Graphical Spatialization Program with Real Time Interactions (GASPR)

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Abstract. There is a dominant paradigm that links playback of audio files in a multi-channel sound system. It consists of a "top view" (or 3D) representation of the listening room with speakers set virtually in this space. The main drawback of this paradigm is the lack of order and harmony of trajectories representation leading to highly complex systems. In addition, it is very difficult to have an overview of a sound piece whole spatialization process. GASPR software gives the composer a new graphical representation of trajectories in space and time. It is based on a programmable behavioral video game engine. It is also possible to use any kind of sensors to control it live. GASPR relies on the RGB (red, green blue) color coding working on three axes: time (x), sound setup (y) and intensity of each sound (z). This paradigm opens up new doors for interactive surround sound composition.

Keywords: surround sound, spatialization, interaction, trajectories, video game engine, sound behavior, graphical representation, color mapping, sound installation, sound art.

1 Introduction

GASPR software creation started in September 2011. At this time, it was a necessity to create a new tool in order to achieve the realization of one big street sound installation during the festival “La fête des lumières” in Lyon.

The project is located in the heart of the city (place Gailleton). The space to be occupied is a large rectangle of 40 meters long and 10 meters wide where Shadow_Collectif [1] chose to work on the jungle theme: “canopy” project.

In charge of the sound creation, I decided to give life to this public space with the simple idea to have sound behaviors. For example, a sound from a monkey (one sound object) can scare other monkeys and will go the opposite direction thanks to the spatialization engine. I quickly realized that none of my sound softwares will manage this task easily, especially with 8 speakers in a strange double row setup (no sweet spots). So I decided to develop my own tool using an RGB mapping technique inherited from the project « Sound Island » [2]. I created this demo some years ago for Virtools company. This technique gives instant visual feedbacks of sound spatialization in a complex 3D environment (Figure 1).

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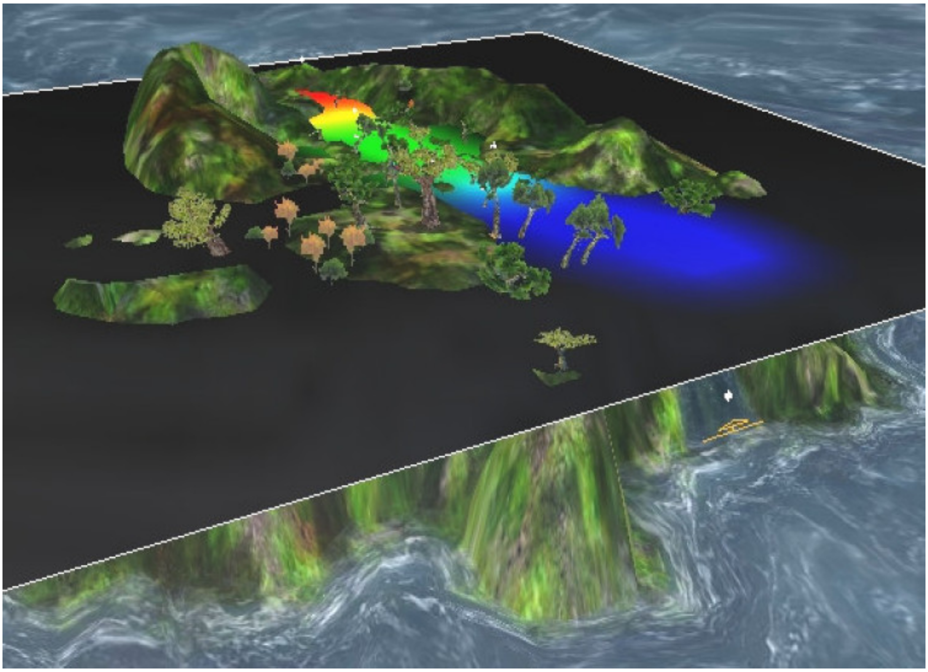

Fig. 1. RGB mapping for « Sound Island » project. Here each color gives its intensity to a sound file, a blend of 2 colors gives a blend of 2 sounds. The whole color pattern can be read as a sound mix driven by the position of an avatar in the 3D world (like GPS coordinate).

