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Anterior Mitral Leaflet Ferret out in Cardiac Echo Sequences using FABC

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ABSTRACT:

The detection of Anterior Mitral Leaflet (AML) is done with the help of Echocardiography or Cardiac echo. Many resources have been available for detecting AML, and its diffused valves. The affected AML may cause the leaflets diffused and have murmuring sounds. The FABC has been introduced as latest, to find out the AML with an accurate range. FABC ha induced a mean filtering system, to eradicate noises in the images. FABC is a non-human based system, so that it doesn't need any parametric method. Results has shown in an accuracy of 98%

Key Words: Anterior Mitral Leaflet (AML), Cardiac Echo, Fuzzy Artificial Bee Colony (FABC), Intra Cardiac Masses and Mathematical Morphology

I. INTRODUCTION

Rheumatic Heart Disease is one of the serious consequences of Acute Rheumatic Fever. Acute Rheumatic Fever is the inflammatory disease that usually begins in childhood, and whose repeated episodes slowly damage the valves of the heart. Since Rheumatic Heart Disease doesnt occur after the very first attack, the early detection is considered vital to define the disease burden and to control disease progression [1, 2]. Echocardiography can play a key role by providing early evidence, since one can confirm the suspected cases (valve involvement), which can be treated accordingly [3, 4].

Remnyi et al. [4] found that the mitral valve damage was dominant with or without the involvement of other valves (aortic valve, pulmonic valve and tricuspid valve). The morphological features such as thickened leaflet, fused leaflet tips, excessive leaflet tip motion and restricted leaflet motion (hockey stick like appearance) can be evaluated using echocardiography [5]. The Paresternal Long Axis (PLA) view is the most suitable view that allows us to access the mitral valve [6]. The thickness, appearance, fused tips and motion of the anterior leaflet can be analysed in this view. To measure such feature, first we need to segment and then track the AML during the whole cardiac cycle. Kass et al. [7] introduced an iterative energy minimizing fluence of image forces and the shape is controlled by an internal constraint. This contours model is known as snakes, which provide a framework that offers automatic/semiautomatic image segmentation and motion tracking.

Later on, several shortcomings of the algorithm were found such as, initialization, convergence, etc., which motivates the researchers to propose various algorithms to improve the classical snake. Cohen et al. [8] introduce a constant force term (balloon force) in the model that drives the snake points inward/outward. The advantage of the new model is to decrease the dependence of the snake on the initialization. Williams and Shah [9] proposed a greedy snake algorithm that computes the movement of individual snake points on the image plane in a discrete way instead of computing the whole snake at once. Xu and Prince [10] proposed the use of Gradient Vector Flow energy instead of classical edge energy. Proposed energy has improved the attraction range of the classical snake and thus minimizes the dependence on initialization.

Echocardiography assessment of cardiac valves plays a vital role in the diagnosis of rheumatic heart disease. In the vast majority of cases, the mitral valve gets affected, leading to the thickening of its leaflets that may result in the fusion of their tips. This changes the appearance and reduces the mobility of the leaflets, which also reduce the heart efficiency. Quantifying such parameters provides diagnostic insight. To achieve that, the first step is to identify and then track fast moving leaflets. The existing method used Active Contour Approach for tracking AML. Active Contour Method has several disadvantages. Active Contour needs initial contour before tracking. So it is not fully automatic approach. If the user gives the inaccurate contour it leads to false tracking of AML. Not only that, it takes very long time for tracking process. So it is not suitable for video sequences. The final disadvantage is, it is noise sensitive. It produces poor performance in the noisy video sequences. To overcome these drawbacks this project develops a method Fuzzy Artificial Bee Colony for tracking AML. It performs well even in noisy inputs. It runs faster than the Fuzzy Active Contour method. It does not need any initial parameter before tracking. So this approach is fully automatic.

The remainder of the paper is organized as follows: In Section II, the overview of proposed method is presented. In Section III, the proposed method is specifically depicted, including its design idea and practical implementation approach. In Section IV, the performance of the proposed method is evaluated. Finally, conclusions are made in Section V.

II. AML TRACKING FROM ECHOCARDIOGRAPHIC IMAGES

The overall block diagram of the proposed method is shown in Fig.1. The further details of these modules are discussed below:

