Dynamical spatialisation of sound. HOLOPHON: a graphical and algorithmical editor for Σ1

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Abstract

This document describes a new sound spatialisation tool running on the Macintosh ProTools TDM platform. This tool allows the user to program the movements of multiple sound files through a multi-speakers sound diffusion system. It is composed of two pieces of software, Σ1 from APBTOOLS, used for calculating movement, and Holophon from GMEM, used for an algorithmic or graphical programming of these movements.

1 Introduction

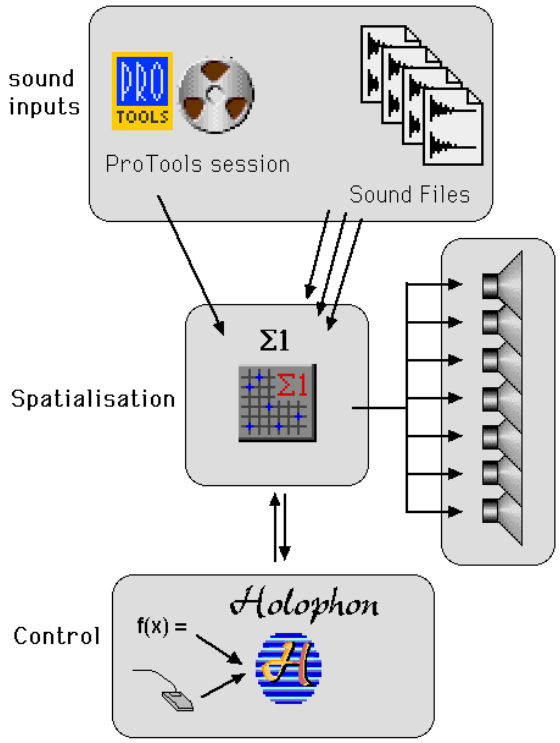

Figure 1: relationships of trades between Σ1, Protools and Holophon.

The Holophon project was launched at GMEM in 1996 supervised by the French composer Christian Calon. It's purpose was to develop a software application designed to diffuse multiple track sound in a 3 dimensional, multi speaker system. This application had to function on the ProTools[1] workstation on Macintosh computers[2].

During a residence at the Sciences and Technology University of Berlin, Christian Calon encountered and used the program Σ1[3], a professional tool of the company "APBTOOLS[4]" for diffusing multiple sound sources through multiple loud speakers. This tool had already met with some success in the realm of cinema (Lukas Film USA, Cinecitta Italy, Bavaria Germany), Theater (Prinzregenten Theatre Munich, Germany) and in musical production and research.

In 1997, GMEM concluded a collaborative agreement with the firm APBTOOLS to develop a graphic and algorithmic interface designed to control the Σ1 program.

2 Spatialising amplified sound

The definition, of spatialisation is the locating within space of a visual or auditive stimulus. During the twentieth century, amplification, synthesis and processing have given sounds a new materiality.

Electrified sound, at it's beginnings, reduced the spatial aspect of musical sound since it was limited to monophonic diffusion. This space was then enlarged thanks to stereophonics nevertheless remaining limited to frontal diffusion and being of limited efficiency in large spaces.

Systems such as the GRM's « acousmonium », made up from a large number loud speakers with different acoustic characteristics, offered an enlarged space for playing tape music and improved sound separation. The use of such systems is however somewhat delicate.

[1] ProTools is a trademark of Digidesign Inc. All

[2] Macintosh is a trademark of Apple Computer, Inc.

[3] Σ1 is a trademark of APB Tools

[4] APB Tools is a development company, partner to the company Digidesign.
APB Tools - Stromstr. 38 - 10551 Berlin - Germany
Web: http://www.kgw.tu-berlin.de/~y2371/SIGMA_1/
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Recently various multi-speaker matrix spatialisation systems have been developed which allow sound to be moved through and localized within a multidimensional space.
Some of these use complex sound processing devices in relation to psycho-acoustics and the acoustics of auditoriums. In general they are only efficient for a relatively small (part of an) audience placed in optimum positions in relation to the speakers.
Other systems only manage the relative volume of sounds in different speakers and aim to define relative positions in space of sounds between themselves. These systems are more specifically used for installations in which the auditors move to discover different ambient sounds in their path. The Σ1 program falls into this second category.

