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ROI Based Medical Image Compression

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Abstract— Bio-medical image processing is considered as one of the broad field as compared to other fields. It includes image forming, biomedical signal gathering, image processing, picture processing and the features extracted from images used for medical diagnosis. It contains analysis of the image, enhancement of the image and display of images captured via Ultrasound, MRI and X-Ray technologies. A Region Of Interest (ROI) is defined as a portion of an image that we want to extract from the image or perform some other operations on it. The objective of the paper is to compress the ROI in lossless manner using Set Partitioning In Hierarchical Tree (SPIHT) algorithm and Non-ROI i.e; background region in a lossy manner using Discrete Wavelet Transform (DWT). A detailed analysis is carried out by using the parameters like Compression Ratio (CR), Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

Keywords*— Region Of Interest (ROI), X-Ray, MRI, SPIHT, DWT, CR, MSE, PSNR*

I. INTRODUCTION

Digital Image :- A digital image is defined as a numeric representation of a two-dimensional image. Depending upon whether the resolution of the image is fixed, it may be of vector or raster type. The term ‘digital image’ usually refers to raster images or bitmapped images. Raster image contains the finite set of digital values called as pixels. The digital image contains a fixed number of rows and columns of pixels. Pixels are the smallest individual element in an image. It represents the brightness of a given colour at any specific point. Typically, the pixels are stored in computer memory as a raster image or raster map, a two dimensional array of small integers and these values are often transmitted or stored in a compressed form [13].

Medical Image :- Medical imaging is defined as the technique of creating visual representation of the interior of a body for medical intervention and clinical analysis as well as visual representation of the function of some tissues or organs. Therefore it plays a vital role in initiatives to improve public health. Furthermore, medical imaging is frequently justified in the follow-up of disease that are already diagnosed and/or treated. Medical imaging seeks to diagnose and treat disease as well as it reveal internal structures hidden by the skin or bones. Medical imaging also establishes a database of normal physiology and anatomy to make it possible to identify the abnormalities. Medical imaging especially X-ray based examinations and ultra sonography, is a crucial in a variety of medical setting and at all major levels of health care [14].

Need for Compression :- Compression refers to reducing the size of the original image. Compression is essential because it allows the data to be stored in an area without taking up an unnecessary amount of space. It also reduces the amount of storage space required for the data and the length of transmission time of data over the network [15].

ROI based Compression :- The aim of ROI based compression for medical image is to improve the compression efficiency for transmission and storage. So the ROI compression is to compress ROI with supreme quality as compared to the other region called as background i.e; non-ROI. For example, while compressing medical image the diagnostically important region i.e; ROI should be compressed with better quality than background. Thus, the ROI area is compressed with less compression ratio and the background i.e; non-ROI with the highest possible compression ratio in order to achieve overall better compression performance [16].

The paper is organized as follows: Section II represents a brief review of existing methods for image compression, classification, performance measures and related work. The proposed work and methods of ROI and Non-ROI are given in section III. Section IV discusses the results of layered lossy compression and finally, the conclusion and future work are summed up in section V.

II. IMAGE COMPRESSION

Compression methods are classified as follows:- lossless compression and lossy compression. Lossless compression includes Huffman Coding, Run Length Encoding, Arithmetic Coding, Predictive Coding and LZW Coding etc and that of lossy compression includes Multi-resolution Coding, DCT, DWT, Fractal Compression, Vector Quantization, etc and the classification is summarised as follows:

Existing Methods:-

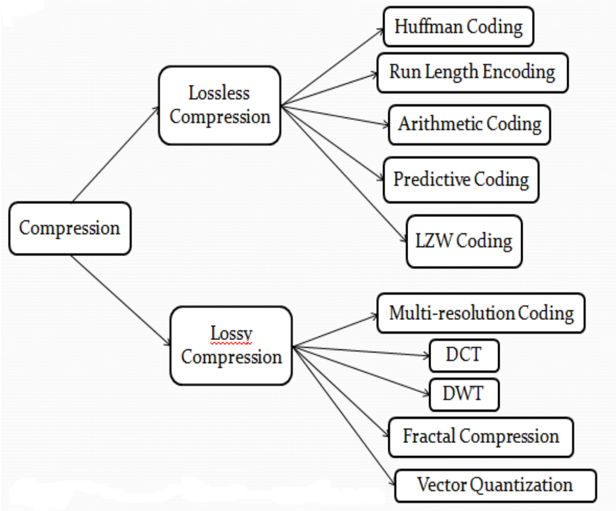

Fig 1: Existing Methods [17]

Image compression is defined as minimizing the size of the image without degrading the quality of the image in order to store or transmit the data in an efficient form [18]. There are two types of image compression are as follows:-

1. Lossless Compression.
2. Lossy Compression.

1. **Lossless Compression :-** No loss of information, the original data can be recovered exactly from the compressed data.

