Improved Logismos Segmentation and Neural Network Classifiers in MRI Brain Images With Disease Diagnosis

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ABSTRACT - Automated segmentation and representation of the human cerebral cortex from magnetic resonance (MR) images play an important role in neuroscience and medicine. A wide number of magnetic resonance imaging (MRI) analysis techniques rely on brain tissue segmentation. Automated and consistent tissue classification is a challenging task since the intensity representation of the data typically does not allow a clear delimitation of the different tissue types present in a MRI. Medical image segmentation is a continuously evolving field. Due to the anatomical complexity and possible presence of pathologies, segmentation tools for general purpose tasks are difficult to derive. Implement a novel method called LOGISMOS – Layered Optimal Graph Image Segmentation of Multiple Objects and Surfaces for simultaneous segmentation of multiple interacting surfaces belonging to multiple interacting objects.

Keywords - Magnetic resonance, White matter, Grey matter, Cerebrospinal fluid

1. INTRODUCTION

Early detection and classification of brain disease is very important in clinical practice. Many researchers have anticipated dissimilar methods for the classification of brain tumors based on different sources of information. Magnetic resonance imaging (MRI) is considered the most medical images can be used for the delineation of soft tissue. MRI can help doctors to diagnose the disease as it provides important information about the anatomy, function, perfusion, and viability of the myocardium. The problem that often occurs in the use of classification techniques are disease diagnosis, credit evaluation and image recognition. Neural network is a technology that is based on such biological neural networks in humans so it can work like a human brain. FreeSurfer is a set of automated tools for reconstruction of brain’s cortical surface from overlay of functional MRI data and structural MRI data onto the reconstructed surface. FreeSurfer is used for a number of procedures including: Creation of computerized models of the brain from magnetic resonance imaging (MRI) data. Processing of functional magnetic resonance imaging (fMRI) data. Measuring a number of morphometric properties of the brain including cortical thickness and regional volumes. Intersubject averaging of structural and functional data using a procedure that aligns individuals based on their cortical folding patterns for optimal alignment of homologous neural regions.

Magnetic resonance imaging (MRI) is a test that uses a magnetic field and pulses of radio wave energy to make pictures of organs and structures inside the body. Magnetic resonance imaging (MRI) is a safe and painless test that uses a magnetic field and radio waves to produce detailed pictures of the body's organs and structures. An MRI differs from a CAT scan (also called a CT scan or a computed axial tomography scan) because it doesn't use radiation.

2. RELATED WORKS


In order to study such cortical properties in humans, it is essential to get an exact and explicit representation of the cortical surface in individual subjects. most approaches to analyzing and displaying human brain imaging data have relied exclusively upon 3-D approaches. The traditional method for reconstructing complex, folded, 2-D surfaces from thin sections was to trace contours from each section onto thin wax sheets, and then align
and stack the sheets for viewing. Intensity variations due to magnetic field inhomogeneities are corrected and a normalized intensity image is created from a high resolution, T1-weighted, anatomical 3-D MRI dataset. We use the automated Talairach registration procedure developed and distributed by the Montreal Neurological Institute to compute the transformation matrix from a high resolution T1-weighted scan taken using a short 3-D acquisition sequence.

The next step in the reconstruction process is the automated stripping of the skull from the intensity normalized image. This procedure involves deforming a tessellated ellipsoidal template into the shape of the inner surface of the skull. Another approach to cortical surface reconstruction is to deform a template using elastic transformations based on MRI intensity information to force it to conform to the shape of the cortex.

Recently, many techniques have been proposed in the computer vision literature to perform oriented filtering of noisy data as a preprocessing step to facilitate segmentation. In this paper, we have presented a set of procedures which automatically reconstruct the gray/white and pial surface of the cerebral cortex from a high resolution T1-weighted MRI dataset.

In [2] Chenyang Xu, Dzung L. Pham, Maryam E. Rettmann, Daphne N. Yu, and Jerry L. Prince et al.

In this paper we address each of these problems and describe a systematic method for obtaining a surface representation of the geometric central layer of the human cerebral cortex. Geometrically, the human cerebral cortex is a thin folded sheet of gray matter (GM) that lies inside the cerebrospinal fluid (CSF) and outside the white matter (WM) of the brain. The acquired data is preprocessed to extract the cerebral and interpolated to cubic voxels. The brain image volume is segmented into fuzzy membership functions of GM, WM, and CSF tissue classes using an adaptive segmentation algorithm that is robust to image intensity in homogeneities.

An iterative process of median filtering and is surface generation on the WM membership function produces an initial estimate of the cortical surface that is topologically correct. Our deformable surface algorithm moves this surface toward the central layer of the cortex, yielding the final reconstructed cortical surface. The first step in our method is to preprocess the image volume to remove skin, bone, fat, and other noncerebral tissue. The final step in preprocessing is to trilinearly interpolate the segmented volume to cubic voxels having the in-plane resolution in all three directions.

