ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

ANALYSIS AND EFFICIENCY OF ERROR FREE COMPRESSION ALGORITHM FOR MEDICAL IMAGE

[1]J HEMAMALINI, [2] D KAAVYA
[1]Asstt Prof., Department of Information Technology, Sathyabama University, Chennai, Tamil Nadu
[2]Asstt. Prof., Department of Information Technology, Sathyabama University, Chennai, Tamil Nadu
E-mail:[1] hemamalini.it@sathyabamauniversity.ac.in ,[2] d.kaavya89@gmail.com

ABSTRACT

Now a day's number of medical images are generated in scan center. These are emerging tool to diagnose diseases. The storage of an image is an economical problem of scan center. Hence digital image compression is necessary in order to solve the problem. Normally during compression, loss of data is not acceptable. Hence the scan images have required high resolution and without any loss of data in a compressed and decompressed digital image. To solve this problem, this paper implements an algorithm known as 8 bit/pixel code string algorithm which is based on pixel redundancy reduction by formulating matrices. The formulating matrices are BM (Binary Matrix) and GSM (Gray Scale Matrix) which is used in compression and decompression process. This method will be useful in Telemedicine, Teleradiology purposes.
Keywords: *Digital image compression, 8 bit/pixel code string, BM, GSM.*

1. INTRODUCTION

The Medical image is a process of creating a visual representation of interior body for analysis. Medical image is an emerging tool for consultants to diagnose the problem in the human body. The medical images consist of Plain X-Ray, Computed Tomography, Medical Ultrasonography, Magnetic Resonance Imaging, Endoscopy, Elastography, Positron Emission Tomography, Thermograph. The most frequent radio-graphic techniques are CT, MRI, PET. These techniques are used for medical research to diagnose the disease, and it supports to plan the treatment [14,17].

Digital image compression technique is used to reduce the size of image and also helps to reduce the amount of storage space or to transmit a scanned image in an efficient manner through internet. The lossy and lossless are the two common techniques used for image compression and decompression. The lossless image representation formats are BMP (Bitmap File), TIFF (Tagged Image File Format), PNG (Portable Network Graphics) [17]. The lossy image representation formats are JPEG (Join Photographic Experts Group), JPEG 2000. The JPEG is flexible because the compression rate can be adjusted and also the compression rate produce low quality. By using this format we can increase compression rate, but more information will be lost. The lossless compression technique which produces no loss of information in an image has high quality [15]. The lossy compression techniques produce some minor loss of information in an output image. The loss of information is invisible and it is difficult to identify where it occurs in a digital image, so it is not acceptable for medical image.

The key factor of image compression is to improve the high speed of transmission and reduces the storage space [1]. The choice of compression method depends on the application. For example, in text compression any loss of information in the text can be tolerated because this will not affect anyone. If any data loss occurs in medical image, that can't be tolerated, the life of a person will be affected. Hence medical image requires high quality resolution without any loss of information in an image [2]. Compressing an image is a significantly different process than compressing the raw binary date [3, 4]. The image compression is a process of encoding image pixel value. The size of the compressed image is lesser than the original image size. The purpose of image compression is used to utilize the storage space to load more images on hard disk and also enhance the speed of transmission by using lesser bandwidth [5, 6, 7].

The proposed system is formulated by BM, GSM and 8 bit pixel code string which are used for compression and decompression.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

2. RELATED WORK

The most trendy lossless coding techniques are Run Length Encoding, Huffman Encoding, Arithmetic Encoding, Entropy Coding, Lempel-Ziv (LZ78), Deflate, Lempel-Ziv-Markov Chain Algorithm. The Run Length Encoding algorithm, the group of pixel is encoded [5, 6, 7,16]. The Huffman Encoding algorithm, the continuous occurrence of pixel value is used to encode by using variable size bit-word [17]. The Entropy Encoding Algorithm creates unique prefix code to each prefix code and the compressed data by replacing each fixed-length input symbol with corresponding variable-length prefix-free output code word [19, 20]. The CALIC (context based adaptive lossless image code algorithm) is producing a context among adjustments pixel [7, 8, 9]. In Low complexity lossless compression for Images (LOCO-I) is a lossless algorithm this process based on fixed context for capturing magnificent dependencies [10,18]. The Lempel Ziff Welch (LZW) algorithm most commonly used for image compression. It is more effective on digital image with a color depth from 1 to 24 bits; 1 bit represents monochrome and 24 bits represents the true color.

