Research Journal of Recent Sciences ISSN 2277-2502
Vol. **4(3),** 75-79, March **(2015)** *Res.J.Recent Sci.*

Importance of Watermark Lossless Compression in Digital Medical Image Watermarking

Gran Badshah, Siau-Chuin Liew, Jasni Mohamad Zain, Syifak Izhar Hisham and Amatul Zehra
Faculty of Computer Systems and Software Engineering, Universiti Malaysia Pahang,TunRazak HighwayGambang, 26300 Kuantan, Pahang MALAYSIA

Available online at: www.isca.in, www.isca.me
Received 30th May 2014, revised 10th August 2014, accepted 19rd December 2014

Abstract

Large size data requires more storage space, communication time, communication bandwidth and degrades host image quality when it is embedded into it as watermark. Lossless compression reduces data size better than lossless one but with permanent loss of important part of data. Data lossless compression reduces data size contrast to lossy one without any data loss. Medical image data is very sensitive and needs lossless compression otherwise it will result in erroneous input for the health recovery process. This paper focuses on Ultrasound medical image region of interest(ROI) lossless compression as watermark using different techniques; PNG, GIF, JPG, JPEG2000 and Lempel Ziv Welsh (LZW). LZW technique was found 86% better than other tabulated techniques. Compression ratio and more bytes reduction were the parameters considered for the selection of better compression technique. In this work LZW has been used successfully for watermark lossless compression to watermark medical images in teleradiology to ensure less payload encapsulation into images to preserve their perceptual and diagnostic qualities unchanged. On the other side in teleradiology the extracted lossless decompressed watermarks ensure the images authentication and their lossless recoveries in case of any tamper occurrences.

Keywords: Ultrasound medical image, roi, watermark, compression, lzw, watermarking.

Introduction

Almost every field of life especially image based medical is fully dependent on digital imaging. Digital imaging is a computer understandable form of real world imaging, capable of modern image processing providing facilities. These facilities include the capability of analysis and recovery of image based human health related problems. Modern health recovery process is involving patient surgery is totally dependent on digital medical imaging. A number of imaging modalities for example computed tomography (CT), X-Ray, Magnetic Resonance Imaging (MRI), Electrocardiography (ECG), Ultra sound (US) etc. has been used for digital medical imaging. Each modality has its own advantages and limitations. The advantages or limitations play its role in the focused purpose achievement or becoming obstacle in their best services. For example X-Ray and ECG modalities directly result in images lossless compressed modes reducing the image size without losing any data. Digital Imaging and Communication in Medicine (DICOM) based teleradiology technology has made it possible to share health care data timely among the parties in a specified health care domain. Although the results are fruitful but image lack security, excessive storage, more communication time, more communication bandwidth usage remain the main problems faced by this technology. Teleradialogy has been integrated by Picture Archiving and Communication System (PACS) to ensure capturing, storing and validating of important medical images. The performance of PACS can be improved by medical images compression for better storage and communication management and easy retrieval as well. In this research our consideration is US images because US images are small in sizes as compared to images produced by other modalities and most of information is located at the central part of the image known as Region of Interest (ROI). The rest of the image other than ROI is known as Region of Non Interest (RONI). The main purpose of image compression is the removal of redundant data in such a way that it can be reversed to their original version for the desired operations[1].

Data compression is a technique mostly applied to text and image data such as programming codes, tabulated statistical, military targets, Satellite and medical image data. Compressed data as compared to original uncompressed data is easy to handle in storage and communication. Mostly the original data is needful after its compression for some type of applications. Such an example is the case of medical images decompression after communication in teleradiology domain. In teleradiology environment expert examine uncompressed to original version of the image for problem diagnoses and treatment suggestions. While some times only the compressed data is sufficient for the onward operations and do not require its reversion to its original state, such as video, satellite images[2]. According to the data compression literature compression can be categorized into two main groups, lossy and lossless. Figure 1 makes clearer the concept of data compression. This shows that decompression of lossless compressed image results into exactly the original image, whereas the decompression of lossy compressed data results into approximation of the original image not same to the original it means some loss of data occurs.

