Segmentation Based Wavelet Compression Using Biorthogonal Discrete Wavelet Transform

Pratishtha Jain[#1], Megha Soni[#2], Anand Vardhan Bhalla[#3]

[#1]*M.Tech scholar, Babulal Tarabai Institute of Research and Technology, Sironja, Sagar,Madhya Pradesh, India.*

[#2,3]*Assistant Professor, Electronics and Communication Engineering Department, Babulal Tarabai Institute of Research and Technology, Sironja, Sagar,Madhya Pradesh, India.*

[1]pratishthajain4@gmail.com

[2]soni_megha1987@yahoo.co.in

[3]anandvardhanbhalla@gmail.com

***Abstract*— Image compression is currently a prominent topic for both military and commercial researchers. Due to rapid growth of digital media and the subsequent need for reduced storage and to transmit the image in an effective manner image compression is needed. Image compression attempts to reduce the number of bits required to digitally represent an image while maintaining its perceived visual quality. This work concentrates on the compression of image based on segmentation using biorthogonal discrete wavelet transform. The performance of this method is compared with the available DWT compression technique. The proposed system improves the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). Time of execution is also reduced in the proposed system.**

***Keywords*— Image Compression, Discrete Wavelet Transform (DWT), Wavelet Transform (WT), Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Wavelet Based Image Compression (WBC), Segmentation Based Wavelet Compression (SBWC).**

I. INTRODUCTION

An image is essentially a 2-D signal processed by the human visual system. The signals representing images are usually in analog form. However, for processing, storage and transmission by computer applications, they are converted from analog to digital form. A digital image is basically a 2-Dimensional array of pixels. Image compression is a method through which we can reduce the storage space of images, videos which will be helpful to increase the storage and transmission process's performance. Image compression may be lossy or lossless. Lossless compression involves with compressing data which, when decompressed, will be an exact replica of the original data. But in lossy compression techniques, some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space.

Due to the increasing requirements for transmission of images in computer, mobile environments, the research in the field of image compression has increased significantly. Image compression plays a crucial role in digital image processing. When we compute the number of bits per image resulting from typical sampling rates and quantization methods, we find that Image compression is needed. Therefore, development of efficient techniques for image compression has become necessary.

Compressing an image is significantly different than compressing raw binary data. Images have certain statistical properties which can be exploited by encoders specifically designed for them, so the result is less than optimal when using general purpose compression programs to compress images. Image compressions have many applications and play an important role in efficient transmission and storage of images. The image compression aims at reducing redundancy in image data to store or transmit only a minimal number of samples And from this we can reconstruct a good accession of the original image in accordance with human visual perception.

Compression more or less depends on our aim of the application. Compression techniques are being rapidly developed for compressing large data files such as images. With the increasing growth of technology a huge amount of image data must be handled to be stored in a proper way, using efficient techniques usually succeed in compressing images. Some of these compression techniques are designed for the specific kinds of images, so they will not be so good for other kinds of images. Image compression is an application of data compression that encodes the original image with fewer bits. The compression ratio is defined as follows:

$$\mathbf{C_r = N_1/N_2}$$

Where, N_1 is the data of the actual image and N_2 is the data of compressed image.

II. WAVELET IMAGE COMPRESSION

The whole process of wavelet image compression is performed as follows: An input image is taken by the computer, forward wavelet transform is performed on the digital image, thresholding is done on the digital image, and entropy coding is done on the image where necessary, thus the compression of image is done. Then with the compressed image, reconstruction of wavelet transformed image is done, then inverse wavelet transform is performed on the image, thus image is reconstructed.

1. Forward Wavelet Transform

Various wavelet transforms are available namely, Daubechies wavelets, Coiflets, biorthogonal wavelets, and Symlets. These various transforms differ in various mathematical properties such as symmetry, number of vanishing moments and orthogonality of compressed image. The Daubechies wavelets are orthogonal, so do Coiflets. Symlets have the property of being close to symmetric. The biorthogonal wavelets are not orthogonal but not having to be orthogonal gives more options to a variety of filters such as symmetric filters thus allowing them to possess the symmetric property.

