International Journal of Emerging Technologies in Engineering Research (IJETER)
Volume 5, Issue 10, October (2017) www.ijeter.everscience.org

A Four-Dimensional Discrete Cosine Transform Using Large Block Wise Image Compression

M. Fatima Parvin
Department of Computer Science, Rani Anna Govt College, Gandhi Nagar, Tirunelveli, India.

Abstract – A Discrete Cosine Transform (DCT) can be effortlessly implemented in software for using compression in the JPEG. In this research focused Four dimensional DCT (4D DCT) approximation are dignified in provisions of high-order tensor deduction more than a few multiplier less 16 * 16 probable technique are proposed. The formulation is complete to higher dimensions with random lengths. In this propose a 4D DCT that can be applied to lossless image coding with also direct-lifting of DCT. In this planned requires a Large side Information Block (LIB), it is validated by its application to lossless image coding. The artificial results showed that the approximate 4D DCT coding methods offer almost identical output visual quality when compared with exact DCT method. The intended 4D approximations were also working as a tool for visual quality improvement of the JPEG .The future approximations were fixed into 4D DCT-based video coding formats. Finally, we discuss how existing solutions can be modified to improve their compression.

Index Terms – Compression; DCT; styling; image block (reduced).

1. INTRODUCTION

In today's digital world, when see digital movie, listen digital music, read digital mail, store documents digitally, making conversation digitally, have to deal with huge amount of digital data. So, data compression plays a very significant role to keep the digital world realistic. If there were no data compression techniques, would have not been able to listen to songs over the Internet, see digital pictures or movies, or would have not heard about video conferencing or telemedicine. How data compression made it possible? What are the main advantages of data compression in digital world? There may be many answers but the three obvious reasons are the saving of memory space for storage, channel bandwidth and the processing time for transmission.

JPEG is the most common image format used by digital cameras and other photographic image capture devices for storing and transmitting photographic images on the World Wide Web. JPEG compression is used in a number of image file formats these format variations are often not distinguished and are simply called JPEG. The term "JPEG" is an acronym for the Joint Photographic Experts Group which created the standard

Image data compression is concerned with minimizing the number of bits required to represent an image with no significant loss of information. Image compression algorithms aim to remove redundancy present in the data (correlation of data) in a way which makes image reconstruction possible; this is called information preserving compression Perhaps the simplest and most dramatic form of data compression is the sampling of band limited images, where an infinite number of pixels per unit area are reduced to one sample without any loss of information. Consequently, the number of samples per unit area is infinitely reduced.

Transform based methods better preserve subjective image quality, and are less sensitive to statistical image property changes both inside a single images and between images. Prediction methods provide higher compression ratios in a much less expensive way.

If compressed images are transmitted an important property is insensitivity to transmission channel noise. Transform based techniques are significantly less sensitivity to channel noise. If transform coefficients are corrupted during transmission, the resulting image is spread homogeneously through the image or image part and is not too disturbing.

Applications of data compression are primarily in transmission and storage of information. Image transmission applications are in broadcast television, remote sensing via satellite, military communication via aircraft, radar and sonar, teleconferencing, and computer communications.

2. RELATED WORK

The JPEG image compression scheme and then review related work on both Lossless compression of individual JPEG images and image set compression. The JPEG group has specified a family of image coding standards. The most popular one is the baseline JPEG. The key components of the baseline encoder. An input image is divided into 8*8 blocks.

Each block is then converted into a frequency domain by an 8 *8 DCT, followed by the scalar quantization which is usually implemented with a set of quantization matrices indexed by a quality factor. The quantized DC coefficients are predicted by DPCM (Differential pulse code modulation) while the AC ones are zig-zag scanned before going through the Huffman-based entropy coding.

Incorrect flips vs. graph rigidity

This process aims to study and understand the general operations used to compress a two dimensional gray scale images and to develop an application that allows the compression and reconstruction to be carried out on the images. The application developed aims to achieve:

1. Minimum distortion
2. High compression ratio
3. Fast compression time

To compress an image the operations include linear transform, quantization and entropy encoding. The thesis will study the wavelet and cosine transformation and discuss the superior features that it has over Fourier transform. This helps to know how quantization reduces the volume of an image data before packing them efficiently in the entropy coding operation. To reconstruct the image, an inverse operation is performed at every stage of the system in the reverse order of the image decomposition.

