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Image Decomposition & Compression using Discrete Wavelet Transform and Sub band Coding

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Abstract: ***Here in this paper we are suggesting a new image compression scheme by using an intensive scheme known as discrete wavelet transformation (DWT), which is based on attempting to preserve the texturally important image properties. The main aspect of the proposed methodology works on the principle that, the image is divided into regions of various significance employing pixels descriptors as criteria and fuzzy clustering methodologies. Wavelet compression is accomplished by decomposing the row and column of the image matrix using the Discrete Wavelet transform. The construction of decomposed the image is feasible just from 1/3th of the decomposed image and even 1/10th of the decomposed image is enough for re-construction and the quality very much depends upon the nature the image. A Rapid and very effective histogram-based quantization method is applied to the decomposed image. More specifically, The DWT is applied separately to each and every region or pixel of image in which the original image is segmented and, depending on how it has been clearly clustered, its related number of all the wavelet coefficients are kept and then, determined. Different compression ratios are applied to the Specific Image. The reconstruction process of the original image involves the linear but complex combination of its corresponding reconstructed clusters. An experimental has been conducted to exactly assessing the proposed compression approach. Moreover, this research work aims at comparing different measures in terms of their results concerning the quality of the reconstructed image.***

Keywords: Discrete Wavelet Transform, Haar Wavelet, Image Compression, Decomposition, Multiresolution Analysis.

1. Introduction

The computer is becoming more and more powerful day by day. As a result of which the use of digital images are increasing day by day. Along with this wide use of digital images comes the serious issue of storing and transferring the huge volume of data representing the images because the uncompressed multimedia (graphics, audio and video) data requires considerable storage capacity and transmission bandwidth. Though there is a rapid progress in mass storage density, speed of the processor and the performance of the digital communication systems, the demand for data storage capacity and data transmission bandwidth continues to exceed the capabilities of on hand technologies. Besides, the latest growth of data intensive multimedia based web applications has put much pressure on the researchers to find the way of using the images in the web applications more effectively. Internet teleconferencing, High Definition Television (HDTV), satellite communications and digital storage of movies are not feasible without a high degree of compression. As it is, such applications are far from realizing their full potential largely due to the limitations of common image compression techniques [1].

Images contain large amounts of various information's which requires large storage space, large transmission bandwidths and at the same time more transmission times. Though it would be more advantageous to compress the image by keeping only the useful information which is needed rebuilt the image. An image can be understood of as a matrix array of pixel (or intensity) values. In order to achieve the compressed image, vulnerabilities must be exploited, As areas where there is small or no change between pixel values By doing so the images having large areas of same colour will have large redundancies, and simultaneously images that have repeated and large changes in colour will be less vulnerable and tough to compress. Discrete Wavelet analysis can be done to divide the information of an image into approximation and detailed sub signals. The approximation sub signal shows the common trend of cluster values, and various detailed sub signals show the vertical, horizontal and diagonal details or changes in the image. Sometimes these details are very small so that they can be set to zero without changing the image. The value under which details are considered small enough and can set to zero is known as the threshold limit of any image. As more the no of zeros more the compression that can be achieved. The amount of information gained by an image after compression and decompression is known as the signals retained and this is proportional to the total of the squares of the pixel values. If the energy retained is 100% then the compression is known as ëlosslessí, as the image can be reconstructed exactly. This occurs when the threshold value is set to zero, meaning that the detail has not been changed. If any values are changed then energy will be lost and this is known as ëlossyí compression. Ideally, during compression the number of zeros and the energy retention will be as high as possible. However, as more zeros are obtained more energy is lost, so a balance between the two needs to be found.

There are a number of various methods in which image files can be compressed. There are two main common compressed graphic image formats namely Joint Photographic Experts Group (JPEG, usually pronounced as JAY-pehg) [2] and Graphic Interchange Format (GIF) for the use in the Internet. The JPEG method established by ISO (International Standards Organization) and IEC (International Electro-Technical Commission) is more often used for photographs, while the GIF method is commonly used for line art and other images in which geometric shapes are relatively simple. More recently, the wavelet transform has emerged as a cutting edge technology, within the field of image analysis.

