A Proposed Work on Segmentation based Enhancement of Medical Images for Rapid Diagnosis in Telemedicine

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Abstract— This review work has main focus on detection of problematic areas in magnetic resonance imaging, x-ray, ultrasound, digital imaging and communications in medicine images. Paper contains survey in telemedicine areas revolve around reducing the amount of storage in these images but the focus around the ailing areas of the subject are still not the recent trends to be concentrated by the various researchers. The study has been proposed to enhance and clarify the focused areas in telemedicine images due to which diagnosis from remote areas can be performed even if the expert is not available. Need of developing a method that highlights the problematic parts in the medical images which will allow the doctors to quickly diagnose the disease. Study on existing work can suggest a technique that reduces the diagnosis time, effort and quick response to the medical queries in this field.

Keyword- Compression, Enhancement, Retrieval, Segmentation of Image, Telemedicine

I. INTRODUCTION

Increasingly, medical images are acquired and stored in the form of different modalities like computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and ultrasound images (US).Storage and preserving different medical modalities is becoming a very big issue[1].Quick retrieval and diagnosis of data at required time getting harder task for practitioners. A hospital with intermediate facilities produces on an average up to 25 GB of data [2], [3], [4]. Therefore, it is hard job to manage the storing and retrieval facilities in hospitals. Ultrasound imaging technique is one of the available tools for cancer diagnosis [5]. Certain limitations are there in the field of telemedicine such as transmission medium in rural areas where technology is not advanced. To reduce the size of medical images various compression techniques are in recent trends of study. Telemedicine is a term encompassing all methods used to determine, investigate, screening, treating when the patient and doctor physically located in different places, transferring the expertise. Needless travelling is eliminated for patients and escorts. Image acquisition, storage, display, processing, and transfer, form the basis of telemedicine [6]. Telemedicine makes an ordinary medical practitioner in rural area to do extraordinary work.

II. SUGGESTED METHODOLOGIES

A. Enhancement of Medical Images

1) Image Denoising: Noise in the medical image can adversely affect the abnormality detection rate and accuracy. Additive noise, speckle noise, gaussian noise, impulsive noise, rasion noise are different types of noise that can degrade the quality to medical image. Speckle noise is inherent property of ultrasound images due to which data gets corrupted. Therefore, despeckling is an important task in US image processing because speckle tends to blur the finer anatomical details [7]. All the parts of body that contain the soft tissue such as breast [8],[9] lung, kidney in which lesion detection and boundary characterization is a major part of ultrasound screening and diagnosing gets influenced by the noise during image acquisition. [10], [11]. For the purpose of imaging the internal anatomy ultrasound is a commanding technique (e.g., abdomen, breast, liver, kidney and musculoskeletal). For the body of human being it is comparatively low-cost, noninvasive, non-harming and transportable, but it suffers from a main drawback, i.e., corruption due to speckle noise. Different methods to reduce speckle noise are already proposed [6], [16]-[19]. Primitive techniques used various spatial filters such as

average, median, and wiener filter [6]-[12], [12]-[19] but, they usually do not correctly preserve all the useful information such as structural boundaries in the image. In recent times, wavelet-based despeckling has been advised [13]. The development of discrete wavelet transform (DWT) resembles to basis decomposition as in fig.1 and fig 2; it provides a non-repeating and exclusive illustration of the signal [20], [21], [22]

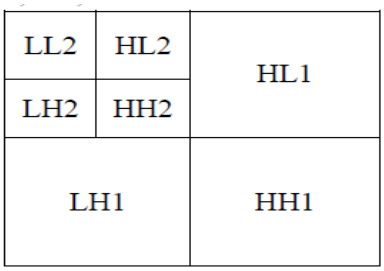

Fig 1. DWT for despeckling ultrasound image

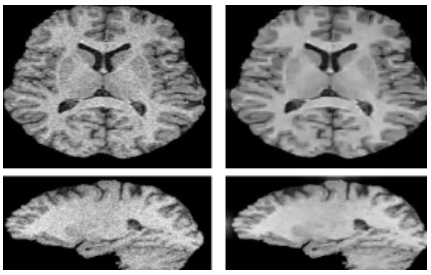

Fig 2. MRI of brain (a) Original (b) Denoised

The presence of noise in images allows detection of edges around the borders which should preferably have no edges. So there is a requirement of denoising before segmentation and enhancement.

