ROBUST IMAGE COMPRESSION USING TWO DIMENSIONAL DISCRETE COSINE TRANSFORM

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Abstract: **The two dimensional discrete cosine transform become paradigm in signal processing.This transforms process the signal in frequency domain. The authentic and significant feature of discrete cosine transform provides higher PSNR. The performance of proposed technique over existing technique is superior due to discrete cosine transform. Peak signal to noise ratio is considered quality check parameters in image compression.**

Keywords:**Image compression, fractional transform, discrete cosine transform.**

1. INTRODUCTION

The authentic techniques that are required to transmit and store visual information's. Such type of transmission and visual information has been increased by the increasing usability of images in the continuous development of multimedia applications [1] because transmission and visual information is directly proportional to usability of image of multimedia. However, the downloading multimedia files from internet is an extremely time consuming. Because of this necessity, image compression has become an important factor and the need for efficient algorithms that can produce large compression ratio with low loss has increased [2]. Multimedia communication contain a major portion of image data which consumes more bandwidth during transmission of techniques[3]. Therefore, the composition of authentic techniques for image compression has become important paradigm [4]. Various image compression techniques have been developed in response to increasing need for medical and microbial consortial images, virtual conferencing and multimedia.

The pre-existing techniques focused on analyzing two dimensional singularities and achieving the fascinating characteristics such as high peak-signal-to-noise ratio (PSNR). Discrete cosine transform (DCT) [5] is very important form the prospective of compressions and it is an adaptation of Fourier series. The DCT is provides accurate approximation of a signal with fewer transform coefficients [6]. Discrete sine transform (DST) is a complementary transform of DCT. DST is used as audio coding and low rate image in compression applications [7-8]. Discrete Walsh Hadamard transform (DWHT) is the simplest transform, but its energy compaction is poorer than that of DCT, so it does not have a potential to be used for data or image compression [9, 10]. KLT, DST and DCT are linear orthogonal blocked transformations which eliminate the interrelating data points or pixels inside the block. These transforms do not care of interrelating over the block boundaries [11]. The hybrid fractal image compression technique [12] which required more execution time due to its high complexity of images.

In 1807, Jean Baptise Joseph Fourier introduced Fourier transform while he was solving a heat conduction dilemma. However, during the development of research area and theme, in 1929, the fractional power of FT operator appeared in the mathematical literature [13-15]. The Fractional Fourier Transform (FrFTs) are commonly called as angular Fourier transform or rotational Fourier transform in some research papers [16, 17]. The applications of FrFT are quantum mechanics [18], signal processing [19-21], pattern recognition [22], and optical, video and audio processing [23-24]. In optics, the continuous FrFT is implemented [25]. Thus in short, it is proved fact that difference provides a richer solution set as compared to their continuous limit differential equations [26]. The decomposition discrete and continous signals and systems in FrFT domain has been introduced [27]. Nowadays, FrFThas various authentic application areas [28-33].

2. PROPOSED IMAGE COMPRESSION TECHNIQUE

Two Dimensional discretecosinetransform(DCT2) is applied for image compression. The quantization of these coefficientsis done using quantization table. After it to get the compressed image we have applied the inverse DCT (IDCT2) to the quantized image.

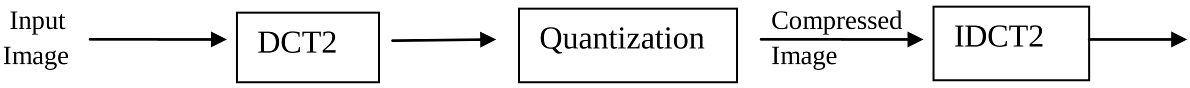

Figure 1. Block diagram of proposed technique

2.1 The Discrete Cosine Transform

The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. In DCT for a image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT[42]. For this reason, the DCT is often used in image compression applications. For example, the DCT is at the heart of the international standard lossy image compression algorithm known as JPEG. (The name comes from the working group that developed the standard: the Joint Photographic Experts Group.)

The important feature of the DCT is that it takes correlated input data and concentrates its energy in just the first few transform coefficients. If the input data consists of correlated quantities, then most of the *n* transform coefficients produced by the DCT are zeros or small numbers, and only a few are large (normally the first ones). The early coefficients contain the important (low-frequency) image information and the later coefficients contain the less-important (high-frequency) image information[2]. Compressing data with the DCT is therefore done by quantizing the coefficients. The small ones are quantized coarsely (possibly all the way to zero), and the large ones can be quantized finely to the nearest integer. After quantization, the coefficients (or variable-size codes assigned to the coefficients) are writtenon the compressed stream. Decompression is done by performing the inverse DCT on the quantized coefficients. This results in data items that are not identical to the original ones but are not much different.

