ANALYSIS OF IMAGE COMPRESSION TECHNIQUE USING DISCRETE COSINE TRANSFORM HAVING DIFFERENT BLOCK SIZE

[1] AVANI PATEL, [2] RAHUL MISRA, [3] ABHISHEK CHOUDHARY

[1]M.Tech.[CSE] Student, Department Of Computer Science And Engineering, Bhagwant Univeristy, Ajmer
[2] M.Tech. [CSE] Student, Department Of Computer Science And Engineering, Bhagwant Univeristy, Ajmer
[3] Asst.Professor, Department Of Computer Science And Engineering, Bhagwant Univeristy, Ajmer

avanipatel46@gmail.com, misra.rrahul@gmail.com, abhishek02mar@gmail.com

ABSTRACT: *Image compression is the application of data compression on digital images. Image compression is the technique through which we can reduce amount of data required to represent a digital image It is also used for reducing the redundancy that is nothing but avoiding the duplicate data, which will helpful to increase storage and transmission process's performance. In image compression, we do not only concentrate on reducing size but also concentrate on doing it without losing quality and information of image. In this paper Discrete Cosine Transform technique is simulated. We apply Discrete Cosine Transform technique using different block size on various kinds of images. The results are shown and analyze different quality parameters.*

Keywords— Discrete Cosine Transform, Image compression, Image processing

I: INTRODUCTION

Many applications need large number of images which can be stored on disk for solving problems. This storing space of image is important, because less memory space means less time required processing the image. Hence image compression [1] is need that reduces the amount of data required to represent a digital image. Image compression is the process of encoding an image to reduce the number of bytes required to store or transmit the image.

Image compression system requires two components: a. Encoding System that converts original image into compressed image and b. Decoding System that converts compressed image into digital image which is more identical to original image.

Image compression, consist of three main steps: Transform, quantizing and coding, as illustrated in fig.1.

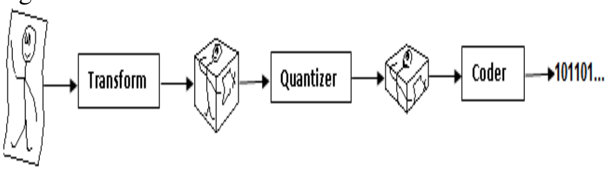


Fig1. The three steps of digital image compression system

Image compression consists of two transform techniques which are based on frequency. First is Discrete Cosine Transform (DCT) and second is Discrete Wavelet Transform (DWT). Both techniques have its' own pros and cons. DWT gives better compression ratio [1,2] without losing more information of image but it need more processing power. While DCT is fast, it can be quickly calculated but it has blocks artifacts means loss of some information. Our main goal is to analyze DCT technique using different block size and comparing its results.

II: DCT TECHNIQUE

DCT is widely used in image processing, especially for compression algorithm for encoding and decoding in DCT technique is shown below.

1) Compression(Encode) Process:

To compress the image following DCT steps are applied

- Take an image and divide into N*N blocks of pixels, where N is usually multiple of 2
- Working from left to right, top to bottom, the DCT is applied to each block.
- Each block's elements are compressed through quantization.
- The array of compressed blocks that constitute the image is stored in a drastically reduced amount of space.

So first the whole image is divided into small N*N blocks then DCT is applied on these blocks and DCT coefficients are generated. The DCT coefficients are all real numbers. The DC relocates the highest energies to the upper left corner of the image. The lesser energy or information is relocated into other areas. After that for reducing the storage space DCT coefficients [4] are quantized through dividing by some value or by quantization matrix & large value is become small one, need small size of space, is called lossy step. So selection of quantization value or quantization matrix [9] is affecting the entropy and compression ratio. If we take small value for quantization then we get less MSE (Mean Square Error), less compression ratio & better quality .Higher the block size higher the compression ratio but with loss of more information and quality. This way block size affects the information & quality.

