A Novel Approach of Conventional Image Compression on Color Images and Transform based Technique using Discrete Cosine Transform

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Abstract— Image compression is a most popular application of data compression on digital images. This compression is reducing the size in bytes of an image without corrupting the quality of the image. The minimization in file size allows more images to be stored in a given amount of disk or memory space. There are numerous different ways are existing for image compression. This paper concerned with the lossy compression techniques implemented for RGB Images, where data loss cannot affect the image quality and the clarity also will not be decreased with presenting the additional procedure for compressing methods. This compression technique is very popular. DCT Image Compression is very easy one for Greyscale images, while compressing the Colour image it is hard to implement. However, this RGB image compression has been implemented successfully. After compression the file size is reduced more and image quality is nearly the same. This analysis of compression techniques addresses the problem of minimizing the amount of data required to represent a digital image. It is also used for eliminating the redundancy that is avoiding the duplicate data. It also reduces the storage space to load an image. The main objectives of this paper are reducing the image storage space without corrupting the visual quality, Easy maintenance and providing security. The proposed Discrete Cosign Transform techniques efficiently work with RGB image which is compressed up to 90%, 80% 70%, 60%, 40% and 20% and optimum results are obtained. The analysis of obtained results has been carried out with the help of MSE (mean square error) and PSNR (peak signal to noise ratio). This compression method is entirely developed by using only basic MATLAB functions.

Key words: Lossy Compression, DCT, Redundancy, Storage Space, PSNR, MSE

I. INTRODUCTION

In the framework of image processing, Data compression refers to the process of reducing the total amount of data which compressed data has been stored in a given storage space and also aimed to reduce the transmission rate of images, while maintaining a good quality level of visualization. Now days there are many applications requiring image compression, such as remote sensing, networking, multimedia, internet, satellite imaging, and perpetuation of art work, those are all sharing and storing the image data professionally that makes a great challenge among the peoples while transmitting and storing millions of images for every instant. Therefore, the demands of image compression techniques are yet very high. For this purpose, the researchers around the world are trying to innovate such a compression mechanism. The main frame of compression standard, which is based on the Discrete Cosine Transform and it is also adequate for most compression applications. The discrete cosine transform (DCT) is a mathematical spatial domain to the frequency domain.

Compressing an image is significantly different than compressing raw binary data. Of course, broad-spectrum of Compression programs be able to be used to compress images, but the result is less than optimal. Compression is achieved by the elimination of one or more of the three basic data redundancies in the data.

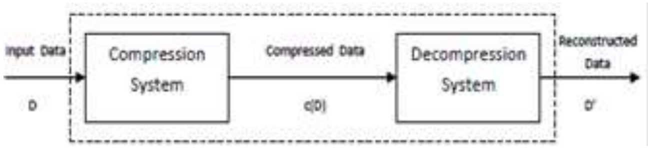


Fig. 1: Image compressing system flow diagram

A. Procedures for Image Compression

The following general steps involved in compressing an image are,

- Specifying the Rate (bits available) and Distortion (tolerable error) parameters for the target image.
- Dividing the image data into various classes, based on their importance.
- Dividing the available bit budget among these classes, such that the distortion is a minimum.
- Quantize each class separately using the bit allocation information derived in step 3.
- Encode each class separately using an entropy coder and write to the file [4].

B. Types of Compression

Compression can be divided into two categories, as Lossless and Lossy compression.

1) Lossless Compression:

Data is compressed and can be reconstituted (uncompressed) without loss of detail or information. These are referred to as bit-preserving or reversible compression systems also lossless compression frequently involves some form of entropy encoding and are based in information theoretic techniques. With lossless compression, every single bit of data that was originally in the file remains after the file is uncompressed. All of the information is completely restored [11] [12].

2) Lossy:

The aim is to obtain the best possible fidelity for a given bit-rate or minimizing the bit-rate to achieve a given fidelity measure. Video and audio compression techniques are most suited to this form of compression. If an image is compressed it clearly needs to uncompressed (decoded) before it can viewed/listened to. Some processing of data may be possible in encoded form however. Lossy compression use source encoding techniques that may involve transform encoding, differential encoding or vector quantisation [10].