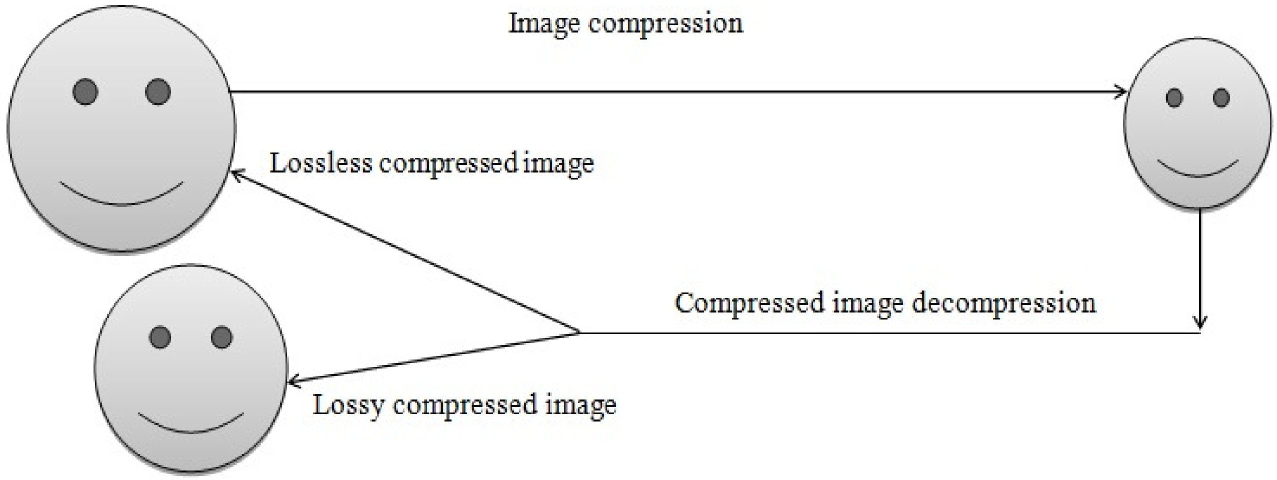

Figure-1
Comparison of imagelossy and lossless compression

The results of compressed and decompressed image data is checked if it results as same to the original one then it is lossless otherwise the compression is lossy as shown in figure 1. In case of lossy compression the resulted image is only the approximated version of the original one not the exact one. So it clears that lossless compression of medical images is suitable for their exact recovery for diagnostic purposes. Lossy compression also termed as irreversible compression in the available literature can be used to compress data up to a range of ten to fifty times of the original data but mostly loosing important parts of data or even damaging the image[3]. The lossy compression is applicable only to non-sensitive data such as videos because it does not make problem if some part of data is lost[4]. Transform coding techniques such as wavelet transform, and cosine transforms are found efficient for such types of compressions[5]. The lossless compression also known as reversible compression is that one which does not cause a loss of data and the compressed data can be reversed to its original version as it was before its compression. Lossless compression techniques can reduce the data size into a ratio up to 10:1 and without disturbing the meaning of data such as the diagnostic properties of medical images[6]. This is the main reason to use lossless compression instead of lossy one for sensitive data such as medical image to enhance PACS performance by reduction of communication bit rate and storage space. In this research Ultrasound images are selected due to small in sizes and region of interest (ROI), the image central part to be selected as watermark[7]. Artificial Neural Network (ANN) has been used for image lossless compression[1]. ANN can perform parallel data processing and can reduce the time taken in image compression[8-10]. Generally ANN is consisting groups of nodes called layer. The number of nodes in a layer is chosen according to the size of image to be processed at a time. One of such popular ANN type used for this purpose is called multilayer back propagation (MLP) neural network[11-12]. Bipolar Coding Technique is a new approach used in image processing field especially for image lossless compression. It works on the basis of special function called bipolar activation function. The use of this function makes possible conversion of the input data from analog to digital form to be processed by the hidden layers nodes or reconversions back before preparation of output to the output layer neurons. ANN based compression quality is dependent on neurons quantitycomprising hidden layers for this operation. Other than ANN different lossless compression techniques have been used for data lossless compression such as Huffman, Run Length Encoding (RLE), Arithemetic encoding, Joint Potographic Expert Group (JPEG), Joint Photographic Group (JPG), Portable Network Graphics (PNG), Graphic Interchange Format (GIF) and Lempel-Ziv Welch (LZW) etc. A transformation coding method is capable of rearranging of data making it easy to be efficiently compressed by using Arithmetic and Huffman data compression techniques[13]. An approach based on the prediction and segmentation to perform lossless compression of a grayscale image has been developed. The prediction part is based on analysis don by linear and other related important parameters required for the image encoding. The second part is the image segmentation for easy encoding of image partially in segments[14]. Another lossless binary image encoding algorithm has been used consist of two major portions. The first portion works for elimination of direct redundancy and the second one is the use of Arithmetic encoding of image[15].

