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Hearing research

AI improves speech understanding of hearing aid users

In noisy environments, it is difficult for hearing aid or hearing implant users to understand their conversational partner because current audio processors still have difficulty focusing on specific sound sources. In a feasibility study, researchers from the Hearing Research Laboratory at the University of Bern and the Inselspital are now suggesting that artificial intelligence could solve this problem.

Hearing aids or hearing implants are currently not very good at selectively filtering specific speech from many sound sources for the wearer – a natural ability of the human brain and sense of hearing known in audiology as the “cocktail party effect”. Accordingly, it is difficult for hearing aid users to follow a conversation in a noisy environment. Researchers at the Hearing Research Laboratory of the ARTORG Center, University of Bern, and Inselspital have now devised an unusual approach to improve hearing aids in this respect: virtual auxiliary microphones whose signals are calculated by artificial intelligence.

Like an invisible microphone on the forehead

The more microphones are available and the more widely they are distributed, the better a hearing aid can focus on sound from a particular direction. Most hearing aids have two microphones close together due to lack of space. In the first part of the study, the Hearing Research Laboratory (HRL) determined that the optimal microphone location (for better focusing) is in the middle of the forehead – though this is a very impractical location. “We wanted to get around this problem by adding a virtual microphone to the audio processor using artificial intelligence,” said Tim Fischer, a postdoctoral researcher at HRL, explaining this unconventional approach.

Cocktail party data, a learning neural network, a subject group test

For the study setup, ARTORG Center engineers used the “Bern Cocktail Party Dataset”, a collection of a variety of noise scenarios with multiple sound sources from multi-microphone recordings of hearing aid or cochlear implant users. Using 65 hours of audio recordings (more than 78,000 audio files), they trained a neural network to refine a commonly used directionality algorithm (beamformer). For improved speech understanding the deep learning approach calculated additional virtual microphone signals from the audio data mixture. 20 subjects tested the AI-enhanced hearing in a subjective hearing test accompanied by objective measurements. Particularly in cocktail party

settings, the virtually sampled microphone signals significantly improved the speech quality. Hearing aid and cochlear implant users could therefore benefit from the presented approach, especially in noisy environments.

"I think that artificial intelligence represents an important contribution to the next generation of hearing prostheses, as it has great potential for improving speech understanding, especially in difficult listening situations," says Marco Caversaccio, Chief Physician and ENT Department Head. As auditory assistive technologies and implants are a major focus of research at the Inselspital, important data-based foundations are being laid here for further development that should bring the natural hearing experience closer. The novel approaches will directly benefit patients within the framework of translational studies.

Outlook

Although within this study the virtually added microphones significantly improved the quality of speech understanding with hearing aids, further studies still need to overcome some technical hurdles before the methodology can be used in hearing aids or cochlear implant audio processors. This includes, for example, a stable functioning directional understanding even in reverberant environments.

Experts:

- PD Dr. Wilhelm Wimmer, Group Leader, Hearing Research Laboratory, ARTORG Center for Biomedical Engineering Research, University of Bern
- Prof. Dr. med. Marco Caversaccio, Chief Physician and Head of Department, Department of Ear, Nose and Throat Diseases, Head and Neck Surgery, Inselspital, University Hospital Bern.
- Dr. Tim Fischer, Postdoctoral Researcher, Hearing Research Laboratory, ARTORG Center for Biomedical Engineering Research, University of Bern

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Links:

- Original publication: https://www.sciencedirect.com/science/article/pii/S0378595521001283
- Bern “Cocktail Party Database”: https://www.nature.com/articles/s41597-020-00777-8
- Hearing Research Laboratory, ARTORG Center & Inselspital HNO: https://www.artorg.unibe.ch/research/hrl
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Hearing Research Laboratory

The Hearing Research Laboratory is a clinically directed research collaboration between the ARTORG Center and the Department of Department of Ear, Nose and Throat Diseases, Head and Neck Surgery, Inselspital (Bern University Hospital). Our multidisciplinary team combines the expertise of engineers, audiologists, surgeons, and physicists. Our goal is to develop novel medical devices and technology to help hearing-impaired persons and to support clinicians in the diagnosis and treatment of inner ear disorders. The range of research activities of our group includes psychoacoustic experiments, anatomical and electrophysiological studies, the design and implementation of clinically applicable software and devices, and the conduct of observational studies and clinical trials. To promote sustainable research progress, our team members actively collaborate with leading medical, academic and industrial partners in hearing research.

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