2. **Lossy Compression :-** Loss of information, the original data can not be recovered from the compressed data.

Performance Measures:-

1. **Compression Ratio (CR) :-** It is defined as the ratio of size of the output data to the size of the input data.

   CR = Size of the output data / size of the input data

   Sometimes Compression Ratio is also defined as,

   CR = Number of bits / symbol

Mean Square Error (MSE) :- The difference between an estimator and the true value of the quantity being estimated.

$$\text{MSE} = \frac{\sum_{(i,j)} (x(i,j) - x^{\wedge}(i,j))^2}{M * N}$$

Where, $x(i,j)$ is the current original image, $x^{\wedge}(i,j)$ is the reference processed image, M is the size of row, N is the size of column.

2. **Peak Signal to Noise Ratio (PSNR):** The ratio between the maximum possible power of a signal and the power of its corrupting noise.

$$PSNR = 10.\log_{10}\left(\frac{\max_I^2}{MSE}\right)$$

Where, $\max_I$ is the maximum value of the image and MSE is the Mean Square Error.

III. Related Work

In an ideal world we would be able to diagnose, treat and cure patients without causing any harmful side effects. The use of medical imaging has enabled doctors to see inside a patient without having to cut them open. Medical imaging also helps us to learn more about neurobiology and human bahaviours.

In [1] the authers has given solution for efficient region based image compression for increasing the compression ratio with less Mean Square Error at minimum processing time based on Fast Discrete Curvelet Transform (FDCT) with adaptive arithmetic coding. The authers has given that the project is heavily utilized for compressing medical images to transmit for telemedicine application. To minimize the information loss, arithmetic entropy coding was used effectively. It will be enhanced by combining speak coding for compressing the secondary region and this hybrid approach was increased the CR and reduce the information loss. The authers has analyzed the performance through determining the image quality after decompression, compression ratio, correlation and execution time.

In [2] the authers has given information about DICOM images. The authers did work on ROI based compression. The authers proposed Haar wavelet technique on medical MRI brain image by detecting ROI and non-ROI parts of the image. Within this technique the authers calculated MSE, PSNR, average difference, structural contend and minimum difference .

In [3] the authers has given the compression technique on medical MRI and CT images. Firstly, the authers converted the image into gray level. After that filter the input images then segmented the image to detect ROI part and background part. In last, the authers used Discrete Cosine Transform (DCT) and Integer Wavelet Transform (IWT) method and revealed that Mean Square Error (MSE) reduces using wavelet compression method. The authers has also discuss the various types of wavelet method.

IV. PROPOSED WORK

The objective of the paper is to compress the ROI in a lossless manner and Non-ROI in a lossy manner and it is summarised in the following diagram.

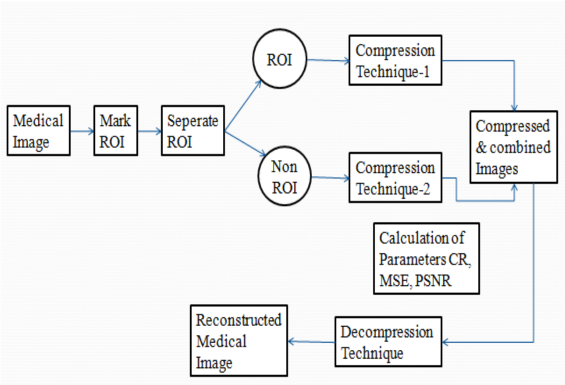

Fig 2: Proposed Scheme

Let $f(x,y)$ be the medical image under consideration. It can also be represented as a set of pixels $S_{ROI} = \{(x_1, y_1, p_{11}), (x_2, y_2, p_{12}), \ldots\ldots\ldots, (x_m, y_n, p_{mn})\}$

Where, the image size is $m \times n$,

x, y : Co-ordinates of pixels

p_{ij} : Intensity of pixels

Now, one can choose ROI as a set.

$$S_{ROI} = \{(x_r, y_s), \ldots\ldots, (x_k, y_l)\}$$

Where the cardinality of this set depend upon the resolution that is desired. This set is the ROI.