Material and Methods

The replacement of the repeated data throughout in image file by short code words is done to reduce correlation in image data[16]. This is a dictionary based approach initially has been used for lossless compression of grayscale images. A coding redundancy elimination based on image lossless compression technique has been used for gray scale image compression[17]. Lempel-Ziv Welch (LZW) approach is a dictionary based lossless compression technique has been used for both image and text data compression[18]. This is a two phase developed algorithm; firstly in 1977, Abraham Lempel, Jakob Zivwere the two scientists who developed this technique together while Terry Welch improved it in 1984. Using LZW the repeating sequences of image pixels as well as repeating sequences of characters in a text file can be effectively eliminated[19]. Using this algorithm it generates its own table listing the character, strings and their codes during a file compression which are used for decompressing it later on. LZW operation fallows simple rules during the file compression such that it checks the code availability for the compressing values of characters or strings in the table. In case of non-availability the new codes are generated and inserted into the table until the whole file is compressed. LZW compression technique is better than other common compression algorithms like Huffman encoding technique by the fact it ensures only the codes available in the table for data decompression rather than whole table[20-21]. Considering an image file for compression using LZW algorithm the image pixels are taken as a single row values even the pixels lies in different rows. At the starting point all the characters of the image are initialized to the integer values in the table. Scanning the image pixels if code for the scanned sequence is available in the table then successive pixel is scanned and reaching a status that the code is not available for the new sequence in the table and a new code is generated, entered into the table and a new scan is started. Mostly the existences of previous codes are helpful in the best compression, this pixels scanning, code formation and insertion continue until finishing the whole file.

An original Ultrasound image of 480x640 sizes was taken as shown in figure-2 and ROI of 100x200 sizes was defined using image segmentation as shown in figure-3. Ultrasound image central part can be defined as ROI as it is more informative part diagnostically. ROI is used as watermark in watermarking process of images like Ultrasound medical images. We used different lossless compression techniques as listed in table 1, below with their descriptions and results. The compression results are listed in the table for specified ROI. JPEG2000 and its other versions have produced good results based on bytes reduction and LZW is the best of all based on compression ratio by 86%. The LZW image compression ratio can be improved by selection of big size ROI. In this work for experiment ROI was taken and then converted into binary values i.e zeroes and ones. All the pixel values converted to binary were added to a file. The binary file has repeating sequences of binary values. The ROI of bigger size has more repeating binary sequences and more repeating sequences improve the compression ratio of the image.

Table-1
A bmp US image ROI compression

No	Compression technique	Mode	Bytes before compression	Bytes after compression	Compression ratio
1	PNG	Lossless	20301	11102	0.546
2	GIF	Lossless	20301	19321	0.952
3	JPG	Lossless	20301	12651	0.623
4	JPEG2000-j2c	Lossless	20301	10260	0.505
5	JPEG2000-jp2	Lossless	20301	10345	0.509
6	LZW	Lossless	20301	1576	0.077

