HoloPad: an original instrument for multi-touch control of sound spatialisation based on a two-stage DBAP

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Abstract. Our main goal is to propose a versatile gestural control system, for monophonic sound spatialisation, over an arbitrary set of loudspeakers, using a multi-touch tablet. It is our first attempt to control sound spatialisation, in a way similar to traditional acousmatic interpretation via a mixing desk, using multi-touch interfaces, metaphorically using each finger as a virtual sound projector in the 2D space.

Keywords: Musical interface, Sound spatialisation, Gestural control of sound in space, Multi-touch instrument, Performance, DBAP

1 Introduction

In the past decades sound spatialisation has become an increasingly important field of research. From Karlheinz Stockhausen's early experiments using moving acoustic sound sources around a set of microphones to contemporary cinematographic multichannel mastering, there is growing interest in experimenting with sound diffusion across multiple loudspeakers. Two main approaches to working with sound in space are distinguishable. The GRM's *Acousmonium*, initiated by Francois Bayle in 1974, spatialises stereo tracks manually from a mixing desk to an "orchestra" of loudspeakers. The differing acoustic characteristics of the loudspeakers combined with their positioning in the concert hall create unique sound sources with specific colour and timbre –some enhancing high frequency, others medium etc. The other main approach is the virtual acoustic model, where sound spatialisation is created by calculations that apply mathematical and acoustical laws of sound in space. Here, movements of sound are produced by controlling the virtual source position either from calculated trajectories or via external input devices such as joysticks or graphics tablets.

This paper focuses on real-time control of sound spatialisation with an external sensing device –here a multi-touch tablet. Previous work in this field tends to be closely related to the virtual acoustic model –controlling virtual sound source on 2D plane with a joystick for example. Here we are striving to enhance and extend this type of gestural control to enable a more "acousmatic" approach to sound in space. Our aim being to (re) enable in a virtual sound environment, the often quite complex gestures performed on mixing desk, during the practice of acousmatic interpretation. Examples of such gestures are displacing sonic waves from rear to front, soloing on a non-adjacent subset of loudspeakers, subtle "breathing" effects obtained by opening and closing a specific loudspeaker or sparkling effects. These types of spatialised gesture are impossible to enact using the virtual sound source model –since the sound is represented by one point (or at best a surface) in the virtual space it cannot be assigned to several different non-contiguous audible areas at a given time. Thus with *HoloPad,* the main idea is to represent the sound projection of a mono source through multiple points (e.g. fingers) or sub-sources in the virtual space. This allows for rich gestural expressivity during real time performance on a custom loudspeaker setup. The following section will explain how we use the DBAP algorithm to attain this result.

2 DBAP Spatialisation Model

The DBAP (Distance Based Amplitude Panning) [1] has proven to be one of the most reliable and configurable amplitude-based panning techniques. As shown in [2], DBAP has been found to be less sensitive to listener position and to give better results with arbitrary sets of speakers in non-standard configurations. In the context of "acousmatic" loudspeaker layout, this feature is very important. The loudspeakers are not necessarily positioned in a circle or sphere; more often they are placed at various distances in order to play with the depth of the auditory scene. Ambisonics [3] or VBAP [4] assumes that all speakers are at equidistant to the centre of the hall and thus fails in these non-standardized situations. The DBAP algorithm calculates the gain of each speaker as inversely proportional to the distance from a particular sound source. A key feature is that the gains are normalized in order to have a balanced system with constant energy.

DBAP introduces two other features to tune the system. The first is "spatial blur", which is, in brief, offset added to each distance between the speakers and the source. Increased blur reduces the variation between gains and thus reduces the sharpness of the sound source image. The second feature is a weighting coefficient for each speaker. It is introduced as a denominator in the distance calculation and allows to control the "influence" of the independent speakers.

