The FABIAN head-related transfer function data base

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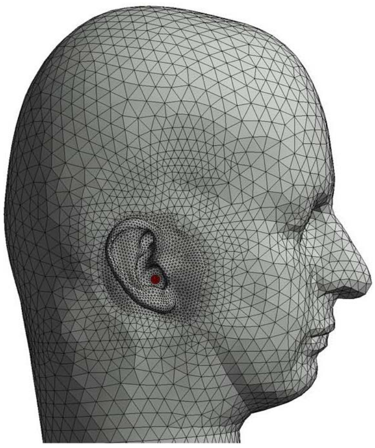


General Information

In the following, The FABIAN [1] head and torso simulator database is described in detail. It is provided under a Creative Commons BY-NC-SA licence, giving you the freedom to redistribute and edit the database for non-commercial purposes if you give credit to the original version and authors. For more information visit http://creativecommons.org/licenses/by-nc-sa/4.0/, and contact the authors for commercial use.

Data base description

1 HRIRs contains head-related impulse responses (HRIRs) for 11 head-above-torso orientations (HATO). They are stored in the SOFA format [2] and can for example be read using the Matlab/Octave API [3]

```
hrir = SOFAread('FABIAN_HRIR_measured_HATO_50.sofa');
```

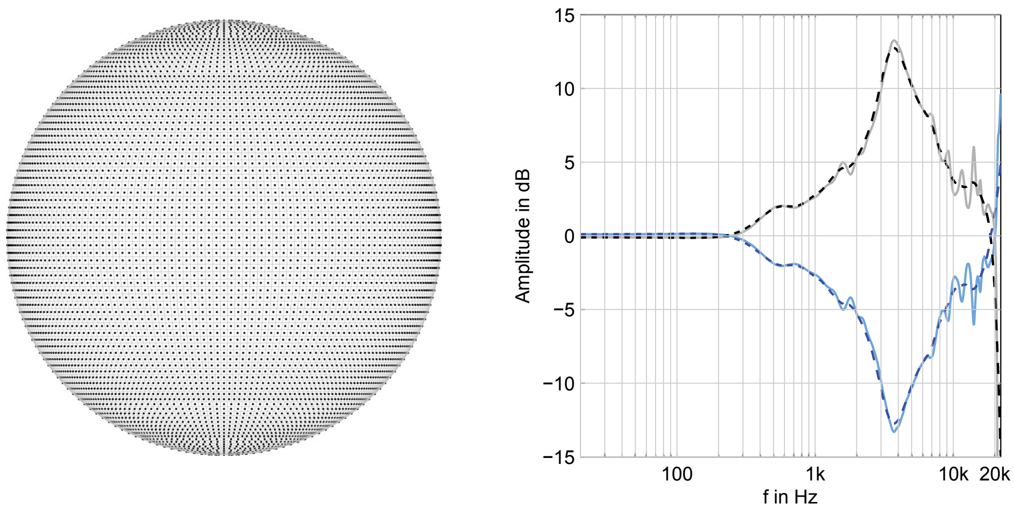
HATOs of 50° and 310° denotes that the head was moved 50° to the left and right, respectively. In the SOFA coordinate convention azimuth angles $\phi = \{0, 90, 180, 270\}^\circ$ specify sources to the front, left, back, and right, and elevation angles $\theta = \{90, 0, -90\}^\circ$ sources above, in front, and below.

The HRIRs are accompanied by minimum phase common transfer functions (CTFs). They were calculated by a weighted root-mean-square average of the HRTF magnitude spectra (HRTFs – frequency domain equivalent of HRIRs) across ϕ, θ, and HATO [4]. Weights were estimated by calculating the area of spherical rectangular segments placed around each sampling point as shown in Figure 1a.

For convenience, spherical harmonics coefficients [5] up to order $N = 35$ are also given. The were calculated based on the complex HRTF and DTF (Directional Transfer Function) magnitude spectra. DTFs were obtained by convoluting the HRIRs with the inverted and 3rd octave smoothed CTF (cf. Figure 1b).