In an image compression, the processes such as Inter pixel redundancy, Coding redundancy, and psycho visual redundancy are used to eliminate the redundant values. To reduce inter pixel redundancy, there are various methods used, such as Run length coding, Data compression, Constant coding, Predictive coding [11].

Drawbacks:

- Time consuming
- Complexion
- Application to non medical images
- It is not possible for real time applications

3. PROPOSED SYSTEM

The compression takes an input M and generates a representation MM that hopefully requires fewer bits. Hence the reconstruction algorithm that operates on the compressed representation MM to generate the reconstruction N and the performance of the algorithm depends on the type of the compression technique.

This paper, based on pixel redundancy reduction by formulating matrices which are Gray Scale Matrix (GSM), Binary Matrix (BM), 8 Bit/Pixel Code String algorithm. These matrices can use for compressing and decompressing the digital image. This paper implements 8 bit/Pixel code string algorithm. The 8 bit/pixel code string algorithm is a standard developed by the ETSI (European Standard (Telecommunications series)) [13].

3.1 Binary Matrix

The binary matrices consist of 0's and 1's. Always the Bitmap file consists of 54 bytes HEADER and the CLUT (Color Lookup Table) consist of 1024 bytes of date for 8-bit grayscale images. The following procedure of binary matrices (BM) is shown in the Figure. 1.

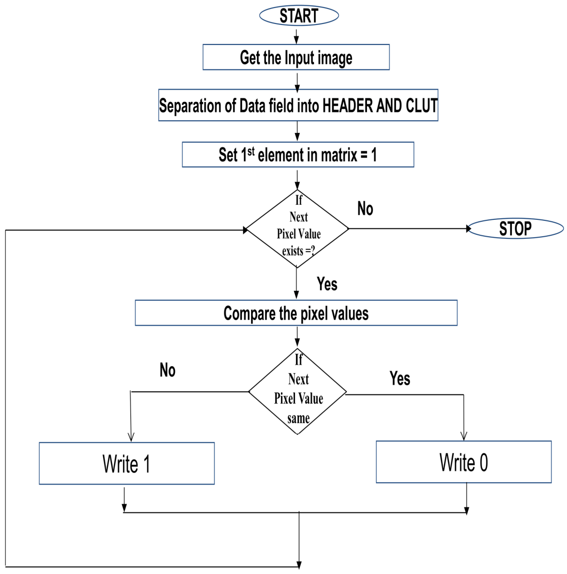


Figure 1. Computation of Binary Matrix

Procedure:

Step 1: Read Scanned image [img].
Step 2: The grayscale image [img] convert into Single dimension format [img_1D] and calculate the size of image [img_size].
Step 3: Construct Binary Matrices by using the following steps.
Set loop from pixel =1 to < img_size do
If img_1D (pixel) = (Logical Not) of img (pixel+1) then
    Assign BM_1D(pixel+1)=1
 End if
 End loop
Step 4: Convert (Binary Matrices) BM_1D (Single Dimension) into BM_2D (Double Dimension).

Illustration of Binary Matrix:
The binary matrix constructed based on example given below

Journal of Theoretical and Applied Information Technology
20th April 2015. Vol.74 No.2

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[img]= 30 30 30 40 40 1 6 6
[BM]= 1 0 0 1 0 1 1 0

3.2 Grayscale Matrix:

The grayscale matrix is a value of pixels in an image, which represents value intensities are within the range and each element are correspond to one image pixel. The following procedure of Grayscale Matrix is shown in the Figure. 2.

