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Improvement in DCT and DWT Image Compression Techniques Using Filters

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ABSTRACT

In the last years, we have been viewing a transformation in the communication technologies. Image compression is one of the enabling technologies in this multimedia revolution. Due to this communication, become easy as it represents the data in compact form. There are different techniques, which are used for the image compression; here we are implementing DCT and DWT techniques for image compression. As we know that during compression, quality of the image plays a great role, therefore further improvement in the DCT and DWT techniques are done using various filters. Improvement in the quality of images is obtained. Comparative analysis of Compression Ratio, PSNR and MSE are done for these techniques.

Keywords: Image Compression, DCT, DWT, Filters

I. INTRODUCTION

A two-dimensional signal processed by human visual system, signals which represent the image are in analog form, but for the processing, image is converted into digital form. Image compression, is the art of reducing the amount of data required for the representation of image, and it emerges as one of the great technologies in the field of digital image processing [1]. Compression is basically of two types:

i. Lossy Compression
ii. Lossless Compression.

Lossy compression of data accepts a certain loss of accuracy in interchange for greatly improved compression. An image which is reconstructed using the lossy compression contains degradation as compared to the original, because this scheme of compression completely discards information which is redundant, but if we view normally, then no such loss of information can be seen. It gives better result in the use over internet communication. Lossless compression contains schemes which definite to create an exact identical of the input data stream. Here the constructed image after compression is numerically identical to the original image. Now in this paper we will discuss the transformation like the DCT and the DWT.

II. METHODS AND MATERIAL

A. Transformation

Discrete Cosine Transform-DCT is basically a sequence of various data points, which are addition of cosine function which oscillates at different frequency. It is basically conversion of signal into frequency components, same as DFT but it contains only real part. When applying properties of DCT, discrete delta function which are transformed by DC at a frequency of 0 therefore image which is transformed has only DC components. [3] DCT is basically a real valued 1 D signal.

$$y(k) = w(k) \sum_{n=1}^{N} x(n) \cos(\frac{\pi}{2N}(2n-1)(k-1)),$$

K= 1,2…., N,

Where,

$$w(k) = \begin{cases} \frac{1}{\sqrt{N}}, & k = 1, \\ \sqrt{\frac{2}{N}} & 2 \leq k \leq N, \end{cases}$$

DCT calculates the different frequencies of part of image and separates them accordingly, where frequencies which are less important are discarded using quantisation and frequency which are important are taken during decoding. DCT packs large information into small number of coefficients. [4] DCT basically involves three processes transformation, quantisation and entropy encoding.

In transformation the image is partitioned into smaller block of images of size N×N, then transform coefficients are measured, and then the parts which contain the more information are quantised. The resultant values obtained are then rounded off. After this, entropy encoding is done. [5]

Discrete Wavelet Transform-Functions which are concentrated in frequency and time domain around a certain point are called wavelets. This type of transformation is good for non-stationary signals, as function vary in both frequency and spatial range, from wavelet transform good frequency resolution and high temporal resolution for low and high frequency components are obtained respectively. [5] Basically it divides the information stored in an image into four detail parts, the approximated subsignal and the three detail subsignal on the horizontal, vertical and diagonal details. When the value of these details are small, they are set to 0, thus compression is achieved.

