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Efficient Medical Image Compression based on Region of Interest

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Abstract: **-- The Radiology places very high demands on the networking and digital storage infrastructure of hospitals. An Efficient method for segmentation and compression of medical images is proposed. In this paper we present a clustering algorithm called Adaptive Fuzzy C means for image segmentation which could be applied on general images and specific images (medical and microscopic images).This algorithm employs the concepts of fuzziness and belongingness to provide a better and more adaptive clustering process as compared to other clustering algorithm. Based on the results obtained the proposed algorithm gives better visual quality as compared to other clustering methods. Compression methods capable of delivering higher reconstruction quality for important parts are attractive in this situation. Only a small portion of the image might be diagnostically useful, but the cost of a wrong interpretation is high. Hence, for medical image compression and transmission Region based coding is necessary. In telemedicine applications Lossless compression schemes with secure transmission play a key role in accurate diagnosis and research. In this paper, we propose lossless scalable RBC for Medical images based on improved Ridgelet Transform and with distortion limiting compression technique for other regions in image. The main objective of this work is to reconstruct the image portions losslessly. For Medical images based on improved Ridgelet Transform and with distortion limiting compression technique for other regions in image. The main objective of this work is to reconstruct the image portions losslessly.**

Index Terms **— Fuzzy C means; Image Compression; Improved Ridgelet transform; Morphological operations; ROI; MSE (means square error); PSNR (Peak signal to noise ratio).**

I. INTRODUCTION

Segmentation of anatomical structures is a fundamental operation in medical image analysis [1]. In literature studies shown that the textural classification of DWT coefficients can improve the sub band coding efficiency by discarding the unimportant coefficients[2].considering the object segmentation rather than textural developed the unsupervised learning technique to locate objects of interest in image by exploiting spatial structures[3] classification .The image processing is now a critical component in science and Technology, the progress in diagnosis has propelled medical imaging into one of the most important subfields in scientific imaging. To visualize the structure of human body imaging is an essential aspect of medical science. With advance of computer techniques the images can be processed and manipulated to help the hidden diagnostic features that are impossible to identify. Partitioning a given image into a finite number of non overlapping regions with respect so some gray level distribution and texture distribution etc.

In the field of medical imaging the large amount of image data is produced in the from of Tomography (CT), Magnetic Resonance Imaging (MRI), and Ultrasound Images, which can be stored in picture archiving and communication system (PACS) or hospital information system . Moreover, such high data demand for high end network especially for transmitting the images over the network such as in telemedicine.. Image compression is useful in, reducing the storage and transmission bandwidth requirements of medical images. For e.g., an 8-bit grey scale image with 512 × 512 pixels requires more than 0.2 MB of storage. If the image is compressed by 8:1 compression without any perceptual distortion, the capacity of storage increases 8 times. Compression methods are classified into lossless and lossy methods. In the medical imaging scenario, lossy compression schemes are not generally used. This is due to possible loss of useful clinical information which may influence diagnosis. In addition to these reasons, there can be legal issues. Storage of Medical images is generally problematic because of the requirement to preserve the best possible image quality which is usually interpreted as a need for lossless compression.

For radiation treatment planning visualization of volume of region of interest defining the boundary of brain tumor etc. Neural Network (NN), fuzzy logic means are the many approaches that are based on segmentation. In medical diagnosis like radiation treatment volume visualization etc the image segmentation can be classified in to three pixel based method, edge based method and region method.

Recently the Region of Interest techniques have become the acknowledged in medical applications for great demand of high compression ratio. Different ROI based techniques and algorithms are based on similarity and particularly which can be divided into different categories: Tresholding[8],templatematching[9][10]andregiongrowing[11][12 algorithms are normally based on similarity and particularly and edge detection and clustering[13].digital image segmentation technique in various filed as engineering computer and mathematics. The clustering algorithms are applied to biomedical image analysis where in images are produced by medical imaging devices. In biomedical image segmentation clustering algorithm is often suitable since the number of clusters for the structure of interest is usually known its anatomical information .the remaining paper has arranged as follows, chapter II Exisitng methodlologies, III proposed method, IV Results and discussions and chapter V conclusion of the work.

