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Image Compression using hybrid approach of SVD-DWT-DCT

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Abstract — *With increase the demand of digital network, need of more and more accurate images are increased. The accurate images are achieved by image compression. Image compression is also important for efficient transmission and storage of images. In image compression, irrelevant data is removed from the image [. Image compression is needed for efficient image transmission. Therefore, development of efficient image compression techniques has become necessary. In this paper, the hybrid approach of image compression using SVD-DWT-DCT is proposed.*

Keywords- *Image Compression, DCT, DWT, SVD, PNSR, MSE, CR, etc.*

I. INTRODUCTION

Now-a-days, the image database increases. So, more images are transmitted. Images require more memory space for storage and more bandwidth to transmission. so, Image compression is needed. Image Compression is very significant for efficient transmission and storage of images. Image compression means reduced the amount of data required to represent a digital image [3]. There are two different types of redundancy relevant to images spatial redundancy and spectral redundancy [1].

The goal of image compression is to diminish the data required to represent a digital image [2]. Image compression is achieved by removing one of following types of redundancy:

1) spatial redundancy:
   It is correlation between neighboring pixel values.
2) spectral redundancy :
   This is defined by correlation between different color planes and spectrum bands
3) Physho- visual redundancy:
   The human eyes are insensitive to color components that are similar to each other so the physco-visual redundancy is produced.

The image compression encoding process is shown as fig.1 [4]. The decoding of image compression is reverse process of encoding. First, original image is applied for color space conversion. Then correlation between pixels is reduced by lossy compression techniques. Quantization is performed to converting continuous pixel values to discrete values. After Quantization, Encoding is applied by lossless compression techniques. Then the compressed image is ready to transmission. The decoding of image compression is reverse process of encoding.

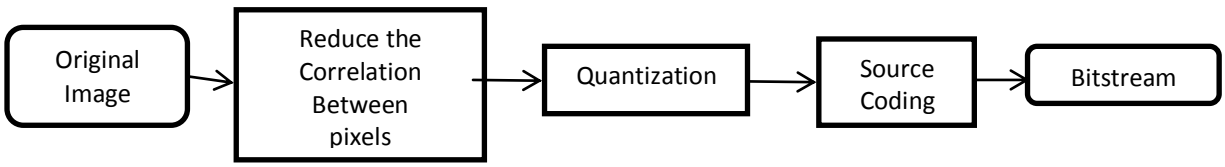


Fig.1 Encoding of image compression [4]

Image compression is classified mainly in two categories:

1) Lossless Compression:
   Lossless compression is a techniques in which reconstructed image is same as original image. There is no degradation in image after lossless compression. Run length encoding, Huffman coding, arithmetic coding etc. are the examples of lossless compression.

2) Lossy Compression:

   There is loss of some bits after applying lossy compression. The reconstructed image has degradation in compare to original image. The example of lossy compression are discrete Cosine transform (DCT), discrete wavelet transform (DWT).

The performance of image compression is estimated by some parameters:

1) Compression ratio [3] :

It is Ratio between original image size and compressed image size.

$$CR = n1/n2 \quad (1)$$

2) Distortion measure [3]:

Mean Square Error is distortion rate in reconstructed image.

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}[X(i,j) - X'(i,j)]2 \quad (2)$$

3) Peak Signal – to – Noise Ratio [4]:

This is widely used quality measurement parameter.

$$PSNR = 10\log_{10}\frac{2552}{MSE}\ (dB) \quad (3)$$

II. LITERATURE REVIEW

The paper [4] represents one lossy image compression technique called JPEG compression. A JPEG compression algorithm is based on DCT and lossy algorithms. There are mainly 3 steps of JPEg algorithm: DCT transform, Quantization, Encoding. DCT is most used technique of image compression. It divides the image's three color component in many blocks size of 8*8.It maps space image into frequency. DCT reduces size of file with less degradation in image through eliminating the less important information. In JPEG, Quantization is division of transformed matrix by quantized matrix. In this step less important but high frequency DCT coefficients are set to zeroes. After this step, Zigzag Scanning is performed to encode low frequency coefficients and then high frequency coefficients. Huffman coding is used compactly encodes the quantized DCT matrix. But this is the lossless compression method. At the end conclusion is that JPEG is fast, efficient and lossy compression technique. JPEG gives good quality of reconstructed image but no better Compression Ratio.

