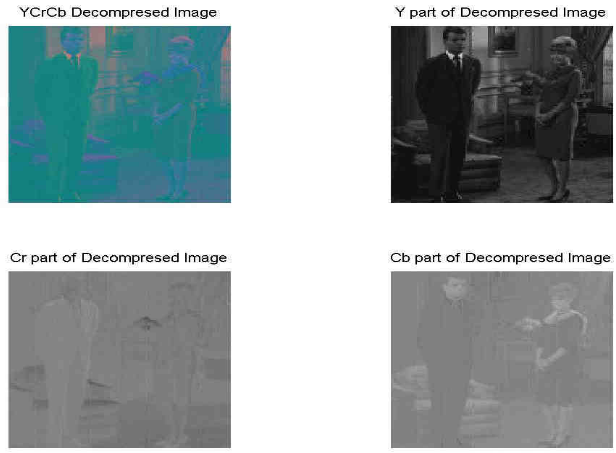

Fig. 5.Luma (Y), Croma Red (Cr) and Croma Blue (Cb) component of decomressed couple image

Fig. 6.Comparing orignal and decompresed color image of couple

Fig. 7.Comparing orignal and decompresed color image of girl 1

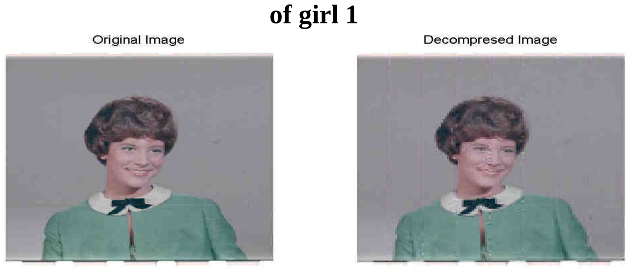

Fig. 8.Comparing orignal and decompresed color image of girl 2

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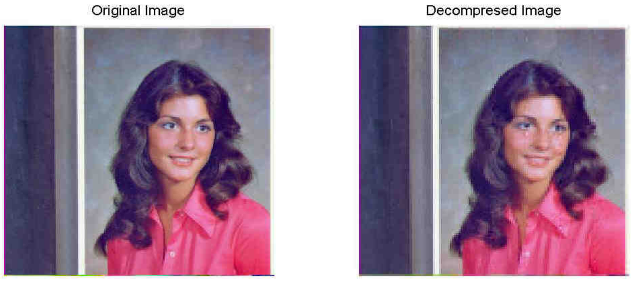

