High Quality Color Image Compression using DCT

Anil W.Bhagat, Balasaheb H.Deokate and Premanand K.Kadbe

Abstract: In this paper we are going study the detail information of image compression. Compression is process to represent the image in less number of bits, this property is helpful to storage and transmission the data over internet. There are two types first is lossless and lossy compression, in lossless compression provide the no loss of information in reconstructed image but lossy compression gives the some loss of information. Now we have used the different types of transform methods to compress image for example-DCT,DWT,Fractal etc. So out of this type we have selected the DCT transform on color image.

We designed DCT based image compression code in MATLAB .We implemented the code and we got the two important result related to image quality like Peak to signal nose ratio(PSNR) and mean square error(MSE) from color image.

Keywords: **Image compression, DCT,PSNR,MSE.**

I. INTRODUCTION

A. Introducing to image compression and decompression

Image compression is getting more and more attention day by day as high speed compression and good quality of image are in high demand. One advantage of an Image compression is to reduce the time taken for transmission of an image [1]. For example, an image has 512 rows and 512 columns. Without compression, totally 512x512x8 = 2,097,152 bits data needed to be stored [1]. And, each pixel is represented by 8-bit data format. Now to compress it means to reduce the number of bits needed to store those bits without sacrificing a lot for image quality [1]. General image compression and decompression block diagram is shown below.

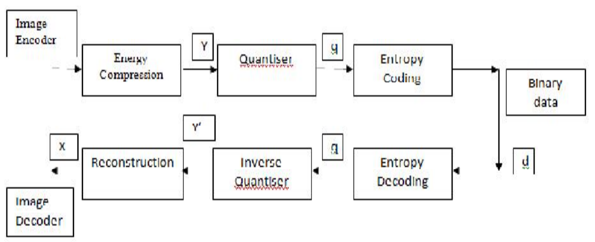

Fig1. Different steps of image compression and decompression

Compression is useful to reduce the cost of extra use of transmission bandwidth or storage for larger size images. In addition, there is always decompression followed by compression. This process involves loss of data, and one should control the ratio of the 2 Information being lost, as images should not be compressed to a level that one cannot even recover them with minimal loss[12].

The organization of this paper is as follow:
Section I. Describe introduction to image compression and type of image compression .Section II describe the DCT details .section III contains the experimental result .In section IV we have given the details conclusion of DCT based image compression.

B. Principle of image compression

- Spatial Correlation:Redundancy among neighboring pixels
- Spectral Correlation:Redundancy among different color planes
- Temporal Correlation: Redundancy between adjacent frames in a sequence of image

C. Types of image compression

Digital image compression can be divided mainly in two large categories: lossless and lossy compression. Lossless compression is used for artificial images. They use low bits rate. There is a possibility of loss some of the data during this process. While lossless compression is preferred in medical images and military images[13].

D. Lossless image compression

In this type of compression, after decompression the images are almost the same as output images. It can allow the difference between the original image and the reconstructed image up to the certain predefined value[10]. Lossless compression can be a valuable solution where we have strict constrains on the reconstruction. In addition, this method is useful where little information on each pixel is very important[6]. We call wavelet a loss less technique. In wavelet algorithm, we do successive re-construction. This makes it possible to receive all the information without a data loss. RLE, LZW, Entropy coding are some examples of lossless data compression[8][13].

E. Lossy image compression

In lossy compression and decompression methods, accuracy is so important. There will be a data loss but it should be under the limit of tolerance. It should be good enough for application of image processing. This kind of

Anil W.Bhagat, Balasaheb H.Deokate and Premanand K.Kadbe are with VPCOE, Baramati, Dist-pune (Maharashtra) 413133, Emails: anilbhagat.entc@gmail.com, b_ash11@rediffmail.com, be_prem@rediffmail.com

compression is used for transmitting or storing multimedia data, where compromise with the loss is allowed.

In contrast to lossless data processing, lossy signal processing repeatedly does compression and decompression on file. That eventually will affect the quality of data. The concept of lossy compression is supported by rate distortion theory. CPC, JPEG, Fractal compression are some examples of lossy signal processing methods. To conclude, on the receiver side, when there is a human eye the signal allows lossy compression as human eye can tolerate some imperfection [3].