There has been a trend in the recent literature favoring the use of fuzzy segmentations over hard segmentations in defining anatomical structures. MR images sometimes suffer from intensity in homogeneities caused predominantly by nonuniformities in the RF field during acquisition. We have presented a method for reconstructing cortical surfaces from MR brain images. This method combines a fuzzy segmentation method, and is surface algorithm, and a new deformable surface model to reconstruct a surface representation of the cortical central layer.

In [3] Reconstruction of the Human Cerebral Cortex from Magnetic Resonance Images

Reconstructing the geometry of the human brain cortex from MR images is an important step in both brain mapping and surgical path planning applications. Due to the difficulties with imaging noise partial volume and image intensity inhomogeneities it becomes more challenging to reconstruct the cortical surfaces. Using fuzzy segmentation algorithm, the problem for reconstructing the entire cortex with correct topology is solved. In this paper they describe a systematic method for obtaining a surface representation of the geometric central layer of the human cerebral cortex such as GM, WM and CSF. The first step in our method is to preprocess the image volume to remove skin, bone, fat, and other noncerebral tissue. Fuzzy segmentations retain more information from the
original image than hard segmentations by taking into account the possibility that more than one tissue class may be present in a single voxel and needs to provide some manual intervention.

In [4] Cortical Surface Reconstruction from High-Resolution MR Brain Images

Reconstruction of the cerebral cortex from magnetic resonance (MR) images is an important step in quantitative analysis of the human brain structure, for example, in sulcal morphometry and in studies of cortical thickness. Existing cortical reconstruction approaches are typically optimized for standard resolution data and are not directly applicable to higher resolution images. A new PDE-based method is presented for the automated cortical reconstruction that is computationally efficient and scales well with grid resolution, and thus is particularly suitable for high-resolution MR images with sub millimeter voxel size. The method uses a mathematical model of a field in an inhomogeneous dielectric and readily scales with imaging resolution is highly valuable.

Limited spatial resolution of MR images, noise, intensity in-homogeneities, and partial volume effects can all be the sources of geometrical inaccuracies and topological errors in the reconstructed cortical mode.

In [5] Load: A Locally Adaptive Cortical Segmentation Algorithm

Thickness measurement of cerebral cortex can aid diagnosis and provide valuable information about the temporal evolution of diseases such as Alzheimer’s, Huntington’s and Schizophrenia. Methods that measure the thickness of the cerebral cortex rely on an accurate segmentation on MR data. But it still poses a challenge due to the presence of noise, intensity non-uniformity and limited resolution of MRI and high cortical folds. A new segmentation method with anatomical tissue priors is proposed with three post processing refinements.

Post processing steps are

- Reduce segmentation bias
- Introduction of explicit partial volume classes

A locally varying MRF based model for enhancement of sulci and gyri.

2. EXISTING SYSTEM

Medical imaging provides effective and non-invasive mapping of the anatomy of subjects. Common medical imaging modalities include X-ray, CT, ultrasound, and MRI. Medical imaging analysis is usually applied in one of two capacities: a) to gain scientific knowledge of diseases and their effect on anatomical structure in vivo, and b) as a component for diagnostics and treatment planning. MRI provides detailed images of tissues and is used for both human brain and body studies. Data obtained from MR images is used for detecting tissue deformities such as cancers and injuries. It aims to partition an image into a set of non-overlapping regions whose union is the original image.

Segmentation of brain tissues in MRI (Magnetic Resonance Imaging) images plays a crucial role in three-dimensional volume visualization, quantitative morphometric analysis and structure-function mapping for both scientific and clinical investigations.

LOGISMOS-B clustering algorithm, an unsupervised clustering technique, has been successfully used for image segmentation. Compared with hard C-Means algorithm, LOGISMOS-B is able to preserve more information from the original image. Its advantages include a straightforward implementation, fairly robust behavior, applicability to multichannel data, and the ability to model uncertainty within the data. A major disadvantage of its use in imaging applications, however, is that LOGISMOS-B does not incorporate information about spatial context, causing it to be sensitive to noise and other imaging artifacts. The pixels on an image are highly correlated, i.e. the pixels in the immediate neighborhood possess nearly the same feature data. Therefore, the spatial relationship of neighboring pixels is an important characteristic
that can be of great aid in imaging segmentation. The spatial function is the weighted summation of the membership function in the neighborhood of each pixel under consideration.