- Transorm coding (FT/DCT/Wavelets)
- Predictive coding

II. Literature Review

This paper shows previous related work done with this vivek Arya#1, Dr. Priti Singh*2, Karamjit Sekhon#3 presented this paper In Volume4Issue4- April 2013 at International Journal of Engineering Trends and Technology (IJETT).

In this paper, the original image was compressed with two dimensional discrete cosine transform (DCT) and the original image is compared with reconstructed image with respect to MSE and PSNR. The algorithm can be used to compress the image that is used in the web applications and where we need different percentage of compression as it need less processing time.

III. Methodology

The discrete cosine transform (DCT) is a mathematical function that transforms digital image data from the spatial to the frequency domain. For an M x N image, the spatial domain represents the colour value of each pixel which is divided into 8X8 pixel blocks. A DCT based method is specified for "lossy'' compression.

1) Capture an image and break up it up into 8-pixel by 8-pixel blocks. If the image cannot be divided into 8-by-8 blocks, then add in empty pixels around the edges, essentially zero-padding the image.
2) For each 8-by-8 block, get image data which contains values to represent the colour at each pixel.
3) Acquire the Discrete Cosine Transform (DCT) of each 8-by-8 block.

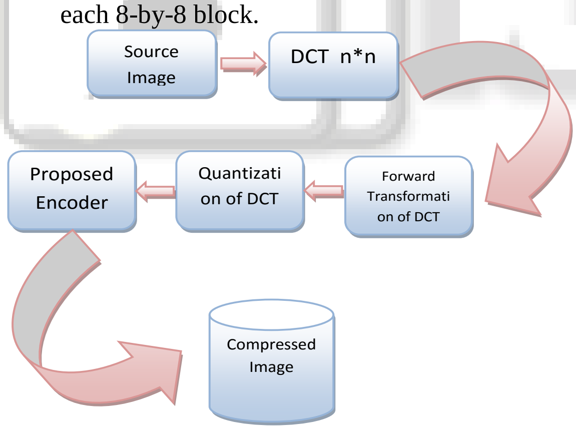


Fig. 2: Block diagram of Image compression

4) After captivating the DCT of a block, matrix multiply the block by a mask that will zero out certain values from the DCT matrix.
5) as a final point, to get the data for the compressed image, take the inverse DCT of each block. All these blocks are combined back into an image of the same size as the original.

IV. Lossy Compression Techniques

On the other hand, lossy compression minimizes the files by permanently eliminating certain information, particularly redundant information. When the file is uncompressed, only a part of the original information is still there (although the user may not notice it). Lossy compression is generally used for video and audio processing, where a certain amount of information loss will not be detected by most users. Using compression techniques, the creator can decide how much loss to introduce and make a trade-off between file size and image quality. Lossy methods deliver higher compression ratios, but sacrifice the ability reproduces the original, uncompressed pixel for pixel.

JPEG is the best known lossy compression standard and widely used to compress still images stored on compact disc. It is considerably more complicated than RLE, but it produces correspondingly higher compression ratios – even for images containing little or no redundancy. Except where every piece of information of a scan is critical – for example, scientific data – a scan must only provide enough information to meet the needs of the reproduction process and the viewer.

- Transformation Coding
- Vector Quantization
- Fractal Coding
- Block Truncation Coding
- Sub-band Coding

A. *Benefits of Lossy Compression Techniques*

The advantage of lossy methods over lossless methods is that in some cases a lossy method can produce a much smaller compressed file than any known lossless method, while still meeting the requirements of the application. Lossy methods are most often used for compressing sound, images or videos. The compression ratio (that is, the size of the compressed file compared to that of the uncompressed file) of lossy video codec's are nearly always far superior to those of the audio and still-image equivalents. Audio can often be compressed at 10:1 with imperceptible loss of quality, video can be compressed immensely (e.g. 300:1) with little visible quality loss. Lossy compressed still images are often compressed to 1/10th their original size, as with audio, but the quality loss is more noticeable, especially on closer inspection. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate. The lossy compression that produces imperceptible differences can be called visually lossless [8].

