www.ijaceeonline.com ISSN: 2456 - 3935

International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

Improving Image Quality with Quadtree Decomposition and Huffman Coding

Rajender Kumar
Assistant Professor, Department of Electronics and Communication Engineering,
BPS Mahila Viswavidyalaya, India
Email: rajender78@bpswomenuniversity.ac.in

Seema Jangra
Assistant Professor, Department of Computer Science, University of Delhi, India
Email: seema.mtech@gmail.com

Vimala Parihar
Assistant Professor, Department of Computer Science, University of Delhi, India
Email: vimalaparihar@gmail.com

Abstract: *In recent scenario, numerous image compression methods are proposed and have been one of the most researched areas in present situation. This is necessary because transmission of image and storage is to be done in an efficient manner. The process of image compression represents image with less correlated pixels reduces redundancy and also eliminates irrelevant information present in image. Some of the most commonly used techniques for image compression are Joint Expert Photo Group (JPEG), Joint Expert Photo Group 2000, Discrete Cosine Transform (DCT) or wavelets but major drawbacks of these techniques are blocking and ringing artefacts and moreover they are unable to capture directional information. One of the most widely technique is Fractal image compression (FIC) but its prime disadvantage is its slowness in encoding. Therefore, a process of integration of fractal image compression with quadtree deposition and Huffman encoding is used for fractal image compression which has enormous potential to get better the efficiency for image storage and image transmission. The integration of these techniques is done in order to increase the compression ratio and reduce the image size with enhanced image quality. The proposed work has been supposed to provide better compression ratio and PSNR value.*

Keyword: *image compression, compression ratio, PSNR (Peak Signal to Noise Ratio), Discrete Cosine Transform (DCT), wavelet.*

1. INTRODUCTION

As we have witnessed lot of advancements in the area of VLSI Design as well as information technology, it also resulted in production of huge amount of information at every moment. Consequently, storage as well as transmission of information increases at a vast rate. It is proved in literature that the need of storage and transmission of data increases at least twice with the increasing demand of storage and transmission capacities [1]. Various devices such as optical fibers, Bluray, Digital Video Disc, Asymmetric Digital Subscriber Line (ADSL) and cable modems are developed but it failed to meet the rate of growth of transmission of data. It is known that a moderate size color photograph with 512*512 pixels needs storage space of 0.75 Mega Bytes (MB). Similarly, a video of one second duration which is not compressed requires more than 20 MB for storage. As a result, these devices as well as development in information technologies failed to address issue of the storage and transmission of data. Therefore, a new field of research has started called data compression. Compression means to transform original information or data to its reduced size. Data compression which may Lossless, lossy, text, image, audio, and video involves bit reduction and data redundancy. This reduction in size is done by removing various types of redundancies present in the data. The first compression of data is done in Morse code which was developed by Samuel Morse in 1838.

Cite this paper:

Rajender Kumar,Seema Jangra,Vimala Parihar, "Improving Image Quality with Quadree Decomposition and Huffman Coding", International Journal of Advances in Computer and Electronics Engineering, Vol. 6, No. 6, pp. 1-9, June 2021.

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

In recent scenario, efficient transmission and storage of image is needed. For this purpose, image size needs to be reduced without degrading the image quality as well as any necessary information. Although lot of progress has been done in form of digital communication with better bandwidth and storage devices, transmission and storage of images with reduced size and without degradation is still a challenging task and still requires compression [2]. Compression of image/pictures can be done in two ways: lossless compression and lossy compression. In lossless compression, original data/information can be completely recovered after decompression whereas in lossy compression, some amount of information is lost and quality of image also degraded. Lossless compression is done especially in medical field such as CT scan image and lossy compression is used in the fields where quality of image is not an issue and only reduced size is primary goal. In Lossy compression, higher compression ratio can be achieved.

Computational complexity and low power devices for storage of image are some of other factors needed for image compression. Therefore, Teleconferencing, High-Definition Television (HDTV), satellite communications and digital storage of movies can be transmitted and stored with much ease due to numerous image compression techniques but these applications are not used with full potential largely due to the limitations of common image compression techniques [3].

The most common image compression system shown in Figure 1 comprises of three main steps such as image transformation, quantization and entropy coding for reduction in redundancy, entropy and entropy encoding. Some of most widely used lossy compression methods are JPEG, JPEG 2000 etc. Joint Expert Photo Group (JPEG) was proposed in 1992 which utilize discrete cosine transform (DCT).

