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Applied two Stages Minimize-Matrix-Size Algorithm with DCT on DWT for Image Compression

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Abstract. As the use of digital imaging is on the rise, compression of acquired digital image data is becoming more and more important to cope with the storage requirements. One of the challenges of compression is to compress images with high efficiently while preserving critical data from getting permanently lost in reconstructed images. In this research we introduce a proposed algorithm for image compression, based on the *Minimize-Matrix-Size Algorithm* for coding and *Limited Sequential Search-Algorithm (LSS-Algorithm)* for decoding. The proposed algorithm starts by using single stage Discrete Wavelet Transform, to decompose an image into four subbands; low frequency and high frequencies. Each "$n \times n$" of the low-frequency subband (LL) are transformed by using two dimensional DCT, store all DC coefficients in different matrix called *DC-Matrix*, and the remain AC coefficients are stored in different matrix called *AC-Matrix*, then applying Minimize-Matrix-size algorithm for the AC-Matrix, to convert each group of AC coefficients into single floating point value. The DC-Matrix transformed again by DWT, and apply Minimize-Matrix-Size algorithm on it. LSS-Algorithm which is represents decoding; DC-Matrix and AC-Matrix, this algorithm is used to estimate original values by using iterative method, which is depends on the probability of the data of the AC-Matrix and DC-Matrix. Our compression algorithm proved good compression ratio, and compared with JPEG and JPEG2000 depending on the PSNR and HVS.

Keywords: Single stage DWT, DCT, Minimize-Matrix-Size, LSS-Algorithm.

1. Introduction

The researches in compression techniques has stemmed from the ever increasing need for efficient data transmission, storage and utilization of hardware resources. Uncompressed image data require considerable storage capacity and transmission bandwidth. Despite rapid progresses in mass storage density, processor speeds and digital communication system performance demand for data storage capacity and data transmission bandwidth continues to outstrip the capabilities of available technologies. The recent growth of data intensive multimedia based applications have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signals central to signal storage and digital communication technology[1-4].

Compressing an image is significantly different from compressing raw binary data. Of course, general purpose compression programs can be used to compress images, but the result is less than optimal. This is because images have certain statistical properties which can be exploited by encoders specifically designed for them. Also, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space.

Lossless compression involves with compressing data which, when decompressed, will be an exact replica of the original data. This is the case when binary data such as executables documents etc. are compressed. They need to be exactly reproduced when decompressed. On the other hand, images need not be reproduced 'exactly'. An approximation of the original image is enough for most purposes, as long as the error between the original and the compressed image is tolerable.

The neighboring pixels of most of the images are highly correlated and therefore hold redundant information from certain perspective of view [4]. The foremost task then is to find out less correlated representation of the image. Image compression is actually the reduction of the amount of this redundant data (bits) without degrading the quality of the image to an unacceptable level [4-7]. There are mainly two basic

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components of image compression – redundancy reduction and irrelevancy reduction. The redundancy reduction aims at removing duplication from the signal source image while the irrelevancy reduction omits parts of the signal that is not noticed by the signal receiver i.e., the Human Visual System (HVS) [7] which presents some tolerance to distortion, depending on the image content and viewing conditions. Consequently, pixels must not always be regenerated exactly as originated and the HVS will not detect the difference between original and reproduced images.

The current standards for compression of still image (e.g., JPEG) use Discrete Cosine Transform (DCT), which represents an image as a superposition of cosine functions with different discrete frequencies [8]. The DCT can be regarded as a discrete time version of the Fourier Cosine series. It is a close relative of Discrete Fourier Transform (DFT), a technique for converting a signal into elementary frequency components. Thus, DCT can be computed with a Fast Fourier Transform (FFT) like algorithm of complexity $O(n\log 2\ n)$. More recently, the wavelet transform has emerged as a cutting edge technology within the field of image analysis. The wavelet transformations have a wide variety of different applications in computer graphics including radiosity [9], multiresolution painting [10], curve design [11], mesh optimization [12], volume visualization [13], image searching [14,15] and one of the first applications in computer graphics, image compression. The Discrete Wavelet Transformation (DWT) provides adaptive spatial frequency resolution (better spatial resolution at high frequencies and better frequency resolution at low frequencies) that is well matched to the properties of a Human Visual System (HVS).

This paper introduces a proposed image compression depends on the single stage DWT which is decomposes an image into approximation coefficients (LL) and high frequency domains (LH, HL and HH). Each "$n \times n$" group of data from the approximation coefficients are transformed by DCT to produce; DC coefficient and AC coefficients. The AC coefficients are coded by Minimize-Matrix-Size algorithm; while the each DC coefficient is stored in a new matrix called *DC-Matrix*. Also the DC-Matrix transformed again by single stage DWT. The high frequencies subbands are coded by using Minimize-Matrix-Size algorithm. This paper also describes LSS-Algorithm used for decode: DC-Matrix, AC coefficients and other high frequencies subbands. Finally these subbands are recomposed decoded low frequency and high frequency by using inverse DWT, Figure-1 shows our compression flowchart.

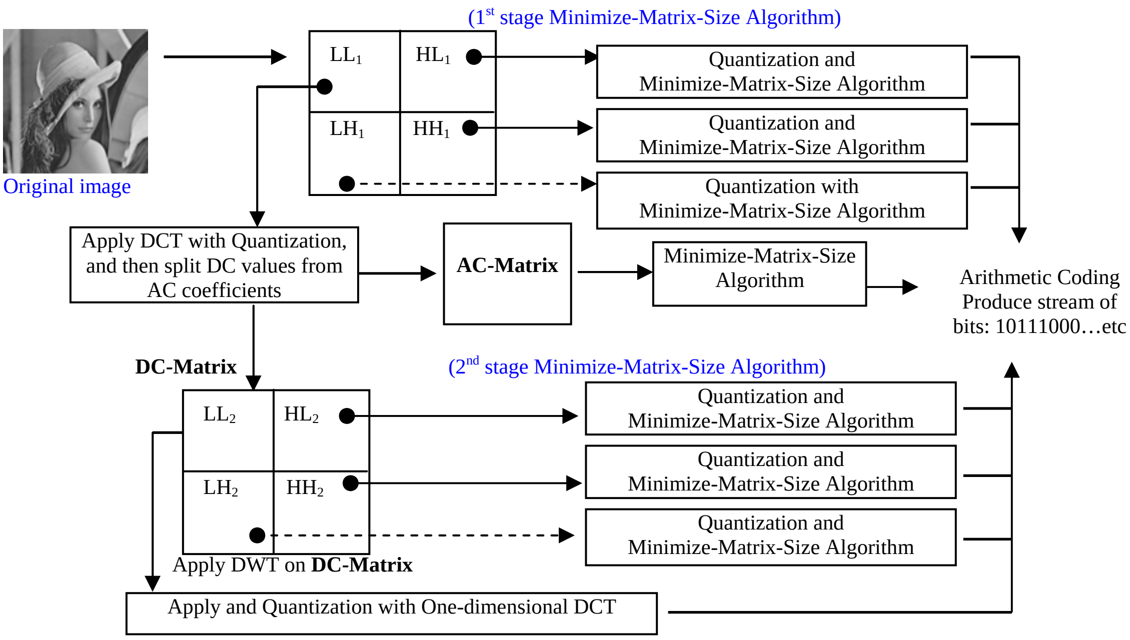

Figure-1, Our Compression algorithm flowchart

2. Discrete Wavelet Transform (DWT)

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)[7]. Another encouraging feature of wavelet transform is its symmetric nature that is both the forward and the inverse transform has the same