II. DCT BASED IMAGE COMPRESSION

This technique is widely used in image processing. Even though it is lossy it provides very high compression rate. It uses the ideas from Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT). The main idea behind this algorithm is to convert the signal in to frequency domain[12][1].

Here 1 D row transform is performed on rows and then on columns. This makes 2 Dimension transform separable. IDCT is a same process but in reverse order. Typical 8x8 image block has two 64 2 D functions. In which are generated by multiplying 8 bits of 1D array to another. Each sets represent, horizontal and vertical frequencies respectively. From both of the dimensions, coefficient with frequency value zero is called DC coefficient. Others are known as AC coefficient. It is needed to make the value of the coefficients of lower frequency near DC component. They can be removed, as they are not important as high frequency values. The human eye is less sensitive to high frequency value [4][14].

The DCT is a widely used transformation in transformation for data compression. It is an orthogonal transform, which has a fixed set of (image independent) basis functions, an efficient algorithm for computation, and good energy compaction and correlation reduction properties. Ahmed et al found that the Karhunen Loeve Transform (KLT) basis function of a first order Markov image closely resemble those of the DCT [7]. They become identical as the correlation between the adjacent pixel approaches to one[2].

The DCT belongs to the family of discrete trigonometric transform, which has 16 members . The 2D DCT of a 1× N

$$X_{pq}=\sum_{m=0}^{M-1}\sum_{n=0}^{N-1} X_{mn}\frac{c(p)c(q)}{4}.\cos\left(\frac{\pi(2m+1)p}{2M}\right).\cos\left(\frac{\pi(2n+1)q}{2N}\right)$$

vector x(n) is defined as[5],

(1)

First the 1D DCT of the rows are calculated and then the 1D DCT of the columns are calculated. The 1D DCT coefficients for the rows and columns can be calculated by separating equation1 into the row part and the column part.

$$C = K \bullet \cos\frac{(2\cdot col\#+1)\bullet row\#\bullet\pi}{2\bullet M} \quad (2)$$

where K = √1/N for row = 0, √2/N for row ≠ 0

$$C^t = K \bullet \cos\frac{(2\cdot row\#+1)\bullet col\#\bullet\pi}{2\bullet N} \quad (3)$$

where K = √1/M for col = 0, √2/M for col ≠ 0

M = total # of columns, N = total # of rows

A. Quantization in DCT

It always requires more space to store an original image that is uncompressed. If the image on which DCT needs to be performed is of 8 bit. The output can be of 11 bits range can vary from [-1024, 1023]. The main advantage with quantization is, division to DCT matrix is done and it stores only integer values. These values are very small. The higher the value of quantization, the more data one lose. Technically, it is a method to reduce the number of bits to store an image[12] .

B. Zigzag Scanning

After quantization, encoding of that information is necessary and zigzag scan is the method for that. In this method, low frequency elements are scanned first, followed by high frequency elements.

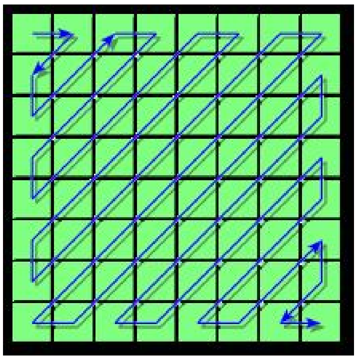

Fig2. Path followed in zigzag scan

When compression on an image is performed, one tries to make most of the bits either zero or near to zero. To encode the bits we have to put all the information, which is similar to each other, together. This scan follows the scan path as shown in the diagram. The scan selects the value with highest value and then lowest value. To get all the zero values together, RLE method is done[3].

Procedure of compression the image is as follows:

1.The image is broken into 8*8 blocks of pixels.

2. Working from left to right, top to bottom, the DCT is applies to each block.

3. Each block is compressed through quantization.

4.The array of compressed blocks that constitute the image is stored in a drastically reduced amount of space.

5. When desired the image is constructed through decompression, a process that uses the Inverse Discrete Cosine Transform (IDCT).

