International Journal of Image Processing and Vision Science

Volume 1 | Issue 4 Article 1

October 2013

A TWO COMPONENT MEDICAL IMAGE COMPRESSION TECHNIQUES FOR DICOM IMAGES

K. S. SELVANAYAKI
Department of Computer Applications, Easwari Engineering College, Chennai, Tamil Nadu, kssindia2004@yahoo.co.in

ATWO COMPONENT MEDICAL IMAGE COMPRESSION TECHNIQUES FOR DICOM IMAGES

K. S. SELVANAYAKI

Department of Computer Applications, Easwari Engineering College, Chennai, Tamil Nadu.
Email:kssindia2004@yahoo.co.in

Abstract-To meet the demand for high speed transmission of image, efficient image storage, remote treatment an efficient image compression technique is essential. Wavelet theory has great potential in medical image compression. Most of the commercial medical image viewers do not provide scalability in image compression. This paper discusses a medical application that contains a viewer for digital imaging and communications in medicine (DICOM) images as a core module. Progressive transmission of medical images through internet has emerged as a promising protocol for teleradiology applications. The major issue that arises in teleradiology is the difficulty of transmitting large volume of medical data with relatively low bandwidth. Recent image compression techniques have increased the viability by reducing the bandwidth requirement and cost-effective delivery of medical images for primary diagnosis.

This paper presents an effective algorithm to compress and reconstruct Digital Imaging and Communications in Medicine (DICOM) images. DICOM is a standard for handling, storing, printing and transmitting information in medical imaging. These medical images are volumetric consisting of a series of sequences of slices through a given part of the body. DICOM image is first decomposed by Haar Wavelet Decomposition Method. The wavelet coefficients are encoded using Set Partitioning in Hierarchical Trees (SPIHT) algorithm. Discrete Cosine Transform (DCT) is performed on the images and the coefficients are JPEG coded. The quality of the compressed image by different method are compared and the method exhibiting highest Peak Signal to Noise Ratio (PSNR) is retained for the image. The performance of the compression of medical images using the above said technique is studied with the two component medical image compression techniques.

Keywords-*Medical Images, DICOM (Digital Imaging and Communications in Medicine, HAAR Wavelet, Set Partioning in Hierarchial Trees(SPIHT), DICOM Previewer, X-ray Images*

1. INTRODUCTION

One of the hottest imaging technologies is compression. In the early stages, compression was limited to JPEG, GIF and Group 3 fax. Compression technologies have multiplied. Now there exist wavelet and fractal compression. Compression is applied to still images, audio and video. Three reasons to compress: save storage space, conserve bandwidth, and speed up application software.

Wavelet theory has great potential in medical image compression. Advanced Medical imaging applications require storage of large quantities of digitized clinical data and due to the constrained requirements of medical data archiving, compression is adapted in most of the storage and transmission applications. There are two categories of compression: Lossy and lossless methods. Based on the system requirement any one of the methods is employed. Lossless compression ensures complete data fidelity after the reconstruction, and yet the compression ratio is limited in general from 2:1 to 3:1. The application of lossy techniques results in information loss to some degree, but it can provide more than 10:1 compression ratio with little perceptible difference between reconstructed and original images. In this paper we attempt to discuss about Image Compression, DICOM Images , Methods for compression of DICOM Images, Compression of DICOM Images using Haar Wavelet and SPIHT Composition.

2. IMAGE COMPRESSION

Image compression addresses the problem of reducing the amount of data required to represent a digital image. It is a process intended to yield a compact representation of an image, thereby reducing the image storage/transmission requirements. Compression is achieved by the removal of one or more of the three basic data redundancies:

1. Coding Redundancy
2. Interpixel Redundancy
3. Psychovisual Redundancy

Coding redundancy is present when less than optimal code words are used. Interpixel redundancy results from correlations between the pixels of an image. Psychovisual redundancy is due to data that is ignored by the human visual system (i.e. visually non essential information).

Image compression techniques reduce the number of bits required to represent an image by taking advantage of these redundancies. An inverse process called decompression (decoding) is applied to the compressed data to get the reconstructed image. The objective of compression is to reduce the number of bits as much as possible, while keeping the resolution and the visual quality of the reconstructed image as close to the original image as possible. Image compression systems are composed of two distinct structural blocks : an encoder and a decoder.

