Ambisonics Directional Room Impulse Response as a New SOFA Convention

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144th AES Convention
25th May 2018
Outline

Introduction
  Presentation

Ambisonics DRIRs
  Ambisonics DRIRs

SOFA
  SOFA
Outline

Introduction
  Presentation

Ambisonics DRIRs
  Ambisonics DRIRs

SOFA
  SOFA
Presentation

About us

https://binci.eu/
info@binci.eu
Main objectives of BINCI project:

- Developing production tools to encourage the creation of binaural contents
- Creating three binaural productions showcased and tested in three cultural and touristic sites
- Integrating software and hardware solutions for a complete immersive audio experience
BINCI
St Andrews Castle
BINC
Die Alte Pinakothek
BINCI
Fundació Miro
Outline

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Ambisonics DRIRs
  Ambisonics DRIRs

SOFA
  SOFA
Ambisonics DRIRs
Impulse Responses

HOW?

- Logarithmic sweep sine technique for recording the RIR\(^1\)
- All microphone's capsules recording at the same time, for each source position
- A to B format conversion either on live inputs or in post-processing
- Impulse is obtained after deconvolution on each Ambisonics channel
- Each source position is measured using a combination of laser meters that give the azimuth, elevation and distance

\(^1\)Simultaneous Measurement of Impulse Response and Distortion with a Swept-Sine Technique, A. Farina, Proc. AES 108th conv, Paris, France
Ambisonics DRIRs
Impulse Responses

WHAT FOR?

- Auralization ²
- Room acoustics analysis ³ and modelling ⁴
- Recording room acoustics for posterity ⁵

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² Object-based reverberation encoding from first-order Ambisonic RIRs, P. Coleman, A. Franck, D. Menzies, P. Jackson, Proceedings of the 142nd AES Convention, Berlin, Germany
³ Measurement of 3D Room Impulse Responses with a Spherical Microphone Array, J.J. Embrechts, Euronoise 2015
⁴ Diffuse Field Modeling Using Physically-Inspired Decorrelation Filters: Improvements to the Filter Design Method, D. Romblom, JAES, Vol. 65, No. 11, November 2017
⁵ Recording Concert Hall Acoustics for Posterity, M. Gerzon, JAES Volume 23 Issue 7 pp. 569, 571; September 1975
Ambisonics DRIRs

Eurecat: 3D Tent
Outline

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Ambisonics DRIRs

SOFA
Different conventions for different HRTF datasets...
SOFA
The problem (again)

Kemar (diffuse)
SOFA
The problem (again)

SADIE (Subject 001)

AES69-2015 Standard
SOFA

SOFA Conventions

SOFA (Spatially Oriented Format for Acoustics)

SOFA is a file format for storing spatially oriented acoustic data like head-related transfer functions (HRTFs) and binaural or directional room impulse responses (BRIRs, DDIRs). SOFA has been standardized by the Audio Engineering Society (AES) as AES150-2015. This website aims at providing SOFA-relevant information.

- General information on SOFA
- SOFA specifications

SOFA conventions are designed for a consistent description of data stored in SOFA. The aim is the exchange of the data between researchers and users. For each conventions, data exist from corresponding measurement setups and its description has been accepted by the peer group. Suggestions for new SOFA conventions and additions to existing ones are highly welcome.

- SOFA conventions

List of repositories with SOFA files containing HRTFs, BRIRs, and DDIRs measured by different researchers. New: Aachen HRTF database with anthropometric data

- Files (HRTFs, BRIRs, DDIRs, HRTFs)

SOFA files can be read and modified by software and application-programming interfaces (APIs). New: WebSofa

- Software and APIs

SOFA is result of the work of many people from various institutions.

- People behind SOFA
The problem (again)

Different conventions for different AmbisonicsDRIR datasets...
SOFA

The problem (again)

Main Church (S3A)
SOFA
The problem (again)

Guildhall Court Chamber (OpenAIR)
SOFA
The problem (again)

QMUL Octogon (Isophonics)

Download
All files are zip files. Each IR is a 96 kHz, 32 bit wav file.

- Documentation (photo of room, diagram of layout) and sample IR (1.8 MB)
- Omnidirectional (60.3 MB)
- W of B-format (64.3 MB)
- X of B-format (64.5 MB)
- Y of B-format (63.4 MB)
- Z of B-format (62.9 MB)
Candidates?

Requirements:

1. Multiple speakers
2. Multiple microphone positions
3. Audio in Ambisonics domain
4. Ambisonics-related information
Candidates?

Convention candidates:
- SingleRoomDRIR
SOFA
Candidates?

Convention candidates:
  - SingleRoomDRIR
  - MultiSpeakerBRIR
Candidates?

Convention candidates:

- SingleRoomDRIR
- MultiSpeakerBRIR
- GeneralFIRE
AmbisonicsDRIR convention (v0.1)
Based on *GeneralFIRE*, with following additions:

- **Global attributes**: `AmbisonicsOrder`, `AmbisonicsMicrophoneModel`, `AmbisonicsConversionMethod`
- **Variables**: `ListenerUp`, `ListenerView`, `EmitterUp`, `EmitterView`
- **Data attributes**: `ChannelOrdering`, `Normalization`
SOFA
Proposal

Data type: FIRE

- $M$: Number of measurements (Listener positions)
- $R$: Number of Receivers (Ambisonics channels)
- $E$: Number of Emitters (speakers)
- $N$: Number of audio samples
SOFA

Examples

Main Church (S3A)
## SOFA

### Examples

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<tr>
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<th>Ls2</th>
<th>Ls3</th>
<th>Ls4</th>
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<th>Ls7</th>
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</tr>
</tbody>
</table>
Examples

- $M$: 1
- $R$: 4
- $E$: 10
- $N$: 65536
- $ListenerView$: [0, 1, 0] (type: cartesian, unit: meter)
SOFA

Examples

Guildhall (OpenAIR)
SOFA
Examples

- $M$: 4
- $R$: 4
- $E$: 3
- $N$: 480000
QMUL Octogon (Isophonics)
SOFA

Examples
SOFA
Examples

- $M$: 169
- $R$: 4
- $E$: 1
- $N$: $n$
Matlab/Octave API:
https://github.com/jdemuynke/API_MO

C++ API:
https://github.com/andresperezlopez/API_Cpp
Thanks.

Questions?