As listed below, the top contenders in the JPEG-2000 standard [3] are all wavelet-based compression algorithms.

- Wavelet coding schemes at higher compression avoid blocking artifacts.
- They are better matched to the HVS (Human Visual System) characteristics.
- Compression with wavelets is scalable as the transform process can be applied to an image as many times as wanted and hence very high compression ratios can be achieved.
- Wavelet based compression allow parametric gain control for image softening and sharpening.
- Wavelet-based coding is more robust under transmission and decoding errors, and also facilitates progressive transmission of images.
- •Wavelet compression is very efficient at low bit rates.
- Wavelts provide an efficient decomposition of signals prior to compression.

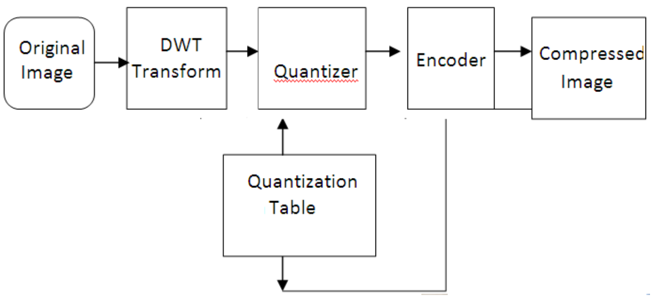


Figure1: Encoder Block Diagram

2. Background

Before we go into details of the method, we present some background topics of image compression which include the principles of image compression, the classification of compression methods and the framework of a general image coder and wavelets for image compression. Before we go into details of the method, we present some background topics of image compression which include the principles of image compression, the classification of compression methods and the framework of a general image coder and wavelets for image compression.

A. Multiresolution and Wavelets

The power of Wavelets comes from the use of multiresolution. Rather than examining entire signals through the same window, different parts of the wave are viewed through different size windows (or resolutions). High frequency parts of the signal use a small window to give good time resolution, low frequency parts use a big window to get good frequency information. An important thing to note is that the 'windows' have equal area even though the height and width may vary in wavelet analysis. The area of the window is controlled by Heisenberg's Uncertainty principle, as frequency resolution gets bigger the time resolution must get smaller.

B. Principles of Image Compression

An ordinary characteristic of most images is that the neighboring pixels are correlated and therefore hold redundant information. The foremost task then is to find out less correlated representation of the image. Two elementary components of compression are redundancy and irrelevancy reduction. Redundancy reduction aims at removing duplication from the signal source image. Irrelevancy reduction omits parts of the signal that is not noticed by the signal receiver, namely the Human Visual System (HVS). In general, three types of redundancy can be identified: (a) Spatial Redundancy or correlation between neighboring pixel values, (b) Spectral Redundancy or correlation between different color planes or spectral bands and (c) Temporal Redundancy or correlation between adjacent frames in a sequence of images especially in video applications. Image compression research aims at reducing the number of bits needed to represent an image by removing the spatial and spectral redundancies as much as possible.

C. Wavelets for image compression

Wavelet transform exploits both the spatial and frequency correlation of data by dilations (or contractions) and translations of mother wavelet on the input data. It supports the multiresolution analysis of data i.e. it can be applied to different scales according to the details required, which allows progressive transmission and zooming of the image without the need of extra storage. Another encouraging feature of wavelet transform is its symmetric nature that is both the forward and the inverse transform has the same complexity, building fast compression and decompression routines. Its characteristics well suited for image compression include the ability to take into account of Human Visual System's (HVS) characteristics, very good energy compaction capabilities, robustness under transmission, high compression ratio etc.

The implementation of wavelet compression scheme is very similar to that of subband coding scheme: the signal is decomposed using filter banks. The output of the filter banks is down-sampled, quantized, and encoded. The decoder decodes the coded representation, up-samples and recomposes the signal.

