TACTILE.SPACE: A MULTI-TOUCH TOOL FOR LIVE SOUND DIFFUSION

Bridget Johnson *Ajay Kapur*

New Zealand School Of Music
Sonic Arts
P.O. Box 2332
Wellington, New Zealand

Abstract
This paper takes a critical look at the performance paradigm of sound diffusion. It proposes a goal towards intuitive and transparent relationships between performative gesture and sonic output. In doing so, the paper introduces *tactile.space* as a new multi-touch performance tool, developed on tangible user interface the *BrickTable,* for live sound diffusion practice.

1. INTRODUCTION

For over half a century electro-acoustic composers have looked at the spatial positioning and movement of sounds in their pieces as an element to be manipulated and implemented in a concert setting. This act of a sound diffusion has taken place on the largely unchanged performance interface of a mixing console, meanwhile our methods of composing and fixed media spatialisation have fully embraced on going technological developments. This leaves us questioning why the same advancing technologies have not been incorporated into the gestural performance of diffusion? *tactile.space* is an attempt to realise some of the possibilities that modern day technology could afford on the gestural performance of real time movement of sound through space.

The paper will first look at work from the relevant fields of sound diffusion and multi-touch in music. It will describe the technologies involved in developing for and running the *BrickTable*. [9] It then outlines the author's research and development of the performance tool, *tactile.space*. The final section presents compositional and artistic developments the project has encouraged, and a look toward future directions of the project.

1.1 Live Sound Diffusion

In 1951 Schaffer and Henry unveiled the *potentiometer d'e space* a mechanism that allowed a performer to control the spatial movements of a piece in real time, across a tetrahedral speaker array [2]. From that point on the French schools of acoustmatic music had a strong tradition of developing spatialisation techniques and systems, this led to the conception of the Gmebaphone [4] in 1973. Spatialisation systems were also developed across Europe most notably the *Acousmonium* of GRM [6], and BEASTS. [14] As with the Gmebaphone, these systems are constantly developing, as technology in the field is refined and are still active today.

Diffusion practise has raised many questions about 'liveness' in electronic music and what constitutes a performance. The general set up for sound diffusion involves a mixing console, with faders for control of the individual gain of each speaker or group of speakers. The audio input is usually in the form of a stereo file (split left/right channels), which in turn encourages the speaker array to be conceptually divided into pairs, often but not always speakers to the left and right of the audience. The action of the performer is to dynamically adjust each speaker's gain in real time, thus perceptually and physically moving sound around the room. This action is inherently problematic, with only two hands and anything above four faders to control (commonly eight but limited only by the confines of the system) the sonic trajectories can be quite limited as all but the most experienced diffusion artists struggle to meaningfully move multiple faders at any point in time. Many systems have dealt with this issue by grouping speakers together and having a single fader control multiple speakers, but here we loose the individuality of the voice of each speaker and instead hear a division of the speaker orchestra into sections [7]. In any

case, we are left with the linear up/down action of physically moving each fader, making an intuitive relationship between performative gesture and sonic output problematic. We have to link the action of one line (the fader) to the circular or spherical movement of sound through multiple speakers.

Croft gives a depiction of the paradigms in live electronic music encouraging the goal of extended instrumentality in development of performance techniques [5]. Yet in diffusion practice we seem to have allowed development of the spatial positioning technology, without encouraging on going change in the performance interface. *tactile.space* is being developed as an attempt to expand the user interface with which diffusion concerts are performed in a move towards achieving this depiction of 'liveness'.

1.2 Multi-Touch In Music

Throughout the late 90s and early 2000s there were many projects that explored the possibilities of a tangible table top surface as a musical controller. Some of the more notable versions being, the *AudioPad* [12] and the incredibly successful *reacTable* [10]. The first instance of the *reacTable* used the interface with "fudicial" objects placed on the table to transmit data to a modular synthesis unit for performance and also for multi-user collaborations as an installation piece. The *reacTable* proved that multi-touch gesture based interfaces had both the intuitive nature needed to increase the learn-ability of a new instrument but also the sophistication required by experienced electronic performers to create a meaningful performance.

2. THE *BRICKTABLE*

The *Bricktable* is a large-scale tangible table-top surface designed and developed by Jordan Hochenbaum and Owen Vallis. [9]

2.1 Hardware

The *Bricktable* uses the diffused illumination technique for vision tracking which, allows detection of both finger and object tracking however *tactile.space* uses only finger tracking. From inside the structure of the table infrared light is shone upon an acrylic screen that diffuses the light, the opposite side of the screen then acts as the touch surface. When a finger touches the screen it reflects significantly more light then is diffused amongst the rest of the screen this enables the camera to track the presence and positioning of the finger. Unlike many commercial touch screen products there is no limit to the amount of fingers that may be tracked at any one time. The camera has an infra-red band pass filter over the lens to separate the projected image from the tracked fingers. [9]

The GUI (Graphical User Interface) is projected onto the acrylic table top surface. This allows the user to feel as if they are touching virtual objects with in the GUI. Fast accurate tracking gives the feeling of dragging an object across the screen as we have become accustomed to with common smart phone technology.

2.2 Software

The *Bricktable* makes use of the *reaTIVision* vision tracking framework. [11] The data chain begins with Community Core Vision (CCV).[1] CCV is the tracking software that recognises the touch data and sends it via the *reacTIVision*[2] Tangible User Interface Objects (TUIO)[3] protocol so it can be unpacked in Processing[4] using the TUIO library for Processing. The *reacTIVision* software and language specific libraries are all open source and available via the NUI group website.