2 Existing Approaches

In « Sound Island » project, the color mapping technique gives the sound designer a tool to fulfill the virtual world with sounds and organize its distribution among space. It gives a simple solution to large scale spatialization scenarios. Other softwares work with a visual representation of the spatial composition like the “Holophon” GMEM [3]. This tool works with two windows, one representing trajectories in a virtual space and one showing sound arrangement on a "timeline" (Figure 2a). Iannix software [4] can show sound trajectories in a high resolution 3D representation as floating color ribbons for light paintings art creation (Figure 2b).

One advantage of these approaches is the immediate understanding of the distribution of sounds in space. Another big advantage is the ability to dissociate the visual rendering from the sound rendering, giving the option to decode the virtual world in stereo, 5.1, ambisonic, WFS, binaural... On the other hand, drawbacks comes from their respective paradigm: time domain is heavily constrained. Rethink the space / time representation is a foundation for GASPR software development.

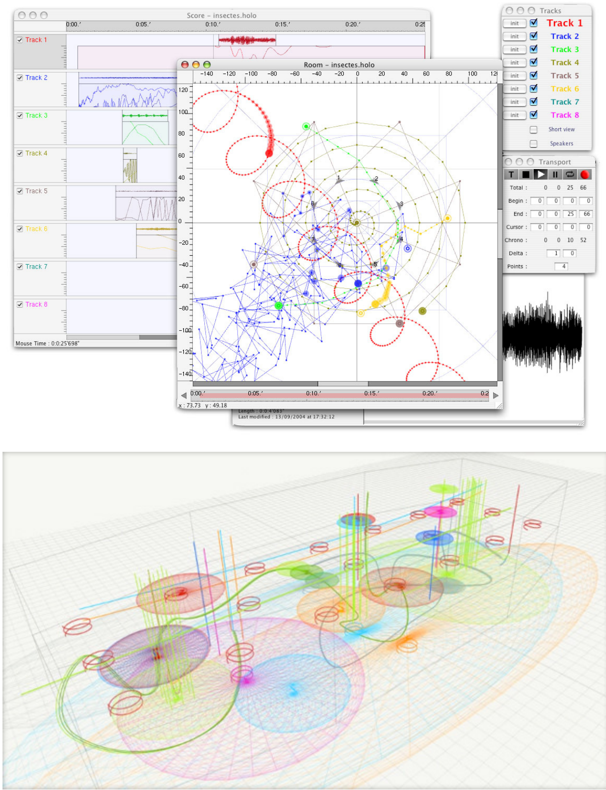

Fig. 2a / 2b. The “Holophon” gives the ability to draw trajectories for a sound setup. One movement and one sound are linked together on the timeline. “Iannix” software can have different style of representation. It is a very programmable approach (here a sound installation for “World Expo 2012”).

3 A New Paradigm

Nicolaus Copernicus [5], has managed to describe planets movements from an other referential than earth. The new referential (the sun) allows both to simplify trajectories representation and, at the same time, to make more accurate measurements. The main idea of Copernicus is to rethink fundamental relationships that link an observation point with perceptual phenomena accepting the idea to get rid of the intuitive model (what we actually see with our eyes).

GASPR software works with an abstract representation of space. In this it is similar to the paradigm used for "Spacemaps" in "CueStation" software [6] which gives relationship maps between speakers dissociated from the “real virtual representation” of an acoustic space. (Figure 6).

