RESEARCH ARTICLE OPEN ACCESS

Comparison Methods of DCT, DWT and FFT Techniques Approach on Lossy Image Compression

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Abstract:

This paper presents a study of image compression methods algorithm for compare the best techniques on lossy image compression. One of the major difficulties encountered in compression for lossy imagethat how to shield quality of image in a way that the compressed image constantlyidentical to the authentic, different from the types of methods that exist in the lossless image that can maintain the quality of the images authenticity. In compressing images there are also many methods that can be used with various algorithms such as Huffman code, Chandhuri and Hocquengham (BCH) Codes, Multiple-Tables Arithmetic Code, Fractal Coding, Block Truncation Coding and many other algorithms. In Transform domain, the image is for gain a rarely coefficient matrix using DWT, DCT and FFT. DCT method is almost similar to discrete Fourier transform (DFT), which works to convert a signal or image by a spatial domain into a frequency domain. Because amount variety of images, Binary Image, RGB image, image intensity. Then adopt compressing an image to decrease the size of the data ortechniques to subtract the amount of bits required to reflect an images. Based on the results of this study using 3 methods that can perform compression image with different compression results with each method (DCT, FFT and DWT) as much as 4 variations of measurement percentage of image compression of each method starting from compressing image with size 10%, 30%, 50% and 70%. Comparing the three methods with four different variations of presentation measurement can give very accurate and clear results which method is best for compression the image of the present percentage size.

Keywords **— DCT, DWT, FFT, comparison, percentage.**

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I. INTRODUCTION

Compression in image is a system by which the description of automatic suggestion is changed and lowered about that the ability required to store or the bit-rate required for transmission. Image is another term to review images as multimedia components prayer one who holds important role as forms of visual information computerized. The image has the characteristics of the data is not owned by text, because imagery rich with information and message inner the images. Thousands word can saving in digital image with storage capacity of the very small, but an image requires need big storage capacity than thousands more word, because consisting of millions bits and millions of color that finally formed and become an image.

Electronic image is in fact two dimensional array of pixels. Email correspondence image require more area for garage and additionally required large bandwidths for moving information. The fundamental aim of image compression is reduces the transmission time and save the garage area so it can additionally cut the cost of storage.

Ideas in image compression fall into two classes: lossless and lossy image compression. Making a choice on which of these two classes relies upon on the utility and on the compression diploma required. In lossy image compression technique as name signifies that a few loss of suggestions this technique is really used for community associated software. The info that have been compressed using lossy innovations commonly can't be recovered or reconstructed exactly.

One of the major method confronted lossy image compression is how to protect the quality of the image in a way that the image decompression seems identical to the long-established. In this paper the author concerned with lossy image compression based on DCT, DWT and FFT which is able of compressing loads of types of image codecs. The proposed methods of compression repeat three times in the photographs to augment the compression ratio, due to the implementation of lossy image compression.

However in lossy compression, the long-established sign can't be accurately reconstructed from the compressed knowledge. The reason is that, a lot of element in the image can be got rid of without tremendously altering the image. As an example consider the picture of a tree, which occupies a couple of hundred megabytes. In a lossy image compression, though the particulars are very good on the picture are women and men, however the image size is vastly reduced.

II. LITERATURE REVIEW

A. Lossy Techniques Compression Image

Image compression is one of the applications of data compression in a digital image that has a goal to reduce the number of bits from an image, to be stored or transmitted more efficient. One of the methods used right for image compression is Discrete Cosine Transform (DCT), which is a class of operations mathematics Fast Fourier Transform (FFT).

B. Classification of compression techniques

1. Entropy encoding
   a) Is loseless image
   b) The technique is not based on media with specifications and certain characteristics but based on sequence of data.
   c) Statistical encoding does not pay attention to semantic data.
   d) Example: Huffman coding, Arithmetic coding and Run-length coding.
2. Source Coding

   Is lossy with respect to semantic data (meaning data) and media. Example: prediction (DPCM, DM), transformation (DCT, FFT), layered coding (bit-position, subsampling, sub-band coding) and vector quantization (PSNR).
3. Hybrid Coding

   Combined between lossy and loseless. Example: JPEG, MPEG, H.261.