V. Color Image Compression Using DCT

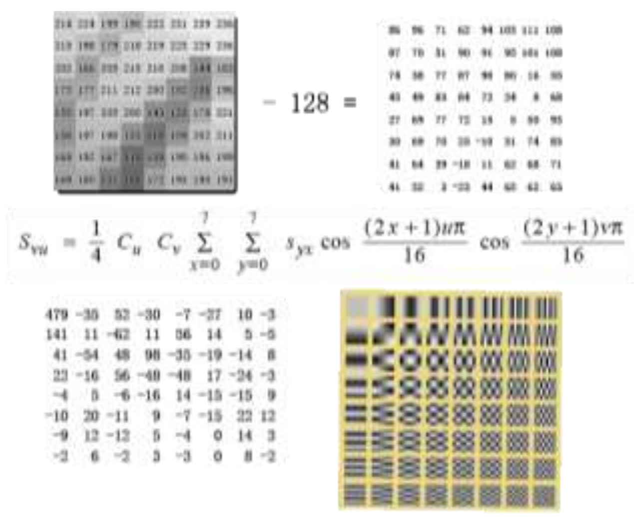


Fig. 3: DCT Result

Image processing extensively use DCT, particularly for compression. While still image compression and compression of individual video frames are performed by some applications of two-dimensional DCT, compression of video streams is the most common application of DCT. We use DCT to compress the image in our proposed method. This is performed by employing DCT to each non-overlapping block of the image.

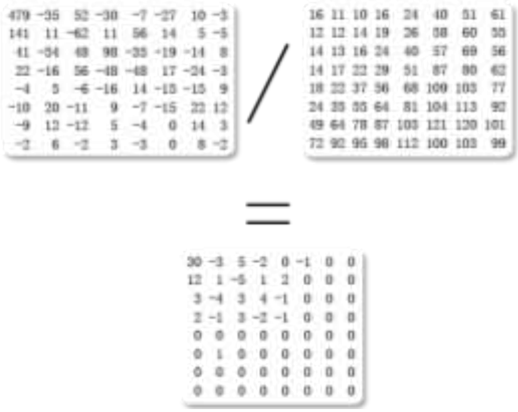
A. Transformer

It transforms the input data into a format to reduce inter pixel redundancies in the input image. Transform coding techniques use a reversible, linear mathematical transform to map the pixel values onto a set of coefficients, which are then quantized and encoded.

B. Quantization

Based on the two techniques, quantizing the image's DCT coefficients and entropy coding the quantized coefficients, DCT-based image compression minimizes the data required to represent an image. Quantization process minimizes the number of bits required to represent a quantity by minimizing the number of possible values of the quantity. A range of values are compressed to a single quantum value to achieve quantization. The stream becomes more compressible as the number of discrete symbols in a specified stream is reduced. Transformation is performed by using a quantization matrix in combination with a DCT coefficient matrix. According to the quantization matrix, the DCT coefficients are normalized by different scales, for high compression [6].

The transformed image matrix is divided by the employed quantization matrix to achieve quantization. Then the values of the resultant matrix are rounded off. The coefficients located near the upper left corner in the resultant matrix have lower frequencies. Human eye is more sensitive to lower frequencies. So, higher frequencies are eliminated and the image is reconstructed by using the lower frequencies.



479	−35	52	−30	−7	−27	10	−3
141	11	−62	11	56	14	5	−5
41	−54	48	98	−35	−19	−14	8
22	−16	56	−48	−48	17	−24	−3
−4	5	−6	−16	14	−15	−15	9
−10	20	−11	9	−7	−15	22	12
−9	12	−12	5	−4	0	14	3
−2	6	−2	3	−3	0	8	−2

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16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

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30	−3	5	−2	0	−1	0	0
12	1	−5	1	2	0	0	0
3	−4	3	4	−1	0	0	0
2	−1	3	−2	−1	0	0	0
0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Fig. 4: Quantization result

C. Entropy Coding

DCT based image compression using blocks of size 8x8 is considered. After this, the quantization of DCT coefficients of image blocks is carried out. The new approach of entropy encoding is then applied to the quantized DCT coefficients. The efficiency of the proposed encoder is analyzed and compared with that obtained after applying Run length coding method.

