Master Thesis Proposal 2021/2022

Title: A Deep Learning Approach to Brain Tracking of Sound

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Background: Natural listening situations that require listeners to selectively attend to a talker of interest in noisy environments with multiple competing talkers are among the most challenging situations encountered by hearing impaired listeners. Such challenges become even more pronounced with increasing background noise and may partially be overcome by adequate hearing aid signal processing support. A key finding that helped the field to progress is that speech-evoked brain responses recorded with electroencephalogram (EEG) are modulated by listener's auditory attention, revealing selective brain tracking (BT) of the target talker**.** Hearing aid strategies were also found to support auditory attention in the hearing-impaired brain. However, BT methods proposed in the literature are linear and are thus sub-optimal, as the human brain is a complex, non-linear system, and cannot easily be modeled by linear methods.

Project description: We now want to work on new machine learning methods, e.g., (deep) neural networks models, to find better input-output representations for BT. Great challenges with EEG and audio are high dimensionality, low SNR, and low correlation ($r<0.2$). This knowledge will bring us one step closer to having intelligent hearing aids steered with our brains.

Method: The datasets will be provided by Eriksholm Research Centre (a part of the world-leading hearing aid manufacturer Oticon A/S). The dataset contains EEG data collected from 35 participants fitted with hearing aids. The participants were instructed to attend to one of two simultaneous talkers in the foreground mixed with multi-talker babble noise in the background.

Program Duration: 20 weeks, 30HP, with a flexible starting date.

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Relevant Literature:

[1] Alickovic, Emina, et al. "A tutorial on auditory attention identification methods." Frontiers in neuroscience 13 (2019): 153.

[2] Lunner, Thomas, et al. "Three new outcome measures that tap into cognitive processes required for real-life communication." Ear and Hearing 41.Suppl 1 (2020): 39S.

[3] Alickovic, Emina, et al. "Neural representation enhanced for speech and reduced for background noise with a hearing aid noise reduction scheme during a selective attention task." Frontiers in neuroscience 14 (2020): 846.

[4] Alickovic, Emina, et al. "Effects of hearing aid noise reduction on early and late cortical representations of competing talkers in noise." Frontiers in Neuroscience 15 (2021).

[5] Geirnaert, S., et al. "Electroencephalography-based auditory attention decoding: Toward neurosteered hearing devices." IEEE Signal Processing Magazine 38.4 (2021): 89-102.