Optimize Disk Storage Space by Using Hybrid Compression Techniques Dwt Dct & Huffman Encoding Without Compromising On Image Quality

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Abstract – Digital image and video in raw form require large amount of storage capacity. Image compression means reducing the size of graphics file, without compromising on its quality. Depending on the reconstructed image, to be exactly same as the original or some unidentified loss may be incurred, two techniques for compression exist. Two techniques are: lossy techniques and lossless techniques. Digital imaging and video play an important role in image processing therefore it is necessary to develop a system that produces high degree of compression while preserving critical image/video. In this paper we present hybrid model which is the combination of several compression techniques. This paper presents DWT and DCT implementation because these are the lossy techniques and also introduce Huffman encoding technique which is lossless. On several medical, endoscopic, Lena and Barbra images simulation has been carried out. At last implement lossless technique so our PSNR and MSE will go better than the old algorithms and due to DWT and DCT we will get good level of compression. The results show that the proposed hybrid algorithm performs much better in term of peak-signal-to-noise ratio with a higher compression ratio compared to standalone DCT and DWT algorithms.

Index Terms – DCT (discrete cosine transform), DWT (discrete wavelet transform), MSE (mean square error), PSNR (peak signal to noise ratio).

1. INTRODUCTION

Compression refers to reducing the quantity of data used to represent a file, image or video content without excessively reducing the quality of the original data. It also reduces the number of bits required to store and/or transmit digital media. To compress something means that you have a piece of data and you decrease its size. JPEG is the best choice for digitized photographs. The Joint Photographic Expert Group (JPEG) system, based on the Discrete Cosine Transform (DCT), has been the most widely used compression method [1][2]. In DCT image data are divided up into n*m number of block. DCT converts the spatial image representation into a frequency map: the average value in the block is represented by the low-order term, strength and more rapid changes across the width or height of the block represented by high order terms. DCT is simple when JPEG used, for higher compression ratio the noticeable blocking artifacts across the block boundaries cannot be neglected. The DCT is fast.

It can be quickly calculated and is best for images with smooth edges. Discrete wavelet transform (DWT) has gained widespread acceptance in signal processing and image compression. Huffman coding is a statistical lossless data compression technique. Huffman coding is based on the frequency of pixel in images. It helps to represent a string of symbols with lesser number of bits. In this lossless compression shorter codes are assigned to the most frequently used symbols, and longer codes to the symbols which appear less frequently in the string. This algorithm is an optimal compression algorithm when only the frequencies of individual letters are used to compress the data. Therefore, when Huffman coding when combined with technique of reducing the image redundancies using Discrete Cosine Transform (DCT) helps in compressing the image data to a better level. The Discrete Cosine Transform (DCT) is an example of transform coding. The DCT coefficients are all real numbers unlike the Fourier Transform. The Inverse Discrete Cosine Transform (IDCT) can be used to retrieve the image from its transform representation. The one-dimensional DCT is useful in processing speech waveforms. The two dimensional (2D) signals useful in processing images, for compression coding we need a 2D version of the DCT data, for optimal performance. JPEG is a commonly used standard method of compression for photographic images. The name JPEG stands for Joint Photographic Experts Group, the name of the committee who created the standard. JPEG provides for lossy compression of images. Lossy compression means that some data is lost when it is decompressed. Lossless compression means that when the data is decompressed, the result is a bit-for-bit perfect match with the original one. The main objectives of this paper are reducing the image storage space, Easy maintenance and providing security, Data loss cannot affect the image clarity, Lower bandwidth\requirements for transmission, reducing cost. Because of their inherent multi-resolution nature, wavelet-coding schemes are especially suitable for applications where scalability and tolerable degradation are important. Recently the JPEG committee has released its new image coding standard, JPEG-2000, which has been based upon DWT. It also offers higher compression ratio. In this paper, we present a new hybrid algorithm: the 2- level 2-D DWT followed by the 4x4 2-D DCT.

The DCT is applied to the DWT low-frequency components that generally have zero mean and small variance, and accordingly results in much higher compression ratio (CR) with important diagnostic information.

2. DWT, DCT, HUFFMAN ALGORITHM

The presented hybrid DWT-DCT algorithm for image compression is to exploit the properties of both the DWT and the DCT (as illustratedin Fig. 1):-

Take the Lena/Barbra image. The original image/frame of size 256x256. Firstly original image/frame divided into blocks of 16x16. By using the 2-D DWT decomposed the each 16x16 blocks. The low-frequency coefficients are LL and high-frequency coefficients are HL, LH and HH.