2. Thresholding

Since the whole purpose of this work is to develop an efficient image compression system using wavelets, fixed threshold is used. The soft and hard thresholdings T_{soft}, T_{hard} are defined as follows:

$$T_{soft}(x) = \begin{cases} 0 & \text{if } |x| \leq \lambda \\ x - \lambda & \text{if } x > \lambda \\ x + \lambda & \text{if } x < -\lambda \end{cases}$$

$$T_{hard}(x) = \begin{cases} 0 & \text{if } |x| \leq \lambda \\ x & \text{if } |x| > \lambda \end{cases}$$

As it could be observed by looking at the definitions, the difference between them is related to how the coefficients larger than a threshold value λ in absolute values are handled. In hard thresholding, these coefficient values are left alone. Unlike in hard thresholding, the coefficient values are decreased by λ if positive and increased by λ if negative.

Fixed threshold value is used so as to have the same given condition. Here, a fixed threshold 20 is used.

3. Entropy Encoding

Entropy is defined as,

$$H(s) = -\sum_{i=1}^{q} P(s_i) log_2(P(s_i))$$

where s_i are codewords and s is the message. Entropy coding uses codewords with varying lengths, here codewords with short length are used for values that have to be encoded more often, and the longer codewords are assigned for less encoded values. H(S) measures the amount of information in the message, i.e. the minimal number of bits needed to encode one word of the message.

4. Reconstruction of Wavelet Transformed Image

At this step, the significance map is taken and with the amplitudes of the non-zero valued wavelet coefficients, the wavelet transformed image is reconstructed.

5. Inverse Wavelet Transformation

The wavelet parameters are converted back into an image almost identical to the original image. How much identical they are will be dependent upon whether the compression was lossy or lossless.

III. SEGMENTATION

Image segmentation refers to the process of partitioning a digital image into N number of parts. The images are segmented on the basis of set of pixels or pixels in a region that are similar on the basis of some homogeneity criteria such as color, intensity or texture, which helps to locate and identify objects or boundaries in an image.

In terms of mathematical formulae, Image segmentation divides a digital image f(x, y) into continuous, disconnect and nonempty subsets, from these subsets higher level information can be easily extracted. Practical applications of image segmentation include object identification and recognition, facial recognition, medical image processing, criminal investigation, airport security system, satellite images, quality assurance in factories, etc. Due to the importance of the image segmentation, large number of algorithms have been proposed but the selection of the algorithm purely depends upon the image type and the nature of the problem.

In recent years, a lot of research is done in the field of image segmentation process. There are currently thousands of algorithms, each doing the segmentation process slightly different from another, but still there is no particular algorithm that is applicable for all types of digital image, fulfilling every objective. Thus, algorithm developed for a group of images may not always apply to images of another class.

Currently image segmentation approach, based on two properties of an image, is divided into two categories:

- *Discontinuities based*

In this category, subdivisions of images are carried out on the basis of abrupt changes in the intensity of grey levels of an image. Our focus is primarily based on identification of isolated points, lines and edges. This includes image segmentation algorithms like edge detection.

- *Similarities based*

In this category, subdivision of images is carried out on the basis of similarities in intensity or grey levels of an image. Our focus here is on identification of similar points, lines and edges. This includes image segmentation algorithms like thresholding, region growing, region splitting and merging.

IV. STEPS INVOLVED IN THE PROPOSED ALGORITHM

Steps involved in the proposed system are:

1. The input image is read.
2. This image is compressed using discrete wavelet transform (output image_1).
3. PSNR, MSE and elapse time is calculated for output image_1.
4. Next, segmentation based wavelet compression using biorthogonal discrete wavelet transform is used for image compression (output image_2).
5. PSNR, MSE and elapse time is calculated for output image_2.