It included two basic techniques, DCT based techniques for lossy compression and second one was predictive method for lossless compression. DCT is used to transform the image from spatial to frequency domain for efficient encoding [4]. DCT of types II is used because it provides superior energy packing ability among any other unitary transform [5].

After forward DCT, quantization is done using 64-element Quantization Table (QT). Scalar, vector and predictive types of quantization method can be used. After quantization, all the quantized coefficients are ordered into zig-zag sequence. This ordering helps to facilitate entropy encoding by placing low frequency non-zero coefficients before high-frequency coefficients.

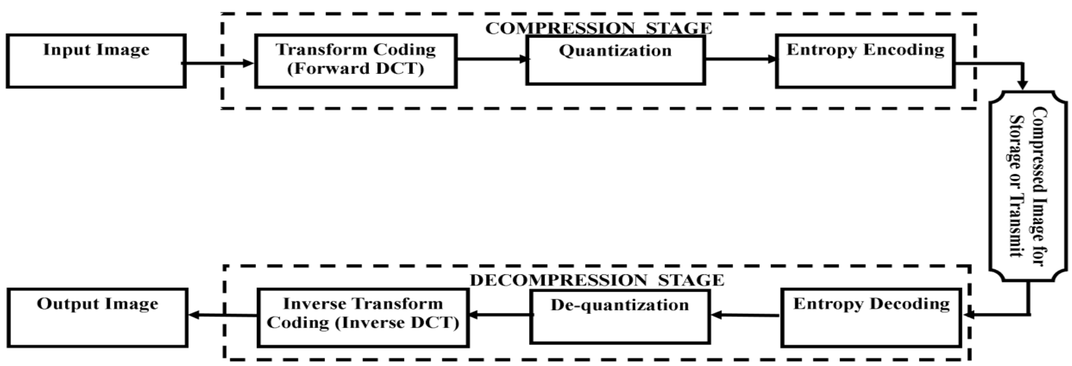

Figure 1 A general image compression model

In entropy encoding such as Huffman coding and Arithmetic coding, short codes are assigned to letters appearing repeatedly and long codes to letters appearing less frequently [6]. It helps to achieve additional compression.

It is pertinent to mention that distortion remained unnoticed by visual perception of human being in case of lower compression ratio but to achieve higher compression ratio, quantization followed by scaling of quantization coefficient is required. For achieving higher compression ratio, DCT offered blocking artifacts and false contouring [7-8].

For the lower compression ratio, the distortion is unnoticed by human visual perception. In order to achieve higher compression it is required to apply quantization followed by scaling to the transformed coefficient. For such higher compression ratio DCT has following two limitations. To overcome these limitations of DCT, wavelet transform which are mathematical tools is getting popular as new cutting edge technology in image compression. Wavelet based techniques have been developed and implemented over the past few years for image compression which provides substantial improvement in image quality with higher compression ratio. So keeping in mind the limitations of DCT, the major objective of this paper is to integrate wavelet based compression technique and Huffman encoding and implemented using MATLAB for reducing redundancies and obtain higher compression ratio while retaining the image quality.

TABLE I DIFFERENCES BETWEEN LOSSLESS AND LOSSY COMPRESSION

Coding Techniques	Main feature used	Compression Types	Advantages	Field of Applications used
Huffman Compression	Entropy based	Lossless	Applicable in all image file formats	ZIP, ARG, JPEG, MPEG, PKZIP
Ziv and Lempel compression	LZ coding with Dictionary based coding	Lossless	All types of data can be compressed	TIFF, GIF, PDF, Gzip, ZIP, V.42, Deflate and PNG
Run Length Encoding (RLE)	Entropy based	Lossless	Simple to implement with less computational time but ineffective for less redundant data increasing the size of compressed file than original file size.	Used for textures, animation and graphic.
Vector Quantization	Improve performance by exploiting the statistical dependence among scalars in the block	Lossy as well lossless	Easy to use with less complexity	Used in fields such as medical image storage, satellite image storage and transmission where limited memory, storage and bandwidth resources are scarce.
Fractal compression	In this technique, images become resolution independent after being converted to fractal code	Lossy Compression	Little bit complex with higher computation complexity	Applicable for textures and natural images
Discrete Cosine Transform	split images into different frequencies with sets of discrete DCT blocks.	Lossy Compression	Reduces the size of file significantly but at the cost of loss in the quality. Do not have discontinuities in images.	Color and Black & white images

The paper is divided in the following section. In section 2, background of various compression techniques are presented along with exploitation of some theoretical work. Section 3 presents the proposed method which integrates Quadtree Decomposition and Huffman encoding for better compression ratio for fractal image compression. The proposed method is implemented and simulated using MATLAB and results along with their analysis are discussed in section 4. Finally, conclusion is presented in last section.