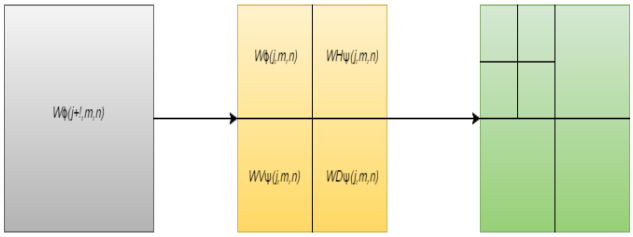


Figure 1. Visualisation of four signals obtained after applying DWT

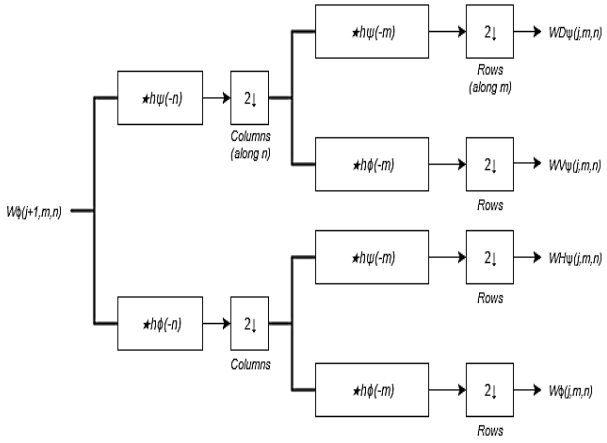


Figure 2. DWT Process

If the original image signal is passed through two filters, high and low pass, then signal is broken into two parts detailed and approximated part. Bandwidth of the filter is halved, redundant information is obtained, out of two consecutive samples obtained pick one and discard the other. Subsampling is done along the columns. Apply 1-D filter along the rows and subsample along the rows. We have successfully vanished the resolution through a factor of 2 beside the horizontal and vertical. Now the image is basically reduced into one fourth samples. [6]

Forward DWT equation is-

$$W_\psi^i(j,m,n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y)\psi_{j,m,n}^i(x,y)$$

Inverse DWT equation is-

$$f(x,y) = \frac{1}{\sqrt{MN}} \sum_m \sum_n W_\varphi(j_0,m,n)\varphi_{j_0,m,n}(x,y) + \frac{1}{\sqrt{MN}} \sum_{i=H,V,D} \sum_{j=j_0}^{\infty} \sum_m \sum_n W_\psi^i(j,m,n)\psi_{j,m,n}^i(x,y)$$

There are different types of wavelet families which are available like the haar, morlet, symlet, daubechies.

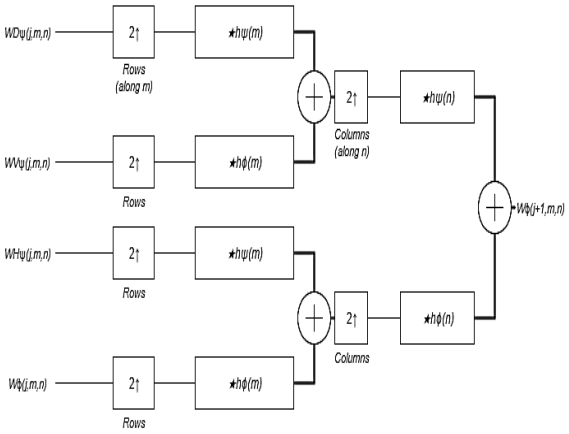
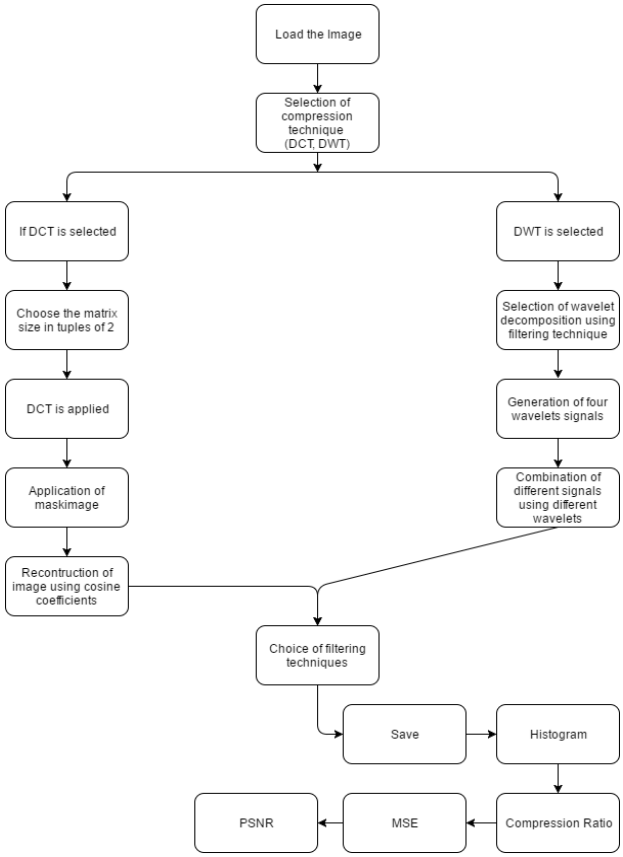


