IMPLEMENTATION OF ABSOLUTE MOMENT BLOCK TRUNCATION CODING SCHEME BASED ON MEAN SQUARE ERROR CRITERION

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ABSTRACT

Image data compression is concerned with minimization of the number of information carrying units used to represent an image. It is well known that raw digital image occupy a large amount of memory, the amount of memory required creates problems in massive digital image storage for image archiving in a variety of applications . With the continuing growth of modern communications technology, demand for image transmission and storage is increasing rapidly. Advances in computer technology for mass storage and digital processing have paved the way for implementing advanced data compression techniques to improve the efficiency of transmission and storage of images. The number of bits required to represent an image may be reduced considerably by coding techniques. Application of coding in the field of image processing generally concern image data compression for storage and transmission as well as feature extraction for pattern recognition. In image transmission application ,interest lies in techniques which achieve maximum reduction in the quantity of data to be transmitted over a given channel, subjected to certain fidelity criterion. In this paper we have implemented absolute moment block truncation coding scheme(AMBTC)in image data compression in order to reduce computational complexity and to achieve minimum mean square error and optimum PSNR. AMBTC is an encoding technique that preserves the spatial details of digital images while achieving a reasonable compression ratio. It is an improved version of BTC ,obtained by preserving absolute moments instead of standard moments. some design innovations are made in our implementation ,the simulation results indicate that both the computational complexity of and the reconstructed image quality obtained using AMBTC algorithm are better than those obtainable with other existing BTC algorithms.

“INTRODUCTION”

The down side to represent images in digital form is that a large number of bits are required to represent even a single digital image and with the rapid advances in digital electronics and sensor technology, this number grows larger with each new generation of products. Further more, the total volume of digital images produces each day increases as more application are found. As a result, it becomes necessary to find efficient representation for digital images in order to reduce the memory required for storage, to improve the data access rate from storage devices and to reduce the bandwidth and time required for transfer across communication channels[1].

The technique, which deals with these types of problems, is called image/data compression. Various data compression techniques are developed to store and retrieve voluminous digital images and video data. Recently, the most popular method for the compression of still images has been joint Photographic Export Group (JPEG). This standard employs discrete cosine transform to reduce the spatial redundancy and minimize the number of bits required to represent the image. Image compression using JPEG is not very economical if very high quality of reconstructed image is required after decompression because of the computational complexity of JPEG. In this case compression using block truncation coding is more appropriate than that using JPEG.

Block truncation coding BTC technique also called a moment preserving quantizer, is a image compression scheme that was proposed by Delp and Mitchel whose performance is comparable to DTC, but which has a much more simpler hardware implementation. In block truncation coding an image is firstly segmented into n x n blocks of pixels. Well in the most cases the size is 4 x 4, but we can choose other size as 8 x 8. Secondly, a two level output is chosen for every block and bitmap is also encoded using 1 bit for every pixel. The main idea is that the two levels are selected independently for every n x n blocks, so encoding the block is a simple binarization process, because every pixel of the block is truncated to 1 or 0 binary representation choosing the reconstruction level (the two level output). The quantizer threshold and the two reconstruction levels are varied in response to the local statistics of a block. As BTC requires square root operations for its implementation, a more efficient algorithm the absolute moment block truncation coding (AMBTC) has been extensively used in signal compression because of its simple computation and better mean square error (MSE) performance. Various BTC approaches have been proposed during last 19 years [4]. The advantages of BTC are easy implementation and improvements in both computing speed and reconstructed image quality.

AMBTC has the same general characteristics as BTC which include low storage requirements and an extremely simple coding and decoding technique. However due to limited quantization levels a staircase artifact and ragged edge appear. Thus it is necessary to increase the number of quantization levels to improve the image quality. In this work we have designed and implemented a multilevel AMBTC algorithm based on mean square error criterion. The key point of this implementation is to increase the number of quantization levels in order to produce a better mean square error (MSE), a measure of image quality.

" BLOCK TRUNCATION CODING"

Block truncation coding (BTC)[2] is a simple and effective coding technique with a two level non-parametric quantizer whose output levels are obtained by preserving some of the moments of the input samples. Basic idea of this method is to split the image into a number of small non overlapping square blocks. Each block is encoded individually. The gray levels within each block are approximated by one of two gray levels g1 and g2 . These gray levels are so chosen that mean and variance of original and approximated gray levels of each block be the same. The two output levels g1 and g2 from the quantizer for each block are computed by:

$$g_1 = \bar{x} - \sigma\left(\sqrt{\frac{p}{m-p}}\right)$$

$$g_2 = \bar{x} + \sigma\left(\sqrt{\frac{m-p}{p}}\right)$$

Where

$\bar{x}$ - mean of the block.

σ - deviation of the block.

p - number of pixels whose values are greater than or equal to x

m- Total number of pixels in the block .

