Lucerne University of
Applied Sciences and Arts

HOCHSCHULE LUZERN

Technik & Architektur
FH Zentralschweiz

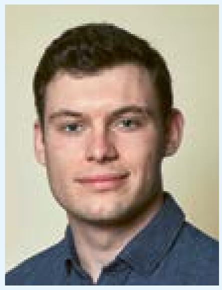
sonova
HEAR THE WORLD

Diplomand **Loïc Bianzina**

Dozenten Prof. Dr. Thomas Graf, Dr. Armin Taghipour

Themengebiet Signal Processing

Projektpartner Sonova AG



Auralization of Static Scenarios

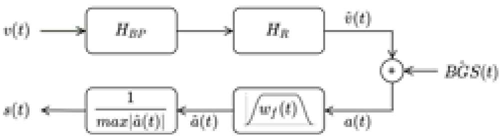


Abb. 1 The general structure of the auralization procedure: A voice signal v(*t*) passes through the bandpass filter (H_{BP}) and room filter (H_R) before BGS is added. Afterward, a fade-in and -out window ($w_f(t)$) is applied and finally, the signal â(*t*) is scaled to +/- one leading to the output signal s(*t*).

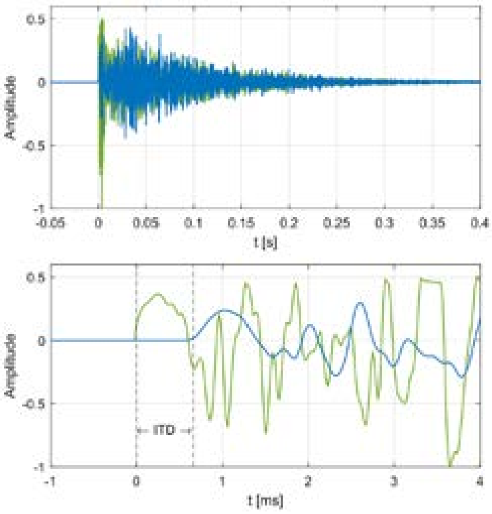


Abb. 2 Binaural RIR example (upper graph) and zoom to the beginning of it (bottom graph) with left earn channel (green) and right ear channel (blue). The interaural time difference (ITD) is the difference in the arrival time of the sound between both ears. The Amplitude difference is the interaural level difference (ILD).

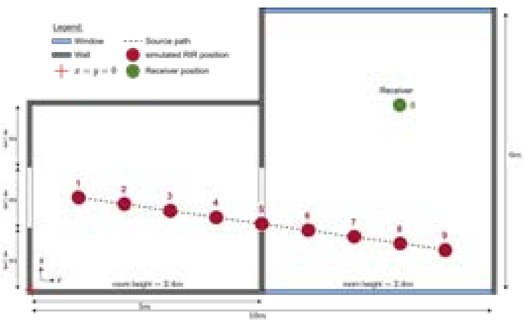


Abb. 3 Auralized moving source scenario example using nine impulse responses between the source positions one to nine and the receiver at position 0. The room is modeled with frequency-dependent and customary reflection coefficients (Graf, 2021). The speaker (source) walks at 3.6 km/h and the hearer sits (receiver).

Problem Definition and Project Goals

Hearing aids are usually tested with unrealistic and artificial scenarios. For this reason, the objective is to develop methods to test these devices in real-life scenarios. Therefore, two approaches are currently being researched: 1) Asking hearing impaired people to rate hearing aids in their daily life; 2) Virtually creating acoustical scenarios that are replayed to hearing impaired people in a lab environment. The second is what we call auralization. The goal of the present bachelor thesis is to investigate auralization techniques. We aim to recreate the feeling of being in different rooms in the presence of various background noises. Moreover, we target to auralize sound sources in different directions to synthesize more lifelike environments. Also, the objective is set to research methods for auralizations with moving sources. Finally, the quality of the established scenarios is to be studied through a psychoacoustic experiment.

Concepts and Implementation

Mono and binaural auralization approaches are presented, compared, and implemented in this work to emulate realistic scenarios. Measured impulse responses characterize different rooms. These allow us to give the hearer the impression of being in a room of choice. The mentioned room impulse responses (RIR) are obtained using non-ideal Dirac impulses generated with balloons. Then, clean voice-, conversations-, and guitar recordings filtered through rooms and added together with background sound form an auralization. Three methods are proposed for binaural background sound (BGS): 1) Adding binaural BGS recorded with a binaural microphone; 2) Adding recorded mono BGS convolved with a binaural impulse response; 3) Adding mono BGS up mixed by using a simplified version of the Head Related Transfer Function. Finally, scenarios with slow-moving sound sources (MS) are implemented using crossfading to interpolate between simulated impulse responses.

Results and Evaluation

With the aid of a psychoacoustic experiment where subjects could recognize rooms very accurately (93.8 %) and directions rather exact (70.0 %), the quality of the performed auralizations was shown.

Future Work

Substances of Future work could be: 1) Evaluate the quality of the MS Auralization 2) Enhance the MS implementation from mono to binaural; 3) Using a better approximation of the HRTF for synthesizing binaural BGS. 3) Investigate scenarios with source and receiver moving.