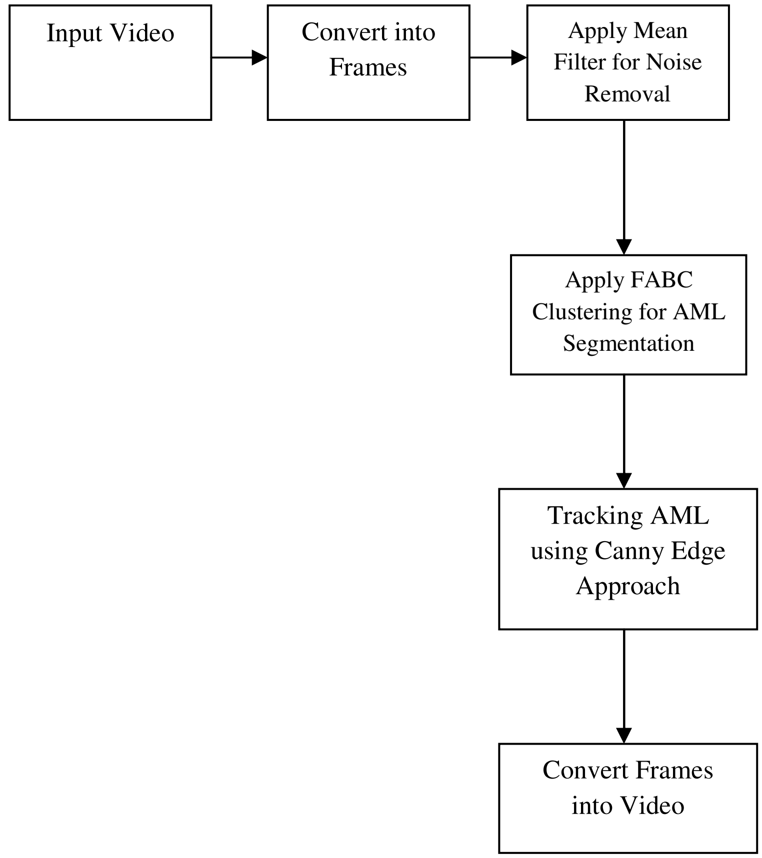


Fig. 1. Overall Block Diagram of Proposed Methods

III. AML TRACKING PROCEDURE FROM ECHOCARDIOGRAPHIC IMAGES

In this work, the echocardiography video is split into frames and we assume perfect (manual) segmentation in the very first frame. The two successive frames are iteratively selected for the analysis. The thin regions of the successive images are extracted, followed by extracting the regions with large displacement. These regions are then merged with the segmentation result of the preceding frame and filtered, in the candidate region part. Regions are then classified based on their shapes and geometrical properties. The results are finally refined using artificial bee colony approach.

A. Thin Region Extractor:

In this stage, two consecutive frames were extracted iteratively until the whole cardiac cycle was covered. For the resolution of the videos used in this paper experiments the maximum recorded thickness of the AMLwas24pixels. Following this, all structures with width less than 24 pixels of thickness are extracted as potential regions. The AML region (Figure 3C) is extracted by taking the difference between the grayscale input image (Figure 3A) and the grayscale opened image (Figure 3B) with the flat disk shape structuring element of 24 pixel diameter.

B. Displace Region:

Based on the analysis of the PLAX videos, the thin AML region shows a very large displacement in successive frames compare to other regions in an image. The regions of septum, inferior wall do not show significant displacement in successive frames and thus overlapped. This prior information is significant to overcome the problem of tracking in frames with large AML displacement.

The focus of this module is to extract region that showed large displacement from frame t-1 to frame t (Equation 1). That can simply be achieved by taking the difference of successive frames followed by selecting only the positive intensity values. Hard threshold is then applied to get the binary image.

C. Candidate Image Creation

The segmented region obtained at the time t-1 is filtered to remove the regions which belong to the blood pool (black region) in frame at time t. Filtered region is then summed up with the results of the displaced region module. Small discontinuities (with a distance of 2 pixels or less) were merged by a morphological closing using a disk shape structuring element with a radius of 2.

D. Region Classification

The regions extracted from the candidate image were classified based on the morphological features, to extract the region that is most probably the AML. The basic morphological and geometrical features such as centroid, area, major and minor axis lengths were used. These features are capable of providing significant structural and locality information. These basic morphological features do not typically change significantly in successive frames. In ideal conditions, these features should be constant throughout the cardiac cycle. The features obtained from the manual segmentation in the first frame are used as a reference for the upcoming frame. After processing each frame, the reference features are automatically updated with the average, by using the feedback channel.

A relative error matrix is created that contain four vectors: centroid distance error, area error and major/minor axis length error.

E. AML Tracking using FABC

The segmentation result of the AML was obtained through the morphological operators and was used as a base to initialize the active contour framework. The contour points of the initial curve are very close to the real boundaries of the AML. Therefore, analyzing local regions can provide robust and well defined boundaries, with a few iterations. And then FABC clustering approach is used for tracking AML. FABC is an unsupervised clustering algorithm which applies the idea of ABC to randomly search for the optimum solution that is a set of cluster centers.

IV. PERFORMANCE EVALUATION

A. Experimental Analysis:

Fig.2. Experimental Image

Fig 5 represents an echocardiogram sequences. A total of 10 clinical echocardiogram sequences were collected at the Department of Echocardiograaphy, in Arthi Scan Centre at Tirunelveli, Tamilnadu, India. These particular echocardiogram sequences were recorded by using ultrasound Imaging system like two-dimension, three-dimension & Doppler and were equipped with a transducer. Then every echocardiogram sequences were stored in AVI (Audio Video Interleave) format. The entire classification method was applied on the sequences, after they were recorded and stored by the cardiologists. After that, the concerned patients were allowed for getting surgery.

