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Image Compression Using Hybrid DCT-DWT Transform

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Abstract— In image compression using Discrete Cosine Transform (DCT) [1] for different quantization laves we can observe different compression ratio and different peak signal-to-noise ratio. In Discrete Wavelet Transform (DWT) [2], [3] with different levels and different thresholds we can observe different compression ratio and different peak signal-to-noise ratio. Based on the application we can select the quantization level. When comparing DCT with DWT, results of DWT are better than DCT. In this paper we are proposing a new hybrid transform by combining DCT and DWT which gives better compression ratio for same PSNR. In proposed transform first image is compressed using DWT and the approximation coefficients of compressed image are again compressed using DCT.

Keywords— Image Compression, Discrete Cosine Transform, Discrete Wavelet Transform, compression ratio, peak signal-to-noise ratio

I. INTRODUCTION

Image compression is the process of converting image into smaller file for efficiency of transmission and storage. As one of the enabling technologies of the multimedia revolution, image compression is a key to rapid progress being made in information technology. It would not be practical to put images alone on websites without compression JPEG (Joint Photographic Experts Group) [4] , which is standard for representing images. In this standards Data compression algorithms are used to reduce the number of bits required to represent an image.

Image compression is the process of representing image in a compact form. Image compression treats information in digital form, which is, as binary numbers represented by bytes of data with very large data sets. For example, a single small 3″ × 3″ size color picture, scanned at 200 dots per inch (dpi) with 24 bits/pixel of true color, will produce a file containing more than 3 megabytes of data. More than one minute is requires for transmission of this image by a typical transmission line (64k bit/second ISDN). To store such picture at least two floppy disks are required. That is why large image files remain a major bottleneck in a distributed environment. Although increasing the bandwidth is a possible solution, the relatively high cost makes this less attractive. Therefore for creating image files with manageable and transmittable sizes compression is a necessary and essential method. In order to be useful, a compression algorithm has a corresponding decompression algorithm that, given the compressed file, reproduces the original file. There have been many types of compression algorithms developed.

These algorithms is of two broad types, lossless algorithms and lossy algorithms [6]. A lossless algorithm reproduces the original image exactly. A lossy algorithm, loses some data, as its name implies. In many applications data loss may be unacceptable. For example, text compression must be lossless because a very small difference can result in statements with totally different meanings. There are also many situations where loss may be either unnoticeable or acceptable. In image compression, for example, value each sample of image is not necessarily exact reconstructed. Varying amounts of loss of information can be accepted depending on the required quality of the reconstructed image.

Image compression using Wavelet transform is lossy compression method. There are also other methods of lossy image compression like vector quantization (VQ) [5], fractal compression and predictive coding. VQ is theoretically an efficient method for image compression, and superior performance will be gained for large vectors. However, in order to use large vectors, VQ becomes complex and requires many computational resources (e.g. memory, computations per pixel) in order to efficiently construct and search a codebook. Predictive techniques have inferior compression ratios and worse reconstructed image quality than those of transform coding. Fractal image compression usually involves a large amount of matching and geometric operations, it is time consuming. The coding process is so asymmetrical that encoding of an image takes much longer time than decoding. Transform based compression methods are superior to other compression methods in computation, complexity, compression ratio and reconstructed quality. DCT is popular transform used by the JPEG (Joint Photographic Experts Group) image compression standard for lossy compression of images. Since it is used so frequently, DCT is often referred to in the literature as JPEG-DCT, DCT used in JPEG. Wavelet transform analysis has emerged as a major new time frequency decomposition tool for data analysis. The wavelet transform has been found to be particularly useful for analysing signals which are transitory, discontinuous, noisy, and so on. Its ability to examine the signal in both frequency and time resolution is distinctive and enables myriads of applications possible that traditional signal analysis tools such as Fourier transform cannot handle. It has now been applied to diverse realm of data analysis/process: climate analysis, financial indices analysis, signals denoising, characterization, feature extraction, data compression, and so on.

In this paper we proposed a new hybrid DCT-DWT compression technique which gives better compression ratio and peak signal-to-noise ratio when compared to image compression using DCT and DWT techniques.

II. HYBRID DCT-DWT TECHNIQUE

The approach is to implement new technique by combining DCT and DWT techniques. In this hybrid DCT-DWT technique first the original image to be compressed is compressed using DWT and decomposed into approximation coefficients and Detail coefficients from this approximation coefficients are separated and divided into 8x8 blocks each block is compressed using DCT. This DWT-DCT compressed image is the actual compressed image which is shown in fig.1. at the decoding end the DCT compressed approximation coefficients are separated from compressed image and reconstructed original approximation coefficients which are then added to detail coefficients. Decompressed image is obtained by applying inverse discrete wavelet transform to this.