AKtools [6] for Matlab can be used to interpolate HRIRs at arbitrary source positions, and HATOs [7]. E.g. left and right ear HRIRs for $\phi = 45°$, $\theta = 15°$, and HATO = 10° are calculated by

```
[l, r] = AKhrirInterpolation(45, 15, 10, 'measured_sh');
```



(a) (b)

Figure 1: (a) Spatial sampling points (dots) and spherical rectangles used to calculate the weights for CTF calculation. (b) CTFs calculated from measured HRTFs, and averaged across head-above-torso orientation. Light grey, and black dashed line: CTF, and 3rd octave smoothed CTF. Light blue, and dashed blue line: Inverted, and 3rd octave smoothed.

2 SurfaceMeshes contains 3D surface meshes for all head-above-torso orientations in to resolutions, that can be used for numerical simulations up to 6 kHz and 22 kHz, respectively. BEM simulations were carried out on meshes with rigid surface impedances that were cut at the torso bottom (cf. Figure 2). Prior to this, the influence of an slightly absorbing torso bottom, as well as absorbing legs was tested but found to be negligible.

Figure 2: 3D surface meshes of FABIAN for numerical simulations up to 6 kHz, and head-above-torso orientations from -50° (left) to 50° (right).

3 Headphones provides headphone filters for equalization of a large variety of commonly used studio, and hi-fi headphones (cf. Figure 3). The filters should be applied when listening to HRIR based auralizations, but could be omitted if using DTF based signals. They were calculated based on 10-12 headphone impulse responses (HpIR) that were measured using swept sines. Headphones were reseated after each measurement. The headphone filters were designed using `AKregulatedInversion.m` from *AKtools* [?] for Matlab by manually designing a regularisation function comprised of high-shelves, low-shelves, and parametric EQs. For convenience, the HpIRs and a plot documenting the filter calculation process are also included in the database.

Figure 3: Sennheiser HD600 headphones on FABIAN.

4 Auralization contains different auralizations for listening to the dataset after reading all the previous paragraphs and looking at the shiny pictures:

AnechoicFixed holds auralizations of a single source comparing (a) original HRIRs to their spherical harmonics based counterparts, and (b) measured to modeled HRIRs.

AnechoicMoving holds auralizations of moving sources in the horizontal , median, and frontal plane, and for comparing head-above-torso movements to source movements.

ReverberantFixed holds auralizations for a fixed source and receiver in the Concertgebouw (Amsterdam, Netherlands) for comparing measured and modeled HRIRs.

Free field auralizations (anechoic) were rendered with *AKtools* [6] for Matlab, and the scripts for generating them are contained in the corresponding folders. The auralization of the reverberant environment are based on room acoustic simulation with RAVEN [8].

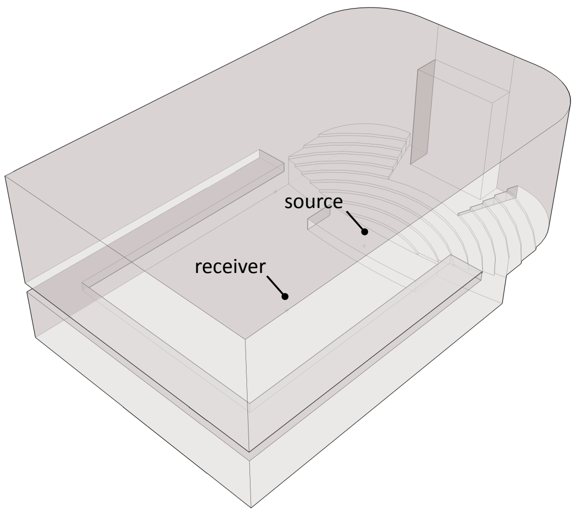


Figure 4: 3D model of the Concertgebouw, Amsterdam, Netherlands.

References

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