$\overline{S_{ROI}}$ is Non-ROI

Let $\bar{0}$ be a 0 image of size $m \times n$

We can create two images,

$$f_{ROI} = S + \bar{0}$$

$$f_{NROI} = \bar{S} + \bar{0}$$

This are the images which will be considered for the further processes.

So we first discuss the compression of Non-ROI image

Compression of Non-ROI image:-

Discrete Wavelet Transform (DWT) :- It is defined as the representation of an image as a sum of the wavelet function known as wavelets with different location and scale. Wavelets are discretely sampled. Some of the characteristics of the DWT are as follows:-

- Inherent multi-resolution nature.
- Wavelet coding schemes for applications where scalability and tolerable degradation are important.
- Higher compression ratio.
- Good localization in time and frequency domain.

Requires less time as compared to DCT technique.

In DWT high pass filter contains detail coefficients (cH, cV, cD) and low pass filter contains approximate coefficient (cA).

Compression of ROI image:-

There are various methods used for ROI compression such as DCT (Discrete Cosine Transform), IWT (Integer Wavelet Transform), JPEG (Joint Photographic Expert Group), EZW (Embedded Zero-tree Wavelet) algorithm, SPIHT (Set Partitioning In Hierarchical Tree) algorithm, etc. But except SPIHT rest of the method contains lots of floating point calculations and also the MSE (Mean Square Error), CR (Compression Ratio) are too high. But SPIHT gives guarantee of zero MSE and CR. So I choose SPIHT algorithm for ROI i.e; for lossless compression.

Set Partitioning In Hierarchical Tree (SPIHT) Algorithm [12]:-

Some of the characteristics of SPIHT are as follows:-
- Efficient multi-resolution coding and decoding.
- Fully coded file, simple and fast.
- Fully self-adaptive lossless compression algorithm.
- Exact bit rate coding and error protection.
- Achieves better image compression in high CR.
- Provides good image quality with high PSNR.
- Best method for progressive image transmission.
- Simpler quantization algorithm.
- No floating point multiplications.
- Best in terms of compression and decompression.
- SPIHT guarantees a fixed target CR.

Compression can be done in three steps:
1) Sorting :- In which lists are organized.
2) Refinement :- Which does the actual progressive coding transmission.
3) Quantization :- Approximation and rounding off.

SPIHT encodes the image data using three lists:
1) LSP:- List of Significant Pixels.
2) LIP:- List of Insignificant Pixels.
3) LIS:- List of Insignificant Sets.

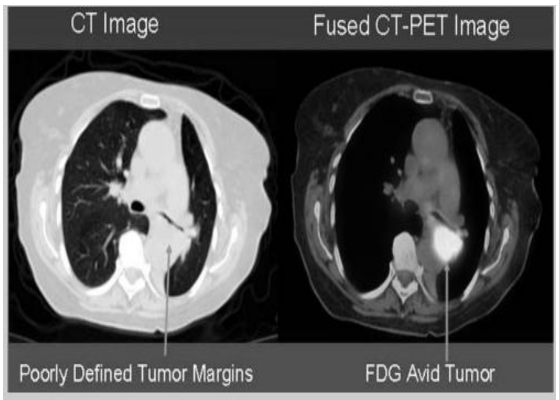

Fig 3: Original Image [11]

Layered lossy compression of Non-ROI:-

Let I be the original image and with the double size as that of original image I labelled as Id. Then proceeded with dwt2 of image Id to get cA, cH, cV and cD respectively.

Where cA is approximated coefficient, cH is horizontal coefficient, cV is vertical coefficient and cD is diagonal coefficient. Out of these four coefficients let make cD zero in order to achieve maximum compression, because in case of non-ROI compression visual appearance is not important. So obtained more number of zeros to achieve maximum compression. Let X be the compressed image Id after idwt2. This is layer 0 compression. Now the output of layer 0 goes as a input to layer 1.