The paper [5] describes an image compression algorithm based on JPEG 2000.The compression performance is improved in JPEG 2000 in compare to JPEG. The process of JPEG 2000 is similar to JPEG but DWT transform is used in place of DCT in JPEG. After color space transform, image divides in numbers of tiles, rectangular blocks of the images. Now the tiles are decomposed into various levels by use of wavelet transformation. By applying decomposition, numbers of sub bands are generated that describes horizontal and vertical spatial characteristics of original image. In wavelet transform, original image is divides in four sub bands [14]:

- LL – low pass filtering of both horizontal and vertical
- LH –horizontal low pass filtering and vertical high pass filtering
- HL – horizontal high pass filtering and vertical low pass filtering
- HH – High pass filtering of both vertical and horizontal.

JPEG 2000 gives higher compression rate with high image quality. It also gives same image with multiple resolutions. DWT has better quality of reconstructed image in compared to DCT but less compression ration than DCT.

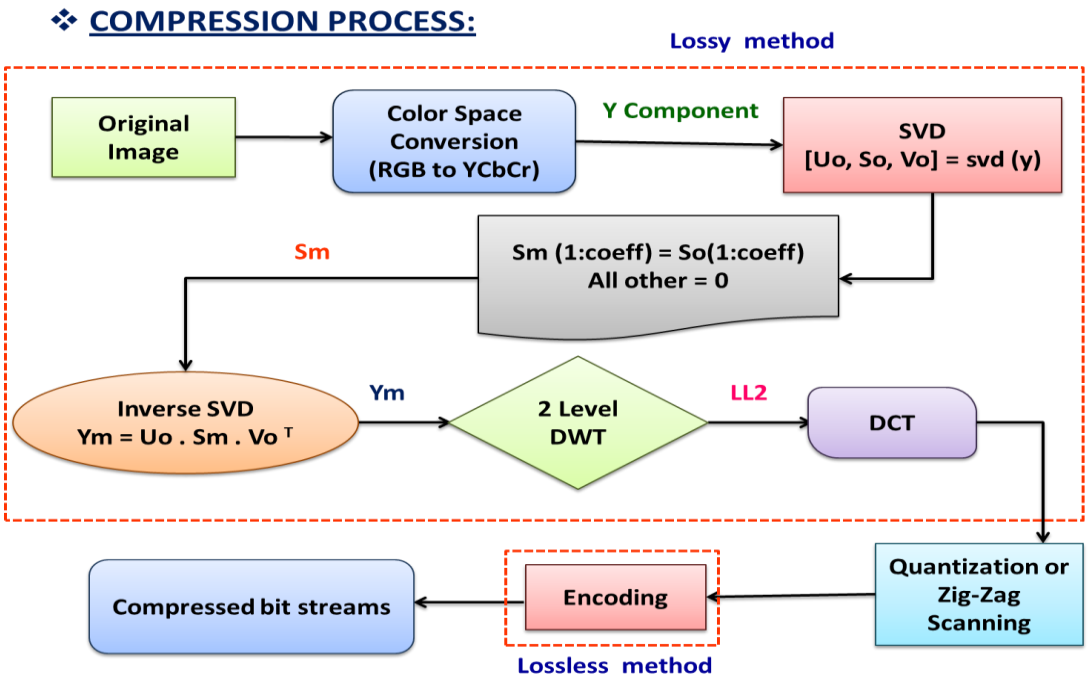
In the paper [6], Authors elaborate a hybrid algorithm of image compression with properties of both DCT and DWT. Huffman coding is used as encoding technique. In this algorithm, original image is divided in blocks of 16*16. Then 2 level 2D – DWT is applied to each block. Then the 2D DCT is applied to LL component of 2nd level 2D-DWT. Then the lossless technique, Huffman coding is applied as encoding and compressed image is got as output of compression. At Receiver, decompression is done by reversing the process of compression and image is reconstructed. The result of this algorithm is shows that at 97-93% compression ratio, hybrid algorithm is better than individual DCT or DWT. The proposed hybrid algorithm gives better CR than DCT and DWT. So this hybrid algorithm gives better Compression and better quality