II. EXISTING METHODOLOGIES

To understand the proposed method, the related works have to be explained. Cziho.A has proposed a vector quantization scheme combined with regions of interest. The input image is to be segmented in to regions and a separate codebook is used for each region. This permits to create codebooks with representative codeword and to obtain good reconstruction quality in relevant zones while reinforcing compression in less important regions. The selected approach is tested on ultrasound images which shown to be very promising

Ujjwal Maulik [17] has proposed a Genetic algorithm which has been found to be effective in medical image segmentation. The problem in medical image segmentation arises due to poor image contrast and artifacts that result in missing tissue boundaries. The resulting search space is therefore noisy with a multitude of local optima. This algorithm brings out considerable flexibility into the segmentation procedure and attempt has been made to review the major application of GAS to the domain of medical image segmentation.

Adrian Munteanu has Proposed a new wavelet based compression technique that exploits the intra band dependies and uses a quad tree based approach to encode the significance maps. The algorithm produces a lossless compression data stream and permits region of coding. The algorithm suits well in telemedicine applications where handling of large image sets over networks with limited or variable bandwidth is required

Chakrapni et al.[18] have applied the technique of genetic algorithm for fractal image compression. This algorithm reduces the search complexity of matching between domain block and range block. The draw back of fractal image compression is that it involves more computational time due to global search. Hence genetic algorithm has been proposed to improve the computational time at an acceptable quality of decoded image. The results have showed that Compare to traditional exhaustive method the Genetic Algorithm was better.

Lavanya [6] has proposed a method to preserve quality in region of interest (ROI).The image is divided in to primary region, secondary region and background region. The two types of compression carried over here are both lossy and lossless. Huffman coding is applied over primary region, The SPIHT algorithm applied over the secondary region and background. This method preserves quality in region of interest while allowing lossy encoding of other region apart from region of interest. This technique will reduce the storage space and transmission cost and obtains good quality in region of interest.

Doukas[16] Picture archiving communication systems(PACS) application designed for viewing DICOM compliant medical images using wavelet compression ROI coding support is been discussed .He proposed a wavelet transform that has been considered to be a highly efficient technique of image compression resulting in both lossless and lossy compressed images of great accuracy enabling its use on medical images..

G. Vallatha [7]has proposed a hybrid compression model for efficient transmission of medical image using lossless and lossy coding for telemedicine application. As the storage space demand in hospitals is increasing compression of medical images is the need of the hour. Region based coding technique is substantial for medical image compression as only a small part should be diagnosed. To achieve high compression ratio lossless and lossy compression is significant .this paper presents a method of employing both method s integer wavelet transform and the SPHIT algorithm helps to reconstruct the medical image up to the desired quality. Maintaining the Integrity of the Specifications

Proposed method

The proposed work has been described in the Fig. 1 it is a ROI based medical image compression, and the techniques for the implementing the proposed work are Image enhancement, morphological operations, Fuzzy c

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means clustering and Ridgelet transform and coding alogirthm

Image enhancement

This technique is designed to improve the quality of an image as perceived by human being .The enhancement can be performed both in spatial as well as in frequency domain. And they are employed to sharpen or smoothen image features for display and analysis. Basically the image enhancement techniques are of two types. Spatial domain which operates directly on pixels Whereas the transform domain method operates on the Fourier transform of an image and then transforms it back to the spatial domain. Improvement in the quality of these degraded images can be achieved by the application of restoration or enhancement technique. The term image enhancement we mean improvement of the appearance of an image by increasing dominance of some features of the image. There are techniques proposed by different authors in order to remove the noise form the image and produce the clear visual of image. Many filters and image smoothing methods are available. Recently neural networks turn to be a very effective tool to support the image enhancement. Neural network is applied in image enhancement because it provides many advantages over the other techniques. The advantage is neural network can be the suitable model for removing all kinds of noise based on its training data. This paper provides survey about some of the techniques applied for image enhancement. There are some other enhancement techniques for increasing the intensity level of the images.