Lossless methods always produce a precise compression image similar to that of the original image or the original image, since no information is lost due to bit compression in that images.

III. METHODOLOGY

A. Discrete Wavelet Transform (DWT)

The elements of compression from wavelet based are basically associated to the relative scarceness of the wavelet area illustration for the sign. The idea at the back of image compression is based on the concept that the regular sign component can be precisely approximated using the following aspects: a small number of approximation coefficients (at certainly selected level) and a few of the element coefficients.

Diversity discrete wavelets (DWT) Discrete wavelet transform F (x) can be written as follows.

$$DWT(f)(j,k) = 2^{j/2}\int_{-\infty}^{\infty} f(x)\psi(2^j t - k)dx \qquad (1)$$

Where j, k € Zthe theory of resolution analysis predicts that there is $\{a_k, k \in Z\}$ so that.

$$\Phi(x) = \sum_{k\in Z} a_k \Phi(2x-k) \qquad (2)$$

and

$$\psi(x) = \sum_{k\in Z} (-1)^k a_{-k+1} \Phi(2x-k) \qquad (3)$$

Then F (x) and y (x) will be called as a function of wavelet scaling and function. The Mallat

algorithm relates the wavelet theory with filter theory.

$$C_{j,k} = \int_{-\infty}^{\infty} f(x) 2^{\frac{j}{2}} \Phi\left(2^j x - k\right) dx \qquad (4)$$

$$= \int_{-\infty}^{\infty} f(x) 2^{\frac{j}{2}} \left(\sum_{n \epsilon Z} a_n \, \Phi\left(2^j x - k - n\right) \right) dx$$

$$= \sum_{n \epsilon Z} a_n \int_{-\infty}^{\infty} f(x) 2^{\frac{j}{2}} \, \Phi\left(2^j x - k - n\right) dx$$

$$= \sum_{n \epsilon Z} a_n \; 2^{-1/2} c_{j+1,2k+n}$$

$$= \sum_{n \epsilon Z} h0_n \; c_{j+1,2k+n} = \sum_{n \epsilon Z} h0_{n-2k} c_{j+1,n}$$

The same way will be obtained:

$$d_{j,k} = \sum_{n \epsilon Z} g0_{n-2k} c_{j+1,n} \qquad (5)$$

The compression aspects of a given wavelet foundation are essentially associated to the relative scarceness of the wavelet area illustration for the sign. The thought at the back of compression is based on the concept that the regular sign component can be precisely approximated using the following features: a small number of approximation coefficients (at definitely selected level) and a few of the element coefficients.

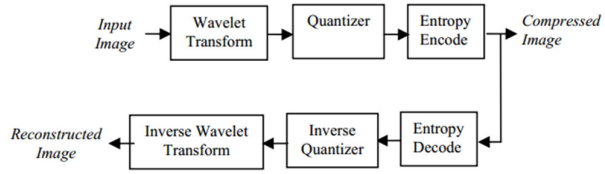

Fig. 1 Structure of wavelet transform based compression

B. Fast Fourier Transform(FFT)

Fast Fourier Transform algorithm is an algorithm for calculating Discrete value Fourier Transform (DFT). DFT is a method for transforming time domain into Frequency domain. Fast Fourier Transform (FFT) is a fourier transform developed from Discrete Fourier Transfrom (DFT) algorithm. With the FFT method, the computational rate of the fourier transformation calculations can be increased. DFT computing is computing that takes time to process loops and requires a lot of memory. By applying the FFT algorithm, the DFT calculation can be shortened, in this case the looping process can be reduced. Viewed from the method used, FFT is divided into two namely DIT (Decimation in Time) and DIF (Decimation in Frequency) method, and both of them have the same function that is to transform the signal into its fundamental frequency. Decimation is the process of dividing the signal into smaller parts that are aimed for get faster processing time. If the input signal at the time domain of N-points is x (n), the initial step is to separate into 2 equal parts (N / 2 ponts).

