A Survey on Various Medical Image Compression Techniques

Alagendran B, Manimurugan S

Abstract-Medical images are much important in the field of medicine ,all these medical images are need to be stored for future reference of the patients and their hospital findings hence, the medical image need to undergo the process of compression before storing it. On these days of medical advancement there exist many compression techniques. This paper investigates mainly on the various types of medical image compression techniques that are existing, and putting it all together for a literature survey. Scope of this study focuses on the different available medical image compression techniques with their performance results.

Keywords-Discrete Cosine Transform, Discrete Wavelet Transform, Medical Image Compression, Set Partitioning in Hierarchical Trees.

I. INTRODUCTION

In these days of medical advancement the usage of medical images became necessary for diagnosis of patients. Due to this, large volumes of medical images are produced and used every day. Hence such image data need to be stored for future reference of patients and their findings. Due to the large generation of medical images became necessary, it is also necessary to undergo the process of compression before storing the medical image or transmitting the medical images through internet. Reduction in transmission time is also important during transmission. Hence, compression of medical images plays an important role for efficient storage and transmission. There are many medical image compression techniques are available and evolving in day to day basis. The study of all such compression techniques are important, different techniques uses different medical images like Magnetic resonance images (MRI) and X-ray angiograms (XA) etc. DICOM (digital imaging and communications in medicine) is used for storing, transmitting and viewing of the medical images.
Now-a-days wavelet based compression techniques have become more popular because they provide exceptional image quality at high compression rate. And it's now the world of 3D, which has also stepped into the medical images and hence, it is also needed to be compressed using various wavelet encoders.

Therefore the following chapter deals with the literature about the various medical image techniques and holds the performance parameter that are used to evaluate the performance of the techniques

Manuscript Received January 09, 2012.

Alagendran .B, PG Research Scholar,Image Processing Group,Karunya University,Coimbatore,India.
(e-mail:alagendran.20@gmail.com)

Manimurugan.S, Assistant Professor,Dept of Computer Science and Technology, Karunya University,Coimbatore,India.
(e-mail: smanimurugan@yahoo.co.in)

II. LITERATURE SURVEY

To study and analyze more about the medical image compression techniques, the following literature survey has done and discussed in this chapter. Because of the limitations on the bandwidth and storage capacity, a medical image needs to be compressed before the transmission process or the storage process. There are many medical image compression techniques are evolving every day. Hence it is necessary to study a literature about it, to understand the techniques also to use the appropriate methods during compression of medical images.

Sukhwinder Singh, Vinod Kumar, H.K. Verma has jointly proposed a novel technique for medical image compression called adaptive threshold-based block classification. In this paper the authors introduces a computational algorithm to classify the blocks based on the adaptive threshold value of the variance. Also this method can be applied to all kind of medical images. As the result of this, CT, an X-ray and ultrasound image are used to evaluate the performance and compares the derived results to the JPEG respective to the quality indices. [1]

J. Jyotheswar, Sudipta Mahapatra has proposed a paper on efficient FPGA implementation of DWT (Discrete Wavelet Transform) and modified SPIHT (set partitioning in hierarchical trees) for lossless image compression. Here the DWT (Discrete Wavelet Transform) architecture which is based on the lifting process was used to exploit the correlation between the image pixels. Also a modified SPIHT (Set Partitioning in Hierarchical Trees) algorithm was used to encode the wavelet coefficients. As the result shows that, the algorithm promotes good compression ratio and better peak-signal-to-noise ratio (PSNR) with 3D medical images. [2]

A new technique of 3D wavelet transform was proposed by Gregorio Bernabe, Jose M. Garcia and Jose Gonzalez for medical videos .Here a lossy compression technique was used which was on the basis of the 3D fast wavelet transform especially for encoding the medical videos. The authors have evaluated the algorithm using various parameters regarding the encoding process, like usage of various wavelets features, the counts of the times that the wavelet function is used, choosing of the threshold value, also selection of the quantization methods and the entropy encoder.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Parameters like 3D-conscious run-length, hexadecimal coding and the arithmetic coding were used to obtain the better performance when compared to the existing ones. Result shows, a good compression ratio and a good quality of the reconstructed video. Also when comparing this scheme with MPEG-2 and EZW, promotes better compression ratios of 119% and 46% respectively for the same PSNR value. [3]

Yen-Yu Chen has designed a novel medical image compression technique called DCT(Discrete Cosine Transform) based subband decomposition and modified SPIHT (set partitioning in hierarchical trees) data organization. Here 8×8 Discrete Cosine Transform (DCT) approach was used for making the subband decomposition. Also the modified set partitioning in hierarchical trees (SPIHT) was used for managing the data and the entropy coding. The detailed features of an image were stored in the translation function. In this method, high-frequency subbands are used in good number for reducing the redundancy by promoting the algorithm with modified SPIHT. Results showed that the quality of the reconstructed medical image has been increased by both the peak signal-to-noise ratio (PSNR) value. [4]

