An Advance Approach to Compress Binary and Color image using Discrete Cosine Transform (DCT) and Analysis of Gamma Factor on Images

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Abstract- Image compression is one of the basic problems in the field of image transmission through internet and to store in digital form on computers. There are lot of technique for compressing an image and we have to compress in such a way that all the precious data must be preserved with good quality that why it become very tedious task to compress an image. We implemented hybrid algorithm using Huffman coding to achieve the desire result. Our main aim is to get peak signal to noise ratio, mean square error, compression ratio and CPU processing time for DCT and IDCT. This work can be extended for the detection of Double JPEG compression. DOUBLE Joint Photographic experts group (JPEG) compression means that a JPEG image will be compressed once again by JPEG compression. The detection of double JPEG compression is of great significance in digital forensics.

Keywords – Compression, DCT, MSE, peak signal to noise ratio, scaling factor, spatial domain

I. INTRODUCTION

Image compression, the art and science of reducing the amount of data required to represent an image, is one of the most useful and commercially successful technology in the field of digital image processing. The number of images that are compressed and decompressed daily is staggering. Web page images and high resolution digital camera photos also are compressed routinely to save storage space and reduce transmission time. Compression of digital images with the help of discrete cosine transform (DCT).Several encoding technique have also been used together with DCT to improve the performance of compression. Image may be defined as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of f(x, y) at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y and the amplitude values of f are all finite, discrete quantities, we call the image a digital image. Images as Matrices:
The coordinate system leads to the following representation of a digitized image function:

$$f(x, y)= \begin{matrix} f(0,0) & f(0,1)\ldots\ldots\ldots\ldots\ldots\ldots & f(0,N-1) \\ f(1,0) & f(1,1)\ldots\ldots\ldots\ldots\ldots\ldots & f(1,N-1) \\ f(M-1,0) & f(M-1,1)\ldots\ldots\ldots\ldots & f(M-1,N-1) \end{matrix}$$

Each element of this array is called an image element, pixel, picture element or pel. A 1*N matrix is called a row vector and M*1 matrix is called a column vector. A 1*1 matrix is called a scalar.

II. BACKGROUND

Image compression is very important for efficient transmission and storage of images. Demand for communication of multimedia data through the telecommunications network and accessing the multimedia data through Internet is growing explosively. With the use of digital cameras, requirements for storage, manipulation, and transfer of digital images has grown explosively. A gray scale image that is 256 x 256 pixels has 65, 536 elements to store, and a typical 640 × 480 color image has nearly a million. Image compression standards bring about many benefits, such as:

(1) Easier exchange of image files between different devices and applications in small time.
(2) Reuse of existing hardware and software for a wider array of products.
(3) Existence of benchmarks and reference data sets for new and alternative developments.
(4) Bandwidth requirement for image transmission also decreases considerably with the increase in compression.

III. DESCRIPTION OF SYSTEM DESIGN AND METHODOLOGY

Predictive coding such as Delta Predictive Code Modulation and Adaptive Delta Predictive Code Modulation were popular for image compression. . In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well known transform and then codes the transformed values (coefficients). This method provides greater data compression compared to predictive methods. DCT algorithms are capable of achieving a high degree of compression with only minimal loss of data. After the DCT coefficient reduction lossless encoding results a higher compression ratio in JPEG as it was not possible with Predictive coding. DCT based image compression technique with Huffman.

As shown on fig 1 Firstly we divide the image into blocks. At this step we also specify the size of block. Then each block of image are subjected to discrete cosine transform. After that each transformed block of image is divided by standard JPEG table, we can set the coefficient of quantization table by scaling factor. At Final step we applied Huffman Encoding over the quantized coefficient. After processing of all blocks algorithm will stop.

Spatial domain versus Transform domain compression: Predictive coding is a spatial domain technique. In predictive coding, information already sent or available is used to predict future values, and the difference is coded. Transform coding, on the other hand, first transforms the image from its spatial domain representation to a different type of representation using some well-known transform and then codes the transformed values (coefficients).

Image Compression Model: First we apply original image then following procedure carried out and finally got compressed image and decoder is its inverse procedure only. In decoder we apply compressed image then inverse transform followed by de quantization and finally lossless entropy decoding.