Image f(x,y) is fed into the encoder, which creates a set of symbols form the input data and uses them to represent the image. If we let n1 and n2 denote the number of information carrying units(usually bits) in the original and encoded images respectively, the compression that is achieved can be quantified numerically via the compression ratio, CR = n1 /n2

As shown in the figure, the encoder is responsible for reducing the coding, interpixel and psychovisual redundancies of input image. In first stage, the mapper transforms the input image into a format designed to reduce interpixel redundancies. The second stage, qunatizer block reduces the accuracy of mapper's output in accordance with a predefined criterion. In third and final stage, a symbol decoder creates a code for quantizer output and maps the output in accordance with the code. These blocks perform, in reverse order, the inverse operations of the encoder's symbol coder and mapper block. As quantization is irreversible, an inverse quantization is not included.

2.1 Benefits of Compression

• It provides a potential cost savings associated with sending less data over switched telephone network where cost of call is really usually based upon its duration. It not only reduces storage requirements but also overall execution time.

• It also reduces the probability of transmission errors since fewer bits are transferred.

• It also provides a level of security against illicit monitoring.

3. DICOM IMAGES

DICOM (Digital Imaging and Communications in Medicine) is a standard for handling, storing, printing, and transmitting information in medical imaging. DICOM differs from some, but not all, data formats in that it groups information into data sets. That means that a file of a chest X-Ray image, for example, actually contains the patient ID within the file, so that the image can never be separated from this information by mistake. This is similar to the way that image formats such as JPEG can also have embedded tags to identify and otherwise describe the image.A DICOM data object consists of a number of attributes, including items such as name, ID, etc., and also one special attribute containing the image pixel data (i.e. logically, the main object has no "header" as such: merely a list of attributes, including the pixel data). A single DICOM object can only contain one attribute containing pixel data. For many modalities, this corresponds to a single image. But note that the attribute may contain multiple "frames", allowing storage of cine loops or other multi-frame data.

4. SPIHT CODER

SPIHT technique is based on a wavelet transform and differs from conventional wavelet compression only in how it encodes the wavelet coefficients. SPIHT is based on three concepts

(1) Exploitation of the hierarchical structure of the wavelet transform by using tree-based organization of the coefficients,

(2) Partial ordering of the transformed coefficients by magnitude,

(3) Ordered bit plane transmission of refinement bits for the coefficient values.

5. PROPOSED ALGORITHM

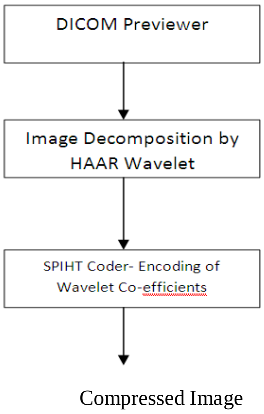
These medical images are volumetric consisting of a series of sequences of slices through a given part of the body. To maintain uniform quality for all sequences of slices a single slice is encoded and compressed bit stream is sent to the decoder. After the encoder and decoder finish all the slices in a sequence, it shifts to process the next sequence of slices. The block diagram of proposed method is shown in below. DICOM Images (X-ray) images are decomposed using Haar Wavelet Transform. The algorithm starts at the coarsest sub band in the sub band pyramid. SPIHT captures the current bitplane information of all the DWT coefficients and organizes them into three subsets:

(1) List of Significant Pixels (LSP),

(2) List of Insignificant Pixels (LIP) and

(3) List of Insignificant Sets of Pixels (LIS).

LSP constitutes the coordinates of all coefficients that are significant. LIS contains the roots of insignificant sets of coefficient. Finally, LIP contains a list of all coefficients that do not belong to either LIS or LSP and are insignificant. During the encoding process these subsets are examined and labeled significant if any of its coefficients has a magnitude larger than a given threshold. The significance map encoding (set partitioning and ordering pass) is followed by a refinement pass, in which the representation of significant coefficients is refined. These thresholds used to test significance are powers of two, so in its essence, the SPIHT algorithm sends the binary representation of the integer value of wavelet coefficients.