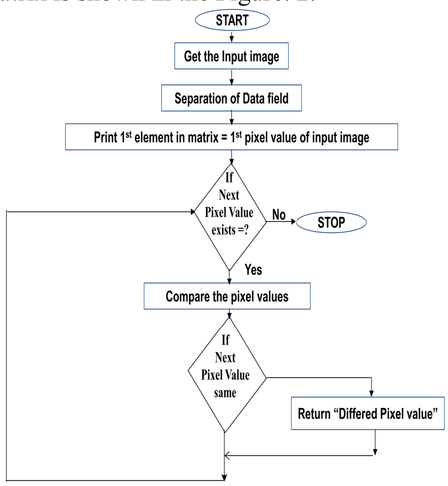


Figure 2. Computation of Grayscale Matrix

Procedure
Construct Grayscale Matrix, using the following steps:

Step 1: Initialize i=1
Step 2: GSM is set to the first pixel value of img_1D
Step 3: set loop pixel =1 to < img_size do
  if img_1D (pixel) = (Logical Not) (pixel+1) then
    Increment i by 1
    GSM(i) = img_1D (pixel +1);
  End if
End loop

Illustration of Gray Scale Matrix:

The gray scale matrix constructed based on example given bellow

[img] = 30 30 30 40 40 1 6 6
[GSM]= 30 40 1 6

3.3 8 Bit/Pixel Code String:

The 8 bit/pixel Code String Algorithm produces efficient compression and lossless decompression of image files especially for grayscale images. The structure of 8 bit/pixel code string given bellow Table. 1. [13].

Table 1: Structure of 8 bit/pixel Code String

The process of 8 bit/pixel code sting is given bellow

8 bit/pixel	Code sting meaning
00000001 to 11111111	One pixel color is 1 to one pixel color 255
00000000 0LLLLLLL	L pixel (1-127) in color 0 (L>0)
00000000 1LLLLLLL CCCCCCCC	L pixel (3-127) in color C (L>2)
00000000 00000000	Ends of 8 bit pixel code string

Step 1: Repetition of same values is numbered
Step 2: L is the number of repetitions
Step 3: C is the repeated value
Step 4: L and C are represented as respective binary formats of length 8 bits.

Example:

BM= [0 0 1 1 1 0 1 1 0 0 0 0 1 1 1 1 1]
L= 2, L=3,L =1, L=2, L=4, L=5
C=0, C=1,C=0, C=1, C=0, C=1
It is encoded as
for L=5 & C=1, it becomes 00000000 10000101 00000001

Algorithm of Medical Image Compression

The process of image compression is given below
Step 1: Read the grayscale image [img].
Step 2: Separate Header and Data field, while analyzing the Header, can observe the detail of the image.
Step 3:Convert Double Dimension(img_2D) input data file into Single Dimension array (img_1D)
Step 4: Build the Binary Matrix [BM] & Build the Grayscale Matrix [GSM].
Step 5: Calculate compression Rate [CR_1] by using equitation

$$CR\_1 = \frac{GSM}{img} \quad (1)$$

Step 6: Compute [o_img] by using 8 bits/pixel code string Algorithm and save on the drive
Step 7: Calculate compression Rate [CR_2] of output image

$$CR\_2 = \frac{o\_img}{img} \quad (2)$$

Algorithm for Decompression of Compressed File

The decompression is a process of reversing the procedure. The following step involves decompressing the compressed file.
Procedure

Journal of Theoretical and Applied Information Technology
20th April 2015. Vol.74 No.2

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Step 1: The Compressed file is decompressed using Run Length Decoding

Step 2: The compressed BM and GSM are decompression of compressed BM raw data

Step 3: Reconstruction of Single Dimension array [img_1D] by using MB and GSM

Step 4: Convert Single Dimension to Double Dimension

Step 5: Reconstruct a Medical image by using Header

Step 6: The reconstructed output image compared with Original image by using LMS Algorithm.

