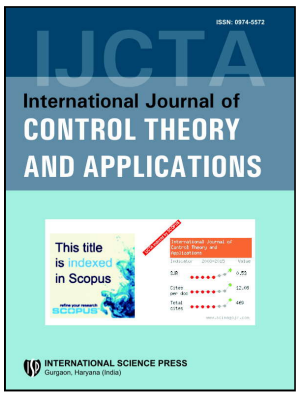

International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 15 • 2017

Comparative Analysis of Lossless Image Compression Techniques for Color Image

Dimple C. Anandpara[1] and Amit D. Kothari[2]

[1] *School of Science RK University, Rajkot, Gujarat, India, Email: dimplemca@gmail.com*
[2] *ITM Universe, Vadodara, Gujarat, India, Email: amitdkothari@gmail.com*

Abstract: Image compression is the process of reducing size of the image that will enhance images sharing, image transmission and easy storage of the image. Image compression techniques are of two types: lossy techniques and lossless techniques. Out of this two types of image compression techniques lossless technique is reversible so it is useful to recover original image after decompression of the image. In this paper we analyze and give comparative analysis of three types of lossless image compression techniques i.e. Huffman encoding, Arithmetic encoding and RLE (Run Length Encoding) method especially for colour image. Experiment is done on four types of colour images i.e. .bmp, .jpg, .png, .tiff. For comparative analysis of image compression techniques mainly two parameters are considered i.e. image compression ratio and image compression time.

Keywords: Watermarking, Haar Wavelet, DWT, PSNR

1. INTRODUCTION

Image compression play important role in applications like tele-videoconferencing, remote sensing, document and medical imaging and facsimile transmission, which depend on the efficient manipulation, storage and transmission of binary, gray scale or colour image. Purpose of image compression is to reduce number of bits required to represent image by removing redundancies [7]. Among lossless techniques and lossy techniques of image compression, according to the applications and requirements image compression techniques are used. The feature of the lossless compression technique is that the original image can be perfectly recovered from the compressed image. Lossless image compression technique is mainly used for applications like medical imaging, property documents etc. where recovery of original image without any distortion is required. Lossy compression technique have more compression ratio then lossless compression technique but lossy technique is not reversible that means we can not recover image or data without any loss.

Now a day interest in reversible image compression techniques i.e. lossless image compression techniques increase for medical image.

This paper is organized as follows. In section II we present working of basic three types of lossless image

compression techniques i.e. Huffman encoding, run length encoding and arithmetic encoding. Section III summarizes parameters used for performance analysis of compression techniques. Section IV summarizes the results of various experiments done using different types of colour image, Section V Gives comparative analysis of best compression method from each category in form of graph. This is followed by conclusion in section VI.

2. LOSSLESS IMAGE COMPRESSION TECHNIQUES

In lossless compression techniques after decompression the image remains same as the actual image [8]-[9].

Lossless data compression most probably exploits statistical redundancy to express data more precisely without any loss in information [1]. As mentioned earlier lossless compression methods are more preferred for medical imaging, technical drawing, satellite image etc. The following are some of the methods which are used for lossless compression.

2.1. Huffman encoding Method

In 1951, David A. Huffman and classmates developed Huffman encoding method [3]. Many researcher works on image compression using Huffman technique [4]-[5]. Huffman encoding technique basically works on the rule of probability distribution. The principle is to reduce size of the image by removing redundancies. Less number of bits is used to encode the image. In first step frequency of each symbol is calculated and then code is assigned to it. Symbol with more probability gets short code. Codes are stored in a code book which may construct for each image. For image decompression both code book and encoded data transmitted to extract original image. For implementation of Huffman encoding method in MATLAB huffmanencode( ) and huffmandecode( ) in build functions are available. Huffman encoding method is used in JPEG image.

2.2. Run-length Encoding Method

Run-length encoding technique is a simplest method of compression. In Run length encoding (RLE) method repeated pixel can be substituted by a number that indicate which pixel value is repeated and how many times it is repeated [6]. In this method runs of data are stored as a single data value and the count of the occurrence. Only the data value that occurs in sequence will count. If we consider any image than there are only two types of data bits used that is 0 and 1. In run-length encoding method occurrence of 0 and 1 in sequence will count. The image file format like TIFF, BMP etc. mostly uses the run length encoding method for image compression.

