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SEGMENTATION TECHNIQUE OF CARDIAC CT IMAGES FOR MEDICAL DIAGNOSIS

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ABSTRACT

Now-a-days advancement in the technology has made healthcare industry dependent on it. As machines are more accurate than humans, using medical equipment to scan human body result in better diagnosis of critical diseases. Heart diseases are becoming very communal so preventive measures must be taken. Study of boundaries of the heart can help in diagnosis of ventricular myopathy and fat accumulation on the heart wall. Here we are relating three segmentation techniques to achieve better dissection of heart wall. By using same pre-processing we are comparing outcomes of the segmentation techniques namely active contour, region growing and Distance regularized Level set method.

Keywords - ***CT scan, Heart wall, Medical imaging, ROI***

I. INTRODUCTION

Due to the fast paced life and unhealthy life style cardiovascular diseases have become the most lethal threat to humans. Thus, early discovery and preventive medicinal action is advisable. Medical scanning is serving a lot in diagnosis of cardiovascular diseases. Doctors prefer medical imaging before planning treatment for critical disease. There are two techniques for diagnosis:

1. Manual method

2. Automatic method

Manual method is usual method using physician's perception and stethoscope. But it cannot give exact diagnosis as it depends on physician's knowledge as well as experience.

The automatic method is more efficient than rest of the methods. It uses software to detect the abnormal conditions. Reliable algorithms are required for the delineation of anatomical structures and other regions of interest (ROI).

II. LITERATURE OVERVIEW

2.1 Model Based Segmentation

Olivier Ecabert *et.al*, [1], proposed a 3-D model based approach for heart segmentation form CT image. As stated earlier, chest CT scan also contains lungs hence localization of the heart is important.

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2.1.1 Preprocessing

Prior to training, the image is processed to enhance the heart from surrounding. Image preprocessing includes image resizing up to 3.0x3.0x3.0mm^3.Thresholding is done up to +50 Hounsfield Units to permit clear difference between the heart and the surrounding. Smoothing is performed to reduce staircase boundaries obtained from thresholding. Edge detection is performed using 3x3x3 Sobel Operator. All the edges with magnitude lower than a given threshold are pruned.

2.1.2 Heart Localization

The heart localization is highly complex task due to interpatient and interphase shape variability, heart pose and location variability in the chest and variation in reconstructed field of view. Therefore very first step is localization of heart in the chest cavity. For localization they had implemented FAST 3-D Generalized Hough Transform. As patient always lie on his back in the scanner, so heart is only searched around longitudinal axis (along z axis).

2.1.3 Parametric Adaption

1. Similarity transform is used for correction of mis- alignment in translation, rotation and scaling.
2. Piecewise Affine Transformation globally resizes and deforms each part of the model to the actual patient's anatomy and phase of the cardiac cycle.

This technique was applied on 150 patients, only failure was for patient with severe aortic root aneurysm. Visual inspection by surgeons stated that model is overall robust and succeeded in segmenting the heart up to minor interactive local correction.

2.2 Localized Curve Detection Technique

V. Appia *et.al*, [2] stated a method for curve evolution using PCA. The curves are identified locally and then combined to form global segmentation. Training data for this approach consists of training shapes and associated target masks.

Level based shape prior models are used in computer vision applications like tracking, object recognition. Use of shape priors in segmentation is introduced by Coots *et.al*, [3].

2.2.1 Segmentation

In this paper they have proposed method which uses localized shape priors for segmentation. At first the image is divided into target regions by grouping part of the global shape which has highly interconnected local variations. Then weighted PCA is performed to learn shape variation in each target area. They had applied local PCA on the level set for the shape and the mask to obtain a group of shape priors and mask priors corresponding to each target mask. To represent local shape priors they had used signed distance function. Where zero level set depicts the shape or mask boundary. Positive distance indicates region inside the boundary and negative distance indicate region external to the borderline.

