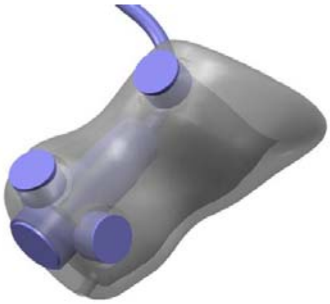
Using brainwaves to control audio processing, specifically Hearing Aids control.

Will future audio systems, including hearing aids, be controlled by the users mind? Systems such as aggressive directional microphones/beamformers and noise reduction schemes help the user to function in complex, demanding listening situations, but the control of such system needs much more consideration. By reading out brainwaves it may be possible to control the audio system in accordance with the user's intent. This MSc work can help towards a mind-controlled hearing aid!

The cocktail party situation with many competing sources is an extremely difficult situation for hard-of-hearing persons and hearing aids of today only have limited benefit in those situations.
Recent research[1,2] have shown that it is actually possible to read out from the brainwaves (electroencephalogram, EEG) which one of several audio sources that a person is attending to. This opens up for mind-controlling interfaces that steer signal processing enhancements towards the wanted/attended source to increase the focus and fidelity on the wanted source. This could be useful in the difficult cocktail-party situation.

Until today different decoding approaches have been used to classify the attended source from the EEG: Canonical Correlation Analysis (CCA), single channel inversion (AESPA) all channel inversion, where the last one produces attention decoding accuracy of 75-95% with 60 seconds of data[2].
However, the drawback with correlation based approaches is that they compare sample by sample. The advantage with CCA is that it catches possible dynamics in the weighting matrices. However, this weighting does not correspond to physics. For instance, it is non-causal, with the consequence that the brain can foresee that there is a person who will speak in the future. It also has an extremely long memory that stretches over the whole set of learning data, meaning that the brain can react on speech that was spoken several minutes ago.



The purpose of this MSc is to explore methods that use a model of higher physical relevance[3], and to benchmark these models against current models/methods. The same dataset that has been used in previous studies[2] will be used in this project. The project may also investigate if it is possible to reduce the number of EEG electrodes from 128 to a fewer number of electrodes suitable for being attached to the surface of a hearing aid placed in the ear canal.

The thesis work is done in cooperation between ISY/Automatic Control, IBL/HEAD, and Eriksholm Research Centre, Oticon A/S.

This MSc is somewhat connected to an Industrial PhD project by Eline Borch Petersen (Eriksholm Research Centre, Oticon A/S and Linnaeus Centre HEAD, Linköping University), with supervision support on EEG.

A prerequisite for the work is that a formal agreement is signed between the thesis workers and the other parties to assure intellectual properties and publication rights.

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