MRI IMAGE REGISTRATION BASED SEGMENTATION FRAMEWORK FOR WHOLE HEART

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Abstract

Magnetic resonance (MR) imaging has proven successful and very important in determining patient's internal morphology. Segmentation of whole heart helps in providing important morphological information of the heart, that is helpful in various clinical applications. To avoid inter-and intra-observer variations of manual delineation, it's extremely necessary to implement a technique for automatic segmentation of the full heart. However automating process is complicated by the large shape variation of the heart and limited quality of the data. The main aim of this framework is to develop automatic and robust segmentation framework from cardiac MRI while overcoming these difficulties. This paper, introduces a registration framework ready to preserve the topology and to alter the big form variability of the heart. The core of our framework relies on two contributions extending this segmentation-propagation frameworks, namely a locally Affine Registration technique (LARM) a new algorithm has been proposed for inverting the transformation based on Dynamic re-sampling And distance Weighting interpolation (DRAW) and a non-rigid registration i.e. free-form deformations with adaptive management of the status of every point(ACPS FFDs) which achieves one to one mapping . Thus the Registered cardiac image can be further segmented to get the optimized results.

Keywords*—Cardiac images, distance weighting interpolation, free-form deformations with adaptive control points, locally affine registration technique*

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1. INTRODUCTION

Medical Imaging and image computing plays a vital role in medical science. Cardiac imaging and CT square measures are progressively used for functional analysis in daily clinical observation. Functional analysis of the heart is essential to know whether it is functioning properly or not. In the past few decades, the provision of morphological and pathological information from medical imaging has made revolutionary impacts in healthcare. Among the diverse imaging modalities, magnetic resonance imaging (MRI) is increasing in popularity owing to its recent technical improvement that enables fast three-dimensional (3D) imaging. With the ability to provide good contrast between soft tissues and a wide field of view (FOV), cardiac MRI provides clear only few researchers have proposed the segmentation of whole heart. This paper uses a registration method for the accurate segmentation that uses two accurate method i.e. Locally affine technique and free form deformation that provides optimized results. Each modalities yield dynamic 3D image knowledge sets. With CT, pictures square measure non-inheritable in associate axial orientation and for functional analysis, typically short-axis (SA) views square measure reconstructed from the axial image knowledge. With MRI, pictures are often non-inheritable in any abstraction orientation. Normally used orientations square measure short-axis and long-axis (LA) views (2-chamber and 4-chamber), and radial stacks. The Storm Troops acquisitions incorporates a full stack of usually 8 to 12 (parallel) slices covering the heart from apex to base. However, there's associate ongoing discussion on potential improvement of useful measurements by victimization LA views or radially scanned long-axis (RAD) image slices, since they seem to give higher volume quantification because of higher definition of the apex and base. Recent work has shown that integration of previous information into medical image segmentation ways is important for strong performance. Several recent methods utilize a applied math form model, and also the seminal work of Coots on second Active form Models (ASMs)- and Active look Models (AAMs) has impressed the event of 3D ASMs, 3D AAMs, 3D Spherical Harmonics (SPHARM), 3D applied math Deformation Models (SDMs) and 3D medial representations (m-reps). However, of these applied math models square measure solely applicable to densely sampled 3D volume knowledge, as a result of the modeling mechanism is either supported a dense meter registration or the matching mechanism relies on a dense set of updates on the model surface. Thus they usually assume a close to identical resolution and parallel image planes. Over the various vary of imaging modalities, functional resonance imaging (MRI) is a distinctive technique that is radiation free and may provide clear anatomy of the heart. Extracting the anatomical information is that the essential step for the event of clinical applications, and getting consistent and unbiased quantitative measurement of the anatomy is so of central importance for the success of those applications. To avoid inter- and intra-observer variations of manual delineation, it is extremely fascinating to develop associate automatic method for the segmentation of the full heart of cardiac image. This has been the main focus of many analysis teams. However, only some studies bestowed whole heart segmentation, while the majority investigated the segmentation of the ventricles of the heart solely. Within the following section, we are going to review the state of the art and provide the motivation for developing a completely unique approach overcoming these limitations.

