



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact Factor: 4.295

(Volume 3, Issue 4)

Available online at: <https://www.ijariit.com>

Fuzzy Enhanced 3-Level DWT Image Compression

Manish Mishra

Dr. APJ Abdul Kalam Technical University,
Lucknow, UP

Dr. Md. Sanawer Alam

Dr. APJ Abdul Kalam Technical University,
Lucknow, UP

Abstract— *The development of the higher quality and cheaper image acquisition devices has produced steady increases in both resolution and image size, and a greater consequent for the design of efficient compression techniques. Although the storage capacity and transfer bandwidth has grown accordingly in past years, many applications still require compression. Uncompressed multimedia (graphics, video, and audio) data requires storage capacity and transmission bandwidth. Despite the frequent progress in mass-storage density, processor speeds, and the performance of digital communication systems, demands for data storage capacity and data transfer bandwidth. The amount of data related to visual information is so large that its storage would require more storage capacity. Storage and/or transmission of such data require large capacity and/or bandwidth, which could be very expensive.*

In this research work, we present a technique which is a combination of DWT technique and enhanced by Fuzzy logic function. The aim is to give a better compression ratio along with increasing the visual perception quality of the image. Fuzzy logic Technique has been used in various areas involving clustering, data aggregation pattern deduction etc. We are using fuzzy logic in this technique to improve the quality of the compressed image resulted from DWT image compression technique.

KEYWORDS: DISCRETE WAVELET TRANSFORM, FUZZY LOGIC, IMAGE ENHANCEMENT, PSNR, MSE.

I. INTRODUCTION

Advancement in digital technology has led to the rise of visual communication. We now obsessed with our smartphones which have latest in-built cameras to capture high-quality images and videos which about a decade ago, required costly cameras and expert photographer. With the advancement in technologies, it has made very convenient and easy for us to communicate to each other through images, to make a memory of important events in our life, taking selfies as and when we feel like and making videos with our handheld smartphones. Visual communication is also becoming increasingly important with applications in teleconferencing, telemedicine, digital television, entertainment, online learning and much more. Parallel to this growth of visual communication is the transmission of color images that is, 'picture messaging' and the Multimedia Messaging Service (MMS). Modern media is overwhelming with graphics such as images and movies. Constraints on bandwidth and memory space create trade-offs between the size and quality of images. The increasing demand for multimedia content such as digital images and video has led to great interest in research into compression techniques. The development of higher quality and less expensive image acquisition devices has produced steady increases in both image size and resolution, and a greater consequent for the design of efficient compression systems [1]. Although storage capacity and transfer bandwidth has grown accordingly in recent years, many applications still require compression.

Despite the improvements made in media storage technology, compression techniques and the performance of transmission media as mentioned earlier, the demand for greater data storage capacity and faster transmission speeds will continue to exceed the capabilities of current technologies. Furthermore, there is still one application field that justifies putting efforts into image compression research. This application is mobile computing. Unlike their desktop counterparts, Internet access via mobile devices is badly affected by low air bandwidth. The radio spectrum is a scarce resource and it cannot be altered. Multidimensional, multispectral and volumetric digital images are the main topics for analysis. The main objective is to design a compression system suitable for processing, storage, and transmission, as well as providing acceptable computational complexity suitable for practical implementation. The basic rule of compression is to reduce the numbers of bits needed to represent an image. In a computer an image is represented as an array of numbers, integers to be more specific, that is called a —digital image. The image array is usually two dimensional (2D), if it is black and white (BW) and three dimensional (3D) if it is color image [3]. Digital image compression algorithms exploit the redundancy in an image so that it can be represented using a smaller number of bits while still maintaining acceptable visual quality. Factors related to the need for image compression include:

- The large storage requirements for multimedia data
- Low power devices such as handheld phones have small storage capacity
- Network bandwidths currently available for transmission
- The effect of computational complexity on practical implementation.

Some of the most popular compression systems use the discrete cosine transform (DCT) system recommended by Joint Photographic Experts Group (JPEG). The simplest JPEG system is the baseline JPEG. This system combines the DCT with a uniform scalar quantizer and a run-length Huffman coder [1], [9]. The DCT system provides high-quality images at reasonable bit rates, but exhibits blockiness at low bit rates. This artifact is caused by independent processes of transformed blocks and the discontinuity of the DCT basis functions [7], [14]. This artifact can be reduced by increasing the bit rate or using more complex systems. However, the gain in quality may not justify additional complexity of the system.