Let cA i.e; approximated coefficient proceeded with dwt2 on cA to get cAA1, cHA1, cVA1, cDA1 and out of these let make cDA1 zero. Let X1 be the compressed image cA after idwt2. Then combined X1 with cH, cV and cD of the original image and then idwt2 is applied. Let Y1 be the single compressed image cA. This is layer 1 compression. Diagramatically it is represented as follows:-

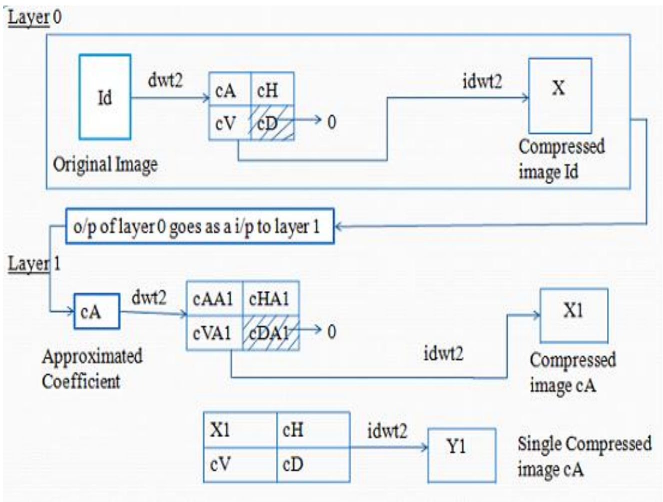

Fig 4: Layer 0 and Layer 1 compression

Similarly, proceeded with dwt2 on cAA1 to get cAA2, cHA2, cVA2 and cDA2. Out of these let make cDA2 zero. Let X11 be the compressed image cAA1 after idwt2. Then combined X11 with cHA1, cVA1 and cDA1 and then idwt2 is applied. Let Y11 be the compressed image cA. Then combined Y11 with cH, cV, cD and idwt2 is applied. Let Z11 be the double compressed image cAA1. This is layer 2 compression. Diagramatically it is represented as follows:-

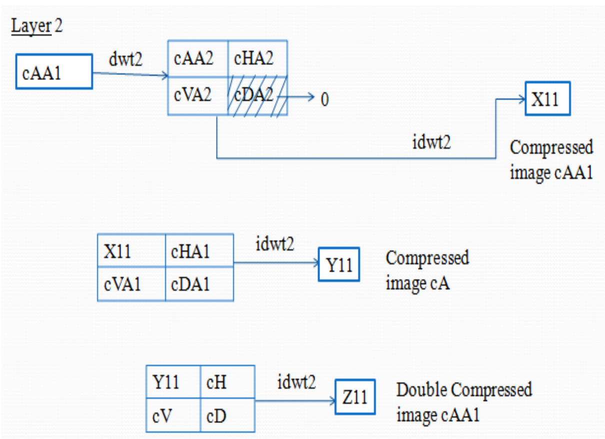

Fig 5: Layer 2 compression

Similarly, proceeded with dwt2 on cAA2 to get cAA3, cHA3, cVA3 and cDA3 respectively. Out of these let make cDA3 zero. Let X111 be the compressed image cAA2 after idwt2. Then combined X111 with cHA2, cVA2 and cDA2 and idwt2 is applied. Let Y111 be the compressed image cAA1. Then combined Y111 with cHA1, cVA1 and cDA1 and idwt2 is applied. Let Z111 be the triple compressed image cA. Let combined Z111 with cH, cV, cD and idwt2 is applied. Let I111 be the triple compressed image.

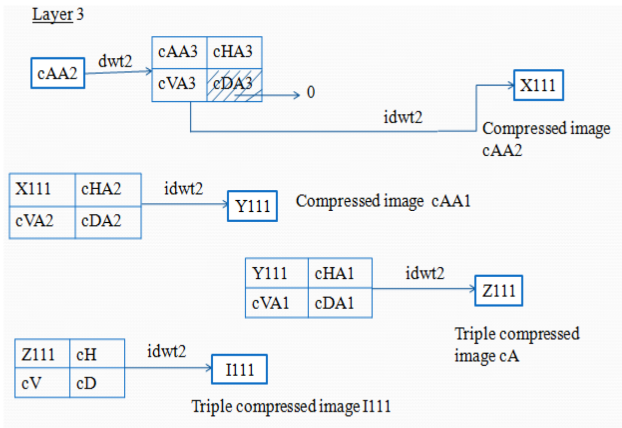

Fig 6: Layer 3 compression

Similar operation performed on cH i.e; horizontal coefficient and cV i.e; vertical coefficient upto layer n.