The fornula for Fast Fourier transform (FFT) can be outlined as follows:

$$X_k = \sum_{n=0}^{N-1} X_n e^{-nk2\pi i/n}$$

Where k is an integer ranging from 0 to $N-1$.
The set of rules first computes the FFT of the even-indexed input x2m(x0,x1,…,xN-2) and odd-indexed inputs x2m+1(x1,x3,...,xN-1), and combines those 2 consequences to produce the FFT of the whole sequence. The set of rules runs at its greatest speed when N is the power of 2. The equation will be:

$$X_k = \sum_{m=0}^{N/2-1} x_{2m} e^{-mk4\pi i/N} + \sum_{m=0}^{N/2} x_{2m+1} e^{-(2m+1)4ki\pi/N}$$

We can factor out he average multiplier out the 2nd sum we obtain:

$$X_k = \sum_{m=0}^{N/2-1} x_{2m} e^{-mk\frac{2\pi i}{N/2}} + e^{-k\frac{2\pi i}{N}} \sum_{m=0}^{N/2-1} x_{2m+1} e^{-mk\frac{2\pi i}{N/2}}$$

$$= E_k + e^{-k\frac{2\pi i}{N}} O_k$$

Because of the periodicity homes of the FFT, the outputs for N/2≤k<N from a FFT of period N/2 are identical to the outputs for 0≤k<N/2. The whole equation will be:

$$X_k = \begin{cases} E_k + e^{-\frac{2\pi i}{N}k} O_k & \text{if } k < N/2 \\ E_{k-N/2} - e^{-\frac{2\pi i}{N}(k-N/2)} O_{k-N/2} & \text{if } k \geq N/2 \end{cases}$$

This equation display the FFT of period N recursively in terms of 2 FFTs of size N/2which can cut hundreds of computingtime.

C. Discrete Cosine Transform (DCT)

Discrete Cosine Transform (DCT) is one of the operating classes Mathematical Fast Fourier Transform (FFT), where this technique takes a signal, which in this case is the pixel data of a matriks image, then transform it with the existing equation. One thing to look at when testing the

DCT algorithm equation is the time required for counting each element in a very DCT Depending on the size of the matrix. Because the calculated image matrix element is sufficient many if the image taken is large, then the computer also requires longer time to do the calculation. To overcome this, DCT implementations typically divide an image into smaller, commonly called blocks, and calculations are done on a vector basis. In the implementation in MATLAB, the calculation with base vector done directly and together, without having to use looping process.

Discrete cosine transform or DCT commonly used is one class of mathematical operations included in fast fourier transform. The basic operation shown in this transformation is to take a signal and transform it from one type to another. This transformation is done frequentative by taking a value from the spatial domain and transforming it into an identical representation. DCT is one method of transformation that can be used for image data compression that has properties lossy. This DCT compression method uses a cosine approximation approach. On essentially DCT will change the color detail of the original image, but due the limitations of the human senses, then the change is not so visible. In this DCT operation the real value is used. There are 2 kinds of equations that can be used that is 1 dimension DCT used for calculate vector data, and dct 2 dimensions used to calculate matrix data.

IV. RESULTS AND DISCUSSION

This section depends on the results and discussion for the image in compression using the existing method. In this discussion compression the image by using 3 method approach that is DWT, DCT and FFT so that the author tried the three methods by using Matlab to compression the image.

A. *Identify of the methods*

In Figure 2 is the result of compression image implementation using DCT method in lossy image technique.