2.2.2 Combined Shape Evolution

Combined shape evolution is a collection of two steps first step is Initialization and next step is evolution. In initialization step, correlated target region is defined such that local regions are isolated from each other but local variations are never completely independent. Thus the combination of local segmentation curves related to each target mask has to be done.

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If the region is inside the mask then output should be 1, if the mask is shorter than desired area then output should decrease to zero and the region where mask overlaps, the hybrid level set will be the average of the overlapping level set.

In evolution step, new parameters is available thus using update equation Eigen shapes are updated. This approach focuses on local PCA for segmentation of each target region separately therefore achieves a better global segmentation.

2.3 Graph Cuts based Segmentation

In this method, authors [4] have used dual source CT scan images. Anisotropies spread algorithm for preprocessing of the images. Graph cuts are used for segmentation.

2.3.1 Preprocessing

Images either have low signal noise ratio (SNR) with good contrast, or have a low contrast with good SNR. If the SNR is minimum or the contrast is very poor then it becomes difficult to detect anatomical structures of the organs. So in medical imaging, high SNR is necessity. Therefore in this method they have used Dual source CT scan. Most of the image segmentation algorithms are highly sensitive to noise. Filtering has the ability to reduce the noise in the image. In linear spatial filtering, the content of a pixel is replaced by average brightness of its immediate neighbors. Disadvantage of this method is, it degrades sharp details of image, such as edges, lines and other fine details.

So as to preserve minute details a method proposed by Perona and Malik [5] is used. In this method they have used spread equation based on anisotropies learning towards differential method. This method strains noise and keeps details as it is .

Anisotropies spread and acquire the monotonic function of the gradient in different direction. Gradient is high in the region of edge because grey levels are changing abruptly at the edges. Pulse noise is generally present in CT image. This technique can easily remove that noise. For segmentation Graph Cut based active contour algorithm is used. Let's first know what graph cuts are.

2.3.2 Graph Cuts

A graph consists an edge, *e*, connecting two vertices, v_i and v_j, is denoted by e_{ij}. In image processing, each pixel is typically associated with a node and the nodes are joint via a four or eight-connected lattice the weight of the side is represented by *c (a, b)* or w_{ij}. Two special vertices are there those called as the source, {s} and sink, {*t*}. Through the partitioning of all the vertices, the image can be segmented, as we can say it sets each pixel in the image as a node, and reset a virtual source and sink. The image segmentation is done by finding the minimum cost about *G*. In general, each node in the graph corresponds to a pixel in an image. The weight of the edge indicates the different characteristic or similarity between the pixels. Above theory is used to build network, make capacity that network cut correspond to visual energy function.

2.4 Extraction of Myocardial Wall from CT Images

In this paper Author have proposed a combination of segmentation algorithm for CT scan images [6].

2.4.1 Preprocessing

In preprocessing they have used cropping, resizing and filtering techniques. For Edge detection they have used Canny's Edge detector as it is one of the finest edge detectors.

2.4.2 Segmentation

For segmentation for heart wall they have use region growing algorithm. In region growing algorithm seed selection is critical task as it is used for growing homogeneous region. Active contours are also used for segmentation of left ventricle and right ventricle. For active contours mask is required here they have selected mask/window with 20 x 20. As beyond 20x 20, accuracy is sacrificed.

2.4.3 Feature Extraction

GLCM features are extracted using sliding window on the input image. In this paper window selection is important task as window is going to choose its own seeds. Myocardium is extracted after segmentation of left ventricle and right ventricle.
To classify the results they have adopted ANFIS classifier.

2.5 Automatic Heart Wall Segmentation

In this method [7], heart wall is localized as a salient component by using geometric and anatomical characteristics. Finally segmentation is achieved by applying saliency map, to find the object portion, followed by extraction of heart wall using region boundary segmentation along with expectation maximization algorithm.