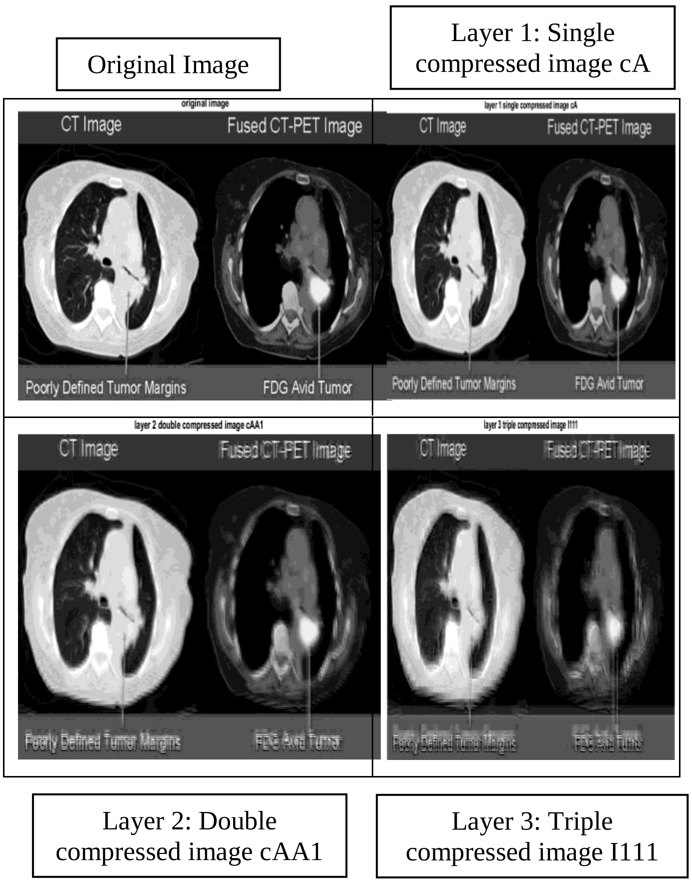

Fig 7: Final result of lossy compression

V. RESULTS

Result of layered lossy compression:

Layered lossy compression performed on approximated coefficient cA, horizontal coefficient cH and vertical coefficient cV and calculated various parameters like CR, MSE and PSNR respectively for layer 1, layer 2 and layer 3. Layer 1 means 1st level compression, layer 2 means 2nd level compression and layer 3 means 3rd level compression.

We have defined the Compression Ratio (CR) as follows: The ratio of number of insignificant coefficients to the size of the image.

CR= Number of insignificant coefficients / Size of the image

1) cA

Lossy Layer	CR	MSE	PSNR
1)	0.7519	496.5394	21.1713
2)	0.8782	2.8066e+04	3.6490
3)	0.9421	1.3814e+05	-3.2725

2) cH

Lossy Layer	CR	MSE	PSNR
1)	0.7519	519.0802	20.9785
2)	0.8782	2.7497e+04	3.7380
3)	0.9421	1.3501e+05	-3.1728

3) cV

Lossy Layer	CR	MSE	PSNR
1)	0.7519	559.7379	20.6510
2)	0.8782	2.7520e+04	3.7344
3)	0.9421	1.3504e+05	-3.1737

Remarks:
It is observed that with every layer the Compression Ratio (CR) increases, Mean Square Error (MSE) also increases but Peak Signal to Noise Ratio (PSNR) decreases. So visual appeal wise the image quality decreases as we increase the Compression Ratio which is consistent. So it is left to the user at what compression ratio the non-ROI is acceptable.

VI. CONCLUSION AND FUTURE WORK

In the medical image only the diagnostically important region is compressed called as ROI. Due to various upcoming telemedicine applications it is required that important medical images either should be transmitted or accessed at remote places within the available bandwidth (BW) also a compromise on quality of medical image is out of question. Hence the ROI based compression scheme attempts to achieve compression without compromising the quality of medically significant areas. DWT acts as a effective tool to achieve compression and provide flexibility for experimentation as well. We propose to evaluate our scheme against non ROI based scheme.

