ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 12, December 2017

A Recent Survey of Lossless Image Compression Techniques

[1] Revathi M,[2] Shenbagavalli R
[1] Full-time Ph.D Scholar, [2] Assistant Professor (Research Supervisor)
Department of Computer Science, Rani Anna Government College for Women, Tirunelveli-08.

Abstract:-- **Image compression in medical image processing is a most significant technique which reduces the burden of storage and transmission time over the network with less degradation in the visual quality and without information loss. The image compression techniques are classified into lossy compression and lossless compression. Lossless image compression is important in the field of medical image application. Medical image processing is an idea to improve the quality of medical imaging like X-Rays, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Ultrasound, and Single Photon Emission Computed Tomography (SPECT). This shows visual representation of inner body structure. This paper describes various lossless compression techniques such as DWT,IWT,EZW, WDR, ASWDR, STW,SPIHT,JPEG2000, CALIC, LZW, RETINEX, DPCM, CREW, Vector Quantization, Huffman Coding, Arithmetic Coding, Run Length Coding Polynomial Approximation to achieve good compression ratio and the performance measurements such as CR,PSNR,MSE,SSIM, Normalized Cross Correlation, Normalized Absolute Error.**

Keywords: **Compression, SPIHT, Polynomial Approximation, Entropy Coding**

I. INTRODUCTION

Image compression is minimizing the size in bytes of a representation without corrupting the nature of image. When the image size is reduced it allows more images to be stored in a given amount of memory space. It also reduces the time required for images to be sent over the Internet. Compression doesn't mean only reducing the image size along with reduction in data it also leads to the position to reconstruct the original data. Medical image processing has been used for the purpose of diagnosing the structure of the human body. For this many medical imaging modalities such as magnetic resonance imaging (MRI), computed tomography (CT), PET, SPECT. In medical image processing the ROI estimation of disease in a particular part is important. The image compression techniques are classified into lossy compression and lossless compression. Compression of medical images is used for the purpose of storage and transmission.

II IMAGE COMPRESSION TECHNIQUES

There are two types of compression in image compression - Lossless and Lossy. In lossless, original image is exactly reconstructed after the decompression process. It is mainly used for artificial images which are icons, clip arts, comics or technical drawings and medical images. In lossy, original image is not confirmed after the decompression and accuracy. It is mainly used to compress multimedia applications such as image, audio and video which are used for activity of internet and media. The amount of compression is higher in lossy compression techniques compared to lossless compression techniques, but the quality of reconstructed image is good in lossless compression.

Techniques for lossless image compression

- Run-length encoding
- Huffman Coding
- DPCM and Predictive Coding
- LZW (Lempel-Ziv-Welch)
- CALIC
- SPIHT with Huffman coding & Arithmetic Coding
- Combination of ASPIHT, encoding methods and polynomial approximation.

Techniques for lossy image compression

Chroma sub-sampling is a method that stores color information at lower resolution than intensity information. The overwhelming majority of graphics programs perform 2x2 chroma sub-sampling, which breaks the image into 2x2 pixel blocks and only stores the average color information for each 2x2 pixel group.

DPCM-Differential Pulse Code Modulation is usually used with lossy compression techniques. Basic concept of DPCM - coding a difference, is based on the fact that most source signals shows significant correlation between successive samples so encoding uses redundancy in sample values which implies lower bit rate.

Transform Coding- Transform coding is used to convert spatial image pixel values to transform coefficient values.

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 12, December 2017

Since this is a linear process and no information is lost the number of coefficients produced is equal to the number of pixels transformed.