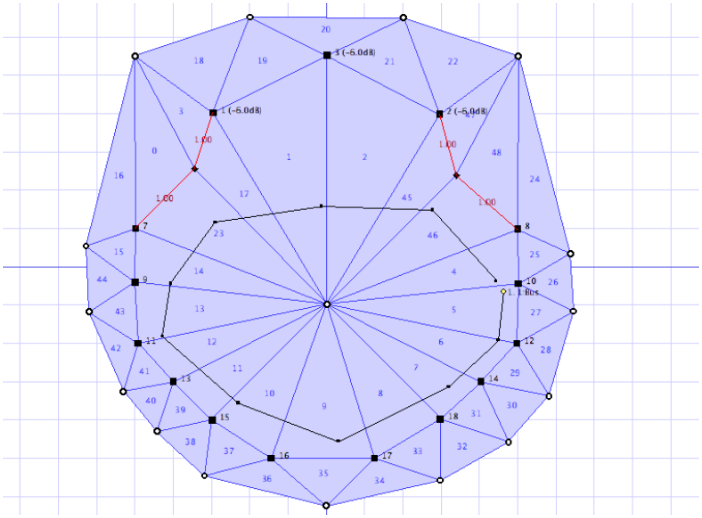

Fig. 3. One “Spacemap” from “CueStation” software (MeyerSound). Black dots represent loudspeakers and the black line is a sound movement. Actual physical loudspeakers position is not equal to this map: with VBAP technique [7], small and large distance between dots gives exactly the same sensation (constant power).

GASPR is based on three video games technologies: a graphic engine (DirectX) a behavioral engine (GameMaker) and a sound engine (FMOD). Visual informations are mapped to control sound informations. In other words, the performance of the graphic engine has a direct influence on the quality of the sound experience ("A new visual paradigm for surround sound mixing" [8]). Spatialization relies on amplitude panning and gives the user the freedom to create weird loudspeaker setups (like for “canopy” project). It allows to work with up to 8 sound outputs. Application field for GASPR is mainly sound art installation but can also work in live situation like concerts and performances. GASPR is a windows stand alone software (not a plug in).

3.1 Graphics Conducting the Sound Experience

Creating a GASPR composition is assembling blocks of different colors and shapes on a 2D timeline (Figure 4). The colors used are red, green and blue (RGB system) and all blends. Blocks shapes can be short or long and can also use transparency. The intensity of each color controls directly the intensity of sound. By mixing different colors together it gives a mix of different sound intensities: a composition. Like in "Sound Island" project, there are real-time position tracking systems which extract color information in order to conduct 8 sound outputs independently. Frame-rate is an important consideration but does not need to be very high for smooth results, most of my compositions are set to only 12 frames per second and give me the opportunity to work even with laptops and limited video cards.

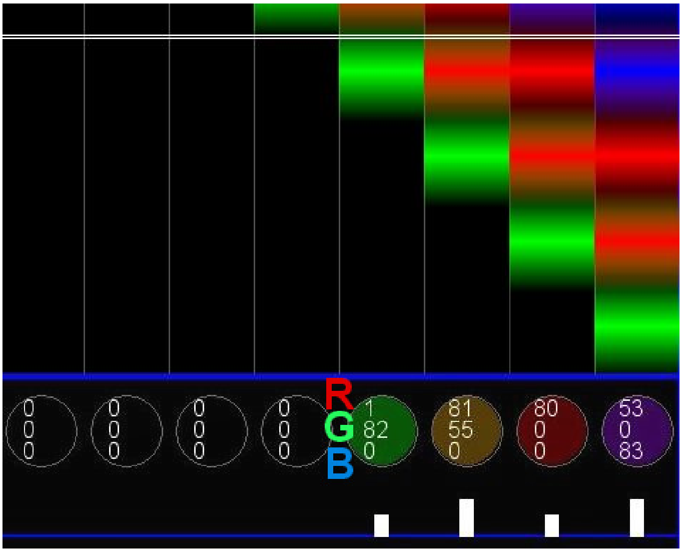

Fig. 4. Close up of a GASPR composition. You can see several colors blended in a vertical disposition. Lower part of the illustration shows the real-time RGB tracking system. Here only 4 outputs are fed with sounds (5, 6, 7, and 8).