Example:

Consider following data sequence:

WWWWWWWWWWWWBBBBBWWWWBWW

After applying RLE method the rendered form is as follows:

12W5B4W1B2W

2.3. Arithmetic Encoding Method

In arithmetic encoding instead of encoding each image pixel (symbol) individually, entire image sequence is assigned single arithmetic code word [2]. A codeword value is in range of 0.0 to 1.0. When arithmetic encoding technique applies to any string then frequently used characters will be stored with fewer bits and none frequently used characters are stored with more bits.

3. PARAMETERS FOR PERFORMANCE ANALYSIS

Performance analysis of various image compression techniques is based on following two parameters.

A. Compression Ratio

B. Compression Time

3.1. Compression Ratio

Compression ratio is the ratio between the original size of the image and the compressed size of the image it is calculated as

Compression Ratio = Original Size/Compressed Size

Original size=width*height*number of colour planes* bit-depth/8(bytes)

Compressed size=size_in_bytes

3.2. Compression Time

Time taken for image compression and decompression must be taken into consideration as in some cases decompression time and in some cases compression time to be considered is necessary and in some cases both of them are necessary.

4. EXPERIMENT AND RESULT

In order to experiment Huffman encoding, Arithmetic encoding and Run length encoding image compression techniques MATLAB software based programs were developed. Experiment is done on basic four types of colour images with difference size i.e. leena.jpg image of size 7.98kb, index.bmp image of size 8.35kb, Leena.png image of size 55.2kb and leena.tiff image of size 81.2kb. Image dimension of all four types of colour image is 225*225.

Table 1 shows compression ratio obtain after experiment of all three techniques on 4 types of colour image.

Table 1
Experiment result of Compression Ratio

	Compression Ratio			
Algorithm Type	*BMP*	*JPG*	*PNG*	*TIFF*
Huffman Encoding	1.0466	1.0688	1.0611	1.1430
Run-length Encoding	1.8679	1.8957	1.8940	1.8453
Arithmetic Encoding	1.0512	1.0342	1.0645	1.1006

Table 2 shows compression time, decompression time and total time obtain after experiment on BMP type colour image.

Table 2
Experiment Result of compression time, Decompression time and Total Time for BMP Image.

Algorithm Type	*Encoding Time (in Second)*	*Decoding Time (in Second)*	*Total Time (in Second)*
Huffman Encoding	24.12	378.6800	402.8070
Run-length Encoding	2.6020	4.5740	7.1760
Arithmetic Encoding	24.7780	30.5360	55.3140

Table 3 shows compression time, decompression time and total time obtain after experiment on JPG type colour image.

Table 3
Experiment Result of compression time, Decompression time and Total Time for JPG Image.

Algorithm Type	*Encoding Time (in Second)*	*Decoding Time (in Second)*	*Total Time (in Second)*
Huffman Encoding	35.79	312.6860	348.4820
Run-length Encoding	2.5620	4.1440	6.7060
Arithmetic Encoding	26.48	29.5420	56.0230

Table 4 shows compression time, decompression time and total time obtain after experiment on PNG type colour image.

Table 4
Experiment Result of compression time, Decompression time and Total Time for PNG Image.

Algorithm Type	*Encoding Time (in Second)*	*Decoding Time (in Second)*	*Total Time (in Second)*
Huffman Encoding	42.9770	437.8600	480.8370
Run-length Encoding	3.7350	4.1040	7.8390
Arithmetic Encoding	26.4130	32.0670	58.4800

Table 5 shows compression time, decompression time and total time obtain after experiment on TIFF type colour image.

Table 5
Experiment Result of compression time, Decompression time and Total Time for TIFF Image.

Algorithm Type	*Encoding Time (in Second)*	*Decoding Time (in Second)*	*Total Time (in Second)*
Huffman Encoding	38.4350	371.2140	409.6490
Run-length Encoding	3.2800	4.1840	7.4640
Arithmetic Encoding	25.7220	32.4510	58.1730

5. COMPARATIVE ANALYSIS

On the base of above experiment results author performed a comparative analysis of all the three types of lossless image compression techniques. Basically 4 types of colour image taken for analysis i.e. .bmp, .jpg, .png and .tiff. Experiment result in terms of compression ratio and compression time is compared.