Figure 3. Inverse DWT Process

Filters-Filtering operations are used in image compression for further improvement in the mean square error, reduction in the peak signal to noise ratio. Basically, filtering enhances the wanted components and removes the unwanted components. There are different types of filters which are available. Filters which are used are described below. [9]

1. Average filter
2. Median filter
3. Unsharp filter
4. Gaussian filter

Methodology - All the coding is performed on the MATLAB software. GUI is made in the GUIDE. The following steps are taken in order to perform this work



III. RESULTS AND DISCUSSION

We are using the GUIDE of MATLAB software for the calculation of the results. [8] The GUI is made which contains the original image, compressed image, filtered image, various panels consisting of DCT, DWT, FILTERS operations application, histogram equalization, compression ratio, PSNR, MSE calculation parameters.[10] The various results obtained after applying DCT, DWT techniques are-

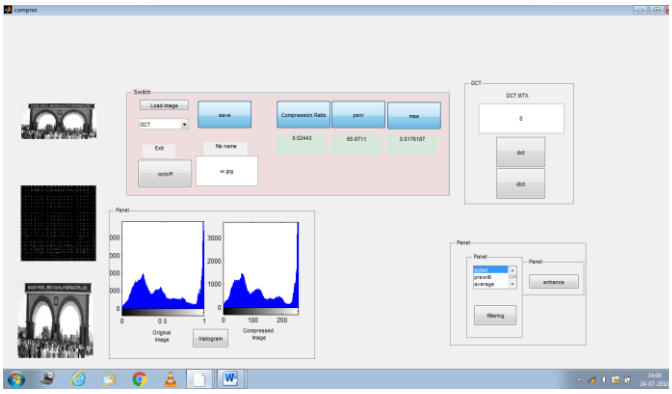


Figure 4. Result obtained after applying DCT on image in guide.

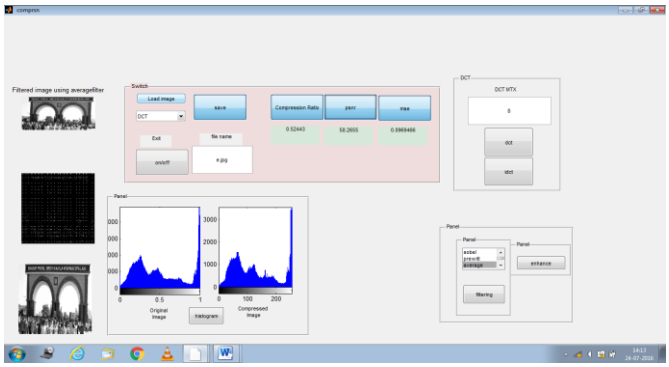


Figure 5. Result obtained after applying DCT and average filter on image in guide.

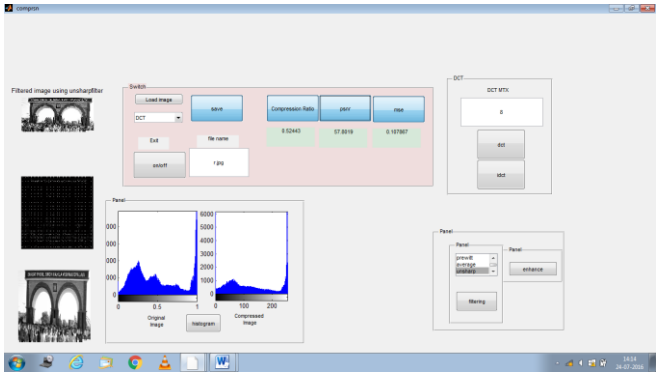


Figure 6. Result obtained after applying DCT and unsharp filter on image in guide.

