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Novel Image Compression Technique with Improved Wavelet Method

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Abstract:- Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The reduction in file size allows more images to be stored in a given amount of disk or memory space. It also reduces the time required for images to be sent over the Internet or downloaded from Web pages. . This would imply the need for a compression scheme that would give a very high compression ratio very high compression ratio usually comes with a price. This refers to the quality of the image. Wavelet method for compression gives better vision and quality. In our case we are taking the Modified Haar wavelet transformation (MFHWT) method with SVD. This research work will not only compress the images but also take care for the loss of information.

Keywords:- Wavelet , Haar, MFHWT, SVD.

I. INTRODUCTION

Medical science grows very fast and hence each hospital needs to store high volume of data about the patients. And medical images are one of the most important data about patients. As a result hospitals have a high volume of images with them and require a huge hard disk space and transmission bandwidth to store these images. Most of the time transmission bandwidth is not sufficient into storing all the image data. Image compression is the process of encoding information using fewer bits (or other information-bearing units) than an un-encoded representation would use through use of specific encoding schemes. Compression is useful because it helps to reduce the consumption of expensive resources, such as hard disk space or transmission bandwidth (computing). On the downside, compressed data must be decompressed, and this extra processing may be detrimental to some applications. For instance, a compression scheme for image may require expensive hardware for the image to be decompressed fast enough to be viewed as its being decompressed (the option of decompressing the image in full before watching it may be inconvenient, and requires storage space for the decompressed image). The design of data compression schemes therefore involves trade-offs among various factors, including the degree of compression, the amount of distortion introduced.Data compression is the process of converting data files into smaller ones for efficiency of storage and transmission. Each compression algorithm has its corresponding decompression algorithm that, given the compressed file, should reproduce the original one. Image compression schemes come under two categories: lossless and lossy compression.Lossless compression uses coding techniques to compress the data while retaining all information content. However, in this case the achieved file size reduction is not sufficient for many applications and thus this technique will not be discussed in this paper [2]. Lossy image compression, as its name implies, results in the loss of some information content while the file size reduction can be much more significant than obtained with lossless compression. Since most digital images are intended for human observers, much research is nowadays focused on lossy compression that minimizes visual distortion and possibly obtains visually lossless results. Image compression is the application of Data compression on digital images.

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1.1 Basic Problem in compression

Compression is the process of reducing the size of a file by encoding its data information more efficiently. By doing this, the result is a reduction in the number of bits and bytes used to store the information. A smaller file size is generated in order to achieve a faster transmission of electronic files and a smaller space for its downloading. With the increasing demand of manipulations, storage and transmission of the images, great effort has been made to develop the compression algorithms that can provide better compression ratio. Many new schemes such as curvelets, ridgelets, wavelets etc have been used for image compression but most of them suffered from the problems of computational complexity, choice of the filters involved and so forth. Still it is a challenge for researchers to improve the compression ratio of compression algorithms, smaller size of the encoding file, improved quality of the decompressed images.

This work focuses on developing a new algorithm based on modified haar wavelet transformation compression. MFHWT image compression is improved in order to

obtain the impressive compression ratio and to reduce the encoding time and also allows the images to be stored in the lesser computer memory.

1.2 Basic Steps of Image Compression

There are 2 types of image compression: lossless compression (reversible) and lossy compression (irreversible) Run-length encoded (RLE) and the JPEG lossless compression algorithms are examples of lossless compression [2][3]. In lossy compression, data are discarded during compression and cannot be recovered. Lossy compression achieves much greater compression than does lossless technique. Wavelet and higher-level JPEG are examples of lossy compression. JPEG 2000 is a progressive lossless-to-lossy compression algorithm. JPEG handles only still images, but there is a w2lMNrelated standard called MPEG for motion pictures.

Compression Algorithms:

There are 3 basic steps:

1. **Transformation**: The discrete wavelet transform cuts the

image into blocks of 64 pixels (8 × 8) and processes each block independently, shifting and simplifying the colours so that there is less information to encode.

2. **Quantization**: The values in each block are then divided by a quantization coefficient. This is the compression step where information loss occurs. Pixels are changed only in relation to the other pixels within their block.
3. **Encoding**: The reduced coefficients are then encoded, usually with Huffman coding (entropy encoding that finds the optimal system of encoding based on the relative frequency of each character) with high ratio compression.

II. IMAGE COMPRESSION WITH MFHWT

Wavelet transform, due to its time frequency characteristics, has been a popular multiresolution analysis tool. Its discrete version, i.e. DWT has been widely used in various applications till date it is seen that SVD method may improve the efficiency for wavelet method and with improved wavelet method it will be much effective. The image quality analysis has been done using two sets of parameters, namely the popular peak signal to ratio method.

