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Image Compression Algorithm Using Improved Haar Wavelet Transform

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Abstract: There are several problems to be solved in image compression to make the process more efficient. the proposed methodology of this paper is to achieve high compression ratio in images using Wavelet Transform. The aim of proposed work is developing computationally efficient and effective algorithms for lossy image compression using wavelet techniques, where This paper proposes a modified simple but efficient calculation haar wavelet transformation in image compression. The haar wavelet is designed using MATLAB. This work has been tested and found suitable for its purpose.

Keywords: Image Compression , wavelet, Haar Wavelet, compression ratios.

I. INTRODUCTION

The image compression is considered of important factors for image storage or transmission any communication ways in internet or other. Compression makes it possible for creating file sizes of easy for manage, storage and transport. Image compression techniques fall under two categories, namely, Lossless and Lossy. In Lossless techniques, the image can be reconstructed after compression, without any loss of data in the entire process. Lossy techniques, on the other hand, are irreversible, because, they involve performing quantization, which result in loss of data, the compression ratio (C.R) in lossy techniques is larger than that of lossless [2]. Wavelets are mathematical functions in which data should be divided into different frequency components and then matched the resolution into its scale [1]. The objective of our paper was to perform the haar wavelet transformation on an image for the purpose of compression. The haar wavelet transformation is composed of a sequence of low-pass and high-pass filters, known as a filter bank. The paper is organized as following .Section 2 describes the Haar wavelet transform. Section 3 introduced the proposed procedures of the work for modified Haar wavelet transform (MHWT). Section 4 is the result analysis.

II. HAAR WAVELET

More recently, the wavelet transform is display as a cutting-edge technology, within the field of image analysis. The haar wavelets are sequence of functions in mathematics forms. It is first invention of wavelet form. Alfred Harr generates the HAAR WAVELET in 1990. The Haar wavelet is the simplest possible wavelet. The technical disadvantage of the haar wavelet is that it is not continuous, and therefore not differentiable [2].
The purpose of wavelet transform is to change the data from time-space domain to time-frequency domain which makes better compression results.
The simplest form of wavelets, the Haar wavelet function (see Figure 1) is defined as[3]:

$$\Psi(x)=\begin{cases} 1 & 0 \le x < \frac{1}{2} \\ -1 & \frac{1}{2} \le x < 1 \\ 0 & otherwise \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

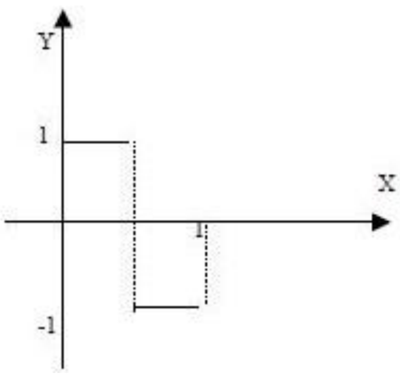

Fig1: The haar wavelet[3]

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And its scaling function φ (x) can be described as[3]:

$$\varphi(x)=\begin{cases}1 & 0 \le x < 1 \\ 0 & otherwise\end{cases} \quad \ldots\ldots\ldots\ldots(2)$$

the wavelet/scaling functions with different scale have a functional relationship [4]:

$$\varphi(x) = \varphi(2x) + \varphi(2x - 1) \ \ldots\ldots\ldots\ldots.(3)$$

$$\psi(x) = \varphi(2x) - \varphi(2x - 1) \ \ldots\ldots\ldots\ldots.(4)$$

The haar wavelet transformation is composed of a sequence of low-pass and high-pass filters, known as a filter bank, The low pass filter performs an averaging/blurring operations, which is expressed as [4].

$$L=\frac{1}{2}(1..1)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(5)$$

The high-pass filter performs a differencing operation and can be expressed as[4]:

$$H=\frac{1}{2}(1-1)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

The low and high filter¡¦s equations above, can be formulated simultaneously through four filters i.e., (LL, HL, LH, and HH) each of (2x2) adjacent pixels which are picked as group such as in the figure (2).

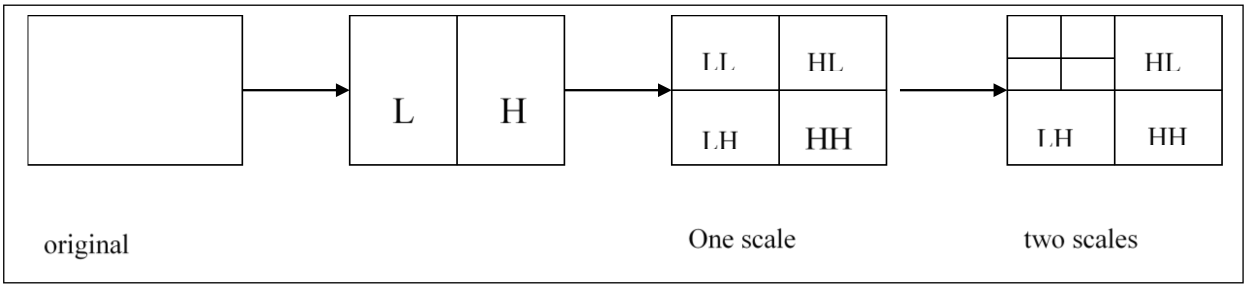

Fig2: The haar wavelet transform[7]

