

1. Subjects and directions of a sound source

Subjects are 61 Japanese adults. The directions of a sound source are: (a) the upper median plane in 30° steps (all of 61 subjects), (b) the upper median plane and the horizontal plane in 30° steps (29 subjects), (c) the upper hemisphere in 30° steps of azimuth and elevation (15 subjects), (d) the upper hemisphere in 30° steps of lateral and vertical angles (8 subjects).

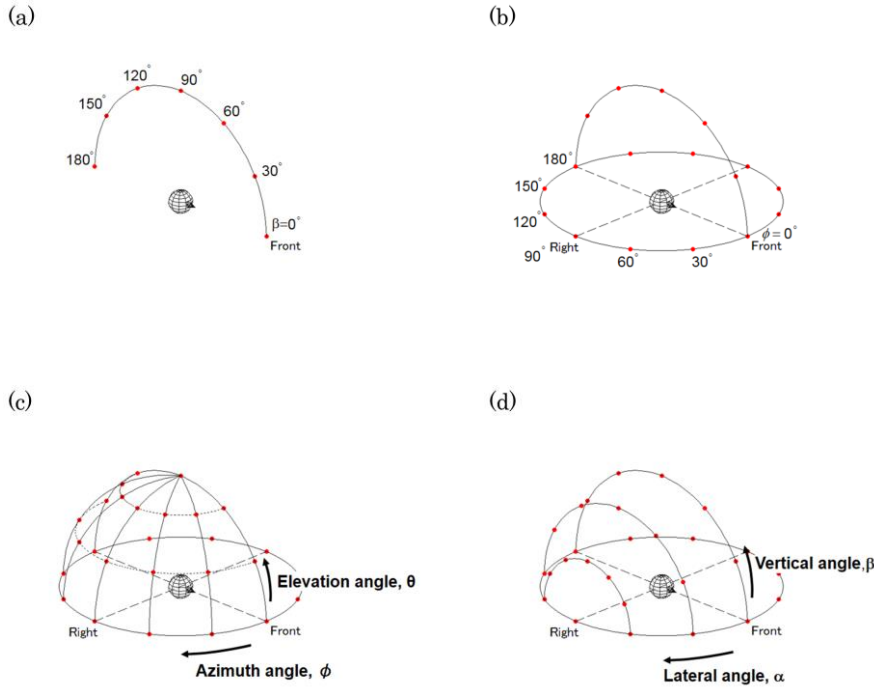


Fig. 1 Directions of a sound source

2. Methods of HRTF measurements

The HRTFs were measured in an anechoic chamber. The test signal was a swept sine wave (2^{18} samples). The sampling frequency was 48 kHz. The test signal was presented by one of the loudspeakers of 80 mm in diameter (FOSTEX FE83E) located in the upper median plane in 30° steps (seven directions). The distance from the loudspeakers to the center of the subject's head was 1.2 m. No frequency equalization was performed.

Ear microphones, miniature electret condenser microphones of 5 mm in diameter (Panasonic WM64AT102) embedded in the silicon resin (Fig. 2(a)), were used to pick up the test signals. The ear microphones were placed into the ear canals of the subjects, then the diaphragms of the microphones were located at the entrances of the ear canals

(Fig. 2(b)). This condition is referred to as the blocked-entrances condition (Shaw and Teranishi, 1968). For details of the ear microphones, see Iida *et al.* (2014).

The HRTF was obtained as

$$HRTF_{l,r}(\omega) = G_{l,r}(\omega)/F(\omega)$$

where $F(\omega)$ is the Fourier transform of the impulse response, $f(t)$, measured at the point corresponding to the center of the subject's head in the free field without a subject, and $G_{l,r}(\omega)$ is that measured at the entrance of the ear canal of the subject with the ear microphones.