The DCT is applied to small parts (data blocks) of the image. It is computed by applying the DCT in one dimension to each row of a data block, then to each column of the result. Because of the special way the DCT in two dimensions is computed, we say that it is separable in the two dimensions. Because it is applied to blocks of an image, we term it a "blocked transform."

The discrete cosine transform (DCT) helps separate the image into parts (or spectral sub-bands) of differing importance (with respect to the image's visual quality).

The DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain.

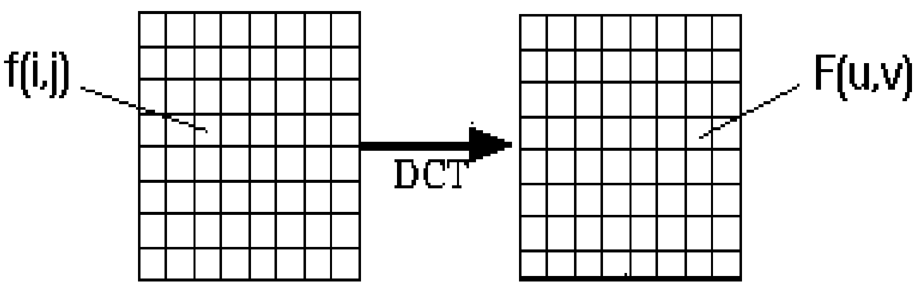

Figure 2. Discrete Cosine Transform

2.2 DCT Encoding

The general equation for a 1D (*N* data items) DCT is defined by the following equation:

$$F(u) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \Lambda(i).\cos\left[\frac{\pi u}{2.N}(2i+1)\right] f(i) \quad (1)$$

and the corresponding inverse 1D DCT transform is simple $F^{-1}(u)$, i.e.:

where $$\Lambda(i) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \varepsilon = 0 \\ 1 & \text{otherwise} \end{cases}$$

The general equation for a 2D (*N* by *M* image) DCT is defined by the following equation:

$$F(u,v) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \Lambda(i)\,\Lambda(j).\cos\left[\frac{\pi u}{2.N}(2i+1)\right] \cos\left[\frac{\pi v}{2.M}(2j+1)\right].f(i,j) \quad (2)$$

and the corresponding inverse 2D DCT transform is simple $F^{-1}(u,v)$, i.e.:

where$$\Lambda(\varepsilon) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \varepsilon = 0 \\ 1 & \text{otherwise} \end{cases}$$

The basic operation of the DCT is as follows:

a) The input image is N by M.

b) f(i,j) is the intensity of the pixel in row i and column j.

c) F(u,v) is the DCT coefficient in row k1 and column k2 of the DCT matrix.

d) For most images, much of the signal energy lies at low frequencies; these appear in the upper left corner of the DCT.

e) Compression is achieved since the lower right values represent higher frequencies, and are often small - small enough to be neglected with little visible distortion.

f) The DCT input is an 8 by 8 array of integers. This array contains each pixel's gray scale level.

g) 8 bit pixels have levels from 0 to 255.

h) Therefore an 8 point DCT would be:

where

$$\Lambda(\varepsilon) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \varepsilon = 0 \\ 1 & \text{otherwise} \end{cases}$$

i) The output array of DCT coefficients contains integers; these can range from -1024 to 1023.

j) It is computationally easier to implement and more efficient to regard the DCT as a set of basis functions which given a known input array size (8 x 8) can be precomputed and stored. This involves simply computing values for a convolution mask (8 x8 window) that get applied (sum m values x pixelthe window overlap with image apply window across all rows/columns of image). The values as simply calculated from the DCT formula. The 64 (8 x 8) DCT basis functions are illustrated in given below figure.

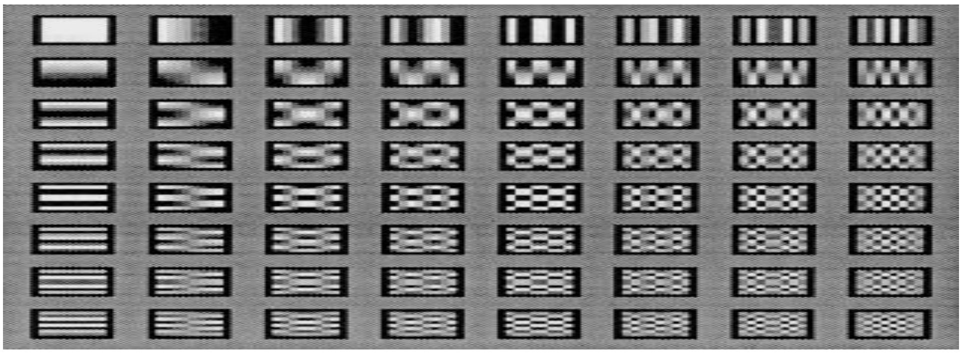

Figure 3. DCT basis functions

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3. RESULTS AND DISCUSSION

The mostly used parameters to estimate image compression algorithms are peak signal-to-noise ratio (PSNR) and compression ratio. In Eq. (4), the PSNR value (in decibels dB) is used to measure the difference between the compressed image ‘ o ’ and the original input image ‘ i ’. In general, for better image quality, the larger the PSNR value.

$$MSE = \left[\frac{1}{255} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \left[o(i,j) - i(i,j) \right]^2 \right] \quad (3)$$

$$PSNR = 10 \log_{10} \left[\frac{M \times N}{MSE} \right] \quad (4)$$

where $M \times N$ is the size of the image.

