Excerpt from my research thesis, describing background to 3DBARE, software allowing listeners to walk inside a piece of music:

Appendix: 3DBARE (3D Binaural Audio Rendering Engine)

3DBARE: pronounced 'threadbare"

Evidence of artifice embodied in loudspeaker delivery is an obstacle to immersive auditory illusion. It follows a concert-hall-based model for presentation of musical composition as a 'thing' to an impassive audience, albeit with little or nothing to see. In virtual delivery, magnification of detail and of scale is possible such as in the listener's perceptual distances from sounds.

In electroacoustic music, decades of experimental research and development have created numerous diverse solutions for real-time sound diffusion. Accessibility of platforms such as MAX/MSP has enabled a vast range of solutions for spatial sound in the electroacoustic domain, such as recent work by David Berezan (the 'Flux' system) and Erik Nystrom (Synthesis of Spatial Texture Topology in Composition and Performance).

In Chapter 1 I covered some of the essential differences between loudspeaker-based and headphone-based listening. The difference between these systems and 3DBARE is in the replacement of complex hardware with a small device such as Android or iPhone handset (placed in the pocket and forgotten by the user).

This permits a number of departures. Firstly, virtualisation of directional sound (retaining its putative physical position in the space, via real-time listener tracking control) to individual listeners makes each individual's experience different according to their choices of movement, stasis and orientation. Secondly, by virtualising sources it is possible to move between virtual environments of audition. An example of this would be the simulation of an occlusion between two imaginary spaces, achieved purely through different BRIR filters imposed at certain coordinates. Moving two metres across an empty room, the listener emerges acoustically speaking from a tiled corridor to wide rocky valley. The simulation of these or any other environments is only possible in generalised forms using loudspeaker systems.

Loudspeaker-listening is characterised by unavoidably audible bleed between outputs, a shared temporal experience by all and the impossibility of gamifying the listening experience. Combined with logistical simplicity, affordability and greater access, the case is shown for 3DBARE's unique offering of truly immersive, interactive experience of virtual music.

In the case of simulating acoustic performance, rather than relaying the palpable artificiality of the electroacoustic, significant new challenges arise. To name three: the vast detail in variance between multiple voices of a part; real-time response of the virtual environment according to source and listener position; congruent interplay between lines whose isolated combination would be inaudible in the entire sound previously heard.

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Current development of 3DBARE

A screen based user-interface running in Processing permits the soundscape designer to position the individual tracks of an ensemble around a virtual space, viewed as a floor plan.

The UI sends real-time coordinates and orientation of listener avatar to a MAX patch combining open source MAX/MSP binaural audio rendering objects. The listener moves and rotates their screen avatar to virtually move between the sounds as though spread in two horizontal dimensions.

The relay is currently 'free field' although some light reverb has been added to the tracks used as demonstration material.

Modelling of the early and late responses of specified types and dimensions of space will follow and the system will ultimately be ported to iOS for Bluetooth-tracking of listener handsets. A beta version is currently under preparation for demonstration early next year.

In the left section of the interface (Figure 61) audio sources are specified and added to the listening space (main screen area). This is a hypothetical space seen from above, where the avatar (at apex) hears four sources. Movement towards/away from a sound fades it in/out. All sources play from the start concurrently, like a live performance. Distance at which sounds become inaudible is changeable and sounds' positions can be changed. The audition space size may be specified according to requirements. In the following pages are articles written for the Web to explain the musical purpose behind the concept of 3DBARE and more generally, of Virtual Performance.