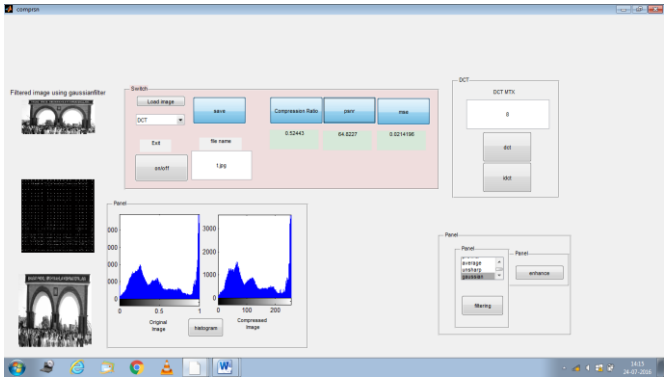


Figure 7. Result obtained after applying DCT and Gaussian filter on image in guide.

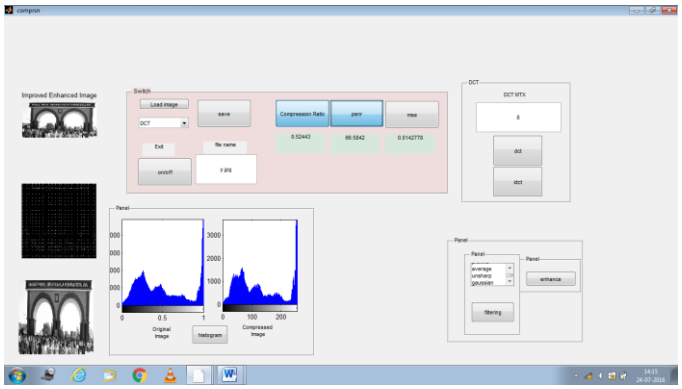


Figure 8. Result obtained after applying DCT and median filter on image in guide.

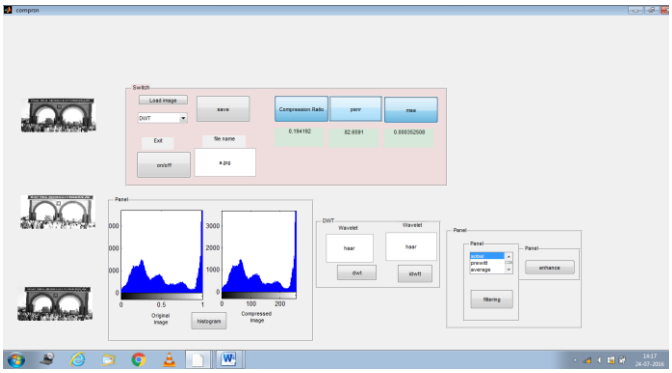


Figure 9. Result obtained after applying DWT (haar) on image in guide.

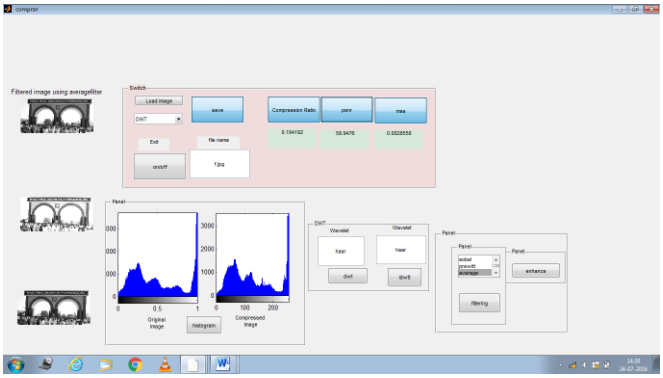


Figure 10. Result obtained after applying DWT (haar) and average filter on image in guide.

