Fachgebiet Audiokommunikation

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Master thesis

Perception of time domain transfer function smearing of delayed subwoofer arrays

For sound reinforcement applications, line arrays are used aiming at homogeneous sound fields for the whole audio bandwidth. In the low frequency range, these systems can be extended by subwoofer arrays. For subwoofers in a linear horizontal array, the individual loudspeakers' input is usually delayed in order to obtain larger opening angles according to a curved array, e.g. an arc array, without the need of physical curving, cf., Hill, 2017.
Using delays for subwoofer arrays in order to obtain larger opening angles also results in an SPL loss on and near the loudspeaker main radiation axis as well as in changes of the transfer functions in the time domain. The transfer functions in the time domain become broader with increasing delay values, i.e., with increasing desired opening angle. Also the edges are bent.
In this thesis, a quantitative measure for the perception of transfer function smearing in the time domain using delayed subwoofer arrays is to be found. This measure should provide a (usability) threshold up to which delay values and opening angles, respectively, this transfer function smearing is not audible in real-life outdoor sound reinforcement setups. A similar study can be found in Shabalina et al., 2011. In this publication, the audibility threshold for the time domain smearing was determined based on a constantly increasing delay difference between adjacent loudspeakers in the subwoofer array referring to a stereo subwoofer setup.
The thesis includes (i) conducting listening tests in order to find the desired audibility threshold using binaural simulations and/or real-life sound reinforcement setups and (ii) analyzing the dependencies on the source-receiver-configuration (number of loudspeakers in the subwoofer array, acoustic center spacing, audience reference distance) of the audibility threshold.

References

Hill, Adam J. (2017): "Practical Considerations for Subwoofer Arrays and Clusters in Live Sound Reinforcement." In: Proc. of the 3rd Int. Audio. Eng. Soc. Conf. on Sound Reinforcement – Open Air Venues, Struer, Denmark.

Shabalina, Elena; Ramuscak, Janko; Vorländer, Michael (2011): "A Study of Human Perception of Temporal and Spectral Distortion Caused by Subwoofer Arrays." In: Proc. of the 130th Audio Eng. Soc. Conv., London, United Kingdom.

Requirements

- Knowledge in sound reinforcement, sound radiation and signal processing
- Experience with MATLAB, Python, Scilab or similar software
- Interest in the design of listening tests

Supervisors

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