Volume 6, Issue 7, July 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Analysis of Image Compression Algorithm Using DCT, DFT and DWT Transforms

Shiwangi, Sanjeev Kumar
Electronics & Communication Engineering, Baddi University of Emerging Sciences & Technology, India

Abstract: Image compression is a widely addressed researched area. Image compression means reducing the size of graphics file, without compromising on its quality. It not only reduces the size of graphic file but at the same time reduces the storage space requirements, cost of the data transferred, and the time required for the transfer. This paper presents a basic information about various image compression techniques.

***Keywords:** DCT, DWT, DFT, PSNR, CR, MSE*

I. INTODUCTION

An image is a 2 dimensional signal processed by human visual system. It is represented in analog form but when it is about to store and transmit the signal , this analog signal has to be converted into digital form. Therefore, a digital image is a 2 dimentional array of pixels. Image compression refers to reducing the quantity of data used to represent a file, image or video content without excessively reducing the quality of the original data. The main purpose of image compression is to reduce the redundancy and irrelevancy present in the image, so that it can be stored and transferred efficiently. [1]

II. PRINCIPLE BEHIND COMPRESSION

Image compression and coding techniques tend to eliminate three types of redundancies: coding redundancy, interpixel (spatial) redundancy, and psychovisual redundancy. The way each of them is explored is briefly described below.

A. Coding redundancy

Image is nothing but combination of pixels and each pixel is represented in binary bits. The number of bits used to represent each pixel is based on number of gray levels. If we use variable length code (number of bits used to represent each pixel) is different for different pixels in an image. If we use less number of bits for more frequent gray levels and more number of bits for less frequent gray levels in the image, then we represent the entire image by using least possible number of bits. In this way we can reduce the coding redundancy. [8]

B. Interpixel redundancy

Because the pixels of most 2-D intensity arrays are correlated spatially, information is unnecessarily replicated in the representations of the correlated pixels. In video sequence, temporally correlated pixels also duplicate information.[10]

C. Psychovisual redundancy

A bulk of experiments conducted on the psychophysical aspects of human vision have proven that the human eye is unable to respond with equal sensitivity to all incoming visual information; some pieces of information are more important than others. The knowledge of which particular types of information are more or less relevant to the final human user have led to image and video compression techniques that aim at eliminating or reducing any amount of data that is psychovisually redundant. The end result of applying these techniques is a compressed image file, whose size and quality are smaller than the original information, but whose resulting quality is still acceptable for the application at hand. [9].

III. TYPES OF COMPRESSION

Compression can be divided into two categories, as lossless and lossy compression. In lossless compression, the reconstructed image after compression is numerically identical to the original image. In lossy compression scheme, the reconstructed image contains degradation relative to the original. Lossy technique causes image quality degradation in each compression or decompression step. In general, lossy techniques provide for greater compression ratios than lossless techniques. The following are some of the lossless and lossy data compression techniques. [2]

A. Lossless coding techniques

- Run length encoding
- Huffman encoding

- Arithmetic encoding
- Entropy coding
- Area coding

B. Lossy coding techniques

- Predictive coding
- Transform coding (DFT/DCT/DWT)

IV. VARIOUS TRANSFORMATION ALGORITHMS

A. Discrete Cosine Transform

Discrete Cosine Transform (DCT) exploits cosine functions, it transform a signal from spatial representation into frequency domain. The DCT represents an image as a sum of sinusoids of varying magnitudes and frequencies. DCT has the property that, for a typical image most of the visually significant information about an image is concentrated in just few coefficients of DCT. After the computation of DCT coefficients, they are normalized according to a quantization table with different scales provided by the JPEG standard computed by psycho visual evidence. Selection of quantization table affects the entropy and compression ratio. The value of quantization is inversely proportional to quality of reconstructed image, better mean square error and better compression ratio. In a lossy compression technique, during a step called Quantization, the less important frequencies are discarded, then the most important frequencies that remain are used to retrieve the image in decomposition process. After quantization, quantized coefficients are rearranged in a zigzag order for further compression by an efficient lossy coding algorithm.[1]