Several researchers have delved into the area of image compression and image enhancement. Upendra et. Al[1], have proposed a hybrid technique using DCT and Fuzzy logic for compression of image files. They have developed a fuzzy enhancement technique after compressing the image files. In [2] Gaurav Kumar et al., present a DWT-DCT and variable length arithmetic –Huffman coding method. The author states that DWT is better than DCT technique in terms of CR and PSNR values. In DCT there is no blocking effect. Huffman coding takes less memory space. Rohit Kumar Gangwar et.al present an analysis based on fuzzy logic techniques on image compression [3]. Fuzzy logic with Huffman codes has been used in the proposed algorithm and better quality of compressed image with high PSNR value and MSE has been achieved when compression rate is high. In [5] Contrast Enhancement using various inter-pixel contextual information has been presented. A constant time 2d target histogram method is proposed. Debdoot Sheet et.al in [6] propose a brightness preserving method using histogram equalization. A novel modification of brightness preserving and contrast enhancement abilities while reducing computational complexities have been proposed. In [7] Rafeef Abugharbieh et.al. propose a novel scalable 3-D medical image compression method with optimized VOI coding. The method is based on a 3-D integer wavelet transform and a modified version of EBCOT that exploits correlations between wavelet coefficients in three dimensions and generates a scalable layered bit-stream. The method employs a bit-stream reordering procedure and an optimization technique to optimally encode any VOI at the highest quality possible in conjunction with contextual background information from a lossy to a lossless representation. A histogram modification framework and its application for image contrast enhancement have been shown by Tarik Arici et.al in their work in [8]. The author presents a general framework for contrast enhancement using penalty terms. The experimental results show effectiveness as compared to previous algorithms. Obtained images are visually pleasing, artifact free and natural looking. The proposed algorithm doesn't introduce flickering.

II. SPROPOSED WORK

This section discusses the implementation details of the proposed work. The DWT technique has been used to compress the image and further enhancement is done using Fuzzy Logic based histogram equalization function. The results of compression show a degradation in perceptual quality of the image thus it is important to enhance the quality of the compressed image post compression. This particular idea has been implemented in this research work. MATLAB 2010 software has been used to implement the algorithm and program the simulation of the proposed work. The MATLAB software platform contains various kinds of toolboxes, which are basically a collection of predefined functions related to various domains. These functions can be readily called into other programs as per requirement. For this research work, Image processing Toolbox and Wavelet Toolbox and their various functions have been used along with some general MATLAB functions.