The paper [7] presents a new lossy compression technique using combination of singular value decomposition and wavelet difference reduction. In the proposed system of this paper, the SVD and WDR both are used because SVD has Good PSNR but low compression ratio but WDR gives High compression ratios. In this system, A SVD compression is used first to decompose the image. By ignoring some singular value, the image is reconstructed and this reconstructed image is given as input to WDR part. In WDR part, first significance pass filtering is applied and then DWT is applied. The higher compression ratio and high quality of image depend on the number of singular values ignored at SVD. This Proposed system is excellent with high compression ratio and high performance. SVD compression compresses the images without much degradation in quality

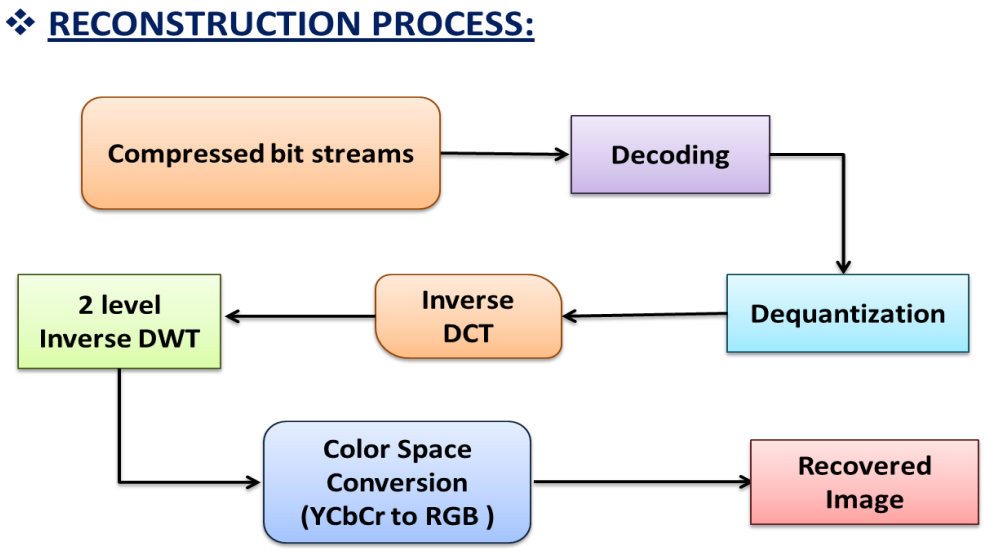
Barbhuiya, A. H. M., & others [8] shows the comparison between DCT and DWT on color JPEG and PNG images. The DWT and DCT are implemented and tested on JPEG and PNG images. The conclusion is that the better compression of image is depending on image format and image size and resolution.

III. PROPOSED APPROACH

The section describes the proposed method of this paper. The proposed method is hybridization of SVD-DWT-DCT with arithmetic coding. The fig.2 show that (a) compression process and (b) reconstruction process of proposed system.