Figure 1 shows comparative analysis graph of image compression ratio. Figure II shows comparative analysis of time taken for image compression and Figure III shows comparative analysis of time taken for image decompression.

On the basis of figure I we can analyze that compression ratio of Run length encoding method is higher then Huffman encoding and arithmetic encoding method for all 4 types of colour images.

As shown in Figure 2 Run length encoding method takes less time for image compression for all 4 types of colour images then other two methods.

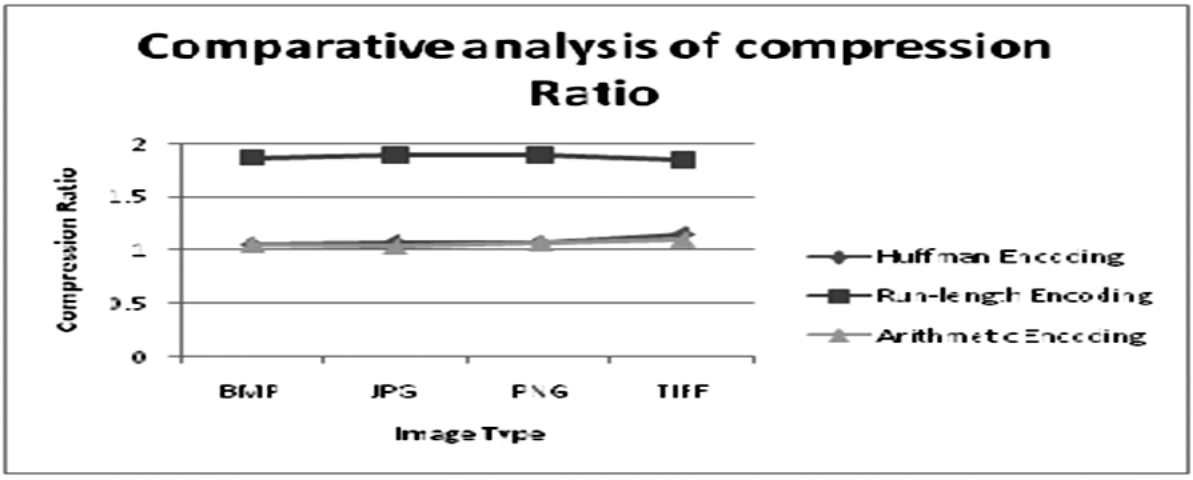

Figure 1: Graph for Comparative analysis of compression ratio

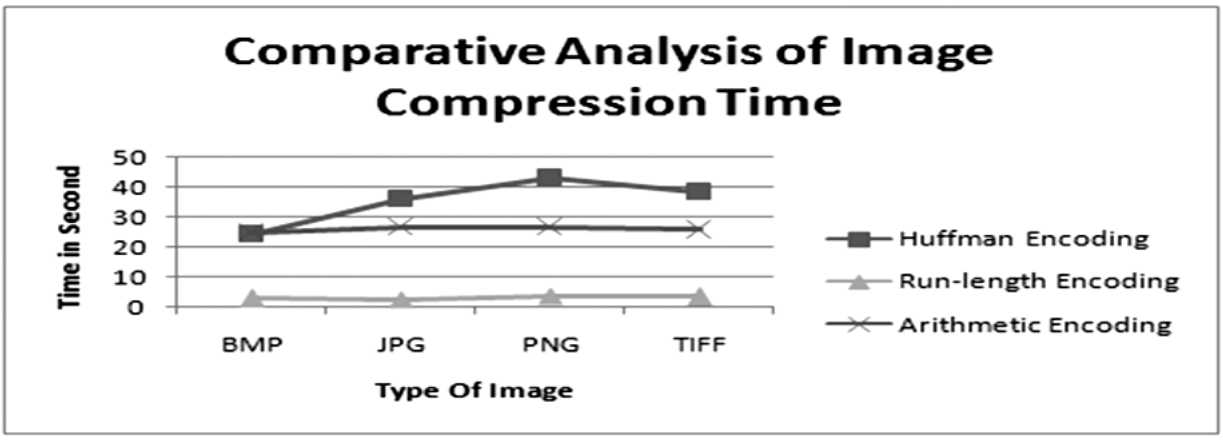

Figure 2: Comparative analysis of Image compression Time

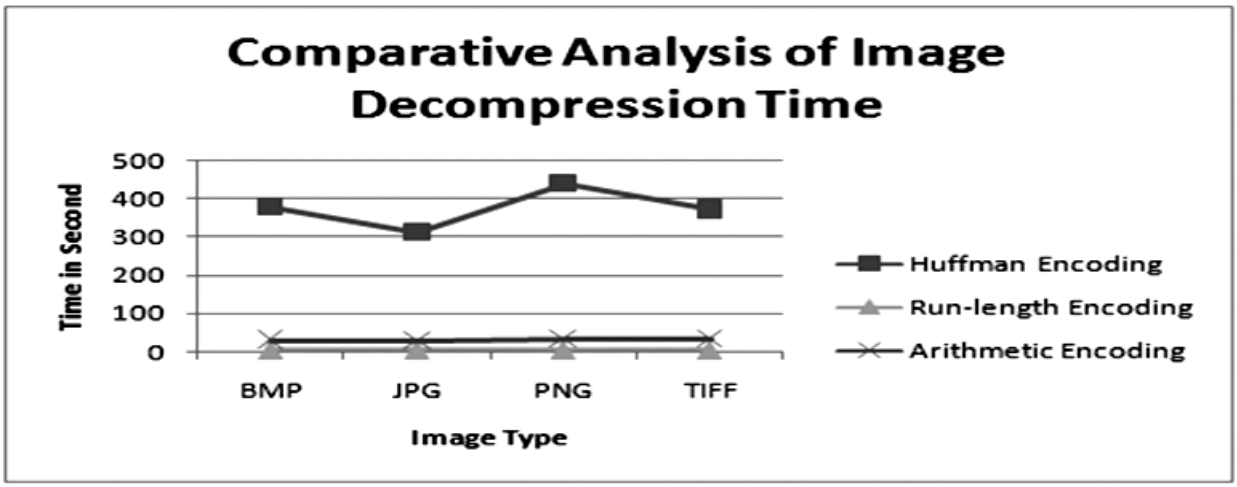

Figure 3: Comparative analysis of Image Decompression Time

Decompression time taken by Run length encoding method is less then Huffman encoding method and arithmetic encoding method for colour image as shown in Figure III.

6. CONCLUSION

Many researches are going on in the field of image compression because need of image transmission increased day by day. In this paper we focus on colour image compression using lossless image compressing techniques mainly of three types i.e. Huffman Encoding, Run Length Encoding, and Arithmetic Encoding. Comparative analysis of above mentioned techniques is given based on the compression ratio and compression time achieved by each technique. After experiment of above mentioned techniques on colour image author found that run length encoding method