D. Error Metrics

Two of the error metrics used to compare the various image compression techniques are Mean Square Error (MSE) and Peak 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. , if find a compression scheme having a lower MSE (and a high PSNR), then could be recognize that it is a better one.

The mathematical formulae for the two are

$$MSE = \frac{1}{MN} \sum_{y=1}^{M} \sum_{x=1}^{N} [I(x,y) - I'(x,y)]^2$$

$$PSNR = 20 * \log10 (255 / \text{sqrt}(MSE))$$

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.

VI. EXPERIMENTAL RESULTS

In this section, we demonstrate the effectiveness of the Proposed color image compression by means of the results obtained from the experimentation, proposed method was implemented by DCT in MATLAB environment. The proposed system has been evaluated using color images. The tested images was determined by measuring the PSNR, MSE and RMSE values and the compression efficiency and ratio, sample output obtained from the proposed method as follows:

Fig. 1: Original Image

Fig. 2: Compressed Image by 20%

Fig. 3: Original Image

Fig 4: Compressed Image by 35%

Fig. 5: Original Image

Fig. 6: Compressed Image by 50%

The following table.1 shows the test reports in the image compression using DCT. Figure 5 shows the Performance comparison between the Tested Image with different coefficients.

Tested Images	original image Size in KB	Compressed image size in KB	Space saving %
Baby	357KB	132 KB	225KB
Cat	658 KB	354 KB	304KB
Peacock	2510 KB	1600 KB	910KB
Beach	949 KB	660 KB	289KB
Tomato	487 KB	131 KB	356KB
Parrot	1550 KB	568 KB	982KB
Capcicum	1480 KB	935 KB	545KB

Table 1: Test reports of compression on Tested Images

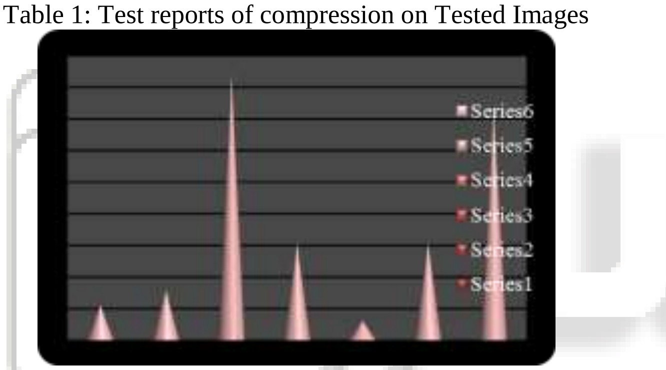
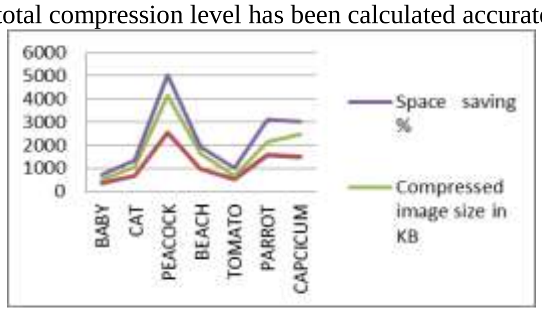


Fig. 7: Performance comparison between the Tested Image

The results of compression of seven images as listed in Table-1which shows the compression quality in percentage and also measures the PSNR, MSE, and RMSE. Finally the correlation coefficient also find out along with the Mean Absolute Error. Table 2 shows the average compression ratio from original image to compressed image. The total compression level has been calculated accurately.



The above chart shows the efficient comparison between the Original image and Compressed Image. In final the space saving has been calculated and drawn in chart.

