Session 4aAA

Architectural Acoustics and Engineering Acoustics: Acoustic Measurement Techniques

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Invited Papers

8:30

4aAA1. Measurement and *in situ* calculation of room acoustic parameters. Torben Jacobsen (Bruel & Kjaer Instruments, 121 Keeler Dr., Ridgefield, CT 06877)

Room acoustic parameters should describe the subjective evaluation of a room. The most important parameter for evaluation of acoustic comfort in a room is the reverberation time, but additional parameters are necessary for evaluation and design of concert halls and auditoria. Beside the reverberation time and EDT (early decay time) it is possible from the integrated impulse response to calculate acoustical parameters such as "early to late sound index" (clarity), "early energy fraction" (deutlichkeit), "center time," and "total sound level." These measurements and calculations are today possible to perform *in situ* by a sound level meter with application modules connected to a sound source and a lap-top computer; traditionally these measurements required a much bigger measurement system. Therefore, by means of this easy portable instrumentation, the results may be inspected in the field and additional measurements can be done if necessary. During the presentation, the above acoustical parameters are mentioned and measurement results, obtained by instrumentation from Bruel & Kjaer, from a European concert hall and from a hall in the USA are described.

8:55

4aAA2. Improved acoustical measurements with MLSSA. Douglas D. Rife (DRA Labs., 24 Halifax Ct., Sterling, VA 20165)

Two fundamental properties of MLS techniques, namely, *phase randomization* and *energy conservation* are exploited by MLSSA to achieve improved acoustical measurements. These include (1) the conversion of nonstationary interfering noise as well as weak nonlinear distortion into stationary noise and, as a consequence, (2) the possibility of correcting, as a post-processing operation, systematic errors in measured Schroeder decay plots whether due to interfering noise or transducer nonlinearities, (3) one-shot STI and RASTI measurements that properly account for contemporaneous background noise including nonstationary noise and, (4) the possibility of characterizing transducer nonlinear distortion by means of incoherency measurements that exclude, or at least attenuate, the contribution of the background noise. This last possibility is in contrast to traditional dual-channel coherence measurements that unavoidably lump together the effects of nonlinearity and noise. All of these results are demonstrated theoretically as well as experimentally using actual MLSSA measurements.

9:20

4aAA3. Measurements and analysis with SYSid. Sunil Puria (Ariel Corp., 433 River Rd., Highland Park, NJ 08904 and Res. Lab. Electron., MIT, Cambridge, MA 02139), Jont B. Allen, Gary W. Elko (AT&T Bell Labs., Murray Hill, NJ 07974), and Patricia S. Jeng (CUNY, New York, NY 10036)

To make measurements a person sometimes has the need for many different test instruments on ones bench. The philosophy behind SYSid (*SYS*tem *id*entification) is to integrate many commonly used test instruments into a single yet accurate and easy to use system. The SYSid software package runs on a DOS platform with the Ariel DSP-16+installed. The theory of operation in SYSid is simple. SYSid excites the system being measured with a stimulus and synchronously averages the measured response of the system. The stimulus can be a chirp, single tone, or multiple tones, MLS, or it can be user-defined (i.e., speech, pink noise, octave-band noise, etc.). It is important to synchronously average a system response in order to obtain accurate phase information. Synchronous averaging also allows one to measure a signal that is below the system noise floor. SYSid then uses FFT techniques to deconvolve the stimulus from the measured response and to further analyze the data. From this basic mode of operation SYSid can perform many types of analyses including phase responses, group delay, impulse response, Hilbert envelope, reverse energy time curve, RT60, waterfall displays, electrical impedance, etc. In addition to these linear measurements, SYSid also provides the capabilities to make distortion measurements due to nonlinearities in the system. These include harmonic distortion, intermodulation distortion, THD+N, input–output functions, and spectral contamination.

9:45

4aAA4. Development of a multi-beam array microphone for multi-channel pickup of sound fields and its applications to room acoustics. Ryou Ikezawa and Takashi Nishi (Auditory Sci. & Acoust. Res. Div., NHK Sci. & Tech. Res. Labs., 1-10-11, Kinuta, Setagaya-ku, Tokyo, Japan)

A new multi-beam array microphone (MAM for short) has been developed. The MAM is composed of four concentric rings, each of which has 12 microphones elements, and a common center microphone. The MAM synthesizes the output phase of each