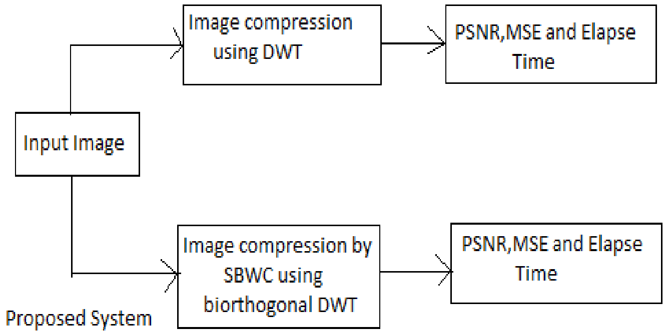

Figure 1: Simulation flow diagram.

V. Simulation Results

The proposed system simulation outputs are as under.

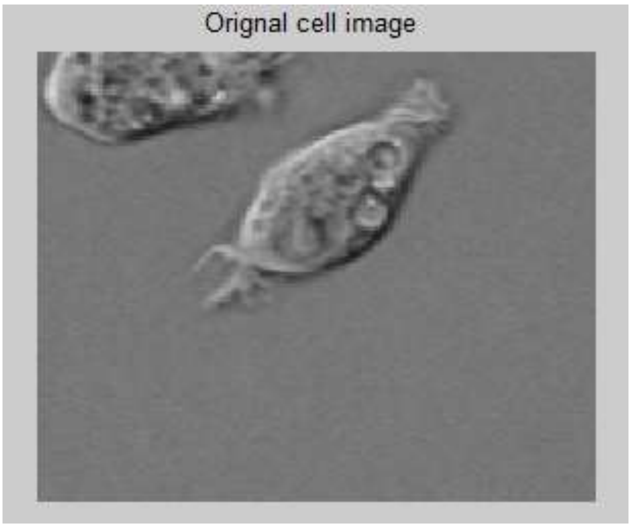

Figure 2: Original image.

Figure 3: Image output using wavelet based image compression (WBC).

Figure 4: Image output using segmentation based wavelet compression (SBWC) using biorthogonal DWT

The figure 2 shows the original cell image which is to be compressed. Figure 3 and 4 shows the image outputs with wavelet based image compression (output image_1) and with segmentation based wavelet compression using biorthogonal DWT (output image_2) respectively. From image outputs it can be seen that the output image_2 is much better than output image_1.

Table 1: Various parameters values obtained.

S.No.	METHODS	PSNR	MSE	Elapse Time
1.	Wavelet Based Image Compression	33.9660	26.0901	7.0096
2.	Segmentation Based Wavelet Compression Using Biorthogonal DWT	41.1356	23.6830	7.0094

Table 1 shows values of PSNR, MSE and elapse time obtained by image compression using Wavelet based image compression and segmentation based wavelet compression. From the table it can be seen that the results with proposed system are better than that with traditional system.

VI. Conclusion

The objective of this work is to develop an efficient image compression system so that a better image can be obtained on reconstruction. In the proposed system segmentation and biorthogonal wavelet transform are used for image compression. Results are derived for wavelet based image compression and for the proposed system both. The parameters of comparison are PSNR, MSE and elapse time. The results show that the PSNR, MSE and elapse time values for proposed system are better than the existing system and hence it can be concluded that the proposed system performance is enhanced.

REFERENCES

[1]. Dipalee Gupta, Siddhartha Choubey, *"Discrete Wavelet Transform for Image Processing",* International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 3, March 2015.

[2]. Mr. Amit S. Tajne1, Prof. Pravin S. Kulkarni2 *"A Survey on Medical Image Compression Using Hybrid Technique*" IJCSMC, Vol. 4, Issue. 2, February 2015, pg.18 – 23.

