ATLAS BASED MEDICAL IMAGE SEGMENTATION TECHNIQUES- A REVIEW

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ABSTRACT

Cardiac disease is the leading cause of death in the developed and developing countries. To reduce the mortality, early diagnosis is critical. Great research efforts over the last decades have been aimed at revealing the factors responsible for the reduction in function the left ventricle (LV) of the heart. CMRI is a non-invasive technique for the study of cardiac deformation. CMR can be used to study multiple aspects of the cardiac system in a single examination. These procedures rely heavily on quantative analysis techniques, such as information on the cardiac anatomy, geometric estimate of ventricular size, function, perfusion, flow and tissue characteristics, temporal behaviour of ventricular wall motion.

Keywords: MRI, CVD, LV, Atlas segmentation, Image registration

I. INTRODUCTION

Digital analysis of medical images is an exciting research area that requires a synergy between technical, engineering, and (bio-) medical disciplines. Medical image processing is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. It is the method to develop computational methods and algorithms to analyze and quantify biomedical images to support the discovery and advancement of biomedical knowledge. The quality of healthcare can only be maintained if the healthcare delivery system becomes significantly more efficient. Cardiovascular disease is the leading cause of death in the world. Recent studies suggest that risk of death in patients who have suffered heart attacks can be predicted using its medical images through magnetic resonance imaging (MRI) and various other medical imaging modalities. These check the function of the heart and examine the irregularity of the heart.

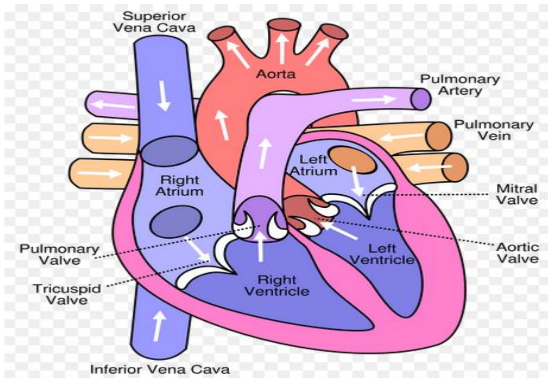

Fig 1: Heart Structure

The heart has four parts in which left and right atrium are the upper parts and left & right ventricles are the lower parts. The cardiac muscle consists of three layers. The most internal layer, i.e. the layer in contact with the blood, is called the endocardium. The most outer layer, i.e. the layer which envelopes the heart, is called the epicardium. Between the endocardium and the epicardium lays the myocardium: the muscular tissue responsible for the contraction of the heart. Systole and diastole are the two phases of one complete cardiac cycle.

Magnetic Resonance Imaging: Cardiac Magnetic Resonance Imaging (MRI) is a non-invasive imaging technique that can provide detailed anatomical and functional information of the heart. In MRI images are created using a strong magnetic field and radio frequency pulses. In this coil, placed around the chest of the patient, send and receive radio waves, produce signals that are detected by the scanner. Then, a computer processes the signals and generates a series of images, each of which shows a thin slice of the body. MRI is used to determine the extent of myocardial damage and to assess its effect on heart function, such as limited blood flow to the myocardium and scarring within the heart muscle after a heart attack. Aim of the study to propose the methods for estimation and measurement of various parameters like Left Ventricular volume measurement, detection of ischemia, object boundaries, delineate the ROI, Ejection fraction, Wall thickness etc.

II. RELATED WORK

In 2008, Xiahai et al. have proposed a new framework for locally affine registrations and a novel inverting transformation technique. These techniques use an atlas-based segmentation framework for automatic whole heart segmentations from cardiac MR images. Both the average and standard deviation of the accuracy have been improved by the locally affine registration method, compared with the single global affine registration and region-based registration [1]. Hrvoje Kalini´ presented the paper which aims guide for classification and distinction of different methods that can be used for atlas-based segmentation. The idea of this work is to use as an aid for beginners in the field while giving an overview of knowledge needed for certain problem solving [2].

2009, Z.Ningbo et al. presented some threshold segmentation, edge detection algorithms, here the Otsu algorithm and the improved Otsu algorithm were discussed. The results show that the improved Otsu algorithm can effectively improve the quality of image segmentation [4]. In 2009, Ivana et al. proposed an atlas-based segmentation method that evaluates the success of the registration between the atlas and the target image locally, and on that basis a weighted decision fusion is performed. The method was tested for segmentation of the heart and aorta in CT images. The proposed method is compared to three existing atlas-based segmentation approaches, namely 1) single atlas-based segmentation, 2) average-shape atlas-based segmentation, and 3) multi-atlas-based segmentation with averaging as decision fusion [5].

