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"STUDY ON IMAGE COMPRESSION USING DISCRETE WAVELET TRANSFORM AND BLOCK CODING "

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ABSTRACT

In the present era of multimedia, the requirement of image/video storage and transmission for video conferencing, image and video retrieval, video playback, etc. are increasing exponentially. As a result, the need for better compression technology is always in demand. Modern applications, in addition to high compression ratio, also demand for efficient encoding and decoding processes, so that computational constraint of many real-time applications is satisfied. Two widely used spatial domain compression techniques are discrete wavelet transform and multi-level block truncation coding (BTC). DWT method is used to stationary and non-stationary images and applied to all average pixel value of image. Muli-level BTC is a type of lossy image compression technique for greyscale images. It divides the original images into blocks and then uses a quantizer to reduce the number of grey levels in each block whilst maintaining the same mean and standard deviation. In this paper is studied of Multi-level BTC and DWT technique for for gray and color image.

Key Words: Discrete Wavelet Transform, Multi-level, Block Truncation Code (BTC), PSNR MSE, Compression Ratio.

I. INTRODUCTION

The rising multimedia technology and growth of GUI based software have made digital image data an inherent part of modern life. When a 2-D light intensity function is sampled and quantized to create a digital image, the amount of data generated may be large in volume that it results in tremendous storage, processing and communication requirements. Therefore, the theory of data compression becomes more and more important for reducing the data redundancy to save more hardware space and transmission bandwidth.

In computer science and information theory, data compression is the process of encoding information using less number of bits or some other information bearing units. Compression is useful as it helps to reduce the consumption of expensive resources such as hard disk space or transmission bandwidth [1] [2]. BTC is a simple and fast lossy compression technique for gray scale images. The basic idea of BTC [3] is to perform moment preserving quantization for blocks of pixels. The input image is divided into non-overlapping blocks of pixels of sizes 4×4, 8×8 and so on. Mean and standard deviation of the blocks are calculated. Mean is considered as the threshold and reconstruction values are determined using mean and standard deviation.

Then a bitmap of the block is derived based on the value of the threshold which is the compressed or encoded image. Using the reconstruction values and the bitmap the reconstructed image is generated by the decoder. Thus in the

encoding process, BTC produces a bitmap, mean and standard deviation for each block. It gives a compression ratio of 4 and bit rate of 2 bits per pixel when a 4×4 block is considered. This method provides a good compression without much degradation on the reconstructed image. But it shows some artifacts like staircase effects or raggedness near the edges. Due to its simplicity and easy implementation, BTC has gained wide interest in its further development and application for image compression.

To improve the quality of the reconstructed image and for the better compression efficiency several variants of BTC have been developed during the last many years. Absolute Moment Block Truncation Coding (AMBTC) [4] preserves the higher mean and lower mean of each block and use this quantity to quantize output. AMBTC provides better image quality than image compression using BTC. Moreover, the AMBTC is quite faster compared to BTC. The algorithm is computationally faster because it involves simple analytical formulae to compute the parameters of the edge feature in an image block. Reconstructed images are of good quality in accordance with human perceptual experience. The algorithm represents the image in terms of its binary edge map, mean information, and the intensity information on both sides of the edges.

II. LITERATURE REVIEW

Shih-Lun Chen et al. [2017], color and multispectral image compression using Enhance block truncation code is proposed [1]. These techniques are based on standard deviation and mean. This technique is applied to satellite image and reshapes the satellite image. The satellite image is divided into various sub-blocks. After calculate mean values, all number of pixel in sub-block are compared to the mean and according to the mean all pixel value is replaced by binary number. Finally MSE, PSNR and compression ratio are calculated for the Enhance block truncation code for satellite image.

Sunwoong Kim et al. [2016], with the continuing growth of modern communication technologies, demand for image data compression is increasing rapidly. Techniques for achieving data compression can be divided into two basic approaches: spatial coding and Transform coding. This research paper presents a proposed method for the compression of digital images using hybrid compression method based on Block Truncation Coding (BTC) and Walsh Hadamard Transform (WHT). The objective of this hybrid approach is to achieve higher compression ratio by applying BTC and WHT. Several grayscale test images are used to evaluate the coding efficency and performance of the hybrid method and compared with the BTC and WHT respectively. It is generally shown that the proposed method gives better results. Processing dependency in the conventional algorithm is removed by partitioning the input image and modifying neighboring reference pixel configuration. Experimental results show that the parallel implementation drastically reduce processing time by 6~7 times with significant visual quality improvement.