VII. REFERENCES

[1]. D.S. Thomas, M. Moorthi, R. Muthalagu, "*Medical Image Compression Based On Automated ROI Selection For Telemedicine Application*" International Journal of Engineering and Computer Science, Vol.3 Issue1, pp.3638-3642, 2014.

[2]. P. Ranjan, P.R. Khan, "*Review of improved A.I. based Image Segmentation for medical diagnosis applications*", International Journal of Computer Sciences and Engineering, Vol.4, Issue.11, pp.75-81, 2016.

[3]. NS. Korde, A.A. Gurjar, "*Wavelet Based Medical Image Compression For Telemedicine Application*", American Journal of Engineering Research, Vol.3, Issue.1, pp-106-111, 2014.

[4]. R. Singh, S Agarwal, "*Theoretic Study of Various Image Compression Techniques: A Survey*", International Journal of Computer Sciences and Engineering, Vol.3, Issue.5, pp.341-344, 2015.

[5]. S. Agarwal, "*Edge Detection in blurred images using Ant Colony Optimization Techniques*", International Journal of Scientific Research in Computer Science and Engineering, Vol.1, Issue.2, pp.21-24, 2013.

[6]. Monisha Sharma, " *An Efficient Medical Image Compression By SPIHT And EZW Based On ROI And NROI Using Wavelet Decomposition*", International Journal of Engineering Research & Technology, Vol. 2 Issue.7, pp.1600-1605, 2013.

[7]. TMP. Rajkumar, MV. Latte, "*ROI Based Encoding of Medical Images: An Effective Scheme Using Lifting Wavelets and SPIHT for Telemedicine*", *International Journal of Computer Theory and Engineering*, Vol.3, Issue.3, pp.338-342, 2011.

[8]. M. Yang, N. Bourbakis, "An Overview of Lossless Digital Image Compression Techniques", 48th Midwest symposium on Circuits and systems, Covington, pp.1099-1102, 2005.

[9]. VK. Padmaja, B. Chandrasekhar, "*Literature Review of Image Compression Algorithm*", International Journal of Scientific & Engineering Research, Vol.3, Issue.6, pp.1-6, 2012.

[10]. A. Mudgal, R. Singh, "*A Hybrid Method of Medical Image De-nosing Using Subtraction Transform and Radial Biases Neural Network*", International Journal of Computer Sciences and Engineering, Vol.3, Issue.9, pp.54-59, 2015.

[11]. LK. Griffeth, "Use of PET/CT scanning in cancer patients: technical and practical considerations". Proceedings of Baylor University Medical Cente, Vol.18, Issue4, pp.321-330, 2005.

[12]. A. Said, W.A. Pearlman, " *A New Fast and Efficient Image Codec Based on Set Partitioning In Hierarchical Trees*," IEEE Trans. Circuits & Systems for Video Technology, Vol.6, Issue.3, pp. 243-250, 1996.

[13]. *Architecture for Content Based Image Retrieval Using Modified SVM and knn-GA*", International Journal of Computer Sciences and Engineering, Vol.2, Issue.10, pp.41-45, 2014.

[14]. Premal B. Nirpal, "*Image Compression using Discrete Cosine Transform, Block Truncation Coding and Gaussian Pyramidal Approach*", International Journal of Computer Sciences and Engineering, Vol.3, Issue.4, pp.21-25, 2015.

[15]. J. Ma, T. Zhang and M. Dong, "*A Novel ECG Data Compression Method Using Adaptive Fourier Decomposition With Security Guarantee in e-Health Applications*", *IEEE Journal of Biomedical and Health Informatics*, Vol. 19, No. 3, pp. 986-994, 2015.

[16]. Pratik Chavada, "*Region of Interest Based Image Compression*", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, Issue.1, pp.1-6, 2014.

[17]. Bhavna Pancholi, "*Tutorial review on existing image compression techniques*", International Journal Of Engineering and Computer Science, Vol.3, Issue.8, pp.7882-7889, 2014.

[18]. Sarvarinder Singh, " *Review: ROI Based Medical Image Compression using DCT and HAAR Wavelet*", International Journal of Advanced Research in Computer and Communication Engineering, Vol.4, Issue.8, pp.223-243, 2015.