Verband Deutscher Tonmeister e.V.

Ambisonics Decoder Description (.ADD)

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Developing a new file format for Ambisonics decoding matrices

G. Arlauskas, J. Ohland, H. Schaar

University of Applied Sciences Darmstadt, Germany, Email: jonas.ohland@stud.h-da.de

Abstract

Different software solutions have been developed for the calculation and implementation of Ambisonics decoding matrices. The present paper presents and describes a new data file format which can be used as an intermediate between solutions.

Currently available software solutions use particular data conventions causing difficult compatibility and exchangeability. In the present work an open-source toolkit is developed for storing, handling and using Ambisonics decoding matrices. The toolkit includes tools for conversion from common matrix data conventions to the ADD-format and back, calculating decoding matrices, decoding Ambisonics signals and extracting existing matrices from external decoding tools.

The new ADD-format and toolkit enables increased flexibility in production workflows and eliminates the drawbacks and limitations regarding compatibility between software solutions.

1. Introduction

1.1. Spatial Audio

Spatial Audio or 3D Audio is either achieved by having multiple speakers placed around aswell as above (and in some cases below) the listener or by using headphones with a head related transfer function (HRTF). This enables the creation of immersive audio experiences.

1.2. Ambisonics

Ambisonics is a 3D audio representation approach based on spherical harmonics. Compared to traditional multichannel audio where each channel contains the signal for one loudspeaker, in Ambisonics the channels contain information about certain properties of the acoustic field.

It was first developed in the 1970s by the British National Research Development Corporation for Broadcasting purposes.[citation needed] Recently the format has found new popularity as higher order implementations in virtual reality applications and special mutlichannel setups.

2. Ambisonics Encoding/Decoding

2.1. Spherical Harmonics

The Legendre polynomials $P_n(x)$ are solutions to Legendres differential equation and can be expressed with a Rodrigues representation

$$P_n(x) = \frac{1}{2^n n!} \frac{d^n}{dx^n} \left(x^2 - 1\right)^n$$

2.2. Normalization

For succesful reconstruction of the sound field encoding and decoding have to agree on the method by which the spherical harmonic compononents are normalized. There are different approaches to calculating the normalization factor N of ambisonics channel m with order ℓ . In the following the most common ones are described.

2.2.1. SN3D

With SN3D or Schmidt semi-normalisation no component will ever exceed the peak value of the 0th order component for single point sources. [3] Since the proposal of the AmbiX

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format it has been widely adopted in modern ambisonics software development.

$$N_{\ell,m}^{SN3D} = \sqrt{(2-\delta_m)\frac{\ell-|m|!}{\ell+|m|!}}, \delta_m \begin{cases} 1 & \text{if m = 0} \\ 1 & \text{if m} \neq 0 \end{cases}$$

2.2.2. N3D

N3D differs from SN3D only by a scaling factor. It ensures qual power of the encoded components in the case of a perfectly diffuse 3D field.[2] It is used in MPEG-H.

$$N_{\ell,m}^{\mathrm{N3D}} = N_{\ell,m}^{\mathrm{SN3D}} \sqrt{2\ell+1}$$

(For further information on normalization see [1])

3. Motivation

When working with Ambisonics in irregular multichannel setups, the choice of decoder is a key component in the quality of the experience a listener might have. So having the option to easily work with multiple tools will be very helpful in designing a listening enviroment which is suitable for ones needs.

In the current field of ambisonics software tools, there is no agreed upon standard for saving and handling ambisonics decoding matrix data, which makes working with multiple software solutions difficult.

4. Implementation

Lorem Ipsum

5. Conclusion

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6. References

[1] Thibaut Carpentier. 2017. Normalization schemes in ambisonic: does it matter?

[2] Jérôme Daniel. 2001. Représentation de champs acoustiques, application à la transmission et à la reproduction de scènes sonores complexes dans un contexte multimédia.

[3] Christian Nachbar, Franz Zotter, and Etienne Deleflie. 2011. Ambix - a suggested ambisonics format.