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Research paper

A Study on Wavelet Transform Using Image Analysis

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Abstract

The wavelet transforms have been in use for variety of applications. It is widely being used in signal analysis and image analysis. There have been lot of wavelet transforms for compression, decomposition and reconstruction of images. Out of many transforms Haar wavelet transform is the most computationally feasible wavelet transform to implement. The wave analysis technique has an understandable impact on the removal of noise within the signal. The paper outlines the principles and performance of wavelets in image analysis. Compression performance and decomposition of images into different layers have been discussed in this paper. We used Haar distinct wavelet remodel (HDWT) to compress the image. Simulation of wavelet transform was done in MATLAB. Simulation results are conferred for the compression with Haar rippling with totally different level of decomposition. Energy retention and PSNR values are calculated for the wavelets. Result conjointly reveals that the extent of decomposition will increase beholding of the photographs goes on decreasing however the extent of compression is incredibly high. Experimental results demonstrate the effectiveness of the Haar wavelet transform in energy retention in comparison to other wavelet transforms.

Keywords: *Wavelet, Haar Transform, PSNR, Symmetrical Transform.*

1. Introduction

We can know the feature structure of the image once the phase congruency map of an image is constructed. As mentioned, the prominent way to compress this feature structure is to use a threshold, which reduces a high image representation into binary structure. However, thresholding is after all extremely subjective and within the last detail it eliminates little or much of the vital data in the image.

2. Literature Survey

Tzu-Heng Henry Lee [1] has given a paper named Wavelet Analysis for Image Processing. In view of this paper wavelet transform has an important role in image compression. Wavelet transform is more applicable than the Fourier transform because the Fourier requires all the pervious and future information about the signal for the entire time domain to compute spectral information as it cannot observe frequency varying wit time because the resulting function is independent of time but whereas the wavelet transforms depends on wavelet were they are varying frequency in limited duration.

Colm Mulcahy [2] who is a famous mathematical professor has given a paper named Image compression using the Haar wavelet transform. In the view of this paper Haar wavelets can be applied on digital images for compression and decomposition. wavelet transform by dividing an image into 128*128 matrix. This matrix helps to determine the pixels in the picture. By using progressive image transmission an image can be transmitted with detailed coefficients for both one and multi-dimensional data analysis wavelet methods provides some better results when compared to Fourier methods.

In 2013 Miss. S.S. Tamboli1, Dr. V. R. Udupi [3] has given a paper named Image compression using Haar wavelet transform. In the view of this paper wavelet transform need to follow perfect reconstruction where original signal must be synthesized from the wavelet coefficients. Image compression must be loss less compression. We can alter the matrices by changing the entries to zero. Nonnegative value can be fixed and for lossy compression matrix need to be sparser.

In 2014 Avinash Ghorpade, Priyanka Katkar [4] has given a paper named Image Compression Using Haar Transform and Modified Fast Haar Wavelet Transform. In the view of this paper Haar wavelet is one of the simplest transformation with respect to local frequency domain. For every row in a matrix a vector must be defined. Modified fast haar wavelet transform is faster than normal haar transform. And the main advantage of using haar is it uses low memory space and helps in fast transformation.

In 2007 Kamrul Hasan Talukder and Koichi Haradal [5] has given a paper named Haar Wavelet Based Approach for Image Compression and Quality Assessment of Compressed Image. In view of this paper image consists of unnecessary data that is it has the same information from various point of view. When we use the data compression techniques we can certainly remove some of the unnecessary data which is present in the image. While using those techniques it decrease's the size in bytes of graphic file without lowering its quality to an unacceptable level, which also helps in time reduction for sending the images over the web. By removing the redundant data certain amount of disk space is allotted where we can store more images.

In 2014 Rathee, Alka Vij [6] has given a paper named Image Compression using Discrete Haar Wavelet Transforms. In view of this paper from past few years, as importance for the storage and transmission of digital images is increasing the image compression has become an important application for it. Communication of multimedia data by telecommunication network, using the multimedia information through web and by the usage of digital cameras necessity for storage, manipulation is rapidly increasing. Discrete wavelet transformation which is done by embedded zero tree encoding is very useful method for image compression.

In 2015 Prabhjot Kour [7] released a paper with the tittle Image processing using discrete wavelet transform which talks about the size of images where they are constantly increasing. While the technology is increasing rapidly many products in the market have been for control and display with Image Compression has the primary process.

In 2012 Sunil Agrawal, Jaskirat Kaur, Renu Vig [8] has published a paper named A Comparative Analysis of Threshold and edge Detection Segmentation Techniques where it refers to the threshold and edge detection becomes prior for analyzing the image because it helps in extracting the basic shape of the image. For analyzing the image, they have used Geo satellite images, medical images. To hold the viscosity of the results error measure is used.

In the year 2017 an article has been published by R.El Ayachi, B.Bouikhalene, M.Fakir [9] titled as new image compression Algorithm using Haar wavelet transform where they discussed about the compression techniques for decreasing the capacity and transmission time. For which they proposed an algorithm based on Haar Wavelet with compression coefficient that handles the compression levels. So, it helps in reducing the complex process for obtaining the excepted level of compression from the original image.

3. Theoretical Analysis

This section contains the implementation of Haar wavelet transform for decomposition of images, de-noising and compression. The two-dimensional Haar wavelet transform decomposes the image into three levels. It produces a vector of detailed and approximation coefficients. After the decomposition of the image, we take another noisy image and denoise it to remove any kind of noises in it and reconstruct it. The PSNR values are calculated after the reconstruction of the denoised image. It is calculated as

$$PSNR = 20 * log10\,(\frac{b}{rms})$$

Where *b* is the largest possible value of a signal and *rms* is the root mean square difference between the noisy and denoised image.

