Volume 2, No. 4, July-August 2011
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
RESEARCH PAPER
Available Online at www.ijarcs.info

# Image Compression Using Haar Wavelet Transform

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***Abstract:*** Compressing an image is significantly different than compressing raw binary data. General purpose compression programs can be used to compress images, but the result is less than optimal. This is because images have certain statistical properties which can be exploited by encoders specifically designed for them. Also, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space. This also means that lossy compression techniques can be used in this area. The discrete wavelet is essentially sub band–coding system and sub band coders have been quite successful in speech and image compression[8]. In this paper we have implemented HAAR Wavelet Transform. The results in terms of PSNR and MSE show that the Haar transformation can be used for image compression. The quantization is done by dividing the image matrix into blocks and taking mean of the pixel in the given block. It is clear that DWT has potential application in the compression problem and the use of Haar transform is ideally suited.

***Keywords:*** Wavelet transforms, Image compression, Haar wavelet, PSNR, MSE.

## I. INTRODUCTION

One of the important factors for image storage or transmission over any communication media is the image compression. Compression makes it possible for creating file sizes of manageable, storable and transmittable dimensions. A 4 MB image will take more than a minute to download using a 64kbps channel, whereas, if the image is compressed with a ratio of 10:1, it will have a size of 400KB and will take about 6 seconds to download[10]. Image Compression techniques fall under 2 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 results in loss of data. Some of the commonly used techniques are Transform coding, (Discrete Cosine Transform, Wavelet Transform, Gabor Transform), Vector Quantization, Segmentation and Approximation methods, Spline approximation methods (Bilinear Interpolation/ Regularisation), Fractal coding etc.[6].

Wavelet Transform has received a great amount of attention in the last decade. Wavelet based image compression introduces no blocky artifacts in the decompressed image[7]. The decompressed image is much smoother and pleasant to eyes. Also, we can achieve much higher compression ratios much regardless of the amount of compression achieved. Another interesting feature of wavelet is that we can improve the quality of the image by adding detail information. This feature is attractive for what is known as progressive transmission of images. We have chosen Haar Wavelet Transformation for image compression in our project.

## II. HAAR WAVELET TRANFORM

Wavelets are mathematical functions that were developed for sorting the data by frequencies[9]. A Wavelet transformation converts data from the spatial into the frequency domain and then stores each component with a corresponding matching resolution scale. The word ``*wavelet*'' stands for an orthogonal basis of a certain vector space.

The Haar function is

$$\psi(t) = \begin{cases} 1 & t \in [0, 1/2) \\ -1 & t \in [1/2, 1) \\ 0 & t \notin [0, 1) \end{cases}$$

and

$$\psi_i^j(t) = \sqrt{2^j}\,\psi(2^j t - i),\ \ j = 0, 1, \ldots \text{ and } i = 0, 1, \ldots, 2^j - 1 .$$

Haar Transform is nothing but averaging and differencing. This can be explained with a simple 1D image with eight pixels

[ 3 2 -1 -2 3 0 4 1 ]

By applying the Haar wavelet transform we can represent this image in terms of a low-resolution image and a set of detail coefficients. So the image after one Haar Wavelet Transform is:

Transformed coefficient
= [ 2.5 -1.5 1.5 2.5 ]
Detail Coefficients
= [ 0.5 0.5 1.5 1.5 ]

The detail coefficients are used in reconstruction of the image. Recursive iterations will reduce the image by a factor of two for every cycle. In 2D wavelet transformation, structures are defined in 2-D and the transformation algorithm is applied for row first, and then for column.

## III. IMPLEMENTATION

The array sizes are expressed in powers of two. Mathematically, the original resolution of the images is converted into the next larger power of two, and the array sizes are initialized accordingly.[1] The Haar transform separates the image into high frequency and low frequency components.

For the first cycle, the transformation algorithm is first run along the ROW

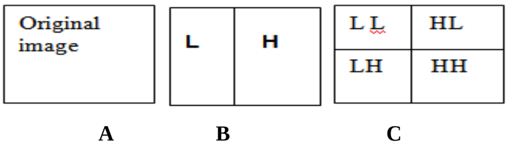


Figure 1

(A – Original Image, B – First Run along Row, C – First Run Along Column)

The image array is split into two halves containing the transformed data and the detail coefficients. The transformed data coefficients are the results of the low-pass filter while the detail coefficients are the results of the high-pass filter. After transforming the image in the *row*, the image is then transformed along the *column*. A program was written in MATLAB and the output is given in the RESULTS section[4].

## IV. QUANTIZATION

Quantization, involved in image processing, is a lossy compression technique achieved by compressing a range of values to a single quantum value. When the number of discrete symbols in a given stream is reduced, the stream becomes more compressible. We have quantized given matrix of pixel by dividing the matrix into blocks and then modifying their values by the mean of the block.

## V. RECONSTRUCTION

For the reconstruction, the detail coefficients resulting from each cycle are added and subtracted to the respective data coefficients to retrieve the original pixels values of the next higher level.

## VI. RESULTS

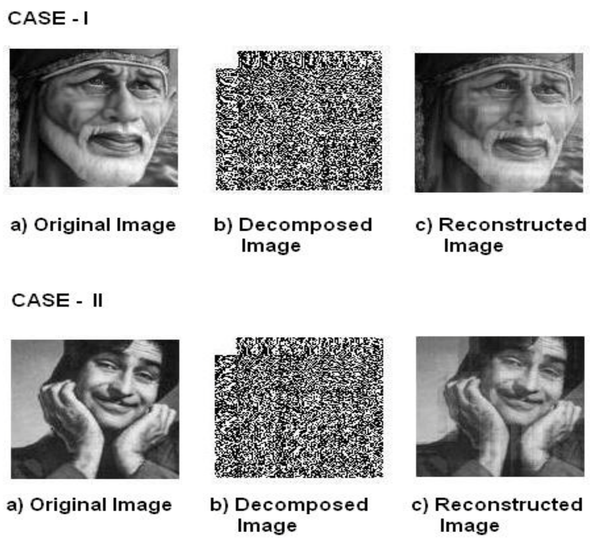


Figure 2

Table I: Observations Table

| S.No | Image | Original Size | Compressed Size | MSE | PSNR |
|---|---|---|---|---|---|
| 1 | Sainath.jpg | 5.46 kb | 5.13 kb | 107.7835 | 27.8053 |
| 2 | Raj.jpg | 5.47 kb | 5.21 kb | 172.6921 | 25.7581 |

## VII. CONCLUSION

This paper reported is aimed at developing computationally efficient and effective algorithm for lossy image compression using wavelet techniques. So the proposed algorithm is developed to compress the image in a time-efficient manner. The results obtained concerning the reconstructed image quality as well as preservation of significant image details are promising. There is a reduction in encoding time with little degradation in image quality compared to existing methods.

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