Fig. 9.Comparing orignal and decompresed color image of girl 3

Fig. 10. Comparing orignal and decompresed color image of house

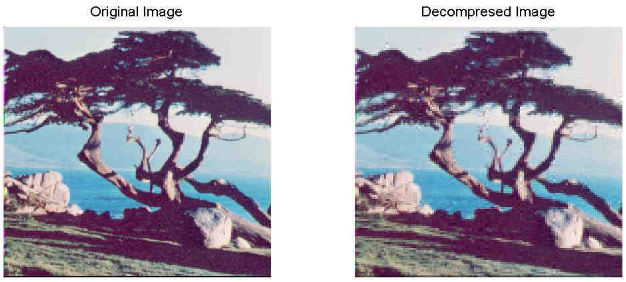

Fig. 11. Comparing orignal and decompresed color image of tree

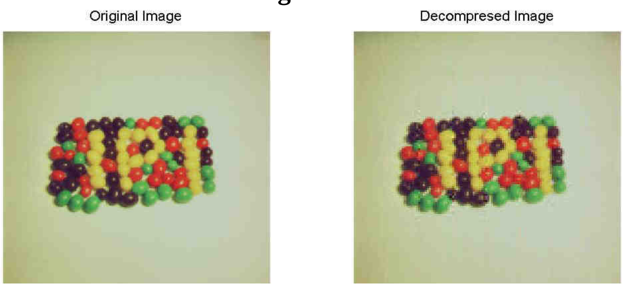

Fig. 12. Comparing orignal and decompresed color image of sweet candy 1

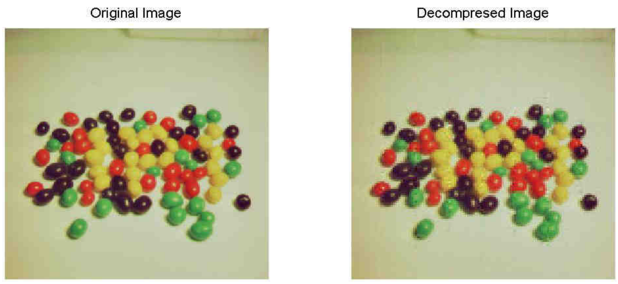

Fig. 13. Comparing orignal and decompresed color image of sweet candy 2

Similar to color image of couple, seven other color images girl1, girl 2, girl 3, house, tree, sweet candy 1 and sweet candy 2 are also compressed with proposed color image compression method based on hybrid wavelet transform by using DWT, DKT and DCT, and decompressed also. Fig. 7 to 13 shows comparison between there original color image and decompressed color image. By comparing all these images it is found that proposed method is efficiently lossless compression and decompression method.

IV. RESULT EVALUATION

To evaluate the method four parameters are used, these are Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Compression Ratio (CR) and Subjective Evaluation Parameter.

The total squared error between first color image and decompressed color image is termed as MSE. Lower esteemed MSE indicates less slip between unique image and decompressed image, and it has the converse connection with PSNR. The MSE can be effectively spoken to by mathematical equation (10).

$$\mathrm{MSE} = \frac{1}{\mathrm{m\,X\,n}} \sum_{y=1}^{m} \sum_{x=1}^{n} [\mathrm{I}(x,y) - \mathrm{I}'(x,y)]^2 \qquad (10)$$

Here I(x, y) is the original image and I'(x, y) is the reconstructed image. m and n are dimensions of the images. PSNR is a measurement of the peak error between original color image and decompressed image. PSNR is generally expressed in terms of the logarithmic decibel scale in (dB). Normally, a higher value of PSNR is good because it means that the ratio of signal to noise is higher. The PSNR is defined as:

$$\mathrm{PSNR} = 10 * \log_{10}\left\{\frac{\mathrm{MAXI}^2}{\mathrm{MSE}}\right\} = 20 * \log_{10}\left\{\frac{\mathrm{MAXI}}{\sqrt{\mathrm{MSE}}}\right\} \qquad (11)$$

Compression ratio (CR) is a measure of the reduction of the detailed coefficient of the data. In the process of image compression, it is important to know how much detailed coefficient one can discard from the input data in order to sanctuary critical information of the original data. Compression ratio can be expressed as:

$$\mathrm{CR} = 1 - \frac{\text{Decompresed Image}}{\text{Orignal Image}} \qquad (12)$$

The visual view of the reproduced picture is key. Sometimes the target quality appraisal does not give legitimate data about the nature of the remade picture. In such situations, it is imperative to examine the remade picture utilizing subjective examination that implies by human perceptual framework. At the point when the subjective measure is considered, viewers concentrate on the distinction in the middle of recreated and unique picture and connect the distinctions.

TABLE I shows compression of mean square error (MSE) between DET, DKT, DCT and propped hybrid method. Similarly TABLE II shows compression of peak signal to noise ratio (PSNR) and TABLE III shows compression of compression ratio (CR) between DET, DKT, DCT and propped hybrid method. MSE comparison between DWT, DCT, CKT and proposed method is also shown in graphical form as in fig. 14. Form these compressions it is found that proposed method has less MSE and higher PSNR as compared then using DWT, CKT and DCT individually. From Table III it also clear that proposed hybrid method also compressed more image data as compared to using DWT, CKT and DCT individually.