However, the standard LOGISMOS-B does not take into account spatial information, which makes it very sensitive to noise. In a standard LOGISMOS-B technique, a noisy pixel is wrongly classified because of its abnormal feature data. This project introduces an improved LOGISMOS-B algorithm for clustering by incorporating spatial information and altering the membership weighting of each cluster with weighting exponent. The proposed algorithm greatly attenuates the effect of noise and biases the algorithm toward homogeneous clustering.

2.1 Drawbacks in Existing System

- Difficult to provide accurate measurement of cortical surface thickness
- Tissue classification can’t be implemented accurately
- Accuracy in measurement of regions such as the cingulated cortex is less
- Signed error range is large

3. PROPOSED SYSTEM

In the proposed system we implemented the improved LOGISMOS-B algorithm for accurate segmentation

3.1 PRE-PROCESSING

In this module, we can upload brain images and remove noise from images for further processing. To do so we first convert the brain images into gray scale format and the noise can be removed by using wiener filter by adding and removing Gaussian noise. Then Feature extraction is done to classify the tissues such as gray matter, white matter and Cerebrospinal fluid.

3.2 GRAPH CONSTRUCTION

The LOGISMOS approach provides a framework for optimal segmentation of multiple interacting surfaces. This is achieved by modeling the problem as a complex geometric graph. Build columns of this geometric graph, based on the generalized gradient vector flows. The first step of segmentation process is by selecting the pattern of input image automatically. GGVF is dense vector field that token from image by minimizing the energy function. The minimizing energy function process is done by measuring a pair of partial differential equation which spreads gradient vector from edge map of gray-level image that measured from image. The energy in here are...
two kinds, there are internal power which comes from curve in deformation process and external power which comes from the image itself. To this end, the preliminary segmentation is converted to a triangular mesh using the marching cubes algorithm. This mesh representation of the preliminary segmentation is referred to as the “base graph” in the LOGISMOS framework. From each node of this base graph (i.e., the vertices of the triangle mesh), a “column” is built, such that the final segmentation will “choose” exactly one node from each column. Consecutive nodes within a column are connected to each other by intra-column arcs. Nodes in neighboring columns are connected to each other by inter-column arcs, which introduce hard constraints on the smoothness of the final surface.

3.3 LOGISMOS segmentation

Segmentation of brain tissue on magnetic resonance (MR) images normally determines the type of tissue present for each pixel or voxel in a 2D or 3D data set respectively, based on the information gathered from both MR images and prior knowledge of the brain. It is one of the most vital preprocessing steps in several medical research and clinical applications, such as quantification of tissue volume, visualization and analysis of anatomical structures, multimodality fusion and registration, functional brain mapping, identification of pathology, surgical planning, surgical navigation, and brain substructure segmentation [1]. Segmentation at preliminary stage is important and necessary for the analysis of medical images for computer-aided diagnosis and treatment.

Each node in the graph is assigned a cost related to the segmentation task such that a desirable segmentation has a low cost. Our cost function is based on edge strength, as defined by the first and second derivatives of image intensity. Then, LOGISMOS finds the minimum closed set of this graph, which is equivalent to the minimum-cost cut or the optimal surface segmentation. The bias corrected T1-weighted image is denoised using gradient anisotropic diffusion filtering for five iterations using the ITK implementation with the default conductance value of 1. For the white matter surface, the gradient magnitude of the T1-weighted image is used as the cost function. For the gray matter surface, a weighted sum of the first and second order derivatives of the T1-weighted image is used, as given by the gradient magnitudes.

3.4 Post processing:

LOGISMOS segmentation results contain varying amounts of brain stem and cerebellum tissue, which are removed via post-processing on the meshes. This is accomplished by creating a binary mask corresponding to the regions to be removed for each subject. To form the binary mask, cerebellar white and gray matter regions that resulted from BRAINSABC tissue classification during pre-processing are merged and morphologically closed to remove any present holes. The brain stem segmentation is obtained by mapping the atlas segmentation to the subject’s image using image registration also computed by BRAINSABC. The largest connected component in the brain stem segmentation is extracted and morphologically dilated to ensure full coverage of undesired mesh vertices. The brain stem and cerebellum segmentations thus obtained are combined together to create the binary mask to be used for post-processing.

3.5 Disease Diagnosis

Early detection and classification of brain tumors is very important in clinical practice. Many researchers have proposed different techniques for the classification of brain tumors based on different sources of information. In this module we propose a process for brain tumor classification, focusing on the analysis of Magnetic Resonance (MR) images and Magnetic Resonance Spectroscopy (MRS) data collected for patients with benign and malignant tumors. Our aim is to achieve a high accuracy in discriminating the two types of tumors through a combination of several techniques for image segmentation, feature extraction and classification. The proposed technique has the potential of assisting clinical diagnosis. So we implement neural network
techniques to find the brain diseases with improved accuracy rate.

REFERENCES