B. Discrete Wavelet Transform

Another method of decomposing signals that has gained a great deal of popularity in recent years is the use of wavelets. Decomposing a signal in terms of its frequency content using sinusoids results in a very fine resolution in the frequency domain, down to the individual frequencies. However, a sinusoid theoretically lasts forever; therefore, individual frequency components give no temporal resolution. In other words, the time resolution of the Fourier series representation is not very good. In a wavelet representation, we represent our signal in terms of functions that are localized both in time and frequency. Recently, wavelets have become very popular in image processing, specifically in coding applications for several reasons. Wavelets are useful for compressing signals. They can be used to process and improve signals, in fields such as medical imaging. Wavelets can be used to remove noise in an image. Wavelets are mathematical functions that can be used to transform one function representation into another. Wavelet transform performs multiresolution image analysis. Wavelet transform represent an image as a sum of wavelet functions, with different locations and scales. [1]

C. Discrete Fourier Transform

DFT converts the sampled function from its original domain to the frequency domain. The input samples are complex numbers and the output coefficients are complex as well. The frequencies of the output sinusoids are integer multiples of a fundamental frequency, whose corresponding period is the length of the sampling interval. The combination of sinusoids obtained through the DFT is therefore periodic with that same period. The DFT is the most important discrete transform, used to perform Fourier analysis in many practical applications. In image processing, the samples can be the values of pixels along a row or column of a raster image. The DFT is also used to efficiently solve partial differential equations, and to perform other operations such as convolutions or multiplying large integers.

V. THRESHOLD PROCESS

Threshold is one of the widely used method for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image. The binary image should contain all of the essential information about the position and shape of the objects of interest (foreground). The advantage of obtaining first a binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification. The most common way to convert a gray-level image to a binary image is to select a single threshold value(T). Then all the gray level values below this threshold will be classified as black (0), and those above T will be white (1). The segmentation problem becomes one of selecting the proper value for the threshold T. A frequent method used to select T is by analyzing the histograms of the type of images that want to be segmented. The ideal case is when the histogram presents only two dominant modes and a clear valley (bimodal). In this case the value of T is selected as the valley point between the two modes.[3]

VI. ERROR METRICS

Two of the error metrics used to compare the various image compression techniques are the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) to achieve desirable compression ratios.

The MSE is the cumulative squared error between the compressed and the original image, whereas PSNR is a measure of the peak error. The mathematical formulae for the two are :

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

PSNR = 20 * log10 (255 / 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 we find a compression scheme having a lower MSE (and a high PSNR), we can recognise that it is a better one. [4]

VII. RELATED WORK

In recent years, many studies have been made on image compression using different techniques. In [5] Gaurav Vijayvargiya , Dr. Sanjay Silakari, Dr.Rajeev Pandey of UIT- RGPV Bhopal proposed a paper in which a survey on various image compression techniques has been done. Analysis of different types of existing method of image compression has been done. There are mainly two types of image compression techniques: Lossy and lossless technique. After study of all techniques it is found that lossless image compression techniques are most effective over the lossy compression techniques. Lossy provides a higher compression ratio than lossless.

In [1], Navpreet Saroya, Prabhpreet Kaur of GNDU, Amritsar, Punjab proposed a paper in which analysis of image compression algorithm using DCT and DWT has been done. In this paper comparative analysis of various Image compression techniques for different images is done based on parameters such as mean square error (MSE) and peak signal to noise ratio (PSNR). DWT gives better results without losing more information of image. Pitfall of DWT is, it requires more processing power. DCT overcomes this disadvantage since it needs less processing power, but it gives less compression ratio. DCT based standard JPEG uses blocks of image. In wavelet, there is no need to block the image.