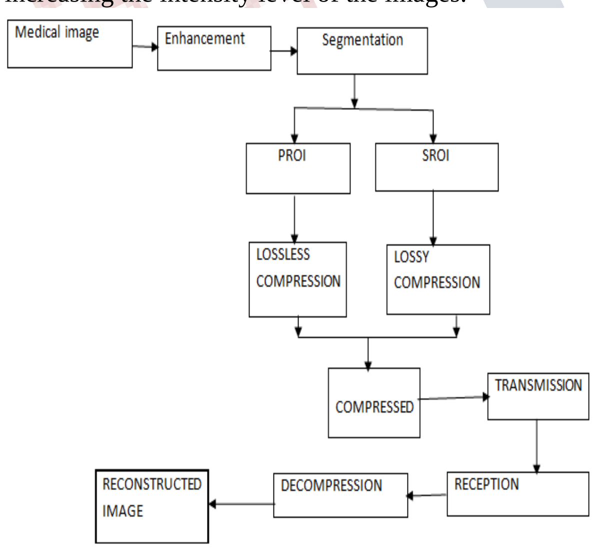

Fig. 1 ROI based medical image compression

B. Morphological segmentation

Morphology is a collection of non linear processes which are applied to an image to remove details smaller than a certain reference shape. To extract the edges of an image, filter an image the morphological operations can be used. We apply dilation, erosion, opening and closing on the images. Mathematical morphology can be used as the basis of developing image segmentation procedures with a wide range of applications and it also play a major role in procedures for image description. The mathematical operations are defined by moving a structuring element over the binary image to be modified in such a way that it centered over every image pixel at some point. When the structuring element is centered over a region of the image, a logical operation is performed on the pixels covered by the structuring element yielding a binary output. At each pixel position a specified logical operation performed between the structuring and the underlying binary image. Binary images are images whose pixels have only two possible intensity values. They are normally displayed as black and white. Numerically the two value are often 0 for black and 1or 255 for white. In order to separate an object in the image from the background the binary images are often produced by thresholding a gray scale or color image. Now the color of object (white) is refereed to as background, the rest (the black) is referred to as the background color. The section details the segmentation of mammograms for identifying the tumor in brain. The proposed approach utilizes mathematical morphology operations for the segmentation. To segment the abnormal regions the morphological operations are applied erosion and dilations are the two elementary operations in mathematic Morphology. The four operations are defined as follows. Dilations is a process in which the binary image is expanded from its original shape dilation is an expansion operator that enlarges binary objects. Erosion shrinks the image. The way the image is shrunk is determined by the structuring element. Opening smoothes the inside of the object contour breaks narrow strips and eliminates thin portions of the image.

C. The Fuzzy Cmeans clustering algorithm:

Fuzzy C-Means, also known as Fuzzy K-Means and Fuzzy ISODATA, is one of the oldest and most ubiquitous fuzzy clustering algorithms. FCM is a generalization of the K-Means clustering algorithm, which is a simple and widely used method for finding crisp clusters. Understanding FCM's crisp ancestor is instructive and is discussed below.

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$$\underbrace{J}_{\text{cost function}} = \sum_{i=1}^{\overset{\text{\# of clusters}}{c}} \underbrace{J_i}_{\text{cost of the } i^{th} \text{ cluster}} = \sum_{i=1}^{c}\left(\sum_{j}^{\overset{\text{number of data points}}{n}} \underbrace{u_{ij}^{\overset{\text{fuzziness exponent}}{m}}}_{\text{membership of the } j^{th} \text{ point to the } i^{th} \text{ cluster}} \overbrace{d(x_j - c_i)}^{\text{distance from point to the } i^{th} \text{ centroid}}\right)$$

Applying the method of Lagrange multipliers to minimize the above cost functions yields the following necessary (but not sufficient) constraints

$$\mathbf{c}_i = \frac{\sum_{j=1}^{n} u_{ij}^{m} \mathbf{x}_j}{\sum_{j=1}^{n} u_{ij}^{m}}$$

Like K-means, FCM is initialized by choosing a fixed number of centroids at random. Also like K-means, FCM after initialization is divided into two phases:

Phase 1: Form Clusters. Each centroid is associated with a different fuzzy cluster. To form these clusters, each point in the data set is evaluated in turn. When evaluated, a point is assigned a membership degree with respect to each cluster. The numerical value of these degrees is given by the second of the above constraints.

Phase 2: Move Centroids. Each of the centroid is now moved to the position obtained via the first of the above constraints.

The MRI contains three parts, ROI, Non-ROI image part and the background information. The ROI is selected by the Radiologists for the diagnose purpose , depending on the selected part ROI mask is generated in such a way that the foreground is totally included and the pixel values in the background are made zero.

The background is made zero using the expression

img[*i, j*] $\le$ *x_th, then*

img[*i, j*] = 0

Here, X_th represents the threshold value of background of the image (img). Reducing the background contents to zero also accounts for complete lossless compression, producing a ready to process image. Morphological operations are effectively used, which contain a value of '1' in the foreground and a value of '0' in the background. Then the mask is logically AND-ed with the image to separate-out ROI part (IMG_ROI) and Non-ROI image part .The separated parts can be processed separately as per the requirement, i.e., ROI part will be processed by lossless technique, while Non-ROI will be compressed with accepted lossy compression methods.

