

ABSTRACT

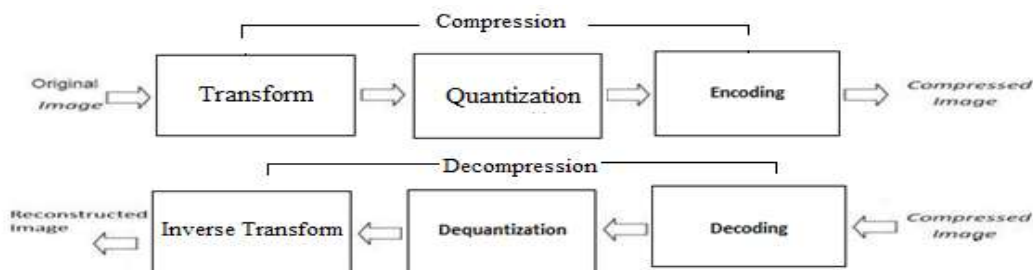
In today's life with the increasing use of digital data in every field every organization has to handle large amount of data. To store this digital data, large disk space is needed. In recent years a lot of research has been done to compress the size of digital data which helps to store data in low disk space and to save the transmission bandwidth required to transmit data. Different types of transforms have been successfully used to compress the images. Image compression can be done by use of single transform or by hybrid of different transforms. Research shows hybrid transforms give better quality of image compression and use of tiling in image compression with hybrid transforms shows better results. Wavelets provide a mathematical way of encoding data. This paper presents the methodology of Image compression by use of tiling with hybrid kekre and haar wavelet transforms. The high frequency data will be removed & then again images are transformed back to spatial domain. The quality of the compressed images has been evaluated using parameters like MSE(Mean Squared Error), PSNR(Peak Signal to Noise Ratio), and CR(Compression Ratio) etc.

KEYWORDS: Image compression, Tiling, Hybrid Kekre and Haar Wavelet Transforms, MSE, PSNR.

INTRODUCTION

Image compression now a days is an important part to be considered by one who is dealing with image processing, image/data storing and transmission etc. Paper work is drastically replacing by digital files. Digital form of data is easy to be processed further, easy to be stored in different places as compared to hard copies. In case of hard copies of record and information, we need a lot of space to store records of so many years. If we want to move that data from one place to another we need heavy transport vehicles. All these problems can be overcome by replacing it with digital form of data. But in case of digital form of Images and other data files large disk space is needed to store the data. In case of transmitting digital data, large bandwidth is required. So to overcome these hurdles in handling, digital data compression is needed. A compressed file can be stored in low disk space and low bandwidth is required for transmission. But compression techniques should also be efficient enough, so that the information/data should not be lost at the time of decompression. Many attempts have been successfully done to compress and decompress data with minimum loss of information.

Figure 1



General process of image compression

In image compression, transform is applied on the original image to be compressed, then quantization is done and quantized data is fed to the encoder after that compressed image is achieved. In decompression process compressed image is decoded by decoder section and after decoding data is dequantized. Then reconstructed image can be achieved by applying inverse of the respective transform. There are different types of compression. Mainly there are two types: Lossy Compression and Lossless compression. Lossless methods are the attempt to compress data without losing its original information. Lossless image compression schemes exploit redundancies without incurring any loss of data. Lossless image compression is therefore exactly reversible. Lossless image compression techniques first convert the images in to the image pixels. Then processing is done on each single pixel. Different Encoding Methods are Run Length, Huffman, Arithmetic, L-Z etc. In case of Lossy methods, some information is lost at the time of decompression but this loss of information should be within tolerable limits. In this, data after compression and decompression retrieves a file that is not exactly as the original data, as there will be loss of data. The image is first transformed into a string of symbols, which are quantized to a discrete set of allowable levels. If the loss in reconstruction quality is acceptable to our visual perception, then this can be used.

Compression can be done by using different transforms. Each transform has its own way to compress data successfully. Different transforms are used for different types of images. Compression can be done by use of single transform or hybrid transform. Last few years' research shows that hybrid of different transforms result in better image compression rather than using a single transform[2].

Tiling in Image Processing

Tile-based processing consists of dividing an image into small, rectangular pieces called "tiles," processing each tile, and reassembling the image [6]. The principle of locality applies, so an image-processing operation usually requires input tiles of approximately the same area as the output tile. Image can be divided in 4 tiles, 16 tiles, etc. and transforms are applied on these tiles, feature sets can be obtained to be used in image retrieval. Clearly, processing each tile requires less memory than processing the entire image.

