Master Thesis

Perception of Coloration in 3D-Audio

The evaluation of audio quality is of high importance when developing tools for 3D audio reproduction such as room acoustic simulation algorithms, interpolation approaches for 3D audio signals, or parametric and non-parametric audio rendering algorithms. During the development of such tools, the perceptual audio quality is often predicted using binaural models as a quick alternative to listening tests. One important aspect of audio quality is the perceived coloration [1], however, existing models used to predict coloration in 3D audio reproduction (cf. [2] for an overview) are missing a dedicated binaural processing stage that considers the relative contribution of the left and right ear signals—a fact that makes them monaural loudness models rather than binaural coloration models. One reason for this is that a unified and comprehensive data set of perceptual coloration ratings is currently missing. Creating such a data set is thus the central aim of this thesis. This includes

1. generating a large stimulus pool for which coloration will be rated in a listening test. This requires exploring and sampling factors that influence the perceived coloration including the source position (HRTF), the audio content, the spectral difference, and the playback level.

2. developing the listening test method considering (i) incomplete test designs in which each participant of the listening test will only rate a subset of the stimuli [3, Chapter 9] and (ii) the possibility to add stimuli to the existing pool in follow up experiments. An incomplete test design will be required because the number of stimuli will by far exceed the number that could be rated by a single participant.

3. developing the listening test procedure (stimulus randomization, audio playback, level calibration, graphical user interface, saving the ratings). Depending on the size of the stimulus pool, the experiment will be conducted in different acoustics research labs (preferred) or as an online experiment (required if the stimulus pool is too large).

4. A statistical analysis of the results (optional, depending on the results from the tests arriving in time)

Literature

[1] F. Rumsey, S. Zieliński, R. Kassier, and S. Bech, “On the relative importance of spatial and timbral fidelities in judgments of degraded multichannel audio quality,” *J. Acoust. Soc. Am.*, vol. 118, no. 2, pp. 968–976, Aug. 2005, doi: 10.1121/1.1945368.

[2] T. McKenzie, C. Armstrong, L. Ward, D. T. Murphy, and G. Kearney, “Predicting the Colouration between Binaural Signals,” *Applied Sciences*, vol. 12, no. 5, p. 2441, Feb. 2022, doi: 10.3390/app12052441.

[3] K. Hinkelmann and O. Kempthorne, *Design and Analysis of Experiments. Volume 1: Introduction to Experimental Design*, 2nd ed. Hoboken, NJ, USA: Wiley, 2008.

Requirements

Basic knowledge of the psycho acoustics of spatial hearing, Audio signal processing and design of graphical user interfaces in Python, and the design and conduction of listening experiments.

Supervision

Dr. Fabian Brinkmann, TU Berlin, fabian.brinkmann@tu-berlin.de
Dr. Thomas McKenzie, University of Edinburgh, thomas.mckenzie@ed.ac.uk
Dr. Steffen Lepa
Prof. Dr. Stefan Weinzierl, TU Berlin