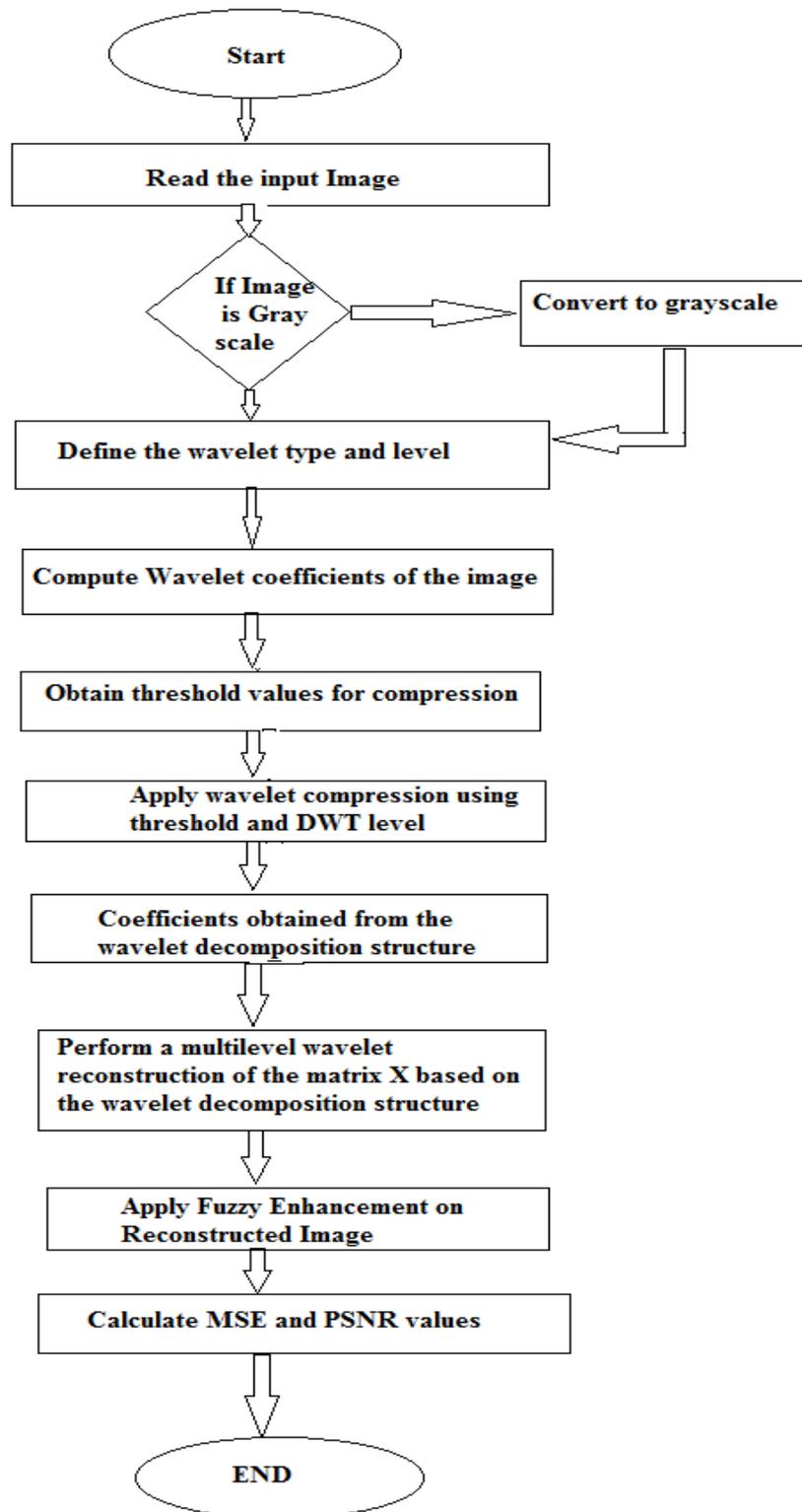


Figure 1: Flowchart of System Implementation

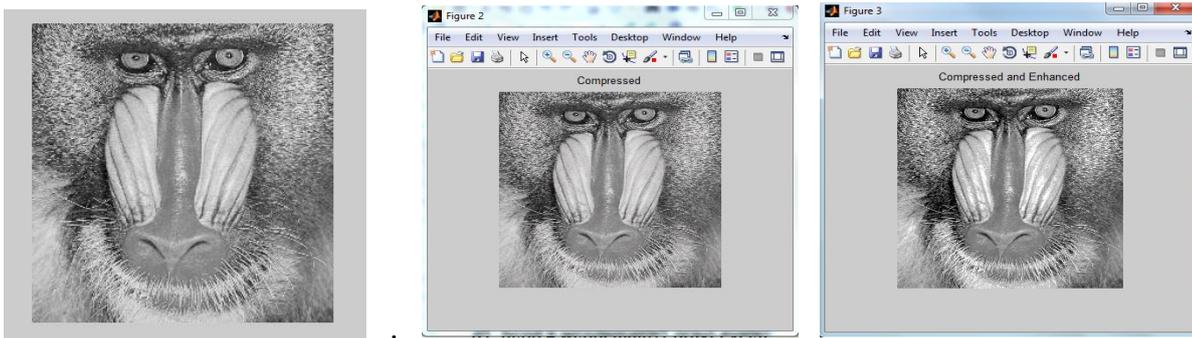
The input image to be compressed is read into the MATLAB environment. The image is available in various distinct formats viz. jpg, png, bmp etc. is brought to the current directory folder for efficient processing. The function then reads the Image as 3-D array, where the rows and columns indicate the pixels of the image in terms of width and height, whereas the third dimension contains the color information in the form of Red, Green, and Blue (RGB).

This image is then converted to grayscale if it is not already. This is done to reduce the computational complexity. In the next step as shown in figure 1, the wavelet filter type and level of decomposition are defined. Based on these values the wavelet coefficients parameters are computed. This gives the low decomposition Lo_D, Low Reconstruction Lo_R, High Decomposition Hi_D and high reconstruction Hi_R filters coefficients. A threshold value is chosen and wavelet compression is applied using Bassert-Massart strategy.

