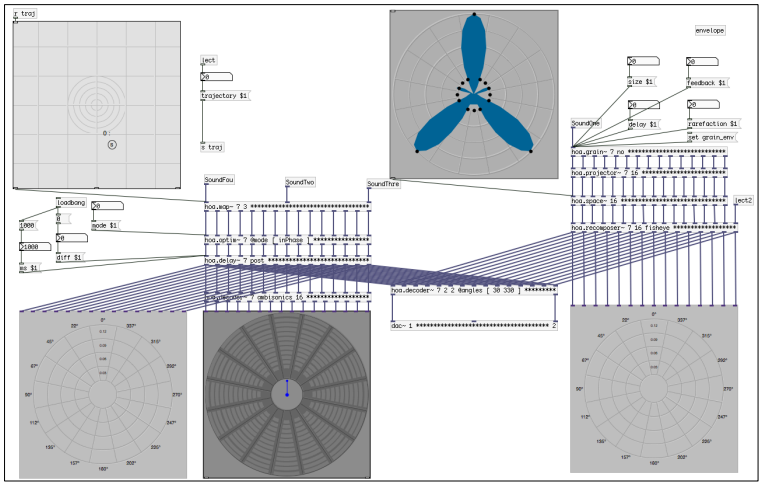
PRESENTATION OF THE HOA LIBRARY FOR THE PD WEEKEND

INTRODUCTION

The Hoa Library is free and open-source and destined for high order Ambisonics sound reproduction. It is made available by CICM, the centre of research on musical composition and computer science of the Paris 8 University. This library is the creation of two projects by Labex Arts H2H “Sound spatialization by the musician for the musician” and “Interfaces for sound space creation”.

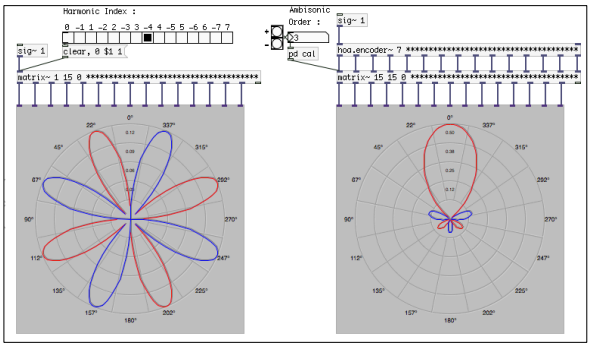
The Hoa Library allows musicians and composers to synthesize, transform and produce sound fields in a creative and artistic way. Thanks to the original graphical interfaces, this library facilitates the understanding and the appropriation of key concepts of Ambisonics. Furthermore, it offers a lot of new signal processing such as the diffusion of sound field, perspective distortion or spatial filtering.



Patch: 1 Introduction

AMBISONICS AND SOURCES SPATIALIZATION

Ambisonics is a set of techniques based on the space decomposition by circular or spherical harmonics. These techniques allow the representation of the signals with their spatial information. This representation facilitates space transformations and provides new processings on the sound field.



Patch: 2 & 3 Harmonics and Resolution

One of the main wishes of musicians is to spatialize point sources in the space. With the Hoa Library, this operation include three main steps:

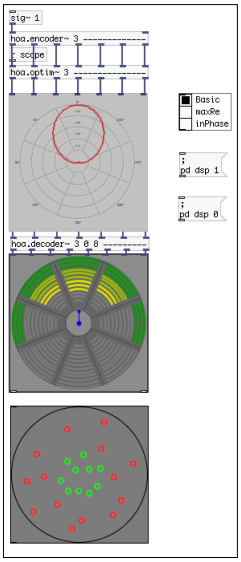
First, we encode one or several sources with distance compensation in the circular harmonic domain. The encoding operation depends on an order that influences the spatial resolution.

Then we apply a sound field optimization. HoaLibrary allows three sound fields optimizations:

- Basic means no optimization. You can see that all the loudspeakers contribute to the sound field reproduction. The resolution is optimum but it should be used for one listener placed exactly in the centre of the loudspeaker arrangement.