3 Presentation of Σ1

The Σ1 program let the user create movement of multiple source sound on a group of speakers. It is a standalone application on Macintosh computers equipped with Protools TDM sound cards and authorizes sound diffusion on up to 16 independent speakers. Σ1 can play ProTools sessions, sound files or live inputs (upper limit: 32 tracks).

Working with S1 consists of graphically positioning speakers on the screen, defining their directionality and attenuation curves (figure 2), then recording, in real time, the sound sources movements using the computers mouse or a MIDI controller.

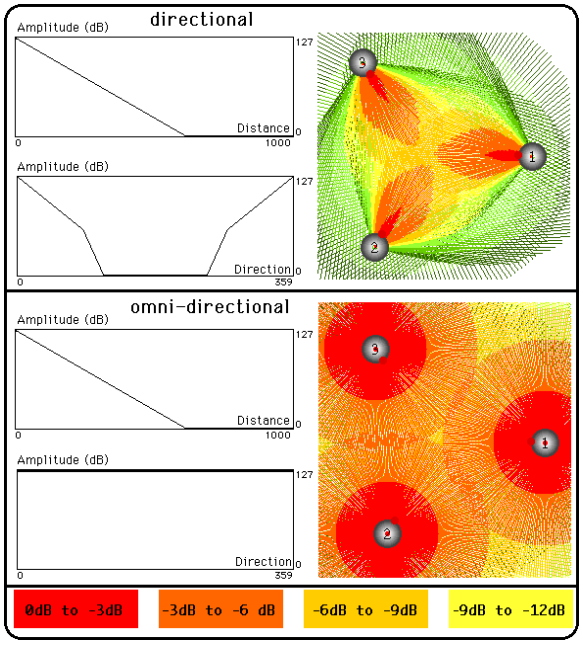

Figure 2: Left: loudspeaker response tables Right: levels curves of the speakers in relation to the tables.

The approach is for drawing trajectories in REALTIME in a Pixel oriented way. S1 is already able to draw trajectories and circles, random movements etc.

4 Holophon

Holophon was written at the GMEM using Common Lisp.

Holophon is a OFFLINE editor for Sigma1 which works vector based. It permits the user to draw vectorial trajectories representing the movements of several sound sources across the different speakers. Jointly to entering and editing trajectories graphically, various algorithms can be used to generate specific trajectories.

Holophon also allows the user to program his own functions using Common Lisp language.

4.1 Placement of speakers

The speakers can be placed on the graphic display, either manually one by one or by using automatic functions.

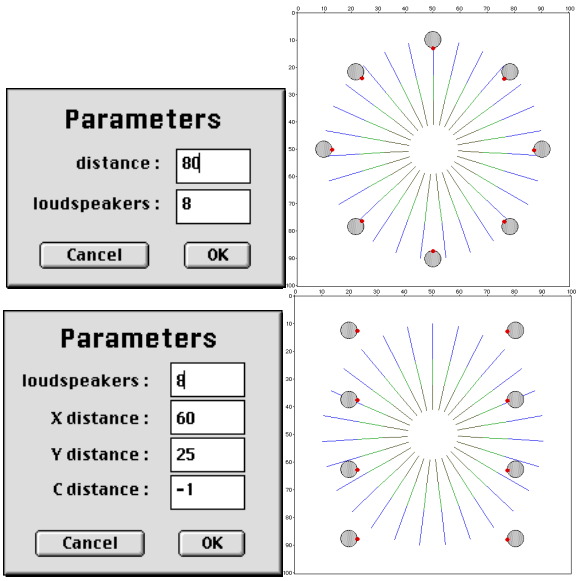

Figure 3: Automatic speaker placement in Holophon (top: circular, bottom: lateral).

4.2 Graphic Movement Editor

The trajectory of each sound source can be programmed graphically by inserting a series of points on the graphic display which succeed each other in time (Figure 3).
Each point determines, by its distance from the speakers and according to their orientations, the sound level of the source in each of these speakers.

