Proceedings of Engineering & Technology (PET)
pp. 873-876

3rd International Conference on Automation, Control, Engineering and Computer Science (ACECS-2016)
20 - 22 March 2016 - Hammamet, Tunisia

Image Compression Based Discrete Cosine Transform Technique (DCT)

Hana H. Saleh

Benghazi University, Faculty of Education- Qmins
Benghazi -Libya
E-mail: ***cleverageh@gmail.com***

Abstract

The field of image compression has increased widely, due to the requirement of image transmission in many applications, as well as image compression play a main role in digital image processing (DIP). Therefore many research centers have specialized teams working in this field. The discrete cosine transform (DCT) is widely used in image compression; it is a technique for converting a signal into elementary frequency components. This paper is to demonstrate the concept of the image compression, as well as study the DCT technique and investigate how its performance is changed on images by varying some of its parameters by using a MATLAB Simulink.

Keywords*: Discrete cosine transform (DCT), Image compression, Bits per pixel (BPP), Compression ratio(R).*

1. Introduction

In a single in a very broad context any function of two variables defined on some bounded and usually rectangular region of a plane is assumed to be an image. The interpretation of the value of the function at any point on the plane depends on the application. The function may represent the luminance of objects in a scene for pictures taken by an ordinary camera, the absorption characteristics of the body tissue in X-ray imaging or the temperature profile in infrared imaging. In computer vision, 'image' usually means recorded image such as a video image, digital image, or picture Image processing refers to all the various operations, which can be applied to the image data. One can imagine various real-life applications, which needs images to be manipulated. Images from an important helper in information exchange. It may be possible to explain a concept that needs a very long language based description or a very detailed figure with a set of photographs or a film in a very short time.the discrete cosine transform (DCT). Developed by Ahmed, Natarajan, and Rao [1974], the DCT is a close relative of the discrete Fourier transform (DFT). Its application to image compression was pioneered by Chen and Pratt [1984]. In this paper the main concept and standers of image compression will be explored, as well as the DCT technique will be reviewed. [1][2]

2. Fundamental Classes of Image Processing.

It is Image processing operations can be broadly grouped into five fundamental dresses: image acquisition, restoration, enhancement, analysis and compression. Each class contains specific operations, as following:

- Image Acquisition.
- Image Restoration.
- Image Enhancement.
- Image Analysis.
- Image Compression.

3. The Concept of the Compression.

Compression is a reversible conversion of data to a format that requires fewer bits, usually performed so that the data can be stored or transmitted more efficiently. The size of the data in compressed form (C) relative to the original size (O) is known as the compression ratio (R=C/O). If the inverse of the process, decompression, produces an exact replica of the original data then the compression is lossless. Lossy compression, usually applied to image data, does not allow reproduction of an exact replica of the original image, but has a higher compression ratio. Thus lossy compression allows only an

ISSN: 2356-5608

approximation of the original to be generated. For image compression, the fidelity of the approximation usually decreases as the compression ratio increases . The success of data compression depends largely on the data itself and some data types are inherently more compressible than others. Generally some elements within the data are more common than others and most compression algorithms exploit this property, known as redundancy. The greater the redundancy within the data, the more successful the compression of the data is likely to be. Fortunately, digital video contains a great deal of redundancy and thus is very suitable for compression.A device (software or hardware) that compresses data is often know as an encoder or coder, whereas a device that decompresses data is known as a decoder.A device that acts as both a coder and decoder is known as a codec.[2]

4. Image Compression.

The images are stored either for visual inspection or automated analysis. Even with moderate resolutions the storage requirements of images is usually very high. Moreover transmission of image data requires large capacity transmission channels, which are very expensive. Because of their wide applications, data compression is of great importance in image processing. If the amount of data necessary to represent an image can be reduced, then the amount of time to transport it is also reduced. Likewise, the amount of storage space required to store the data is reduced. This way, image compression can yield a significant savings. For instance, the compression of image data by a ratio of ten to one will allow the transport of ten compressed image in the same time required for one uncompressed image. Still-image compression schemes can be divided into two general groups, loss-less compression and lossy compression, as shown in figure (1). Lossless image compression preserves the exact data content of the original image quality, but will not preserve the absolute data content of the original.