III. RELATED WORK

Compression in medical image becomes an important research area. A lot of work is done to solve the problem of compression in medical images. Following are the some image compression techniques used in medical image processing:

Ming Yang and Nikolaos Bourbakis proposed various lossless image compression techniques and the types of image standards. Lossless compression is necessary for high performance applications such as geophysics, telemetry, nondestructive evaluation, and medical imaging. Lossless image compression can be always modeled as a two-stage procedure one is Decorrelation and other one is entropy coding. Current standards for lossless compression include, Lossless JPEG, JBIG, GIF, Photo CD, PNG, JPEG-LS and JPEG-2000. [1]

Jia ZhiGang, Guo XiaoDong and Li LinSheng proposed the combination of integer lifting wavelet transform with set partitioning in hierarchical trees algorithm for compression. This algorithm takes Human Visual System and modifies SPIHT algorithm is according to the characteristic of weighted wavelet coefficients and analyzing contrast sensitivity function (CSF) through distributing different weights to different sub-bands then improves coding algorithm. PSNR for lena image with three db value. Original: 28.3177 31.4093 34.3746 New : 28.1089 31.2882 33.7661.[2]

Puja Bharti, Dr. Savita Gupta and Ms. Rajkumari Bhatia proposed a framework for ROI based compression of medical images using JPEG2000 and SPIHT compression techniques.JPEG2000 and SPIHT are the wavelet-based image compression technique. The performance is evaluated using image quality metrics like PSNR, SSIM and Correlation. Wavelet-based coding provides good quality of image and high compression ratio. [3]

Kavinder and Vinay Chopra proposed a new compression algorithm combining the features of both lossy (DCT) and lossless (Huffman Coding) compression techniques .The performance of proposed algorithm is improved using Vector Quantization technique to increasing Compression Ratio and the quality of compressed images. PSNR value of X-ray image using VQ is 45.9584. MSE value of X-ray image using VQ is 1.6491. CR value of X-ray image using VQ is .47222. [4]

MFerni Ukrit and G.R.Suresh proposed the algorithm that combines Super-Spatial Structure Prediction technique with inter-frame coding and a new method HCC to achieve a good compression ratio. Super-Spatial Structure Prediction algorithm is applied with the fast block-matching process which includes Diamond Search method. The proposed method CR is 6.100. [5]

Md. Ahasan Kabir, M. A. Masud Khan, Md. Tajul Islam, Md. Liton Hossain, Abu Farzan Mitul proposed the algorithm for medical image compression based on lifting base wavelet transform coupled with SPIHT (Set Partition in Hierarchical Trees) coding algorithm to improve the drawbacks of conventional wavelet transform. PSNR value of brain axial slice image is 26.83. MSSIM value of brain axial slice image is 0.77. [6]

Miss. Rohini N. Shrikhande and Dr. Vinayak K. Bairagi proposed the performance of various lossless grayscale image compression algorithms using the method called CALIC. It is standard of context-based, adaptive and lossless image code. CALIC is based on paradigm of universal modeling and coding. CALIC operate in two modes binary and continuous modes. Compression ratio achieved by using the method of CALIC is 0.4130. [7]

Amol Baviskar, Shweta Ashtekart and Amruta Chintawar proposed a 3D-Discrete Cosine Transform (DCT) for compressing high resolution of images. Performance evaluation of various algorithms such as JPEG Lossy, Sub-Band replacement DWT and K-Means. Each of the compression algorithms can be evaluated by using the image quality metrics such as PSNR, MSE, CR, Normalized Cross Correlation, Normalized Absolute Error. [8]

Ledya Novamizanti,Gelar Budiman and Iwan Iwut Tritoasmoro proposed a secured data using a combination of LZW Compression, RSA Encryption, and DCT Steganography". Secure information transfer can be achieved by cryptography and steganography. Cryptography is a technique for secure communication in the presence of third parties. Steganography is the process of hiding a secret message. The purpose of steganography is to maintain the secret communication between two parties. The message is encrypted by using RSA method. These messages are compressed by LZW method and it is hidden by DCT technique. [9]

C.Rajan, K.Geetha and S.Geetha Proposed the methods of encoding, DCT, Compression methods and security over the network. The genetic algorithm protocol is used to transferring data in wireless network environment. FMMIS fuzzy min-max neural network for image segmentation increases the boxes from particular set of pixels which helps to find the maximum bounded rectangle in every object which presents in images. This algorithm performed on wooden images. [10]