A close work is the one from Memo Akten with "Simple Harmonic Motion study # 2a" [9]. A 3D geometrical structure, moves around a center line. When the nodes of the structure meet the line a sound is produced. The graphic engine conducts the sound experience. The behavioral model used is very important because it transforms the structure and the sound creation. The visual representation in GASPR is dynamic: color blocks can move, disappear, change in shape...

3.2 Free Loudspeakers Positionning

GASPR deals only with physical sound card outputs: 8 outputs for the current version. Typically each output is linked to a physical loudspeaker but we can find other scenarios where we can use more loudspeakers. Each output has its "track" that is filled with sounds. One advantage of this completely free loudspeakers positioning system is at the expense of a non intuitive aspect of the representation. One can put 8 speakers in circle, in line, with the use of height, split in 2 rooms, with different kind loudspeakers (several sub-woofers...). This is very similar to a stage lighting system (for theater) where the light immersion comes from the addition of discrete light sources set in a custom way.

In the previous illustration, loudspeakers are arranged from loudspeaker 1 (left) to 8 (right). It is important to decide clearly the layout in conjunction with the physical space. For example a diagonal line in block composition can represent a sound moving around us (Figure 5) only if the loudspeakers are put in circle. The same composition can give other perceptual results depending on loudspeakers disposition.

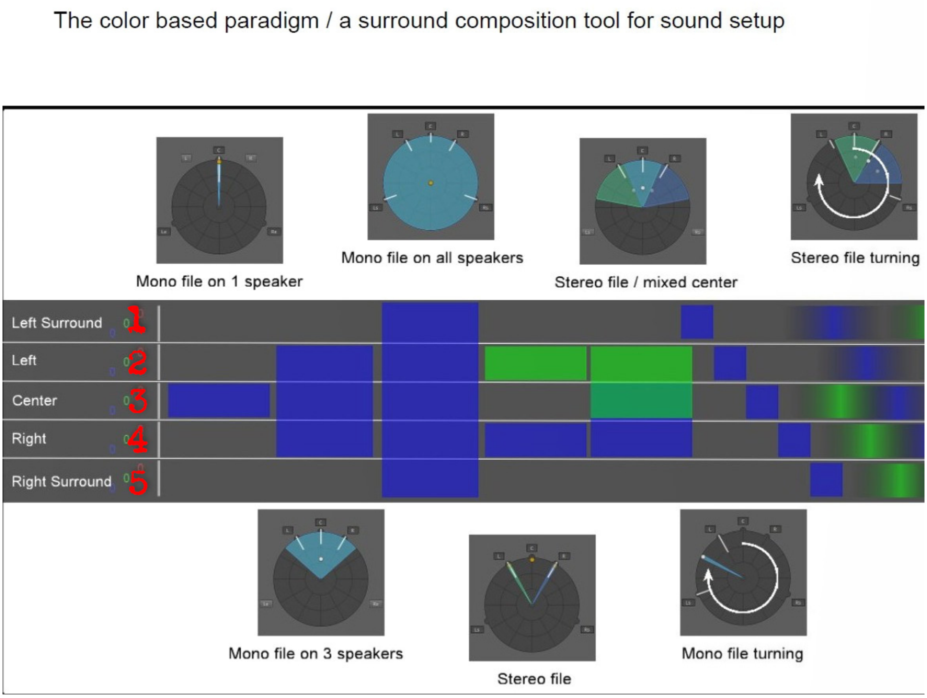

Fig. 5. GASPR paradigm represented for traditional 5.1 surround sound setup. (the sub-woofer is not represented here). Pay attention to the loudspeakers layout on the left part (vertical axis).

3.3 Absolute and Relative Time

The horizontal axis of the timeline represents the temporal component of the creation. There is one playback bar (white vertical bar) which linked the real-time RGB color tracking system.

Time can be absolute: at constant speed with a movement of the playback bar from left to right. The composer can create a sound piece of 5 minutes for example.