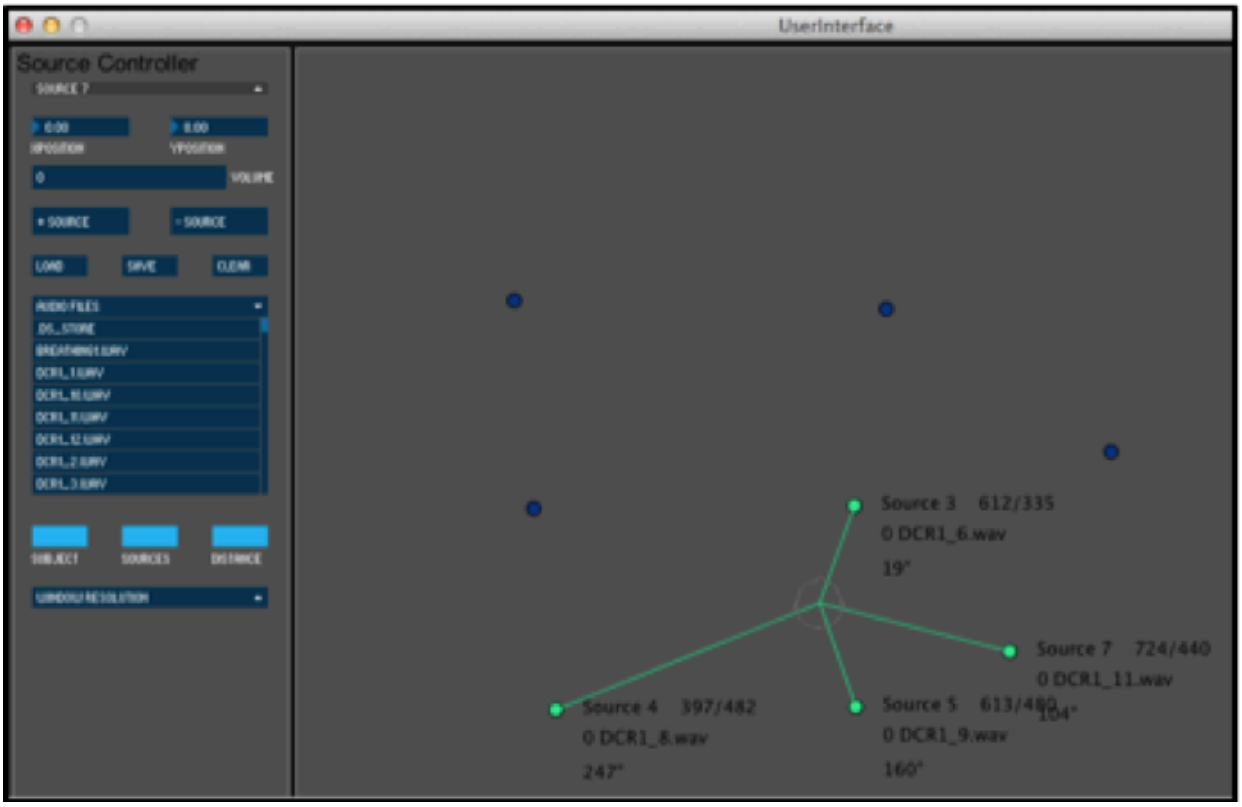

Figure 61: 3DBARE user interface with 4 sources audible via screen avatar

The screen captures in Figure 61 and Figure 62 show the current iteration of 3DBARE's user interface. The green dot at apex of radial lines shows the user's avatar listener. As the avatar is moved, the twelve pianos playing *Dreaming at the Circular Ruins* 1 can be approached and heard to the exclusion of further away performers.

With between four and seven of the parts audible in this configuration, the listener hears a selective version of a whole too complex to differentiate at once. If she is stationary, only those parts shown by radial lines will be heard.

Combinations of static and moving listening create unique and irreplicable versions of the music on each détournement.

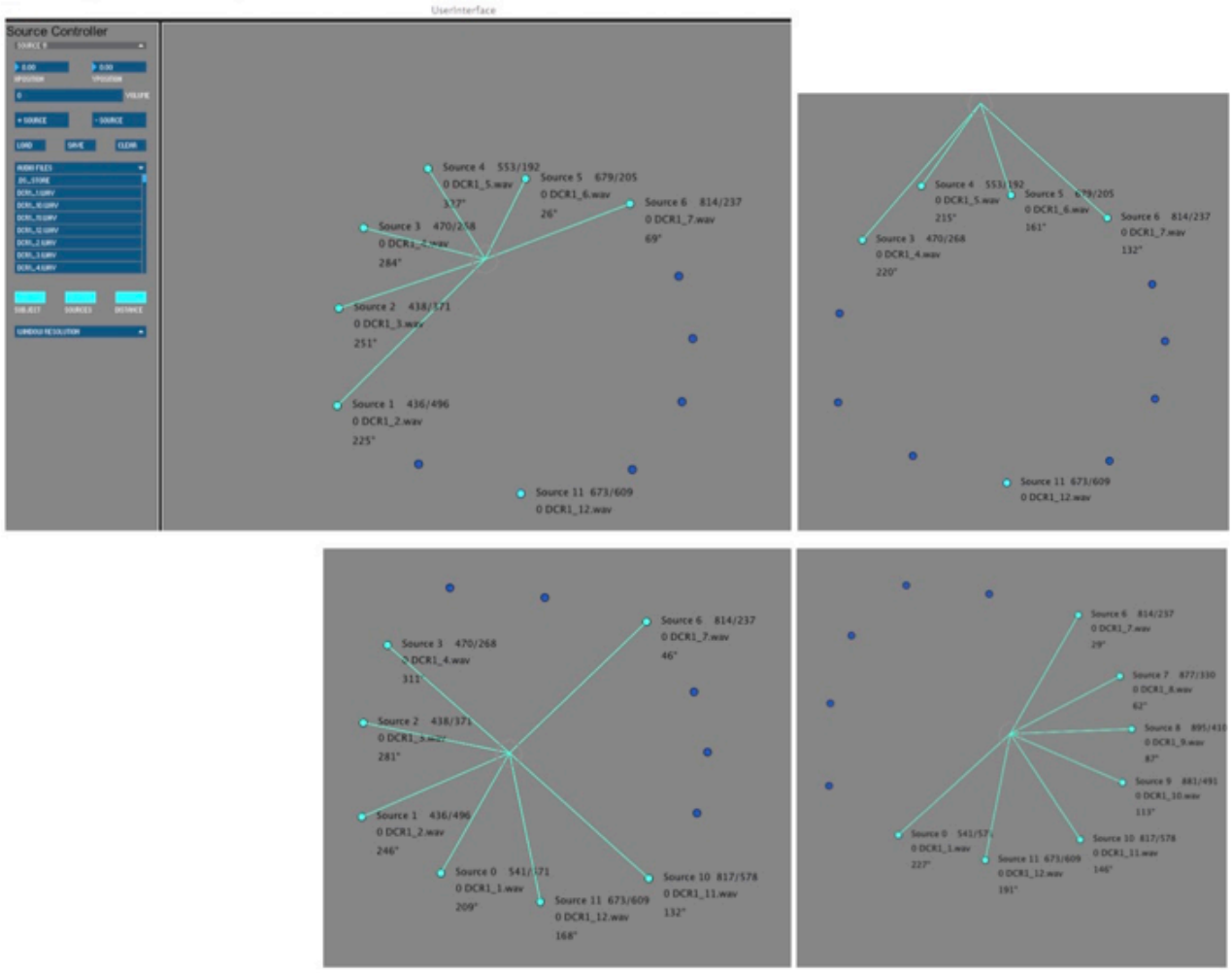

Figure 62: 3DBARE UI. As avatar is moved, listener isolates/amplifies separate parts