Fachgebiet Audiokommunikation
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Master Thesis

Effects of room acoustical qualities on timbre semantics

The proposed thesis is part of a cross-cultural study conducted by the Audio Communication Group at TU Berlin and the Cognitive and Computational Musicology Group at the Aristotle University of Thessaloniki (Greece). The objective is to understand how room acoustics influence the semantic description of instrumental timbre across two different linguistic groups (German/Greek).

Most prior research work on timbre semantics has investigated musical instruments by means of recorded samples or synthetic emulations. Common semantic dimensions have been summarized as luminance, texture, and mass [1]. However, in evaluating the timbre of a musical sound, listeners invariably evaluate timbral characteristics of the presentation space, too. The influence of the latter on the spectral shape of a sound, as illustrated by the room acoustical transfer function, is manifested in a characteristic amplification or attenuation of certain frequencies, superimposed by an increasing attenuation of the spectral envelope towards higher frequencies due to air absorption. The extents of these effects can vary substantially from one space to another, depending on the geometry and materials of the room. In addition, recent studies have highlighted timbre as a central aspect of room acoustical qualities, with “bright”, “rough”, “warm”, and “metallic”, among others, considered important timbral attributes of a specific performance venue [2].

The proposed thesis will

1. collect semantic ratings from a large number of listeners (N = 90; German group only) of a highly diverse set of stimuli comprising acoustic and electromechanical instrument timbres (n = 54) presented in different rooms via dynamic binaural synthesis;
2. calculate acoustic properties of the rooms (ISO 3382-1) and (dry) sound stimuli (Timbre Toolbox [3]);
3. test a multivariate general linear model (GLM) with mean scores of perceived room (RAQI) and timbre qualities as predictors, and stimulus-based mean scores for each semantic factor as dependents;
4. find the best multivariate regression prediction solution for the same question, drawing on SVM-regression, random forest regression, regression trees, etc.
5. test a GLM with room acoustic properties and audio descriptors as predictors (same dependents);
6. find the best multivariate regression prediction solution for the same question.

- Note that analyses 2–6 depend on results from the thesis “Investigating language-invariance in timbre semantics”.

Literature

[1] A. Zacharakis, K. Pastiadis, and J. D. Reiss, “An interlanguage study of musical timbre semantic dimensions and their acoustic correlates,” *Music Percept.*, vol. 31, no. 4, pp. 339–358, 2014.

[2] S. Weinzierl, S. Lepa, and D. Ackermann, “A measuring instrument for the auditory perception of rooms: The room acoustical quality inventory (raqi),” *J. Acoust. Soc. Am.*, vol. 144, no. 3, pp. 1245–1257, 2018.

[3] G. Peeters, B. L. Giordano, P. Susini, N. Misdariis, and S. McAdams, “The Timbre Toolbox: Extracting audio descriptors from musical signals,” *J. Acoust. Soc. Am.*, vol. 130, no. 5, pp. 2902–2916, 2011.

Requirements

- Basic knowledge in room acoustics, binaural synthesis, and timbre psychoacoustics
- Extended knowledge in audio content analysis (e.g., audio descriptors of timbre)
- Extended knowledge in statistical modelling (regression, linear models, etc.)
- Extended knowledge in machine learning (random forests, support vector regression, etc.)
- Experience with MATLAB/Python/R programming

Supervisors

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