provide good compression ratio compared to Huffman encoding method and arithmetic encoding method for colour image. Along with that after experiment we found that image compression time, image decompression time and total time for image compression and decompression using run length technique is less than other two discussed techniques.

REFERENCES

[1] Data Compression Conference (DCC '00), March 28-30, 2000,Snowbird, Utah.

[2] Khalid Sayood, Ed Fox (Editor),Introduction to Data Compression, , March 2000.

[3] Suri, Pushpa R., and Madhu Goel, "Ternary Tree and Memory-Efficient Huffman Decoding Algorithm." IJCSI International Journal of Computer Science ,Issues 8.1, 2011 .

[4] Jagadish H. Pujar, Lohit M. Kadlaskar, "A New Lossless Method of Data Compression and Decompression using Huffman Coding" International Conference on Circuit, Power and Computing Technologies [ICCPCT] Techniques, 2016.

[5] Mridul Kumar Mathur, Seema Loonker, Dheeraj Saxena, "Lossless Huffman Coding Technique for Image Compression and Reconstruction using Binary Tree" IJCTA, pp. 76- 79, 2012.

[6] F. Semiconductor, "Using the Run Length Encoding Features on the MPC5645S," pp. 1–8, 2011.

[7] Rabbani, Majid, and Paul W. Jones. "Image compression techniques for medical diagnostic imaging systems." Journal of digital imaging vol. 4.2,pp. 65-78,1991.

[8] Nelson, M., & Gailly, J. L, The data compression book ,New York: M&t Books,1996,vol. 2.

[9] Yang, Ming, and Nikolaos Bourbakis. "An overview of lossless digital image compression techniques." 48th Midwest Symposium on Circuits and Systems, IEEE, 2005.