(a) Compression process



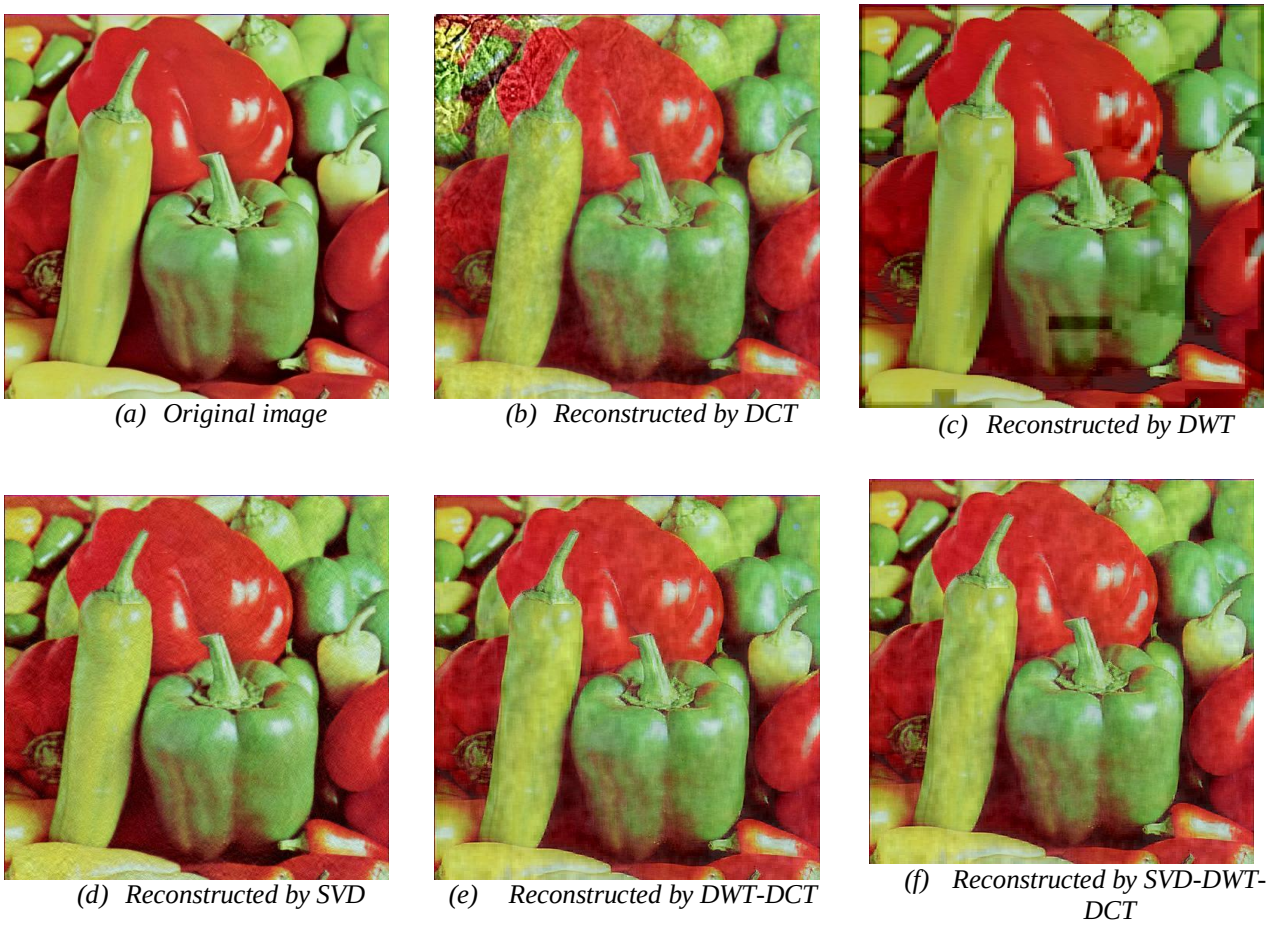
(b) Reconstruction Process

Fig.2 Proposed System (a) compression process, (b) reconstruction process

The steps for proposed method are: Color space conversion, lossless compression, encoding. The color space of image is converted from RGB to YCbCr. Then the SVD is applied and some singular values are discarded and invers SVD is applied to get image that is compressed by SVD. The 2-level DWT is applied to output of Inverse SVD. The second level DWT gives LL2, HL2, LH2 and HH2. The approximate component LL2 is given for applying DCT. The DC matrix is generated and scanned by zig-zag scanning. At the encoding is applied. In this proposed system, Arithmetic coding is used as encoding.

