A Review on Improved Adaptive Block Truncation coding over existing blocks truncation coding methods for Image compression.

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Abstract

The Block Truncation Coding (BTC) is one of the lossy image compression algorithms. In this paper, we have proposed a method called the Improved Adaptive Block Truncation Coding (IABTC) based on Adaptive Block Truncation Coding (ABTC). The feature of inter-pixel redundancy is exploited to reduce the bit-rate further by retaining the quality of the reconstructed images. The proposed method outperforms the existing BTC based methods both in terms of bit-rate and PSNR values.

Keywords - block, bit plane, bpp, compression, PSNR, quantizers.

1. Introduction

Data compression algorithms lead to reduction in transmission time and storage cost. Image compression techniques are classified into lossy and lossless techniques. In lossless techniques, the reconstructed image will be the exact replica of the original image whereas in lossy techniques, the reconstructed image will be an approximation of the original image.

One of the main goals for image data compression is to reduce redundancy in the image block as much as possible. That is, it is very important to represent an image with as few bits as possible while maintaining good image quality. Both compression and decompression algorithms should be simple and efficient. BTC is one of the simple and easy to implement image compression algorithms. [1]. It comes under lossy image compression techniques. Though some data is lost, it does not make much difference to the Human Visual System (HVS). [2]

BTC has the advantage of being easy to implement. BTC achieves 2 bits per pixel (bpp) with low computational complexity [1]. In this paper, we have presented a method named Improved Adaptive Block Truncation Coding (IABTC) based on the Adaptive Block Truncation Coding (ABTC) method. In that we will try to achieve the bit rate less than 2 with maintaining a good quality image while compressing it.

2. Literature Review

In digital image processing generally we do the image compression in many applications. For image compression many methods are going to use but here we are considering Block Truncation Coding (BTC). It is easy to implement with less computational complexity. Standard BTC method achieves 2 bits per pixel (bpp) and we measure quality of reconstructed image in peck signal to noise ratio (PSNR). Absolute Block Truncation Coding algorithm also gives average bpp 2 and little variations in PSNR. After both these algorithms we will implement Improved Adaptive Block Truncation (IABTC) algorithm may this algorithm achieves 1 bpp with good PSNR. Through this algorithm we can maintain the good quality of reconstructed image. This method will give significantly better result than the existing methods. We will also implement IABTC in LCD overdrive for image compression.

3. Btc Based Algorithms

Some of the existing BTC based algorithms are discussed in this section.

3.1 Standard BTC Algorithm

Block Truncation Coding (BTC) works by dividing the image into small sub blocks of size 4x4 pixels and then reducing the number of gray levels within each block. This reduction is performed by a quantizer that adapts to the local image statistics. The basic form of BTC divides the whole image into N blocks and codes each block using a two-level quantizer. The two levels a and b are selected using the mean ($\bar{X}$) and standard deviation (σ) of the gray levels within the block and are preserved [1]. Each pixel value within the block is then compared with the mean and then is assigned to one of the two levels. The $\bar{X}$ and σ are calculated using the following equations

Where, m is the number of pixels in each block, and x_i is the original pixel value of the block. If the pixel value of each block is greater than or equal to mean, it is represented by 1 and if

$$\mathbf{a} = \bar{X} - \sigma \sqrt{\frac{m-q}{q}}$$

$$\mathbf{b} = \bar{X} + \sigma \sqrt{\frac{q}{m-q}}$$

Where, q is the number of pixel values greater than or equal to $\bar{X}$, and (m-q) is the number of pixels whose gray levels are less than $\bar{X}$. While reconstructing the image, the 0 in the bit plane is replaced by a and the 1 in the bit plane is replaced by b. The difference between the original image and reconstructed image is called Mean Square Error (MSE) and is calculated using the following equation.

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(y_i - x_i)^2$$

Where, y_i is the reconstructed pixel value x_i is the original pixel value and N is the number of pixels in an image.

The quality of the reconstructed image called the Peak Signal to Noise Ratio (PSNR) is calculated using the equation

$$PSNR = 10.\log_{10}[\frac{MSE}{255^2}]$$

By implementation on BTC coding us get PSNR and BTC achieves 2 bits per pixel (bpp) with low computational complexity [1]. But for improving image quality we will do some modifications in BTC coding. We will discuss it in next section.

