

Variable acoustics by wave field synthesis

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Variable acoustics systems can be applied to adapt the acoustical properties of an enclosure, assuring an optimal perception of each possible performance. This thesis describes the design of a variable acoustics system, based on electro-acoustic techniques. Its contents can be related to three elements that play a role in room acoustics: analysis, synthesis and perception. A new concept of wave field analysis is described, applying linear microphone arrays. The application of microphone arrays reveals the spatial coherence of wave fields and spatial processing techniques are made accessible. The spatial processing technique applied in this thesis is the Radon transform, performing a plane wave decomposition. Array measurements show a considerable amount of non-specular reflections within the first 100 ms of the impulse response, and some clear anisotropy until 200-300 ms after the direct sound. These results do not endorse a sharp distinction between early reflections and reverberation. Wave field synthesis denotes a technique of generating wave fronts by means of loudspeaker arrays. The application of loudspeaker arrays is inevitable in order to accurately generate sound fields with predefined temporal, spectral and spatial properties. Hence, wave field synthesis offers a volume solution, instead of the point solution offered by conventional multi-channel systems. The design of a variable acoustics system should be based on perceptually relevant parameters. Parameters relevant for perception have been described with respect to the reverberant sound field. The spatial properties are parametrized separately from the temporal and spectral properties. Perceptual experiments reveal that the described parameters are perceptually highly relevant. A laboratory prototype system, based on a rectangular loudspeaker array configuration, has been designed and built. The reverberant sound field is generated by means of 11 plane waves, while different FIR filters are attributed to each plane wave to control the temporal and spectral properties. The early reflections are presently generated by synthesizing a limited number of mirror image sources, ignoring the presence of non-specular reflections.

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