IV. RESULT AND ANALYSIS

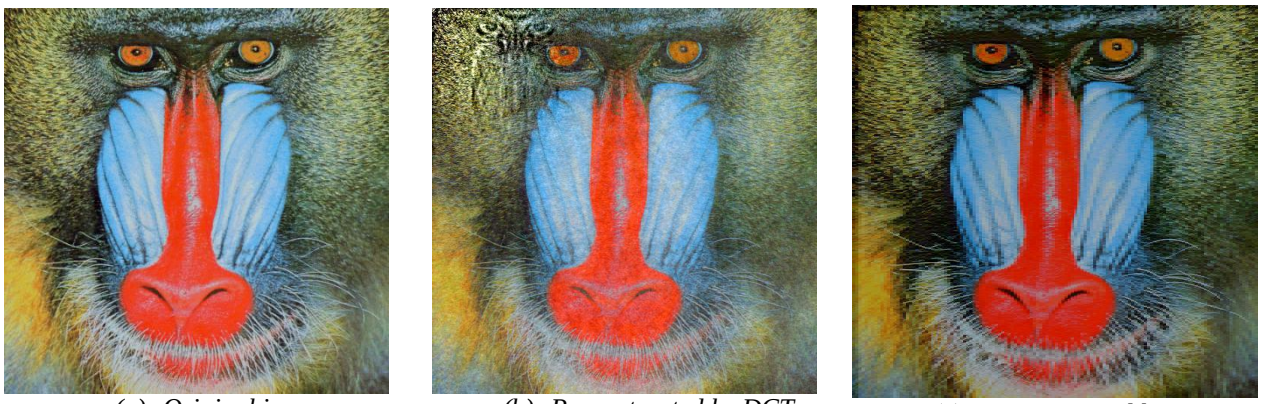
The proposed method is implemented in MATLAB 7.10.0. The various images are tested by the proposed system. The result of the proposed system is compared with the other existing methods. Fig.3 shows original chili image with the reconstructed image using DCT, DWT, SVD, DWT-DCT and proposed method. Fig. 4 shows the mandril image with result of other existing method and proposed method.



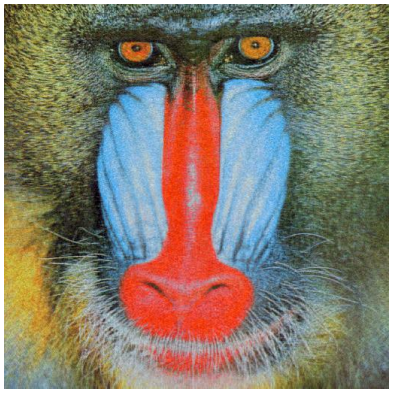
(a) Original image *(b) Reconstructed by DCT* *(c) Reconstructed by DWT*

(d) Reconstructed by SVD *(e) Reconstructed by DWT-DCT* *(f) Reconstructed by SVD-DWT-DCT*

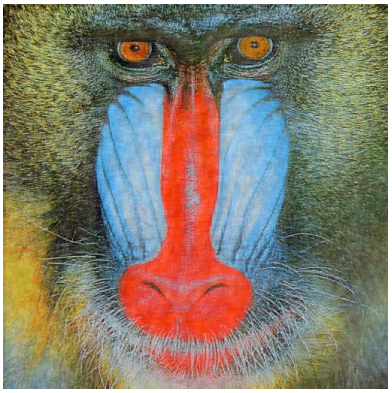
Fig.3 shows the results of chili image using other existing methods and proposed method.



