Session 4pAA

Architectural Acoustics and Psychological and Physiological Acoustics: Perceptual Aspects of Real and Virtual Rooms

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Chair's Introduction—1:30

Invited Papers

1:35

4pAA1. Challenges and solutions for realistic room simulation. Durand R. Begault (NASA Ames Res. Ctr., M.S. 262-2, Moffett Field, CA 94035, dbegault@mail.arc.nasa.gov)

Virtual room acoustic simulation (auralization) techniques have traditionally focused on answering questions related to speech intelligibility or musical quality, typically in large volumetric spaces. More recently, auralization techniques have been found to be important for the externalization of headphone-reproduced virtual acoustic images. Although externalization can be accomplished using a minimal simulation, data indicate that realistic auralizations need to be responsive to head motion cues for accurate localization. Computational demands increase when providing for the simulation of coupled spaces, small rooms lacking meaningful reverberant decays, or reflective surfaces in outdoor environments. Auditory threshold data for both early reflections and late reverberant energy levels indicate that much of the information captured in acoustical measurements is inaudible, minimizing the intensive computational requirements of real-time auralization systems. Results are presented for early reflection thresholds as a function of azimuth angle, arrival time, and sound-source type, and reverberation thresholds as a function of reverberation time and level within 250-Hz–2-kHz octave bands. Good agreement is found between data obtained in virtual room simulations and those obtained in real rooms, allowing a strategy for minimizing computational requirements of real-time auralization systems.

2:05

4pAA2. Effects of reverberation on spatial auditory performance and spatial auditory cues. Barbara Shinn-Cunningham (Hearing Res. Ctr., Depts. of Cognit. and Neural Systems and Biomed. Eng., Boston Univ., 677 Beacon St., Boston, MA 02215) and Norbert Kopčo (Boston Univ., Boston, MA 02215)

Ordinary room echoes and reverberation influence sound localization performance, moderately degrading judgments of source direction (i.e., judgments of azimuth and elevation) while vastly improving judgments of source distance. The relative magnitude of the influence of room acoustics on localization performance depends on the location of the listener in a room; specifically, performance is best when the listener is far from any wall (when there are no early, intense echoes). However, in addition to depending on listener location, localization performance in all three spatial dimensions depends on past experience in a particular room and improves over time. This room learning (which is not seen in a comparable anechoic study) at least partially generalizes across listener positions in a room. After reviewing results of localization studies demonstrating these effects, acoustic analyses are presented that show how echoes and reverberation alter and distort the spatial acoustic cues reaching the listener in an ordinary room and how these distortions vary with listener location in the room. Possible mechanisms to explain how spatial auditory processing might adapt in different acoustic environments in order to improve localization accuracy will be discussed. [Work supported in part by AFOSR Grant F49620-01-1-0005 and the Alfred P. Sloan Foundation.]

2:35

4pAA3. The direct-to-reverberant ratio as cue for distance perception in rooms. Adelbert W. Bronkhorst (TNO Human Factors, P.O. Box 23, 3769 ZG Soesterberg, The Netherlands, bronkhorst@tm.tno.nl) and Pavel Zahorik (Waisman Ctr., Univ. of Wisconsin, Madison, WI 53705)

Although it is evident that in order to localize a sound source, one has to perceive both its direction and its distance, localization research has for many years focused mainly on the directional component. This situation has changed in the last few years. Recent studies have provided more insight into distance perception and the specific cues that are used by the auditory system. It appears that auditory and visual distance perception are similar, because both rely on a combination of cues, which are weighted differently in different environments. One auditory cue that has received particular attention is the direct-to-reverberant energy (D/R) ratio, because it is thought to be relatively stable, particularly in rooms. At present, however, it is not clear what the precise contribution of this cue