Fig. 1. DCT Compression with Lena image

Measurement of visual quality is of fundamental importance for numerous image and video processing applications, where the goal of quality assessment (QA) algorithms is to automatically assess the quality of images or videos in agreement with human quality judgments. Over the years, many researchers have taken different approaches to the problem and have contributed significant research in this area and claim to have made progress in their respective domains. It is important to evaluate the performance of these algorithms in a comparative setting and analyze the strengths and weaknesses of these methods. In this process, present results of an extensive subjective quality assessment study in which a total of 779 distorted images were evaluated by about two dozen human subjects. The "ground truth" image quality data obtained from about 25 000 individual human quality judgments is used to evaluate the performance of several prominent full-reference image quality assessment algorithms. To the best of knowledge, apart from video quality studies conducted by the Video Quality Experts Group, the study presented in this process is the largest subjective image quality study in the literature in terms of number of images, distortion types, and number of human judgments per image. Moreover, have made the data from the study freely available to the research community. This would allow other researchers to easily report comparative results in the future [1].

Recent years have witnessed a growing interest in developing objective image quality assessment (IQA) algorithms that can measure the image quality consistently with subjective evaluations. For the full reference (FR) IQA problem, great progress has been made in the past decade. On the other hand, several new large scale image datasets have been released for evaluating FR IQA methods in recent years. Meanwhile, no work has been reported to evaluate and compare the performance of state-of-the-art and representative FR IQA methods on all the available datasets. In this process, aim to fulfill this task by reporting the performance of eleven selected FR IQA algorithms on all the seven public IQA image datasets. In this evaluation results and the associated discussions will be very helpful for relevant researchers to have a clearer understanding about the status of modern FR IQA indices.

This process presents an efficient metric for quantifying the visual fidelity of natural images based on near-threshold and supra threshold properties of human vision. The proposed metric, the visual signal-to-noise ratio (VSNR), operates via a two-stage approach. In the first stage, contrast thresholds for detection of distortions in the presence of natural images are computed via wavelet-based models of visual masking and visual summation in order to determine whether the distortions in the distorted image are visible.

If the distortions are below the threshold of detection, the distorted image is deemed to be of perfect visual fidelity (VSNR = infin) and no further analysis is required. If the distortions are supra threshold, a second stage is applied which operates based on the low-level visual property of perceived contrast, and the mid-level visual property of global precedence.

These two properties are modeled as Euclidean distances in distortion-contrast space of multistage wavelet decomposition, and VSNR is computed based on a simple linear sum of these distances. The proposed VSNR metric is generally competitive with current metrics of visual fidelity; it is efficient both in terms of its low computational complexity and in terms of its low memory requirements; and it operates based on physical luminances and visual angle (rather than on digital pixel values and pixel-based dimensions) to accommodate different viewing conditions[2][3].

(A) (B)

Fig. 2. (A)The original Lena Image. (B)The Compressed Lena Image with r = 1 sparse Matrix

The compression scheme in the color space does not rely on the quantization of the DCT, but rather on the similarity (or not) of the chrominance of neighboring pixels. In that, it is very close in spirit to the Haar transform that we shall see in wavelets. We will implement a Haar variant to compress the chrominance signal. After looking at the implementation of the wavelet transform, you will approximate (and later compress) color images the following way

- Convert the image from RGB to YCbCr
- JPEG compress the Y channel by quantizing its DCT as explained before
- For each of the two Cb and Cr channel, perform a Haar decomposition of the channels at 2 scales. The Haar obtained by loading and using two scales means that you are working on blocks of 4 *4 pixels.
- Depending on a number n that you decide, you only keep the n largest.
- Wavelet coefficients. In the Haar basis, this means you keep only the
- Largest variations in chrominance, either from pixel to pixel, or from one
- 2 *2 block of pixels to another.
- Reconstruct the Cb and Cr channels from their wavelet transform
- To combine the three channels to obtain an RGB image

This is very similar to the scheme in Figure 2 that you will find on Wikipedia. It shows the approximation of the Lena image with r = 2 and the others parameters being the same as for the Mandrill image.