The wavelet coefficients for reconstruction are obtained. This is used to reconstruct the image matrix based on wavelet decomposition structure. Fuzzy Enhancement function is then applied to enhance the quality of compressed image.

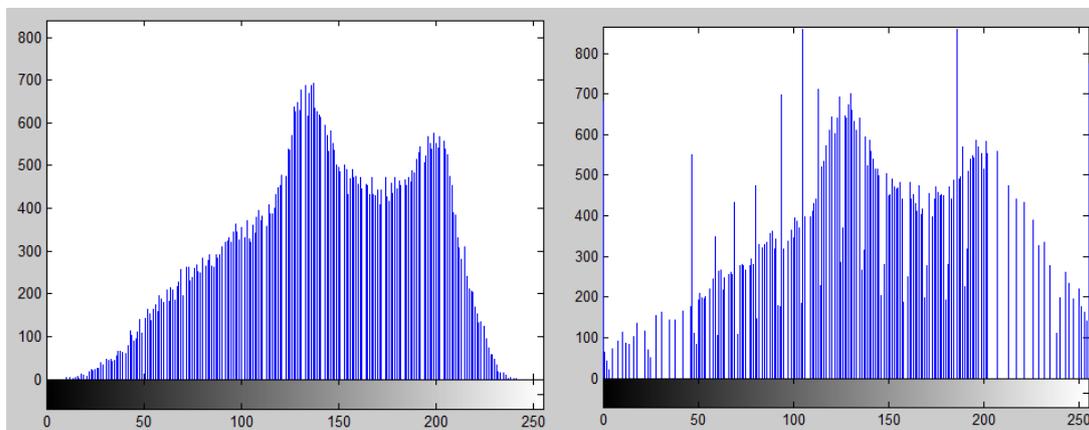
III.SIMULATION RESULTS

A number of images have been used to test the algorithm viz. Barbara, baboon, boat etc. This chapter presents the results of the implementation. For ease of system complexity, all the test images taken for this research work are grayscale and of size 256x256 pixels. The results obtained have been shown below.



a) Input Image (Baboon) b) Compressed Image c) Compressed & Enhanced

Figure 2: Results for Baboon Image



a) Histogram Plot for Input b) Histogram Plot of Final Image

Figure 3: Histogram Plot

The Figure 2a shows the input image which is read into the system for processing. Figure 2b shows the compressed image obtained after applying DWT compression techniques. Figure 2c shows the fuzzy based enhanced image obtained as the final image. As can be seen, the perceptual quality of the image has improved considerably and sufficient compression up to the order of around 1/5th of

original disk on size has been obtained. Figure 3a and 3b show the histogram comparison of the original input image and enhanced image. As can be seen due to the spread of frequencies the image has been enhanced.

Table 1: Compression Ratio

Image	Size of Original(kb)	Size of Compressed(kb)	Compression Ratio
Baboon	83.3	23.4	3.55
Barbara	85.6	16.4	5.21
Lena	163	38.2	4.26
Peppers	79.9	13.3	6.00

Table 2: MSE and PSNR values

Image	MSE	PSNR
Baboon	2.0664	44.9786
Barbara	0.3164	53.1284
Lena	0.6742	49.8427
Peppers	0.1406	56.6502

Table 1 shows the MSE and PSNR comparison for various images used in the test of the algorithm. Table 2 shows the compression ratio of the images. As can be observed from the tables the proposed method fares well on the aspects of PSNR and compression ratio.

Table 3: Comparison with Previous Work

Properties	Our Implementation	DCT	DWT	DCT+DWT
Compression Ratio	78.17	26.546	30.237	52.539
PSNR	51.14998	48.248	40.232	27.592

IV. CONCLUSION

In this paper analysis of Image, compression was performed and a novel approach based on DWT approach has been implemented. The compressed image shows degradation in quality and requires to be enhanced. A fuzzy based enhancement technique has been used to improve the quality of the image. The compression is done using 3 level DWT and Bassert-Massart strategy, which is based on a threshold value of compression. The analysis was done for different images based on parameters, compression ratio (CR), mean square error (MSE), peak signal to noise ratio (PSNR). Our simulation results show that we can achieve higher compression ratio using this technique. The DWT based compression as shown gives better compression ratio without losing more information of the image. The fuzzy based enhancement improves the visual appearance of the images obtained after compression using histogram equalization.

