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A Review on Label Image Constrained Multiatlas Selection

Ms. VAIBHAVI NANDKUMAR JAGTAP[1], Mr. SANTOSH D. KALE[2]

[1]PG Scholar , Department of Electronics and Telecommunication, SVPM College of Engineering, Malegaon (BK), Maharashtra, India.

[2]Assistant Professor , Department of Electronics and Telecommunication, SVPM College of Engineering, Malegaon (BK), Maharashtra, India.

Abstract: *Multiatlas selection method is a powerful and frequently used for medical image segmentation when a standard atlas is available. In recent era of image segmentation manifold ranking based methods are very useful. Magnetic resonance imaging (MRI) provides an attractive way for confined mapping of the anatomical structure of the thing. In multiatlas based image segmentation, the two key factors affecting the performance are atlas selection and combination. It is difficult to receive the correct atlas selection result due to prostate structure in raw images. In this paper we try to solve the problem of manual segmentation by proposing a new approach for MRI image segmentation using multiatlas selection method which is automatic method useful for diagnosis of prostate.*

***Keywords*: Atlas selection, computer vision, normalization, image segmentation, manifold ranking.**

1. INTRODUCTION

In American men the second cause of death is prostate cancer. The existing methods are effective in some cases; automated segmentation of prostate MR image is still very challenging due to the unclear boundary information in some areas. Atlas-based segmentation has become a standard method for automatically labeling regions of interest (ROIs) on MR brain images. In the method of atlas-based segmentation, the atlas is registered to the individual brain image by discovering the best spatial alteration, and then mapping the structural information in the atlas on the individual brain image.

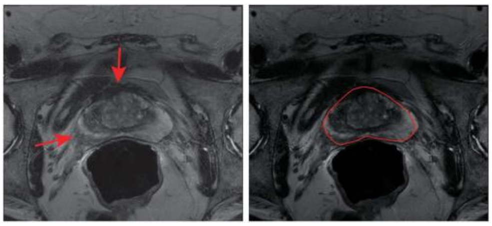

Fig.1. [1] Left: original MRI image with two red arrows to demonstrate the weak border.
Right: prostate segmentation detected by an expert with red curve.

Fig.1 shows the red curve in the MR image on the right is a segmentation of the prostate detected by an expert. It can be seen that the boundary is very weak in the areas indicated in the original MR image by the two red arrows in the left of Fig. 1. Experts fragment these areas mainly according to their knowledge of the anatomical structure of the prostate. Therefore, it is important to use the anatomical knowledge in the automated methods. The atlas essentially depicts the shapes and locations of anatomical structures and together with the spatial relationships between them. Thus, atlas based segmentation is one of the most common techniques applied to the automatic segmentation of the prostate MRI image. Generally, an atlas consists of a raw image and label image. In the process of multiatlas selection method, each atlas is first registered to the target image, which will generate deformed atlas that close to the image to be segmented. Based on certain of selection criteria a subset of atlases is selected from the deformed atlases. Finally, the selected atlases are combined into a single binary template for segmentation. The approach of atlas selection is one of the most vital factors affecting the correctness of segmentation in all the three steps of multiatlas based method. Besides that, atlas combination is another important ingredient, where assigning the proper weight for each selected atlas is a crucial factor.

2. RELATED WORKS

2.1 LITERATURE SURVEY:

A. LEAP: Learning embeddings for atlas propagation, R. Wolz, P. Aljabar, J. Hajnal, A. Hammers, and D. Rueckert,[2] proposed a novel framework for the automatic propagation of a set of manually labeled brain atlases to a diverse set of images of a population of subjects. A manifold is learned from a coordinate system embedding that allows the identification of neighborhoods which contain images that are similar based on a chosen criterion. Within the new coordinate system, the initial set of atlases is propagated to all images through a succession of multi-atlas segmentation steps. This breaks the problem of registering images that are very "dissimilar" down into a problem of registering a series of images that are "similar". At the same time, it allows the potentially large deformation between the images to be modeled as a sequence of several smaller deformations.