3. PORPOSED MODELLING

In this propose the use of Discrete Cosine Transform Type-IV (DCT4) for multicarrier modulation. There are two DCT4 (even and odd) and, for each of them, we derive the expressions for both prefix and suffix to be appended into each data symbol to be transmitted. Moreover, DCT4 are closely related to the corresponding inverse DCT Type-III even and odd. Furthermore, we give explicit expressions for the 1-tap per subcarrier equalizers that must be implemented at the receiver to perform the channel equalization in the frequency-domain. As a result, the proposed DCT4 The efficient compression method for a set of clustered JPEG images and speed up the encoding and decoding process by introducing parallel techniques.

The DCT is a fast transformation method that takes an input and transforms it into linear combination of weighted basis function, these basis function are commonly the frequency, like sine waves. DCT compression seems to work better than the discrete Fourier transform method possibly because it allows smoother transitions between adjacent blocks. We know that be the DCT uses lower spatial frequencies with respect to DFT. The DCT transform is generated by dividing the pattern into square blocks and then reflecting each block about the axes [6, 8, 11, 9]. A DCT block is a group of pixels of an 8×8 window. DCT grid is the horizontal and vertical lines that partition an image into blocks for the compression. After computation of image compression the DCT algorithm is used to generate reconstructed image.

The 4-D DCT transform applied separately to each block, irrelevancy reduction is then applied to the resulting transform coefficients of each block such that the most relevant information is retained for transmission or storage while the rest is eliminated. The DCT transforms the images of block size 16x16 pixels and the DCT is typically restricted to this size rather than taking the transformation of the image as a whole, the DCT is applied separately to blocks of the images. The DCT coefficients for each block are quantized separately by discarding the redundant and information high-coefficients. After transformation the image is applied for quantization method and receiver decodes the quantized DCT coefficients of each block separately and computes the 4D-IDCT of each block and then puts the blocks back together into a single image. The image file size is also reduced by dividing the coefficients into a quantization matrix. De-quantized and compressed image is reconstructed by using Inverse discrete cosine transformation although there is some loss of quality in the reconstructed image. It is recognizable as an approximation of the original image.

DCT BASED IMAGE COMPRESSION

The 16x16 image block uses a set of 256 four-dimensional cosine basis functions that is created by multiplying horizontally oriented set of one-dimensional 16 point cosine basis function by vertically oriented set of same functions [15].

(A) Original Image

(B) DCT apply Transform Image

Fig. 3. DCT Process Image

The horizontally oriented set of cosine coefficient represents the horizontal frequencies and the other set of coefficients represents the vertical frequencies. An N×M matrix image transform to DCT a 16×16. The transform of DCT is applied to each row and column. Images are separated into part of different frequency by the DCT as seen the figure 03. Each block of 16*16 is converted to a frequency domain representation using a 4D- DCT.

The coefficient with zero frequency in both dimensions is called the DC coefficients and the remaining 256 coefficients are called AC coefficients. The DC value is a sum over the whole image coefficients. The DC [17, 16] is a term of the horizontal basis which stored to the left of the output matrix whereas DC is a terms vertical basis function stored at the top. Thus, the top left corner of the matrix is the DC coefficients. The DC coefficients are of low bit rates, so that many high-frequency coefficients are rejected and the quantization of the DC coefficients generally causes the mention level of each block within a quantization interim. The 16 X 16 matrix of the original image can represent in table 1 and the table 2 presents the 16 X 16 matrix of the same image after applying the 4D DCT method.

141	140	139	138	137	138	139	140	141	141	140	139	138	137	138	139
139	138	137	136	136	138	139	140	139	139	138	137	136	136	138	139
137	137	136	135	136	138	139	141	137	137	137	136	135	136	138	139
138	137	137	136	137	138	141	141	138	138	137	137	136	137	138	141
141	140	139	138	139	138	141	143	141	141	140	139	138	139	138	141
145	144	142	141	141	140	143	144	145	145	144	142	141	141	140	143
141	140	139	141	140	139	138	137	138	139	141	140	139	138	137	138
139	138	137	139	138	137	136	136	138	139	139	138	137	136	136	138
137	137	136	137	137	136	135	136	138	139	137	137	136	135	136	138
138	137	137	138	137	137	136	137	138	141	138	137	137	136	137	138
141	140	139	141	140	139	138	139	138	141	141	140	139	138	139	138
145	144	142	145	144	142	141	141	140	143	145	144	142	141	141	140
148	146	145	148	146	145	143	142	143	144	148	146	145	143	142	143
141	140	139	141	140	139	138	137	138	139	141	140	139	138	137	138
139	138	137	141	140	139	138	137	138	142	139	138	137	136	136	138
138	142	141	136	141	140	139	138	137	138	139	140	141	135	141	139