2. REWIEV FOR IMAGE COMPRESSION TECHNIQUES

Numerous image compression techniques have been developed and proposed by researchers. In this section, some of the important image compression contributions are presented after reviewing various existing literature. Broadly, two types of image compression exist, one is Lossless and other is Lossy compression. Original information of image are retained exactly and compression is done by exploiting the statistical redundancies in the image where as in Lossy compression, some of information are lost but at cost of higher compression ratio. Table 2 illustrates the major differences between two compression techniques. An image compression technique can be classified as lossless or lossy depends on the nature of application. Lossless compression technique is commonly used in medical field whereas lossy compression technique can be for image or video compression. In image and video compression, removal of irrelevant information does not affect the human visual system. Numerous compression techniques were proposed and fig. 2 illustrates some of them. Lossless compression techniques which commonly used can be categorized further into transform based and non-transform-based image compression techniques.

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

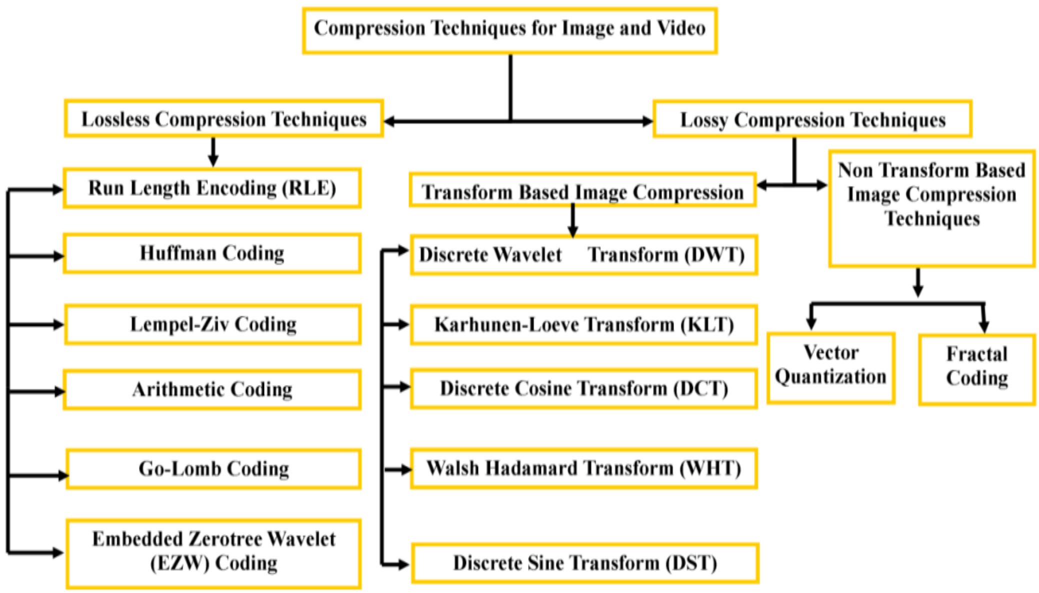

Figure 2 various image compression techniques

The most frequently used lossless compression techniques in entropy encoding are Huffman encoder and the arithmetic encoder. Huffman compression technique is used to compress the grey-scale images and this technique yield 10% more compression [9]. Simple Run Length Encoding (RLE) is used for applications which require fast computational time [10]. RLE can compress images in three different ways namely Encoding along X-axis, Encoding along Y-axis, and Zig-zag encoding [11]. Embedded Zerotree Wavelet (EZW) Image Compression technique was introduced by J. M. Shapiro which is based on the property of generating fully embedded bit stream in order of importance [12]. Various compression techniques with its applications for different fields and performance assessment were presented in [13]. This paper enlightened Huffman compression, Run Length encoding (RLE) encoding, LZ algorithm, Arithmetic coding, JPEG and MPEG with their applications in diverse fields.

