Session 4pAAb

Architectural Acoustics: Predictions and Simulation

Paul T. Calamia, Chair
Rensselaer Polytechnic Inst., School of Architecture, 110 8th St., Troy, NY 12180

Chair's Introduction—3:45

Contributed Papers

3:50

4pAAb1. Modifications to the diffusion model for room-acoustic prediction. Yun Jing and Ning Xiang (School of Architecture, Rensselaer Polytechnic Inst., 110 8th St., Troy, NY 12180-3590)

Recently, a diffusion model has drawn attention in room-acoustic predictions. This paper proposes possible modifications to the diffusion model to predict the reverberation times and sound pressure distributions in enclosures. While the original diffusion model [Ollendorff, Acustica **21**, 236–245 (1969); J. Piacut *et al.*, Acustica **83**, 614–621 (1997); Valeau *et al.*, JASA **119**, 1504-1513 (2006)] usually has a good performance for low absorption surfaces, the modified diffusion model, including a new boundary condition and a higher order approximation of a transport equation, yields more satisfactory results for both low and high absorption surfaces. Examples of cubic rooms, flat rooms, and long rooms with various absorption coefficients are presented for comparisons between the modified model, the original model, a geometrical-acoustics model, and several well-established theories in terms of reverberation times and sound pressure level distributions. This paper will discuss improved prediction accuracies by the modified diffusion model.

4:05

4pAAb2. Investigation of voice stage support: A subjective preference test using an auralization system of self-voice. Cheuk Wa Yuen and Paul T. Calamia (Grad. Program in Architectural Acoust., School of Architecture, Rensselaer Polytechnic Inst., 110 8th St., Troy, NY 12180, wa@amusical.org)

The human voice plays an integral role in dramatic art. The performance of singers and actors, who perceive their voice through their ears as well as bone conduction, is highly related to the acoustic condition they are in. Due to the proximity of the sound source and the spectral difference in the transmission through the skull as compared to air, a support condition different from that for musical instrumentalists is needed. This paper aims at initiating a standardization of methodology in subjective preference testing for voice stage support in order to collect more data for statistical analysis. A proposal of an acquisition/auralization system for self-voice and a set of subjective test procedures are presented. The subjective evaluation of the system is compared to previous designs reported in the literature, and the implementation is validated. A small playhouse has been measured and auralized using the system described, and subjective-preference tests have been conducted with 13 professionally trained actors. Their preferred stage-acoustic conditions (in relation to locations on stage and head orientations) are reported. The results show potential directions for further investigations and identify the necessary concerns in developing an objective parameter for voice stage support.

4:20

4pAAb3. Validation study of computer modeling of source directivity. Michelle C. Vigeant and Lily M. Wang (Architectural Eng. Prog., Univ. of Nebraska–Lincoln, Peter Kiewit Inst., 1110 S. 67th St., Omaha, NE 68182-0681, mvigeant@mail.unomaha.edu)

Previous research has focused on the changes in objective and subjective results when changing source directivity in a computer model, but little work has been done to validate these simulated changes experimentally. An investigation was carried out to compare the measured and simulated room acoustics parameters which result from using a directional sound source, a JBL Eon-10 G2 loudspeaker. Measurements were made in a 100-seat lecture-style classroom, using the sine sweep method, with (a) an omni-directional and (b) the directional loudspeaker oriented in four directions. The measured differences in reverberation time (T30) were minimal across the two source types and four orientations, while significant differences resulted for early decay time (EDT) and clarity index (C80). An ODEON v6.5 model of the classroom was calibrated against the omni-directional results to within two just-noticeable-differences (JNDs) across the three parameters of interest: T30, EDT, and C80. Simulations with the directivity of the JBL loudspeaker were then performed and the results differed by less than two JNDs from the measurements for all source-orientation/receiver combinations. In conclusion, ODEON v6.5 does accurately model the changes in room acoustic parameters which result from using different source directivities. [Work supported by the National Science Foundation.]

4:35

4pAAb4. Modeling room impulse response by incorporating speaker polar response into image source method. Zhixin Chen and Robert Maher (Dept. of Elec. and Computer Eng., Montana State Univ., Bozeman, MT 59717-3780)

Simple computer modeling of impulse responses for small rectangular rooms is typically based on the image source method, which results in an impulse response with very high time resolution. The image source method is easy to implement, but the simulated impulse responses are often a poor match to measured impulse responses because the description of the source is often too idealized to match the real measurement conditions. For example, the basic image source method has often assumed the sound source to be an omni-directional point source for ease of implementation, but a real loudspeaker may include multiple drivers and exhibit an irregular polar response in both the horizontal and vertical directions. In this paper, an improved room impulse response computer modeling technique is developed by incorporating the measured horizontal and vertical polar responses of the speaker into the basic image source method. Results show that compared with the basic image source method, the modeled room impulse response using this method is a better match to the measured room impulse response.