[3]. Priyanka Shivhare, Vinay Gupta, "*Review of Image Segmentation Techniques Including Pre & Post Processing Operations*", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-4 Issue-3, February 2015.

[4]. Sun Yongqian and Xi Liang *, "A New Parallel Segmentation Algorithm for Medical Image"*, International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 8, No. 2 (2015), pp. 139-146.

[5]. Zhang Ning and Zhu Jinfu, *"Study On Image Compression and Fusion Based on the Wavelet Transform Technology"*, International Journal On Smart Sensing And Intelligent Systems Vol. 8, No. 1, March 2015.

[6]. Sudeepti Dayal ,Neelesh Gupta,Neetu Sharma, *"Image compression using Super Resolution Technique: A Review"*, International Journal of Computer Applications (0975 – 8887) Volume 109 – No. 7, January 2015.

[7]. Navneet Kaur Aulakh Er. Yadwinder Kaur, "*Increasing Image Compression Rate using (DWT+DCT) and Steganography*", International Journal of Emerging Research in Management &Technology ISSN: 2278-9359 (Volume-4, Issue-5)2015.

[8]. Athira Mayadevi Somanathan1, V. Kalaichelvi2*, "An Intelligent Technique for Image Compression*", International Journal of Recent Development in Engineering and TechnologyWebsite: www.ijrdet.com (ISSN 2347-6435(Online), Volume 2, Special Issue 4, June 2014) International Research Conference on Engineering, Science and Management 2014(IRCESM2014).

[9]. Archana Parkhe ,Nilam Bire ,Anuja Ghodekar ,Tejal Raut ,Tanuja Sali, "*Enhancing the Image Compression Rate Using Steganography",* The International Journal Of Engineering And Science (IJES) Volume-3 Issue- 2Pages16-21,2014 ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805.

[10]. M. Venkata Subbarao, N.Sayedu Khasim, Jagadeesh Thati and M. H. H.Sastry, "*Hybrid Image Compression using DWT and Neural Networks*", International Journal of Advanced Science and Technology Vol. 53, April, 2013.

[11]. Mr.M.Arun, Ms.L.Sasikala ,Ms.D.Kalaiarasi, Mr.M.S Saravanan *,"Enhanced ROI for Medical Image Compression Using segmentation*" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering An ISO 3297: 2007 Certified Organization Vol. 3, Special Issue 3, April 2014.

[12]. M.Suganya , A.Ramachandran , D.Venugopal , *A.Sivanantha Raja, "Lossless Compression and Efficient Reconstruction of Colour Medical Images",* Proceedings of International Conference On Global Innovations In Computing Technology (ICGICT'14), Vol.2, Special Issue 1, March 2014.

[13]. *M*. Prantl, "*Image compression overview*", rXiv.:1410.2259v1 [cs.GR] 14 Sep 2014 industrial standard. It outperforms PNG and lossless JPEG2000 (in both, quality and speed).

[14]. A.M.Raid1, W.M.Khedr2, M. A. El-dosuky1 and Wesam Ahmed , "*Jpeg Image Compression Using Discrete Cosine Transform - A Survey"* , International Journal of Computer Science & Engineering Survey (IJCSES) Vol.5, No.2, April 2014.

[15]. Bhawna Gupta Manju Gupta Banita Chadha, "*Image Compression Technique under JPEG by WaveletsTransformation"*, Volume 4, Issue 6, June 2014 ISSN: 2277 128X International Journal of Advanced Research in Computer Science and Software Engineering.

[16]. Muhammad Waseem Khan, "*A Survey: Image Segmentation Techniques*", International Journal of Future Computer and Communication, Vol. 3, No. 2, April 2014.

[17]. Wu-Lin Chen , Yu-Chen Hu , Kuo-Yu Liu , Chun-Chi Lo and Chia-Hsien Wen, "*Variable-Rate Quad tree-segmented Block Truncation Coding for Color Image Compression*", International Journal of Signal Processing, Image

[18]. Ms. Pallavi M. Sune Prof. Vijaya K. Shandilya*., "Image Compression Techniques based On Wavelet and Huffman Coding",* Volume 3, Issue 4, April 2013 ISSN: 2277 128X International Journal of Advanced Research in Computer Science and Software Engineering.