B. Construction and validation of mean shape atlas templates for atlas-based brain image segmentation, Q. Wang,[3] evaluate different schemes for constructing a mean shape anatomical atlas for atlas-based segmentation of MR brain images. Atlas construction and atlas based segmentation are performed by non-rigid intensity-based registration using a viscous fluid deformation model with parameters that were optimally tuned for this particular task. Firstly, other atlas construction schemes could have been included. In for instance, a mean shape template was constructed for the bee brain by first performing an affine registration of all images to a common reference image, followed by non-rigid warping of the same set of images to the intensity averaged image obtained after affine registration. This process was iterated until convergence using the average brain from a previous iteration as template. However, for human brain images that show substantial inter-subject variability, the averaging of affinely co-registered images introduces significant blurring that is likely to affect the accuracy of subsequent NRR steps. The segmentation performance of each atlas scheme is evaluated on the same database using a leave-one-out approach and measured by the volume overlap of corresponding regions in the ground truth manual segmentation and the warped atlas label image.

C. Manifold learning for biomarker discovery in MR imaging, R. Wolz, P. Aljabar, J. Hajnal, and D. Rueckert,[4] presented a method for deriving biomarkers from low-dimensional manifolds which are learned from variations in inter-subject appearance in a dataset at baseline and from intra-subject changes over time. Laplacian eigen maps were used to nonlinearly embed images based on pair-wise similarities. In the embedded space, we estimated a separating hyper plane from labeled images to classify test data into groups of clinical interest. Applying the framework to similarities based on a region of interest (ROI) around the hippocampus in images taken from a large, multi-center AD study (ADNI) leads to classification results as good as those obtained from automatically determined hippocampal volume and atrophy. They have proposed a fast and robust alternative to classify subjects that is generic, data-driven and easy to extend to different structures or areas in the brain without the need for complex priors. The embedding of subjects in a continuous manifold space, however, allows an application beyond classification. In particular, the correlation between clinical variables and subjects' condition with coordinates in the embedded space needs to be further investigated to potentially explore other ways of inferring a subject's state.

D. Optimum template selection for atlas-based segmentation, Minjie Wu,CaterinaRosano,Pilar Lopez-Garcia,Cameron S. Carter,and Howard J. Aizensteind,[5] addressed atlas selection with a different approach: instead of choosing a fixed brain atlas, we use a family of brain templates for atlas-based segmentation. For each subject and each region, the template selection method automatically chooses the 'best' template with the highest local registration accuracy, based on normalized mutual information. The region classification performances of the template selection method and the single template method were quantified by the overlap ratios (ORs) and intra class correlation coefficients (ICCs) between the manual tracings and the respective automated labeled results.

2.2 PROPOSED SYSTEM

Proposed system is based on the idea to constrain the computation of the affinity matrix of raw images to employ label images in constructing the lower-dimensional manifold space, as shown in Fig. 2(b).

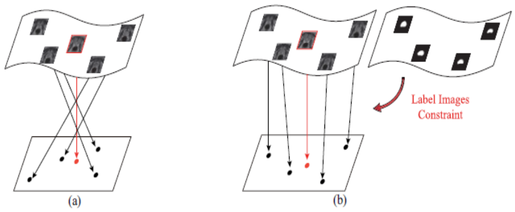

Fig. 2. [1] (a) Misleading manifold projection due to the influence of other anatomical structures in raw images. (b) Manifold projection constrained by the label images to reduce the influence and preserve the neighborhood structure.

When learning the manifold ranking the region of interest information from the label images is exploited together with the raw images. The intrinsic similarity between the target regions can be exposed in the lower-dimensional manifold space due to the constraint. In this space, the atlases are closer to the test image are selected in terms of the regions of interest (ROI), and then the final fused atlas template can recover the performance of the segmentation.

A new weight assignment method for the atlas combination is also proposed based on this manifold subspace analysis. The label images and the raw images of the selected atlases can be assumed to share an identical manifold structure in the lower-dimensional space. As a result, weight assignment for the elected label images can be measured as calculating the weights for the conversion of the data points of raw images in the manifold space. Then, the computed transformation weights can be mapped for label images for combination.

3. SYSTEM FRAMEWORK:

The block diagram of the label image constrained atlas selection method is shown in Fig.3. The proposed method consists of three main steps: registration, selection and combination. The different raw MR images of atlases within the same dynamic range is done using normalization step. After normalization, the next stage is registration that each raw image of atlases maps to the test image. In transformation stage each atlas is warped to the test image, generating the deformed atlas. The next stage is atlas selection. The atlas selection method should measure the similarity between only the regions of interest across images. Thus, manifold ranking should not only preserve the neighborhood of the original manifold of raw images, but also consider the intrinsic similarity between the regions of interest. Final step of system is segmentation.