Table-1 Original image matrix (16x16)

191.8750	18.1593	0.6253	0.3499	-0.1250	-0.0455	-0.1237	-0.2295	191.8750	191.8750	18.1593	0.6253	0.3499	-0.1250	-0.0455	-0.1237
-11.8915	-12.2765	6.6924	0.2246	0.0982	0.4984	-0.5590	-0.2612	-11.8915	-11.8915	-12.2765	6.6924	0.2246	0.0982	0.4984	-0.5590
-6.8943	-7.5500	0.1616	0.1920	0.0676	0.1283	-0.6402	0.1063	-6.8943	-6.8943	-7.5500	0.1616	0.1920	0.0676	0.1283	-0.6402
-7.2842	-0.0503	0.0227	-0.1053	-0.1734	-0.0789	0.4131	-0.2923	-7.2842	-7.2842	-0.0503	0.0227	-0.1053	-0.1734	-0.0789	0.4131
0.1250	-0.5161	0.0280	-0.2169	0.1250	0.4564	0.3943	0.4071	0.1250	0.1250	-0.5161	0.0280	-0.2169	0.1250	0.4564	0.3943
0.1669	-0.0613	0.6044	-0.1521	0.0345	0.0425	0.6549	-0.5074	0.1669	0.1669	-0.0613	0.6044	-0.1521	0.0345	0.0425	0.6549
0.0144	0.0938	0.1098	0.2190	-0.1633	0.0115	0.3384	0.0187	0.0144	191.8750	18.1593	0.6253	0.3499	-0.1250	-0.0455	-0.1237
-0.2606	0.1656	0.2227	0.4587	0.1470	0.1289	0.0957	-0.1607	-0.2606	-11.8915	-12.2765	6.6924	0.2246	0.0982	0.4984	-0.5590
191.8750	18.1593	0.6253	0.3499	-0.1250	-0.0455	-0.1237	-0.2295	191.8750	-6.8943	-7.5500	0.1616	0.1920	0.0676	0.1283	-0.6402
-11.8915	-12.2765	6.6924	-0.2246	0.0982	0.4984	-0.5590	-0.2612	-11.8915	-7.2842	-0.0503	0.0227	-0.1053	-0.1734	-0.0789	0.4131
-6.8943	-7.5500	0.1616	0.1920	0.0676	0.1283	-0.6402	0.1063	-6.8943	-6.8943	-7.5500	0.1616	0.1920	0.0676	0.1283	-0.6402
-7.2842	-0.0503	0.0227	-0.1053	-0.1734	-0.0789	0.4131	-0.2923	-7.2842	-7.2842	-0.0503	0.0227	-0.1053	-0.1734	-0.0789	0.4131
0.1250	-0.5161	0.0280	-0.2169	0.1250	0.4564	0.3943	0.4071	0.1250	0.1250	-0.5161	0.0280	-0.2169	0.1250	0.4564	0.3943
0.1669	-0.0613	0.6044	-0.1521	0.0345	0.0425	0.6549	-0.5074	0.1669	0.1669	-0.0613	0.6044	-0.1521	0.0345	0.0425	0.6549
0.0144	0.0938	0.1098	0.2190	-0.1633	0.0115	0.3384	0.0187	0.0144	191.8750	18.1593	0.6253	0.3499	-0.1250	-0.0455	-0.1237
-0.2606	0.1656	0.2227	0.4587	0.1470	0.1289	0.0957	-0.1607	-0.2606	-11.8915	-12.2765	6.6924	0.2246	0.0982	0.4984	-0.5590

Table-2 after apply DCT transform method in image pixel value (16x16)

4. RESULTS AND DISCUSSIONS

The process involves in compression and another one is decompression. In compression method reduce the number of bits needed to represent the digital image by using Discrete Cosine Transform (DCT).