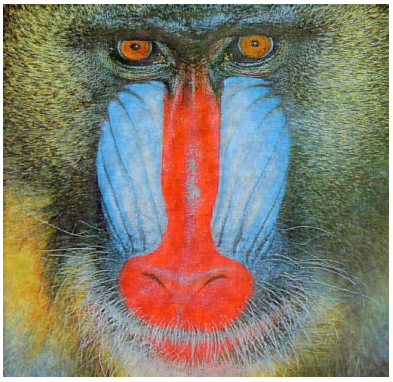
(a) Original image *(b) Reconstructed by DCT* *(c) Reconstructed by DWT*



(d) Reconstructed by SVD



(e) Reconstructed by DWT-DCT



(f) Reconstructed by SVD-DWT-DCT

Fig.4 shows the results of mandril image using other existing methods and proposed method.

The Result of images is evaluated by PSNR, CR and MSE parameters. The processing time is also calculated to evaluate the elapsed time. The Fig. 5, Fig.6, Fig.7 and Fig.8 are shows the comparison of proposed method with the other existing methods for chili image.

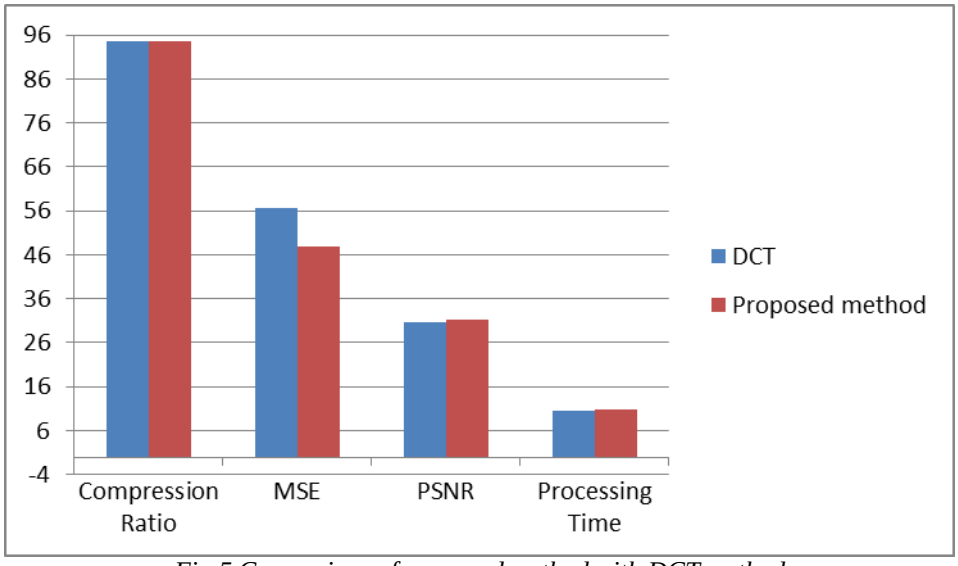


Fig.5 Comparison of proposed method with DCT method

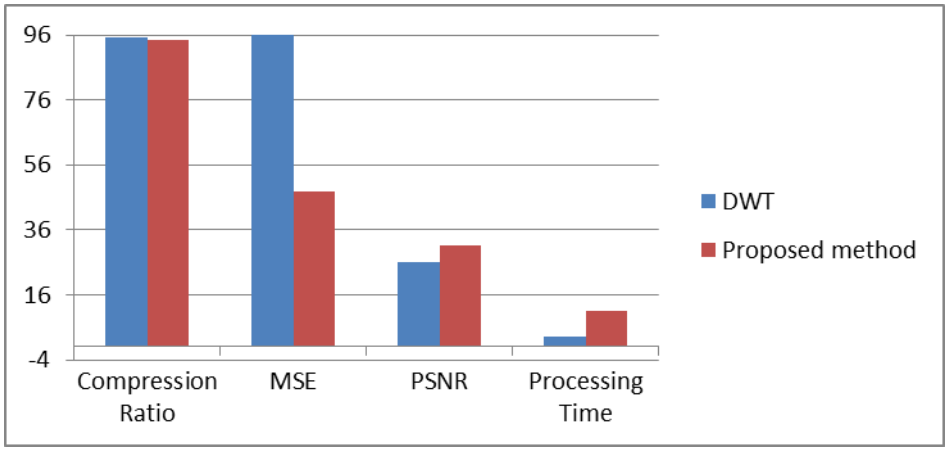


Fig.6 Comparison of proposed method with DWT method.