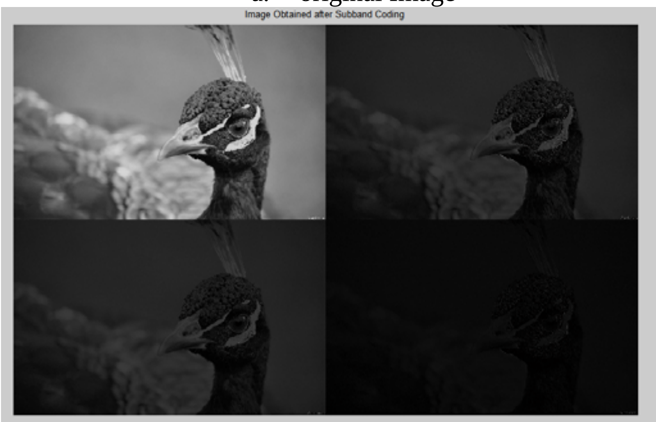
3. Proposed Work

In this research a new and very effective image compression scheme is proposed and tested based on discrete wavelet transform those results less mathematical complexity with no tolerance in image quality. The effect of the proposed algorithm has been compared with some other common compression standards. Various quality measurement and variables like SNR, peak signal to noise ratio (PSNR) and mean square error have been evaluated to determine how good an image is reproduced with respect to the reference image.

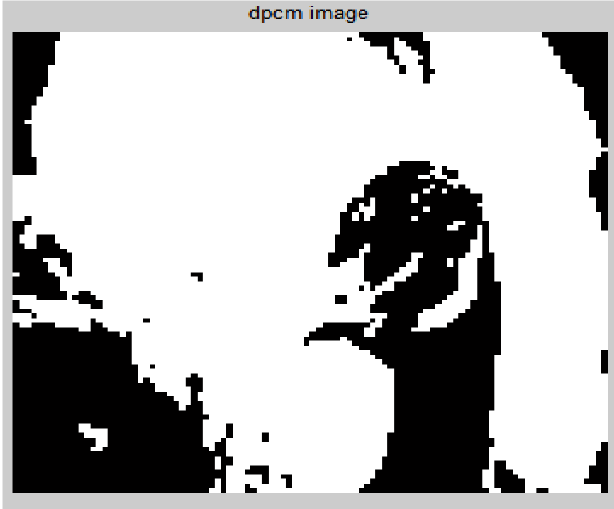
4. Results and Analysis

In this research, an effective compression technique based on discrete wavelet transform (DWT) and sub band encoding is proposed and developed. The algorithm and code has been implemented using MATLAB Tool In which a bunch of test images are taken to justify the effectiveness of the proposed algorithm. Below Figures shows a test image and resulting compressed images using JPEG, GIF and the proposed compression methods.