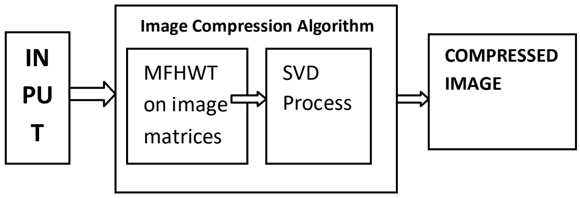

Fig 2.1 Process for image compression with MFHWT

- Read the image as a matrix.
- Apply MFHWT, along row and column wise on entire matrix of the image.
- Computes the approximation coefficients matrix and details coefficients matrices obtained by a wavelet decomposition **MFHWT** of the input matrix.
- Applying Singular value decomposition on approximation coefficients matrix
- So that it produce a diagonal matrix , of the same dimension as image Matrix and with nonnegative diagonal elements in decreasing order, and unitary matrices.
- After applying MFHWT we get a transformed image matrix of one level of input image.
- For reconstruction process, applying the inverse.
- Calculate MSE and PSNR for reconstructed image.

The proposed algorithm has been implemented to test a set of different natural gray scale images.

2.2 Proposed Algorithm

Step I: Consider the input image medical Image (Grayscale.

Step II: Decompose the image using wavelet (Sub band) with MFHWT:

Modified Fast Haar Wavelet Transform: In MFHWT, first average subsignal (a' =a1,a2, a3… $a_{n/2}$), at one level for a signal of length N i.e. f =(f1, f2,f3,f4…fn) is

$$a_m = \frac{f_{4m-3}+f_{4m-2}+f_{4m-1}+f_{4m}}{4},\quad m=1,2,3,\ldots,N/4, \qquad \text{------- (1)}$$

and first detail sub-signal(d'= $d_1,d_2,d_3\ldots d_n$), at the same level is given as :

$$d_m = \begin{cases} \frac{(f_{4m-3}+f_{4m-2})-(f_{4m-1}+f_{4m})}{4}, & m=1,2,3,\ldots,N/4, \\ 0 & , \; m=N/2,\ldots,N. \end{cases} \qquad \text{-------- (2)}$$

III. SINGULAR VALUE DECOMPOSITION

Singular Value Decomposition, SVD is an important linear algebra tool, which is often used in image compression, A digital image can be composed of many matrixes of non-negative scalars from the aspect of linear algebra. SVD of an N×N image C is computed as :

$C = USV^T$

Where U, V are N×N unitary matrices (UUT=I, VV^T=I), and S is a unique diagonal N×N matrix,(S = diag(s1,s2…,sr ,0,…,0) , where s1 ≥s2 ≥…. sr > 0), known as the singular value (SV) matrix of C .

Applying SVD to decomposed sub-signal(d'= $d_1,d_2,d_3\ldots d_n$)

IV. MEASURING IMAGE QUALITY

In objective measures of image quality metrics, some statistical indices are calculated to indicate the reconstructed image quality. The image quality metrics provide some measure of closeness between two digital images by exploiting the differences in the statistical distribution of pixel values. The most commonly used error metrics used for comparing compression are Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) .

The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is often used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed, or reconstructed image.

The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error metrics used to compare image compression quality. The MSE represents the cumulative squared error

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between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE, the lower the error.

To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N} \qquad \text{--------} \quad (3)$$

In the previous equation, *M* and *N* are the number of rows and columns in the input images, respectively. Then the block computes the PSNR using the following equation:

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right) \qquad \text{---------} \quad (4)$$

In the previous equation, *R* is the maximum fluctuation in the input image data type. For example, if the input image has a double-precision floating-point data type, then *R* is 1. If it has an 8-bit unsigned integer data type, *R* is 255, etc.

V. CONCLUSION

Image compression using the modified Wavelet method with SVD seems to be very powerful for the medical images. As far as the quality for medical images Is concern, there is lot of information that need to maintained to diagnose the disease , So with compression this may be lost for example the DCT was used for the JPEG format to compress images, wavelet analysis can be seen to be far superior, This is because the wavelet analysis is done on the entire image rather than sections at a time. Changing the decomposition level changes the amount of detail in the decomposition. Thus, at higher decomposition levels, higher compression rates can be gained. However, more energy of the signal is vulnerable to loss. The wavelet divides the energy of an image into an approximation sub signal, and detail sub signals. Wavelets that can compact the majority of energy into the approximation sub signal provide the best compression. This is because a large number of coefficients contained within detailed sub signals can be safely set to zero, thus compressing the image. However, little energy should be lost. Wavelets attempt to approximate how an image is changing, thus the best wavelet to use for an image would be one that approximates the image well. So for this the Singular Value of decomposed sub bands has been used and later on we Compare the Singular Value and replace the larger singular value for the respective Sub bands. Thus Modified haar with SVD technique not only compressed the image at extent but also maintain the image quality.

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