[19]. B.B.S.Kumar, Dr.P.S.Satyanarayana, 2013, "*Image Analysis Using Biorthogonal Wavelet‖",* Published in International Journalof Innovative Research And Development, Vol 2.

[20]. Sanjeev Singla, Abhilasha Jain, 2013, *"Improved 2-D DCT Image Compression Using optimal compressed"*, value‖ Sanjeev et al. IJAIR, Vol. 2.

[21]. John Kerekes, *"image data compression*". Rochester Institute of Technology.

[22]. S.Michael Vanitha, K.Kuppusamy, *"Survey on Fractal Image Compression"*. International Journal of Computer Trends and Technology (IJCTT) - volume4 Issue5–May 2013.

[23]. Gaurav Vijayvargiya, Dr. Sanjay Silakari, Dr.Rajeev Pandey. *"A Survey: Various Techniques of Image Compression".* International Journal of Computer Science and Information Security, Vol. 11, No. 10, October 2013.

[24]. Ms. Pallavi M. Sune, Prof. Vijaya K. Shandilya. *"Image Compression Techniques based On Wavelet and Huffman Coding".* International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 4, April 2013 ISSN: 2277 128X.

[25]. S.Srikanth, Sukadev Meher*,"Compression Efficiency for Combining Different Embedded Image Compression Techniques with Huffman Encoding*" IEEE, 2013.

[26]. Mr.E.PraveenKumar1, Dr.M.G. Sumithra, *"Medical Image Compression Using Integer Multi* Wavelets *Transform for Telemedicine Applications",* International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 2 Issue 5 May, 2013 Page No. 1663-1669.

[27]. M. Erdt, S. Steger, G. Sakas, "*A New View of Image Segmentation and Registration",* GermanyCopyright © 2012 Journal of Radiation

Oncology Informatics ISSN: 1663-618X, J Radiat Oncol Inform 2012;4:1:1-23.

[28]. Ms. Sonam Malik and Mr. Vikram Verma , 2012, *"Comparative analysis of DCT, Haar and Daubechies Wavelet for Image Compression"*, Published in International Journal of Applied Engineering Research, Vol.7-No.11.

[29]. Ashutosh Dwivedi, N Subhash Chandra Bose, Ashiwani Kumar. *"A Novel Hybrid Image Compression Technique"*, Wavelet-MFOCPN, 2012.

[30]. Firas A.Jassim and Hind E.Qassim, "*Five Modulus Method for Image Compression"*, Vol.3, 2012.

[31]. Firas A. Jassim and Hind E. Qassim, "*Five Modulus Method for Image Compression",* SIPIJ Vol.3, No.5, pp. 19-28, 2012.

[32]. G.M.Padmaja,P.Nirpuma *"Analysis of various image compression techniques",* APRN journal of science and technology VOL.2, NO.4,May 2012

[33]. S. Sahami and M.G. Shayesteh, *"Bi-level image compression technique using neural networks",* IET Image Process, Vol. 6, Issue 5, pp. 496–506, 2012.

[34]. D.Sasirekha, Dr.E.Chandra, *"Enhanced Techniques for PDF Image Segmentation and Text Extraction"*, (IJCSIS) International Journal of Computer Science and Information Security Vol. 10, No. 9, September 2012.

[35]. Ms.Yamini S.Bute, Prof. R.W. Jasutkar, 2012, *"Implementation of Discrete Wavelet Transform Processor For Image Compression*", International Journal of Computer Science and Network (IJCSN), Vol. 1.

[36]. M. Mozammel Hoque Chowdhury and Amina Khatun, 2012, *"Image Compression Using Discrete Wavelet Transform",* IJCSI International Journal of Computer Science, Vol. 9- No 1.