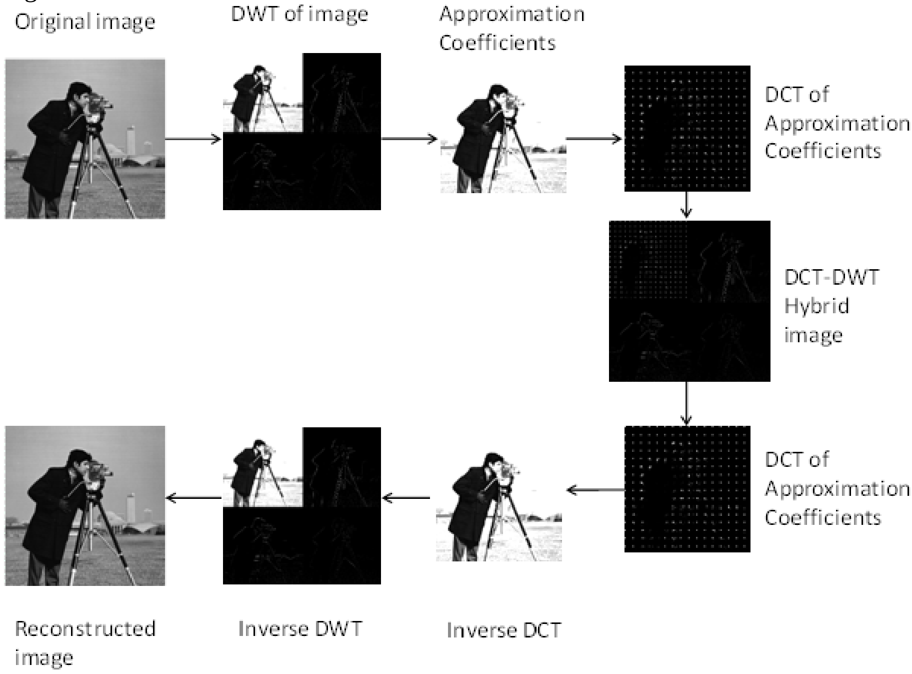

Fig.1 DCT-DWT Hybrid image compression technique block diagram.

III. PERFORMANCE

Two error metrics are used to compare the various image compression techniques are:- 1.The Mean Square Error (MSE) and 2.The peak Signal-to-Noise Ratio (PSNR) [7]. 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

$$t = \sum(\text{original\_image-reconstructed\_imagr})^2$$
$$MSE = t/N$$
$$PSNR = 10*\log10(255*255/MSE)$$

Where N is the number of pixels in the image.

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. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

One more performance metrics is compression ratio this is the ratio between the size of original image to the size of compressed image.

IV. RESULT ANALYSIS

More the compression ratio more the compression. If compression ratio is more quality of reconstructed image is less than mean PSNR is less. Depending on our application we have to balance between compression ratio and PSNR. Our application needs more quality of reconstructed image go for less compression ratio. Research is going on how to get better quality for higher compression ratio. If an algorithm is able to give better quality for higher compression ration the that is the best algorithm. This proposed technique is able to give good quality of reconstructed image for higher compression ratio.

Figures 2, 3 and 4 shown below are the results of DCT, DWT and DCT-DWT respectively. In each figure first image is the original image to be compressed, second one is compressed which we need to store are transfer through communication channel and third one is reconstructed image or decompressed image.

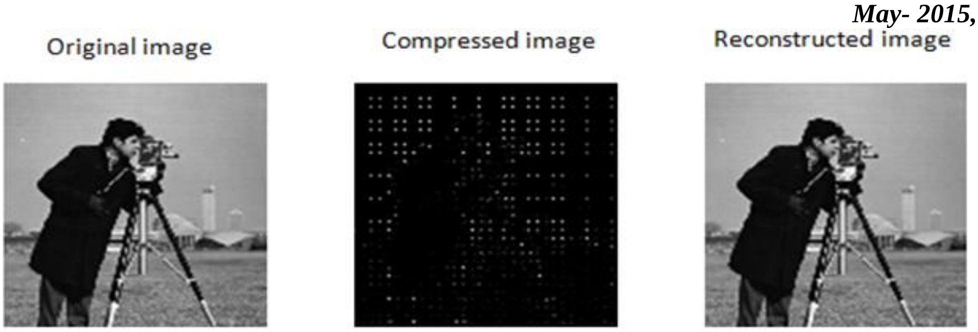

Fig.2 DCT compression of cameraman image

Fig.3 DWT compression of cameraman image

Fig.4 DCT-DWT compression of cameraman image

We have applied the hybrid DCT-DWT image compression technique on several images and the results are shown in this section. Results are also compared with standard DCT and DWT techniques.

TABLE I COMPARISON COMPRESSION RATIO AND PSNR FOR DCT, DWT AND HYBRID DCT-DWT FOR DIFFERENT IMAGES

	DCT		**DWT**		**DCT-DWT**	
	Compression ratio	**PSNR**	**Compression ratio**	**PSNR**	**Compression ratio**	**PSNR**
cameraman	2.8078	40.4402	2.7207	40.4864	3.2097	41.8955
Cell	8.5012	41.8859	3.8162	44.7214	7.0017	44.0382
Moon	7.3827	41.9671	5.2479	40.5273	6.0913	42.2231
Mri	9.3316	45.1883	4.9227	54.2077	4.6678	57.6345
westconcord orthophoto	1.3107	43.2604	1.336	44.4695	1.3842	44.4559

From the above comparison table it is clear that for different images cameraman, cell, moon, mri and westconcordorthophoto proposed algorithm performs better then DCT and DWT.

V. CONCLUSIONS

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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