4. RESULTS AND DISCUSSION

Using Matlab the above algorithms are implemented and found 8 bit/pixel code string algorithm is more efficient, output image shown in Table. 2. Hereby calculated MSE (Mean square error) and efficiency. The Mean Square Error and Efficiency is calculated by using procedure is given below.

Mean Square Error:

Step 1: Read input image [img] and decompressed output image [o_img]
Step 2: Read [o_img] width and height and calculate MSE (Mean Square Error) using following formula

$$\mathrm{MSE} = \frac{1}{wh}\sum_{i=1}^{w}\sum_{j=1}^{h}[\mathrm{img}(i,j) - \mathrm{o\_img}(i,j)]^2 \qquad (3)$$

If MSE is 0, means both image are equal

Efficiency:

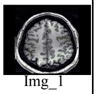
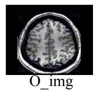
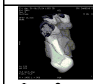
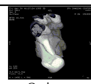
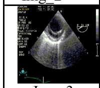
Step 1: Read input image [img] and decompressed output image [o_img]
Step 2: if input image w & h (width and height) is equal to output image w & h (width and height)

$$E = \begin{cases} \mathrm{img}_{(i,j)} == \mathrm{o\_img}_{(i,j)} & c = 0 \\ \text{otherwise} & c = 1 \end{cases} \quad \forall \text{ pixels } i = 0 \text{ to } w \;\&\; j = 0 \text{ to } h \qquad (4)$$

Where c=0 means 100% efficiency otherwise error

Hereby, original image and decompressed image are Compared using bit-by-bit pixel matching

Table 2: Comparison of GSM & 8 bit/pixel code string

Image	Original size	Compressed Image size		De_comp Image	De_comp image Size	MSE
		GSM	8bit/pixel code string			
 Img_1	257 KB	73 KB	40.3 KB	 O_img	257 KB	0
 Img_2	395 KB	72.4 KB	44.0 KB	 O_img	395 KB	0
 Img_3	361 KB	76.4 KB	45.0 KB	 O_img	361 KB	0

Advantages:

- Less computational load
- Low complexity
- Coding and decoding is made easier
- Image communication is made faster
- No risk of losing data

5. CONCLUSION

This paper implements a 8 bit/pixel code string Algorithm for digital image compression. An experimental results compared with GSM is plotted in Figure 3. The 8 bit/pixel code string algorithm is proved and it takes very less memory space. It is very useful for medical image scan center to load more scan images and can transmit images very faster through a network by using less bandwidth. Digital image data compression is necessary in order to solve the storage problem. This algorithm is more efficient than the previous ones in every aspect. We can say that it is the maximum compression that can be achieved in medical images. In future, the same technology can extend to video compression in medical field even for live transmissions. For live video compressions, we need a faster operation of the algorithm.

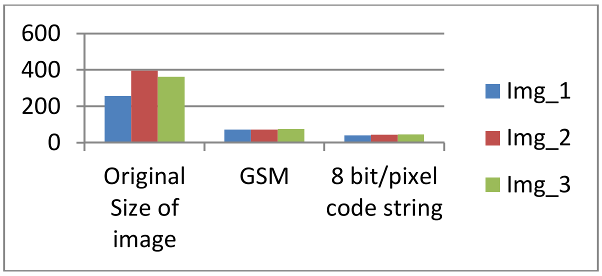


Figure 3: Experimental results of 8bit/pixel code string compared with GSM

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Acknowledgements

I would like to thank the management of Sathyabama University for their support in publishing this paper.

REFRENCES:

[1] Streams, S.D., L. Tan and N. Magotra, 1993. "Lossless compression of waveform data for efficient storage and transmission". IEEE Trans. Geosci. Remote Sens., 3I: 645-654.