[37]. A.Alice Blessie, J. Nalini and S.C.Ramesh, 2011, "*Image Compression Using Wavelet Transform*", Based on the Lifting Scheme and its Implementation‖ IJCSI International Journal of Computer Science Issues, Vol. 8-No. 1.

[38]. Ashraf A. Aly1, Safaai Bin Deris2, Nazar Zaki, *"Research review for digital image segmentation techniques",* International Journal of Computer Science & Information Technology (IJCSIT) Vol 3, No 5, Oct 2011.

[39]. Samir Kumar Bandyopadhyay, Tuhin Utsab Paul, Avishek Raychoudhury, "Image Compression using Approximate Matching and Run Length", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 6, 2011.

[40]. Priyanka Singh, Priti Singh, Rakesh Kumar Sharma*,"JPEG Image Compression based on Biorthogonal, Coiflets and Daubechies Wavelet Families",* International Journal of Computer Applications , Volume 13– No.1.-2011.

[41]. Maneesha Gupta, Dr.Amit Kumar garg, Mr.Abhishek Kaushik, *"Review: Image Compression Algorithm",* IJCSET , Vol 1.2011.

[42]. D. Maheswari 1, Dr. V.Radha2*,"Enhanced Hybrid Compound Image Compression Algorithm Combining Block and Layer-based Segmentation",* The International Journal of Multimedia & Its Applications (IJMA) Vol.3, No.4, November 2011.

[43]. V. Dey a , Y. Zhang a, M. Zhong **,"***A Review On Image Segmentation Techniques With Remote Sensing Perspective",* ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7A.

[44]. Hai Wang, "Fast Image Fractal Compression with Graph-Based Image Segmentation Algorithm", International Journal of Graphics Vol. 1, No.1, November, 2010.

[45]. Sindhu M., Rajkamal R.,*"Image and its compression techniques",* International Journal of Recent Trends in Engineering, Vol 2, No. 4, November 2009

[46]. Yi Ma, Senior, Harm Derksen, "*Segmentation of Multivariate Mixed Data via Lossy Data Coding and Compression*", IEEE transactions on pattern analysis and machine intelligence, vol. 29, no. 9, september 2007

[47]. P. Raviraj and M.Y. Sanavullah, 2007, "*The Modified 2D-Haar Wavelet Transformation in Image Compression*", Middle-East Journal of Scientific Research, 2 (2): 73-78.

[48]. Kamrul Hasan Talukder and Koichi Harada,2007, "*Haar Wavelet Based Approach for Image Compression and Quality Assessment of Compressed Image",* Published in IAENG International Journal of Applied Mathematics, 36:1.

[49]. Mohamed I. Mahmoud, Moawad I. M. Dessouky, Salah Deyab, and Fatma H. Elfouly. 2007*, "Comparison between Haar and Daubechies Wavelet Transformions on FPGA Technology",* Proceedings Of World Academy Of Science, Engineering And Technology, VOLUME 20.

[50]. Radomir S. Stankovic, Bogdan J. Falkowski, 2003, *"The Haar wavelet transform",* its status and achievements‖ Computers and Electrical Engineering, 25–44.

[51]. M. Atonini, M. Barlaud, P. Mathieu, and I. Daubechies, "*Image coding using wavelet transform,"* IEEE Trans.Image Processing, vol. 1, pp. 205–220, Apr. 1992.

[52]. H. S. Malvar, "*Signal Processing With Lapped Transforms. Norwood*", MA: Artech House, 1992.

[53]. W. A. Pearlman. "*High Performance, Low Complexity Image Compression",*Applications of Digital Image Processing X, Proc. SPIE 3164, July 1997, pp. 234 – 246.

[54]. G. K. Wallace. "*The JPEG Still Picture Compression Standard"* Communications of the ACM, vol. 34, April 1991,pp. 31 – 44.

