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# DWT based Segment Matrix Algorithm for Image Compression

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**ABSTRACT**

Image compression means reducing the size of graphics file, without compromising on its clarity. In effective DWT algorithm, it increases the performance of image compression and also improves the Peak Signal Noise Ratio. The image is transmitted over the wireless channel through DWT transform to eliminating relevant information for image compression. Therefore, the speed of computation degrades considerably. Although, speed algorithm are called as "segmented matrix algorithm" where 2D images are compressed with a single matrix operation instead of two separate 1D transforms. In real time, the images are of enormous in size with respect the availability and development of image capturing tools. Some common wavelet based applications have to manage large scaled representation method. It speedup in high computation requirement to direct way for similar computing. The segmented-matrix algorithm is effective for implementing k-level 2-D Haar DWT and it improving the PSNR ratio as well.

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## INTRODUCTION

Discrete Wavelet Transform used in variety of applications especially used in image compression, video encoding and decoding and so on. In traditional approach, 2D (two-dimensional) Haar DWT is performed in two phase- one row operation and one column operation but column operation cannot be performed until the row operation is completed. With the help of DWT, an additional algorithm "segmented matrix algorithm" is used to compress 2D images with less computational power. The ultimate goal of using DWT with SMA is to compute relatively prodigious sized data with considerable amount of power used. With the evolution of variation in the VLSI technology, the innovation is highly developed on taking account of images and audios. Usually JPEG images are processed using the two dimensional DWT image compression technique. Nowadays, much VLSI architecture for 2-D DWT has been proposed to meet the requirements of real-time processing. First the complexity of wavelet transform is several times higher than that of DCT. Second, DWT needs extra memory for storing the intermediate computational results. Moreover, for real time image compression, DWT has to process massive amounts of data at high speed. The uses of software implementation of DWT image compression provide flexibility for manipulation but it may not meet some timing constraints in certain applications. Hardware implementation of DWT will have some problems. The first obstacle is that the high cost of hardware implementation of multipliers.

The amount of time taken for analyzing the data in every level is reduced nearly 50% of the time taken in the past levels because of the decimation operation, which leads to efficient utilization of hardware. Hence, MRPA is feasible for 1D DWT architecture but it is not suitable for the 2D DWT architecture.

In Haar transform, two high, low pass filters are applied. The coefficients used are (1, 1) and (1,-1). In Haar Wavelet transform, the summation and difference operations are used to handle the operations with pixels in an image. Usually the images are divided into four components namely WLL, WLH, WHL, and WHH.

Normally, a row operation followed by a column operation is carried out in order to process an image using two dimensional Haar transform technique. The output of row activity is given input to the column matrix operation.

***Related Work:***

***a) Segmented Matrix Algorithm:***

The compressed pixel value from Haar Transform is given as input to Segment Matrix

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Algorithm (SMA). The pixel values are compressed again using SMA principle and the values are stored in the text file. For using SMA Algorithm, need only limited memory for storage and transmission as compared to Haar Transform. This Algorithm follows as step by step process.

1. The Haar transform image data N: an m × n matrix which stands for the Haar image (assume m and n are multiples of 2).
2. The sub-blocks Bij: 2 × 2 matrices, where i range from 1 to m/2 and j range from 1 to n/2. In other words, N is divided into mn/4 such sub-blocks. The method to obtain these Bij from N will be described in details later.
3. The filter coefficient matrix is applied.
4. The row vectors Aij: mn/4 such matrices of size 1×4. They are obtained by applying some data rearrangement to Bij respectively.
5. The intermediate matrix M: an 4 4 mn × matrix.
6. Matrix M′: an 4 4 mn × matrix.
7. Matrix W: an m × n matrix. This is the final result of 2-D Haar DWT coefficients matrix.
8. Find H= M×C.

The reordering of elements of H from above algorithm is divided into 4 additional matrix data will help in getting the output of transformation.

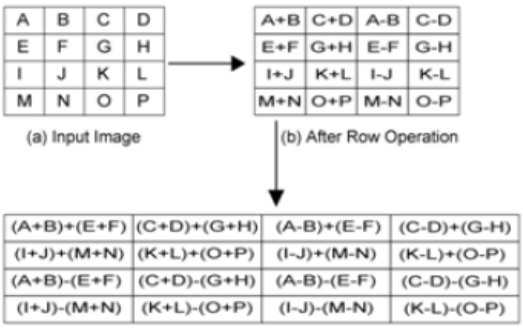


**Fig. 1:** 2D Haar DWT of a 4×4 image by traditional approach.

*b)* ***Matlab:***

MATLAB is a numerical computing environment, allows matrix operations, and to interact with programming languages which in turn will be helpful in building applications, new algorithms and models. In this paper, MATLAB is used to covert the images into text files (embedded values) and vice versa. It can be used to improvise the coding quality and performance.