R. Srikanth and A. G. Ramakrishnan has put forth a method for medical image compression called contextual encoding in uniform and adaptive mesh based lossless compression of MR images. Here a mesh based coding technique for 3-D brain Magnetic Resonance images was used which promotes the rejection of the irrelevant background that leads to meshing of the brain part of the image. Also performs the content-based mesh method with the spatial edges and optical flow. Also generates solution to an aperture problem at the edges, this paper focuses mainly on the lossless coding of the images, and then compares the performance of both the uniform and adaptive mesh-based methods. Result showed that decent range of bit rates when compared with three-dimensional (3-D) wavelet-based techniques. Separately the mesh based method is efficient in compression of 3-D brain computed tomography. And the adaptive mesh based method gives good result than that of the uniform mesh-based methods with high complexity.[5]

R. Shyam Sunder, C. Eswaran, N. Sriraam has jointly framed a novel medical image compression technique by using 3-D Hartley transform. In this framework, a 3-D discrete Hartley transform (3D DHT) is used to compress both the magnetic resonance images and X-ray angiograms. As the result of this, good comparison can be made against 3-D discrete cosine and Fourier transforms with respect to the PSNR and the bit rate. It is also shown that the 3-D discrete Hartley transform promotes better results. [6]

Aaron T. Deever and Sheila S. Hemami have proposed a method called lossless image compression with projection-based and adaptive reversible integer wavelet transforms. Here, a projection based scheme is introduced to reduce the first-order entropy of transform coefficients and to increase the performance of reversible integer wavelet transforms. Also the projection method has been framed for predicting a wavelet transform coefficient. This technique promotes Optimal fixed prediction methods for the lift based wavelet transforms .on the other side the projection technique was emphasized for an adaptive prediction method which differentiates the final prediction process of lift based transform on basis of modeling context. The result showed that, the projection technique poses very good performance on reversible integer wavelet transforms with the superior lossless compression when compared to current fixed and adaptive lift based transforms.[7]

Zixiang Xiong et al have jointly proposed a technique called lossy to lossless compression using 3D wavelet transforms. In this technique the authors exhibits a 3-D integer wavelet packet transform structure that supports implicit bit shifting of wavelet coefficients for the process of approximation of a 3-D unitary transformation.3-D wavelet video coding methods that are used in this proposal are 3D-SPIHT (set partitioning in hierarchical trees) and 3D included subband coding using optimal truncation process. Results in good lossy and lossless compression of volumetric medical images.[8]

B. Ramakrishnan, N. Sriraam has developed a medical image compression technique called internet transmission of DICOM images with effective low bandwidth utilization .Here a wavelet based encoder called SPIHT (set partitioning in hierarchical trees) has been used for the progressive transmission of DICOM images. The process goes like this, that the header of the DICOM image has to be transmitted firstly, the compressed image secondly and then the images are reconstructed from low quality to high quality at the receiver's side. Results shows that, the performance of the coder has been found by using the two metrics called mean squared error (MSE) and mean structural similarity (MSSIM) index. [9]

3-D medical image compression using 3-D wavelet coders was developed by N. Sriraam and R. Shyamsunder. Daubechies 4, Daubechies 6, Cohen–Daubechies–Feauveau 9/7 and Cohen–Daubechies–Feauveau 5/3 are the four wavelet transforms that were used in this method with the encoders like 3-D SPIHT, 3-D SPECK and 3-D BISK to find out the best wavelet–encoder combination. Two versions of wavelet transform are used known as symmetric and decoupled wavelet transform. Magnetic resonance images (MRI) and X-ray angiograms (XA) are used for testing the algorithm. The best compression result possessed by the 3-D Cohen–Daubechies–Feauveau 9/7 symmetric wavelet with the 3-D SPIHT encoder. [10]

A. Performance Parameters

Considering the evaluation of performance of any medical image compression can be made by the parameters such as PSNR (peak signal-to-noise ratio), BR (Bit Rate)

PSNR (dB) = 20 × log_{10} (Maximum pixel value) / $\sqrt{MSE}$ (1)

Where, MSE represents the mean squared error of the image defined as,

$$MSE = 1/N \times \sum_i \sum_j (f(i,j) - F(i,j))^2 \qquad (2)$$

Where, N is the total number of pixels,

$F(i, j)$ denotes the pixel value in the reconstructed image and

$f(i, j)$ is the pixel value in the original image.

$$BR\ (bpp) = \frac{\text{Size of the compressed image in bits}}{\text{Total no of pixel}} \qquad (3)$$

If the bit rate increases, it results in improvement in quality of the reconstructed image.[10]

From the above literature, some of the readings were taken to represent the performance parameter in accordance with the Bit rate and the PSNR value, which is given in I.

