ROI BASED MEDICAL IMAGE COMPRESSION USING BLOCK BASED PCA

[1]Nikita Mishra, [2]Chandrashekhar Kamargaonkar

M.E. Student, Associate Professor

Department of Electronics and Telecommunication

SSTC, SSGI, Junwani, Bhilai, Chhattisgarh, India

Abstract

CT or MRI Medical imaging produces digital form of human body pictures. There exists a need for compression of these images for storage and communication purposes. Current compression schemes provide a very high compression rate with a considerable loss of quality. In medicine, it is necessary to have high image quality in region of interest, i.e. diagnostically important regions. This work discusses a model of lossless compression in region of interest with Block based PCA with high compression rate(CR) as well as high PSNR. Also the value of Mean Square Error (MSE) is very low. We evaluate our method on medical thyroid gland**.** This proposed method will reduce the errors caused due to manual analysis, time consuming, inaccurate and also eliminate the need of intensive trained person's in order to avoid diagnostic errors.

Keywords: **Block based PCA, Region of Interest, PSNR, MSE, and CR**.

I: INTRODUCTION

Medical imaging has had an excellent impact on the identification of diseases and surgical planning. However, imaging devices still generate a lot of information per patient, usually one thousand images or 500 MB(approx). These information requires large storage space and economical transmission. Regardless of greater improvement in transmission storage space and communication technologies, the medical image compression plays the demanding role[1].

Image compression is a field where an original image is reduced to a smaller sized image and then for the purpose of remote communication this reduced image is used. At the receiver site, this reduced image is again converted to original image by the implementation of some algorithms. The result of these algorithms produces another image which may be very close to the original one[2].

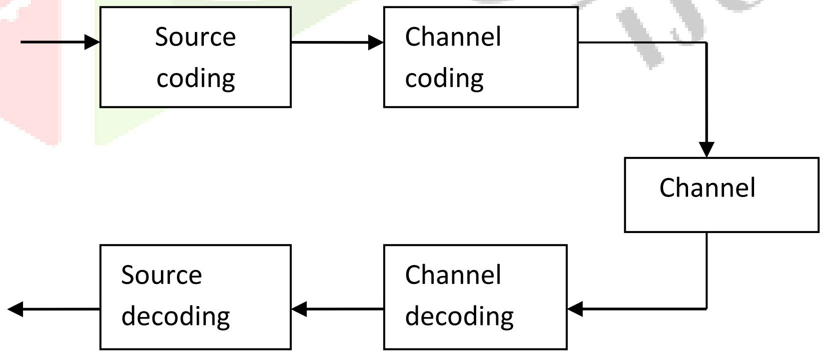


fig (1): block diagram of image compression

In telemedicine, medical images generated from medical centers with efficient image acquisition devices such as for example Computed Tomography (CT), Magnetic resonance Imaging (MRI), Ultrasound (US), Electrocardiogram (ECG) and Positron Emission Tomography (PET) have to be compelled to be transmitted handily over the network for studying by another medical professional Apart from preserving essential information in the medical images, high compression ratio and capability to decode the compressed images at various qualities will be the major concerns in medical image compression[1].

In this paper we describe a coding scheme based on block based principal component analysis to compress medical images. Usually only part of the image is important to the diagnosis. Using the thyroid gland image as an example, only the Region of interest areas are important and other regions can be coded with much lower bit rate without decreasing the diagnostic value of the image. The background area can be coded as simple models. As for the region of interest, more sophisticated algorithm will be required to achieve high compression ratio and preserve necessary information for diagnosis at the same time. This suggests t:hat block based principal component analysis will be a good candidate for the block transform coding.

II: METHODOLOGY

A: Patient

According to a study conducted among twenty five thousand four hundred and thirty seven thyroid patients were referred to the radioimmunoassay (RIA) laboratory of the Institute of Radiotherapy and Nuclear Medicine (INRUM), Peshawar, during the year 1984-1990 (except 1987), 1995 and 1996. The data revealed that thyroid problems prevailed more in the adults group (> 13-40 years) and females. The referral of thyroid patients was more common in summer (May-Jun.) than other seasons.

B: Processing

A **grayscale** image (also called gray-scale, gray scale, or gray-level) is a data matrix whose values represent intensities within some range. MATLAB stores a grayscale image as an individual matrix, with each element of the matrix corresponding to one image pixel.

C: Segmentation

Segmentation of image is very important and can be classified as the most difficult function in image processing. Segmentation is defined as the grouping of data which is share same characteristics such as color, intensities etc. The analysis task such as classification and recognition depend on the result produced from segmentation.

