Automated Identification of Alzheimer's Patients based on Support Vector Machine Learned by Image Features Related to Cerebral Atrophy determined in 3-D MR images

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Introduction

Alzheimer's disease (AD) is associated with the atrophy in the cerebral cortex, which leads to a volume loss of cerebral cortex or a volume increase of cerebrospinal fluid (CSF) in cerebral sulci and lateral ventricles (LVs). It is very important to measure the focal cortical thickness and the volume of CSF for identification of AD patients. Although neuroradiologists attempt to evaluate the atrophy of the cerebral cortex based on MR images, it is very difficult to quantitatively estimate the atrophy. Therefore, the purpose of this study was to develop an automated method for identification of AD patients by measuring of image features related to the atrophy, i.e., cortical thickness and CSF volumes, based on three-dimensional (3-D) magnetic resonance (MR) images.

Materials and Methods

Our method consists of *determination of image features* and *identification of AD patients*. Image features were determined based on measurement of the cortical thickness and CSF volumes. Identification of AD patients was performed by using a novel pattern recognition technique, i.e., support vector machine (SVM), which is a robust and non-linear classifier. The cortical thickness was measured with normal vectors, which were determined by a level set method, from white matter surface to cortical gray matter surface on a voxel-by-voxel basis.[1] Each brain region was split into upper and lower regions at around top of lateral sulcus, and then each region was divided into 16 subregions. Eight lobes, i.e., frontal, parietal, temporal, and occipital lobes in left and right hemispheres roughly correspond to some labels of thirty labeled cuboidal regions. The CSF spaces in the sulci and LVs in a brain were extracted by wrapping the brain tightly in a propagating surface determined with a level set method, which functions like as plastic wrap.[2] The model of the classification was produced by learning feature values on cortical thickness and CSF volumes, and then an unknown case was classified into AD and non-AD candidates based on the model. We applied our proposed method to high-resolution 3-D T1-weighted MR images of the whole brains obtained from 49 patients who visited our memory clinic, including 29 clinically diagnosed AD cases (ages: 57-82; mean: 70, M=8, F=21) and 20 non-AD cases (49-78; 63, M=8, F=12). Our proposed method was evaluated by use of a leave-one-out test method.

Results

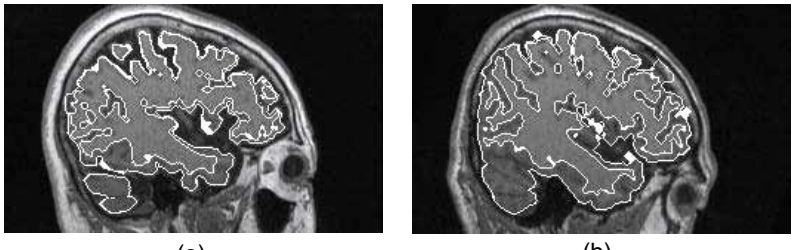
The results for the segmentation of brain region (outer line) and white matter (inner line) are shown in Fig. 1. The cortical thicknesses in the temporal lobe for this AD patient are thinner than those for this non-AD subject. The segmentation of gray and white matter regions was acceptable for measurement of the cortical thickness. Figure 2 shows an example of the relationship in the mean thickness of cerebral cortex between upper and lower subregions. The mean cortical thicknesses in lower and upper subregions for most of AD patients were thinner than those for non-AD subjects. As a result, the area under a ROC curve (Az value) obtained by our computerized method was 0.856 based on a leave-one-out test in identification of Alzheimer's patients among 49 cases.

Discussion

Image features on CSF volumes and cortcal thicknesses were useful for identification of AD patients, especially the mean cortical thickness in the 32 subregions obtained by dividing each brain. Our preliminary results showed that our proposed method is promising for identification of AD patients.

References

1. Arimura H et al, *Proc SPIE 2006*; 6144: 1239-1246.
2. Arimura H et al, *IFMBE Proc.2006*; 14: 2184-2187.



(a) (b)

Fig. 1 Results of segmentation of brain region (outer line) and white matter (inner line): (a) AD patient and (b) non-AD subject.

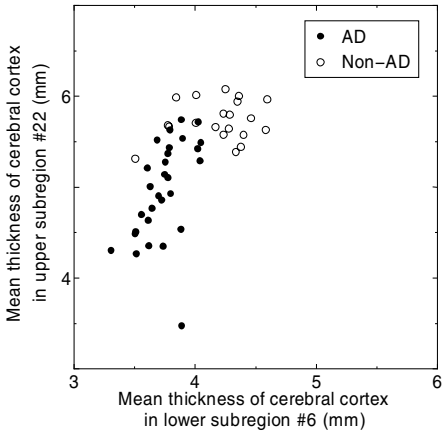


Fig. 2 Relationship in the mean thickness of cerebral cortex between upper and lower subregions.