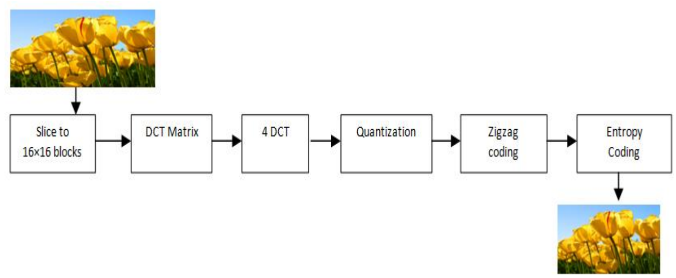

Fig. 4. Block Diagram: DCT Compression

The input is an image which consists of data in terms of pixels. A grayscale image is of resolution 1024x768, i.e. it consists of 786432 no of pixel values. An 16x16 DCT matrix is considered here.

The DCT Matrix

To get the matrix form of Equation (1), will use the following equation,

$$T_{ij} = \left\{ \begin{array}{ll} \frac{1}{\sqrt{N}} & \text{if } i = 0 \\ \sqrt{\frac{2}{N}} \cos\left[\frac{(2j+1)i\pi}{2N} \right] & \text{if } i > 0 \end{array} \right\}$$

DCT on a 16 x 16 block

Before begin, it should be noted that the pixel values of a black-and-white image range from 0 to 255 in steps of 1, where pure black is represented by 0 and pure white by 255. Thus it can be seen how a photo, illustration, etc. can be accurately represented by these 256 shades of gray. Since an image comprises hundreds or even thousands of 16 x 16 blocks of pixels, the following description of what happens to one 16 x 16 block is a microcosm of the JPEG process; what is done to one block of image pixels is done to all of them, in the order earlier specified. Now, let‘s start with a block of image pixel values. This particular block was chosen from the very upper-left-hand corner of an image.

Because the DCT is designed to work on pixel values ranging from -128 to 127, the original block is “leveled off” by subtracting 128 from each entry. This results in the following matrix are now ready to perform the Discrete Cosine Transform, which is accomplished by matrix multiplication.

$$D = TMT'$$

In Equation (2) matrix M is first multiplied on the left by the DCT matrix T from the previous section; this transforms the rows. The columns are then transformed by multiplying on the right by the transpose of the DCT matrix.

This block matrix now consists of 256 DCT coefficients, c (i, j), where i and j range from 0 to 15. The top-left coefficient, c (0, 0), correlates to the low frequencies of the original image block. As move away from c(0,0) in all directions, the DCT coefficients correlate to higher and higher frequencies of the image block, where c(15, 15) corresponds to highest frequency. Higher frequencies are mainly represented as lower number and Lower frequencies as higher number. It is important to know that human eye is most sensitive to lower frequencies.

Quantization

16x16 blocks of DCT coefficients is now ready for compression by quantization. A remarkable and highly useful feature of the JPEG process is that in this step, varying levels of image compression and quality are obtainable through selection of specific quantization matrices. This enables the user to decide on quality levels ranging from 1 to 100, where 1 gives the poorest image quality and highest compression, while 100 gives the best quality and lowest compression. As a result, the quality/compression ratio can be tailored to suit different needs.

Subjective experiments involving the human visual system have resulted in the JPEG standard quantization matrix. With a quality level of 50, this matrix renders both high compression and excellent decompressed image quality.

Zigzag Coding

The quantized matrix C is now ready for the final step of compression. Before storage, all coefficients of C are converted by an encoder to a stream of binary data (01101011...). In-depth coverage of the coding process is beyond the scope of this article. After quantization, it is quite common for most of the coefficients to equal zero. JPEG takes advantage of this by encoding quantized coefficients in the zigzag sequence.

Entropy Encoder

This is the last component in the compression model. Till now, have devised models for an alternate representation of the image, in which it is inter pixel redundancies were reduced. This last model, which is a lossless technique, then aims at eliminating the coding redundancies, whose notion will be clear by considering an example. Suppose, have a domain in an image, where pixel values are uniform or the variation in them is uniform. Now one requires 16 bpp (bits per pixel) for representing each pixel since the values range from 0 to 255. Thus representing each pixel with the same (or constant difference) value will introduce coding redundancy. This can be eliminated, if transform the real values into some symbolic form, usually a binary system, where each symbol corresponds to a particular value.