In 2010,Xiahai et at. In this paper, a multi-atlas method is proposed for cardiac magnetic resonance (MR) image segmentation. In this author proposed a patch-based label fusion model in a Bayesian framework. And registration accuracy was improved by utilizing label information, which leads to improvement of segmentation accuracy. The proposed method was evaluated on a cardiac MR image set of 28 subjects [6]. Hortense et al. presented a fully automatic method for segmenting the whole heart and cardiac chambers from 3D CTA datasets. The accuracy of method is assessed with a quantitative evaluation on 8 patient cardiac CTA datasets [7]. Van et al. have proposed two generally applicable multi-atlas segmentation methods, adaptive multi-atlas segmentation (AMAS) and adaptive local multi-atlas segmentation (ALMAS). AMAS automatically select the most appropriate atlases for a target image and automatically stops registering atlases when no further improvement is expected. The methods employed a computationally cheap atlas selection strategy, an automatic stopping criterion, and a technique to locally inspect registration results and determine how much improvement can be expected from further registrations [8].

2013,Corné et al. presented a detailed atlas and spatio-temporal statistical model of the human heart which is based on a large population of 3D+time multi-slice computed tomography sequences, and the framework for its construction. It uses spatial normalization based on non rigid image registration to synthesize a population mean image [10]. Hongzhi et al. proposed label fusion strategies, however, one limitation of most weighted voting methods is that the weights are computed independently for each atlas, without taking in to account the fact that different atlases may produce similar label errors. To address this problem, the joint label fusion technique and the corrective learning technique have been developed [11]. Albert et al. presented a that aimed to qualitatively and quantitatively assess the selection of atlases to combine in the framework of multi-atlas segmentation using 3 different manifold learning techniques. We consider Isomap, Locally Linear Embedding (LLE) and Laplacian Eigen maps (LEM) [12].

In 2014, Gerard et al. proposed a supervised learning approach to model the relationships between a pair of images (i.e. atlas and target images) and the relevance of their contribution to segmentation. In this method input is taken as a set of atlases linearly aligned to a common space, e.g., a template image [15]. In 2014,Martin et al. propose a novel multi-region image segmentation approach to extract myocardial scar tissue from 3-D whole-heart cardiac late-enhancement magnetic resonance images in an interactive manner. A graphical user interface has been developed to initialize a fast max-flow-based segmentation algorithm and segment car accurately with progressive interaction [16]. Liangjia et al. proposed a complete system in their paper for an automatic segmentation of the left ventricular myocardium from cardiac computed tomography (CT) images using the shape information from images to be segmented. The system followed a coarse-to-fine strategy by first localizing the left ventricle and then deforming the myocardial surfaces of the left ventricle to refine the segmentation [17]. Guanyu et al. presented method that mainly based on an accurate multi-atlas registration method. First of all multi-atlas registration method has been improved which was presented by Kirişli et al. by adding an extra registration step. a two-stage framework used which was based on multi-atlas registration to segment the LV in the 4D sequence[18].

III. SUMMARY

In this paper, different image segmentation techniques have been discussed . Research in the segmentation of medical images will strive towards improving the accuracy, precision, and computational speed of segmentation methods, as well as reducing the amount of manual interaction.

IV. REFERENCES

[1] An Atlas-Based Segmentation Propagation Framework Using Locally Affine Registration – Application to Automatic Whole Heart Segmentation Xiahai Zhuang,Kawal Rhode, Simon Arridge, Reza Razavi, Derek Hill, David Hawkes, and Sebastien Ourselin, D. Metaxas et al. Springer-Verlag Berlin Heidelberg 2008, pp. 425–433.

[2] Atlas-based image segmentation: A Survey Hrvoje Kalinic´ Department of Electronic Systems and Information Processing.

[3] Automated Detection of Regional Wall motion Abnormalities Based on a Statistical Model Applied to Multislice Short Axis Cardiac MR Image Avan Suinesiaputra, Alejendro F.Frangi, Theodrous A.M. Kaandrop, Hilido

J.Lamb,Jeroen, J.Bax,Johan H.C.Rieber,Boudewijn P.F.Lelieveldt. *IEEE Transaction on Medical Imaging*, VOL.28, NO.04 November 2009.