I. Comparison of different medical image compression techniques

Reference	Technique	Bit Rate (bpp)	PSNR(dB)
[2]	Modified SPIHT	0.5	35.7
[4]	DCT-CSPIHT	0.5	36.6
[6]	3D-DHT	0.5	41.72

The graphical representation of the above readings is as follows,

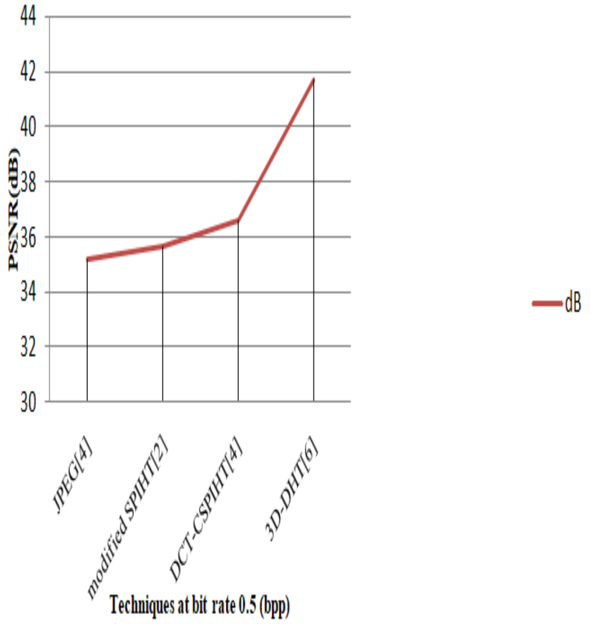

Fig.1.Graphical representation of Table 1

Fig.1 depicts the line graph of the different image compression techniques such as JPEG, modified SPIHT, DCT-CSPIHT and 3D-DHT plotted with PSNR value against Bit Rate that are discussed in this chapter. Each method gives different PSNR value, for the 0.5 bpp of bit rate, and some of the readings are compared to show the performance .Hence obtaining the high PSNR value promotes good quality of image.

III. CONCLUSION

Hence some existing medical image compression techniques has been discussed well with their performance results, image quality of the image after compression is the main criteria that all the compression techniques should hold .To conclude, all the compression techniques are useful for real-time medical image transmission or storage process. Each technique is different and gives appropriate results for the each technique. Everyday new compression technique is evolving hence selection of high PSNR value will lead to maintain the quality of the image and success in compression process.

REFERENCES

1. Sukhwinder Singh, Vinod Kumar, H.K.Verma ,"Adaptive threshold based block classification in medical image compression for teleradiology ",Computers in Biology and Medicine ,Vol.37, pp. 811 – 819,2007
2. J. Jyotheswar, Sudipta Mahapatra ,"Efficient FPGA implementation of DWT and modified SPIHT for lossless image compression", Journal of Systems Architecture, Vol.53, pp.369–378, 2007
3. Gregorio Bernab , Jose M. García , José González ,"A lossy 3D wavelet transform for high-quality compression of medical video", The Journal of Systems and Software, Vol. 82, pp.526–534,2009
4. Yen-Yu Chen," Medical image compression using DCT-based sub band decomposition and modified SPIHT data organization", International journal of medical informatics, Vol.76, pp. 717–725, 2007
5. R. Srikanth, A.G. Ramakrishnan, "Contextual encoding in uniform and adaptive mesh based lossless compression of MR images", IEEE Transactions on Medical Imaging,Vol. 24,pp.1199–1206, 2005.
6. R. Shyam Sunder, C. Eswaran, N. Sriraam, "Medical image compression using 3-D Hartley transform", Comput. Biol. Med, Vol.36, pp.958–973, 2006.
7. A.T. Deever, S.S. Hemami , "Lossless image compression with projection-based and adaptive reversible integer wavelet transforms", IEEE Transactions on ImageProcessing. vol.12 , pp.489–499. 2003.
8. Z. Xiong, X. Wu, S. Cheng, J. Hua, "Lossy to lossless compression of medical volumetric data using 3D integer wavelet transforms", IEEE Transactions on Medical Imaging ,vol.22, pp.459–470, 2003.
9. B. Ramakrishnan, N. Sriraam, "Internet transmission of DICOM images with effective low bandwidth utilization", Journal of Digital Signal Process, Vol.16, pp. 825–831,2006.
10. N. Sriraam, R. Shyamsunder." 3-D medical image compression using 3-D wavelet coders", Elsevier on Digital Image Processing,Vol.21,pp.100-109,2010.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

AUTHOR PROFILE

1.Alagendran.B received the B.E degree in Computer Science and Engineering from the Anna University, Chennai, India, in 2010, and pursuing his M.Tech degree in Software Engineering in Karunya University, Coimbatore, India. His research interests include image processing, software engineering, data mining.

2. Manimurugan.S received the B.E. degree in Computer Science and Engineering from the Anna University, Chennai, India, in 2005, and the M.E. degree in Computer Science and Engineering in 2007. He is currently pursuing the Ph.D. degree in Computer Science and Engineering in Anna University, Coimbatore, India. His current research interests are in Image Processing, Information Security.