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A comparative analysis on various block truncation methods in the E-learning environment

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Abstract

Image compression and Image processing are the two aspects that affect image specific e-learning environment. In this regard, there are various methods proposed to process and compress the image effectively. Recent works mainly concentrate on finding the memory complexity and processing complexity of various techniques. According to that, block truncation models are widely applied over various e-learning fields. Block Truncation Model (BTM) considers the images as collection of individual blocks to be processed. These blocks are extracted and evaluated for image compression. To compress the images, the least important blocks need to be ignored or suppressed. At this stage, standard BTC, Absolute Moment BTC (AMBTC), Machine Learning (ML) based BTC and Deep Learning (DL) based BTC techniques are emerged from various resources. This work is analyzing various BTC models in terms of time efficiency, memory efficiency and computation efficiency. The results shown in this work reveal the detailed comparisons of e-learning based block truncation models.

Keywords: E-learning, BTC, Functions, Comparison, Performance Evaluations

1. Introduction

BTC and AMBTC are widely applied image compression techniques used to reduce the image contents under lossy or lossless manner. Particularly, the need for image compression under e-learning resources is more crucial and more effective. In this platform, various data like text files, image files and other multimedia files can be stored. At the same time, e-learning models work optimally when

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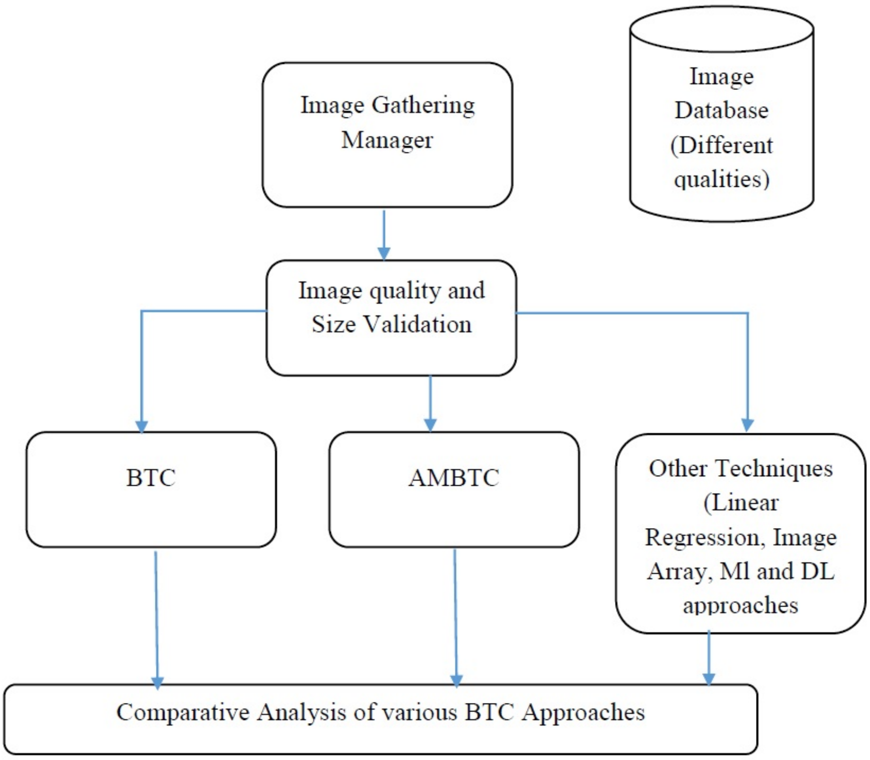

Figure 1: Comparative Analysis Models

the data are stored and managed effectively. In this situation, various image compression techniques are used worldwide to reduce the image size optimally without affecting the image quality.

Figure 1 illustrate the basic image compression and e-learning platform for handling the images. As given in figure 1, the images in the e-learning databases are classified and truncated based on various techniques. This comparative analysis model executes and evaluates these techniques through various performance metrics such as compression quality, time complexity and others.

