BRAIN MORPHOMETRY FOR IMAGE-BASED CLASSIFICATION OF NEURODEGENERATIVE DISEASE

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ABSTRACT

The modern tomographic imaging methods are playing very good role to detect the brain structure and function and also in understanding the way in which these changes occur during the development. The information obtained through the analysis of brain image help to differentiate the normal one. The brain diseases including Alzheimer’s Disease (AD), introduce tissue loss that is believed to be regionally specific. The functional changes can often be identified early in the disease process different diagnosis and treatment decision difficult moreover imaging based structural measurements. These more advance morphological brain changes are being explored as possible to surrogate markers of therapeutic efficiency of potential treatments to stop the progression of AD. Therefore, more advanced methods of morphometric analysis could potentially help diagnose the disease even earlier, before measurable functional loss occurs and at stage in which treatment might be more and at stage in which treatment might be more effective and may help to monitor the efficiency of interventions in clinical trials.

Keywords: Alzheimer’s Disease (AD), Gabor filter, Saliency maps, Magnetic Resonance Imaging (MRI)

1. INTRODUCTION

Image processing is a type of processing in which we extract the useful things from the image for applications. In image processing, the image is a matrix of pixels and the pixel is a small unit or element of an image. From the existing studies we can suggest neuroimaging is a tool in the initial diagnosis of neurodegenerative diseases by considering the anatomical patterns and also detecting hidden relations from structural magnetic resonance (MR) images. By analyzing structural brain MR images, a main goal is to find anatomical changes in the local or global and also the related functional disturbances in the brain. In particular, radiologists examine images by looking at distinctively regions and compare them by searching differences.

Medical imaging helps to provide a better way to understanding about a disease process that leads to discovery of potential treatments that intervene in that process. Therefore, imaging can help to provide a better way to understanding about how that medicine or treatment works at the molecular level which leads to understand the disease process and then to development of a more highly suitable medicine or drug to treat the disease.

The most common neurodegenerative diseases are Alzheimer disease (AD), Mild Cognitive Impairment (MCI), Schizophrenia. In particular, AD is the most common form of mental disorder affecting the millions of people. Alzheimer’s disease is a disease of the brain that causes problems with memory, thinking and behavior. And different types of imaging techniques are used to report the brain structure (anatomy), functions, and biochemical actions of individual neurons and also help to know about the cells functions, behavior and interaction between them. The three main categories of medical imaging are structural, functional and molecular imaging. While many imaging techniques are used throughout the body, the explanations are provided to focus on their use in the nervous system, particularly on the brain.
2. RELATED WORK

Toews et.al.,[1] has proposed Feature Based Morphmetry (FBM) technique for the discovering the different patterns of anatomical structure of the brain to detect the AD. FBM includes two steps that is extracting local image features in scale space and probabilistic modeling of features. FBM is a data-driven technique for detecting the anatomical changes in the brain pattern.

Ashburner et.al.,[2] has proposed Voxel Based Morphometry (VBM) technique for removing areas of mis-segmented non-gray matter voxels by using preprocessing to remove non brain voxels before anatomical representation and segmentation. The VBM technique compares voxel by voxel coming from the preprocessing steps to find the local differences.

Salim lahmiri et.al.,[3] has proposed automatic detection AD in brain using fractal features. Fractal Based Processing (FBP) is used to detect AD and does not require preprocessing and segmentation steps because it leads to simple implementation. This analysis provides the characterization for the brain MR images of normal one and affected by AD, it separates them into normal and abnormal signals.

Padila, Lopez, et.al.[4] has proposed NMF-SVM Based CAD Tool is used for the diagnosis of the Alzheimer’s disease (AD) based on nonnegative matrix factorization (NMF) and support vector machines (SVM). The CAD tool is used as a classifier is fed with different features. Dimensionality reduction technique is used to reduce the computational time, irrelevant information and noisy factors.

C. plant et al.,[5] has proposed multi-channel brain atrophy pattern analysis in neuroimaging retrieval. In which the high throughput 3D neuroimaging datasets are used for neuroimaging data retrieval. This technique is used for disease brain structures for neurological disorders and to increase the neuroimaging retrieval. The advantage of this approach is possibility to learn the atrophy patterns of neurological disorders.

Styner et.al.,[6] has proposed Parametric Estimate of Intensity Inhomogeneities Applied to MRI in which estimates the factors of 2D and 3D inhomogeneties of nonlinear optimization. The correction method called parametric bias field correction (PABIC) is a simple method of the imaging process, this polynomial model is used for image classification in the inhomogeneity field. This is method is used in the wide range of 2D/3D application.

Donoho et.al,[7] has proposed Uncertainty Principles and Ideal Atomic Decomposition in which evaluation of the performance of a classification algorithm by representing the highly sparse superposition of atoms. The sparse condition represents the minimum atomic decomposition. The important applications are band-limited approximation, error correction encryption and separation of uncoordinated data.