In [6], Rajesh K. Yadav, S.P. Gangwar and Harsh V. Singh ,N.D. University of Agriculture & Technology, Kumarganj, Faizabad Proposed a paper in which comprehensive study with performance analysis of very recent Wavelet transform based image compression techniques has been done. Discrete Wavelet Transform (DWT) is a recently developed compression technique in image compression. DWT image compression includes decomposition (transform of image), Detail coefficients thresholding, and entropy encoding. This paper mainly describes the transform of an image using DWT and thresholding techniques. In this paper ,the standard image Lena of size 256X256 of 8 bit depth is taken and applied DWT (haar). Then two results set are obtained by applying two different techniques of thresholding and then compare the result.

In [7], Prabhakar Telagarapu, V.Jagan Naveen, A.Lakshmi Prasanthi, G.Vijaya Santhi of

GMR Institute of Technology, Andhra Pradesh 2011, presented a paper based on image compression using DCT and Wavelet transform. This paper aims at the analysis of compression using DCT and Wavelet transform by selecting proper threshold method, better results for PSNR have been obtained. Extensive experimentation has been carried out to arrive at the conclusion. By considering several images as inputs, it is observed that MSE is low and PSNR is high in DWT than DCT based compression. From the results it is concluded that overall performance of DWT is better than DCT on the basis of compression rates. In DCT image need to be "blocked", correlation across the block boundaries is not eliminated. This results in noticeable and annoying "blocking artifacts particularly at low bit rates. Wavelets are good to represent the point singularities and it cannot represent line singularities. [7]

VIII. CONCLUSION

By studying and discussing all the techniques, we find lossy compression techniques provides high compression ratio than lossless compression scheme. Lossy compression is used when higher compression ratio is needed and Lossless compression is used when the original image and reconstructed image are to be identical. We study three lossy compression techniques, discrete cosine transform, discrete Fourier transform, discrete wavelet transform. Discrete wavelet transformation is best among the three techniques on the basis of PSNR and MSE.

REFERENCES

[1] Navpreet Saroya, Prabhpreet Kaur, "*Analysis of image compression algorithm using DCT and DWT transforms"*, International Journal of Advanced Research in Computer Science and Software Engineering, vol 4, issue 2, February 2014

[2] *Digital Image Processing* (Pearson Education, Second Edition) By Rafael C. Gonzalez and Richard E.Woods.

[3] Salem Saleh Al-amri, N.V. Kalyankar and Khamitkar S.D, *"Image Segmentation by Using Threshold Techniques"*, Journal of computing,vol.2, issue 5, May 2010

[4] Prabhakar.Telagarapu, V.Jagan Naveen, *"Image Compression Using DCT and Wavelet Transformations "*, International Journal of Signal Processing, Image Processing and Pattern Recognition ,Vol. 4, No. 3, September, 2011

[5] Gaurav Vijayvargiya , Dr. Sanjay Silakari, Dr.Rajeev Pandey , "*A Survey: Various Techniques of Image Compression",* International Journal of Computer Science and Information,Security, vol. 11, no. 10, October 2013

[6] Rajesh K. Yadav, S.P. Gangwar and Harsh V. Singh," *Study and analysis of wavelet based image compression techniques",* International Journal of Engineering, Science and Technology vol. 4, no. 1, 2012

[7] Prabhakar.Telagarapu, V.Jagan Naveen, *"Image Compression Using DCT and Wavelet Transformations ",* International Journal of Signal Processing, Image Processing and Pattern Recognition, vol. 4, no. 3, September, 2011

[8] Bhonde Nilesh, Shinde Sachin, Nagmode Pradip, D.B. Rane, "*Image Compression Using Discrete Wavelet Transform*", International Journal of Computer Technology and Electronics Engineering, vol 3, special issue, March-April 2013

[9] Dr. Ajit Singh , Meenakshi Gahlawat, "Image *Compression and its Various Techniques",* International Journal of Advanced Research in Computer Science and Software Engineering , volume 3, issue 6, June 2013

[10] Sachin Dhawan, "*A Review of Image Compression and Comparison of its Algorithms"*, International Journal of Electronics & Communication Technology, Vol. 2, Issue 1, March 2011