2.5.1 Preprocessing

For image pre-processing they have used, Bicubic interpolation as it smoothens the image. Bicubic interpolation considers 16 pixels (4x4). The Image processed using bicubic interpolation has fewer artifacts and it conserves minute details better than collective algorithms. It improves the apparent sharpness of the image.

2.5.2 Edge Detection

Very initial contour is outlined by geometric active contour the then Neumann Boundary condition is used for boundary detection. Final outline detection is done by Active contours without edges followed by saliency mapping.

Extraction of myocardial wall is carried out by lambda-μ-sigma method. The lambda- μ-sigma method models the data, smooth the model parameters and then estimates smoothed percentiles from the model parameters. The LMS method models the entire distribution taking into account degree of skewness (L), central tendency (M) and dispersion (S). Its benefits are that, it permits calculation of *z* score as well as percentiles and allows calculation of any preferred percentile. Exact estimation of percentile from the LMS method relies on the theory that after transformation and smoothing, the variable of interest is normally distributed. Expectation minimization algorithm is an iterative algorithm for defining maximum likelihood or maximum posteriori (MAP) estimates of parameters depending on unobserved latent variables.

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2.5.3 Segmentation

Region based segmentation involves region growing by pixel aggregation, region merging, region splitting, split and merge. The main goal is to find homogeneous regions in the image. The major advantage is, region based techniques are generally better in noisy images. Region growing should fulfil the conditions of comprehensive segmentation and the maximum region homogeneity conditions.

III. PROPOSED SYSTEM

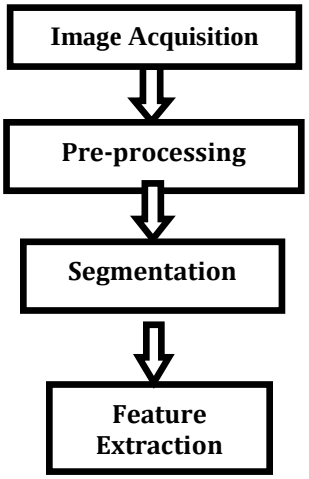

Fig 1: Block Diagram

3.1 Image Acquisition

Computed tomography is a non-invasive scanning technique. CT scan is a scanning modality which uses X-rays to obtain structural and functional information about the organs. The CT image is reconstructed image and it is reconstructed on the basis of X-ray absorption profile. X-rays are electromagnetic waves and used in diagnosis based on its property that all matters and tissues differ in their ability to absorb X-rays. Dense tissues such as the bones appear white on a CT film while soft tissues such as the brain or liver appear grey. Here we have processed CT images obtained from Vinchurkar Diagnostics Centre, Nashik.

3.2 Image Pre-processing

Pre-processing is carried out in three steps, as cardiac CT scan also includes lunges so we have to remove unwanted part.

1. Cropping
2. Resizing
3. Filtering

For Cropping we have used crop function from MATLAB. As we can receive image in any resolution so do define common frame work, we have to resize input image in 240 x 240 pixel format. Median filtering is used for image smoothing and to remove noise.

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3.3 Segmentation

The level set method for searching non uniform interfaces and shapes was introduced by Osher and Sethian [9] in 1987.

The basic idea of level set method is to show contour as the zero level set of a higher dimensional function, called as a level set function (LSF), and express the movement of the contour as the evolution of the level set function. Here we have used a new Variational level set technique in which the regularity of the level set function is inherently preserved throughout the level set evolution. The level set evolution is derivative of the gradient flow that lessens an energy functional with a distance regularization term and an external energy that pushes the motion of the zero level set toward desired locations.