Segmentation of hyperspectral images enables easier analysis of hyperspectral scene using unsupervised learning methods. There are different studies on the segmentation of hyperspectral images. In one of those studies, independent component analysis based approach is proposed which extracts density of the data in each cluster and models distribution of the data using non-Gaussian methods. Two segmentation studies based on Gauss mixture models and non-Gauss mixture models using only spectral information are introduced. Hidden Markov model is another method used for segmentation of hyperspectral images. It is also aimed to obtain segmentation maps using supervised algorithms such as artificial neural networks and support vector machines. Both spectral and spatial information is utilized using hierarchical clustering in. Multi-objective optimization based segmentation approaches are also introduced for spectrospatial segmentation of hyperspectral images using genetic algorithms and particle swarm optimization.

D: Block based PCA

Rather than compressing the entire image at once, we are interested in acting on the sub - block of the original image. Block-by-block PCA was initially proposed by Taur and Tao [8] after they tested the thought of applying a different number of principal components for every blocks in the image. The input image is partitioned off into blocks of size n and PCA algorithm was applied one-by-one on every blocks. Each block X_i^{th} consists of intensity values f(x, y) where ith represent the block number of the image.

$$X_i^{th} = \begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,n-1) \\ f(1,0) & f(1,1) & \cdots & f(1,n-1) \\ \vdots & \vdots & \vdots & \vdots \\ f(n-1,0) & f(n-1,1) & \cdots & f(n-1,n-1) \end{bmatrix}_{(n\times n)}$$

In this work, compression ratio relation is developed based on the matrix size stored in the compressed data:

$$CR_b = 1 - \left(\frac{nk}{MN} \times \frac{MN}{n^2}\right)$$

Where $\frac{MN}{n^2}$ is the total number of blocks for an image with size MxN.

E: Block to row PCA

Like block-by-block PCA, the original image is divided into nxn blocks. Every block is concatenated into row to get a transformed matrix,

$$D=[x_1 \quad x_2 \quad \cdots \quad x_{block}]_{(n^2 \times block)}$$

Where x_i contains all elements within a block,

$$X_i^{th} = \begin{bmatrix} f(0,0) \\ f(1,0) \\ \vdots \\ f(n^2-1,0) \end{bmatrix}_{(n^2 \times 1)}$$

PCA is then applied on the transformed matrix. The compressed information obtained during this case is,

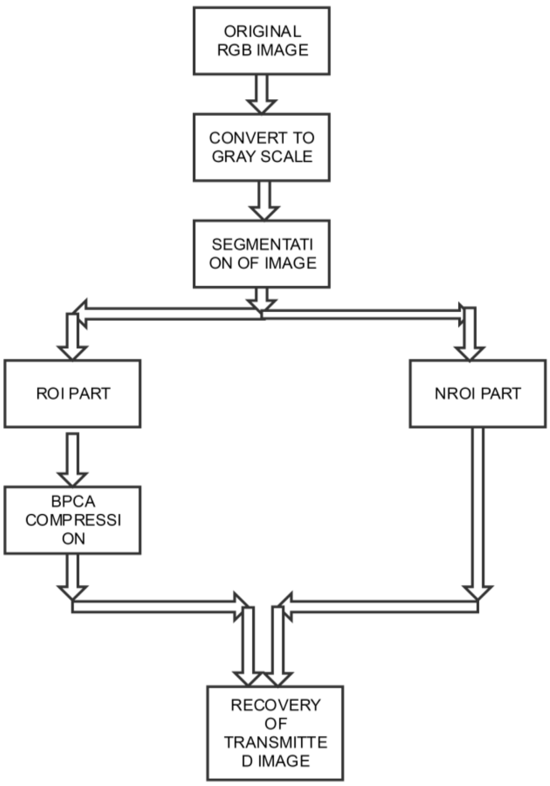
$$Y= [V^T * \bar{D}^T]_{(n^2 \times k)}$$

Where V is the feature matrix and $\bar{D}$ the mean-adjusted matrix. This compressed image can be reconstructed utilizing backwards strategy that was utilized in concatenation. Consequently, the compression ratio, again based on the compressed data, is characterized as:

$$CR_r = 1\text{-}(\frac{n^2 k}{MN})$$

E: Proposed Work

The proposed methodology shown in fig 2. The region of interest part is segmented first and then is compressed by using Block based PCA.



fig(2): flow chart of proposed method

During segmentation no.of ROI's are selected where diagnosis has to be done. Then the selected ROI is fed to Block based PCA algorithm i.e. Block based PCA as well as block to row PCA.

