

ERCIM “Alain Bensoussan” Fellowship Scientific Report

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In this report, I will describe my scientific research activity during my ERCIM fellowship in VTT, under the direction of Mark van Gils and Jyrki Lötjönen. The topic of my research is image processing and I am involved in the EU project for diagnostics of Alzheimer’s disease, PredictAD (www.predictad.eu)

I - Scientific activity

Brain MR imaging is playing an important role in neuroscience.

Neurodegenerative brain diseases mark the brain with morphological signatures; detection of these signs may be useful to improve diagnosis, particularly in diseases for which there are few other diagnostic tools. For example, early and disproportionate hippocampal atrophy in people who have memory complaints points to a diagnosis of Alzheimer's disease (AD)

PredictAD’s objective is to provide a standardised and objective tool for enabling earlier diagnoses of AD, improved monitoring of treatment efficacy, and improved cost-effectiveness of diagnostic protocols.

AD is the most common cause of dementia. It is a devastating disease for those who are affected and presents a major burden to caretakers and society.

The extraction of biomarkers from structural magnetic resonance (MR) images forms a major field of research.

Brain volume loss, as measured with MRI structural imaging, is accepted as a sensitive and objective marker of disease progression.

The main focus in this area is directed at measurement of cortical thickness and volume measurements of subcortical structures. The hippocampus is one of the first structures to be affected by Alzheimer's disease.

Atrophy has been measured with a variety of methods, some of which are longitudinal (measuring atrophy rate, for example, percentage brain volume change, using two or more temporally separated scans per subject) and others being cross-sectional (measuring atrophy state, for example, brain volume normalized for head size, with a single scan per subject).

My work is focused on looking for more accurate techniques of measuring atrophy of brain by simultaneously segmenting longitudinal magnetic resonance images with Expectation maximization approaches and Markov Random Fields method.

Lötjönen et al., 2011 proposed a method for computing automatically the volume of hippocampus using a multi-atlas segmentation and intensity model based on segmentation using expectation maximization (EM). (fig. 1)

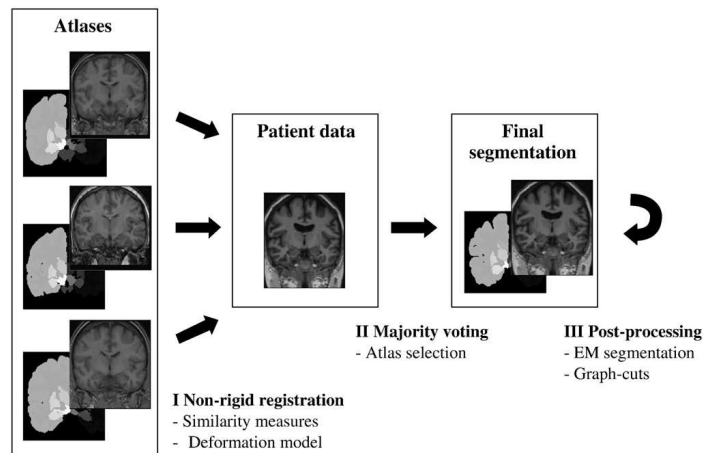


Fig. 1 Steps of mutli-atlas segmentation

I used that method and extended it from 3D segmentation in 4D segmentation, in order to improve the accuracy of the segmentation, comparing results with graph-cut method in Wolz et al., 2009. I tested 120 ADNI (<http://adni.loni.ucla.edu/>) cases (60 AD patients, 60 Healthy subjects) investigating and checking carefully different approaches for 4D probabilistic atlas, in addition to the probabilistic atlas produced for the baseline images used for all timepoints.

In order to improve the similarity index, I also tested different ways to use the affine registration both using the whole volume and the hippocampus area.

The method in 4d segmentation give good results but it does not yet produce a higher similarity index. For that reason the future plan is to investigate the reasons to improve the combination of 4d segmentation and the affine registration methods.

III -Attended Seminars, Workshops, and Conferences

- PredictAD meeting project, 25-26 May 2010, Milan, Italy
- PredictAD meeting project, 9-10 October 2010, Stockholm, Sweden
- Intra Nordic workshop, 10-12 January 2011, Trondheim, Norway
- Data Mining results seminar, 25 March 2011, VTT, Tampere, Finland

IV – Research Exchange Programme (12 month scheme)

- Trondheim, NTNU (Norwegian University of Science and Technology), Department of Computer and Information Science, 07.01.11 – 14.01.11, Trondheim, Norway, Prof. Øystein Nytrø.
- University of Copenhagen, Department of Computer Science, 13.03.11- 20.03.11, Copenhagen, Denmark, Prof. Mads Nielsen.