Ambisonics & the ATK @ DXARTS

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Ambisonics & the ATK @ DXARTS

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Pacific Northwest Section of the AES
Wednesday, November 15, 2017
University of Washington, Raitt Hall 121
Seattle, WA, USA
Assigned Reading

Ambisonics is...

Holographic

Periphonic

Isotropic

Rational

“Scene based”

Convenient

Hierarchical
Ambisonic Vocabulary

- order
- encoding
- decoding
- B-format
- NFC
- A-format
- HOA
Ambisonic Flavors

“Classic” B-format, aka Gerzonic
- FOA

Furse-Malham, aka FuMa
- HOA ($\leq 3^{rd}$)

AmbiX
- HOA

ACN-N3D (with NFC)
- HOA
Some other software solutions...

Production
- Blue Ripple Sound — Pro Audio
- ambiX — Ambisonic plug-in suite

Research
- Higher Order Ambisonics Library
- Ambisonic Decoder Toolbox
- Sound Field Synthesis Toolbox
- SOFiA
ATK @ DXARTS

DXARTS Sound Lab – Mid-field Spherical Array

DXARTS Sound Lab – Near-field Hemi-spherical Array

DXARTS Media Lab – Mid-field Hemi-spherical Array

DXARTS Sound Lab – Loudspeaker Measurement & Correction
ATK Platforms
ATK Objectives
ATK: ‘Think Ambisonic!’
ATK Paradigm

Author

encoder

transformer

decoder

Image

Monitor

microphone

microphone array

synthesiser(s)

virtual speaker array

3D speaker array

2D speaker array

stereo array

headphones
Encoding: Soundfield Authoring

\[
\begin{pmatrix}
\frac{1}{\sqrt{2}} \\
\cos \phi \cos \theta \\
\cos \phi \sin \theta \\
\sin \phi 
\end{pmatrix}
\]

OUTRS tetrahedral microphone array, courtesy Stephen Thornton (www.michaelgerzonphotos.org.uk)

Soundfield microphone, Soundfield Ltd. (soundfield.com)
Encoding: Soundfield Authoring

Encoding Mono using ATK for Reaper
**A-format & B-format: ‘Think Ambisonic’**

- Synthesise complex soundfields
- Process soundfields

\[ S_{FLU} = \frac{1}{2} \begin{pmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & 1 & -1 \\ 1 & -1 & -1 & 1 \end{pmatrix} \]
Soundfield Authoring: ‘Think Ambisonic’

Synthesis
- In A-format
- Diffuse / active soundfield
- Followed by imaging

Synthesiser
- $\text{Synth}_{fu}$
- $\text{Synth}_{rd}$
- $\text{Synth}_{bd}$
- $\text{Synth}_{bru}$

A-format to B-format

Imaging Transform

$W$ $X$ $Y$ $Z$
**Soundfield DAFX: ‘Think Ambisonic’**

Audio Effects
- Process in A-format
- Preserve imaging
- Effect complete soundfield → Ambisonic DAFX!

![Diagram showing process from B-format to A-format with DAFX effects.](image)
**ATK Imaging: Zoom**

- Zoom Transform
- Dominance
- Reshape Soundfield

\[
Z_{X,\alpha} = \begin{pmatrix}
1 & \frac{1}{\sqrt{2}} \sin \alpha & 0 & 0 \\
\sqrt{2} \sin \alpha & 1 & 0 & 0 \\
0 & 0 & \cos \alpha & 0 \\
0 & 0 & 0 & \cos \alpha
\end{pmatrix}
\]
**ATK Imaging: Focus**

- Focus Transform
- Dominance
- Reshape Soundfield

\[
\mathbf{F}_{X,\alpha} = \begin{pmatrix}
\frac{1}{1 + \sin |\alpha|} & \frac{1}{\sqrt{2}} \left( \frac{\sin \alpha}{1 + \sin |\alpha|} \right) & 0 & 0 \\
\frac{\sin \alpha}{1 + \sin |\alpha|} & \frac{1}{1 + \sin |\alpha|} & 0 & 0 \\
0 & 0 & \frac{\cos \alpha}{1 + \sin |\alpha|} & 0 \\
0 & 0 & 0 & \frac{\cos \alpha}{1 + \sin |\alpha|}
\end{pmatrix}
\]
**ATK Imaging: Push**

- **Push Transform**
- **Two metaphors:**
  - Spatial Shelving-Filter
  - Re-align Tetrahedron
- **Reshape Soundfield**

\[
U_{X,\alpha} = \begin{pmatrix}
1 & 0 & 0 & 0 \\
\sqrt{2} \sin |\alpha| \sin \alpha & \cos^2 \alpha & 0 & 0 \\
0 & 0 & \cos^2 \alpha & 0 \\
0 & 0 & 0 & \cos^2 \alpha
\end{pmatrix}
\]
Decoding: Soundfield Monitoring

\[
\begin{pmatrix}
\alpha_i \\
\beta_i \\
\gamma_i
\end{pmatrix}
= \frac{1}{\sqrt{2}} nk \left[ \sum_{j=1}^{n} \begin{pmatrix}
x_j^2 & x_j y_j & x_j z_j \\
x_j y_j & y_j^2 & y_j z_j \\
x_j z_j & y_j z_j & z_j^2
\end{pmatrix} \right]^{-1}
\begin{pmatrix}
x_i \\
y_i \\
z_i
\end{pmatrix}
\]
ATK Produced Works...

epiphanie sequence

20 Odd Years
music for flute(s) & live electronics

Performed by:
Jos Zwaanenburg

Composed by:
Jonny Harrison
Alistair MacDonald
Stephen Montague
Roger Marsh
Tim Howie
Mike Vaughan
Paul Dibley
Michael Young
ATK Produced Works...
ATK Produced Works...

Jonty Harrison – Espaces cachés

Possible set-up for Jonty Harrison – hcm/ 2015 (tbc)

Joseph Anderson — November 15, 2017

ATK @ DXARTS — PNW Section of the AES
ATK in Action...

End of month!
ATK in Practice

Ambisonic Toolkit
(SuperCollider Library)
Quick Look
ATK in Practice

Ambisonic RIR from the Fort Worden Cistern
Ewa Trebacz & Josiah Boothby

Seattle P-I
ATK in Practice

VR & Holographic Sound Synthesis with the ATK

Daniel Peterson & Martin Jarmick
ATK in Practice

AmbiVerbSC: An Ambisonic tank reverb model for SC3

James Wenlock
ATK, Future Development...

Coming Soon (SC3)...
- Soundfield Analysis
- Soundfield (matrix) transform display

On the Horizon...
- T-design A-format
- ADT integration
- Revised beam-forming model
- HOA-NFC! (SC3 & Csound)
ATK, WTF?

Questions...?
References


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References


Thanks!!

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dxarts.washington.edu
www.ambisonictoolkit.net
Guides/Intro-to-the-ATK
github.com/ambisonictoolkit