There are different types of BTC and BTC variants available in research fields. The motive of this work is to understand the benefits and limitations of different BTC approaches and compare them. This article is organized as literature survey in section 2. Section 3 illustrates the technical ideas and performance evaluations of each related BTC approach. Section 4 gives the conclusion with several future scopes.

2. Literature Survey

Lyu et al. [4] proposed linear regression models for block truncation among images. This work integrates linear regression codes and BTC routines to improve the image compression ratio. This scheme enriches the image compression ratio by doing linear image data distributions and then applying BTC procedures. In this experiment, BTC, AMBTC and linear regression models are evaluated for various images. However, these schemes are not compared under performance metrics such as compression time and complexity.

Soniminde et al. [8] developed content wise video retrieval algorithms with the help of sorted image arrays and applied BTC procedures for evaluating the performances. This system created more color spaces and gray scale coordinates for managing BTC based image compression schemes.

Additionally, authors used thepade's approach for sorting the image arrays. This work was commendable in terms of handling more image spaces. Anyhow, it is not good enough for evaluating them under resource constraint e-earning platforms.

Dai et al. [2] developed critical component extraction and block analysis models in single dimensional data analysis space. This work analyzed independent blocks and compute the mutual relationship between various blocks. This scheme worked as same as nearest block matching techniques for compression the least critical block contents. On the other hand, this approach is not sufficient for handling more variant data in images. Here the need for ML and DL based BTC models is more crucial.

Simialrly. Olsen et al. [7] proposed BTC and image plane coding methodologies for various image samples. In this case, the images are considered as individual planes with pixel values. Over these image data, this scheme applies BTC in each image blocks to truncate the irrelevant details. On the other side, Ruba Soundar et al. [5, 6, 9] proposed various wavelet based approaches for the image / video processing applications. These systems were using generative adversarial approaches and convolutional neural systems.

The BTC techniques used for various images need to be improved with time factors and computation factors [3]. This work analyses various techniques listed above. Section 3 illustrates the overall idea and technical aspects of various BTC techniques. Further, it gives the comparative evaluation models and performance analysis of BTC approaches.

3. Comparative Analysis

3.1. Linear Regression with BTC (LRBTC)

In this LRBTC model, linear image data distribution models are created as given in equation (3.1).

$$a = x0 + x1bi + Bi \tag{3.1}$$

In this equation, a-dependent image component, $x0$-image content population, $x1$-slope, bi-image independent factor, Bi-Bias.

According to this model, the image linearity is generated and identified with various image components and bias values. Anyhow, this is not supportive for nonlinear models [10].

3.2. Image Arrays with BTC (IABTC)

The IABTC approach delivers truncated estimations once the images are classified as linear set of arrays instead of blocks. Then BTC analyses each array and converts the arrays in to block for next phase compression. Figure 2 illustrates the image arrays.

As given in figure 2, images are treated as arrays and then BTC algorithm creates image blocks in each array as illustrated in equation (3.2).

$$IB = xibi + ai \quad \text{for all blocks} \tag{3.2}$$

Here, IB-blocked arrays, $xibi$-block components for all arrays, ai-noise factor

This technique also has only linear distribution of image components and this approach is not suitable for complex image analysis frameworks.