III. EXPERIMENTAL RESULT

We are implement DCT based image compression and decompression on an image first we have performed image compression by taking the following image as original color image .The PSNR is calculated using the equation given below:

$$PSNR = \frac{255^{2}}{MSE} \tag{4}$$

$$MSE = \frac{1}{M * N}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(I(i,j) - I^{\wedge}(i,j)\right)^{2} \tag{5}$$

where, I(i,j) is the original image and I^(i,j) is the decompressed one, M and N are the number of columns and rows in the image.

Fig 3.Original flower image

I used functions of matlab to implement this algorithm. First, we converted that image into Ycbcr format. That was the first step of the compression. The next step was to extract the Y component of that image. Results are shown below in figure.

Fig 4.YCrCb image

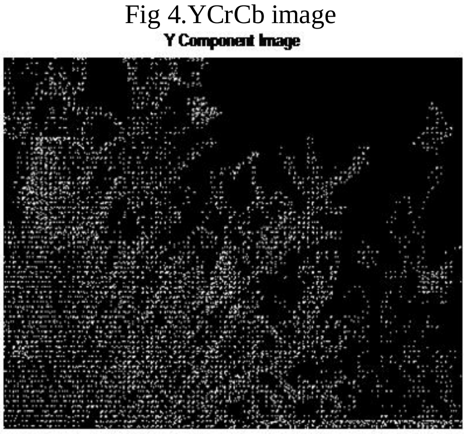

Fig5.Y component image

Fig 5 show that the only Y component images this image

After this image we verify the reconstructed image by taking the inverse DCT

Fig 6.Quantized Y component of image

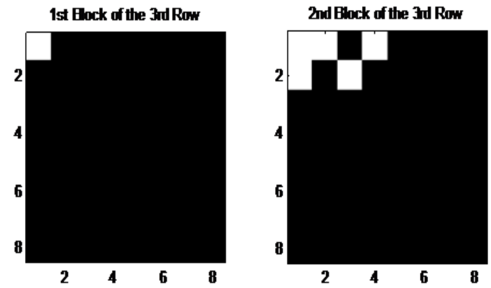

Fig7.Block of rows

After this image we want to verify the reconstructed image which is shown in below fig8 ,fig9.

Fig8.Reconstructed YCrCb image

Fig9.Reconstructed original image

If we see following fig 10. is the error image difference between original image and reconstructed image. If you see the difference image given below you can clearly see the amount of data we are losing. This is the main advantage of the compression using this method we are losing some amount of data here, but we can achieve high compression ratio.

Fig10.Error image

TABLE1

Result of Different images

SR No	Images	MSE	PSNR
1	Flower(512*512)	8.0588	34.544dB
2	Lena(600*600)	9.125	27.94dB
3	Anil(256*256)	5.066	50.33dB

IV. CONCLUSION

We have successfully implemented, DCT based algorithm in MATLAB. By viewing the SNR for the DCT a based image compression, a clear quality difference between them can be noticed. Reliability has helped the Police department to use this algorithm for a finger print reader. In hospitals to check images this algorithm is been used. At both these places accuracy and quality is very essential.

PSNR achieved by DCT based compression is 34 dB and MSE is 8.0588.

REFERENCES

[1] Watson, Andrew B. "Image Compression Using the Discrete Cosine Transform." Mathematical 4.1 (1994): 81-88. Vision.arc.nasa.gov. Jan.-Feb. 1994. Web. 20 Apr. 2011

[2] Kumar, Satish. “An Introduction to Image Compression.” Debugmode. Ed. Satish Kumar. 22 Oct. 2001

[3] Kingsbury, Nick. “A Basic image Compression Example.” Connexions. Ed. Elizabeth Gregory. 8 June. 2005

[4] G. K. Wallace, “The JPEG Still Picture Compression Standard”, IEEE Trans.On Consumer Electronics, vol.38, No.1, pp. xviii – xxxiv, Feb 1992.

[5] N. Ahmed, T. Natrajan, and K. R. Rao, “Discrete Cosine Transform”, IEEE Transactions on Computers, vol. 23, July 1989.

