

# The HUTUBS HRTF database

— Documentation —

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## General information

This documentation describes the data structure and use of the HUTUBS head-related transfer function (HRTF) database. The data is provided under the free culture CC BY license that grants unlimited access for everyone. The license can be viewed under <https://creativecommons.org/licenses/by/4.0/>. If you use this data please reference

Fabian Brinkmann, Manoj Dinakaran, Robert Pelzer, Peter Grosche, Daniel Voss, and Stefan Weinzierl (2019). “A Cross-validated database of measured and simulated HRTFs including 3D head meshes and anthropometric features.” *J. Audio Eng. Soc.*

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All relevant information on the acquisition and validation of the database can be found in the article above.

## Database

This section describes the structure of the HUTUBS data and how to access it. The database contains 96 subjects. Subject 1 and 96 are repeated measurements of the FABIAN head and torso simulator (Lindau *et al.*, 2007), and subject 22 and 88 are repeated measurements of a human subject. Besides acoustically measured and numerically simulated head-related impulse responses (HRIRs), the database contains head-phone impulse responses (HpIRs) for two different headphone models, anthropometric measures, and 3D head meshes. The table below gives an overview about the data that is available for each subject. Two different Sennheiser HD800S headphones were used during the acquisition of the database, which is indicated by the letters in the corresponding fields. Shaded fields indicate that the corresponding subject did not consent to publish that part of the dataset. In total, 96 HRIR sets, 96 HpIRs of the Sennheiser HD800S, 64 HpIRs of the Sennheiser HD650, 93 sets of anthropometric measures and 58 head meshes are available.

Subject ID	HRIRs	HpIRs HD800S	HpIRs HD650	Anthropometry	Head mesh
1	a	a			
2	a	a			
3	a	a			
4	a	a			
5	a	a			
6	a	a			
7	a	a			
8	a	a			
9	a	a			
10	a	a			
11	a	a			
12	a	a			
13	b				
14	b				
15	b				
16	a	a			
17	b				
18	b				
19	a	a			
20	a	a			
21	a	a			
22	a	a			
23	a	a			
24	b				
25	b				
26	b				
27	b				
28	b				
29	a	a			
30	a	a			
31	a	a			
32	a	a			
33	a	a			
34	b				
35	b				
36	b				
37	b				
38	b				
39	b				
40	a	a			
41	a	a			
42	b				
43	b				
44	a	a			
45	a	a			
46	a	a			
47	a	a			
48	a	a			
49	a	a			
50	b				
51	b				
52	b				
53	b				
54	b				
55	a	a			
56	b				
57	a	a			
58	a	a			
59	a	a			
60	a	a			
61	a	a			
62	a	a			
63	a	a			
64	b				
65	b				
66	a	a			
67	a	a			
68	a	a			
69	a	a			
70	a	a			
71	a	a			
72	a	a			
73	a	a			
74	b				
75	a	a			
76	a	a			
77	a	a			
78	a	a			
79	a	a			
80	a	a			
81	a	a			
82	a	a			
83	b				
84	b				
85	b				
86	b				
87	b				
88	a	a			
89	a	a			
90	a	a			
91	a	a			
92	a	a			
93	a	a			
94	a	a			
95	a	a			
96	a	a			

## Head-related impulse responses – HRIRs

This folder contains the measured and simulated HRIRs. They are stored in SOFA files according to AES-69 (AES Standards Committee, 2015), and in Matlab files that contain spherical harmonics coefficients. The SOFA files contain HRIRs at the source positions shown in Fig. 1. This is also the data that was used to obtain the spherical harmonics coefficients. There are different options to access the data. The easiest and most flexible possibility is to use the open Matlab toolbox AKtools (Brinkmann and Weinzierl, 2017). To get started download AKtools from [www.ak.tu-berlin.de/AKtools](http://www.ak.tu-berlin.de/AKtools). To add AKtools to Matlab, open Matlab, navigate to the folder where AKtools is stored. Then go to the Matlab Command Window and type

```
AKtoolsStart.m
```

to add AKtools to your Matlab search path. To add the HRIRs to the search path type

```
addpath( genpath( path/to/the/database ) )
```

If you want to save your search path to make AKtools and the HUTUBS HRTF database permanently available type

```
savepath
```

to obtain HRIRs you can now type

```
hrirs = AKhrirDatabase( 'pp1_measured_ir', [90 0] ),
```

which will load the measured HRIR from the SOFA file of participant 1 that is closest to the specified source positions (azimuth  $\phi = 90^\circ$ , elevation  $\theta = 0^\circ$ ). To obtain HRIRs at arbitrary source positions by means of spherical harmonics interpolation use

```
hrirs = AKhrirDatabase( 'pp1_measured_sh', [17 -23] ),
```

and to obtain numerically simulated HRIRs type

```
hrirs = AKhrirDatabase( 'pp1_simulated_sh', [17 -23] ).
```

For information about additional input and output parameters type

```
help AKhrirDatabase.
```