Resultant Compression ratio of ROI, CR(%)= $CR_b \times ROI\ area$

Or

Resultant Compression ratio of ROI, CR(%)= $CR_r \times ROI\ area$

Where ROI area= $\frac{Size\ of\ ROI\ image}{Size\ of\ original\ image}$

For image quality matric PSNR is calculated as

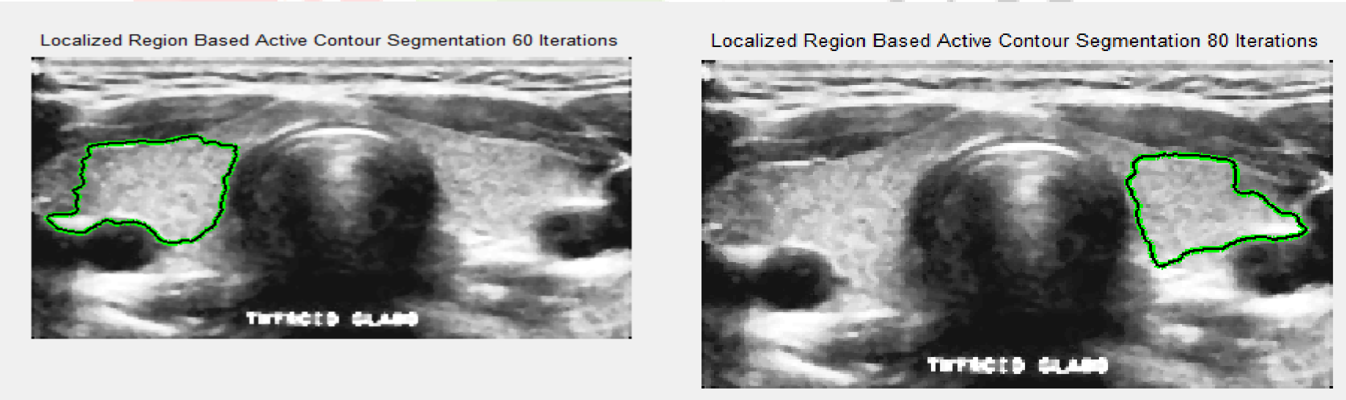
PSNR= $10\times\ log_{10}\left(\frac{255}{\sqrt{MSE}}\right)$, where MSE is Mean Square Error,

$$MSE=\frac{1}{MN}\sum_0^{M-1}\sum_0^{N-1}\|f(i,j) - g(i,j)\|^2$$

f - Original image Pixel Value
g - Compressed image Pixel Value
M - Number of rows of the images and i represents the index of that row
N - Number of columns of the images and j represents the index of that column.

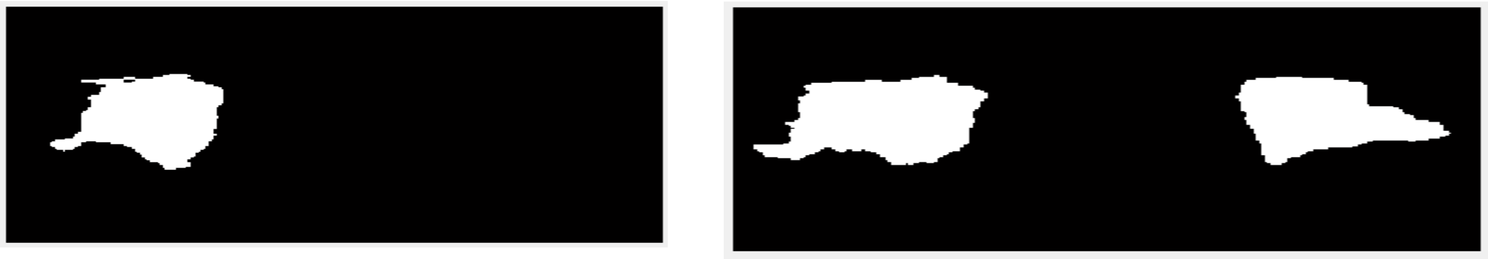
III: RESULTS AND DISCUSSION

The host medical image is tested on an Intel (R) core i5 PC using MATLAB R2014a. The host RGB image is firstly converted into GRAY scale image then segmentation is done. During segmentation ROI part is extracted from the converted image and compression of selected ROI part is done by using Block based PCA.

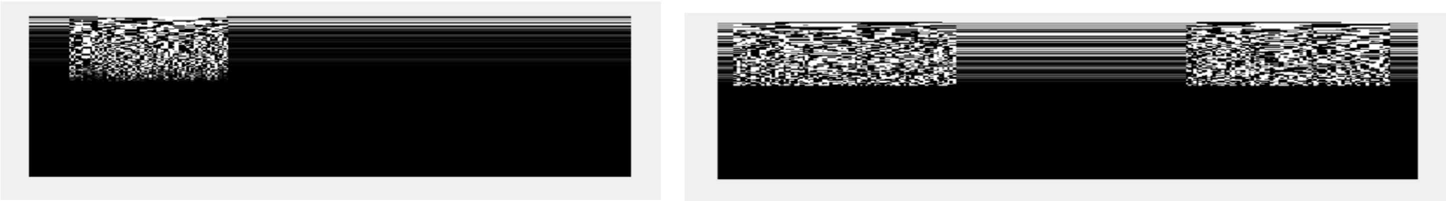


fig(3): detection of 1st and 2nd ROI

fig(3) shows the detection of ROI's whereas the below fig(4) shows the detected Region of Interest blocks which will be transmitted after compression through Block based PCA. ROI region require the quality of image should be high. And fig(5) is showing the output of compression of ROI part via Block based PCA(BPCA).