- MaxRe is an optimization that increases the energy propagation in the sources directions. Nevertheless, it decreases the sound field resolution. It should be used for listeners confined to the centre of the loudspeakers circle.

- InPhase optimization disables the phase oppositions between the loudspeakers. The sound field resolution is greatly but it can be used even if the auditory covers the entire loudspeakers circle.



Patch: 4 Optimizations

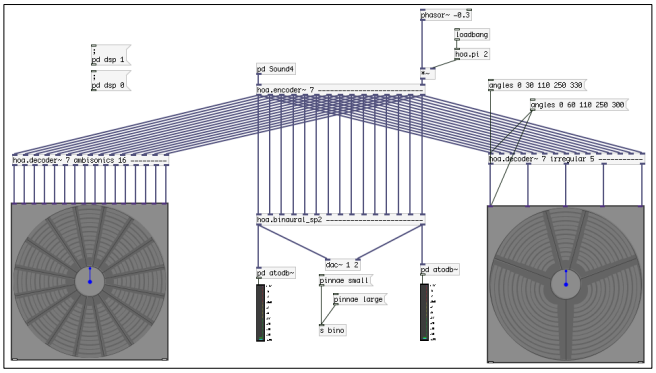
Depending on the sound field characteristics and the decoding mode, the optimizations can damage or improve the sound reproduction. The best choice is to trust your ears.

The last part of the processing is the decoding operation. The Hoa Library offers three decoding modes:

- Ambisonic mode is used for a minimum number of loudspeakers, 2 * order + 1, placed to equal distance on a circle. This is the optimum restitution for an ambisonic sound field.

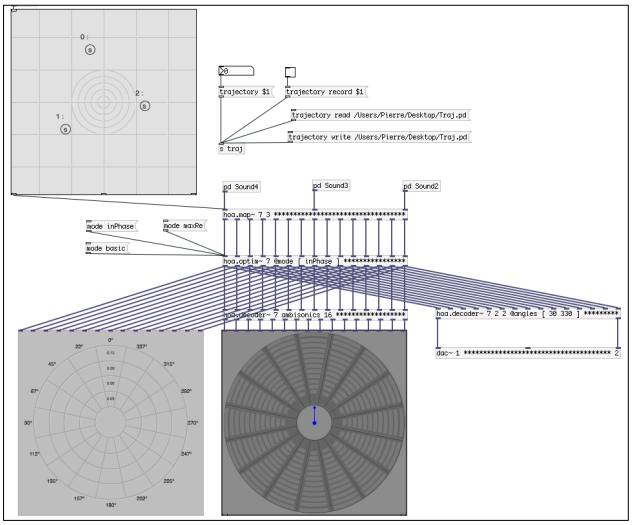
- Binaural mode should be used for headphones. HRTFs are based on kernel heads, with large and small ear pinna, from the CIPIC database.

- Irregular mode allows the configurations of loudspeakers of your choice. Like 5.1 or stereo.



Patch: 5 Decoding

The Hoa Library offers graphical user interfaces. We already noted the hoa.meter~, which displays Peak levels for a circular set-up of loudspeakers, and the hoa.scope~ this displays a representation of the sound field as a sum of circular harmonics. These tools are useful to analyse the sound field and visualize the processing. We offer also the hoa.map, an interface to control position sources and trajectories. Many operations are available (add and remove sources, create groups, record and play trajectories etc.).



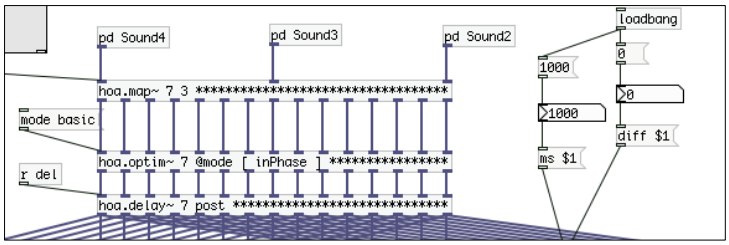
Patch: 6 Sources

DIFFUSE SOUND FIELD

We have presented the basics tools for sound spatialization, but another characteristic of the Hoa Library is the ability to offer sound fields transformations. One of them is the diffusion of the sound field.