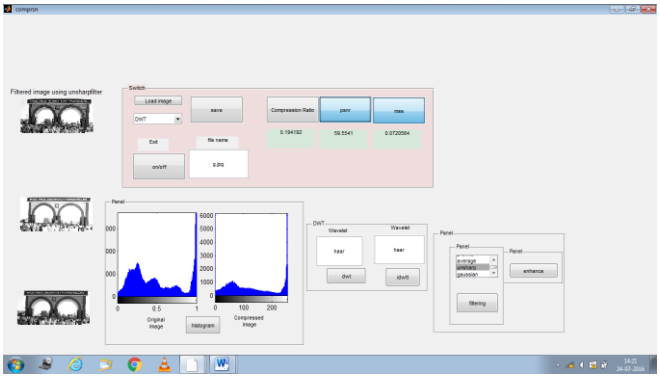


Figure 11. Result obtained after applying DWT (haar) and unsharp filter on image in guide.

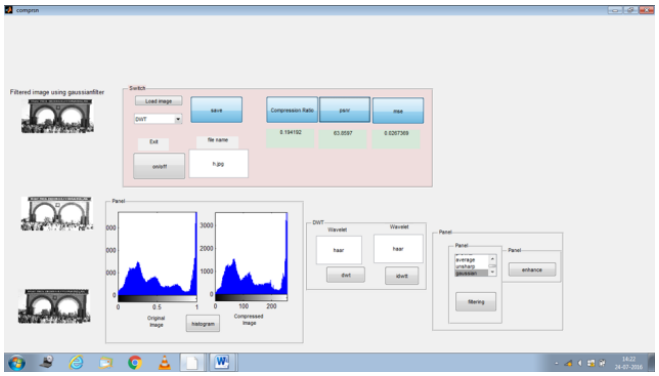


Figure 12. Result obtained after applying DWT (haar) and Gaussian filter on image in guide.

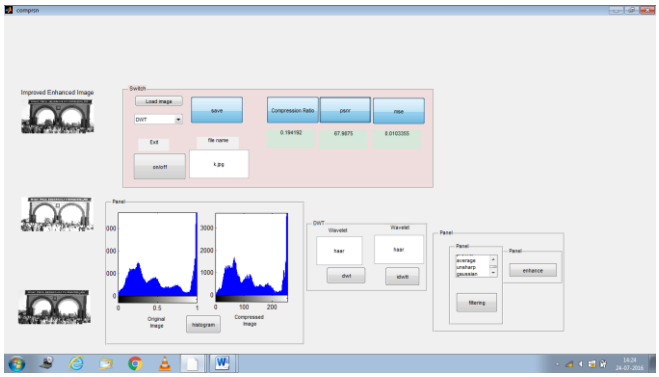


Figure 13. Result obtained after applying DWT (haar) and median filter on image in guide.

Transform used	Filtering technique	Compression ratio	MSE	PSNR
DCT		0.52443	0.0176187	65.6711
DCT	Unsharp	0.52443	0.107867	57.8019
DCT	Gaussian	0.52443	0.0214196	64.8227
DCT	Average	0.52443	0.0969466	58.26655
DCT	Median	0.52443	0.0142778	65.5842
DWT		0.194192	0.000352508	82.6591
DWT	Unsharp	0.194192	0.0720564	59.5541
DWT	Gaussian	0.194192	0.00884678	68.663
DWT	Average	0.194192	0.0828558	58.947

				6
DWT	Median	0.194192	0.0078894 8	69.160 3

IV. CONCLUSION

In this paper, we have discussed DCT, DWT techniques and compression ratio, MSE, PSNR are calculated for an image for DCT and DWT. Then various filters are applied for the further improvement in the quality of the image obtained. We analysed the PSNR, MSE for various filters and better results for DCT and DWT are obtained using these filters.

Various new techniques can be developed for the further improvement in the compression schemes for image. New methods can be proposed for further new observations.

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