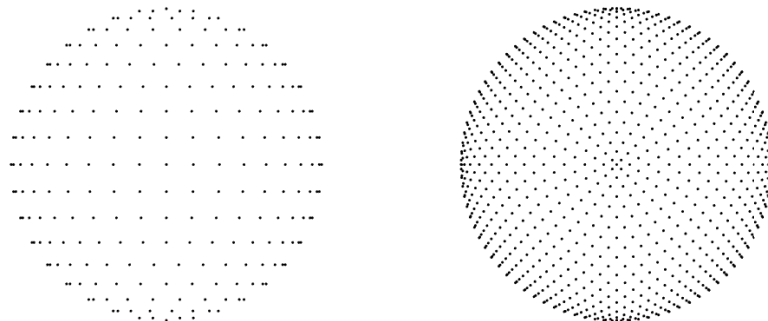


Figure 1: Sampling grids for measured (left) and simulated (right) HRIRs with 440, and 1730 sampling points, respectively.

Alternatively, the data can be loaded directly with

```
hrirs = SOFALoad( 'pp1_HRIRs_measured.sofa' );, and  
sh = load( 'pp1_SHcoefficients_measured.mat' );
```

The structure of the HRIRs in the SOFA files is in accordance with the [AES Standards Committee \(2015\)](#). The structure of the spherical harmonics coefficients is similar, and the coefficients themselves are stored in the matrices `sh.HRIR.coeffLeft`, and `sh.HRIR.coeffRight`. They hold the coefficients for each frequency  $f$ , SH order  $n$ , and SH degree  $m$ , which are stored in `sh.HRIR.f`, `sh.HRIR.n`, `sh.HRIR.m`.

## Headphone impulse responses – HpIRs

This folder contains measured headphone impulse responses (HpIRs) for all subjects and up to two headphones. They are stored in SOFA files ([AES Standards Committee, 2015](#)). After adding AKtools and the HRTF database to your Matlab search path as described in the previous section, HpIRs of the Sennheiser HD800s and participant 1 can be loaded by going to the Matlab or Octave Command Window and typing

```
hpirs = SOFALoad( 'pp1_HD800S.sofa' );
```

## Anthropometric measures

The anthropometric measures are stored in a text file. The corresponding PDF file gives the assignment of the short name to the complete names of each measure. The definition of the measures is shown in Fig. 2.

## 3D head meshes

The head meshes are stored in ply files and can for example be loaded with the open software tools [Blender](#) and [MeshLab](#).

## Figures

Contains three figures for each participant for comparing measured and simulated HRTFS

`pp#_HorizontalPlane` shows measured and simulated HRIRs and HRTFs in the horizontal plane.

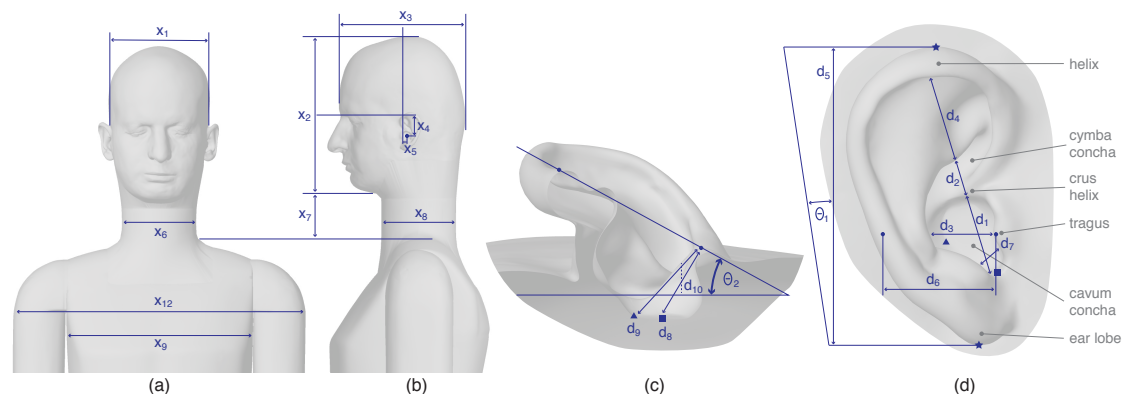


Figure 2: Definition of anthropometric measures.

pp#\_selected\_HRTFs shows magnitude spectra of measured and simulated HRTFs at four positions on the horizontal plane.

pp#\_difference shows spectral differences between measured and simulated HRTFs in auditory filters, and differences between inter aural time delays.

## References

AES Standards Committee (2015). *AES69-2015: AES standard for file exchange - Spatial acoustic data file format* (Audio Engineering Society, Inc.).

Brinkmann, F., and Weinzierl, S. (2017). “AKtools – An open software toolbox for signal acquisition, processing, and inspection in acoustics,” in *142nd AES Convention, Convention e-Brief 309*, Berlin, Germany.

Lindau, A., Hohn, T., and Weinzierl, S. (2007). “Binaural resynthesis for comparative studies of acoustical environments,” in *122th AES Convention, Convention Paper 7032*, Vienna, Austria.