Transform based lossy compression techniques are used to transformed an image from spatial domain to frequency domain using one of the well known transform such as DCT (discrete cosine transform) and DWT (discrete wavelet transform). Lossy DCT based compression techniques offers unwanted block artifact effects but in recent time, DWT based compression techniques are being more used in different fields due to higher quality of output image. One of the most widely used DCT based compression technique for digital imaging was developed by JPEG (Joint Photographic Experts Group) committee named as JPEG standard in 1992 [14].

Some of modes which are developed for JPEG are baseline, progressive, and hierarchical. Out of these modes, baseline mode is most popular and used for only lossy compression using the DCT. The paper listed in [15] presents DCT and DWT image compression techniques based on different performance parameters such as PSNR, compression ratio, throughput, life-time of battery and average delay for Media Access Control layer. As wavelet offers multi-resolution nature, they are used for applications where scalability and degradation tolerance are significant. Qunatizer in transform compression is another important component in quantization process having non linearity in the image compression system. It converts a series of floating point to series of integers [16]. Table 1 illustrates the comparison of various image compression techniques.

3. INTEGRATION OF QUADTREE DECOMPOSITION AND HUFFMAN ENCODING FOR FRACTAL IMAGE COMPRESSION

3.1 Technique for Image Quality Enhancement

In the previous section, we have reviewed various video compression techniques. The ultimate goal of these techniques is to achieve compression with some advantages and disadvantages. One of the hybrid techniques which combine the positivity of both DCT and DWT is presented in [22]. This hybrid technique DCT and DWT provides better compression rato compared to JPEG and JPEG 2000, and also retained almost information of image with good image quality after decompression. The disadvantages of DCT such as false contouring, blocking artifacts, and ringing effect also got reduced in this technique.

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

TABLE I COMPARATIVE STUDY OF IMAGE COMPRESSION TECHNIQUES

Coding Techniques	Main feature used	Compression Types	Advantages	Field of Applications used
Huffman Compression	entropy based	Lossless	Applicable in all image file formats	ZIP,ARG, JPEG, MPEG, PKZIP
Ziv and Lempel compression	LZ coding with Dictionary based coding	Lossless	All types of data can be compressed	TIFF, GIF, PDF, Gzip, ZIP, V.42, Deflate and PNG
Run Length Encoding (RLE)	Entropy based	Lossless	Simple to implement with less computational time but ineffective for less redundant data increasing the size of compressed file than original file size.	Used for textures, animation and graphic.
Vector Quantization	Improve performance by exploiting the statistical dependence among scalars in the block	Lossy as well lossless	Easy to use with less complexity	Used in fields such as medical image storage, satellite image storage and transmission where limited memory, storage and bandwidth resources are scarce.
Fractal compression	In this technique, images become resolution independent after being converted to fractal code	Lossy Compression	Little bit complex with higher computation complexity	Applicable for textures and natural images
Discrete Cosine Transform	Split images into different frequencies with sets of discrete DCT blocks.	Lossy Compression	Reduces the size of file significantly but at the cost of loss in the quality. Do not have discontinuities in images.	Color and Black & white images

Fractal Image Compression (FIC) which is most widely used image compression techniques exploited self similarity property resourcefully using block self-affine transformations [17], [18], [19], [20].

Fractal Transform coding is based the fact that image redundancies got exploited using block self affine transformation thus achieving higher compression ratio. The few advantages of fractal image are resolution independence and fast decoding compared to as other image compression techniques. Hence, fractal image compression technique is most widely and potentially used technique offering great capability for improving the efficiency of image storage and transmission.

FIC utilizes a mathematical theory called iterated function systems (IFS) [21] but one of the disadvantages of this method is that it takes too much time for encoding process. Consequently, it is better to combine fractal coding with some other coding methods to reduce the encoding time while obtaining higher PSNR and Compression Ratio. Numerous hybrid methods have been developed and proposed by various researchers in literature. In this paper, we have combined fractal image compression using Quadtree deposition technique and Huffman coding to improve the performance in terms of PSNR and CR. Partition Iterated Function System (PIFS) technique is used in fractal image coding in which an input image is split into a set of non-overlapping sub-blocks, called range block (R) that cover up the whole image. The size of every range block is N X N. At the same time, the original image is also partitioned into a set of other overlapping sub-blocks, called domain blocks (D), which size is always twice the size of range blocks. The domain blocks are allowed to be overlapping and need not cover the whole image. The main advantage of this method is that it provides better compression ratio with retaining most of the image information and better reconstructed image quality. This will also reduce blocking artifacts which was the major disadvantage of DCT compression method. The proposed method for integration of Quadtree Decomposition technique and Huffman encoding is illustrated in Figure 3.