[2] Carbal, J. E. and Y. Kim, 1996. "Multimedia Systems for Telemedicine and their Communication requirements", IEEE Commun. Mag., 34: 20-27. DOI: 10.1109/35.526884

[3] Rafael C. Gonzalez and Richard E. Woods. Digital Image Processing, *Pearson Education*, Englewood Cliffs, 2002.

[4] Loganathan R et. al., "Medical Image Compression Using Biorthogonal Spline Wavelet With Different Decomposition, *(IJCSE) International Journal on Computer Science and Engineering*, Vol. 02, No. 09, 2010, 3003-3006.

[5] Sami Khuri and Hsiu-Chin Hsu, Interactive Packages for Learning Image Compression Algorithms lists, requires prior specific permission and/or a fee. *ITiCSE* 2000, Helsinki, Finland.

[6] Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, *Pearson Education*, 2002.

[7] Debashis Chakraborty et al, Efficient Lossless Colour Image Compression Using Run Length Encoding and Special Character Replacement, *International Journal on Computer Science and Engineering (IJCSE),* ISSN : 0975-3397 Vol. 3 No. 7 July 2011, p:2719-2725.

[8] W. B. Pennebaker and J. L. Mitchell, JPEG: Still Image Data Compression Standard, *Van Nostrand Reinhold*, New York, 1993.

[9] Tinku Acharya, Ping-Sing Tsai. JPEG2000 Standard for Image Compression.

[10] Marcelo J. Weinberger, Gadiel Seroussi, et. al," LOCO-I: A Low Complexity, Context-Based, Lossless Image Compression Algorithm, *IEEE Data Compression Conference, Snowbird*, Utah, March-April 1996.

[11] Jagadish H. Pujar, Lohit M. Kadlaskar , A New Lossless Method of Image Compression and Decompression Using Huffman Coding Techniques, *Journal of Theoretical and Applied Information Technology*, 2005 – 2010, p-18 to 23.

[12] S.E. Ghrare, M.A. Mohd. Ali, el at., An Efficient Low Complexity Lossless Coding Algorithm for Medical Images, *American Journal of Applied Sciences* 6 (8): 1502-1508, 2009.

[13] 8 bit/pixel code string Algorithm referred in Final draft ETSI EN 300 743 V1.2.1 (2002-06), *European Standard (Telecommunications series).*

[14] Meena A, Raja K, Segmentation of Alzheimer's Disease in PET Scan Datasets using Matlab, *International Journal on Information Sciences & Computing*, Vol 6, No-2, July 2012.

[15] Mridul Kumar Mathur, Gunjan Mathur, Image Compression using DFT Through Fast Fourier Transform Technique, *International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)*, Volume 1, Issue 2, July – August 2012 ISSN 2278-6856.

[16] Khaled Sahnoun, Noureddine Benabadji, A Hybrid DPCM-DCT and RLE Coding for Satellite image compression, IJCSI *International Journal of Computer Science Issues*, Vol. 10, issue 6, no 1, November 2013, page-82 to 85.

[17] Sashikala, Melwin.Y., Arunodhayan Sam Solomon, M.N.Nachappa, A Survey of Compression Techniques, *International Journal of Recent Technology and Engineering (IJRTE)*, ISSN: 2277-3878, Volume-2, Issue-1, March 2013, Page-152 to 156.

[18] Chien-Wen Chen, Shi-Huang Chen, el. at., A Modified JPEG-LS Image Compression Scheme for Low Bit-Rate Application, *Proceedings of the International MultiConference of Engineers and Computer Scientists* 2008 Vol I, IMECS 2008, 19-21 March, 2008, Hong Kong.

[19] Entropy encoding concept refereed in this website: http://en.wikipedia.org/wiki/Entropy_encoding.

[20] Entropy encoding concept refereed in this website: http://doras.dcu.ie/15074/2/Thesis.pdf