TESTED IMAGES	Compression Quality in %	PSNR	MSE	RMSE	CORRELATION COEFFICIENT	MEAN ABSOLUTE ERROR
BABY	20	84.50304	0.0007	0.0264	5558347.962	0.02469
CAT	35	83.67611	0.00084	0.02904	7967034.736	0.03805
PEACOCK	40	81.33096	0.00145	0.03804	42278523.7	0.04888
BEACH	25	78.27422	0.00293	0.05409	15444248.86	0.06093
TOMATO	45	98.16994	0.0000	0.00547	3147060.769	0.00729
PARROT	30	81.75569	0.00131	0.03623	15469752.09	0.04268
CAPCICUM	50	88.37181	0.00029	0.01691	36977927.82	0.02126

Table 2: Average compression Ratio (Size in KB)

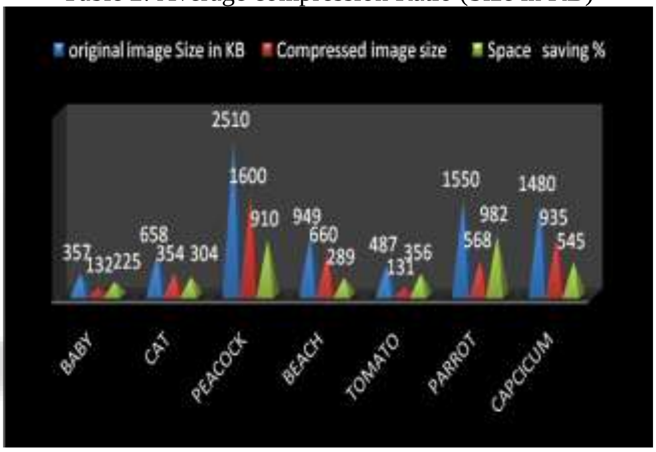


Fig. 8: Compression Level measurement diagram

VII. Conclusion & Future Scope

This Research work is successfully performed and implemented with the color image compression using DCT. This compression system is entirely proposed by using MATLAB software. In this paper, the color image compressed by own choice in percentage wise (20%, 45%, 60% etc). The Original image is compared with the compressed image with the value of MSE and PSNR. This compression algorithm provides an enhanced quality picture as that are increasing percentage of compression.

Additionally, the future work will analyse different types of compression algorithms & techniques for progress of best result along with the compression ratios. The techniques also can be extended for video & audio compression.

Reference

[1] A.B.Watson,“ Image Compression using the DCT”, Mathematica Journal, 1995,pp.81-88.

[2] Vivek Arya, Dr. Priti Singh, Karamjit Sekhon, “RGB Image Compression Using Two Dimensional Discrete Cosine Transform” International Journal of Engineering

Trends and Technology (IJETT) - Volume4Issue4-April 2013
[3] N. Ahmed, T. Natarajan, and K. R. Rao, " Discrete Cosine Transform", IEEE Trans. Computers, 90-93, Jan 1974.
[4] Monika Rathee, Alka Vij "Review of Image compression Techniques Based on Orthogonal Transforms". International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3, Issue 4, July 2014
[5] Mr. T. Sreenivasulu reddy, Ms. K. Ramani, Dr. S. Varadarajan, Dr. B.C.Jinaga "Image compression using transform coding methods" , International journal of Computer science and network security, vol.7 no.7, July 2007.
[6] Bovik Z. and Alan C., "A Universal Image Quality index," IEEE Signal Processing Letters, vol. 9, no. 3, pp. 81-84, 2002.
[7] Chaur-Chin Chen, "On the selection of image compression algorithms," 14th International conference on pattern recognition (ICPR'98) - Volume 2, 1998.
[8] Anilkumar Katharotiya, Swati Patel1 Mahesh Goyani, "Comparative Analysis between DCT & DWT Techniques of Image Compression" Journal of Information Engineering and Applications Vol 1, No.2, 2011.
[9] K. R. Rao and P. Yip, Discrete Cosine Transform. New York: Academic, 1990.
[10] Nageswara Rao Thota , Srinivasa Kumar Devireddy Image Compression Using Discrete Cosine Transform Georgian Electronic Scientific Journal: Computer Science and Telecommunications 2008|No.3(17)
[11] Lina J. Karam, "Handbook of image and video processing" Second Edition, 2005, Pages 643-660
[12] M. H. El Ayadi M. M. Syiam A. A. Gamgoum" A Comparative study of lossless image compression technique" IJICIS, Vol. 5,
[13] Amhamed saffor, Abdul Rahman Ramli, Kwan-Hoong Ng, "A Comparative study of Image Compression between JPEG and WAVELET". Malaysian journal of computer science, vol. 14 no. 1, June 2001, Pages.39-45.