Bhagyashree I. Kochi and B.B.S.Kumar proposed the analysis of EZW, SPIHT and denoising algorithms. X-ray image has been used for implementing EZW, SPIHT and

denoising algorithm. The quality of image is measured by PSNR, MSE and CR. Denoising is calculated by adding Speckle noise for both soft and hard threshold. PSNR value of hard thresholding is 47.53 MSE value of hard thresholding is 1.14. [11]

Dilpreet Kaur , Harsh Kumar Verma and Ravindra Kumar Singh proposed the combination of data compression and and stegnography to provide hiding the data of an image. Data hiding capability will be evaluated from the kekre's algorithm. LZW compression scheme is used to optimize the size of secret data. These provide security of data against RS detection attack. PSNR value of kekre's method is 42.9216. [12]

Vandana Rajput, Sandeep Kumar Tiwari and Rohit Gupta proposed the image security using RSA cryptography and Spatial Orientation Tree Wavelet compression (STW) for color or grayscale image. Steganography is the science of hiding secret messages. To obtain stegano image by using embedding f encoded image into compressed image. Base PSNR value is 55.927 and proposed PSNR value is 77.397. [13]

Mr. Chandrashekhar Kamargaonkar and Dr. Monisha Sharma proposed a hybrid medical image compression method using spiht algorithm and haar wavelet transform. In the medical image, the ROI part that is the diseased part extracted by using the thresholding method of segmentation and compress the ROI by the use of wavelet based compression technique called SPIHT and NROI part is compressed by using Haar Wavelet Transform. PSNR = 34.8400 for bpp = 1.00 for SPIHT algorithm. PSNR = 41.8750 for bpp = 1.00 for Haar Wavelet Transform. [14]

Preeti V. Joshi and C.D.Rawat proposed a region based hybrid compression for medical images. In this brain image the ROI part is compressed by using arithmetic coding and NROI part is compressed by using SPIHT. The hybrid method is evaluated by Peak Signal to Noise Ratio (PSNR), Structural Similarity Index (SSIM) and Virtual Information Fidelity (VIF) for MRI brain images. PSNR for SPIHT is 23.90 and SSIM for SPIHT is 0.8398 VIF for SPIHT is 0.3455. [15]

Surabhi N and Sreeleja N Unnithan proposed a review of various image compression algorithm EZW, DWT, SPIHT and also the performance metric (PSNR, MSE, CR) for these algorithm. The main objective of image compression is to decrease the redundancy of the image thereby increasing the capacity of storage and efficient transmission. [16]

IV PERFORMANCE METRICS

The image quality can be determined on the basis of various quality metrics. The metrics are MSE, PSNR, CR, Normalized Absolute Error and Normalized Cross Correlation. The MSE stands for mean square error which is the cumulative squared error between the compressed and the original image and the PSNR is the peak signal to noise ratio which is a measure of the peak error between the compressed and the original image. The compression ratio is used to measure the ability of image compression by comparing the size of the image being compressed to the size of the original image. The Structural Similarity (SSIM) index is a method for measuring the similarity between two images. Mean Absolute Error (MAE) is a measure of difference between two continuous variables. Cross correlation is a measure of similarity of two series as a function of the displacement of one relative to the other.

CR- Compression Ratio

CR= (Original image File size)/ (compressed Image File size)

As the compression ratio increases, reconstructed image is more compressed and the quality of image will be degrades.

PSNR - Peak Signal to Noise Ratio (PSNR) represents a measure of the peak error and is expressed in terms of decibels.

The PSNR (in dB) is defined as:

$$PSNR=20.\log_{10}(MAX_I)-10.\log_{10}(MSE)$$

MSE - Mean Square Error (MSE) represents the mean squared error between the compressed and the original image

$$MSE = \Sigma_{m,n}[I_{1(m,n)} - I_{2(m,n)}]\ 2/\ (M + N)$$

V CONCLUSION

In this survey, various image compression techniques are discussed. Lossless compression is used in the field of medical image for the purpose of reducing image size over the network. Here we analyzed a literature survey of all related image compression techniques, algorithms and compression with cryptography and steganography were discussed. Recent research in image compression techniques is also presented in this survey. The performance evaluation parameters CR, MSE, PSNR, SSIM, Normalized Absolute Error and Normalized Cross correlation are used to evaluate the performance of compression techniques. Future study is planned on implement these techniques in video image processing and compress with new techniques.

