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Alzheimer Disease detection on structural MRI

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1. Introduction

Alzheimer disease (AD) is the most common form of dementia. Structural (MRI) measurements allow detecting and following the evolution of brain atrophy which is a marker of the disease process. Recently, several pattern recognition methods have been proposed to automatically discriminate between patients with and without Alzheimer disease [1] [2] [3]. Support Vector Machines help to identify patterns in data that differentiate between several classes. Hippocampus is the principal region involved in AD. In this work, we use visual description of the hippocampus ROI to detect Alzheimer disease from structural MR images.

1. Material and methods

Our approach consists initially in brain image normalization. Spatial normalization is the process of transforming brain images from their natural form to a standard form to reduce inter-individual variability and to facilitate subject comparison. It is usually done by using a standard brain called "template". In our work, all images are aligned to the atlas MNI 512 provided by the Montreal Neurological Institute (MNI) using linear (affine) transformations. Statistical Parametric Mapping (SPM) and the VBM toolbox are employed to fulfill the registration. We use an affine transformation to retain the local structure of ROI and not to deform its pattern. Then Hippocampus region is extracted from the images using the Automated Anatomical Labeling (AAL) template, after that we apply the Circular Harmonic Functions (CHF) [4] on those areas to extract representative features. A Bag-of-Visual-Words (BoVW) approach is applied on obtained features to generate a signature for this Region of interest (ROI). The BoVW representation consists in computing visual descriptors inside the ROI, assigning them to a nearest cluster (visual word" from a vocabulary), and then accumulating the assignments inside an ROI into a histogram of words. However, the region's shape differs from one projection to another. Thus, we choose to perform the clustering procedure three times from different projections (sagittal, axial and coronal) and to generate one visual vocabulary per projection. The final signature per subject is obtained by concatenating all signatures of all projections. The global signatures are classified using the Support Vector Machines (SVM). Figure 1 presents a diagram of the proposed framework.

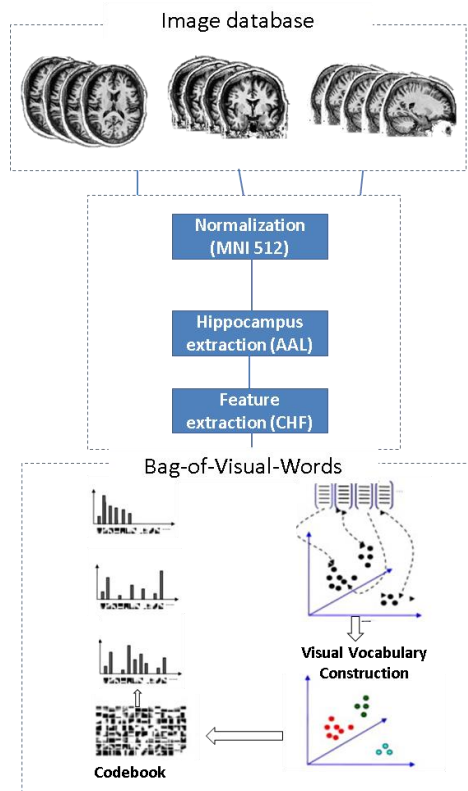


Figure 1 Proposed framework

This study was accomplished with 188 total participants from the ADNI¹ dataset with 41 AD, 60 (Normal Control) NC and 87 (Mild Cognitive Impairment) MCI. Furthermore, a 3T weighted contrast MRI from the real cohort “Bordeaux Cohort” were also tested. The subset of the latter database contains 37 images (16 AD and 21 NC)” obtained from a subsample of a large cohort of French epidemiological study, the Three-Cit (3C) study, described for instance in [5].

2. Results

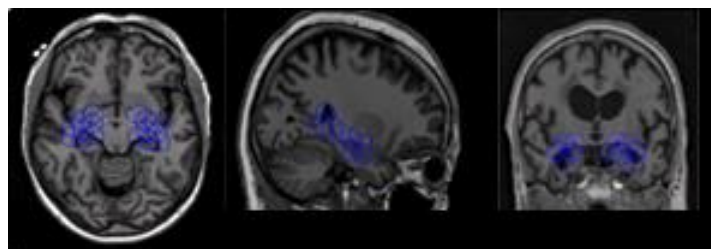


Figure 2 Features extraction from hippocampus (3 projections)

¹ <http://www.adni-info.org/>

Figure 2 shows features detected on the hippocampus area from 3 projection of an MRI scan. Hippocampus features gives a high accuracy on brain image classification. Across a range of tests, useful level of recognition rates was achieved. For example, the leave-on out cross validation accuracy obtained on training data is about 81 % for classifying (Alzheimer Disease) AD versus Normal control (NC) and about 80 % for classifying (Mild cognitive impairment) MCI versus NC on the ADNI dataset. Classification is achieved we small features size and in reduced time.

3. Conclusion

Our approach allowed us to provide the clinicians with semantic similarity, and thus could potentially support their diagnostic decision. Obtained results showed that machine learning algorithms and visual descriptors together with structural MRI data provide a robust measure to discriminate between AD subjects.

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