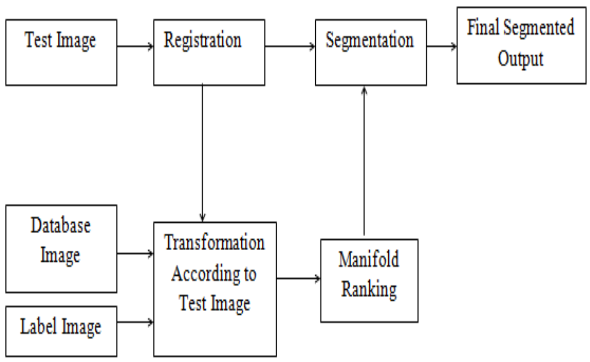

Fig.3. Block diagram of label image constrained multiatlas selection

Normalization

In image processing, normalization is a process that changes the range of pixel intensity values. Applications include photographs with poor contrast, for example due to frown. Normalization is sometimes called contrast stretching or histogram stretching. It is referred as dynamic range expansion in more common fields of data processing, such as digital signal processing. The purpose of dynamic range expansion in the various applications is usually to get the image, or new kind of signal, into a range that is familiar or usual to the intellect, hence the term normalization. Often, the motivation is to achieve consistency in dynamic series for a set of signals, data, or images to avoid mental disturbance or weakness. In order to make the different raw MR images of atlases within the same dynamic range, the classical z-score normalization is done.

Registration method

Registration is the determination of a geometrical transformation that aligns points in one view of an object with corresponding points in another view of that object or another object. Atlas-based segmentation labels the anatomical regions on individual images by registering the template image of the brain to the individual brain image. After image normalization, each normalized raw image of atlases is aligned to the normalized test image. With the parameters of transformation yielded from the alignment, each atlas is warped to the test image, generating the deformed atlas.

Atlas Selection

Ideally, the atlas selection method should measure the similarity between only the regions of interest across images. A new manifold projection method is developed by taking the label image information into account for selecting atlases on a lower-dimensional manifold for image segmentation, which has been overlooked by other existing methods. Atlas-selection is an important step affecting the accuracy of MAS. On one hand, using small subsets of atlases may produce less accurate segmentations as some related information from other atlases possibly left out. On the other hand, using large subsets of atlases may undermine the segmentation performance because of the high amount of irrelevant information introduced.

Subspace Analysis for Weighted Combination

In atlas combination step, weight assignment for the selected atlases is also an important factor affecting the segmentation performance. In this system, the weight computation is based on the lower-dimensional manifold subspace. The objective of combination is to make the result near to the ground truth as possible. Specifically, the goal is to reduce the difference between the ground truth and the combination result. The atlas combination weights are computed by solving a problem of reconstruction of data points in the manifold subspace.

3.2 ADVANTAGES

- It is an automatic method of medical image segmentation.
- This method improves the performance of atlas selection and final segmentation.
- It reduces the influence of surrounding anatomical structures in raw images.
- MAS have been successfully used in a large variety of biomedical segmentation problems

3.3 APPLICATIONS

- Biomedical segmentation problem.
- Segmentation of cortical and sub cortical regions in structural images.
- Skull stripping and tissue classification, the segmentation of tumors, eyes and optic nerves.
- Segmentation of brain MRI in animal studies.
- MAS have also been used in abdominal imaging.

4. CONCLUSION

A novel method is proposed for prostate cancer identification. In order to analyze a disease, Physicians consider MR imaging modality is the most efficient one for identification of cancer present in a variety of organs. Consequently, analysis on MR imaging is necessary for efficient disease diagnosis. In this system, we proposed a novel manifold learning based atlas selection method and a novel weight computation algorithm for atlas combination in multiatlas based segmentation. In atlas selection step, it employs the label images to constrain the manifold projection to reduce the influence of surrounding anatomical structures in raw images.

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BIOGRAPHIES

Ms. VAIBHAVI NANDKUMAR JAGTAP

Pursing Master Engineering (M.E.E&TC),

From SVPM College of Engineering Malegaon (BK).

Santosh D. Kale:- Currently working as a Assistant Professor at college of engineering, Malegaon (Bk), Baramati. He received B.E. Degree in Electronics & Telecommunication in 2001, from North Maharashtra University of Jalgaon, Maharashtra, India. He received M.Tech Degree in (Electronics Instrumentation) in Electronics & Telecommunication, from college of Engineering, Pune (COEP), India. He guided several UG & PG projects. His research area includes signal and image processing.