The Ridgelet Transform

For many of the image processing techniques that take advantage of the sparse representation of the image, the wavelet transform was mostly used. But these wavelets fail to effectively represent the line singularities along two-dimension. So, to overcome the issues in the wavelet transform, Candes and Donoho established a new scheme named ridgelet transform which effectively represents the line singularities in two-dimension. The main idea behind this ridgelet transform is to map the line singularity into point singularity and then make use of the wavelet transform for representing this point singularity.

The continuous ridgelet transform (CRT) of a bivariate function f(x) in R2 is defined by,

$$CRT_f(a,b,\theta) = \int_{R^2} \psi_{a,b,\theta}(x) f(x) dx$$

where the ridgelets $\psi_{a,b,\theta}(x)$ are defined from the 1D wavelet $\Psi(x)$ as,

$$\Psi_{a,b,\theta}(x) = a^{-1/2}\Psi((x_1\cos\theta + x_2\sin\theta - b)/a)$$

As mentioned above, the ridgelet transform is the application of 1D wavelet transform to the radon transform and it consists of four parts for processing the image. (a) Two dimensional Discrete Fourier Transform (2-D DFT)

(b) Radon Transform

(c) One dimensional Inverse Discrete Fourier Transform (1-D IDFT)

(d) One dimensional Discrete Wavelet Transform (1-D DWT)

In this improved ridgelet transform, the one dimensional discrete wavelet transform is replaced by the slantlet transform (SLT). This slantlet transform is an orthogonal DWT and provides improved time localization with two zero moments. Hence, this improved ridgelet transform is expected to provide higher performance than the existing ridgelet transform

Coding algorithm

The set partition in hierarchical trees (SPIHT) coding algorithm is best in terms of compression performance (Said

& Pearlman 1996). Previously, the SPIHT was designed for lossy data Compression. By combining the Slantlet transform with the SPIHT, both the lossy and lossless compression modes are now supported. The major advantage of using SPIHT coding technique is that, it supports embedded coding along with progressive transmission, which is suitable for telemedicine.

A new coding algorithm is presented here.

(i) Read image from database and get dimensions.

(ii) Apply threshold to remove background.

(iii) Select ROI, and separate out ROI and Non-ROI.

(iv) Accept compression levels from user.

(v) Apply wavelet for Non- ROI to execute 2D heap.

(vi) Do operation of distortion as per level selected by user for Non-ROI, and Lossless zip technique for ROI

(vii) Perform slantelt transform recursively combine ROI.

(viii) Compare the quality of original image with newly reconstructed image

Experimental Results

Algorithm is implemented on a group of MR DICOM images. SPIHT is proved to iterations; less execution time is achieved compared to others. Hence the proposed system is efficient and is less error sensitive iterations, less execution time is achieved compared to others. Hence the proposed system is efficient and is less error sensitive iterations, less execution time is achieved compared to others. The experimental results has shown in Fig 2 and Table 1.Hence the proposed system is efficient and is less error sensitive be the best. But for ROI-based compression computational complexity is also one of the important issues to be considered, while addressing real time applications A new and simple algorithm as explained above is used to encode the image.. The 'compressed image' is the image which is generated at the decoder side after reconstruction process.

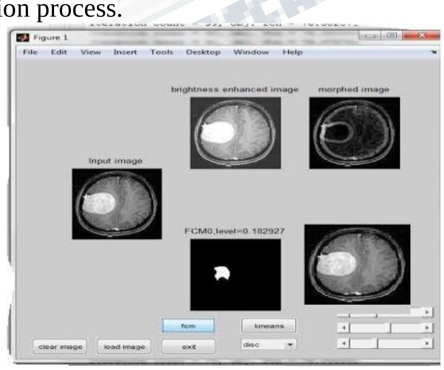

Fig. 2 Reconstructed image using Fuzzy Cmeans algorithm

TABLE I PERFORMANCE OF PROPOSED APPROACH

IMAGE	*PSNR*	*MSE*	*ENCODE TIME*	*DECODING TIME*	*COMPRESSION RATE*
1	81.2067	4.9637	0.0234	0.6057	59.93
2	77.8341	0.0011	0.0151	0.6401	59.68
3	73.96	0.0026	0.0156	0.245	58.54

V. CONCLUSION

Every image contains some redundant information, which needs to be identified by the user to obtain compression. The Rigelet transform is recommended for critical medical application because of its perfect reconstruction property. ROI-based compression is providing better results as compared with lossless Methods, along with preservation of diagnostically important information. Such method is recommended for telemedicine system especially rural area, where network resources have limitations. Advanced version of the proposed method may include the compression based on the information contents as well as compression based on ROI to be selected automatically. The ROI can be encoded and transmitted with better quality than the rest of the image.

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