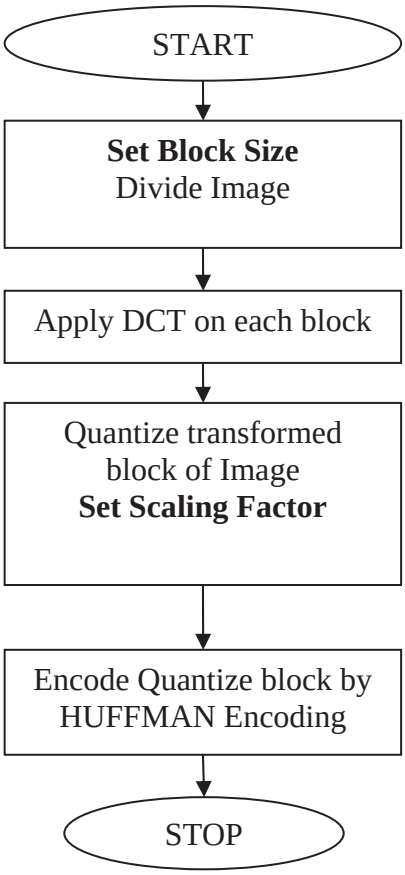

Fig.1 Flow Chart for DCT Image compression with Huffman Encoding

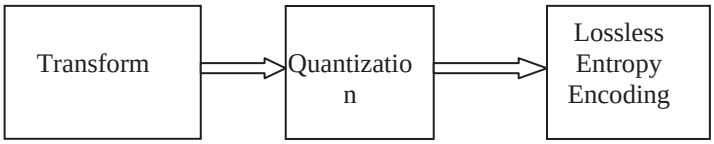

Fig.2 Encoder for Image compression

Discrete Cosine Transform: Discrete Cosine Transform (DCT) is a Fourier-related transform similar to the Discrete Fourier Transform (DFT), but using only real numbers. It transforms a signal or image from the spatial domain to the frequency domain DCT is a mechanism used in the JPEG compression algorithm to transform successive 8×8-pixel blocks of the image from spatial domain to 64 DCT coefficients in each frequency domain. The discrete cosine transform of a list of n real numbers p(x, y), is given by

$$D(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} P(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right] \quad (3.1)$$

$$C(u) = \begin{cases} \frac{1}{\sqrt{2}} & \text{if } u = 0 \\ 1 & \text{if } u > 0 \end{cases}$$

$$D(i,j) = \frac{1}{\sqrt{2N}} C(i)C(j) \sum_{x=0}^{7} \sum_{y=0}^{7} P(x,y) \cos\left[\frac{(2x+1)i\pi}{2N}\right] \cos\left[\frac{(2y+1)j\pi}{2N}\right] \quad (3.3)$$

P (x,y) is the x, y^{th} element of the image represented by the matrix P. N is the size of the block. The equation calculates one entry (i,jth) of the transformed image from the pixel values of the original image matrix.
Consider the example of 8*8 sub image.

$$\begin{pmatrix} 52 & 55 & 61 & 66 & 70 & 61 & 64 & 73 \\ 63 & 59 & 55 & 90 & 109 & 85 & 69 & 72 \\ 62 & 59 & 68 & 113 & 144 & 104 & 66 & 73 \\ 63 & 58 & 71 & 122 & 154 & 106 & 70 & 69 \\ 67 & 61 & 68 & 104 & 126 & 88 & 68 & 70 \\ 79 & 65 & 60 & 70 & 77 & 68 & 58 & 75 \\ 85 & 71 & 64 & 59 & 55 & 61 & 65 & 83 \\ 87 & 79 & 69 & 68 & 65 & 76 & 78 & 94 \end{pmatrix}$$

After the subtraction of 128 from greay levels is presented below:

$$\begin{pmatrix} -76 & -73 & -67 & -62 & -58 & -67 & -64 & -55 \\ -65 & -69 & -73 & -38 & -19 & -43 & -59 & -56 \\ -66 & -69 & -60 & -15 & 16 & -24 & -62 & -55 \\ -65 & -70 & -57 & -6 & -26 & -22 & -58 & -59 \\ -61 & -67 & -60 & -24 & -2 & -40 & -60 & -58 \\ -49 & -63 & -68 & -58 & -51 & -60 & -70 & -53 \\ -43 & -57 & -64 & -69 & -73 & -67 & -63 & -45 \\ -41 & -49 & -59 & -60 & -63 & -52 & -50 & 34 \end{pmatrix}$$

The next step is to take the two-dimensional DCT, which is given by:

$$\begin{pmatrix} -415 & -30 & -61 & 27 & 56 & -20 & -2 & 0 \\ 4 & -22 & -61 & 10 & 13 & -7 & -9 & 5 \\ -47 & 7 & 77 & -25 & -29 & 10 & 5 & -6 \\ -49 & 12 & 34 & -15 & -10 & 6 & 2 & 2 \\ 12 & -7 & -13 & -4 & -2 & 2 & -3 & 3 \\ -8 & 3 & 2 & -6 & -2 & 1 & 4 & 2 \\ -1 & 0 & 0 & -2 & -1 & -3 & 4 & 1 \\ 0 & 0 & -1 & -4 & -1 & 0 & 1 & 2 \end{pmatrix}$$

The large value of the top-left corner represent DC coefficient. The remaining 63 coefficients are called the AC coefficients. The advantage of the DCT is its tendency to aggregate most of the signal in one corner of the result, as may be seen above.