IV. RESULT AND DISCUSSION

4.1 Input Image

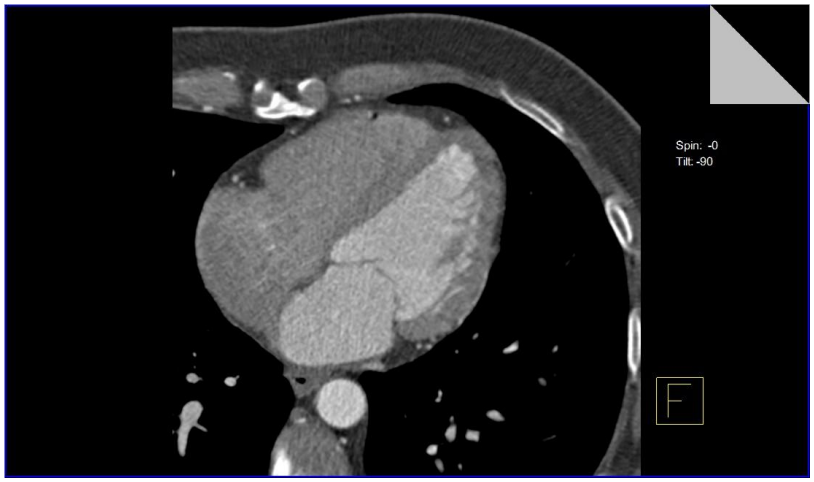

Fig. 2 : Input Image

4.2 Cropping

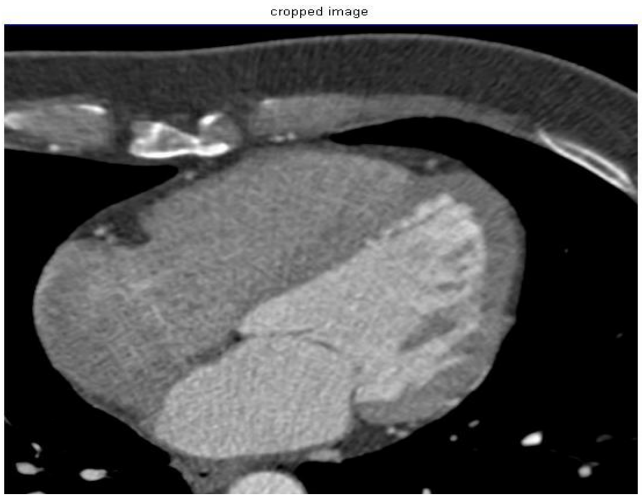

Fig. 3: Cropped Image

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4.3 Median Filtering

Fig. 4 : Result of Median Filtering

4.4 Level set method

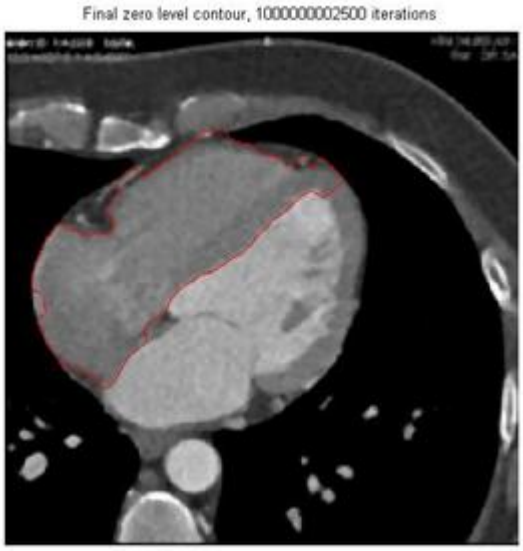

Fig.5 : Level Set Function Output

GLCM features obtained for five images are as follows,

Table 1: Features extracted from segmented images

Level set			
Contrast	Homogeneity	Correlation	Energy
0.005539338	0.997230331	0.008556472	0.757191564
0.004421061	0.99778947	0.009401003	0.802077055
0.005478137	0.997260931	0.008531425	0.768876015
0.005548054	0.997225973	0.008410175	0.757208259
0.005810217	0.997094891	0.009618836	0.757684269
0.005696533	0.997151733	0.008656012	0.751669312

V. CONCLUSION

Here we have implemented level set method for segmentation of cardiac CT images. Level set methods are highly efficient techniques for CT images segmentation due to its robust architecture. In future we will implement some more advance techniques in level set method to improve accuracy.

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