Time can also be relative: sound blocks are not triggered with the playback bar (like in traditional sound software), instead they are constantly played in loop with their intensity driven by their opacity. So even if the playback bar stops in the middle of a block, sound is still heard. If you add the option that blocks can move independently, you can create non predictable sound creations.

One strong aspect of GASPR is the ability to create a behavioral sound creation and navigate into it. Then the playback bar can be considered as a virtual listener in a sound world in constant evolution. For example you walk deep in the jungle, go back, stay somewhere in order to discover a strange animal very shy or even run quickly through the forest. A GASPR composition is virtually endless in the time domain.

4 Behavioral Sound Creation

GASPR is a dynamic environment, each block has its own life. They are considered as video games sprites by the engine. They can receive behavior scripts such as random generation, dynamic color change, dynamic color opacity, artificial intelligence... They are born, die, meet, hate... Like in “Spatium” software [10] where sound objects use gravity linked to spatialization.

The composer must programmed these behaviors at first and then “test” his creation. If lot of interactions take place in the composition, he will not be able to listen to all sound combinations. It is possible to even create emergent creations that the composer, himself, can not predict.

4.1 SoundObject

These are the main building blocks. They are linked with a sound file playing in loop. The sound file can be a mono file or an 8 channels file. Depending on the sound card, it is possible to play up to 24bits 96kHz. wav files with virtually no limits on length. Number of blocks is limited by the processing power especially if they contain lot of dynamic behaviors.

There are 3 main colors used in GASPR: Red, Green and Blue. It is possible to mix these 3 colors together, and make a mix of 3 sounds simultaneously (per output). In the current GASPR version there are 3 timelines in sync. It gives a maximum of 9 sounds mixed in real-time per output that is 72 sounds at one time for the whole 8 outputs. One limit of this model is that you can link separate Red blocks (for example) with separate sound files but you will not be able to mix it (same color).

Color coding is performed on 8 bits (256 values) and if 2 blocks of different colors meet a priority system takes place: Red is above Green and Green is above Blue. Maximum value is still maintained to 256 and a real time color fade occurs. It is similar to an “auto-ducking” effect in classic sound production. It is a solution to complex behavioral creations by giving the composer the ability to make sounds to always come from above or below.

4.2 SoundStructure

A "SoundStructure" is a collection of "SoundObjects" sharing an overall behavior. In a social context, a "SoundObject" is an individual and a "SoundStructure" a population. For example, a group of 4 blocks distributed over 4 outputs with a back and forth movement is a "SoundStructure." This may be related to sounds of wind appearing and disappearing gradually from the loudspeakers. Another structure is “monkeys”. Here, SoundObjects are attracted by the playback bar if it does not move too fast, else “monkeys” are moving away.

The "SoundStructure" may also be useful in order to play multichannel files (up to 8 channels) or perform sound premix.