REFERENCES

- [1] Upendra Kumar Srivastav, Harikesh Pandey, "Hybrid Image Compression Using Dct And Fuzzy Logic", International Journal of Advance research, Ideas and Innovations in Technology. 2016.
- [2] Gaurav Kumar, Sukhreet Singh Brar, Rajeev Kumar, Ashok Kumar, "A Review: Dwt-Dct Technique And Arithmetic-Huffman Coding Based Image Compression", I.J. Engineering and Manufacturing, 2015, 3, 20-33.
- [3] Rohit Kumar Gangwar, Mukesh Kumar, A.K.Jaiswal and Rohini Saxena, "Performance Analysis Of Image Compression Using Fuzzy Logic Algorithm", Signal & Image Processing: An International Journal (SIPIJ) Vol.5, No.2, April 2014.
- [4] Neha Pandey, Himani Agrawal, "Hybrid Image Compression Based On Fuzzy Logic Technology", International Journal of Science, Engineering and Technology Research, Volume 3, Issue 9, September 2014.
- [5] Yu-Wen Tsai, Fan-Chieh Cheng, Shanq-Jang Ruan, "Constant time O(1) contextual and variational contrast enhancement with integral histogram", IEEE 2012.
- [6] Sheet D., Garud H., Suveer A., Mahadevappa A., and Chatterjee J., "Brightness Preserving Dynamic Fuzzy Histogram Equalization," IEEE Transactions on Consumer Electronics, vol. 56, no. 4, pp. 2475-2480, 2010
- [7] Victor Sanchez, PanosNasiopoulos, and Rafeef Abugharbieh, "Novel Lossless fMRI Image Compression Based on Motion Compensation and Customized Entropy Coding", IEEE Transactions On Information Technology In Biomedicine, Vol. 13, No. 4, July 2009.
- [8] Tarik Arici, Salih Dikbas, Yucel Altunbasak: A Histogram Modification Framework and Its Application for Image Contrast Enhancement. IEEE Transactions on Image Processing 18(9):1921-1935 (2009)
- [9] Neha Gupta, Prof. Mahesh Prasad, "An Image Compression Technique Based on Fuzzy Transform", International Journal of Engineering Trends and Technology (IJETT) – Volume 12 Number 7 - Jun 2014.
- [10] Priyanka Dixit, Mayanka Dixit, "Study of JPEG Image Compression Technique Using Discrete Cosine Transformation", International Journal of Interdisciplinary Research and Innovations (IJIRI), Vol. 1, Issue 1, pp: (32-35), Month: October-December 2013
- [11] Artificial Intelligence - Fuzzy Logic Systems, http://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_fuzzy_logic_systems.htm.
- [12] Ying Bai and Dali Wang, "Fundamentals of Fuzzy Logic Control – Fuzzy Sets, Fuzzy Rules, and Defuzzification", Advanced Fuzzy Logic Technologies in Industrial Applications, Chapter 2.
- [13] A. Said and W. Pearlman, "Low-complexity waveform coding via alphabet and sample-set partitioning in visual communications and image processing," in Proc. SPIE, 1997, pp. 25–37.
- [14] S.-T. Hsiang and J. W. Woods, "Embedded image coding using zero blocks of subband/wavelet coefficients and context modeling," in Proc. ISCAS 2000 Geneva Circuits and Systems, vol. 3, 2000, pp. 662–665.
- [15] R.Costantini, J.Bracamonte, G.Ramponi, J.L.Nagel, M.Ansorge, and F.Pellandini, "Low complexity video coder based on discrete Walsh Hadamard transform," in Proc. European signal processing conference, 2002, pp. 1217–1220.
- [16] M. Ezhilarasan and P. Thambidurai, "A hybrid transform technique for video coding," LNCS, vol. 4308, pp. 503–508, 2006.
- [17] Arturo San Emeterio Campos, Run Length Encoding, Arturo San Emeterio Campos, Barcelona 1999.
- [18] Pizurica and Philips, Digital Image Processing, Ghent University, Lecture notes in Computer science, January 2007.
- [19] Subramanya and Youssef, Performance Evaluation of Lossy DPCM Coding of images Using Different Predictors and Quantizers, ISCA CAINE98 Conference, Las Vegas, Nevada, November 1998.
- [20] S. P. Nanavati and P. K. Panigrahi, Wavelet: Application to Image Compression-II, Springer India, in co-publication with Indian Academy of Sciences, Volume 10, Number 3 / March 2005.