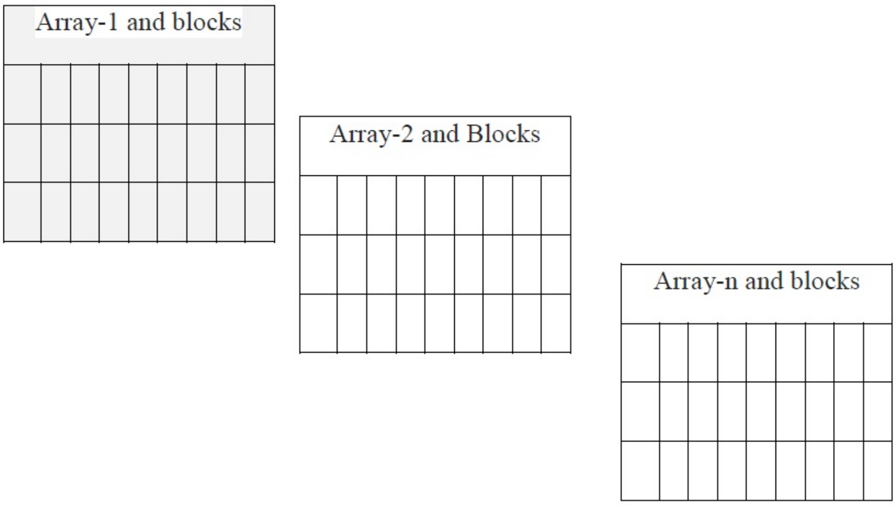

Figure 2: Image Arrays and Blocks

Table 1: Compression Rate Basic BTCs

Number of Images	LRBTC	IPBTC	IABTC
200	34.5	35.6	40.5
500	32.4	32.2	38.7
1000	29.4	31.5	37
2000	26.8	28.9	31.8

3.3. Image Plane Coding with BTC (IPBTC)

The IPBTC approach is suitable for small scale images and limited data compression qualities. Equation (3.3) gives the function of IPBTC.

$$C(B) = xi + ci + ni\text{for planes} \tag{3.3}$$

$C(B)$-coded blocks, xi-image components in the block, ci-correlation factor, ni-noise factor

Comparing to other systems, this method is simpler but not efficient. At this stage the need for improved ML and DL based BTC approaches are mandatory.

3.4. ML and DL based BTC

As discussed, several research works created DL and ML based BTC mechanisms for intelligent image analysis and extraction. Consequently, these approaches are using various training models and analysis routines based on neural networks. As mentioned, generative image compression models, and convolutional image compression models are working effectively compared to other techniques.

Table 2: Compression Rate ML and DL Techniques

Number of Images	Generative BTC	Convolutional BTC
200	45.7	46.7
500	45.3	46.1
1000	44.2	45.5
2000	40.3	45.2

Table 3: Time complexity Analysis

Number of Images	**LRBTC**	**IPBTC**	**IABTC**	**Generative BTC**	**Convolutional BTC**
200	89.8	88.1	87.2	90.1	92.2
500	90.3	89.3	88.2	91.2	93.6
1000	93.2	90.5	89.5	91.6	94.5
2000	98.9	91.4	90.1	91.8	95.5

Table 4: Memory complexity After Compression

Number of Images	**LRBTC**	**IPBTC**	**IABTC**	**Generative BTC**	**Convolutional BTC**
200	89.9	90.1	92.3	70.1	69.4
500	90.3	90.9	94.5	71.1	69.6
1000	93.3	95.7	97.7	72.3	70.1
2000	97.8	96.7	98.1	73.1	70.9

In this manner, images shall be effectively compressed and reconstructed with less error rate [1]. Table 1 illustrates the comparison of basic BTC models.

Table 2 gives the details of image compression qualities of advanced ML and DL approaches. In the same manner, the time complexity values are illustrated in table 3.

In this time complexity and space complexity analysis (table 3 and 4), it is noted that the convolutional model gives optimal space complexity after the images are compressed. Thus the experiment reveals the DL approach work better for producing good image compression ratio.

4. Conclusion

Image compression or image block truncation techniques are widely accepted and needed for various data management systems. In this domain, e-learning based image data management principles require more effective image compression techniques. Under this scope, this article analysed LRBT, IABTC, IPBTC, DL based generative techniques and DL based convolutional techniques. The comparative analysis of this work revealed that the DL based techniques worked optimally than other existing systems. The experimental results shown in this work justify the need for DL based BTC techniques for handling the e-learning images in resource effective manner. This work shall be improved with more DL associated image compression and BTC models.

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