Figure 2



Tiling of an image 1T and 4T respectively

TRANSFORM CODING

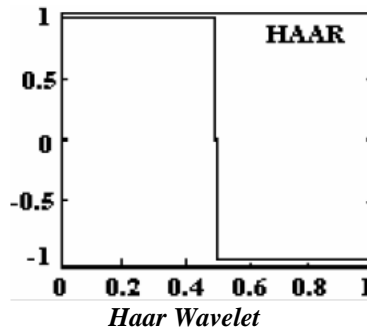
Image compression can be done by using different types of transforms. Here hybrid of two different transforms Haar and Kekre are used. Transform coding techniques [9] use a reversible, linear mathematical transform to map the pixel values onto a set of coefficients, which are then quantized and encoded. Transform coding relies on the premise that pixels in an image exhibit a certain level of correlation with their neighboring pixels. Consequently, these correlations can be exploited to predict the value of a pixel from its respective neighbors. Different commonly used mathematical transforms are DCT, DWT, HWT, & Kekre etc. Transforms used in the presented methodology have been explained below.

Haar Transform

Haar wavelet compression is an efficient way to perform. The Haar wavelet is also the simplest possible wavelet. [7] Haar Transform is a very fast transform as its computational speed is high. It is memory efficient, since it can be calculated in place without a temporary array. In Haar Transform the original signal is split into a low and a high frequency part and filters enabling the splitting without duplicating information are said to be orthogonal. [8]. Implementing the discrete Haar transform consists of acting on a matrix row-wise finding the sums and differences of consecutive elements. To calculate the Haar transform of an array of n samples:

- [1] Treat the array as $n/2$ pairs called (a, b)
- [2] Calculate $(a + b) / \sqrt{2}$ for each pair, these values will be the first half of the output array.
- [3] Calculate $(a - b) / \sqrt{2}$ for each pair, these values will be the second half.
- [4] Repeat the process on the first half of the array

Figure 3



Kekre Transform

Kekre Transform [6] matrix is the generic version of Kekre's LUV color space matrix. Kekre Transform matrix can be of any size $N \times N$, which need not have to be in powers of 2 (as is the case with most of other transforms). All upper diagonal and diagonal values of Kekre's transform matrix are one, while the lower diagonal part except the values just below diagonal is zero. The formula for generating the term K_{xy} of Kekre Transform matrix is :

$$K_{xy} = \begin{cases} 1 & : x \leq y \\ -N + (x - 1) & : x = y - 1 \\ 0 & : x > y + 1 \end{cases}$$

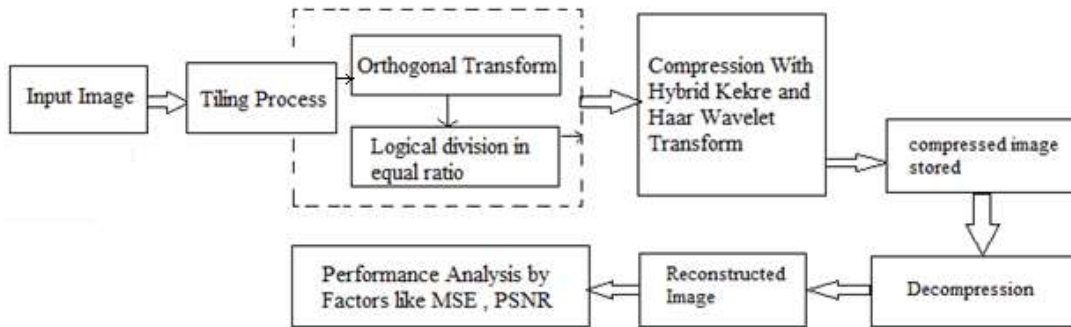
Quantizer

A quantizer is used to reduce the number of bits needed to store the transformed coefficients by reducing the precision of those values. As it is a many-to-one mapping, it is a lossy process and is the main source of compression in an encoder.