PSNR (Peak Signal to Noise Ratio)

$$PSNR = 10\log_{10} \frac{255^2}{MSE}$$

Mean Square Error (MSE)

$$MSE = (1/M \times N)\sum_{i=1}^{M}\sum_{j=1}^{N}(a_{ij} - b_{ij})^2$$

Where MSE is the mean squared difference between the compressed and original images.

Compression Ratio: If n1 and n2 denote the number of information carrying units in original and compressed image respectively, then the compression ratio CR can be defined as

CR=(n1/n2);

IV. RESULT

We have presented the relationship between the compression ratio and the scaling factor of quantization tables. The default quantization table which is mostly employed for DCT based image compression is defined as

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

Now we are listing our result in which according to quality we receive different DCT CPU processing time compression ratio, inverse DCT CPU time and peak signal to noise ratio. And after that gamma correction result of different images are list and after that region growing result of JPEG image will be listed.

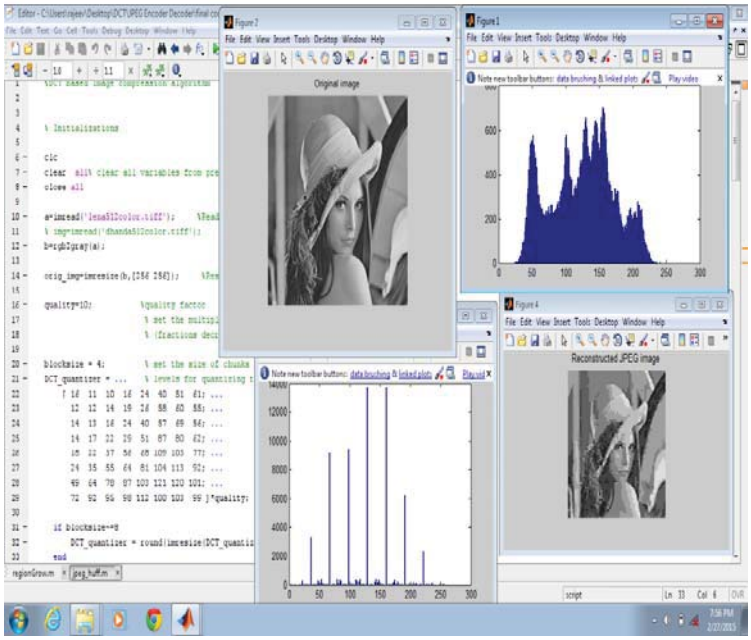

Fig.3 JPEG image compression with quality factor 10

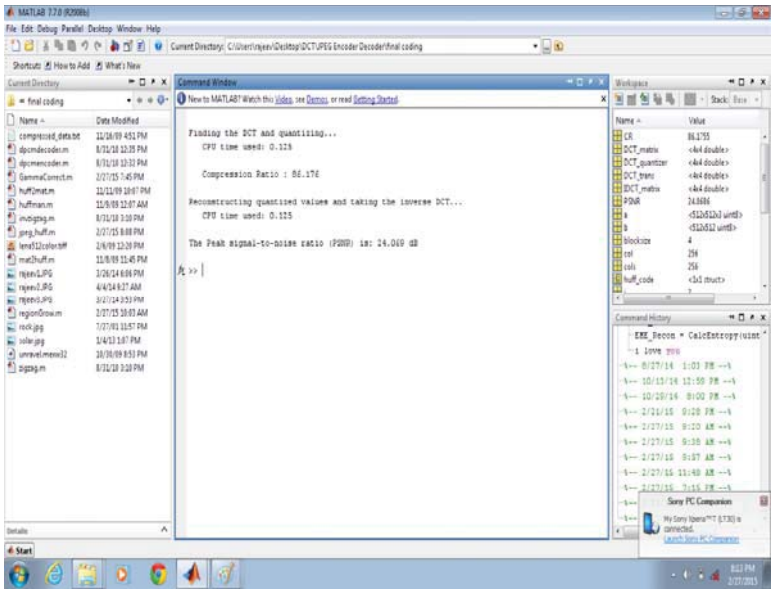

Fig.4 JPEG image compression showing DCT CPU time, Compression ratio PSNR

TABLE I

Sr. No	Quality Factor	CR	DCT /IDCT Processing Time	PSNR (db)
1	6	84.879	0.094/0.078	27.007
2	8	85.498	0.094/0.078	25.953
3	10	85.876	0.125/0.109	24.678
4	12	86.176	0.125/0.125	24.069

Gamma Correction Result:

In this we take the different gamma factor and corresponding result are shown in figure.

