WAVELET BASED IMAGE COMPRESSION

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Abstract- Wavelet is a recently developed compression technique in image compression. In this study, after multiple level 2-D wavelet transform of images, approximation and detail coefficients are obtained. These coefficients are quantized that more important coefficients are represented with higher accuracy and retained coefficients are represented with less accuracy or they are neglected. Afterward the quantized coefficient (symbols) is coded in a bit stream using recursive splitting Huffman coding. The quality of reconstructed images is measured with PSNR value, and compression ratio is calculated using given formula. Generally wavelet performs better Discrete Wavelet Transform (DWT) for image compression using MATLAB. In this approach we use JPEG2000 standard for both lossy and lossless compression. In order to reduce complexities of the design linear algebra view of DWT has been used in this concept.

Keywords- DWT, MATLAB

I.INTRODUCTION

During last decade there has been enormous increase in digital images. This type of information gives rise to high transmission and storage cost. To store these images or make them available over networks, compression techniques are needed. Image compression plays a critical role in telematics applications, where it is desired that either single images or sequences of images be transmitted over computer networks at large distances so as that they could be used for a multitude of purposes. Image compression is a fast paced and dynamically changing field with many different varieties of compression methods available. Images contain large amount of data hidden in them, which is highly correlated. A common characteristic of most images is that the neighbouring pixels are correlated and therefore contain redundant information.

There are three types of redundancy that can be exploited by image compression systems.

- Spatial redundancy; in almost all natural images the values of neighbouring pixels are strongly correlated.
- Spectral redundancy; in images composed of more than one spectral band the spectral values for the same pixel location are often correlated.
- Temporal redundancy; Adjacent frames in videosequence often show very little change.

Research advances in wavelet theory have created a surge of interest in applications like image compression. Mainly compression methods can be divided into two classes; lossless and lossy compression techniques:

- Lossless compression guarantees thêiginal signal can be reconstructed without any errors. This is important for application like compression of text or medical images.

- Lossy compression gives higher compression rates. But exact data cannot be reconstructed. Human visual system is not sensitive or has low sensitivity to some kind of errors. That's why the compression potential is much higher when small reconstruction errors are allowed.

The investigation and design of computationally efficient and effective software algorithms for lossy image compression forms the primary objective of this thesis.

II. IMAGE QUALTY MEASUREMENT

The two most prominently used parameters that define the quality of the image are:

- Compression Ratio (CR) can be defined by the following formula:

$$\text{Compression Ratio} = 100 - \left[\frac{no.of\ bits\ in\ the\ ompressed\ image}{no.of\ bits\ in\ original\ image}\right] \times 100 \qquad (1)$$

- Peak Signal to Noise Ratio (PSNR) can be defined by the following formula:

$$\text{Peak Signal to Noise Ratio} = 20\log_{10}\frac{MX}{RMSE} \qquad (2)$$

Where:

MX is the image depth
RSME is the root mean square error which can be further defined by the following formula:

$$\text{RSME} = \sqrt{\frac{1}{SP}\sum_{x=1}^{S}\sum_{y=1}^{P}[f(x,y)-f'(x,y)]^2} \quad (3)$$

Where:
Sand P is the width and the height of the given image in pixels.
f is the original image
f' is the reconstructed image after decompression

III. ANALYSIS OF WAVELET

The most widely used mathematical technique for analysing any given signal is Fourier analysis. What Fourier analysis does is that it breaks a signal into sinusoids of different frequencies, thus requiring all previous and future information about the signal over the time domain thus resulting in a function which is independent on the time. This can be usefully for applications where the analysis of both time and frequency domain is not required at the same time. In case of image compression wavelet transform is considered more suitable than Fourier transform as it helps to overcome the drawbacks of Fourier transform. Wavelets are mathematical functions that cut up data into different frequency components and then study each component with resolution matched to its scale. They have advantage over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes. Wavelet transform can be expressed by the following formula:

$$f = \sum_i a_i \varphi_i \quad (4)$$

IV. DISCRETE WAVELET TRANSFORM

Image compression by wavelets is the order of the day as it has several advantages over the other compression techniques. Firstly, it uses a basis function that decreases the size of the expansion coefficients to a minimum value as the index values increase. It not only allows for a more precise but also a localized isolation and description of the signal characteristics. Secondly, the flexibility of choosing a wavelet gives scope to design wavelets tailored to fit the requirements. Calculating the wavelet coefficients at every possible scale generates a lot of awful data. If scales and positions based on powers of 2 –called dyadic scales and positions- are chosen then analysis become more efficient and accurate. Such an analysis obtained from the discrete wavelet transforms (DWT). The analysis start from signal s and results in the coefficients C(a,b).

$$C(a,b)=C(j,k)=\sum_{n\in Z} s(n)g_{j,k}(n)$$
(5)

In most of the signals we see that the low frequency content is the contains important information and the high frequency content has less importance.