3.2 Performance Parameters Used for Proposed Compression Technique

The analysis and performance of compression techniques can be determined in terms of image quality, compression ratio, and computational time for decompression, energy consumption and storage memory requirement

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

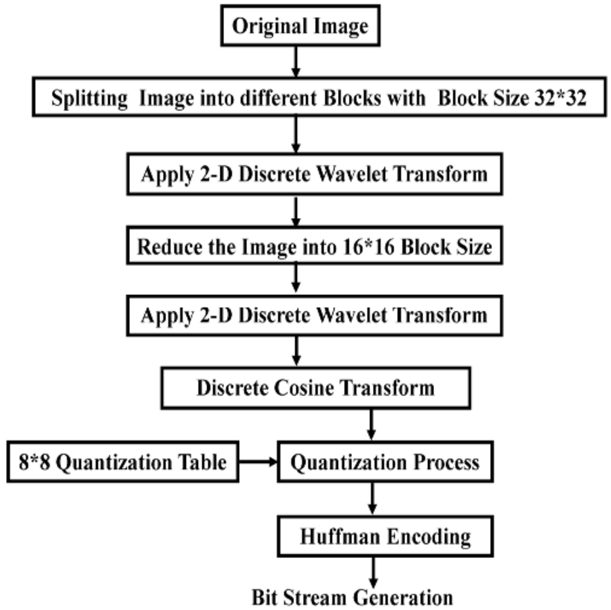

Figure 3 Flowchart for proposed method of image compression technique

Compression can be represented as reduction in original size therefore factor is needed which can defines differences between the two units i.e the original and the compressed data. The factor which represents amount of change or distortion is known as image quality.

The assessment of image compression technique can be performed in two ways i.e. objective measure and subjective measure. In objective measure, statistical characteristics are used whereas in subjective measure, quality of reconstructed image is decided by viewers. In this paper, performance evaluation is done using vital distortion measures such as mean square error (MSE), peak signal-to-noise ratio (PSNR) measured in decibels (dB) and compression ratio (CR).

i) Mean Square Error (MSE): Mean Square Error (MSE) can be defined the collective squared error between the reconstructed compressed image and the original input image [16]. The mathematical representation of MSE is provided by Eq. 1.

$$\mathrm{MSE} = \frac{1}{M*N}\sum_{i=0}^{N}\sum_{j=0}^{M}(I_0(i,j) - I_r(i,j)) \quad (1)$$

Where, $I_0(i,j)$ is the original image and $I_r(i,j)$ is the reconstructed image and M, N is the dimensions of the input image. It is concluded in [17] that if the value of MSE is lower than quality of reconstructed image will be better.

ii) Peak Signal to Noise Ratio (PSNR): PSNR is defined as measuring the pixel difference between the original image and compressed image and usually expressed in terms of decibels (dB) scale with range between infinity to zero. The mathematical equation for computing PSNR is given by Eq.2.

$$\mathrm{PSNR} = 20\log_{10}\left(\frac{\mathrm{Max}^2}{\mathrm{MSE}}\right) \quad (2)$$

Where, Max is maximum value of pixel in image i.e 255 pixels and MSE is the mean square error calculated using Eq. 1. Higher the value of PSNR means higher the value of Signal to Noise Ratio.

iii) Compression rate (CR): CR can be defined as ratio between original image size and compressed image size. It shows how much detailed coefficient can be discarded from the input data in order to sanctuary critical information of the original data. Compression ratio can be expressed by Eq. 3.

$$\mathrm{CR} = \frac{\text{Decompressed image Size}}{\text{Original Image Size}} \quad (3)$$

It can be shown that quality of reconstructed image degraded with higher compression ratio.

iv) Computational complexity: Computational complexity means time and space complexities involved in compression process. Lossy compression techniques needs more computational time and space, therefore memory, power and processing capability requirement are high.