3 Control Metaphor and Principle

The goal of this research is to offer complex gestural control of monophonic sound spatialisation across an arbitrary set of loudspeakers, using a multi-touch tablet. Most works in this field are closely related to the virtual acoustic model [5] –having one finger on the sensor surface control one source position in the virtual space. The original idea of *HoloPad* is to permit multiple fingers to control the diffusion of one source. Metaphorically, each finger injects a specific sound source at different position in the 2D virtual space.

As seen in Fig. 1, we can distinguish two stages in this process. First, the source has to be separated into multiple sub-sources. The global sound energy has to be constant, no matter the number of sub-sources (i.e. Fingers) used. The key to this process is that the sub-source vector is normalized according to the number of instances created. Thus constant energy for the sum of the sub-sources is maintained. Another feature we have added is the possibility to weight the different sub-sources independently by varying the pressure of each finger touch. This allows for a highly expressive gestural control. When engaging multiple non-moving fingers on the tablet and modulating the finger pressure, the performer creates subtle, evolving, spatial masses of sound. It is also very useful when the user want to smoothly add or remove a particular sub-source to a specific sound diffusion topography.

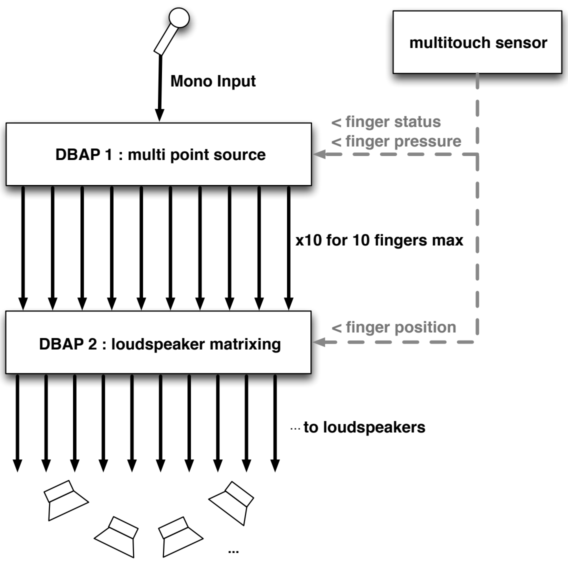

Fig. 1. Synopsis of the system

The second stage is more straightforward. Each active sub-source is distributed on the array of loudspeakers according to its position. We have implemented a classical 10 inputs / *n* outputs spatialiser configuration. At this stage different “tunings”, inherent to the DBAP algorithm, are possible. These include: spatial blur, roll-off and temporal smoothing.

4 Implementation and Future Work

We have used Cycling’74 Max for the interaction and DSP processes. The multi-touch tablet used for our experiment is an Apple iPad and the interface was created using the Lemur OSC controller application as shown in Fig.2. On the left of the interface is the track selector with multi-touch trajectory recording capabilities. On the right is the playable 2D surface.

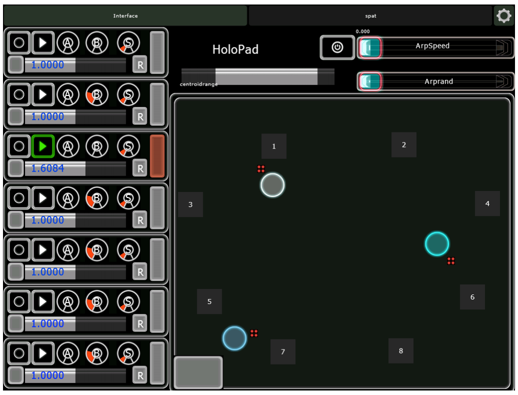

Fig. 2. Multi-touch interface

This real time spatialisation interface has proved itself to be highly expressive enabling rich and dynamic audio gestures. The simple underlying metaphor makes it simple and intuitive to use. The current major draw back, is the “one sound at a time” gesture control (on a single interface). Hand recognition could be a good solution for 2-track spatialisation but at the time of writing, such devices, coupled with a multi-touch surface, are uncommon. A remaining solution is to find a more advanced control metaphor for multi-track control on a single surface.

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