Wavelet Based Compression Techniques: A Survey

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Abstract. The main purpose of image compression is to reduce the memory space or transmission time and that of cryptography is to keep the security of the data. These two technologies are separate. But in some cases an image can be compressed if necessary, and then encrypted. To encrypt the compressed data and for transformation function many techniques are used in several areas. In this work, some of the Discrete Wavelet Transform based methods are discussed and a comparative study is performed between these methods. Then states the advantages of Discrete Wavelet Transform. Out of these methods Resolution Progressive Compression provides the best features.

Keywords: CREW, EBCOT, RPC.

1 Introduction

The image compression algorithms are mainly used for reducing the redundancy and irrelevancy and can thus store the image efficiently. The main goal of image compression is to achieve the quality of the image at a given bit rate or the compression rate. Mainly compression techniques are categorized into two such as lossless and lossy compression[1]. For compression several techniques are used. Some of these techniques are applicable to gray scale images, some others to color images and some others do both. There are various types of coding techniques. Here only the Discrete Wavelet Transform based method is focused.

This section gives an idea about the basic techniques used in image processing and the types of compression techniques. In the following sections, section 2 explains the transform coding and section 3 compares the these different techniques, section 4 explains advantages of DWT and the conclusion is in section 5.

2 Transform Based Techniques

In transform coding the pixel values are transformed from spatial to frequency domain. The basic steps in transform coding is shown in Fig. 1. Here the Discrete Wavelet Transform(DWT)[2][3] based technique is described based on several methods and a comparison is made between the DWT methods.

V.V. Das and J. Stephen (Eds.): CNC 2012, LNICST 108, pp. 394–397, 2012.

Wavelet transform is a variant of discrete cosine transform(DCT) [4]. Discrete Wavelet Transform(DWT)decomposes a given image into different levels and these decomposition levels contain a number of sub bands, which consist of coefficients that describe the horizontal and vertical spatial frequency characteristics of the original image. The wavelet transform is computed separately for different segments of the time-domain signal at different frequencies. In DWT the compression error is uniform. DWT provides better image quality but the implementation is more expensive.

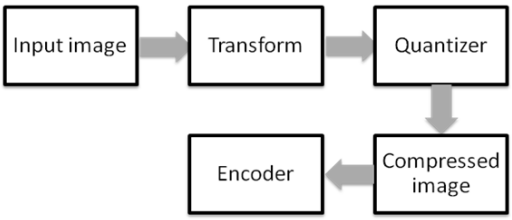

Fig. 1. Transform Based Coding

Several DWT based techniques are existing in image processing. This section gives the basic idea, coding method and features of some methods such as Compression with Reversible Wavelets(CREW), Embedded Block Coder(EBCOT) and Resolution Progressive Compression(RPC) Methods . These comparisons are based on [5][6].

2.1 Compression with Reversible Embedded Wavelet (CREW)

CREW is a wavelet based image compression systems introduced by A. Zandi[6]. It can handle multiple component images. The previous methods do not support region of interest. This method provides high quality image and supports region of interest. Here the natural pyramids of image resolutions are not exploited. This method provides better compression quality and offers flexibility.

Coding method: At first the image is tiled into different regions of rectangular grid. They are called “tile components”. The size of the tile can b chosen by the user. If the size is too small better the compression efficiency. These tile components are coded separately.

2.2 Embedded Block Coding with Optimization Truncation(EBCOT)

The previous schemes EZW and CREW exhibits one or at most two dimensions of scalability. Therefore for exhibiting more scalability David Taubman[6] developed another wavelet based method EBCOT.

Coding method: EBCOT generates a code-block by partitioning each sub bands into small blocks. The code-blocks are of size 64x64 and the sub blocks are of 16x16. The EBCOT algorithm exploits the property of SNR scalability which is achieved by

omitting the unwanted layers. Here the bit plane coder is used. Four types of bit plane coding primitives are used in the significant test such as zero coding(ZC), run length coding(RLC), sign coding(SC) and magnitude refinement(MR).

2.3 Resolution Progressive Compression(RPC)

The previous methods discussed here results rate loss. The method developed by Wei Liu[5] suffered two type of rate loss such as image coding loss and source coding loss compared to previous methods. Resolution Progressive Compression(RPC) is a wavelet transform based compression technique.T o achieve progressive compression, discrete wavelet transform (DWT) coefficients are converted to sign-magnitude form and encoded one bit plane at a time starting with the most-significant magnitude bit plane. The wavelet decomposition uses a reversible transform, so lossless compression isachieved when all subband bit planes are coded. Correlation between adjacent coefficients in a subband is exploited via predictive coding and context modeling.

Coding Method: The encoder gets the cipher text and decomposes it into multiple levels. In Wei Liu work he uses three level decomposition. Then the encoder encodes each subband independently by using the Slepian Wolf Coding and transmits the encoded bits from the lowest to the highest. Here a Context Adaptive Interpolator(CAI) is used for SI generation.. For this four horizontal and vertical neighbours and four diagonal neighbours are used. Here a two step interpolation is used. At first the subimage 11 is interpolated from 00. Then after decoding the subimage 11, 00 and 11 are used for interpolating 01 and 10. The CAI can be calculate according to equation (1).

$$S= \begin{cases} \text{mean(t); if (max(t) - min(t)>=\_ 20)} \\ \text{(t1 + t2) /2; if (|t3 - t4|) -(|t1 - t2|) > 20)} \\ \text{(t3 + t4)/2; if (|t1 - t2|) -(|t1 - t2|) > 20)} \\ \text{median(t); (otherwise) .} \end{cases} \quad (1)$$

Then the interpolated image together with secret key is used as the Side Information to decode the next resolution level. This is repeated until the whole image is decoded. Here the decorrelation task is shifted to the decoder.

Features of RPC

(1) Efficiently exploiting Source dependency in an encrypted image.
(2) Reverse cryptosystem is used in this scheme. Thus the method is more secure.

This section gives the basic idea, coding method and features of the Discrete Wavelet Transform based methods CREW, EBCOT and RPC. Out of these the Resolution Progressive Compression scheme provides best features and performs efficiently.

3 Performance Evaluation

The previous section discussed several DWT techniques. Here certain performance measures are used to compare these techniques. For comparison the performance measures such as compression ratio, peak signal to noise ratio and mean square error. The comparison is shown in Table 1. From these it can be clear that highest PSNR and lowest MSE values provides best features.

Table 1. Comparison Between Different Dwt Methods

PERFORMANCE MEASURE	SFQ	CREW	SR	EBCOT	RPC
PSNR	33.81	34.18	34.19	34.26	39.46
MSE	152.1413	155.6279	148.4356	146.1438	128.6754

4 Conclusion

Compression of encrypted image is an important issue in image processing. Here the performance of DWT based methods such as CREW, EBCOT and RPC are compared. Out of these Resolution Progressive compression(RPC) scheme proposes to compress the image progressively in resolution so that the decoder can access the image partially. This property offers better results compared to other methods. This method has better coding efficiency and less computational complexity than existing approaches.

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