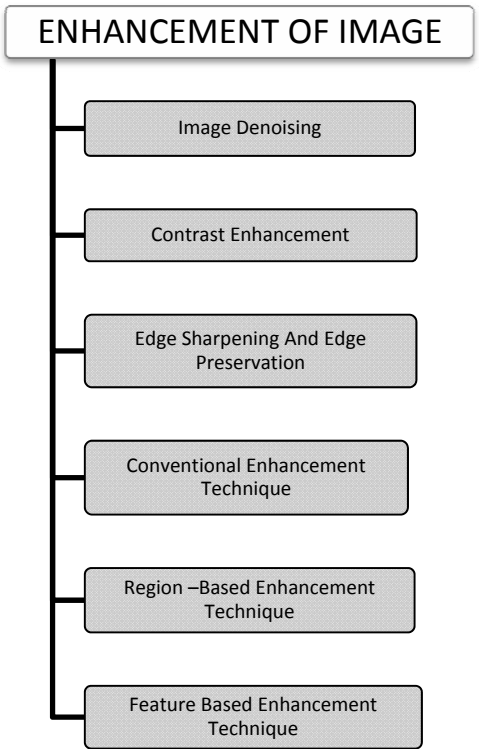

Fig 3. Enhancement Techniques

2) Contrast Enhancement (Smoothening): Image Enhancement or contrast enhancement alters the brightness of an image based on modelling technique does not depend on cause of degradation, it is done to enhance [23] the feature that are not cleared in the image. The most common technique used to enhance the image are Contrast stretching technique which is used to enhance the quality of image by increasing the dynamic range of grey level in image. And secondly most common technique used is histogram equaliser, in which it automatically determines a transformation functions that seeks to produce an output image that has uniform histogram. This technique is comparatively simple [24], [25] and easier to perform.

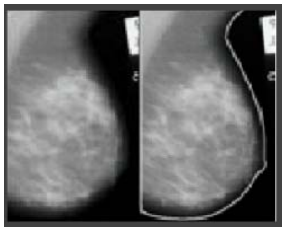

Fig 4. Image Enhancement

3) Edge Sharpening and Edge preservation: Edge detection in image processing is typically used for data reduction by identifying the region of interest (ROI). Edges indicate discontinuities while texture denotes continuity. Firstly, generation and thickening of edges. Secondly, on the foundation of exemplar textures the edges are filled and image is regenerated. All removed blocks of the normally coded image are filled in. Decoding of image is performed usually for a normally coded image. While renovating texture the area outermost from the edge will be generated so as not to interfere with the edge regeneration [6], [17], [28], [29], [30].

4) Conventional Enhancement Technique: This [25], [31] technique is used to enhance the masses in medical images.

5) Region –Based Enhancement Technique: Region based Enhancement technique is used to [25], [31], [32] automatically enhance the particular region where the abnormality is analysed.

6) Feature Based Enhancement Technique: Feature based enhancement technique is used in mammography in which features like masses and micro calcification [25], [31], [32], [33] is detected.

B. Segmentation

The process of dividing a digital image into multiple parts is known as image segmentation. The focus of segmentation is to simplify and/or change the description of an image into some meaningful part for analyzing the image and also used for locating boundaries and objects in images as in fig 3 [16]. The structural properties of the image are preserved and the unwanted background information is filtered out. The major goal of salience map is to highlight any pixels that vary from the rest of the background as in fig 4 and catch the human attention towards any diagnostic detail [15], [16], [34], [35].