B. Performance Analysis:

There are plenty of performance metrics available for evaluating an echocardiogram sequences. This project employs the overall accuracy (ACC), the sensitivity (SEN), and the specificity (SPE), of its performance.

Overall Accuracy

Overall Accuracy is the measurement system, which measure the degree of closeness of measurement between the original AML and the detected AML by the proposed method.

$$ACC = \frac{TP}{TP + FN + FP + TN}$$

Where, TP – True Positive (equivalent with hit)

FN – False Negative (equivalent with miss)

TN – True Negative (equivalent with correct rejection)

FP – False Positive (equivalent with false alarm)

Sensitivity

The sensitivity is the fraction of retrieved instances that are relevant to the find.

$$SEN = \frac{TP}{TP + FN}$$

Where TP = True Positive (Equivalent with Hits)

FN = False Negative (equivalent with miss)

Specificity

The specificity is the fraction of relevant instances that are retrieved according to the query.

$$SPE = \frac{TP}{FP + TN}$$

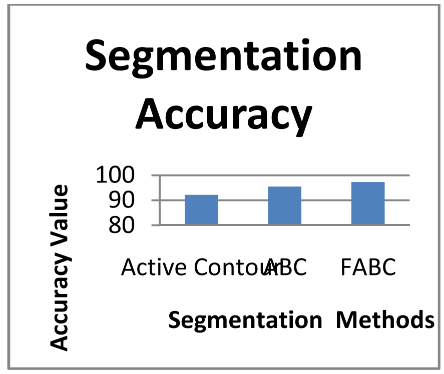
Where FP = False Positive (equivalent with false alarm)

TN = True Negative (equivalent with correct rejection)

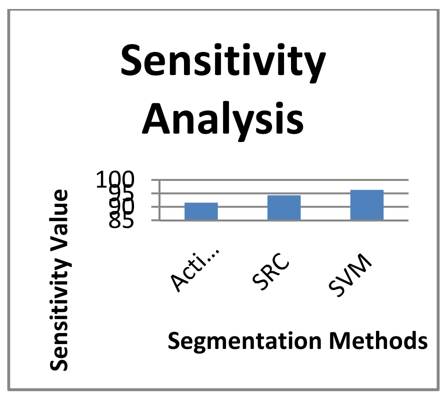
TP – True Positive (equivalent with hit)

To analysis the performance of the three methods by using the performance metrics which are mentioned above. This is shown in the below tables and graphs

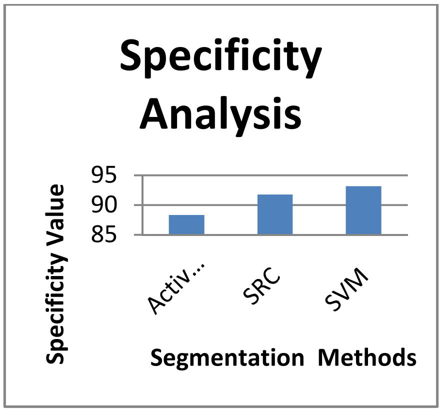
Segmentation Methods	ACC
Active Contour	92.16
ABC	95.57
FABC	97.27



Segmentation Methods	SEN
Active Contour	91.59
SRC	94.29
SVM	96.36



Segmentation Methods	SPE
Active Contour	88.36
SRC	91.8
SVM	93.15



V.CONCLUSION

In this project, a new method is proposed for the tracking of the Anterior Leaflet in Echocardiographic Sequences. Echocardiography assessment of cardiac valves plays a vital role in the diagnosis of rheumatic heart disease. In the vast majority of cases, the mitral valve gets affected, leading to the thickening of its leaflets that may result in the fusion of their tips. This changes the appearance and reduces the mobility of the leaflets, which also reduce the heart efficiency. Quantifying such parameters provides diagnostic insight. To achieve that, the first step is to identify and then track fast moving leaflets. The existing method used Fuzzy Active Contour Approach for tracking AML. Fuzzy Active Contour Method has several disadvantages. Fuzzy Active Contour needs initial contour before tracking. So it is not fully automatic approach. If the user gives the inaccurate contour it leads to false tracking of AML. Not only that, it takes very long time for tracking process. So it is not suitable for video sequences. The final disadvantage is, it is noise sensitive. It produces poor performance in the noisy video sequences. To overcome these drawbacks this project develops a method Fuzzy Artificial Bee Colony for tracking AML. It performs well even in noisy inputs. It runs faster than the Active Contour method. It does not need any initial parameter before tracking. So this approach is fully automatic.

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