3.2 Adaptive Block Truncation Coding (ABTC)

Adaptive Block Truncation Coding (ABTC) is based on multi level quantizer. In this method, the quality of the reconstructed image is improved with the increase in bit-rate. The input blocks are classified into three groups depending on the inter-pixel correlation within each block [1].

Low activity blocks - where all the pixel values inside the block are approximately the same and visually represent a flat area of gray. Medium activity blocks - where there are some small transitions between pixels but these blocks do not

$$\bar{X} = \frac{1}{m}\sum_{i=1}^{m} x_i$$

$$\sigma = \sqrt{\frac{\sum(y_i - x_i)^2}{m}}$$

less than the mean, it is represented by 0. The collection of 1s or 0s for each block is called a bit plane. In BTC two statistical moments a and b are computed using the following equations as [3]
represent any contrasting edges, and High activity blocks - contain big pixel value changes with contrasting edges.

A simple mathematical way of classifying the blocks would be using the standard deviation in equation where, class 1 contains all low σ blocks, class 2 contains medium σ blocks, and class 3 contains the high σ blocks. In order to efficiently code the pixel blocks and to maintain better image quality, three set of quantizers are used in the ABTC method for all blocks: a 1-level quantizer for low activity blocks, a 2-level quantizer for the medium activity blocks, and a 4-level quantizer for the high activity blocks.

The output equation of the 1-level quantizer can be simply described using the equation same as above in BTC coding which is the sample mean $\bar{X}$ of the block.

The medium activity blocks are the kind of pixel blocks for which the standard BTC method is best designed. The bit-rate for this class is 2 bpp.

Based on the 2-level MMSE quantizer, a 4-level MMSE quantizer can be designed. By increasing the number of output quantization levels, the raggedness produced by standard BTC in the high activity edge blocks can be smoothed. The results of the quantization will be a bit plane whose individual elements are of size 2 bits and the output levels are a, b, c and d. Hence the bit-rate for this quantizer is 4 bpp [1].

4. Proposed Work

4.1 Improved Adaptive Block Truncation Coding (IABTC)

The proposed method (IABTC) is based on Adaptive Block Truncation Coding and is used in further reducing the bit rate and to improve image quality. All the input image blocks are categorized into three groups based on sum value (S), which is calculated using the equation

$$S = \sum_{i=1}^{m} abs(x_i - \overline{X})$$

The blocks are categorized into three groups as follows:
1. Low detailed block, if S <= t1,
2. Medium detailed block, is S>t1and S<=t2
3. High detailed block, if S > t2 and S <= t3

The threshold values t1, t2 and t3 are 50,170 and 256 respectively.

$$\mathbf{Thr = min + ((max\text{-}min)\ r/n)}$$

Where, Thr represents the rth value of threshold and n is the number of quantization levels and the four quantizing levels a, b, c and d are computed using the below equations, min and max are the minimum and maximum intensities of the block respectively.

$$a = min$$
$$b = (2min+max)/3.$$
$$c = (min+2max)/3.$$

[1] d = max. Yun-Ho Ko, Jin-Hyung Kim, Si-Woong Lee, and Hyun-Soo Kang, "Dual Block Truncation Coding for Overdriving of Full HD LCD Driver " in IEEE Transactions on Consumer Electronics, Vol. 58, No. 1, February 2012 .

The compression of image will be done in two levels in IABTC:

i) By making slight modifications to ABTC and
ii) Dividing the statistical moments by 4.

By this coding we will try to achieve the good quality image while compression with less bits per pixels and high peck signal to noise ratio. And we will try to achieve it with low computational complexity. Also we will try to use this coding in LCD overdrive application by taking following references.

5. Conclusion

The bpp obtained with ABTC may vary with images, the average bpp is 2. But the average bpp obtained with IABTC will may less than 2. As far as the PSNR is concerned, there may be a significant improvement in IABTC. Both in terms of bpp and PSNR, IABTC will outperform the other techniques. So we will get a better quality of compressed image in any application.

6. Future Scope

From Improved Adaptive Block Truncation Coding Algorithm we will achieve near about bpp1 with significant improvement in PSNR so we will get better quality of reconstructed image. Hence this method can be used in any image compression application like in LCD overdrive, Data hiding application etc.

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8. References

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