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

TABLE I PERFORMANCE PARAMETERS FOR DIFFERENT IMAGES AT THRESHOLD VALUES=0.2 AND 0.5

Benchmark Image	Image Size	Type of Image format	Compression Ratio	PSNR in dB	Encoding Time in Seconds	Decoding Time in Seconds
Threshold Value = 0.0						
Cameramen	256*256	jpg	5.163	24.37	13.660	134.328
Miss Lena	512*512	Jpg	5.103	25.50	11.419	139.011
Flower	256*256	.jpg	5.106	27.14	11.433	140.045
Threshold Value = 0.25						
Cameramen	256*256	jpg	16.189	24.23	4.796	40.7785
Miss Lena	512*512	jpg	10.978	24.52	6.173	64.299
Flower	256*256	.jpg	16.320	25.21	2.681	40.293
Threshold Value = 0.50						
Cameramen	256*256	jpg	24.280	23.14	3.197	22.246
Miss Lena	512*512	Jpg	25.833	20.84	4.179	24.001
Flower	256*256	.jpg	29.263	23.05	2.742	19.995

4. TEST RESULT AND ANALYSIS

In this section of the paper, the proposed algorithm is applied on some of the benchmark images using MATLAB computational tool. The benchmark images are standard images which are widely used for image processing. After implementation, the results of fastidious simulation for some benchmark images are presented in this section. Table 2 illustrated the simulated results for images of size 128x128, 256*256 and 512x512.

It is observed from the Table 1 that value of Compression Ratio (CR) decreases with increase in threshold value whereas PNSR also decreases. Fig. 4 shows original, quadtree decomposition and decompressed images of Cameraman with different value of threshold in quadtree decomposition.

It is seen from Table 1 that Compression ratio increases with increase in value of threshold. It is found that cameraman image has 5.163 as CR when threshold value is zero but it increases to 24.28 when threshold value is 0.5. This is done at the cost degrade in image quality as shown in Fig. 4. Similarly, decompression complexity i.e computational complexity of decompressed image decrease from 134.328 to 22.246. PSNR value remains almost same in this case. Similarly, experiment is performed for Miss lena and Flower image and result obtained for different threshold value is illustrated in Table 1.

Table 1 shows that compression ratio which was 5.103 when threshold is zero increased to 25.833 when threshold value becomes.0.5 but maintaining the PSNR value almost same. In case of Flower image, initial value CR is 5.106 and it increases to 29.263 when threshold value is 0.5. this is the highest increase among all the three images taken in this study. PSNR value is 27.14 and it falls to 23.05 i.e means there is some lost of information and decompressed image is degraded.

Fig. 4 shows the Original, its quadtree decomposition and reconstructed image for Cameraman and Miss lena and images for different values of threshold respectively. Therefore, it can be concluded that integration of fractal image compression using quadtree decomposition and Huffman coding which improves the decoding time i.e decompressed computational complexity while decreasing in PSNR is not so high for the entire tested image taken in this paper. The compression ratio also increases five times when threshold value changes from 0 to 0.5. The PSNR value decreased by a very small amount, which is not so significant in case of lossy compression. Thus, it improves some of the performance parameters but at the cost of slight degradation in image quality.

5. CONCLUSION

It is always demanded to handle large amount of image or video data to solve the storage and limited bandwidth problem. So, numerous image and video compression techniques have been proposed for image and video data. This paper outlines and presented exhausted review of image compression techniques along with their advantages and disadvantages. After exhausted review of these techniques, it is concluded that integration of different image compression techniques can improve the decoding time and also some other parameters such as compression ratio (CR), mean square error (MSE), peak signal to noise ratio (PSNR). In this paper, a demonstration is presented by integrating fractal image