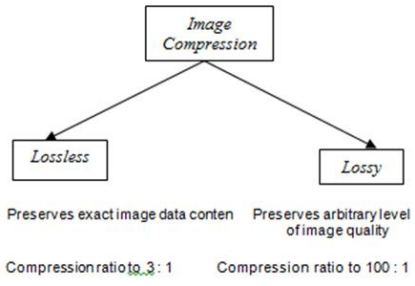

Fig.1. Image compression techniques can be grouped into two major categories: lossless and lossy methods

5. Video Compression.

Since the size and streaming rate of raw format of video file which is YUV format is huge enough and is not feasible to transmit this format over any wired and wireless network, so the raw format needs to be compressed. Compression reduces the number of bits used to represent each pixel in the image. Compression systems exploit the mechanism of human perception to remove redundant information, but still produce a compelling viewing experience. As a result redundant data can be eliminated if the raw video file is compressed. Redundant data may consists of like by reducing the total numbers of colors, amplitude of neighboring pixel are often correlated, consecutive frames often having same object perhaps undergoing some movements. So a lower compression ratio results in less data being discarded and higher compression ratio results in higher data being discarded. Hence if the compression is increased more artifacts become apparent. That is why it needs to trade-off the level of artifacts of the video and the bandwidth if transmission medium.[4]

6. Image Compression Schemes.

A number of standardized image compression techniques have evolved to support the requirements of different industries. A good example includes the compression standards created for facsimile (Fax) machines to transmit a document's image. Many standards have also been created to compress common still images. Let's look at some of the most common non-proprietary image data compression schemes used today.

6.1 JPEG.

Designed by the Joint Photographic Experts Group. This comes under the class of algorithms known as transform coding. These first transform the image into another space, usually similar to the frequency domain, before removing redundancies and coarsely quantizing some elements. image from the frequency strengths some errors can occur, usually blurring or block effects. The figure (2) shows the basic frequencies (basis functions) for a 4x4 Hadamard Transform, which uses square waves

instead of smooth sine waves. This makes it computationally easier and hence faster but the DCT used in JPEG is now preferred.

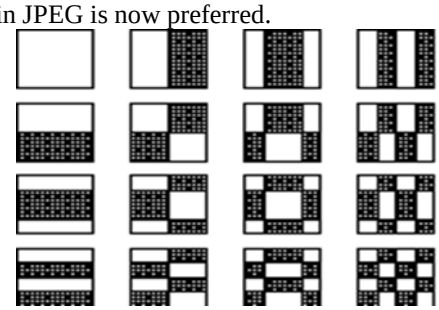

Fig.2. Basis frequencies for 4x4 Hadamard Transform

6.2 JTIF.

JTIF (JPEG File Interchange Format) is just a file format for a compressed JPEG image. TIFF can actually store its pixels compressed in a wider variety of ways, including JPEG. JTIF is the common JPEG file format seen in *.jpg files. SPIFF is an alternative.

6.3 JPEG 2000.

This compression is a newer system based on Wavelet compression and has extension (.jp2). It has the following properties:.

- *Degrades more gracefully than JPEG so is useful for highly compressed images.*
- *Handles smooth generated graphics better than JPEG.*
- *Can be lossy or lossless (lossless JPEG was not popular).*
- *more graceful degradation when corrupted - better in rough transmission*
- *Handles compound documents – e.g. pages with text and image blocks.*
- *Better random access and progressive transmission is better.*
- *Regions of interest - some areas can have better quality!*[3]

7. The Discrete Cosine Transform.

The Discrete Cosine Transform (DCT) attempts to decorrelate the image data as the other transforms. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency. This section describes the DCT and some of its important properties.

7.1 The One-Dimensional DCT.

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

$$C(u) = \alpha(u) \sum_{x=0}^{N-1} f(x) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \quad (1)$$

for $u = 0, 1, 2, \ldots N-1$. Similarly, the invers transformation is defined as

$$f(x) = \sum_{u=0}^{N-1} \alpha(u) C(u) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \quad (2)$$

for $x = 0,1,2,\ldots,N-1$. In both equations (1) and (2) $\alpha(u)$ is defined as

$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}}, for \quad u = 0 \\ \sqrt{\frac{2}{N}}, for \quad u \neq 0 \end{cases} \quad (3)$$

7.2 Then Two-Dimensional DCT.

This necessitates the extension of ideas presented in the last section to a two-dimensional space. The 2-D DCT is a direct extension of the 1-D case.[5]

8. Simulation and Test Results.

The image compression is simulated by using MATLAB and figure (3) shows the Simulink model .

