PhD subject 2021-2024 – CEA Grenoble – LETI/DSYS

Ultra Low Power and High Performance Microphone Signal Processing for Speaker Localization and Auditory Attention Detection : Application to Next Generation Hearing Aids

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Summary

Located on the MINATEC campus in Grenoble, CEA-Leti's main mission is to create innovation and transfer it to industry by generating research results that will be used in industry in the medium and long term, positioning its research between academic research and industrial R&D. Within LETI Systems Department, the mission of the Sensor Systems and Electronics Service is to design and produce innovative systems to meet the needs of industrial innovation in a wide range of fields, from the automotive industry to sports and the building industry. The skills involved range from electronics to physics, electromagnetism, magnetostatics, signal processing and applied mathematics.

Hearing loss is a major public health problem, affecting about 10% of the world's population. This handicap has a strong impact on the comfort of patients who suffer from it, in many aspects of their lives. Furthermore, with increased stimulation of our hearing system over long periods of time through various digital uses, the trend of increasing prevalence of hearing loss is clearly on the rise.

Many forms of hearing loss can be treated through the use of hearing aids that significantly improve the lives of millions of people with hearing loss around the world. These hearing aids have benefited from considerable efforts to improve the underlying technologies in recent years, and today offer very high performance in terms of audio signal quality, amplification, noise filtering, compactness, and autonomy. However, these devices still have several limitations. In particular, in certain sound environments, the separation between the useful signal to be amplified and the interfering acoustic signals to be filtered remains a challenge. In this study, we propose to focus on the Cocktail Party Problem. The Cocktail Party Problem (CPP), is a psychoacoustic phenomenon that refers to the remarkable human ability to listen and selectively recognize an auditory source in a noisy environment, where the overlapping auditory interference is produced by competing speech sounds or a variety of noises that are often assumed to be independent of each other.
The resolution of this type of problem, also called Auditory Attention Detection, represents a major problem for which few solutions have yet been found and which is currently the subject of intense research.

This PhD thesis, which is part of the "Cyber-Physical Systems" and "Edge AI" roadmap of the Systems Department of CEA-LETI (Grenoble), will aim to make a major contribution to this Auditory Attention Detection theme, for the automatic recognition of the speaker by future generation hearing aids. The thesis will be based on advanced technological solutions using embedded artificial intelligence (Edge AI). We will address the problem through a multi-sensor data fusion approach (acoustic, inertial, video sensors). Indeed, we will consider coupling a processing of acoustic voice signals thanks to high performance microphones with a video processing of faces to realize a vocal activity detection of the speaker (automatic lip reading). The sensor data will be processed and coupled by adapted artificial intelligence algorithms. It is also envisaged to use several microphones to perform acoustic beamforming processing, and to possibly hybridize with inertial sensors to reinforce the localization estimation of the speaker.

The validation of the implemented methods and the developed algorithms will be realized thanks to test campaigns in instrumented acoustic chamber (high performance microphone, video captures, etc...).

Keywords: hearing aid, audio signal processing, artificial intelligence, sensor fusion, cocktail party problem, auditory attention detection

EDUCATION

Engineer or MSc - Artificial Intelligence, Signal Processing, Audio processing, Computer Science, Electronics

INFORMATION

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