2. LITERATURE SURVEY

In this section we represent the various methods for heart segmentation.

X. Zhuang proposed a method for the segmentation of the whole heart through registration method that provides accuracy[1].Two methods i.e. Locally affine method and free form deformation helps us to get the optimized results.

J. S. Suri addressed the segmentation of left ventricle and introduced computer vision pattern recognition[2].This consists of the model based segmentation techniques for left ventricle modelling V. Jarvinen et al. [3] Performed Five segmentations were: two manual resultant segmentations by the researchers, segmentation i.e. performed automatically, and the remaining two segmentations where a user was allowed to correct errors in the automatic segmentation for 2 minutes and without time limits. Some measures evaluate the segmentation quality i.e. volumetric, visual scaling and distance measures.

U. Kurkure has proposed a novel method for segmentation of left ventricle and its localization[4].The method combines texture and intensity based fuzzy affinity maps acquired through novel multiclass and multifeature fuzzy method for the volumetric and complete cardiac cardiac analysis, accurate dilenation of the left ventricular myocardial boundaries is necessary.

G. Hautvast [5] introduced a new technology for automatic contour propagation in cardiac MRI. The technique consists of contour models which helps to maintain a fixed contour environment by matching gray values in the contour. To get the optimized results the constant position should be maintained by contours with respect to the neighboring anatomical structures. This is essential in cardiac images because the contours adjacent to the papillary muscle is not defined by the local image features. Various parameters is influenced by the accuracy of the method. The technique has been applied to number of cardiac images. The optimization procedure was performed for each contour in each view.

H. Van Assen et al [6] a new technology (cramps) Cardiac MRI image data sets with arbitrary inclination, and under sampled regions consisting of multiple planes with the automatic partition based on a 3D-ASM. run a two-stage model of historical posts Upgrade. First, close to the intersections with historical images are updating positions, that such models of entire sites are new to place second, updated information is propagated to the image information, without areas. Feature point detection based on fuzzy C-means clustering is performed by a fuzzy inference system on a computer cluster and computational model parameters; loading were customized by distributed grid computing.

3. PROPOSED APPROACH FRAMEWORK AND DESIGN

3.1 Problem Definition

The propagation assumes that the correspondence of boundary points should be optimal after the deformable adaptation. However, this adaptation does not guarantee a true anatomical correspondence if the surfaces of the model and the unseen image have not been closely initialised. So initilazation is an important issue in this framework. Clinical data usually have noise, artefacts, and intensity inhomogeneity, which are collectively referred to as intensity inconsistencies. The driving forces used to deform the surfaces of the model should be robust against these intensity inconsistencies. It is desirable that the propagation from the model to the unseen image is a one-to-one mapping, namely a diffeomorphic segmentation. Without the diffeomorphism, the topology of the heart may no longer be preserved, and this may lead to errors such as two or more surfaces intersecting each other. To overcome all these limitations an alternative framework is to propagate a pre-constructed atlas image to unseen images using image registration techniques. Intensity-based registration makes full use of the global intensity information from the registration images, such as mutual information (MI) or normalised mutual information (NMI), which have been shown to be robust against noise and different intensity distributions. For the initialisation issue, we propose a new locally affine registration method (LARM) which globally deforms the image but locally preserves the shapes of substructures of the heart. With the initialisation from LARM, we then further propose a new nonrigid registration approach which adaptively sets the control point status of a free-form deformation grid, referred to as ACPS FFD registration. Both LARM and ACPS FFD registration are designed to be diffeomorphic. For the sufficient information issue, first of all we guarantee that the registration algorithms used in the whole heart segmentation framework, including LARM and ACPS FFD registration, should keep the global intensity information. We then investigate the problem of the entropy-based nonrigid registration and propose to encode the spatial information in the registration. A unified framework of spatial information encoding is then proposed and a nonrigid registration method, the spatial information encoded mutual information is developed. We propose a registration-based segmentation propagation framework for cardiac MRI and validate the method using a test set which represents a large diversity and variation of morphologies and involves a variety of pathologies. At the same time, a generic method, which is required in the segmentation framework, is proposed to invert dense displacements to produce the inverse transformation of a registration result. In this work atlas image is used as reference image which is used in the registration framework and thus help us to get the required results. The registered image is further segmented by using a standard method to get the segmented image of the heart which could be helpful for us to detect whether there is any functional abnormality in the normal functioning of the heart,