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

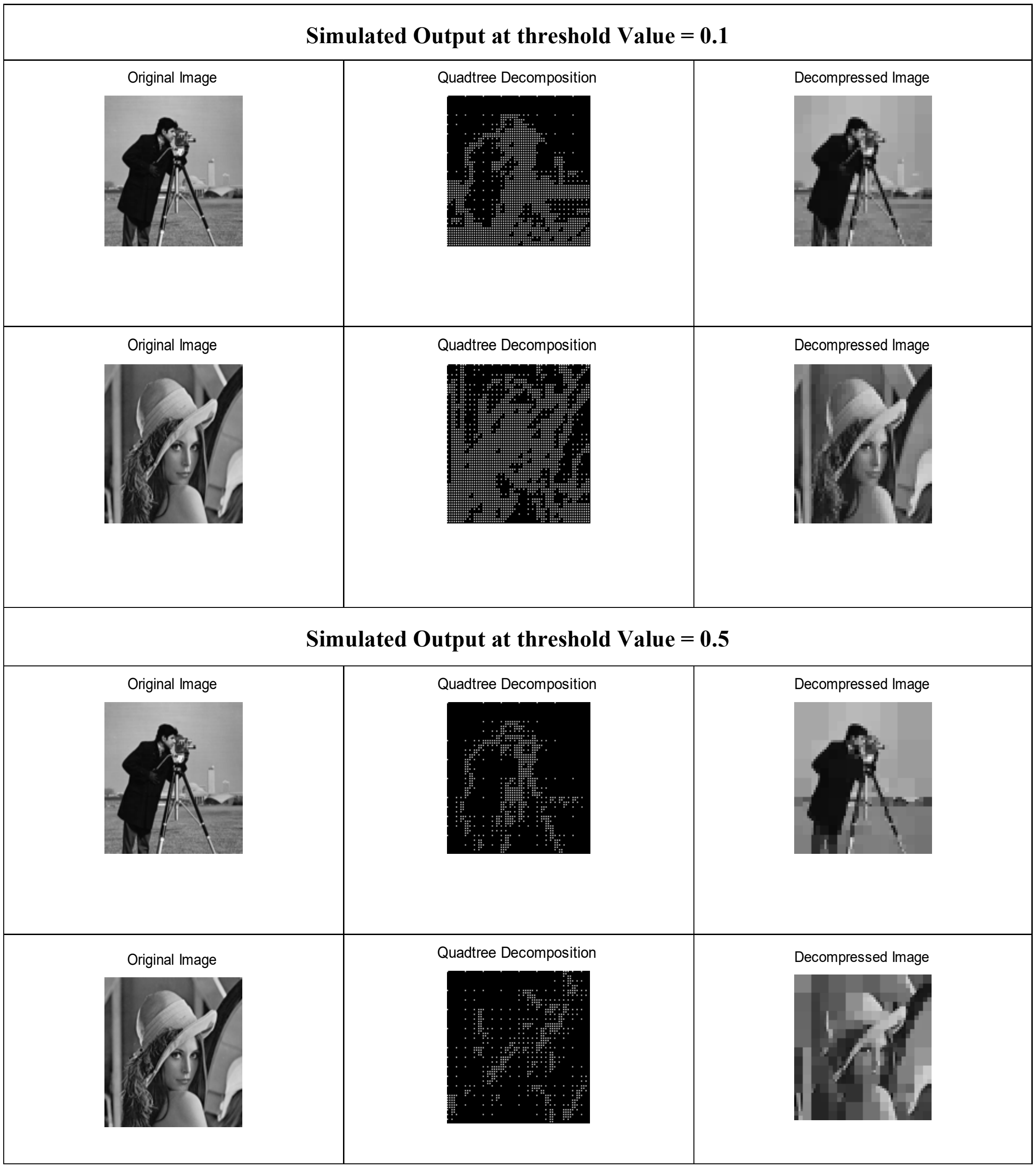

Figure 4 Original, Quadtress decomposition and decompressed image at different threshold value = 0.1 and 0.5

compression technique using quadtree decomposition and Huffman coding and results after simulation shows great improvement in decoding time as well as some other parameters such as CR, PSNR etc with different value of threshold in quadtree decomposition. It is shown by experimental study that integration of wavelet transform with Quadree Decomposition and Huffman Coding improves the compression ratio but there must be some trade-off between decompressed images.

It provides good PSNR as well as decreased decompressed time thus making it suitable for regular applications. The biggest disadvantage of this method is the fixed block size for the range and domain blocks in image. There are various regions present in images which are hard to code. Therefore, a new mechanism is required which adopt the block size depending on the values of certain statistical parameters such as mean or variance of block. So, that it may be suited for medical as well as Surveillance Systems respectively. The future scope for this work is that hardware implementation can be done by applying rate and distortion constraints so that optimal rate distortion can be achieved for a given image without degradation in image quality.

ISSN: 2456 - 3935
International Journal of Advances in Computer and Electronics Engineering
Volume 6, Issue 6, June 2021, pp. 1 – 9

REFERENCES

[1] Parkinson, C.N., 1957. Park Parkinson's First Law: ''Work expands so as to fill the time available." In: Parkinson's Law and Other Studies in Administration. Ballantine Books, New York

[2] A. Jain (1989), "Fundamentals of Digital Image Processing", Prentice-Hall, 1989..