fig(4): final detected ROI's



fig(5) : output of BPCA compression of ROI parts

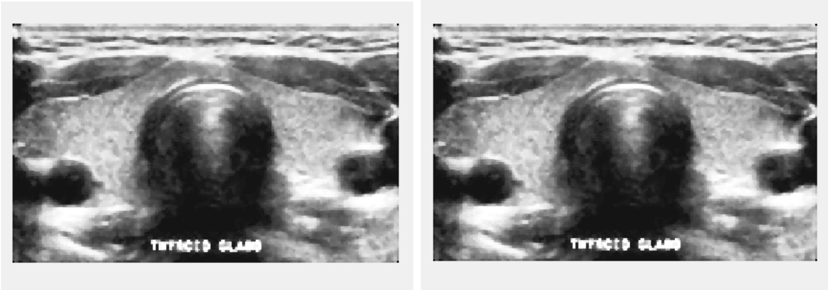
TABLE I: BLOCK BY BLOCK PCA with block size=8

PSNR db	**Compression Ratio and MSE**		
	ROI(1)	**CR $_{\text{Total}}$**	**MSE**
85.2043		.901045	12.96
	ROI(2)	**CR $_{\text{Total}}$**	**MSE**
79.6143		.82539	22.6713

TABLE II: BLOCK TO ROW PCA with block size =8

PSNR db	**Compression Ratio and MSE**		
	ROI(1)	**CR $_{\text{Total}}$**	**MSE**
81.0256		.94025	10.23
	ROI(2)	**CR $_{\text{Total}}$**	**MSE**
70.2158		.896324	18.232

PSNR in dB is the measure of quality of the reconstructed image varies with compression ratio. PSNR value equals to infinity if there is no quality discrepancy between the original gray image and the reconstructed image. Compression ratio equals to zero if all principal components are chosen while compression ratio approaches to one if lesser principal components are used.



fig(6): reconstructed images

IV: CONCLUSION

In this work we've done our work on Region of Interest of a medical image of a thyroid gland. From the work, it can be concluded that the compression performance of block-to-row PCA is better than block-by-block PCA, in terms of Mean Square Error and compression ratio.therefore we are getting maximum CR on ROI part without degrading the quality of the image. Future work incorporates localizing the ROI in a more accurate way for example to segment the exact shape of ROI tracing the boundary since almost all of the medically vital data is in arbitrary shape.

REFERENCES

[1] Ravi kiran and Chandrashekhar Kamargaonkar," Region Based Medical Image compression Using Block- Based PCA", International Conference on Computation of Power, Energy Information and Communication (ICCPEIC),pp:91-96,2016.

[2] Neha Sikka and Sanjay Singla," Lossless Image Compression Technique using Haar Wavelet and Vector Transform", International Conference on Research Advances in Integrated Navigation System(RAINS),April 06-07,2016.

[3] V.Gomathy and U. Snekhalatha," Automated segmentation using peA and area estimation of thyroid gland using ultrasound Images", IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems IClIECS', 2015.

[4] Lim Sin Ting, David Yap Fook Weng and Nurulfajar Bin Abdul Manap, "A Novel Approach for Arbitrary-Shape ROI Compression of Medical Image Using Principal Component Analysis (PCA)", Trends in Applied Sciences Research, pp. 68-76, Academic Journals Inc, 20 15.

[5] S. T. Lim, D. F. W. Yap and N. A. Manap, "Medical image compression Using Block-Based PCA algorithm", IEEE International Conference on Computer, Communication, and control technology (I4CT 20 14), pp. 17 1- 175, Langkawi, kedah, Malaysia, 20 14.

[6] Chandrashekhar Kamargaonkar and Dr. Monisha Sharma," Hybrid Medical Image Compression Method Using SPIHT Algorithm and Haar Wavelet Transform", International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT),pp:897-900,2016.

[7] Salih Burak Gokturk, Carlo Tomasi, Bernd Girod and Chris Beaulieu, "Medical Image Compression Based on region of interest with application to Colon CT images", Engineering in Medicine and Biology Society, 2001. Proceedings of the 23rd Annual International Conference of the IEEE (Volume: 3), 2001.

[8] J. S. Taur and C.W. Tao, "Medical image compression using principal component analysis", IEEE Internation Conference on Image Processing, vol. 2, pp. 903-906,1996.