Compression of knowledge is taking part in a major role thereby prioritizing it so that we can store huge amount of data as much as possible within a small unit. This also further helps in fast transmission speed. These needs don't seem to be in transaction or relation with previous techniques of compression like Fourier remodel, Haar and cos remodel etc. but are attributable to massive mean sq. error occurring between original and reconstructed pictures. The rippling remodel approach serves the aim terribly expeditiously. The core plan behind the compression is that in most of the pictures we can discover that neighboring pixels are extremely related to and have redundant info. it's thus, necessary to seek out a less related to illustration of the image and it is often done by removing redundancy and non-relative pixels. Redundancy reduction removes duplication in image and non- relativeness reduction omits that part of the signal that isn't noticed by Human sensory system. The Haar remodel is memory economical and is specifically reversible while not the sting effects but it's quick and straightforward. Changed quick Haar rippling remodel is one amongst the algorithms which may cut back the tedious work of calculations. We take another image and compress it to see how much of energy from original image is retained.

Approximation coefficient: It contains the most of the features of the image. If we remove this approximation coefficient from there will be maximum distortion in the image.

Horizontal coefficient: It has the hidden vertical lines information of the image. If this coefficient is excluded from the image the horizontal details of the image is lost.

Vertical coefficient: It contains the hidden horizontal lines information of the original image. If this coefficient is excluded from the image all the vertical details of the image is lost.

Diagonal coefficient: It contains the diagonal details of the input image. Removing this coefficient will not lead to minimum distortion in the image.

4. Results

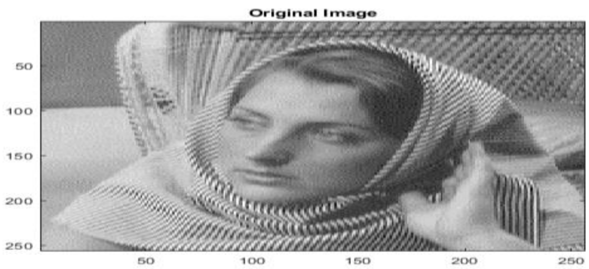

Figure 1: Original image before decomposition

After decomposition into three levels, the image is shown using the approximation, horizontal, vertical and diagonal coefficients.

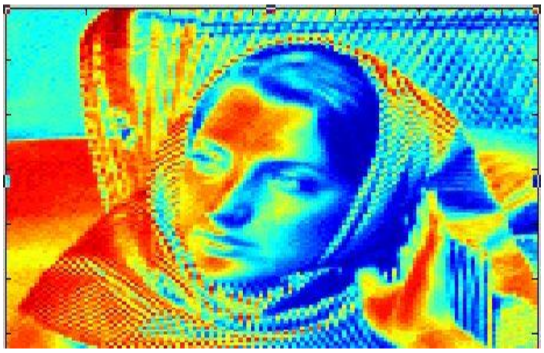

Figure 2: Approximation Coefficient

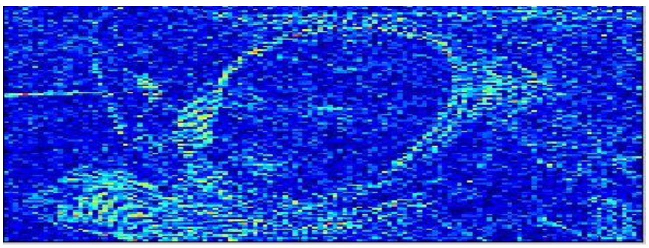

Figure 3: Horizontal Coefficient

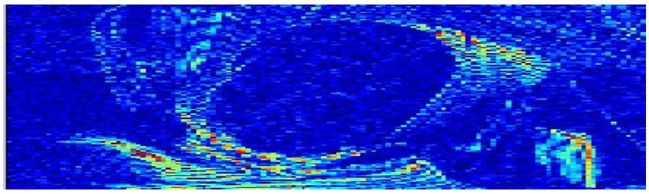

Figure 4: Vertical Coefficient

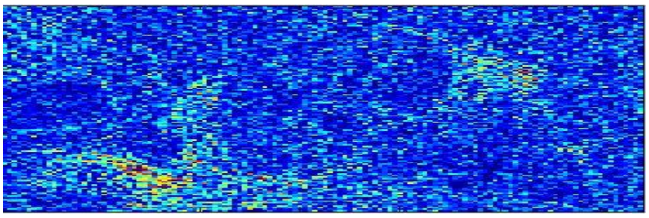

Figure 5: Diagonal Coefficient

Figure 6: Original image before compression

Figure 7: Image after compression

Table 1: Comparison of PSNR values of different wavelet transforms

Wavelet Transform	PSNR
Symmetrical	37.349
Haar	37.526

Table 2: Comparison of Energy Retention in compression of wavelet transforms

Wavelet Transform	Energy Retention
Symmetrical	97.35
Haar	98.91

5. Conclusions

The edge that Haar transform has over symmetrical wavelet transforms is its computationally more feasible to implement and it also offers the best compression ratio than other transforms. The PSNR values for denoising images is also more in Haar than in symmetrical wavelet transform. We have taken an input image for compression and after decomposition of image and compression, the compressed image has retained 98.91% of original image. This can be hugely advantageous for file transfer over the network. Without losing the quality of the image it can be transferred easily and swiftly.

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