When LL passed to the next stage where the high-frequency coefficients (HL, LH and HH) are discarded. The passed LL components are further decomposed using another 2-D DWT and the detail coefficients (HL, LH and HH) are discarded. . 4x4 DCT has been applied to the reaming approximate DWT coefficients (LL) and can be achieved high CR. Then Huffman codes are performed on 4x4 and assign the codes to low-frequency coefficients and high-frequency coefficients. . In this lossless compression shorter codes are assigned to the most frequently used symbols, and longer codes to the symbols which appear less frequently in the string.

Then the images are compressed and finally, the image is reconstructed followed by inverse procedure. During the inverse DWT, zero values are padded in place of the detail coefficients.

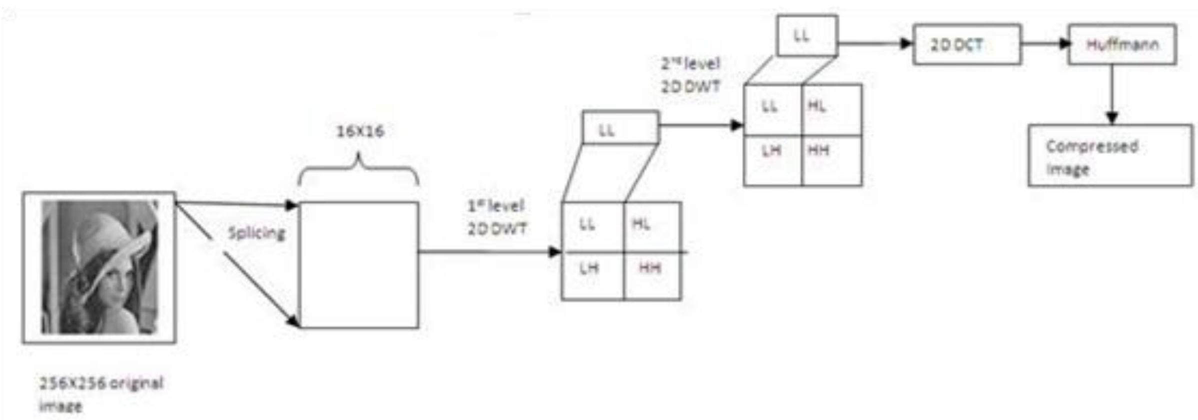

Figure 1. Block diagram of the proposed hybrid DWT-DCT,huffman algorithm

3. PERFORMANCE

Error Metrics: **-** Two error metrics are used to compare the various image compression techniques are:- 1.The Mean Square Error (MSE) and 2.The probalistic Signal to Noise Ratio (PSNR). The MSE is the cumulative squared error between the compressed and the original image, whereas PSNR is a measure of the peak error. The mathematical formulae for the two are

$$MSE=1/NM=\sum_{V=1}^{M}\sum_{X=1}^{N}[I(x,y)-I'(x,y)^2]$$

PSNR = 20 * log10 (255 / sqrt (MSE))

Where I (x,y) is the original image, I'(x,y) is the approximated version (which is actually the decompressed image) and M, N are the dimensions of the images.

A lower value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a high value of PSNR. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction. So, if you find a compression scheme having a lower MSE (and a high PSNR), you can recognise that it is a better one.

4. RESULT ANALYSIS

We have applied the hybrid image compression algorithm on several images and the results are shown in this section. Several images are used e.g endoscopic image, X-ray, Lena, Barbra, CT scan. The results are also compared with the standalone DCT and DWT algorithms.

Take an image of size 256x256 pixels. The original image is resized to 16x16 pixels. Then hybrid image compression algorithm is applied. The following graphs depict the results in terms of PSNR for a constant CR of 97%. If we change our CR to 93%, still our hybrid image compressed performance much better than DWT, DCT standalone techniques.