The time interval separating two points as well as the temporal resolution to cover this space can be chosen by the user for each new point.

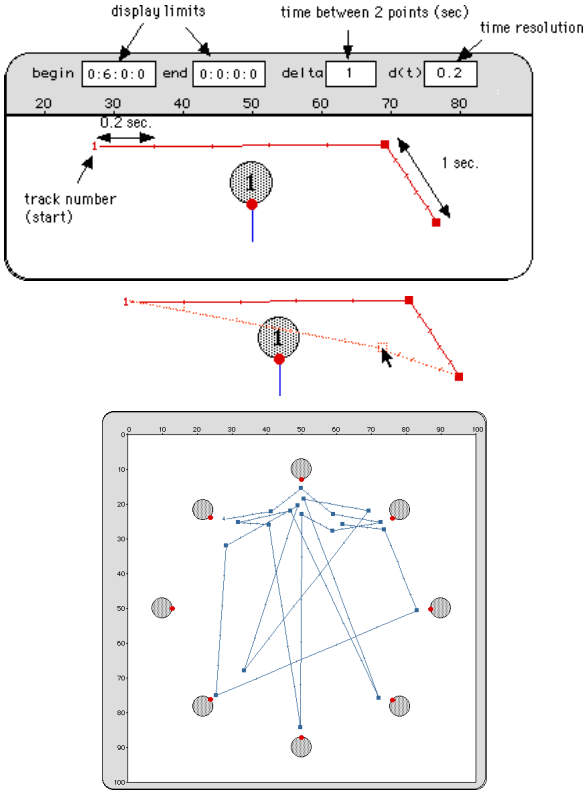

Figure 4: top: graphic layout of a trajectory in Holophon, center: editing a point, bottom: complete layout for one track.

4.1 algorithmic programming of movements

Various functions allow the automatic programming of trajectories. Some of these allow the reproduction or the modification of the existing trajectory: duplication, translation, rotation, symmetry. Other functions construct trajectories from mathematical algorithms : rotation, spirals, oscillations, semi random displacements.