In order to test the efficiency of proposedtechnique, we have used the test images: “Lena”, “Peppers”, “Barbara”and “Baboon”. In it we have worked on the entire image without block processing. Therefore, the proposed algorithm performed well and provides blocking artifacts free compressed images. Figure 5 gives the visual results of proposed algorithm. Table 1 presented comparative results of various existing techniques and our proposed technique, which shows that proposed algorithm is superior in performance.Which depicts that proposed algorithm provide better PSNR. Another important advantage of proposed technique is, it required less execution time.Image compression with DCT2 performs better and tries to save the bandwidth.

(a) Lena (b) Peppers (c) Barbara (d) Baboon

Figure 4.Original Images

(a) Lena (b) Peppers (c) Barbara (d) Baboon

Figure 5.Compressed Images

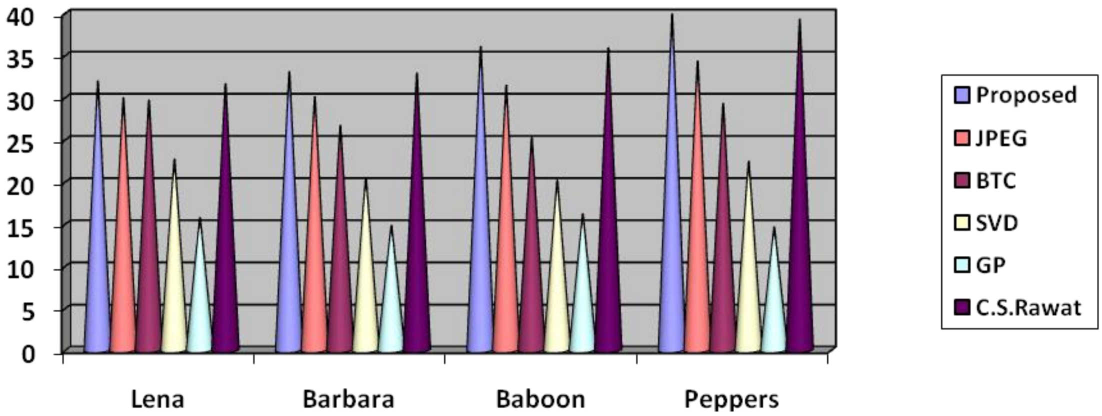

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Table 1. Comparison of proposed method with different methods

Images	PSNR (in dB)					
	JPEG	Block Truncation Coding (BTC)	Singular Value Decomposition (SVD)	Gaussian Pyramid (GP)	C.S.Rawat (14)	Proposed Method
Lena	29.8870	29.6116	22.6225	15.6656	31.5739	31.8649
Barbara	30.00	26.5894	20.4283	14.7322	32.7810	32.9752
Baboon	31.3421	25.1743	20.0996	16.1080	35.8160	35.9158
Peppers	34.2700	29.2346	22.3442	14.5351	39.2185	39.8585

4. CONCLUSIONS

In this paper, we have proposed an efficient technique for image compression using DCT2. The proposed technique efficiently compressed the images and found optimum PSNR. Many existing techniques produce the blocking artifactsAs we are not working on non-overlapped blocks or sub images in our proposed approach and here, artifacts were removed by working on the whole image not by blocks.We have worked with single block (of size 256x256) due to which another advantageis it required less execution time. From the simulation results, we have proved that the proposed technique is robust and efficient for compressing the images. The future scope will be implementation of other discrete fractional transform for image compression.

REFERENCES

[1] Annadurai S. and Sundaresan M., “Wavelet Based Color Image Compression using VectorQuantization and Morphology,” in Proceedings of the International Conference on Advances inComputing, Communication and Control, USA, pp. 391-396, 2009.

[2] Krikor L., Baba S., Arif T., and Shaaban Z., “Image Encryption using DCT and Stream Cipher,” European Journal of ScientificResearch, vol. 32, no. 1, pp. 48-58, 2009.

[3] Loussert A., Alfalou A., El-Sawda R., and Alkholidi A., “Enhanced System for Image'sCompression and Encryption by Addition of Biometric Characteristics,” International Journalof Software Engineering and its Applications, vol. 2, no. 2, pp. 111-118, 2008.