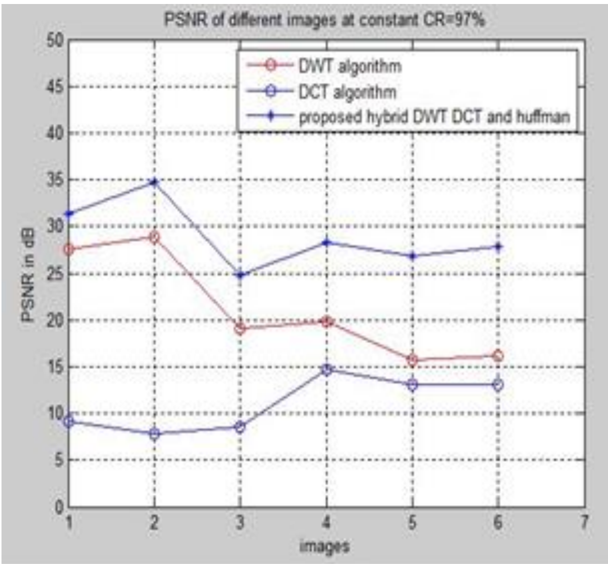

Figure2:- graph shows the DCT,DWT and Huffman results at CR=97%

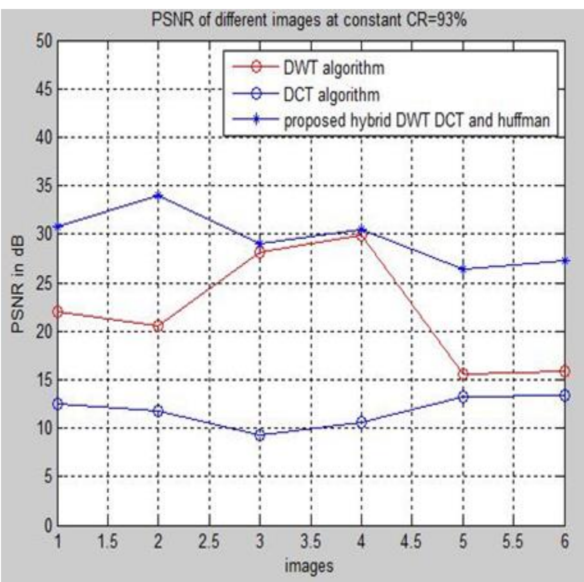

Figure3:- graph shows the DCT,DWT and Huffman results at CR=93%

5. CONCLUSION

In this paper we present a hybrid DWT, DCT and Huffman algorithm for image compression. The proposed scheme helps in many areas like telemedicine, wireless capsule endoscopies where the degree of compression is important.

The performance analysis on several images shows that the hybrid algorithm achieves the higher compression ratio and better PSNR.

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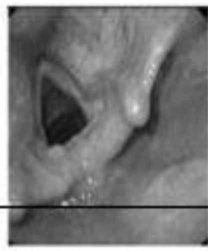
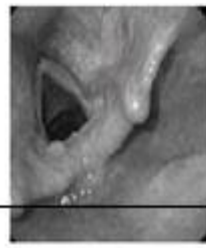
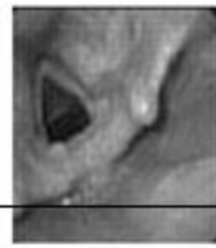
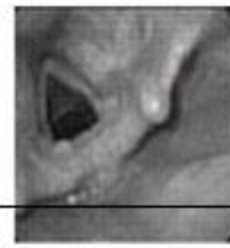
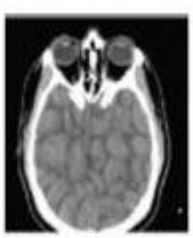
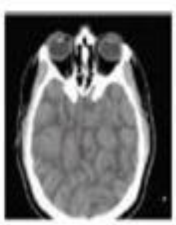
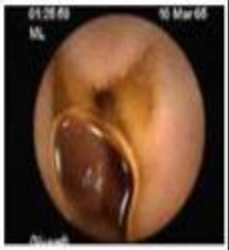
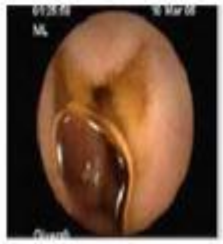
SAMPLE RECONSTRUCTED IMAGE AT COMPREESION RATIO OF 97%				
	Original Image	Reconstructed Images		
		DWT algorithm	DCT algorithm	Proposed hybrid DWT, DCT,Huffman algorithm
Endoscopic image(larynx)				
PSNR(db)		27.50	9.13	31.37
X-ray (chest)				
PSNR(db)		28.85	7.76	34.69
CT scan image				
PSNR(db)		19.04	8.56	24.77

Endoscopic video FRAME1				
PSNR(db)		19.84	14.63	28.25
	Original image	DWT algorithm	DCT algorithm	Proposed hybrid DCT, DWT, Huffman algorithm
Lena image				
PSNR(db)		15.76	13.13	26.79
Barbra image				
PSNR(db)		16.21	13.11	27.82

Table 1:- shows the sample reconstructed image compression at ratio97%

SAMPLE RECONSTRUCTED IMAGE AT COMPREESION RATIO OF 93%

	Original Image	Reconstructed Images		
		DWT algorithm	DCT algorithm	Proposed hybrid DWT, DCT, Huffman algorithm
Endoscopic image(larynx)				
PSNR(db)		22.00	12.57	30.77
X-ray (chest)				
PSNR(db)		20.50	11.78	34.00
CT scan image				
PSNR(db)		28.88	9.28	28.99

ENDOSCOPIC VIDEO FRAME1				
PSNR(DB)		29.88	10.55	30.55
LENA IMAGE				
PSNR(DB)		15.15	13.17	26.32
BARBRA IMAGE				
PSNR(DB)		15.89	13.34	27.30