C. Senthil kumar et al. [2016], In this paper, image compression plays vital role in saving memory storage space and saving time while transmission images over network. The color and multispectral image is considered as input image for the image compression. The proposed technique with Enhanced Block Truncation Coding [EBTC] is applied on component of color and multispectral image. The component image is divided into various sub blocks. After evaluating mean values, the number of bits can be reduced by Enhanced Block Truncation Coding. Finally, compression ratio table is generated using the parameters such as MSE, SNR and PSNR. The proposed method is implemented through standard color and multispectral images using MATLAB Version 8.1 R2013a.

Jing-Ming Guo et al. [2014], Block truncation committal to writing (BTC) has been thought of extremely economical compression technique for many years. Moreover, this method can provide excellent processing efficiency by exploiting the nature parallelism advantage of the dot diffusion, and excellent image quality can also be offered through co-optimizing the class matrix and diffused matrix of the dot diffusion. According to the experimental results, the proposed DDBTC is superior to the former error-diffused BTC in terms of various objective image quality assessment methods as well as processing efficiency.

A modified Block Truncation Coding using max-min quantizer (MBTC) is proposed in this paper to overcome the above mentioned drawbacks. In the conventional BTC, quantization is done based on the mean and standard deviation of the pixel values in each block. In the proposed method, instead of using the mean and standard deviation, an average value of the maximum, minimum and mean of the blocks of pixels is taken as the threshold for quantization.

Jayamol Mathews et al. [2013], with the emerging multimedia technology, image data has been generated at high volume. It is thus important to reduce the image file sizes for storage and effective communication. Block Truncation Coding (BTC) is a lossy image compression technique which uses moment preserving quantization method for compressing digital gray level images. Even though this method retains the visual quality of the reconstructed image with good compression ratio, it shows some artifacts like staircase effect, raggedness, etc. near the edges. A set of advanced BTC variants reported in literature were studied and it was found that though the compression efficiency is good, the quality of the image has to be improved. A modified Block Truncation Coding using max-min quantizer (MBTC) is proposed in this paper to overcome the above mentioned drawbacks. In the conventional BTC, quantization is done based on the mean and standard deviation of the pixel values in each block. In the proposed method, instead of using the mean and standard deviation, an average value of the maximum, minimum and mean of the blocks of pixels is taken as the threshold for quantization. Experimental analysis shows an improvement in the visual quality of the reconstructed image by reducing the mean square error between the original and the reconstructed image. Since this method involves less number of simple computations, the time taken by this algorithm is also very less when compared with BTC.