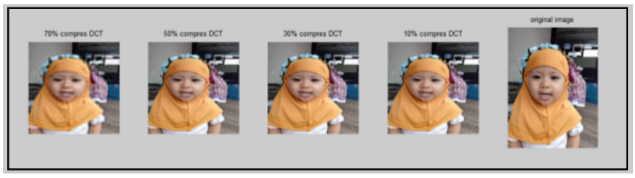

Figure 2. DCT method compression image

From DCT method to compression image the best result from every percentage is 10%.

In Figure 3 is the result of compression image implementation using FFT method in lossy image technique.

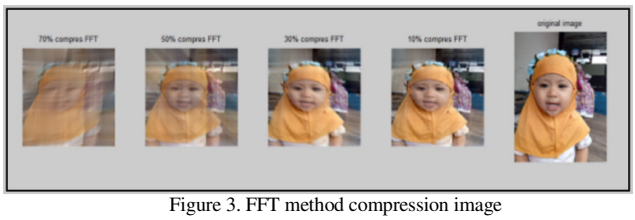

Figure 3. FFT method compression image

From FFT method to compression image the best result from every percentage is 10% althougt not as good like DCT method for every percentage.

In Figure 4 is the result of compression image implementation using DCT method in lossy image technique.

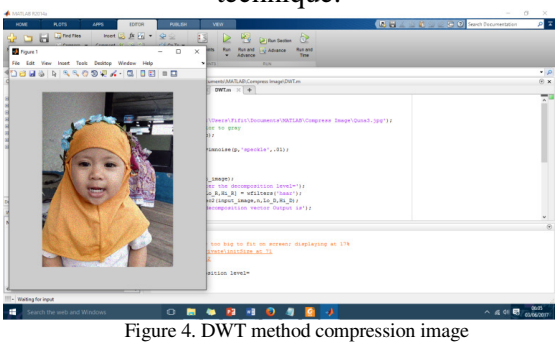

Figure 4. DWT method compression image

From Fig.4 that is DWT method to compression image and for this research only show the result from decomposion:10 % only.

B. Comparison Methods On Lossy Image

In the experiments, we have used Quna3.jpg with RGB image as the test images. The images are of size 256 x 256 pixels for DCT method, size 100 x 100 pixels for FFT method and size 720x720 pixels for DWT method. We use alternative codebooksizes of 128, 256, 512 and 1024 to compare the functionality of reconstructed image. To compare a compress image using 3 different

methods, to make it easier to create a comparison table to give the value of each image percentage. In addition to the comparison table provides convenience to this research to make a better percentage in compressing the image.

From the table above we can see the comparison between the three methods DCT, FFT and DWT in compressing the image has a value similarity quality different from each percentage. And proves that DCT (discrete wavelet transform) is the best image compression technique in lossy image.

TABLE I

Table of Comparison Compression Image

COMPARE	IMAGE	SIZE	PERCENTAGE OF COMPRESSION IMAGE			
			10%	30%	50%	70%
DCT	QUNA3.JPG	256 X 256	95%	70%	60%	40%
FFT	QUNA3.JPG	100 X 100	60%	40%	25%	10%
DWT	QUNA3.JPG	720 X 720	90%	-	-	-

V. CONCLUSIONS

One of the main problems of compressing lossy images in whole in the damaged image is not identical when compared with the methods that exist in lossless images that can maintain the image's authenticity. In the lossy compression of this image the author tries to compare between the 3 methods provide in the lossy image to prove the authenticity of the image better among other methods namely DCT, FFT and DWT. And then after doing a comparison of the compressed image using 3 methods in lossy image, then the conclusion is:

a. The best method for compression image by using DCT method when compared with DWT and FFT method.
b. In every methods the best percentage is 10%, because the size of image can decrease although not much but still keep the quality of the originality the image.

ACKNOWLEDGMENT

Thanks to all colleagues who have helped and cooperated in completing research writing on compressing images, especially for Prof. Teddy Mantoro who has given this writing be an assignment to be useful and expected future there is a better writing.

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