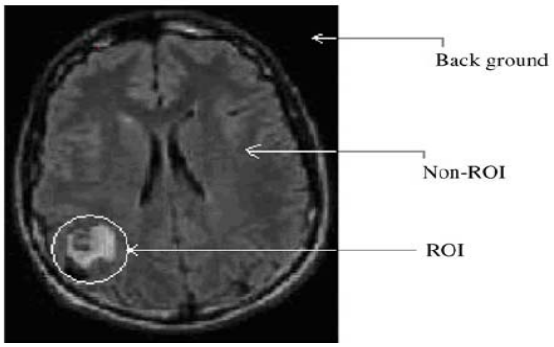

Fig 5. Segmented region of interest (ROI), Non ROI, and other background

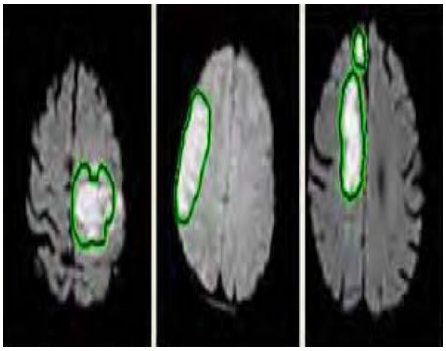

Fig 6. Edge detection and highlighted image

1) Pixel based Segmentation: Pixel based segmentation is segmentation based on the gray level value, color, intensity, texture of image or called as threshold value. This [36], [37], [38], [39] can be categorized as global threshold technique and local threshold technique. Global threshold is based on the global information such as histogram. After finding a threshold value image is segmented.

2) Region Based Segmentation: This technique is based on the neighboring pixel which is grouped as homogenous region. Region based segmentation includes Region [36], [37] Growing which is mostly used in mammography in order to extract the potential lesion from its background. In region growing methods pixels are grouped into regions. A seed pixel is chosen as a starting point from which the region iteratively grows and aggregates with neighboring pixels. Other technique which come under region based segmentation is Region Split and Merge. In this region [39] Split and Merge technique the merging and splitting of the various regions depends on threshold value, it is done on the basis of the difference in the minimum and maximum intensities of each region. If the difference between the regions is within the threshold then those regions are merged into one single region. If the difference exceeds the threshold the region is split into [40], [41] half. This mechanism is based on a quadtree structure.

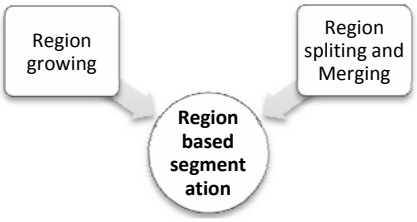

Fig 7. Types of Region based Segmentation

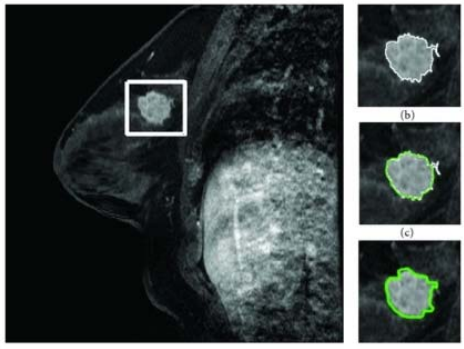

Fig 8. Region Based Segmentation of Breast

3) Fuzzy Method: Segmentation techniques are based on the features like color, texture, location but fuzzy method is proposed to extract the regular geometric shape. Fuzzy method is not used for [36] arbitrary shape. FCM (fuzzy C means) [42] algorithm, Modified Fuzzy C-Means [68], GK (Gustafson-Kessel), GMD (Gaussian Mixture Decomposition), FCV (Fuzzy C varieties) etc. Fuzzy Clustering Mean algorithm is most accepted since it can preserve much more information than other approaches.

4) Neural network based: The neural network is trained with training sample set to determine the connection and weights between nodes. The new images [36], [43] are segmented with trained neural networks. Neural network based segmentation is parallel network of processing element that simulate biological learning. This is used to segment new data using training data and it uses unsupervised method as clustering method. There are two basic steps involved in neural network based segmentation: First the extraction of features which determine the input of neural network. This [43], [44], [69] extracts some important features from images which help for segmentation. Second step is Image segmentation [45], [46], [47], [48] in which segmentation of specific region is done based on its features.