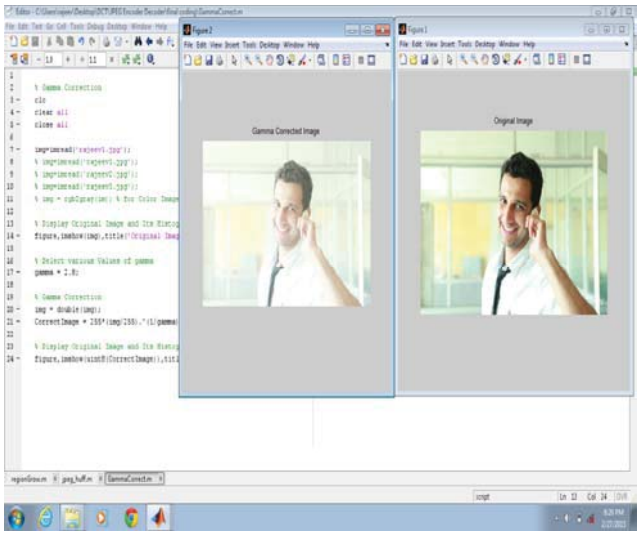

Fig.5 Gamma correction image with gamma factor 2.8

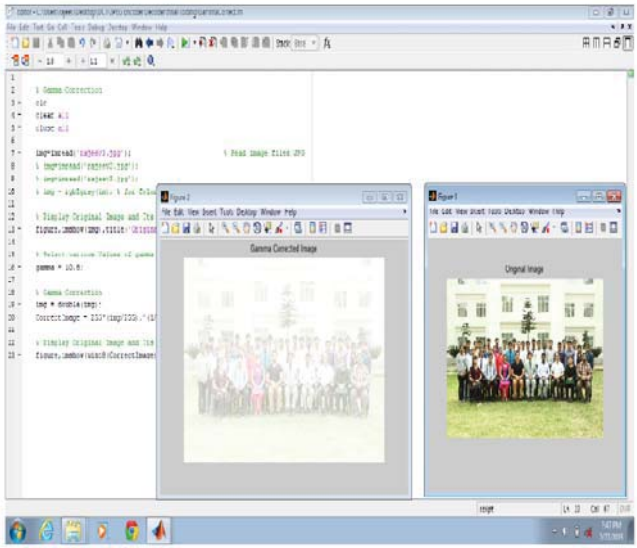

Fig.6 Gamma correction image with gamma factor 10.8

Region Growing:

As shown in figure 7 after applying advanced algorithm we get output result and it can be accomplished by double click on the dark circle of figure 7

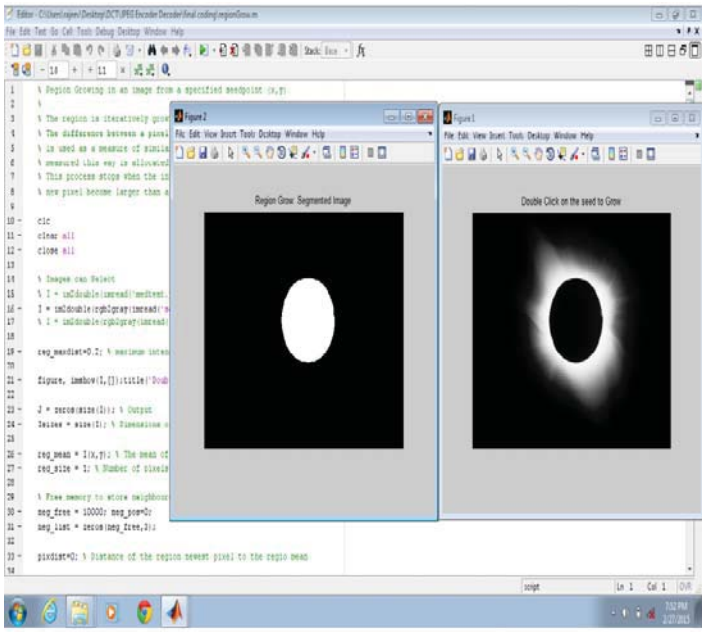

Fig.7 Region growing of an image

V. CONCLUSION

We have made following conclusion: The compression gain can be improved with the increasing scaling factor of original Quantization table. Peak signal to noise ratio varies inversely to the compression ratio. Higher compressed images result in poorer image quality. Mean square error between original and compressed image increase as the scaling factor of original quantization table increases. Discrete cosine transform (DCT) CPU processing time differ from Inverse discrete cosine transform [IDCT]

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