III. PROBLEM FORMULATION

Coupling ICDF and ECSQ together, we build up the compression-dependent TDDC (CDTDDC) for the compression of image signals and the framework of this coding scheme is shown in Fig. 1. Moreover, when the proposed CDTDDCbased coding is adopted in the compression of grayscale images, it will work competitively with the JPEG baseline coding as two coding modes for each macro-block. On the other hand, when it is used to compress color images, it is only performed on two chrominance components after the RGB to- YCbCr conversion. In this way, it offers not only a new solution to reduce the data-size of color images but also a high compression efficiency.
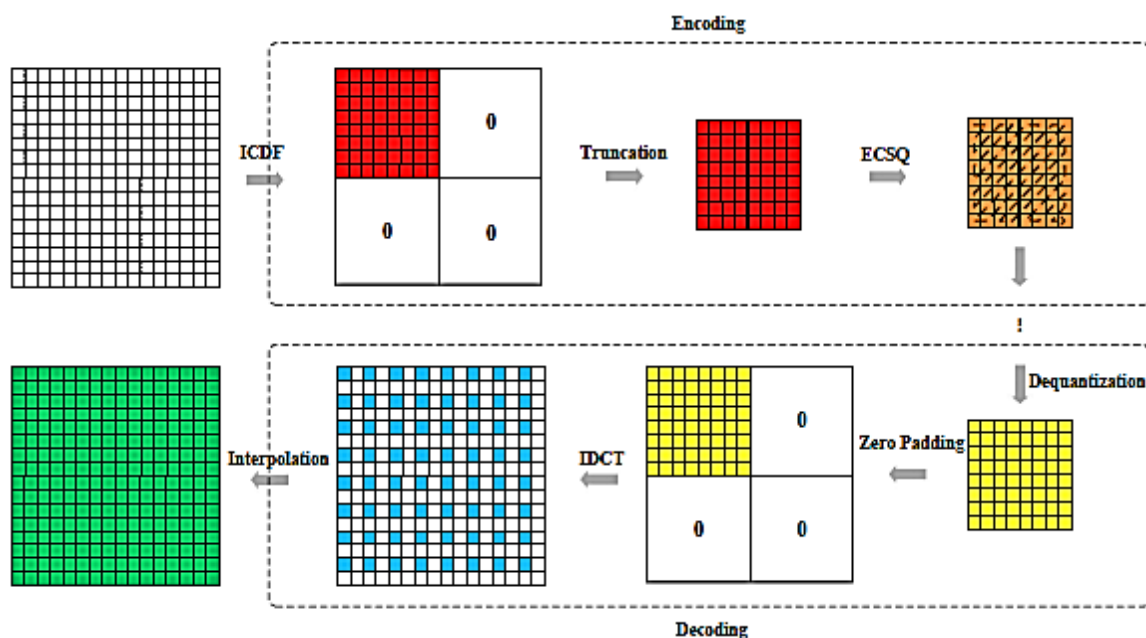

Figure 1: Previous Design

IV. METHODOLOGY

Discrete Wavelet Transform

Wavelets are signals which are local in time and scale and generally have an irregular shape. A wavelet is a waveform of effectively limited duration that has an average value of zero. The term 'wavelet' comes from the fact that they integrate to zero; they wave up and down across the axis. Many wavelets also display a property ideal for compact signal representation: orthogonality. This property ensures that data is not over represented. A signal can be decomposed into many shifted and scaled representations of the original mother wavelet. A wavelet transform can be used to decompose a signal into component wavelets. Once this is done the coefficients of the wavelets can be decimated to remove some of the details. Wavelets have the great advantage of being able to separate the fine details in a signal. Very small wavelets can be used to isolate very fine details in a signal, while very large wavelets can identify coarse details. In addition, there are many different wavelets to choose from. Various types of wavelets are: Morlet, Daubechies, etc. [6].

This technique first decomposes an image into coefficients called sub-bands and then the resulting coefficients are compared with a threshold. Coefficients below the threshold are set to zero. Finally, the coefficients above the threshold value are encoded with a loss less compression technique. The compression features of a given wavelet basis are primarily linked to the relative scarceness of the wavelet domain representation for the signal. The notion behind compression is based on the concept that the regular signal component can be accurately approximated using the following elements: a small number of approximation coefficients (at a suitably chosen level) and some of the detail coefficients.
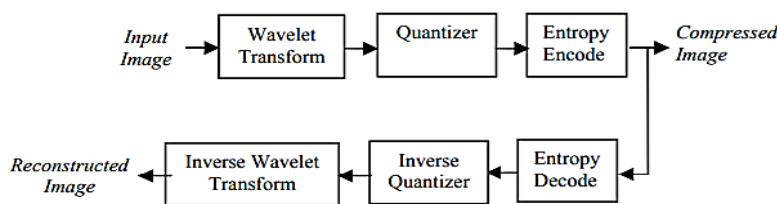

Figure 2: The structure of the wavelet transform based compression.

The steps of compression algorithm based on DWT are described below:

I. Decompose Choose a wavelet; choose a level N. Compute the wavelet. Decompose the signals at level N.
II. Threshold detail coefficients For each level from 1 to N, a threshold is selected and hard thresholding is applied to the detail coefficients.
III. Reconstruct Compute wavelet reconstruction using the original approximation coefficients of level N and the modified detail coefficients of levels from 1 to N.