METHODOLGY

The proposed method is implemented using MATLAB. During testing, four different types of images of size 512*512 were compressed using the proposed method. Compression of digital images by use of haar wavelet and kekre transformation is done. Hybrid of haar wavelet and kekre transformation has been applied. Initially an image database is prepared and image is loaded. Image tiling is carried out in next step. Orthogonal transform is used to bring about logical division of image into equal ratio(4T). Then compression is done by using KekreHaar wavelet hybrid transform which is followed by the performance analysis parameters like MSE (Mean Squared Error), PSNR(Peak Signal to Noise Ratio), and CR(Compression Ratio) etc.

Figure 4



Process of image compression with tiling using Hybrid Kekre and Haar Wavelet Transform

RESULTS AND DISCUSSION

To evaluate the performance of the proposed approach of image compression using hybrid Kekre-haar wavelet transforms with tiling, four standard images are considered. The PSNR and MSE are mostly used as a measure of quality of reconstruction of image compression. Formulae for PSNR and MSE are given below

Formulae:

$$PSNR = 10 \log_{10} \left[\frac{R^2}{MSE} \right] \quad (1)$$

Where, R is the maximum possible pixel value of the image. For 8 bit pixel value R=255.

$$PSNR = 10 \log_{10} \left[\frac{R^2}{MSE(RGB)} \right] \quad (2)$$

Above formulae is for color images with three RGB values per pixel

$$MSE = \frac{\sum_{m,n} [I_{input}(m,n) - I_{reconstructed}(m,n)]^2}{m*n} \quad (3)$$

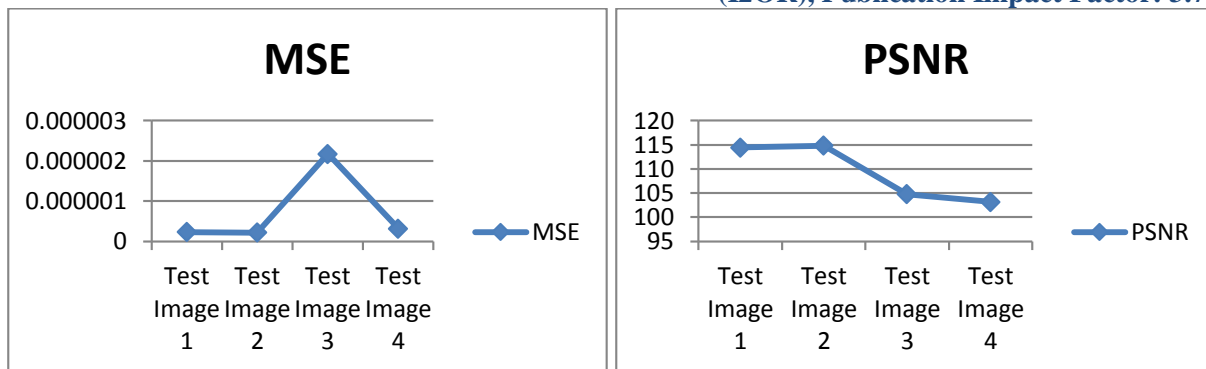
Where 'm' and 'n' are the number of rows and columns, respectively, in the two images (the original image I_{input} and its reconstructed image $I_{reconstructed}$).

Table 1

Haar Kekre	Input Test Images			
	Test Image 1	Test Image 2	Test Image 3	Test Image 4
	Values of MSE for different Test Images with C.R(95%)			
4T	$2.34*10^{-7}$	$2.15*10^{-7}$	$2.17*10^{-6}$	$3.14*10^{-7}$
	Values of PSNR for the same			
4T	114.43db	114.80db	104.76db	103.16db

Values of MSE and PSNR with 4 tiles with C.R(95%) using different test images, transformed using hybrid Haar and Kekre Transforms.

Figure 5



Values of MSE and PSNR respectively for different Test images

CONCLUSION

Here in this approach, image compression is done with tiling, it is proved that image compression with tiling gives better quality. Previous research also shows that hybrid transforms give better results as compared to individual transforms, an attempt of showing effect of tiling with hybrid kekre and DCT shows very good results in MSE of original and reconstructed images. Haar wavelet, the simplest possible wavelet, which is a very fast transform as its computational speed is high and is memory efficient also. As per previous research it has been proved that Haar gives better results of MSE as compared to DCT. So Hybrid Kekre and Haar wavelet transforms are used here with tiling to compress the images to get improved results. Results can be analyzed by using parameters like MSE, PSNR, CR etc.

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