3.2 Proposed Architecture and Design

The architecture diagram figure 1 shows the proposed system. In this the image to be segmented is applied as an input, then further global affine and local affine transformation is used to globalize and localize the heart then inverse transformation is performed to obtain the desired results, further computation is performed using Free form deformation method to get the resultant transformation and to get enough accuracy and finally we generate the segmentation to get the heart segmented into seven basic regions i.e ventricles, atrium, myocardium pulmonary artery and the aorta.

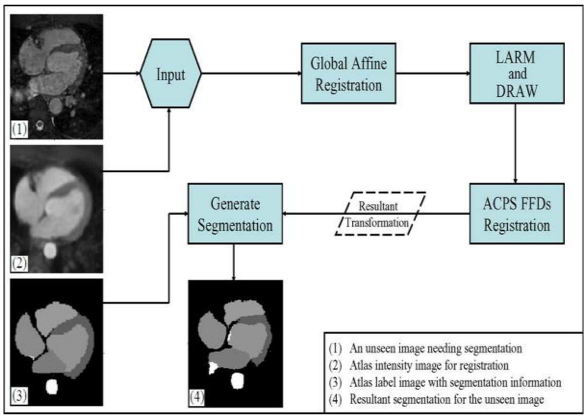

Fig. 1: Proposed System architecture

3.3 Algorithm: Proposed LARM algorithm

Input:
Global transformation, $F(x) = T \circ G$ and
$T = T_m \circ T_{m-1} \circ \ldots \circ T_1$, Optimize Global affine G
Optimize local affine G_i to T_m,

Process:
1. for each optimization step Compute derivative

$$\frac{\partial H}{\partial \theta_i} \approx F_{\Omega}^{\theta_i} = -\sum_{l,k} \frac{\partial P_{\ddot{\Omega}}}{\partial \theta_i}(1 + \log(p(l,k))) \quad (1)$$

Where $(1 + \log(p(l,k))$ = preserving the global intensity linkage, it is constant for the transformation parameters. $\frac{\partial P_{\ddot{\Omega}}}{\partial \theta_i}$ is transformation parameter. Ω is volume.

2. for Regularization Compute overlap correction

$$V_i = G_i^{-1}(G_i(V_i) - \oplus L(R_{ij}))$$

$$= V_i - G_i^{-1}(\oplus L(R_{ij}) \ (2)$$

$where$ $\{Vi\}$=set of predefine local region which have minimal distance between each other. $\{Gi\}$=set of the assigned local affine transformations.$R_{ij} = \cup_{i \neq j} (G_i(V_i))$ =the volume of other local regions that V_i should not overlap after transformations. $\oplus L$ is the morphology dilation with length.

$$if(|V_i| = 0)then$$

$$end\ registration$$

$$end\ if$$

$$else$$

Recomputed distance transformation of V_i as

$$\mathcal{W}_i(x) = \frac{1/d_i(x)^e}{\sum_{i=1}^{n} 1/d_i(x)^e} \ (3)$$

$where, e$ controls the locality of affine transformations. $\mathcal{W}_i(x)$=a normalized weighting factor related to the distance $d_i(x)$ between point x and regionV_i.

$$end\ else$$

$$if(MIN(\det(JT_m)) < 0.5), then$$

$$T = T_{m+1} + 1 \circ T \ and \ m = m + 1 \ (4)$$

$$end\ if$$

3. $end\ for$

4. $end\ for$

4. WORK DONE

In this section the practical environment, scenarios, performance metrics is being discussed

4.1 Input

For experiments we use dataset of cardiac MRI heart images.

4.2 Hardware and Software Configuration

Hardware Requirements:
Processor : Pentium IV 2.6 GHz
Ram : 512 MB DD RAM
Monitor : 15" COLOR
Hard Disk : 20 GB

Software Requirements:
Front End : Matlab
Tools Used : Matlab 2012
Operating System: Windows 7/8

4.3 Matrix Computation

Results are compute using the rms error; the mean error, the standard deviation, and the percentage of error ranges are presented [1].