In this transform, the bases of these 4-filters could be derived as follows[4]:

- The horizontal low pass followed by the vertical low pass filter is equivalent to:

$$LL=\frac{1}{2}\begin{pmatrix}1\\1\end{pmatrix}(1\ 1)=\frac{1}{2}\begin{pmatrix}1 & 1\\1 & 1\end{pmatrix}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

- The horizontal high pass filter followed by vertical low pass filter is:

$$HL=\frac{1}{2}\begin{pmatrix}1\\-1\end{pmatrix}(1\ 1)=\frac{1}{2}\begin{pmatrix}1 & 1\\-1 & -1\end{pmatrix}\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

- The horizontal low pass filter followed by vertical high pass filter is equivalent:

$$LH=\frac{1}{2}\begin{pmatrix}1\\-1\end{pmatrix}(1\ \ -1)=\frac{1}{2}\begin{pmatrix}1 & -1\\1 & -1\end{pmatrix}\ldots\ldots\ldots\ldots\ldots\ldots(9)$$

- The horizontal high pass filter followed by vertical high pass filter is:

$$HH=\frac{1}{2}\begin{pmatrix}1\\-1\end{pmatrix}(1\ \ -1)=\frac{1}{2}\begin{pmatrix}1 & 1\\-1 & -1\end{pmatrix}\ldots\ldots\ldots\ldots\ldots(10)$$

III. PROCEDURE OF COMPRESSION IMAGE

The original image is processing by using several operation to compression image for haar wavelet (see Figure 2), These processes are given below.

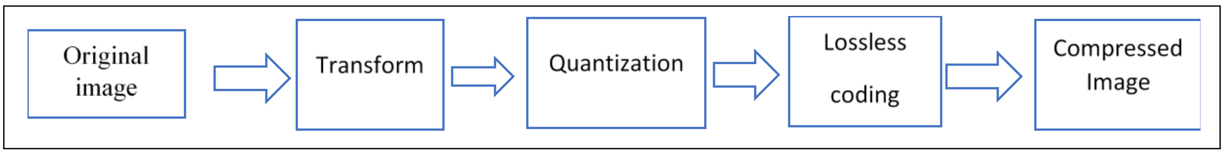

Fig3: Image compression Model[8]

In the first step convert image to matrices (8*8) by using several processing on color image, the color image consists of a coordinate matrices and 3-color matrices. Coordinate matrices contains x,y coordinate values of the image. The Color matrices are labeled as red (R), green (G), and blue (B)[5] and convert to matrix 8*8.

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The second step to calculate the row-column transformed matrix (x) to demonstrate how wavelet transform works we first describe transforming data string called averaging and differencing. To understanding what it actually does we treat each row separate data string, there are three steps in transform process .the first four numbers in the second row and averages of pairs in first row. Similarly, the first two number in the third row are averages of those four averages taken two to time and first entry in the last row is average of preceding two computed averages. After completing this process on all rows, we move forward in doing the same transformation on columns. The final result is 8*8 matrix x, called the haar wavelet transform of p. A matrix with a high proportion of zero entries is said to be sparse[6]. The third step we arrive at the door of wavelet compression :fix a non negative threshold value ε and decree that detail coefficient in wavelet transformed data whose magnitude is less than or equal to ε will be reset to zero, then rebuild an approximation of the original data using doctored version of wavelet transform data. This process is called lossless compression when no information is lost and otherwise its referred to as lossy compression[6].

IV. RESULT

The paper aims with implementation of haar wavelet compression techniques and comparison over various input mage. We first look in to results of wavelet compression ratios. The image shown on the figure(4 .a) is the real image and the image that is on the figure (4.b) is the compressed one. The image on the left you are right now viewing is compressed using haar wavelet method and the loss of quality is not visible. Because image compresses by using haar Wavelet is one of the simplest ways.

a. Original Image(Mona Lisa.jpg)

b. Compressed Image(Mona Lisa.jpg)

Fig4 : The image(Mona Lisa.jpg) before and after compression

We select several images for test project program founded the increases compassion-level To get best result compassion and Percent of zeros(POZ) occured in the compressed data with accepted quality for original image such as in the table 1.

TABLE I
The result for multi-level compassion data

Nb	Original Image	Compassion level	POZ	Compassion image size
1	Mona Lisa .jpg 599*341 82,8KB	40	93.8926%	38.3KB
		50	95.0117%	37.1KB
		60	95.7451%	35.7KB
2	sunrise.jpg 713*476 113.2KB	40	95.7282%	59.6KB
		50	96.4625%	58.5kB
		60	97.0992%	57.9KB

The results obtained concerning reconstructed image quality as well as preservation of significant image details, while on the other hand achieving high percentage compression rates is 30% increase in MHWT vs HWT, 10% increase PSN rate in MHWT and 20% decrease in MSE MHWT.

V. CONCLUSION

The project deals with the implementation of the improved haar wavelet compression techniques and a comparison over several input images with different size and pixel. the good results obtained concerning reconstructed image quality as well as preservation of significant image details, while on the other hand achieving high compression rates. the percentage compassion rate 30% increase in MHWT vs HWT, 10% increase PSN rate in MHWT and 20% decrease in MSE MHWT.

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