[4] A fast 2d otsu thresholding algorithm based on improved histogram Z. Ningbo, W. Gang, Y. Gaobo, and D. Weiming, in Pattern Recognition, 2009, pp. 1–5.

[5] Multi-Atlas-Based Segmentation With Local Decision Fusion—Application to Cardiac and Aortic Segmentation in CT Scans Ivana Iˇsgum*, Marius Staring, Annemarieke Rutten, Mathias Prokop, Max A. Viergever, and Bram van Ginneken, *IEEE Transaction on Medical Imaging*, VOL. 28, NO. 7, JULY 2009.

[6] Registration-Based Propagation Framework for Automatic Whole Heart Segmentation of Cardiac MRI Xiahai Zhuang, Kawal S. Rhode, Reza S. Razavi, David J. Hawkes, and Sebastien Ourselin *IEEE Transaction on Medical Imaging*, VOL. 29, NO. 9, SEPTEMBER 2010.

[7] Fully automatic cardiac segmentation from 3d cta data: a multiatlas based approach in SPIE Medical Imaging.H. Kirisli, M. Schaap, S. Klein, L. Neefjes, A. Weustink, T. van Walsum, and W. Niessen, 2010.

[8] Adaptive local multi-atlas segmentation: Application to the heart and the caudate nucleus (Article) van rikxroot, E.M., Isgum I, Arzhaeva Y.,Staring, M, Klien S, Viergever, M. A.,Pluim, P.W. van Ginneken Volume 14, Issue 1, February 2010, Pages 39-49.

[9] Medical Image Segmentation Methodologies-A Classified Overview, V.C.Chijindu,H.C. Inyiama,G.UzedheAfrican Journal of Computing & ICT ISSN 2006-1781 IEEE 2012.

[10] A High-Resolution Atlas and Statistical Model of the Human Heart From Multislice CT Corné Hoogendoorn, Nicolas Duchateau, Damián Sánchez-Quintana, Tristan Whitmarsh, Federico M. Sukno,Mathieu De Craene, Karim Lekadir, and Alejandro F. Frangi, *IEEE Transaction on Medical Imaging*, VOL. 32, NO. 1, JANUARY 2013.

[11] Hongzhi and Paul multi-atlas segmentation with joint label fusion and corrective learning—an open source implementation published: 22November 2013.

[12] Using Manifold Learning for Atlas Selection in Multi Atlas Segmentation Albert K. Hoang Duc, Marc Modat, Kelvin K. Leung, M. Jorge Cardoso, Josephine Barnes2, Timor Kadir, Se´bastien Ourselin, 2013.

[13] D.R. Chittajallu S.K. Shah I.A. Kakadiaris A Shape-Driven MRF Model for the Segmentation of Organs in Medical Images IEEE. 2013.

[14] M. C. Grebol, "Atlas-based Segmentation of Multiple Sclerosis Lesions in Magnetic Resonance Imaging" PhD Thesis, University of Girona, Spain, 2013.

[15] Learning-Based Atlas Selection for Multiple-Atlas Segmentation Gerard Sanroma,

Guorong Wu, Yaozong Gao, Dinggang Shen Department of Radiology and BRIC,IEEE.2013.

[16] Interactive Hierarchical-Flow Segmentation of Scar Tissue From Late-Enhancement Cardiac MR Images Martin Rajchl, Jing Yuan, James A. White, Eranga Ukwatta, John Stirrat, Cyrus M. S. Nambakhsh, Feng P. Li, and Terry M. Peters, *IEEE Transaction on Medical Imaging*, VOL. 33, NO. 1, 2014.

[17] A Complete System for Automatic Extraction of Left Ventricular Myocardium From CT Images Using Shape Segmentation and Contour Evolution Liangjia Zhu, Yi Gao, Vikram Appia, Anthony Yezzi, Chesnal Arepalli, Tracy Faber, Arthur Stillman, and Allen Tannenbaum, *IEEE Transaction on Medical Imaging*, VOL. 23, NO. 3 MARCH 2014.

[18] Automatic Left Ventricle Segmentation Based on Multi Atlas Registration in 4D CT Images Guanyu Yang, Yang Chen, Lijun Tang, Huazhong Shu, Christine 5978-1-4673-1961-4/14 IEEE.2014.

[19]http://cdn.medicexchange.com/images/whitepaper/ge-quantitative-analysis-overview.pdf

[20] http://www.imageanalysis.org.uk/

[21] http://www.ncbi.nlm.nih.gov/