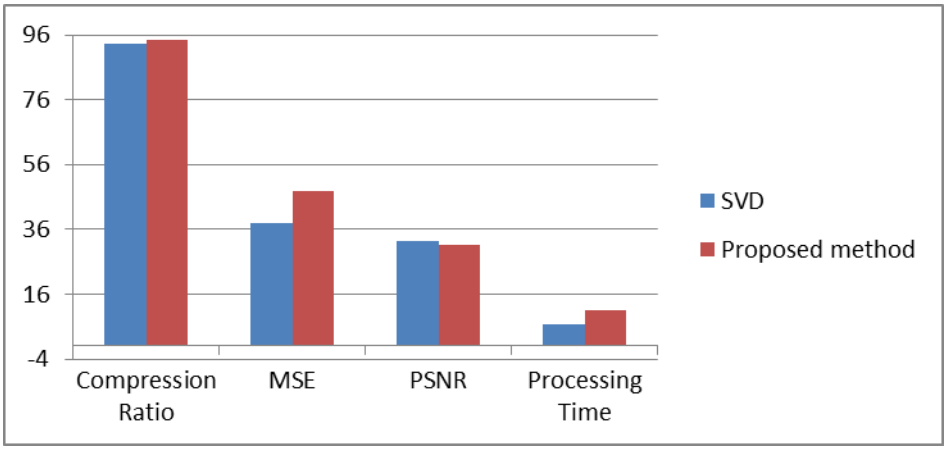


Fig.7 Comparison of proposed method with SVD method.

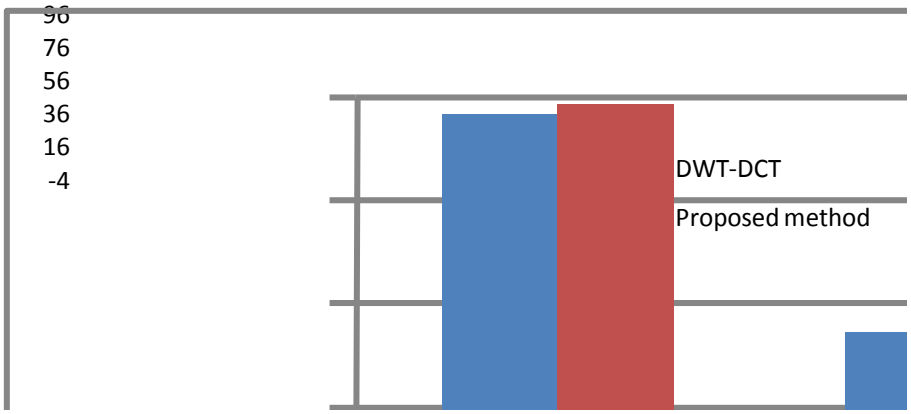


Fig.8 Comparison of proposed method with DWT-DCT method.

V. CONCLUSION

After implementing and comparing the proposed method, it is shows that the proposed method is better for compression and quality than other method. The time taken by proposed method is little bit more than other methods. The proposed method is best applied for the application where compression is important like, satellite images, medical images. The conclusion is that the proposed method is an efficient and robust method in terms of compression and quality. In future, The processing time of the proposed method can be reduced.

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