2) Equation:

The most common DCT definition of 1-D sequence of length N is:

$$Y[k] = C[k]\sum_{N=0}^{N=1} X[n]\cos\left[\frac{(2n+1)k\pi}{2N}\right] \quad (1)$$

For k= 0, 1, 2… N– 1. Similarly, the inverse DCT transformation is defined as:

$$X[n] = \sum_{k=0}^{N=1} C[k]Y[k]\cos[\frac{(2n+1)k\pi}{2n}] \quad (2)$$

For k = For k= 0,1,2,…,N– 1 . In both equations (1) and (2) C[n] is defined as:

$$C[n] = \left[\begin{array}{l} \sqrt{\frac{1}{n}} \; for n = 0 \\ \hline \sqrt{\frac{2}{n}} \; for n = 1,2,.., N-1 \end{array}\right] \quad (3)$$

The 2-D DCT is a direct extension of the 1-D case and is given by:

$$y[j,k] = C[j]C[k]\sum_{m=0}^{N=1}\sum_{n=1}^{N=1} x[m,n]\cos\left[\frac{(2m+1)j\pi}{2N}\right]\cos\left[\frac{(2n+1)k\pi}{2N}\right] \quad (4)$$

Where: j, k = 0, 1, 2,… ,N −1 and. The inverse transform is defined as:

$$x[m,n] = \sum_{j=0}^{N=1}\sum_{k=1}^{N=1} x[m,n]\cos\left[\frac{(2m+1)j\pi}{2N}\right]\cos\left[\frac{(2n+1)k\pi}{2N}\right] \quad (5)$$

Where: m, n = 0, 1, 2,…., N −1. And c[n] is as it is as in 1-D transformation.

3) Decompression(Decode) Process:

To Decompress (Decode) the image means reverse process of encoding, to get identical to original image from compressed image. After loading compressed image from the disk, Image is broken into N*N blocks of pixels. Then each block is de-quantized by applying exactly reverse process of quantization. Apply inverse DCT on each block & combine these blocks into an image which is identical to the original image.

In this decompression process, we have to keep N's value same as it used in encoding process. De-quantization process is done by multiplying with quantization value or quantization matrix. Output of compressed image is not 100% identical of original image but it is same as original image. Efficiency of this process is measured by compression ratio, defined by ratio of storage bits of original image and storage bits of compressed image.

$$Cr = \frac{n1}{n2} \quad (6)$$

Where n1= number of bits required to store original image, n2= number of bits required to store compressed image.

Mean square Error (MSE) [1, 4] is defined as loss of information between reconstructed image and original image. If MSE of reconstructed image to original image is greater than the information lost is more.

$$MSE = \sum_{i=1}^{M}\sum_{j=1}^{N} (x(i, j) - x'(i, j)) \quad (7)$$

Where M, N is dimension of image x(i, j) is pixel value of (i,j) coordinate of original image while x'(i,j) is the reconstructed image's pixel value.

III. SIMULATION RESULT

Here, we implement DCT encoding and decoding algorithms in MATLAB. We take 1x1, 2x2, 4x4, 8x8, 16x16, 32x32, 64x64,128x128 block size and apply encoding and decoding algorithms and get resulted image and we also get different quality parameters like MSE [1,4]. We apply it on two images. Results are shown below. We can see the quality

Original Image

Block-Size = 1

Block-Size = 2

Block-Size = 4

Block-Size = 8

Block-Size = 16

Block-Size = 32

Block-Size = 64

Block-Size = 128

Fig 2. Reconstructed Images (Baby) after applying different block size DCT transform

In fig 2. We can see that block size 1, 2, 4, 8's images have more block artifacts. While in block size 64 and 128 there are blurred image. But, in block size 16 and 32 there are no block artifacts and also not blurred. The quality parameter of these various images is shown below table.

Table 1. MSE of reconstructed images (Baby)

BLOCK SIZE	MSE(BABY)
1	94958580
2	47378842
4	26290148
8	17012605
16	12711397
32	11250789
64	10590005
128	12703074

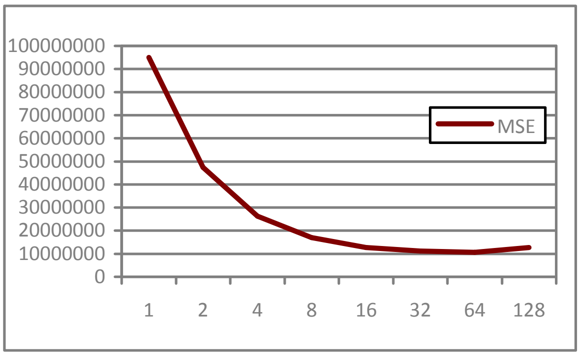


Fig 3. Graph for MSE of Reconstructed image (Baby)

In graph we can see that there are least MSE in Block size 16 and 32. And in block size 1, 2, 4, 64, 128 there are highest MSE. So it is better to use 16 or 32 block size for transformation.