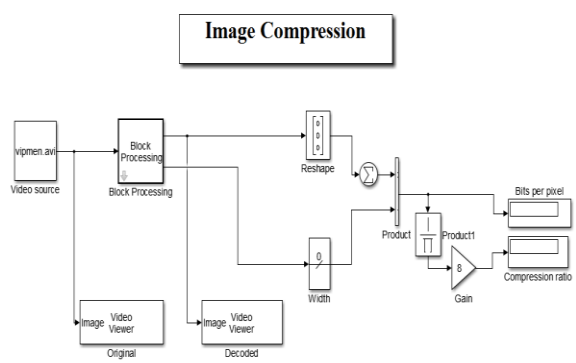

Fig.3. The model of image compression using DCT

Table .1 Illustrates result of BPP and compression ratio with varying value of gain.

8.1 Plotted Figures.

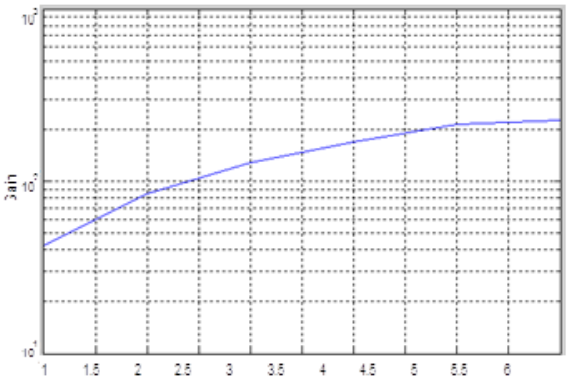

Fig.4 Bit Per Pixel with Gain

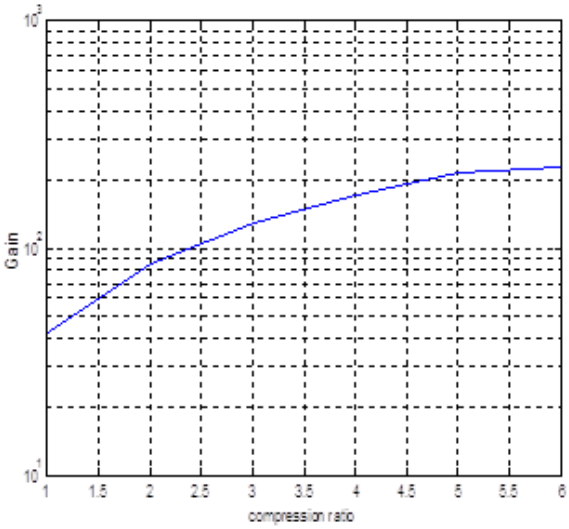

Fig.5 Compression Ratio with Gain

9. Conclusions.

The image compression based DCT is successfully simulated using MATLAB; in this work, the major components, concept and are covered. The higher Gain, thus a higher BPP and decreases the resolution of the image, However The DCT-based image compression such as JPEG performs very well at moderate bit rates; however, at higher compression ratio, the quality of the image degrades because of the artifacts resulting from the block-based DCT scheme.

gine	*Bits per pixal*	*Compression ratio*
42.5	*1.153*	*6.941*
85	*1.218*	*6.218*
127.5	*1.38*	*5,796*
170	*1.434*	*5,581*
212.5	*1.468*	*5.448*
255	*1.663*	*4.812*

References

[1] D. Salomon, Data Compression. The Complete Reference, 3rd ed.New York: Springer, 2004.

[2] G. K. Wallace, “The JPEG still picture compression standard,”*Commun. ACM*, vol. 34, no. 4, pp. 30–44, 1991.

[3] *Wavelet Image and Video Compression*P. N. Topiwala, Ed. Norwell,MA: Kluwer, 1998.

[4] B. Wohlberg and G. Jager, “A review of the fractal image coding literature,”*IEEE Trans. Image Process.*, vol. 8, no. 12, pp. 1716–1729,Dec. 1999.

[5]Watson, A. B. 1993. DCT quantization matrices visually optimized for individual images.Proceedings of the SPIE 1913: 202-216 (Human Vision, Visual Processing, and Digital DisplayIV. Rogowitz ed. SPIE. Bellingham, WA).