Image is given as input to the MATLAB for converting respective pixel values. It converts image into equivalent pixel value and stores in the text file processing through MATLAB The converted text file is stored in the memory of VLSI(Modelsim). Text file is stored in the VLSI memory which is loaded for processing in Modelsim. The pixel values in the text file are compressed using DWT Haar transform. The compressed pixel values from Modelsim are stored again in another text file which is used for reshaping the compressed image. Text file which is converted from Modelsim, is transferred to MATLAB and stored in its memory. The pixel values in the text file that is stored in the MATLAB is converted into an image. The compressed and original image (which is given as input) pixel value are compared to verify its PSNR ratio.

***c) Modelsim:***

ModelSim is an alternative version of VLSI design which used to compile multiple models into a common working library. ModelSim is used to convert pixel values from the text file to reduced compressed format. It is used as different coverage types.

***Problem Statement:***

In the existing system, only Haar transform is used to compress the images. A data loss will be occurred in the existing system. A Mean Square Error (MSE) value is high in the Discrete Cosine Transform (DCT). Peak Signal-to-Noise Ratio (PSNR) ratio is low in this compression technique.

Only two dimensional (2D) approaches are used in this technique. In order to produce compressed image, it makes significant power consumption.

***Proposed Works:***

Image compression using Haar Transform with segmented matrix algorithm for improving the PSNR ratio. DWT algorithm is used to improve the Performance of image compression. Mean Square Error (MSE) value is low. The proposed system can obtain high peak Signal-to-Noise Ratio (PSNR) value. Both two dimensional (2D) and three dimensional (3D) images can be compressed using these techniques. Design consumes low power and low cost implementation can be performed.

***Enhanced Image Compression Quality:***

***a) Two Level Dwt:***

The working structure of two-level DWT operation on 2d images is shown below.

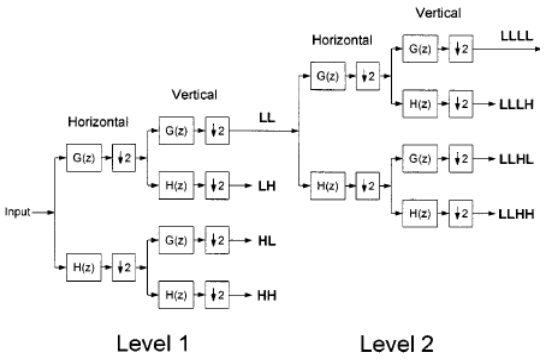


**Fig. 2:** Two level DWT.

In fig.2, each decomposition level comprises two stages: stage 1 performs horizontal processing, and stage 2 performs vertical Processing, which filters the data. During first-level decomposition, input size of the image will be A * A, and the outputs are the three sub bands LH, HL, and HH, of size A/2*A/2. While on second- level decomposition, the input will be LL band and the outputs produced will be three sub bands LLLH, LLHL, and LLHH, of size A/4*A/4 ,in process, which is similar to above process.

***b) Block Diagram:***

The figure.3 shows the 2-D Discrete Wavelet Transformation (DWT). DWT also converts the produces for images same as the above model.

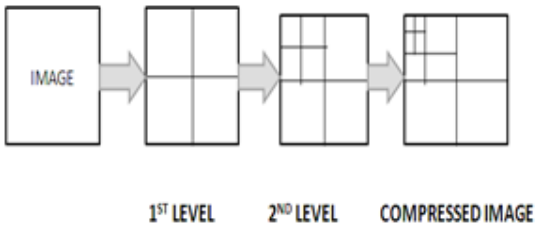


**Fig. 3:** Frequency distribution of DWT.

***c) Two Level DWT Architecture:***

The 2D DWT architecture resembles the systematic flow of the process that is used to convert or process the images**.** Usually coding gray level for images are coded enormously with in turn cause the output with duplicated content which doesn't need to have that entire data. Usually the needless data is obtained in conversion with the compression. The 2D-DWT process will have input memory, output memory and three 1D-DWT processed images as shown in Figure 4.