[6] Rao, K. R. and Yip, P. Discrete Cosine Transforms - Algorithms, Advantages, Applications, Academic Press, 1990.

[7] Digital Compression and coding of Continuous-tone still images, part 1,requirements and Guidelines. ISO/IEC JTC1 Draft International Standard 10918-1, Nov. 1991.

[8] H. A. Ilgin and L. F. Chaparro, “Low bit rate video coding using DCT based fast decimation/interpolation and embedded zerotree coding,” *IEEE Trans. Circuits Syst. Video Technol.*, vol. 17, no. 7, pp. 833–844, Jul. 2007

[9] Robert M. Gray,IEEE, and David L. Neuhoff, IEEE"Quantization", IEEE Trans. on Information Theory, Vol. 44, NO. 6,pp. 2325-2383, OCTOBER 1998

[10] Greg Ames,"Image Compression", Dec 07, 2002.

[11] "JPEG." Wikipedia, the Free Encyclopedia. Web. 02 May 2011.

[12] Khalid sayood “Introduction to data compression”

[13] Kingsbury, Nick. “A Basic image Compression Example.” Connexions. Ed. Elizabeth Gregory. 8 June. 2005

[14] R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Reading. MA:Addison Wesley, 2004.

First Author:

Anil W. Bhagat, PG Scholar ELECTRONICS (Digital System) at VPCOE ,Baramati. University of Pune Maharastra-413133. Anil W. Bhagat received degree in Electronics & Telecommunication Engineering in the year 2008 at VPCOE,baramati from Pune University, and Appeared for M.E. in the Electronics Engineering in the year 2013 from VPCOE,Baramati Pune University.

He has an Industrial experience of 1 years & teaching experience of 4 years. Anil has attended Electronics Post Graduate Conference(EPGCON). Anil is a life member of ISTE. Presently Anil is Lecturer in Electronics & Telecommunication department.

Second Author:.

Balasaheb H.Deokate is an Assistant professor in E&TC department at VPCOE,baramati university of pune, Maharastra (pune)-413133. He has received graduate degree in Electronics & Telecommunication Engineering in the year 2004 and M.E. in the Microwave Communication Engineering in the year 2010

He has an Industrial experience of one year in R & D Department, teaching experience of 8 years. Balasaheb attended workshop on Teaching Methodology for SE (E & Tc/ Electronics) 2008 syllabus. He also attended Electronics Post Graduate Conference (EPGCON). Balasaheb is life member of IEEE, IETE and ISTE, and has guided various projects in instrumentation, Communication, Microprocessor. His one project on “Prepaid Energy Meter” has won 2nd prize in “Avishkar” at National level competition held in year 2006. He is among one of the expert staff appointed by University of Pune for revised syllabus 2012 for the subject Basic Electronics Engineering. Balasaheb is ISTE coordinator. He teaches Digital Logic Design, Digital System, Digital Electronics & Logic design, Digital Electronics & Microprocessor, Electronics Circuits & Applications, Microprocessor & Interfacing Techniques, Control System, Mechatronics, Principles of Communication Engineering, Analog Communication (Communication Engineering), Communication Theory. He is presently Assistant Professor in Electronics & Telecommunication department.

Third Author:.

Pemanand K. Kadbe is an Assistant professor in E&TC department at VPCOE, Baramati university of pune , Maharastra (pune)-413133. He has received degree in Electronics & Telecommunication Engineering in the year 2003 from Amravati University, and M.Tech. in Electronics Engineering in the year 2007 from R.S.T.M. Nagpur University. He has Industrial experience of 2 years & teaching experience of 7 years. He had attended workshop on Teaching Methodology for SE(E & Tc/ Electronics) 2008 syllabus. Premanand had attended various workshops on VLSI, Communication and Embedded Systems at Govt. Institutes, IIT, NIT, and private institutes. Premanand also attended Electronics Post Graduate Conference(EPGCON). Premanand has guided many UG and PG projects in Signal Processing, Communication, VLSI Embedded. Premanand is a Reviewer and Member of Editorial Board for various International Journals and Conferences, and life member of MIE, IETE and ISTE.