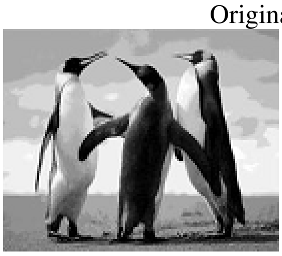
Table 2. No of bits to represents a pixel value and its compression ratio

BLOCK SIZE	NO OF BITS TO REPRESENT A PIXEL VALUES	COMPRESSION RATIO
1	4	8/4=2.0
2	4	8/4=2.0
4	5	8/5=1.6
8	5	8/5=1.6
16	5	8/5=1.6
32	6	8/6=1.33
64	6	8/6=1.33
128	7	8/7=1.14

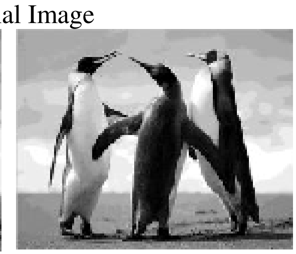
In table 2 we can say that in block size 1, 2, 4, 8 we can get better compression ration because it need small size (No. of bits) value for represent gray level of particular pixel. But there are more MSE so quality is decreased. So choosing block size is important.

There are also shown one another example

Original Image



Block-Size = 1



Block-Size = 2

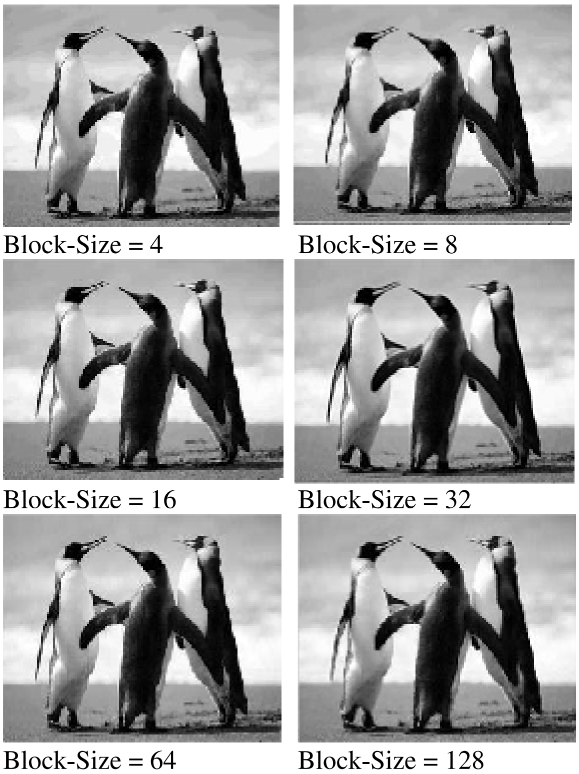


Fig 4. Reconstructed Images (Penguins) after applying different block size DCT transform

Table 3. MSE of reconstructed images (Penguins)

BLOCK SIZE	MSE(PENGUINS)
1	38116883
2	24183375
4	18107267
8	15368164
16	14611625
32	14983792
64	16042347
128	18425994

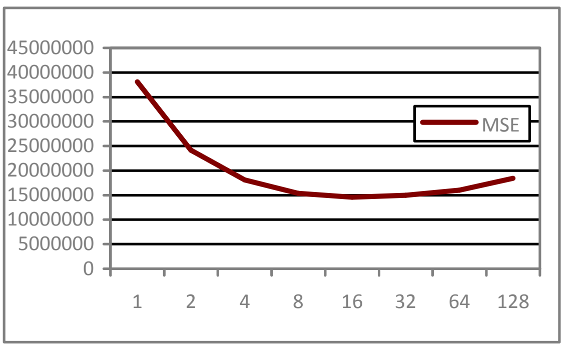


Fig 5.Graph for MSE of Reconstructed image (Penguins)

VI: CONCLUSION

Experiments' results shows that block affect the parameters like compression ratio, Mean Square Error. We can conclude that block size is small we can get better compression ratio. As the block size increase compression ratio is decrease. While Block artifacts in lower (1, 2, and 4) size and higher size (64, 128) are maximum and in medium size (16, 32), there are minimum block artifacts. In higher block size there are very much block artifacts and images are blurred. So it is beneficial to use 16 or 32 block size to achieve high compression.

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