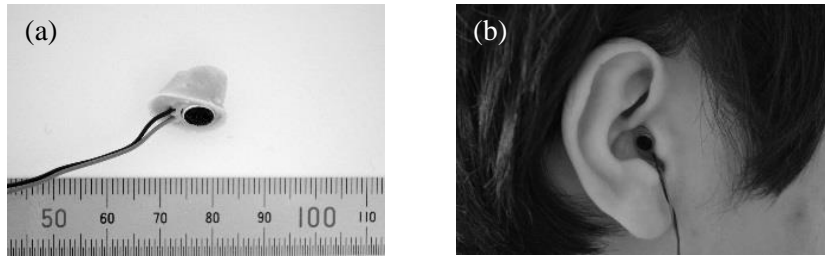


Fig. 2 Photographs of (a) an ear microphone and (b) its placement into the ear canal of a subject.

3. Apparatus for HRTF measurements

- PC: XPS 1340 (DELL)
- Audio-interface: Fireface400 (RME)
- Amplifier: HC1500 (YAMAHA)
- Speaker-selector: AS-5III (LUXMAN)
- Loudspeaker: FE83E (Fostex)
- Microphone: WM64AT102 (Panasonic)
- A/D converter: M-10MX (Roland)

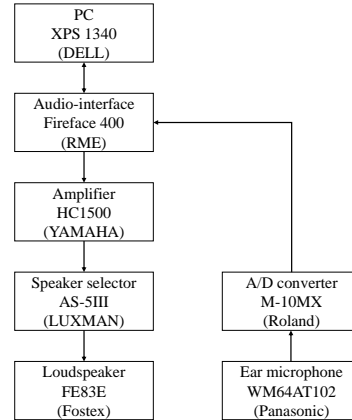


Fig. 3 Apparatus for measurements

4. N1, N2, and P1 frequencies

The prominent spectral peaks and notches are the cues for vertical localization. The first spectral peak around 4 kHz (P1) and the two lowest spectral notches (N1 and N2) above the P1 frequency in the HRTFs for the front direction (both lateral and vertical angles are 0°) were extracted. Since N1, N2, and P1 are generated by the pinnae (Shaw and Teranishi, 1968; Lopez-Poveda and Meddis, 1996; Takemoto *et al.*, 2012), they were

extracted from the early part of the head-related impulse response (HRIR). N1, N2, and P1 of 120 ears (two ears in 59 subjects and one ear in two subjects) were obtained. Two of the 122 ears have only one notch in the spectrum of HRTFs. For details of the extraction algorithm, see Iida *et al.* (2014).

5. Ten anthropometric parameters of the pinna

Ten anthropometric parameters of the pinna, shown in Fig. 4 and Table 1, were measured for 59 subjects (28 subjects for x_a). Nine anthropometric parameters (x_1 through x_8 and x_d) of the pinna were measured using a vernier caliper. The tilt of the pinna (x_a) was measured from a photograph of the profile of the subject.

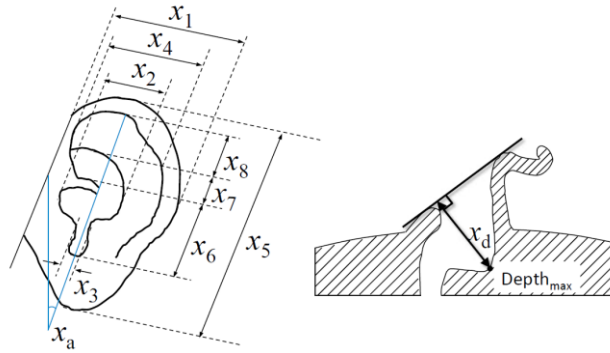


Fig. 4 Ten anthropometric parameters of the pinna

Table 1 Name of ten anthropometric parameters.

Width of				Length of				Depth of	Tilt of
pinna	concha	incisura intertragica	helix	pinna	concha	cymba conchae	scapha	concha	pinna (°)
x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_d	x_a

6. Notice

The CIT HRTF database is limited to research use only. Use of the database should be acknowledged in the publication when the database is used in research activities.

For use of the commercial products, contact by an e-mail is required to be sent to: kazuhiko.iida[at]it-chiba.ac.jp.

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References

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