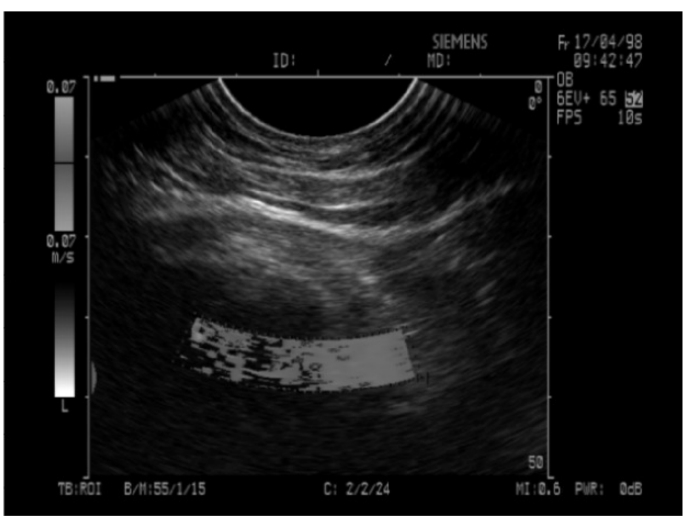

Figure-2
Original BMP image

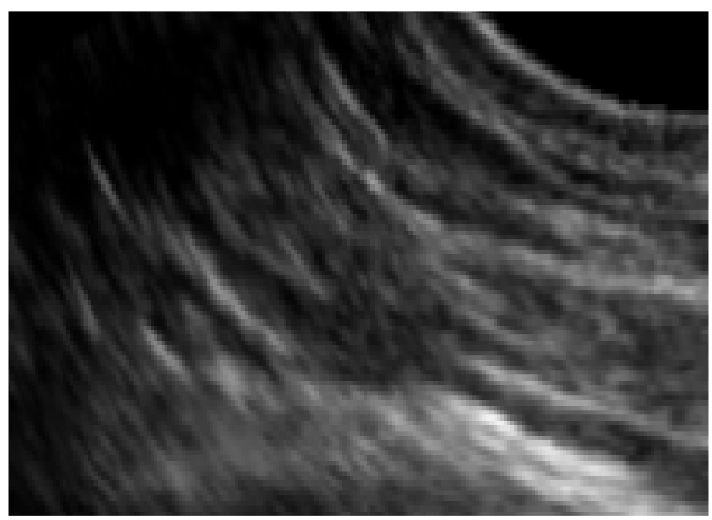

Figure-3
Selected ROI

Results and Discussion

MATLAB R2010a, Windows 7 Professional and HP ® Core (TM) i7-3770IntelCPU @3.40GHZ were used for these experiments. The ROI consists of the image pixel values of size 100*200 which can be changed according to the requirements but here we have just to define watermark and make its compression for experiments. All the watermark compression techniques used as listed in table 1 were lossless by specification of their lossless modes in the develop algorithm. From the table it is evident that LZW technique has its tremendous performance in image compression via it is better than all other even from jpeg 2000 by 86%. Here we consider the technique is best if it has its compression ratio near to zero based on the concept that the watermark size has been reduced near to zero. We can see this from line graph plotted as shown in figure-4 that for LZW technique the value for the compressed watermark is near to zero. The performance of LZW can be improved by resizing the watermark in bigger size to the exixting one.

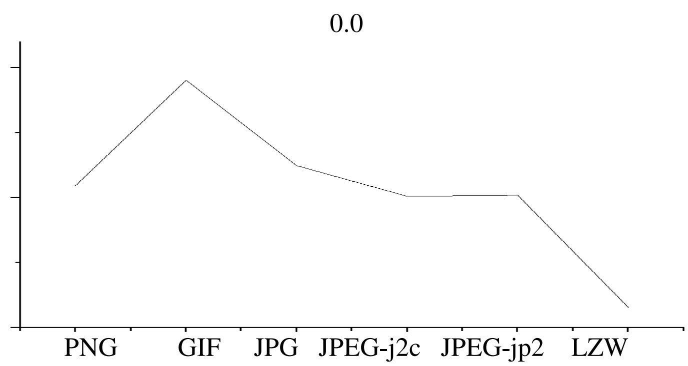

Figure-4
Comparison of watermark compression ratios using different compression techniques

It is necessary to explain that watermark shown in figure-3 is just a look of ROI not the compressed one as it is seemed that expended. It has been shown in bigger size as compared to the original for better analysis by specifing the selected coordinates. As it is a one hundered rows and two hundred column selection from the original image of size 480x640 shown in figure-2.

Conclusion

Digital image compression has important applications in image processing based research. These applications are prominent in the fields of air space and medical image security. For example the compression of satellite and medical images ensures the image data reduction for easy communication and storage. Medical image security is one of these applications based on watermarking of medical images. In this work ROI as a watermark of Ultrasound medical image has been lossless compressed because a minor change is also not affordable for such sensitive data otherwise it will lose its originality and will make direction towards wrong decision making. Many lossy and lossless data compression techniques are available being used for image compression but here we only discussed lossless compression and their comparison as shown in table-1. It is evident from the tabulated data that the compression ratio for each of the techniques is different. The comparison was based on compression ratio. Lempel Ziv Welch (LZW) was found the best out of these all. The comparison shows that the compression ratio is better than others by amount of 86 percent. The selected technique is suggested for medical image ROI compression to be as digital watermarking of images. The watermark lossless compression ensures the lossless recovery of watermark at the receiver hand and tampered portions localization and lossless recoveries of images ROI. In digital watermarking of Ultrasound medical images, the image is divided into ROI and RONI. ROI is lossless compressed and embedded into RONI as lossless compressed watermark. In case of image tampering the decompression of lossless compressed watermark can be used for the image recovery into its original version. LZW technique of watermark compression is not only restricted to Ultrasound images but successfully can be used as the same way for other modalities produced digital images security.

Acknowledgement

Thanks to Universiti Malaysia Pahang (www.ump.edu.my) for funding this research under grant GRS, 110336, FSKKP. The digital images used in this research experiments were downloaded from internet.