[4] Ames G., “Image Compression,” International Journal of Advancements in ComputingTechnology, vol. 1, no. 2, pp. 205-220, 2002.

[5] N. Ahmed, T. Natarajan and K.R. Rao, “Discrete cosine transform”, IEEE Trans. Comm., 90-93, 1974.

[6] K.R. Rao and P. Yip, “Discrete Cosine Transform: Algorithms Advantages and Applications”, Academic Press, New York, 1990.

[7] P.M. Fanelle and A.K. Jainn, “Recursive block coding: A new approach to transform coding”, IEEE Trans. Comm., pp. 161-179, 1986.

[8] M. Bosi and G. Davidson, " High quality low bit rate audio transform coding for transmission and multimedia applications”, Journal of audio Eng. Soc., pp. 43-50, 1992

[9] D. Solomaon, “Data Compression: The complete Reference”, Springer Verlag, Newyork, 2004.

[10] F. J. Macwilliams and N.J.A. Slone, “The Theory of Error Correcting Codes”, Elsevier, Amsterdam, 1977.

[11] Y. T. Chan, “Wavelet Basics”, Kluwer Academic Publishers, Norwell, MA, 1995.

[12] C.S. Rawat and S. Meher, “A Hybrid Image Compression Scheme using DCT and Fractal Image Compression”, the international Arab Journal of Information Technology, vol.10, no.6, Nov. 2013.

[13] N. Wiener, “Hermitian polynomials and Fourier analysis. J. Math. Phys., pp.70–73, 1929.

[14] E. U. Condon, “Immersion of the Fourier transform in a continuous group of functional transformations”, Proc. Nat. Acad. Sci. USA, pp.158–164, 1937.

[15] H. Kober and Wurzelnaus der Hankel, “Fourier- und aus an-derenstetigentransformationen”, Q. J. Math. Oxford Ser., pp. 45–49, 1939.

[16] B. Santhanam, J. H. McClellan, “The discrete rotational Fourier transform”, IEEE Trans. Signal Process, pp.94–998, 1996.

[17] A.W. Lohmann, "Image rotation, Wigner rotation and the fractional Fourier transform", J. Opt. Soc. Am, pp.2181–2186, 1993.

[18] V. Namias, "The fractional order Fourier transform and its application to quantum mechanics", J. Inst. Maths. Appl., pp. 241–265, 1980.

[19] L.B. Almeida, "The fractional Fourier transform and time frequency representations", In IEEE Trans. Signal Process., pp. 3084–3091, 1994.

[20] Vijaya, C., Bhat, J.S.: Signal compression using discrete fractional Fourier transform and set partitioning in hierarchical tree. Signal Process, pp. 1976–1983, 2006

[21] Tao, R., Deng, B., Wang, Y.: Research progress of the fractional Fourier transform in signal processing. Sci. China Ser. F Inf. Sci., pp. 1–25, 2006.

[22] Bracewell, R. N.: The Fourier Transform and Its Applications, 2nd Revised. McGraw Hill, New York , 1986.

[23] Abomhara, M., Zakaria, O., Khalifa, O.O.: An overview of video encryption techniques. Int. J. Comput. Theory Eng., pp. 103–110, 2010

[24] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd edition, 2008.

[25] D. Mendlovic, H.M. Ozaktas, "Fractional Fourier transforms and their optical implementation", I. J. Opt. Soc. Am. A, pp. 1875–1881, 1993.

[26] N. M. Atakishiyev, L. E. Vicent, K.B. Wolf, "Continuous vs. discrete fractional Fourier transforms", J. Comput. Appl. Math. 73–95 (1999) SIViP (2014) 8:1543–1553 1553

[27] S.I. Yetik, M.A. Kutay, M.H. Ozaktas, "Continuous and discrete fractional Fourier domain decomposition", In IEEE, pp. 93–96, 2000.

[28] M.H. Ozaktas, Z. Zalevsky, M.A. Kutay, "The Fractional Fourier Transform with Applications in Optics and Signal Processing", Wiley, New York, 2000.

[29] Pei, S.C., Yeh, M.H., "A novel Method for discrete fractional Fourier transform computation", ISCAS 2001, pp.585–588.

[30] Yeh, M.H., Pei, S.C.: A method for the discrete-time fractional Fourier transform computation. Signal Process, pp. 1663–1669, 2003.

[31] Pei, S.C., Yeh, M.H., Tseng, C.C., "Discrete fractional Fourier transform based on orthogonal projections", In: IEEE Trans. Signal Process., pp. 1335–1348, 1999

[32] Djurovic, I., Stancovic, S., Pitas, I., "Digital watermarking in the fractional Fourier transformation domain", J. Netw. Comput. Appl., pp. 167–173, 2001

[33] Rubio, J.G.V., Santhanam, B., "On the multiangle centered discrete fractional Fourier transform", In IEEE Signal Process. Lett., 2005.