Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Determination of optimal HRTF's for binaural synthesis

Christensen, Flemming; Møller, Henrik; Olesen, Søren Krarup; Minnaar, Pauli

Link to publication from Aalborg University

9:00

3aSP4. Determination of optimal HRTFs for binaural synthesis. Flemming Christensen, Henrik Moeller, Soeren K. Olesen, and Pauli Minnaar (Aalborg Univ., Fredrik Bajersvej 7B4, DK-9220 Aalborg OE, Denmark, acoustics@kom.auc.dk)

Earlier studies have shown that a carefully selected human substituting an artificial head can minimize the amount of localization errors for a group of people in a listening experiment, thus indicating that a set of head-related transfer functions (HRTFs) can be found, which to some extent fits a population. This study aims at exploring ways of designing such general sets of HRTFs suitable for larger populations. An effort is put into considering the importance of, e.g., different frequency regions of the transfer functions in order to focus on the most general characteristics and avoid focusing attention on highly individual features. The physical origin of the different parts of the HRTFs will be taken into consideration, and HRTF design methods using parameters derived through signal analysis will be studied.

9:20

3aSP5. The effects of source characteristics on the auditory localization of nearby sources. Douglas S. Brungart (Air Force Res. Lab., 2610 Seventh St., Wright–Patterson AFB, OH 45433-7901, brungart@falcon.al.wpafb.af.mil) and Nathaniel I. Durlach (MIT, Cambridge, MA 02139)

A series of recent experiments has examined the auditory localization of a nearby (<1 m) sound source under four conditions: (1) a fixed-amplitude condition where loudness-based distance cues were available; (2) a monaural condition where the contralateral ear was occluded by an ear-plug and muff; (3) a high-pass condition where the stimulus bandwidth was 3 Hz–15 kHz; (4) a low-pass condition where the stimulus bandwidth was 200 Hz–3 kHz. The results of these experiments were compared to those of a previous experiment that measured localization performance for a nearby broadband, random-amplitude source [Brungart *et al.*, J. Acoust. Soc. Am. **102**, 3140(A) (1997)]. Directional localization performance in each condition was consistent with the results of previous far-field localization experiments. Distance localization accuracy improved slightly in the fixed-amplitude condition, especially near the median plane, but was severely degraded in the monaural condition. Distance accuracy was also found to be highly dependent on the low-frequency energy of the stimulus: in the low-pass condition, distance accuracy was similar to that in the broadband condition, while in the high-pass condition, distance accuracy was significantly reduced. The results suggest that low-frequency interaural intensity differences are the dominant auditory distance cue in the near-field.

9:40

3aSP6. Role of two ears in upper hemisphere localization. Masayuki Morimoto (Environ. Acoust. Lab., Faculty of Eng., Kobe Univ., Nada, Kobe, 657-8501 Japan, mrmt@kobe-u.ac.jp)

It is well known that the elevation of a sound source is determined by spectral cues in the median plane, where the input signals to both ears are regarded as being identical. It is, however, still a problem how the elevation of a sound source is determined in any plane apart from the median plane, because the input signals to both ears are not identical. This paper investigates how the input signals to the left and right ears contribute to determine the elevation of a sound source at any position in the upper hemisphere. The localization tests regarding the elevation in five planes parallel to the median plane were performed. In the localization tests, pinna cavities of both or one of two ears were occluded. The results indicate that both ears play a role in determining the elevation of a sound source in any plane. Furthermore, they infer that the summation of spectral features of input signals to the left and right ears contributes to determine the elevation.

10:00–10:20   Break

10:20

3aSP7. Generation of binaural information using cross ambiguity functions. Michiaki Uchiyama and Mikio Tohyama (Kogakuin Univ., Bldg. 5-603, Nakano-machi 2665-1, Hachioji-shi, Tokyo, 192-0015 Japan)

This paper describes a method to generate binaural information. First of all, the accuracy of a conventional linear interpolation was examined by using signal-to-deviation ratio (SDR) and spectrum distortion. It was found that the accuracy of left and right direction HRTFs ($60-120°$) did not deteriorate despite the presence of a wide directional interval (SDR $\cong$ 23 dB). However, the accuracy of front and back direction HRTFs ($0--60°$ and $120-180°$) deteriorated as the interval broadened. For the shade-side ear's HRTFs, particularly, it was confirmed that the accuracy of linear interpolation deteriorated dramatically (SDR$\cong$8 dB). Therefore, a method was investigated for generating a shade-side ear's HRTF by using cross ambiguity functions (CAFs) whose model is related to dichotic listening. A shade-side HRTF could be generated with about a 10-dB SDR from a sunny-side HRTF, while the SDR becomes about 8 dB for a conventional linear interpolation estimation method. In this paper, the independence of HRTFs is also discussed, using the singular value decomposition from the point of view that it is possible to generate a new vector from a linear combination of vectors. In this article the accuracy of a linear interpolation from a base of HRTFs by SDR and spectrum distortion is examined.

10:40

3aSP8. Audition and the sense of presence in virtual environments. R. H. Gilkey, B. D. Simpson, S. K. Isabelle, A. J. Kordik (Dept. of Psych., Wright State Univ., Dayton, OH 45435), and J. M. Weisenberger (Ohio State Univ., Columbus, OH 43210)

Historical reports from suddenly deafened adults describing a sense of detachment from a world devoid of auditory input suggest that auditory cues may be crucial for achieving a sense of presence in virtual environments [R. H. Gilkey and J. M. Weisenberger, Presence **4**, 357–363 (1995)]. However, factors other than acoustic fidelity can affect the perceived quality of a virtual auditory display. For example, Simpson *et al.* [J. Acoust. Soc. Am. **100**, 2633(A) (1996)] showed that the sense of presence in virtual auditory environments was driven by characteristics of the real listening environment in which the virtual audio was heard. Specifically, when