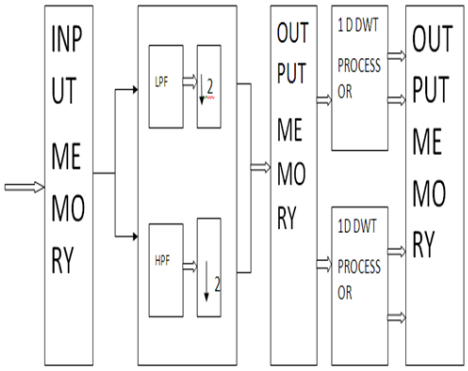


**Fig. 4:** 2D-DWT Architecture.

***d) General expression:***

Two dimensional discrete wavelet transform (DWT) is defined as the following, the four pass filters are applied below.

$$xJLL(n1,n2) = \sum_{i1=0}^{K-1}\sum_{i2=0}^{K-1} g(i1)g(i2).xJ - 1LL(2n1 - i1)(2n2 - i2)$$

$$xJLH(n1,n2) = \sum_{i1=0}^{K-1}\sum_{i2=0}^{K-1} g(i1)g(i2).xJ - 1LL(2n1 - i1)(2n2 - i2)$$

$$xJHL(n1,n2) = \sum_{i1=0}^{K-1}\sum_{i2=0}^{K-1} g(i1)g(i2).xJ - 1LL(2n1 - i1)(2n2 - i2)$$

$$xJHH(n1,n2) = \sum_{i1=0}^{K-1}\sum_{i2=0}^{K-1} g(i1)g(i2).xJ - 1LL(2n1 - i1)(2n2 - i2)$$

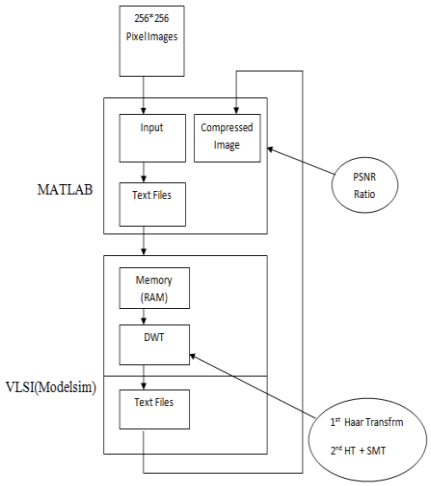


**Fig. 5:** Work Flow Diagram.

Where $x_{LL}$ (n1, n2) → input image
J → 2D DWT level
K → filter length

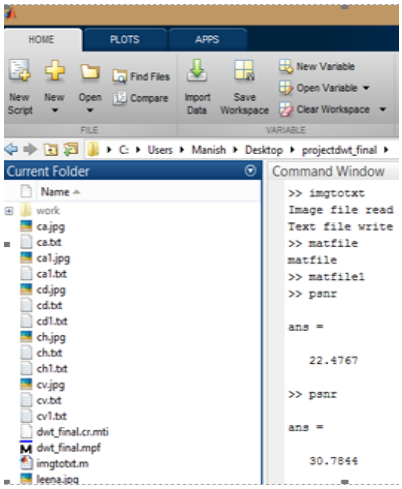


**Fig. 6:** PSNR Variation of Compressed Image.

g(n) →impulse response of the low-pass filter
h(n) →impulse response of the high-pass filter

$$\mathrm{SNR(dB)} = 10\log_{10}\left(\frac{P_{\mathrm{signal}}}{P_{\mathrm{noise}}}\right) = 20\log_{10}\left(\frac{A_{\mathrm{signal}}}{A_{\mathrm{noise}}}\right)$$

Where P is average power and A is RMS amplitude

***System Requirement:***

Processor : Pentium IV and above
Speed : 2 GHz and above
RAM : 1 GB and above
Hard Disk : 40 GB and above
Platform : Windows Xp / Windows 7
Front End : MATLAB 8.1, Modelsim

***Conclusion:***

Images from Haar Transform and segment matrix algorithm pixel value are compared using PSNR ratio. Usually a good image should be greater than 30db (decibel), it is taken as better image for use. Image compression techniques for different images are done based parameters mean square error (MSE), peak signal to noise ratio (PSNR). DWT gives better results without losing more information of image. The presented methods also have relevance for the fields of image segmentation image comparison and image abstraction and we hope to be able to report on results from these fields in the future.

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