References

1. Vilas H. Gaidhane, Vijander, Yogesh V. Hote and Mahendra Kumar, New Approaches for Image compression Using Neural Network, *Journal of Intelligent Learning System and Applications,* **5(3),** 220-229 **(2011)**

2. Kosmas Karadimitriou and John M. Talor, Min-Max Compression Methods for Medical Image Databases, *ACM SIGMOD Record*, **26(1), (1997)**

3. S. Wong, L. Zaremba, D. Gooden and Huang H.K., Radiologic Image Compression A Review, *Procc. IEEE,* **83(2),** 194-218 **(1995)**

4. Gaidhane V.H., Hote Y.V. and Singh V., A New Approach for Estimation of Eigen values of Images, *International Journal of Computer Applications,* **26(9),** 1-6 **(2011)**

5. Miaou S.G. and Lin C.L., A Quality-on-Demand Algorithm for wavelet-based compression of Electrocardiogram Signals, *IEEE Transaction on Biomedical Engineering,* **49(3),** 233-239 **(2002)**

6. E. Watanabe and K. Mori, Lossy Image Compression Using a Molecular Structured Neural Network, *Proceedings of IEEE Signal* Processing *Socity Workshop,*

Washington DC, 403-412 **(2001)**

7. Hashwmi Berenjabad S., Mahloojifar A. and Akhvan A., Threshold based lossy Compression of Medical Ultrasound Images using contourlet Transform,*IEEE Iranian Bio Medical Engineering conference, Tehran,* **(2011)**

8. Ma L. and Khorasani K., Application of Adaptive Constructive Neural Network to Image Compression,*IEEE Transactions on Neural Networks,* **13(5),** 1112-1126 **(2002)**

9. Q. Du, W. Zhu and J. E. Fowler, Implementation of Low Complexity Principal Component Analysis for remotely sensed Hybrid Spectral Image Compression, Proceeding *of IEEE Workshop on Signal Processing Systems, Shang hai,* 307-312 **(2007)**

10. Vilovic, An Experience in Image Compression Using Neural Networks, *Proceeding of 48th International Symposium Elmar, Zadar,* 95-98 **(2006)**

11. V. Gaidhane, V. Singh and M. Kumar, Image Compression Using PCA and Improved Technique with MLP Neural Network, *Proceedings of IEEE International Conference on Advances in Recent Technologies in Communication and Computing, Kottayam,* 106-110 **(2010)**

12. M. Daszykowski, B. Walczak and D. L. Massart, A Journey into Low-Dimentional Spaces with Autoassociative Neural Networks, *Talanta,* **59(6),** 1095-1105 **(2003)**

13. P. Franti, A Fast and Efficient Compression Method for Binary Image,*Signal Processing: Image communication,* **6(1),** 69-76 **(1994)**

14. M. Burrows and D. J. Wheeler, A Block-Sorting Lossless Data Compression Algorithm,*Systems Research Center,* **(22),** 1-18 **(1994)**

15. B. Meyer and P. Tischer, TMW- A New method for Lossless Image Compression,*Department of Computer Science Monash University Australia,* 3168, **(1997)**

16. Brittain N.J. and El-Sakka M.R., Grayscale True Two Dimensional Dictionary-Based Image Compression, *Journal of Visual Communication and Image Representation,* **18(1),** 35-44 **(2007)**

17. Chen R.C., Pai P.Y., Chan Y.K. and Chang C.C., Lossless Image Compression Based on Multiple-Tables Arithmetic Coding, *Mathematical problems in Engineering,* 1-15, **(2009)**

18. Alarabeyyat S., Al-Hashemi, Khdour T., Hjouj Btoush M., Bani-Ahmad S. and Al-Hashemi, Lossless Image Compression Technique Using Combination Methods,*Journal of Software Engineering and Applications,* **(5),** 752-763 **(2012)**

19. Dr Jennifer Burg (burg@wfu.edu), The Science of Digital Media, Chapter 3,*Digital Image Processing, Grant No. 0340969,* 49-51 **(2007)**

20. Jennifer Burg and Annie Lausier, Supplement to Chapter 3 of the Science of Digital Media- Digital Image Processing, The National Science Foundation supported research, Grant Numbers, *DUE-0127280, DUE-0340969,* 1-13 **(2007)**

21. Mark Nelson, Jan Hakenberg, David Littlewood and Joe Snyder, LZW Data Compression. *Dr. Dobb's Journal,* **(1989)**