Multi-level Block Truncation Code

The Encoder and decoder block of the multi-level block truncation code algorithm is shown if figure 2. Encoder part of the proposed algorithm shows that the original image is divided into three parts i.e. R component, G component and B component. Each R, G, B component of the image is divided into non overlapping block of equal size and threshold value for each block size is being calculated.

Threshold value means the average of the maximum value (max) of 'k × k' pixels block, minimum value (min) of 'k × k' pixels block and m_1 is the mean value of 'k × k' pixels block. Where k represents block size of the color image. So threshold value is:

$$T = \frac{\max + \min + m_1}{3} \tag{1}$$

Each threshold value is passing through the quantization block. Quantization is the process of mapping a set of input fractional values to a whole number. Suppose the fractional value is less than 0.5, then the quantization is replaced by previous whole number and if the fractional value is greater than 0.5, then the quantization is replaced by next whole number.
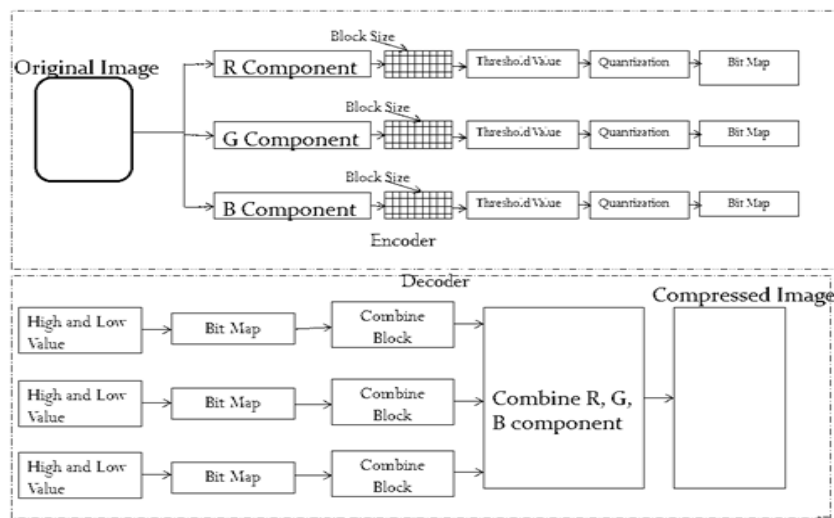

Figure 3: Block Diagram of BTC Algorithm

Each quantization value is passing through the bit map block. Bit map means each block is represented by '0' and '1' bit map. If the Threshold value is less than or equal to the input image value then the pixel value of the image is represent by '0' and if the threshold value is greater than the input image value then the pixel value of the image is represented by '1'.

Bit map is directly connected to the high and low component of the proposed decoder multi-level BTC algorithm. High (H) and low (L) component is directly connected to the bit map, bitmap converted the '1' and '0' pixel value to high and low pixel value and arrange the entire block.

$$L = \frac{1}{q} \sum_{i=1}^{p} W_i \quad W_i \leq T \tag{2}$$

$$H = \frac{1}{p} \sum_{i=1}^{p} W_i \quad W_i > T \tag{3}$$

W$_i$ represent the input color image block, q is the number of zeros in the bit plane, p is the number of ones in the bit plane. In the combine block of decoder, the values obtained from the pattern fitting block of individual R, G,B components are combined after that all the individual combined block are merged into a single block . Finally compressed image and all the parameter relative to that image will be obtained.

Error-compensated scalar quantization

The application of ICDF in the TDDC-based coding aims at a better interpolation and a lower compression cost. However, when the compression happens, the interpolation efficiency as well as the coding efficiency will be limited by the distortion occurring on those filtered pixels (denoted as ~x) that will be used for interpolation. To solve this problem, we purpose to reduce the sum of square error (SSE) distortion of ~x as much as possible via controlling the quantization error of the transformed macro-block based on an error-compensated scalar quantization (ECSQ).

V. CONCLUSION

Such method is suitable in situations where image or image is compressed once but decoded frequently. It is clear that the decoding time due to spatial domain based compression is much less than that of the sub-band compression techniques. In his paper the study of discrete wavelet transform, mult-level block truncation code and error-compensated scalar quantization technique. Further work of this paper is to implement proposed algorithm in MATLAB software and compare result in base paper.

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