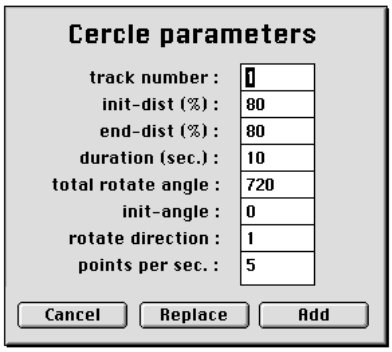

Figure 5: programming circles and spirals in Holophon

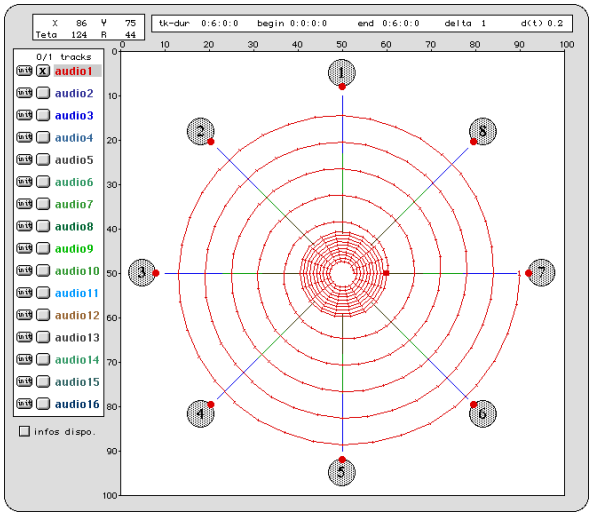

Figure 6: circles and spirals in Holophon

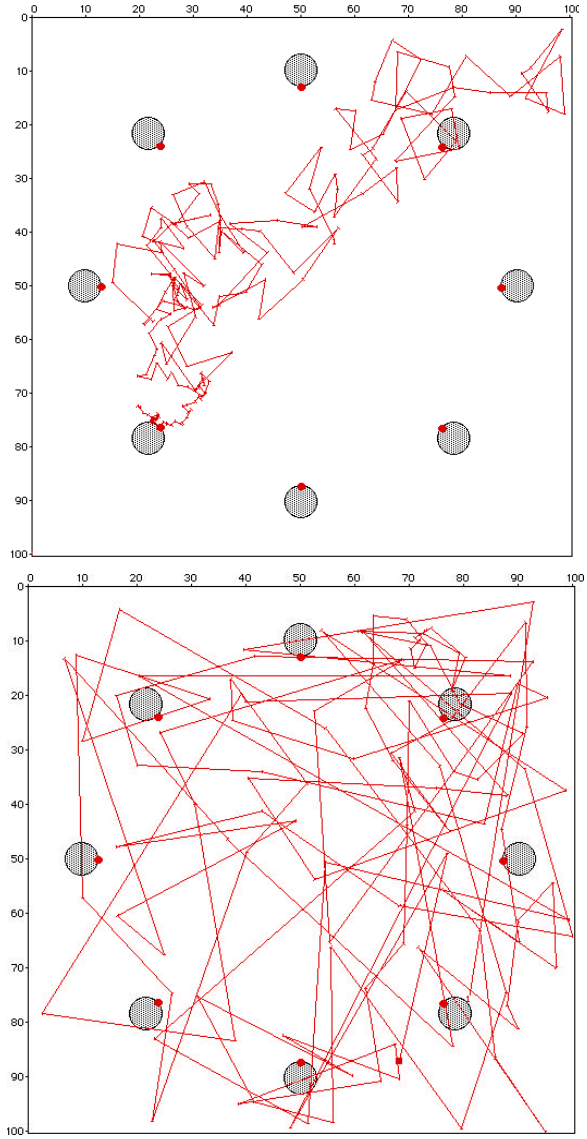

Figure 7: Brownien movements in Holophon

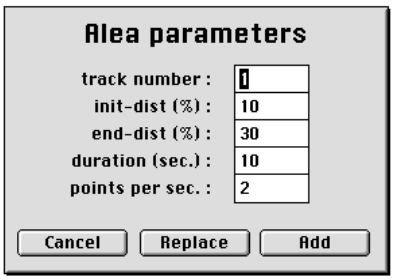

Figure 8: programming random movement in front of the speakers

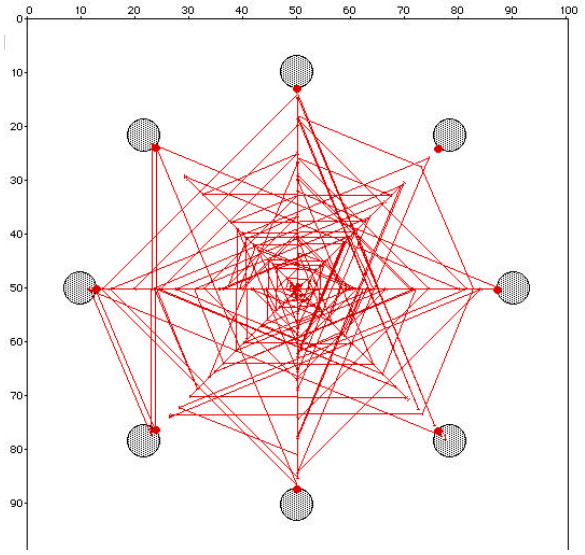

Figure 9: random movement in front of the speakers

Finally numerical data provided by the analysis of a sound e.g. its amplitude envelope, can be used to automatically calculate the trajectory of the sound in a space.

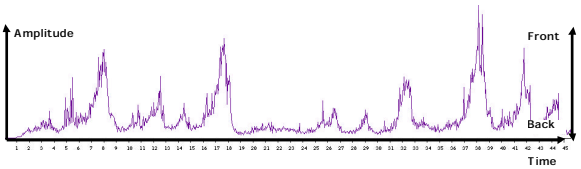

Figure 10: A sound's amplitude envelope being used to calculate it's trajectory in a space

Reference

[1] Acts of the conferences "Sound and its space", editions GRAME, Lyon, 1996