4.4 Results of Work Done

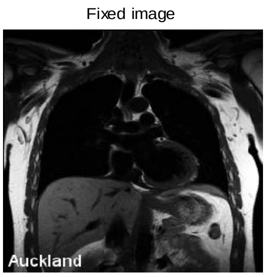

Fig. 2: Input Image 1

The first input is the unseen image the image which we want to segment

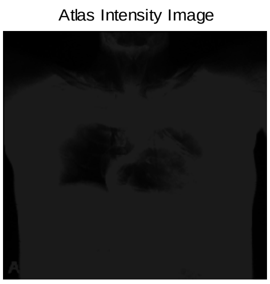

Fig. 3: Input Image 2

The second image is the atlas intensity image which is the reference image that is used in the registration framework. It is created by taking the meant of the cardiac MRI images of the healthy volunteers

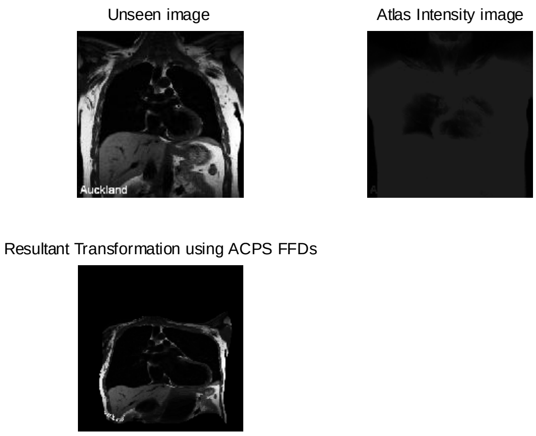

Fig. 4: Transformation result

Thus the image is registerd using registration framework which includes LARM(locally affine registration method) and ACPS FFD method which achieves one to one mapping to get the optimized registerd image which could be further segmented

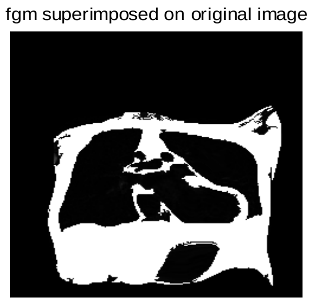

Fig. 5: Image Registration result

Fig 5 shows the resultant registered image which can be further segmented to get the desired output.

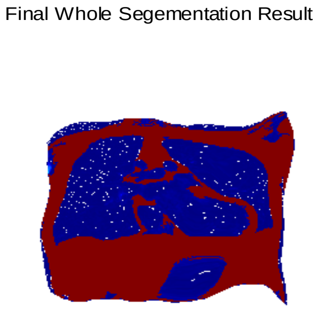

Fig.6 Segmented image

Fig 6 shows the segmented output which is achieved by using watershed algorithm after the registration process. This figure shows the segmented image of the heart which could be further used to get the knowledge that whether the heart is functioning normally or not and can be further used for diagnosis of any of the diseases by calculating the eccentricity, area, volume and perimeter of the segmented heart region and then comparing it with the standard dataset of the healthy volunteer we could obtain the abnormalities in the functioning of the heart.

5. CONCLUSIONS AND FUTURE WORK

In this paper, a registration based integrated framework for heart image segmentation and Disease detection is presented. LARM is applied to obtain robust initialization of substructure of heart (Four chambers and major vessels), and after the initialization, ACPS FFD registration is used to refine the local detail. This scheme makes advantageous use of prior knowledge to adaptively associate each control point in the FFDs with a status, active or passive, extending the nonuniform FFDs. This contributes to avoiding the *myocardial leaking*, meaning the epicardium of the atlas is mapped to adjacent tissues of the epicardium in the unseen image i.e one to one mapping is achieved between the two images. Atlas framework which is used can overcome various limitations and could achieve proper initialization and diffeomorphism which could be further helpful to get the accurate results. The properly registered image is further being segmented to get the required segmentation of whole heart and its results when compared with the other segmentation techniques are accurate due to the registration framework. The results could be further used in detecting the diseases by performing various computation on the obtained results.

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