The Influence of Overlapping Band Filters on Octave Band Decay Curves
This study showed that the overlap of practically-used bandpass filters can influence the octave band decay curves, especially if the decays are calculated from a filtered impulse response that has been created from octave band energy responses. Energy from a frequency band with a long reverberation time can leak into a neighbouring band with a shorter reverberation time. This also means that neither octave band decays from a measured response are independent, nor are measured octave band reverberation times.

Auralizations with loudspeaker arrays from a phased combination of the image source method and acoustical radiosity
In order to create a simulation tool that is well-suited for small rooms with low diffusion and highly absorbing ceilings, a new room acoustic simulation tool has been developed that combines a phased version of the image source with acoustical radiosity and that considers the angle dependence of the surface properties. The new tool is denoted PARISM, and here PARISM is used to create loudspeaker array-based auralizations. Different auralization techniques are compared, such as Ambisonics, vector-based panning, and the method of nearest loudspeaker. The implementations of the auralization techniques with PARISM are described and compared to implementations of auralizations with another geometrical acoustic simulation tool, i.e., ODEON and the LoRA toolbox that applies Ambisonics to ODEON simulations. In opposition to the LoRA toolbox, higher order Ambisonics are also applied to the late part of the PARISM impulse response, because more directional information is available with acoustical radiosity. Small rooms with absorbing surfaces are tested, because this is the room type that PARISM is particularly useful for.
Evaluation of a Loudspeaker-Based Virtual Acoustic Environment for Investigating sound-field auditory steady-state responses

Measuring sound-field auditory steady-state responses (ASSR) is a promising new objective clinical procedure for hearing aid fitting validation, particularly for infants who cannot respond to behavioral tests. In practice, room acoustics of non-anechoic test rooms can heavily influence the auditory stimulus used for eliciting the ASSR. To systematically investigate the effect of the room acoustics conditions on sound-field ASSR, a loudspeaker-based auralization system was implemented using a mixed order Ambisonics approach. The present study investigates the performance of the auralization system in terms of objective room acoustic measurements and sound-field ASSR measurements, both in the actual room and in the simulated and auralized room. The evaluation is conducted for a small room with well-defined acoustic properties. The room is carefully modeled using the novel room acoustic simulation tool PARISM (Phased Acoustical Radiosity and Image Source Method) and validated through measurements. This study discusses the limitations of the system and the potential improvements needed for a more realistic sound-field ASSR simulation.
PARISM - en rumsakustisk simuleringsmodell för vanliga lokaler

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Scattering from objects and surfaces in room acoustical simulations
In room acoustical simulations, scattering objects are often modeled as impenetrable boxes with high scattering coefficients assigned to the surfaces. In some cases, a cluster of objects is modeled as a virtual impenetrable box, such that no sound propagation can take place between the objects. Thus, the scattering only takes place on the boundary surfaces of the box and the acoustic volume of the room is reduced. Another challenge with representing scattering objects by reflecting surfaces is that it increases the number of surfaces, which greatly increases the calculation complexity for methods such as the image source method. In this paper a modeling method where the scattering from objects takes place in certain parts of the room volume is proposed. In this method, sound can still travel through scattering objects, but be partly scattered. This volume scattering method has at present been implemented in the simulation tool PARISM (Phased Acoustical Radiosity and Image Source Method). Scattering from objects and surfaces is likely to be strongly frequency dependent and the frequency dependence can depend on their sizes, shapes and structure. The importance of the frequency dependence is investigated and discussed through simulations.

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Acoustic behavior of porous ceiling absorbers based on local and extended reaction (L)
The acoustic behavior of ceiling absorbers can be predicted under different surface reaction assumptions: Local and extended reaction. This study aims to experimentally validate acoustic transfer functions near a ceiling absorber in an anechoic chamber based on the two surface reaction models. First, a ceiling absorber with two mounting conditions is modeled by equivalent fluid models, such as Delany-Bazley’s, Miki’s, and Komatsu’s model, in various ways: (1) Local vs extended reaction and (2) plane wave vs spherical wave incidence. For a single absorber under an echoic condition, the acoustic transfer functions for four source-receiver pairs are simulated using a pressure-based image source model, and then compared with measurements. For a rigid backing condition, both the local and extended reaction models agree well with the measurement. For an absorber backed by an air cavity, the extended reaction model agrees better at larger incidence angles at lower frequencies than the local reaction model.

Comparing a phased combination of acoustical radiosity and the image source method with other simulation tools
A phased combination of acoustical radiosity and the image source method (PARISM) has been developed in order to be able to model both specular and diffuse reflections with angle-dependent and complex-valued acoustical descriptions of the surfaces. It is of great interest to model both specular and diffuse reflections when simulating the acoustics of small rooms with non-diffuse sound fields, since scattering from walls add to the diffuseness in the room. This room type is often seen in class rooms and offices, as they are often small rectangular rooms with most of the absorption placed on the ceiling. Here, PARISM is used for comparisons with other simulation tools and measurements. An empty, rectangular room with a suspended absorbing ceiling is used for the comparisons. It was found that including the phase information in simulations increases the spatial standard deviation, even if only the propagation phase is considered. It was furthermore found that it is difficult to match simulations with measurements, when the input data are unknown and therefore estimated.

Development and validation of a combined phased acoustical radiosity and image source model for predicting sound fields in rooms
A model, combining acoustical radiosity and the image source method, including phase shifts on reflection, has been developed. The model is denoted Phased Acoustical Radiosity and Image Source Method (PARISM), and it has been
A model that combines image source modelling and acoustical radiosity with complex boundary conditions, thus including phase shifts on reflection, has been developed. The model is called PARISM (Phased Acoustical Radiosity and Image Source Model). It has been developed in order to be able to model both specular and diffuse reflections with complex-valued acoustical descriptions of the surfaces. This paper mainly describes the combination of the two models and the implementation of the angle dependent surface descriptions both in the image source model and in acoustical radiosity. It furthermore describes how a pressure impulse response is obtained from the energy based radiosity model. Validation of the image source model with real-valued boundary conditions is done by comparison with the analytical Green’s function in an enclosure. The full model is compared with measurements done in a rectangular room with a highly absorbing ceiling.
valued acoustical descriptions of the surfaces. In this paper the PARISM model is used to simulate a rectangular room with most of the absorption located in the ceiling. This room configuration is typical for classroom conditions. The simulations are done using different boundary conditions in order to investigate the influence of phase shifts in reflections, the angle dependence of the reflection coefficient and the scattering coefficient. The focus of the simulations is to investigate the influence of the boundary condition on room acoustic measures which are important for evaluation of the acoustics in classrooms.

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Development of a pressure based room acoustic model using impedance descriptions of surfaces
If a simulation tool is to be used for the optimization of absorbent ceilings, it is important that the simulation tool includes a good description of the surface. This study therefore aims at developing a model which can describe surfaces by their impedance values and not just by their statistical absorption coefficient, thus retaining the phase and the angle dependence. The approach of the proposed model will be to calculate the pressure impulse response using a combination of the image source method and acoustic radiosity. The image source method will account for the specular reflections and acoustic radiosity will account for the diffuse reflections. This paper presents the motivation for the new model in the form of results in literature, which show the importance of retaining the angle dependence and phase information in reflections along with simple examples of angle dependent reflection from a porous absorber.

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