5. CONCLUSION

In this paper the technique of 4D DCT and quantization is used to compress the images of different sizes. The inverse 4D DCT is used to reconstruct the images on the varying block sizes 16×16. The quantization matrix is constructed and increased until the best result is not obtained for reconstructed compressed images. The 1024×768 size of Tulips image as shows above is reconstructed. This image is containing higher PSNR value among all the experiment with minimum error. It indicates that DCT compress the image with high quality when the original image is of 1024×768 resolution size. It is also observed that the minimum quantization matrix is used for lossless compression to improve the picture quality. The vice-versa results were also obtained if the maximum quantization matrix is used. The original image was reconstructed after 4 D DCT, quantization with verifying the accuracy of implementation that reduce the blocking artifacts and simultaneously improve PSNR value of compression image.

REFERENCES

[1] Anithas, “image compression DCT and DWT”, international journal of scientific and engineering research, 2 (8) 2011, 17-24.
[2] Andrew, B. Watson, “image compression using the DCT”, NASA Ames research centre in Mountain View California, Mathematica Journal, 4(1), 1994, 81-88.
[3] A. M. Raid, W. M. Khedr, M. A. El-Dosuky, W. Ahemed, “jpeg image compression using DCT- A survey”,International Journal of Computer Science & Engineering, 5(2) 2014, 39-47
[4] Anil. W. Bhaget, Balasaheb, H. Deokate, P. K. Kadbe, “High Quality Color Image Compression Using DCT”, International Journal of Emerging Trends in Electrical and Electronics (IJETEE) 2(3), 2013, 43-46.
[5] D. Sun, W. Cham, “post processing of low bit rate block DCT coded images based on a fields of experts prior”, IEEE transaction on image processing, 16 (11) 2007, 2743-2751.
[6] G. Strang, “The discrete cosine transform”, SIAM Review, 14 (1), 1999, 135-147.
[7] G. Wallace, “The jpeg still picture compression standard”, multimedia engineering digital equipment corporation mayanrd, Massachusetts, IEEE transaction consumer electronics, 38 (1) 1992, 1-17.

[8] J. H. Zhu Chen, L. L. Wang, X. Tang, "detecting doctored jpeg image via DCT coefficients analysis", ECCV-2006, Part-III, Springer - Verlag Berlin Heidelberg 2006, 423-435.
[9] J. J. Chae & B. S. Manjunath, "Atechnique for image data hiding and reconstruction without host image", Department of electrical and computer engineering university of California, 2011.
[10] J. Luo, C. W. Chen, K. J. Parker, T. S. Huang, "Artifact Reduction in Low Bit Rate DCT-Based Image Compression", Digital Image processing workshop proceeding, IEEE-1996, 157-160
[11] J. Nagi, S. Khaled A. F. Nagi, "A matlab based face recognition system using image processing & neural network" 4th international and colloquium on signal processing and its application march 7, 2008, Malaysia, 83-88.
[12] N. A. Amhed & T. Natarajan & K. R. Rao, "Discrete cosine transform", IEEE transaction on computers, 23 (1) 1974, 90-93.
[13] N. R. Thota & S. K. Devireddy, "Image compression & DCT", Georgian electronic Scientific Journal of Computers science & Telecommunication, 3 (17) 2008, 35-43.
[14] S. A. Khayam, "The DCT theory and application", Department of electrical and computer engineering Michigan state university, ECE 802-602, March 10, 2003, 1-31.
[15] V. Arya, P. Singh, K. Sekhon, "RGB image compression using two dimensional DCT", International Journal of Engineering Trends and Technology (IJETT), 4 (4) 2013, 828-832.

Author

Ms. M. FATIMA PARVIN ,M.C.A., M.Phil., She is working as a Guest lecturer in Rani Anna Govt College for women, Tirunelveli-8, in computer science department for the past ten years. She has qualified the SET exam in Bharathiar University in the year 2012.And her area of interest is in Digital Image Processing.