a. original Image



b. image after subband coding



c. DPCM Image

d. Original Image

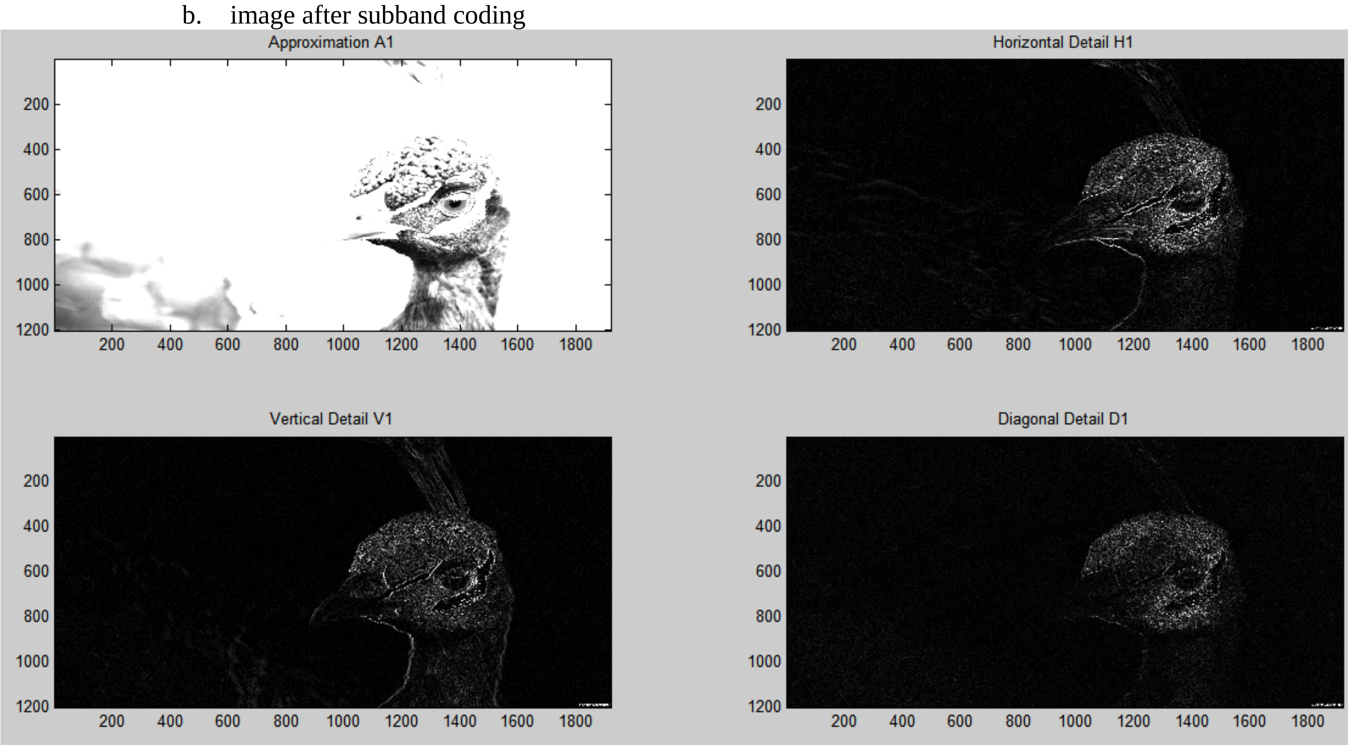


Figure 2: Approximation A1

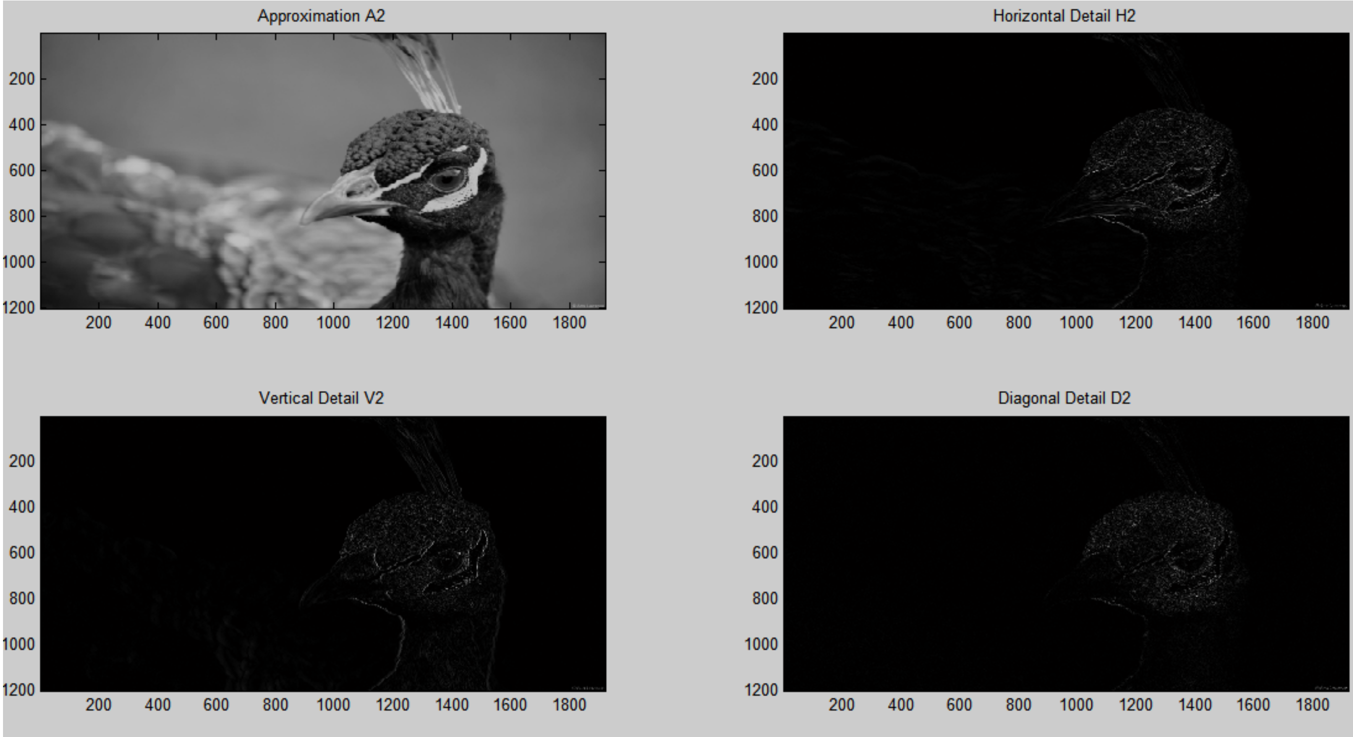


Figure 3: Approximation A2

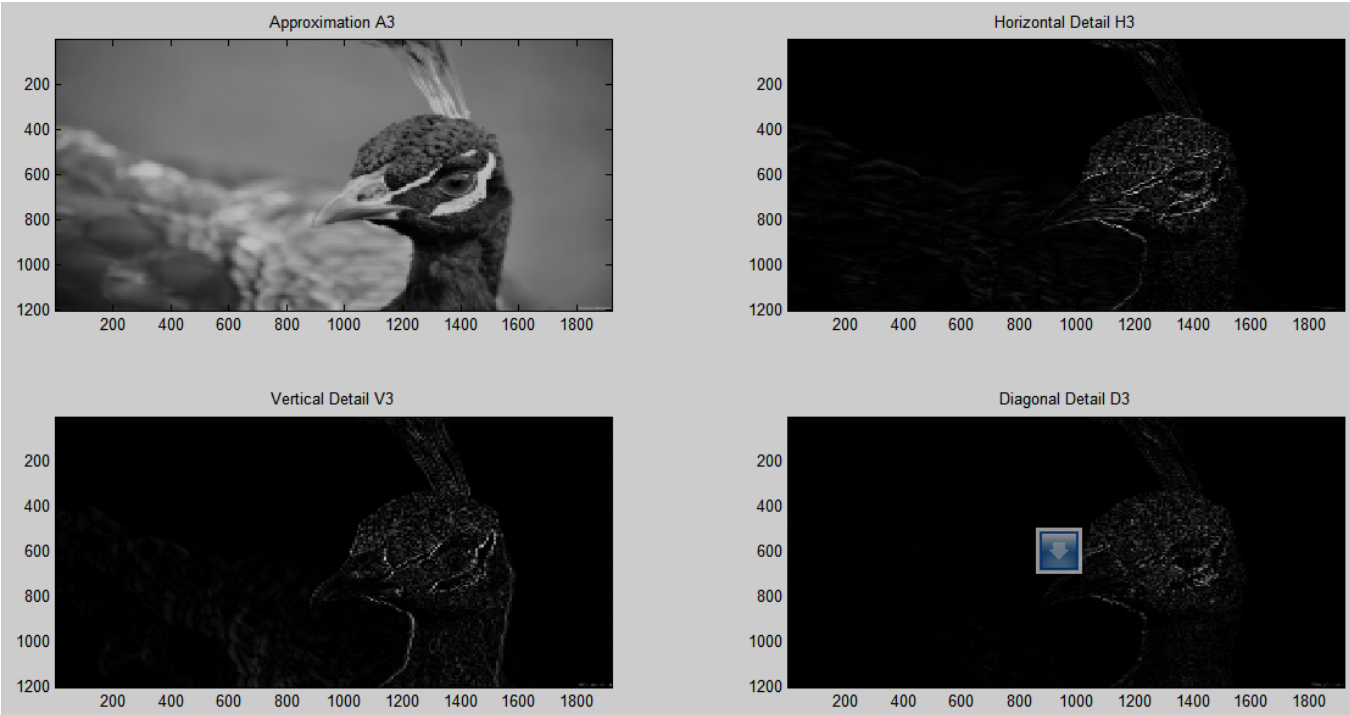


Figure 3: Approximation A3

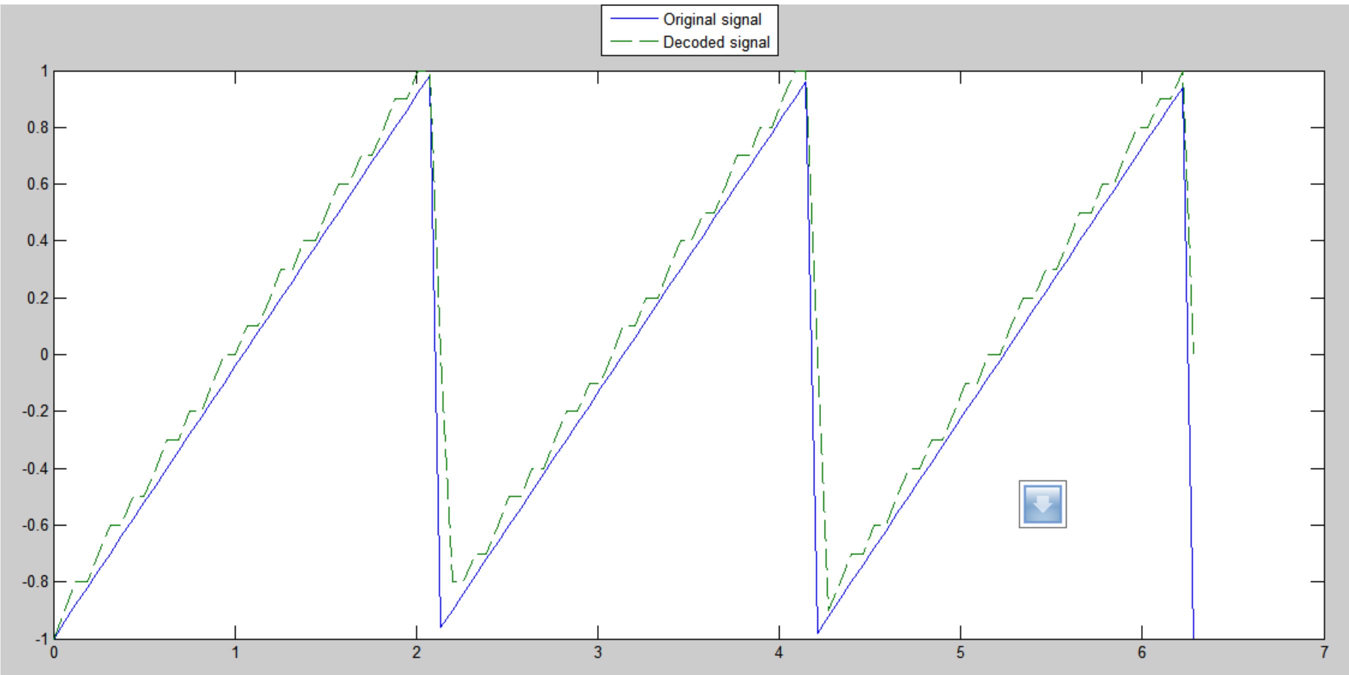


Figure 5: Waveform after Compression

5. Conclusion & Future Work

A new image compression scheme based on discrete wavelet transform has been evaluated in this work which gives sufficient high compression ratios with no degradation in quality of image. The effectiveness of this method has been justified using a set of original images. The images are taken randomly. To see the performance of the suggested method, a comparison between various technique and other common compression techniques has been done, As results of which it has been evaluated tat, the suggested algorithm gives far better performance than other compression techniques. Wavelets are better suited to time-limited data and wavelet based compression technique maintains better image quality by reducing errors. Further this research can also be implemented as a compression technique using neural network.

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