Broderson et.al.,[8] has proposed the balanced accuracy and posterior distribution which helps to evaluate the classification performance by measuring the degree of identified unseen examples and the class labels. In this approach, the generalizability key for performance evaluation of classification algorithm of given dataset. The posterior balance accuracy uses the binary classification of the different datasets which represents class in the classifier towards the more frequent classes.

John Ashburner et.al.[9] has proposed the Deformation Based Morphometry (DBM) which helps to identify the anatomical differences in the Brain image volume globally. This technique allows making conclusion about the differences in macroscopic anatomy of brain MR images. This technique helps to make out the differences in the shape and size of the different brain images.

Magnin et.al.,[10] has proposed the SVM based classification of Alzheimer’s disease for the complete magnetic resonance image to detect the disease. In this paper[10] the feature parameter is designed for classifier to detect the disease and normal. The gray scale differences in the brain structure helps to identify the pathological one.
3. PROPOSED METHOD

The proposed method is used for the extraction of brain features for the classification in structural brain MR images. This method is based on visual saliency method that combines fusion and learning approach. In this paper, the proposed method consists of four modules for the brain morphometry. The graphical representation of the proposed method is depicted in the figure 1.

A. Saliencey map calculation

Calculation of saliency maps starts by extracting the features of the brain image volume, which is the scale and feature. The Gabor filters are used for calculating the saliency maps. The Gabor filter is used to calculate the similarity and dissimilarity between the regions of the brain pattern and consider the unique values for the further classification.

B. Fusion

This method provides the set of saliency maps for a volume which consists of different scales and different types features. After calculating the saliency maps, saliency models uses different types of methods for fusion of set of saliency maps which corresponding to different features. A common approach to calculate the overall saliency map is to weight the maps. Finally, the saliency is stored in the different kernels.

C. Learning

The learning module is used to adapt the framework of the fusion module to represent the features in the different saliency maps to get a greater weight value. In this module, the main aim is to decrease the set of saliency maps to classify patterns of normal and AD cases. The saliency map kernels can be combined to a large single mixed kernel by linear combination method which is suitable for classification of pathological and the normal controls.

D. Anatomical Interpretation

The important contribution of this paper is this model not only helps to classify the MR images into normal and pathological but also helps to highlight the regions which are affected by the Alzheimer’s disease. This helps the
radiologist to understand in a better way about the disease and helps to design the treatment properly in the clinical management.

In the proposed approach, saliency maps are calculated for set of features for every single voxel. The overall saliency maps are calculated for set saliency maps and then saliency data is stored in the different kernel. Then set of kernels are fused into a single mixed kernel by using linear combination technique. The features are classified into Alzheimer’s disease and normal condition for the clinical interpretation. They are finally interpreted on the Brain MR image by highlighting the disease portion red color and normal one by blue. Therefore any radiologist can identify the disease.

4. IMPLEMENTATION

The saliency based feature extraction is implemented by using MATLAB R2013a with windows 7 PC of Intel corei5 processor and 500GB of RAM at 2.50GHz. For calculating the saliency maps from brain MR images, the features include intensity and orientation. Intensity information corresponds to the individual gray value of each voxel in the volume; orientation information is calculated using a Gabor filter bank with four different orientations (0°, 45°, 90°, and 135°).

The feature maps are also calculated at different scales, in this case by sub sampling the volume to 1/4, 1/8, and 1/16 of the original size. In summary, a set of 18 different feature maps at various scales (three for intensity, 12 for orientation, and three for edges) is final collected. The proposed method uses a group of 18 individual kernels that comprise different intensity, orientation (each orientation, angle evaluated separately) and Sobel operator is used for evaluation of edge information and evaluated at three different image scales (1/4, 1/8, 1/16).

Then, saliency maps per feature and scale were individually compared using the histogram intersection, while the model parameters were learned by solving the optimization problem for a set of labeled training volumes. Cross-validation over a subset of training images (10-fold cross-validation) was used to find an optimal value for the regularization parameter and with the optimal; the final classification of test subjects is performed.

5. EXPERIMENTAL RESULTS

Figure 2 illustrates the loading the Brain MR images from the standard databases, then applying saliency map provided by third party of MATLAB. Apply Saliency Map using Spatio-temporal saliency detection Algorithm using phase spectrum of quaternion fourier transform technique produces Feature_1 kernel up to n kernel.

Figure 3 illustrates the results of learning model, test and enhanced classification model. In the learning model, by applying Linear Discriminant Analysis (LDA) algorithm we construct learning model for the brain database. In the classification model, For testing, need to generate few test Brain Image for evaluation purpose and by using Enhanced Classifier which Performs matching score calculation based on the nearest neighbor classifier in order to provide better identification produces good accuracy and sensitivity. This is required in order to compare with IEEE base paper.

Figure 2 : Displays the final saliency map by extracting the features from the original brain MR image.
Figure 3: Result of learning model test and enhanced classification model.

6. CONCLUSION AND FUTURE ENHANCEMENT

This paper presents the automatic approach to find presence of the Alzheimer’s disease in the brain pattern. This morphometrical analysis method is very useful and efficient way to differentiate between the pathological and normal pattern of the brain. In future enhancement, we can implement in the 3D for better results.

REFERENCES