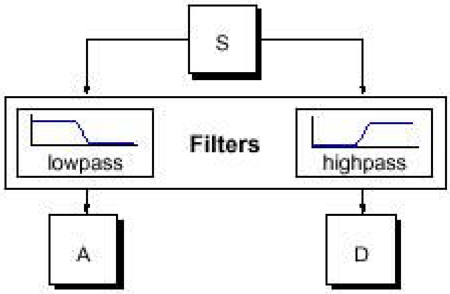

Fig1. The signal S passes through 2 filters to produce 2 signals

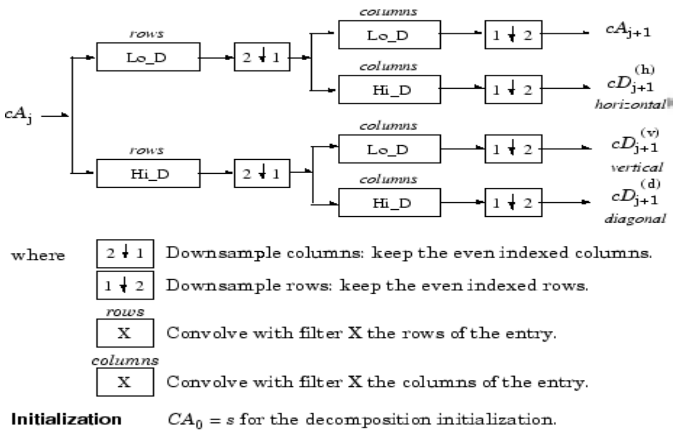

Fig2. 2-D Discrete Wavelet transforms

V. INVERSE DESCRETE WAVELET TRANSFORMATION

Any signal (s) decomposed through wavelet transform can be reciprocated back to the original signal by Inverse discrete wavelet transforms. The above synthesis can be represented by the following equation:

$$s(t)=\sum_{j\in Z}\sum_{k\in Z} C(j,k)\varphi_{j,k}(t) \quad (6)$$

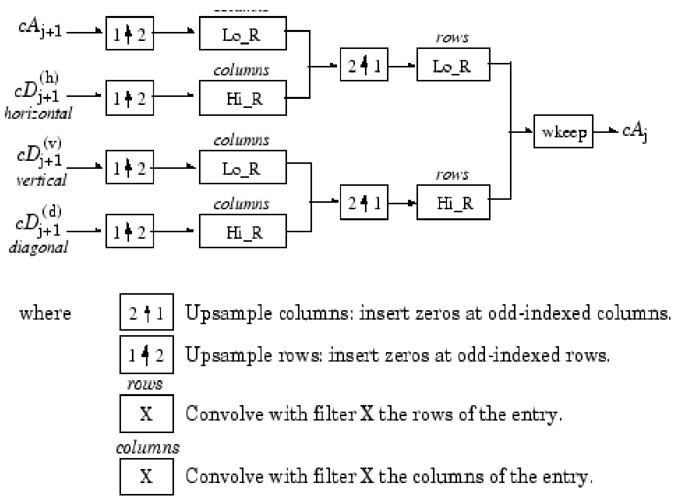

Fig3. 2-D Inverse Discrete Wavelet transforms

VI. IMAGE COMPRESSION USING DWT

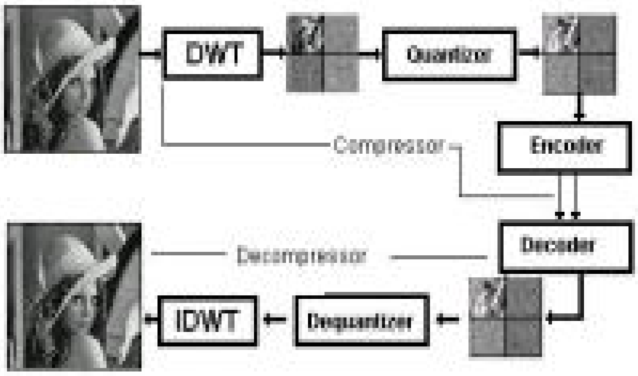

Fig4. Block Diagram for wavelet image coders

In this paper we have mentioned wide variety of wavelet based image compression scheme like simple entropy coding to more complex techniques such as vector quantisation [5] adaptive transform [6] tree encoding [7] edge based coding and Huffman coding. The general framework in which the wavelet based scheme work can be demonstrated through the fig 4. In the above mentioned method the first step is to perform wavelet transform of the given images, and detail coefficients are obtained. In the second step the coefficients obtained are quantised In the next step the quantised coefficient are coded in a bit stream using recursive splitting Huffman coding and compressed data is obtained. The decompression process is just the inverse. To decompress, the compressed images are decoded and then de-quantised to obtain the wavelet coefficients. In the last step we apply the inverse discrete wavelet transform original image reconstructed. The quality of reconstructed images is determined by examining the PSNR value, and compression.

VII. CONCLUSION

Wavelets have made incredible advancement in the last few years. Image compression techniques that use wavelets have become very popular because the decompressed image is better in quality that the Jpeg which is the current international standard for image compression. In this study multiple-level decomposition of images and compression of images using different wavelet families have been showed. The results is found that wavelet has better performance in image compression than known standards. That's why wavelet becomes new international standards for image compression.

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