VI REFERENCES

[1] Ming Yang and Nikolaos Bourbakis , "An Overview of Lossless Digital Image Compression Techniques" , IEEE ,0-7803-9197-7, 2005.

[2] Jia ZhiGang, Guo XiaoDong and Li LinSheng , "A Fast Image Compression Algorithm Based on SPIHT", IEEE, 978-1-4244-2800-7, 2009.

[3] Puja Bharti, Dr. Savita Gupta and Ms. Rajkumari Bhatia, "Comparative Analysis of Image Compression Techniques: A Case Study on Medical Images", International Conference on Advances in Recent Technologies in Communication and Computing, 978-0-7695-3845-7, 2009.

[4] Kavinder and Vinay Chopra , "DICOM Image Compression using Huffman Coding Technique with Vector Quantization", International Journal of Advanced Research in Computer Science, Volume 4, No. 3, March 2013.

[5] MFerni Ukrit and G.R.Suresh, "Effective Lossless Compression for Medical Image Sequences Using Composite Algorithm", International Conference on Circuits, Power and Computing Technologies, 978-1-4673-4922-2, 2013.

[6]Md. Ahasan Kabir, M. A. Masud Khan, Md. Tajul Islam, Md. Liton Hossain, Abu Farzan Mitul , "Image Compression Using Lifting Based Wavelet Transform Coupled With SPIHT Algorithm", IEEE, 978-1-4799-0400-6, 2013.

[7] Miss. Rohini N. Shrikhande and Dr. Vinayak K. Bairagi , "IMAGE COMPRESSION USING CALIC", International Conference on Advances in Communication and Computing Technologies, 978-1-4799-7319-4, 2014.

[8] Amol Baviskar, Shweta Ashtekart and Amruta Chintawar , "Performance Evaluation of High Quality Image Compression Techniques", IEEE, 978-1-4799-3080-7, 2014.

[9] Ledya Novamizanti,Gelar Budiman and Iwan Iwut Tritoasmoro , "Designing Secured Data Using a Combination of LZW Compression, RSA Encryption, and DCT Steganography", IEEE, 978-1-4673-8434-6,2015.

[10] C.Rajan, K.Geetha and S.Geetha , "An analysis of compression methods and implementation of medical images in wireless network", World Academy of Science, Engineering and Technology International Journal of Computer, Electrical, Automation, Control and Information Engineering Vol:9, No:9, 2015.

[11] Bhagyashree I. Kochi and B.B.S.Kumar , "EZW and SPIHT Algorithms for Image Compression and Denoising ", ITSI Transactions on Electrical and Electronics Engineering, , Volume -4, 2320 – 8945 Issue -2, 2016.

[12] Dilpreet Kaur , Harsh Kumar Verma and Ravindra Kumar Singh, "A Hybrid Approach of Image Steganography", International Conference on Computing, Communication and Automation, 978-1-5090-1666-2,2016.

[13] Vandana Rajput, Sandeep Kumar Tiwari and Rohit Gupta, "An Enhanced Image Security Using Improved RSA Cryptography and Spatial Orientation Tree Compression Method", International conference on Signal Processing, Communication, Power and Embedded System (SCOPES), 978-1-5090-4620-1, 2016,

[14] Mr. Chandrashekhar Kamargaonkar and Dr. Monisha Sharma , "Hybrid Medical Image Compression Method Using SPIHT Algorithm and Haar Wavelet Transform", IEEE, 978-1-4673-9939-5,2016.

[15] Preeti V. Joshi and C.D.Rawat, "Region Based Hybrid Compression for Medical Images", International conference on Signal Processing, Communication, Power and Embedded System (SCOPES), DOI-10.1109(SCOPES),2016.

[16] Surabhi N and Sreeleja N Unnithan , "Image Compression Techniques: A Review", IJEDR, Volume 5, Issue 1 ISSN: 2321-9939, 2017.