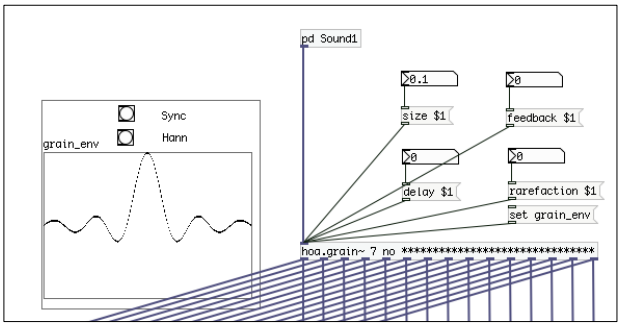
These techniques try to synthesize a chaotic sound field where the sounds seem to arrive from all directions. They could be compared to the synthesis of the late reflexions in a reverberant space but we aim to achieve a musical and an artistic approach. There are many ways to diffuse a sound field.

Here we use an array of delay lines to decorrelate each of the harmonics dependant signals. As the direction of the sources is not important in this case, we disable optimization to increase the effect and avoid reproduction artefacts. All of the harmonics delay times are defined by a mapping of a global delay time depending on the index of the harmonics and the decomposition order. In a similar way, we control the diffusion with a factor that activates or deactivates the delay line of each harmonic.



Patch: 7 Delay

HoaLibrary offers others techniques to directly synthesize sound fields. In this example, we use a quasi-synchronous granular synthesiser where each stream of grains generates the signal for a single harmonic. As per the previous example, each parameter is mapped depending on the index of the harmonics and the decomposition order. Thus, the parameters allow modulating the sound field characteristics (grain size, delay time, feedback, rarefaction, and the window).



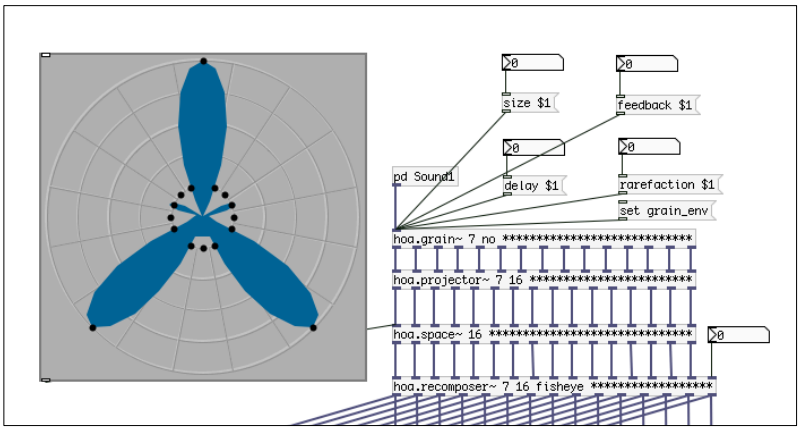
Patch: 8 Granular

SOUND FIELD TRANSFORMATIONS

This process is specific to the circular harmonic representation. We also want to offer local transformations of the sound field.

For this, the Hoa Library is able to project the sound field in the plane wave domain. This operation discretizes the sound field into a set of virtual microphones. It is then possible to apply processing on each ones of those to transform defined parts of the space.

One of the most important effects is the spatial filtering, this involves applying gains on the virtual microphones signals. To easily understand and control the sound field transformation we offer a graphical user interface that allows drawing the sound space. Here again we offer several interactions like expansion and rotation.



Patch: 9 Plane Waves

This is one example and we can offer many other modifications, such as delay or frequency filtering to create originals sound fields.

Now, the Hoa Library allows coming back into the circular harmonics domain. The re-composition processing allows a very specific transformation, named *fisheye* in comparison to the visual effect. It compresses or retracts the sound field forward to the front of the space.

CONCLUSION

We have presented some of the typical effects of the Hoa Library; we invite you to discover the other possibilities and to create new ones.

CICM - Anne Sèdes, Eliott Paris and Pierre Guillot.

Project website: http://www.mshparisnord.fr/hoalibrary/