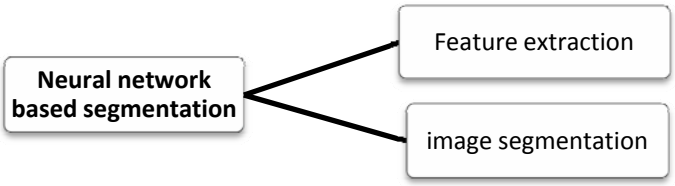

Fig 9. Neural Network Based Segmentation

5) Threshold Method: There are certain pre-processing and post-processing techniques required for threshold segmentation. Histogram thresholding is used to segment the image. Experiments and comparative analysis of techniques have shown that HDT (Histogram Dependent Technique) and EMT (Edge Maximization Technique) are the best thresholding [49] techniques which outperform all other thresholding techniques. This is a powerful technique for segmenting the image. Two methods are used in threshold method first [50] global thresholding. This global thresholding is used when there is intensity distribution between object of foreground and background. And second is local threshold. In this [51] local threshold, the image is divided into sub regions and then opt various threshold.

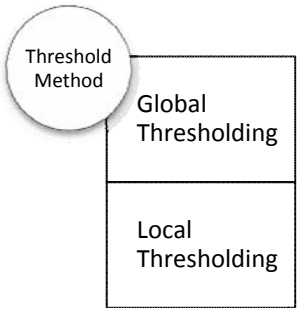

Fig 10. Threshold Method for Segmentation

6) Random Walk Method: This method is used for segmentation of breast tissue for detection of defective cells. Random Walk method works on discrete random motion in which particle moved in fixed direction. Starting point is known as seed point. When this [41], [56] seed point is detected random walk method is performed.

7) Watershed Algorithm: Watershed segmentation is gradient based segmentation technique. It solves a variety of image segmentation problems. This [52], [54] technique is mostly suitable for those images that have higher intensity value. To control the over segmentation, marker controlled watershed segmentation is used.

Table 1. Comparison of Segmentation techniques

Segmentation Techniques	Advantages	Disadvantages
Pixel Based	1. Global thresholding is simple and computationally fast. 2. Local thresholding is very useful for segmenting objects with varying background.	1. Fails when there is low contrast between object and background or if image is noisy.
Region based	1. Region growing method works best when region similarity criteria are well defined and is more immune to noise. 2. In slit and merge technique, starting segmentation do not require any homogeneity condition to be met. 3. Watershed algorithm provides closed contours.	1. Depends a lot on the seed region selection and the order of examination of pixels. 2. Resulting segments after this method appear too square because of the algorithm. 3. The risk of over segmentation is also there.
Edge based	1. Edge detection techniques are good for images which have good contrast and don't require prior knowledge about the content of the image. 2. These are computationally fast.	1. It will be cumbersome process if edges are ill defined or there are too many edges. 2. Detection of fake or weak edges further makes the segmentation worst.
Fuzzy Model	1. This method gives good results for overlapped data. 2. FCM is better than K-means method.	1. These are computationally expensive. 2. Fuzzy based segmentation method are often sensitive to outliers and initial guess of number of clusters.
Neural Network based	1. Good for solving complex problem. 2. Parallel configuration makes it possible to perform in real-time.	1. Rate of convergence is slow. 2. Requires apriori learning parameters.
Deformer based	1. These methods have less computational requirements. 2. Capable of representing complex shapes and the variability in shapes of anatomical structures.	1. If the initial snake is far from the target, then this approach doesn't work. 2. It is not fully guaranteed.

8) Clustering Technique: Clustering is unsupervised [69] learning task. In unsupervised learning no supervisor is present. In this similar [49] cluster are made and grouped together according to the similar features based on color, shape, size. Clustering Technique [49], [56], [57] include K-means cluster. This technique is used to divide iteratively in K clusters.

9) Segmentation by Morphological Algorithm: Segmentation based on Morphological is used for segmenting the boundaries of image. This algorithm includes two steps first preprocessing and second segmentation.

D. Compression

To shrink or eradicate the data redundancies which may exist when storing an image is the major focus of image compression so that the compressed image size can be minimal. Similarity of data comprise of three basic redundancies inter-pixel redundancy, psycho-visual redundancy and coding redundancy [19]. The techniques for image reduction are categorized into two such as: lossy and lossless compression. The lossy compression, some data may be diminished during the processing but the alteration level of the reconstructed image must be acceptable and cannot be recognized by human eyes [18]. Lossless compression reconstructs the image while conserving its original information to the same level as in fig 5 before the compression is operated [30], [58], [59].

