ERCIM "Alain Bensoussan"
Fellowship Scientific Report

Fellow: Dimitrios Ververidis
Visited Location : VTT Technical Research Center of Finland
Duration of Visit: 1st Sep. 2009 -> 31st May 2010

I - Scientific activity

In VTT, research was focused primarily on *early prediction of Alzheimer's disease* and secondarily on *ventilation assist for critically-ill patients*.

For the *early prediction of Alzheimer's disease* a method based on biomarkers selection and linear regression on time was invented. An improved version of sequential feature selection method that it was invented during author's doctoral study is used in order to select the best features out of neuro-psychological, brain imaging, and blood analyzing ones. The subjects are assigned by physicians into three classes, namely Alzheimer's disease patients, the mild-cognitive impaired patients, and the healthy subjects.

The criterion employed is the correct classification rate of the Bayes classifier when the class-conditional probability density functions are modeled as Gaussians. Linear regression is used to fit lines on the measurements in time, and exploit the time context of the selected features.

The results indicate that neuropsychological tests outscore biomarkers with 94% against 58% correct classification rate, with random classification being at the level of 33%. The most usefull biomarkers are the ones related to the brain volume. It is observed that brain is smaller in MCI and AD subjects than in healthy subjects. Among the brain parts, hippocampus is the most informative. Its volume distribution fits well in the Gaussian model employed in the classifier. The linear regression method proposed can be used by clinicians to predict when a healthy subject will become MCI or AD patient. Based on two measurements a future value of a feature is estimated for a certain subject. The first results of the survey are published in [2]. Later, the method is extended, a software for computer assisted diagnosis is written and the results are submitted in [3].

For *assisting the ventilation of critically-ill patients*, a technique to derive a decision of the adequate level of assist is invented. The technique is based on the processing of the electrical activity of the diaphragm, a signal that is measured by inserting an electrode from the naso-gastric tube down to diaphragm. Such kind of assist is called neural adjusted ventilation assist (NAVA), and it is the state of the art method for the patients that can not respond to physician. The technique developed aims to reduce the burden of the physician by automatically estimating the adequate NAVA level from the plateau of the electrical activity of the diaphragm multiplied by the NAVA level, the so called airway pressure signal. The work is done with co-operation with the Dr. med Lukas Brander from Bern Univ. Hospital. A software is written, and the case of a patent is examined by VTT Research Center Commitee.

II- Publication(s)

Accepted

D. Ververidis, M. Van Gils, J. Koikkalainen, and J. Lotjonen, "Feature selection and time regression software: Application on predicting Alzheimer's disease progress," in Proc. European Signal Processing Conf. (EUSIPCO), Aalborg, 2010.

Abstract: In this paper, the Bayes classifier is used to predict Alzheimer's disease progress. The classifier is trained on a subset of the Alzheimer's Disease Neuroimaging Initiative database. Subjects are diagnosed by doctors as belonging to healthy, mild-cognitive impaired, and Alzheimer's disease class. A software tool for features selection and time regression is developed. The tool utilizes a variant of the Sequential Forward Selection (SFS) algorithm for feature selection, where the criterion used for selecting features is the correct classification rate of the Bayes classifier. The tool also employs linear regression to predict future values of selected biomarkers, such as the hippocampus volume, from past measurements, so that future class of the subject can be predicted.

Submitted

D. Ververidis, M. Van Gils, J. Koikkalainen, J. Lotjonen, J. Mattila, C. Kotropoulos, and the Alzheimer's disease Neuroimaging Initiative, "On estimating Alzheimer's disease progress with feature selection and linear regression," submitted in IEEE Trans. Biomedical Eng., June 2010.

III -Attended Seminars, Workshops, and Conferences

1. VTT Technical Research Center of Finland Strategy Seminar, Hameenlinna-Finland, April 2010.
2. 18th European Signal Processing Conference (EUSIPCO), Aalborg-Denmark, August 2010.