6. RESULTS

HAAR Wavelet decomposition is one of the best method of decomposition of images. The decomposed image is passed as an input to the SPIHT Coder to compress. As the SPIHT gives the best results in compression for the Lena and Barbara Images, the decomposed image would give the best results. The input image can be the CT Brain (2 sets) and CT Mono 16 ankle. The performance is studied by PSNR(Peak Signal To Noise Ratio) values and CR (Compression Ratio) Values. The standard objective measure of image quality PSNR is used to study the performance of the Compression of Medical Images. The PSNR value for the CT Image of Brain is listed n the table.

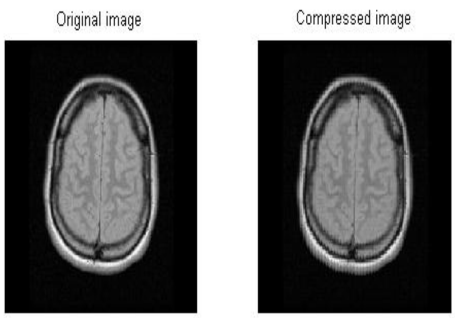


Fig: 1 CT Image of Brain

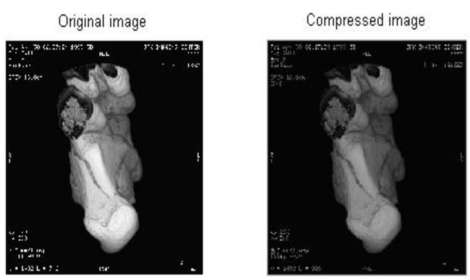


Fig 2: CT MONO 16-ankle

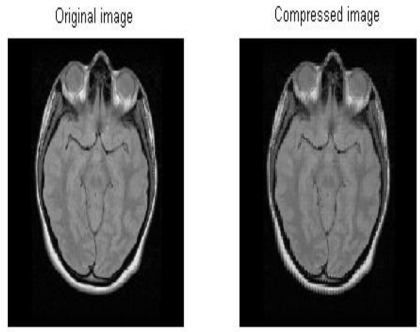


Fig: 1 CT Image of Brain

S.No	Image	MSE	PSNR
1	CT Image of a Brain – Fig 1	1.0531	47.9061
2	CT MONO 16-ankle	13.9120	36.6969
3	CT Image of a Brain – Fig 3	1.4275	46.5851

CONCLUSION

A wavelet based compression with set partitioning in hierarchical trees brings out good performance in DICOM series of images for medical image compression. The statistical data shows that proposed algorithm brings better performance than standard compression algorithms. To study the performance, various subjective measures based on the visual inspection of the compressed images and the evaluations are carried out among different images at various bit rates and decomposition levels. The SPIHT algorithm appears to give extremely good performance for medical image compression, and may be very useful in practical implementations of teleradiology and digital picture archiving and communications (PACS) systems.

ACKNOWLEDGEMENTS

I would like to express my gratitude to all those who gave me these possibilities to submit the paper for the journal. I want to thank the Department of Computer Applications for their continuous support in the research. I extend my sincere thanks to Dr. Dhanapal, Head of the Department for his help. I thank the almighty and my research guide Dr. Rm. Somasundaram, Professor – Department of Computer Science , SNS College of Engineering, Coimbatore for his valuable guidance.

REFERENCES

[1] S.Hludov, Chr.Meinel, " DICOM – Image Compression", IEEE, 1999.

[2] S. Shenbaga Devi, K. Vidhya, " Development of Medical Image compression Techniques", International Conference on computational Intelligence and Multimedia Applications, 2007.

[3] T. Kesavamurthy, "Dicom Color Medial Image compression using 3D-SPIHT for Pacs Application", International Journal of Biomedical Science, june 2008.

[4] Chandrajit bajaj , Insung ihm and Sanghum Park, "3D RGB Image compression for Interactive applications," the university of Texas at Austin Oct 2006.

[5] Alexis Tzannes, "Compression of 3-Dimensional Medical Image Data using part 2 of JPEG 2000," Aware.Inc, Nov, 2003.

[6] A said and W A Pearlman, "A new, fast and efficient image codec based on Set partitioning in Hierarchial Trees," IEEE Transaction on Circuits system for video Technology, 6, pp 243-250, 1996.

[7] Sungdae Chob, Dongyoun Kim and William A. Pearlman, "Lossless compression of Volumetric Medical Images with improved 3D-SPIHT algorithm," Nov 2007.