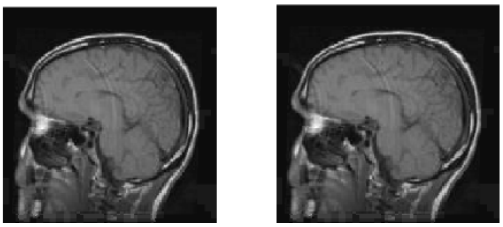

Fig 11. (a) Input Image (b) Output image

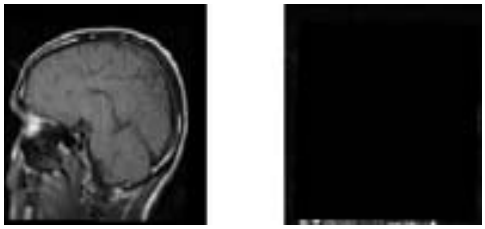

Fig 12. (a) Lossless Compression (b) Lossy compression

For the segmented region of interest (ROI) part highlighted the detected tumor part lossless compression technique is applied and for the non-region of interest part lossy compression technique is applied as in fig 6. There are many types of lossless and lossy compression techniques which can be used to compress the image. Less storage space for a compression scheme are vital functionalities that prove helpful in telemedicine application [4] .Segmented ROI is compressed with lossless version of compression technique such as Huffman, Arithmetic, RLE, LZW, ZIP, etc., while Non-ROI is compressed by SPIHT [60].

E. Retrieval of Image: Retrieval of medical images can be done in two ways text based and content based image retrieval. In text based image retrieval images are retrieved by manually text description. In content based image retrieval the images are retrieved on the basis of features such as [32], [61] texture, shape, size, colour which are derived from image.

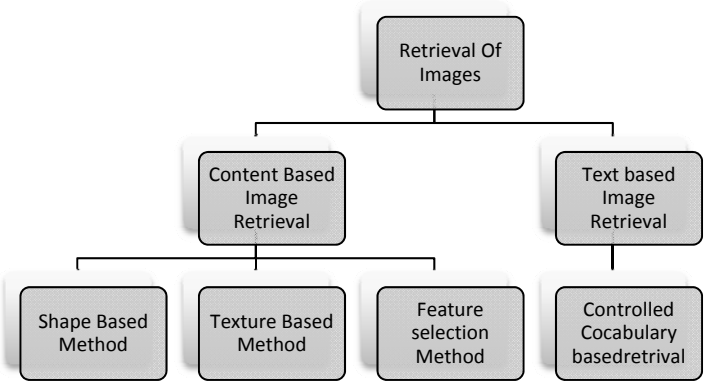

Fig 13. Classification and Method of Image Retrieval

F. Suggested Algorithm

STEP-1 Take the medical image and apply segmentation.

STEP-2 Classify them by interesting and non-interesting regions.

STEP-3 Perform manual diagnosis by highlighting the detection.

STEP-4 Edge preservation and texture enhancement for manually diagnosed pattern.

STEP-5 Compression and transmission.

STEP-6 Reception by decompression that will emphasize the diagnosed region.

G. Telemedicine

Effective delivery of telehealth services requires maintaining standards with reference to privacy, authentication, confidentiality, telecommunications, records, authorized access to patient data, encryption, guaranteed reliability, interpretability, legal obligations, multimedia applications, performance levels and security. India provides environment for an ideal setup of telemedicine industry to be implemented. Our country is distinguished by low penetration of healthcare services. The distant rural areas comparatively are less facilitated from cities and towns where 80% of secondary & tertiary healthcare facilities are provided. Basic health care facilities for rural population are highly inadequate [51], [62], [63], [64], [65], [66].

III. EXISTING RESULTS AND DISCUSSIONS

All different medical modalities contain some important information, which needs to be recognized by the user to obtain compression. Segmentation and enhancement provides a clear view for that particular region. The lossless methods are matched with region based compression methods that results better, along with preservation and enlightenment of diagnostically important information is a reason why they are recommended for telemedicine system specifically for rural area, where bandwidth of network and time both are sensitive areas to work. This study could be improving the medical images by using the various combinations of enhancements. Further this could be the work to be carried out in videos.

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