TABLE I. MSE COMPARISSION BETWEEN PROPOSED AND OTHER METHODS

Color Image	Mean Square Error (MSE)			
	DWT	***DKT***	***DCT***	***Proposed Hybrid Transform***
Girl 1	20.2354	19.3458	18.9578	18.7163
Girl 2	14.2465	13.2458	12.4785	10.3702
Girl 3	19.2457	19.1247	17.1458	16.9122

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Couple	21.3245	20.2458	19.2457	18.2303
House	21.2356	20.5487	19.8745	19.1082
Tree	39.2458	38.2476	36.4578	37.0940
Shuger Candey 1	12.2488	11.2458	8.9654	8.9538
Shuger Candey 2	16.2458	16.1247	14.2147	13.4395

TABLE II. PSNR COMPARISSION BETWEEN PROPOSED AND OTHER METHODS

Color Image	Peak Signal to Noise Ratio (PSNR)			
	DWT	***DKT***	***DCT***	***Proposed Hybrid Transform***
Girl 1	29.3478	39.2457	42.2447	44.9850
Girl 2	28.3458	38.2444	46.2478	47.5493
Girl 3	28.1475	37.2548	43.2457	45.4252
Couple	29.3698	38.2457	42.3145	45.0993
House	29.3654	36.2147	40.1247	44.8950
Tree	29.9875	35.2478	40.2156	42.0142
Shuger Candey 1	26.3457	36.2147	43.1578	48.1872
Shuger Candey 2	29.3457	38.2145	41.2457	46.4234

TABLE III. COMPRESSION RATION (CR) COMPARISSION BETWEEN PROPOSED AND OTHER METHODS

Color Image	Compression Ratio (CR)			
	DWT	***DKT***	***DCT***	***Proposed Hybrid Transform***
Girl 1	0.4214	0.5478	0.6478	0.7758
Girl 2	0.4587	0.6324	0.7245	0.8349
Girl 3	0.5321	0.5799	0.8974	0.7780
Couple	0.4879	0.5214	0.6741	0.7825
House	0.4587	0.5687	0.7214	0.7687
Tree	0.3248	0.4987	0.6598	0.7181
Shuger Candey 1	0.5478	0.5897	0.7458	0.8178
Shuger Candey 2	0.4258	0.6891	0.6845	0.7785

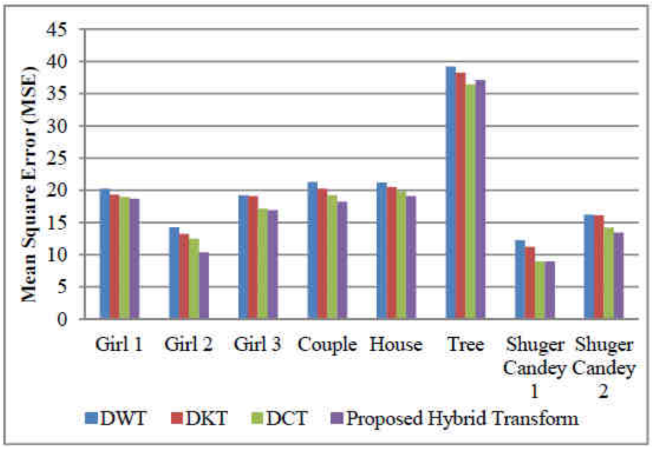

Fig. 14. MSE compression between DWT, DKT, DCT and proposed Hybrid Transform

V. CONCLUSION

This paper presents a novel conception of the hybrid wavelet transform by utilizing three orthogonal transform. It enhances lossless compression ratio of color image. Here hybrid wavelet transform is generated using DWT, DKT and DCT together for image compression and decompression. From experimental results inference drawn is that the hybrid wavelet transform are better than their respective wavelet transforms. Proposed hybrid wavelet transform has given best performance in terms of MSE, PSNR and Compression Ratio after encoding. The experimental results prove that hybrid wavelet Transforms are better in performance as compared to wavelets of orthogonal transformed individually. In future various other transform can be considered for hybridizing to generate new hybrid wavelet transforms for particular applications.

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