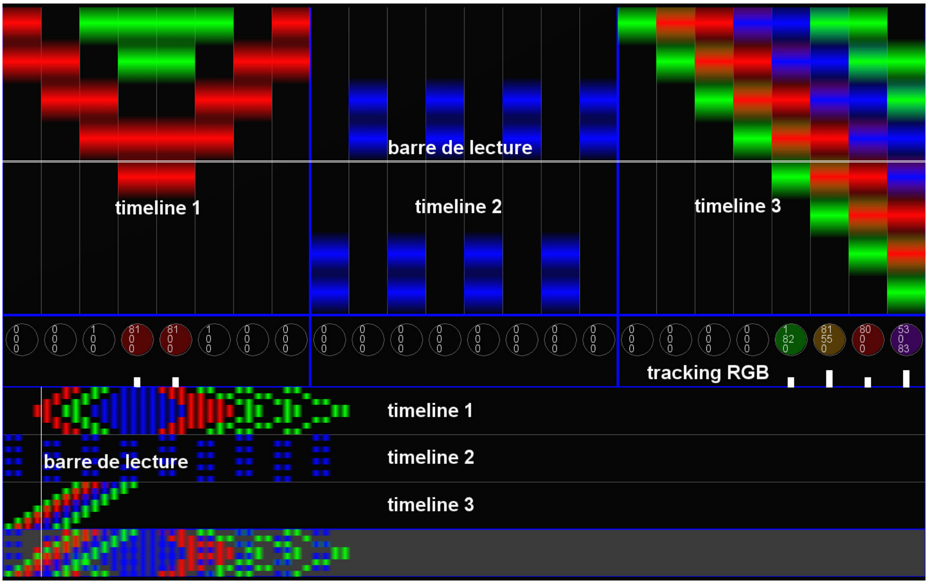

Fig. 6. GASPR actual version. You can see here 3 timelines horizontally and vertically (close up). Playback bar is the vertical white line in the lower left side and the horizontal white line from left to right (upper part).

4.3 MixMap

The "MixMap" represents the overall distribution of sounds over the 8 outputs. It is the gathering of all “SoundStructures” and “SoundObjects”. It is represented simultaneously in two ways (horizontally and close up vertically). Just by looking to a “Mixmap”, one can say that the creation will occupy very rarely all the speakers in the whole composition for example. It is possible to read a "MixMap" like a musical score but you do not read note pitch but sound spatialization among time (absolute or relative).

With GASPR built-in editor, one can create a whole “Mixmap” easily by adding color blocks, move and duplicate them. Built-in script language is also part of GASPR in order to create sound behaviors and interactions.

Several “Mixmaps” can be prepared in advance and launched in real-time. For example, one “MixMap” with birds can change into a “MixMap” with insects at the end of the day or during a performance you can follow a musician, changing the musical mood. In live situations it is important to attach a controller (like a gamepad) or map actions on the computer keyboard.

For art installation, thanks to a special dll, we can make communicate GASPR with Arduino. It opens a whole world of possibilities, making interactions between sensors, motors, lights... and real-time behavioral spatialization.

5 Conclusions

Developing a new paradigm for time, space, surround sound and interactions is an important quest that needs to rethink fundamentals of our intuitive models. By moving to more abstract representation of the acoustic space we can put in front the time and the interactive domain.

As a human being, our visual perception (and brain processing) is limited to a given amount of information at a given time. That's why it's important to help the composer brain giving him useful informations first and quality feedbacks. Sound composition tools and composers interact together mainly with visual informations. The beauty of this is at the end of the process, the audience will receive sound only.

GASPR software is developed with the idea of giving the composer a creative environment that will not be more and more messy if the composition is more an more dense. The interface has no scrolling bar, or menus and you can still have a virtually endless creation with surround sound (on 8 outputs) opened to interactivity.

Current GASPR version has an option to render an interactive composition into a single .exe file. All sound files are encrypted (with FMOD technology) inside a separate folder in order to protect them from being stolen. It gives the opportunity to share these creations to the public quite easily: there is no installation and it uses the Windows OS sound layer in order to output sound. Client framerate is automatically tested and limited in order to have the same quality of interactions.

The only thing to do from the user side is to set his sound card to 7.1 mode in Windows (if he has a 7.1 soundcard). Even if he has a built in stereo sound card in his computer, GASPR composition will play and he will hear only the first 2 outputs. One future development is to integrate several versions of a composition inside one GASPR file (stereo, quad, 5.1, 7.1) in order to give interesting results for a larger audience.

One option currently being tested, is to let the public replace sounds from the encrypted folder with their own sounds. It is then possible to create a new piece out of a current piece but keeping the actual behavioral model: the composer is no more a sound only composer but also a behavioral composer. By giving a degree of interaction opened to the public (able to interact with the piece through the computer keyboard for example), listeners are no more passive and they become: sound designers.

Interactive spatial composition is a huge space of expression for today's artists. I hope this proposition will help the community.

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