[3] Talukder, Kamrul Hasan, and Koichi Harada (2010), "Haar wavelet based approach for image compression and quality assessment of compressed image", arXiv preprint arXiv: 1010.4084.

[4] K. Rao and J. Hwang, (1996), "Techniques and Standards for Image, Video and Audio Coding", Prentice-Hall, 1996.

[5] Yun Q. Shi and Huifang Sun (2000), "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards", CRC Press LLC, Boca Raton FL,.

[6] K. Rao and J. Hwang (1996), "Techniques and Standards for Image, Video and Audio Coding", Prentice-Hall.

[7] M. Ghanbar (2003),"Standard Codecs: Image Compression to Advanced Video Coding" Institution Electrical Engineers,

[8] E. Whittake (1915) r, "On the Functions which are Represented by the Expansions of Interpolation Theory", Proc. Royal Soc., Edinburgh, Section A 35, pp. 181-194.

[9] Awwal Mohammed Rufai, Gholamreza Anbarjafari, and Hasan Demirel (2013), "Lossy medical image compression using Huffman coding and singular value decomposition", 21st Signal Processing and Communications Applications Conference (SIU), PP- 1-4.

[10] Nelson, M (1995), "The Data Compression Book", 2nd edition, M&T books.

[11] Chris Solomon and Toby Breckon (2011), "Fundamentals of Digital Image Processing: A practical approach with examples in Matlab", John Wiley & Sons,

[12] J. M. Shapiro (1993), "Embedded Image Coding Using Zerotrees of Wavelet Coefficients," IEEE Trans. on Signal Processing, Vol. 41, No. 12, PP. 3445-3462.

[13] Hosseini, M (2012)., "A survey of data compression algorithms and their applications", Appl. Adv. Algorithms, PP. 1-14. https://doi.org/10.13140/2.1.4360.9924.

[14] Thyagarajan, S.K (2007), "Still image and video compression with Matlab", John Wiley & Sons.

[15] Tarek, S., Musaddiqa, M., Elhadi (2016), "Data compression techniques in Wireless Sensor Networks", Future Generation Computer Systems, Vol. 64, PP. 151–162, https://doi.org/10.1016/j.future.2016.01.015.

[16] Rao, K.R. and P. Yip (1990), "Discrete Cosine Transform", Academic Press, New York.

[17] M. Barnsley (1988), "Fractals everywhere", Academic Press, New York, 1988.

[18] Jacquin, A. E. (1992), "Image coding based on a fractal theory of iterated contractive image transformation", IEEE Transactions on Image Processing, Vol. 1, Issue 1, , pp. 18-30.

[19] Jacquin, A. E (1993), "Fractal image coding: a review", Proceedings of IEEE, Vol. 81, Issue 10, pp. 1451–1465.

[20] Y. Fisher (1995), "Fractal image compression: theory and application", Springer-Verlag, New York.

[21] Barnsley, M. F., Demko, S (1985), "Iterated function systems and the global construction of fractals", In: Proceedings of the Royal Society of London. Series A, Mathematical and Physical Sciences, pp. 243-275

[22] T.-H. Yu and S. K. Mitra (1997), "Wavelet based hybrid image coding scheme", in Proc. IEEE Int. Circuits and Systems Symp, vol. 1, pp. 377–380.

Authors Biography

Rajender Kumar, is Assistant Professor Department of Electronics and Communication Engineering in Bhagat Phool Singh Mahila Viswavidyalaya, Sonipat Haryana since 2009. He completed his graduation degree in Electronics and Communication Engineering from MDU Rohtak, Haryana and mater degree in VLSI Design and Embedded System from GJUS&T, Hisar, Haryana. His research interests are VLSI Design, Image Processing and Video compression.

Seema Jangra received her M.Tech in Computer Science and Engineering from GJUS&T, Hisar in 2007. Current she is working as an Assistant Professor in IP College for Women, University of Delhi, Delhi. His research interests are mainly networking, digital image processing etc.

Bimla Varihar received her MCA from IGNOU in 2004 and M.Phil form Algappa University in 2027 Current she is working as an Assistant Professor in IP College for Women, University of Delhi, Delhi. His research interests are mainly networking, digital image processing etc.

Cite this paper:

Rajender Kumar,Seema Jangra,Vimala Parihar, "Improving Image Quality with Quadree Decomposition and Huffman Coding", International Journal of Advances in Computer and Electronics Engineering, Vol. 6, No. 6, pp. 1-9, June 2021.