AMBTC an improved version of BTC, preserves absolute moments rather than standard moments, here also a digitized image is divided into blocks of n x n pixels. Each block is quantized in such a way that each resulting block has the same sample mean and the same sample first absolute central moment of each original block. The two-quantization output levels for each block are

$g_1 = (1/(m-p)) \sum x_i$, $x_{i <= x_{th}}$

$g_2 = (1/p) \sum x_i$, $x_{i > x_{th}}$

" ADVANTAGES OF AMBTC"

In the case that the quantizer is used to transmit an image from transmitter to a receiver, it is necessary to compute at the transmitter the two quantities, the sample mean and the sample standard deviation for BTC and sample first absolute central moment for AMBTC. When we compare the necessary computation for deviation information, we will see that in case of standard BTC it is necessary to compute a sum of m values and each of them will be squared while in case of AMBTC it is only necessary to compute the sum of these m values. Since the multiplication time is several times greater than the addition time in most digital processors, thus using AMBTC the total calculation time at the transmitter is significantly reduced. This simplify the operation, but still it is not the optimal two-level BTC quantizer, Because of the limited number of quantization levels it does not perform equally well in every region resulting in ragged edges and introduces noise at edges. Thus for improvement in image quality we have designed and implemented an algorithm which can be used as a generalized multilevel BTC algorithm and is based on increasing the number of quantization levels by proper thresholding of pixels.

“ THRESHOLDING OF PIXELS”

The threshold values of multilevel quantizer having levels of n can be calculated by

$$th_r = m_n + ((m_x - m_n)r/n)$$

m_x and m_n are the minimum and maximum intensities of the block respectively, th_r represents the r^{th} value of threshold and n is the number of quantization levels.

“ IMAGE COMPRESSION USING AMTC”

Images contain a large amount of data therefore the question arise how this data can be decreased or compressed without losing important details. AMBTC has been extensively used in signal compression because of its simple computation and better mean squared error (MSE) performance. It has the advantages of preserving single pixel and edges and having low computational complexity. The original algorithm preserves the block mean and the block standard deviation [2,5]. Other choices of the moments result either in less MSE or less computational complexity [3,6]. In AMBTC algorithm similar to BTC there are three separate steps while coding a single block of size n x n. First is quantizer design, which includes selection of the threshold, and the quantization levels second, the coding of quantization data and third is coding of bit plane. Here we are considering only quantizer design and implementation. However a two level quantization is simply not able to code a highly busy image with satisfactory fidelity [7]. To achieve high fidelity we use a multilevel quantizer with minimum mean square error criterion, rather then the conventional two level moment preserving quantizer.

In this work we have compressed the image using AMBTC algorithm with multilevel quantization scheme. For that we have used Lena (512x512) image for our implementation. Design and implementation is done for 3,4, and up to 5 quantization levels which can be extended up to m levels .The methodology adopted is shown below:

Break the original image into blocks of size 4x4 or 8x8 for processing.

Find the maximum and minimum pixel values in a block and store them invariables mx and mn respectively.

Find the values of thresholds for a particular block by using the formula:

$$th_r = m_n + ((m_x - m_n)r/n)$$

Compare each pixel grayscale value in the block with the threshold values and assign every pixel to one of the n quantization levels depending on the comparison of pixel values and thresholds .

Encode the pixels in binary within each Quantization level using two bits.

Compute the mean pixel value for each Quantization level. This becomes the Quantized pixel grayscale value for that level.

Repeat the above steps for each block in the image.

To reconstruct the image, assign the respective Quantized grayscale values to the pixels in each Quantization level within each block.

Compute the Mean Square Error, which is the difference between the original image and reconstructed image and the Peak Signal to Noise Ratio by :

$$PSNR = 10x\log ((255^2)/MSE)$$

“SIMULATION RESULTS”

The data of original ‘LENA’ image was utilized for the simulation of this work . The block size taken was 4x4 and 8x8 pixels.

PSNR (peak signal to noise ratio) is taken as measure of reconstructed image quality , it is defined as

$$PSNR = 10 \text{ Log10 } [255^2/MSE]$$

Where 255 is the maximum intensity and MSE is mean square error between original image and reconstructed image .

Initial work is done on 2 and 3 level BTC ,later AMBTC is implemented for 4 and 5 quantization levels , algorithm is implemented in matlab . Results are given below:

THRESHOLD	QUANTIZATION LEVEL	MSE	PSNR	CODING SCHEME
1	2	28.20	33.62	Btc 2level
2	3	11.59	37.48	Btc 3 level
3	4	10.60	37.87	Btc 4 level

"CONCLUSIONS"

In this paper we implemented 2 level, 3 level and 4 level AM BTC. However it can also be generalized for n quantization levels to further enhance the quality of the compressed image.
The computer simulation results for the proposed method highlighting various performance parameters have been shown in the table. These results clearly confirm that the proposed method can approach optimal quantization with much less computational effort.

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