The bulk of the custom software development has happened in Processing. Processing is responsible for drawing and updating the GUI and also for making meaning of the TUIO data and updating all values to then compile and send Open Sound Control (OSC)[15] messages to Max/MSP[5]. Max/MSP deals with all the audio, playing the audio files and receiving the appropriate gain levels to be sent to each speaker.

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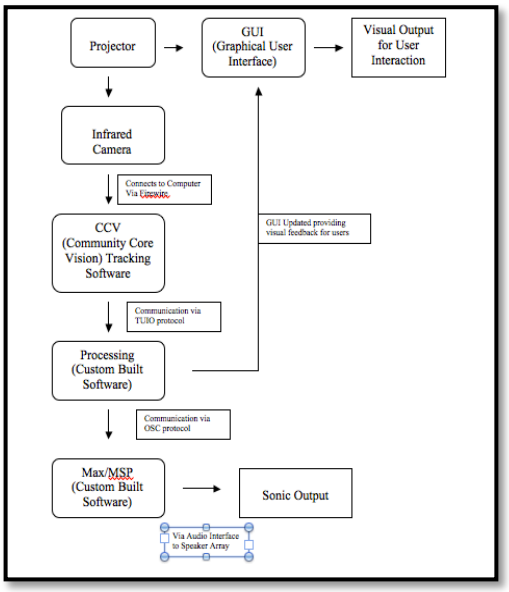

Figure 1: Data Flow Chart

3. TACTILE.SPACE

tactile.space is being developed for the first authors Masters research at the NZSM. The main objective of the project is to introduce a multi-touch program that can be used as a user interface for live diffusion practice. The program presents users with a pantophonic listening space and representations of their speaker array and allows them to drag their fingers around the space and have the sounds move based on the positioning of the fingers.

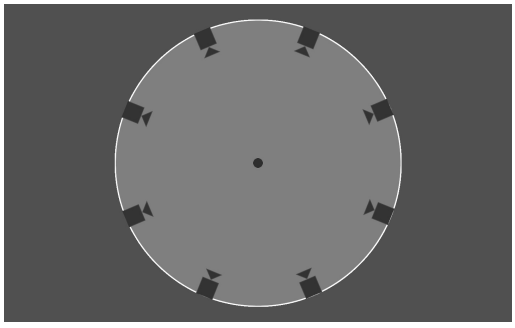

Figure 2: *tactile.space* Graphical User Interface

What at first appeared a simple project has actually showed it's potential, as development has taken place, proving that the addition of multi-touch could indeed be very beneficial to many composers who are looking for an intuitive way to perform their electro-acoustic pieces. Whilst research for the project has discovered many of the debatable points around the differing methods of spatialisation the project is not intending to offer an opinion about the accuracy of source positioning across each spatialisation technique, nor as an attempt to add a new category to this debate. The project is primarily concerned with an attempt to increase the 'liveness' of diffusion practice.

3.1 Modularity

It is important for the project that the program has as much user configurability as possible. This will eventually allow it to be run on any multi-touch surface rather then as an institution specific application. As such the program is set up to work with any possible number of speakers providing that amount of outputs are made available. At the time of writing this is done by adjusting a variable 'numOfSpeakers' within Processing, however in the future this will be built into the GUI so all these adjustments can be made on the table itself. If selecting to use 8 speakers the user may then also choose between the European standard for octophony (front speakers at 22.5° and 337.5° from listener, shown in Figure 2) and the U.S. standard (one single front speaker at 0° to listener). Users may also choose from different 'modes', which determine the type of spatialisation algorithms to be used.

3.2 Stereo Pairing

As previously mentioned it is common amongst diffusion rigs to implement some form of stereo pairing as a spatialisation technique. *tactile.space* is also capable of this style of diffusion. When activated the stereo pairing mode splits all the speakers into left/right pairs and allows the user to control the relative gains of speakers within each pair by moving their finger to the area with which the desired phantom source will appear. The program implements the trigonometric panning law, to give more accurate source positioning across a wider "sweet spot". [8]

$$L = cos(p)*input$$
$$R = sin(p)*input$$

Where L and R represent the gain of the left and right speakers of the pair respectively and p represents the position of the phantom source.

3.3 Vector Based Amplitude Panning

Vector Based Amplitude Panning (VBAP) is a spatialisation technique introduced by Ville Pulkki in 1997. [13] At the time the idea was

to extend the uses of stereo panning into larger two and three dimensional speaker arrays. When the VBAP mode of *tactile.space* is activated users may move their fingers around the listening area and the program will first calculate which of the speakers should be used in order to position the phantom source in the desired position and will then calculate the appropriate gains for each speaker involved in the positioning of the source.

Using this mode means that the performer may provide their piece in up to 8 audio tracks "stems". They then have control over the positioning of each stem individually. Making for a highly dynamic sound field depiction.

4. ARTISTIC USES

Many interesting things have come out of the project in terms of the types of artistic practice it encourages. One of the most interesting to note is the encouragement of composition of stems. This is not a new concept Jonty Harrison of BEASTS has discussed the idea that diffusion practice could be heightened by the composer aesthetically grouping different sounds to be moved amongst the space together and bouncing their pieces into a series of stems rather then a straight stereo or multi-channel bounce where we see one track per speaker or group of speakers.[6] [14] Being able to control the spatial positioning of each stem individually gives the diffusion artist much more aesthetical control over multiple positions of different sounds or groups of sounds. The integral part of this compositional development is having the sounds grouped for aesthetic reasons rather then technical limitations. Previously the diffusion artist has been limited in their trajectories of sounds by the configuration of the mixing desk ie, the order in which faders are linked to speakers. However now that this motion takes place on the representation of a pantophonic system the aesthetics available through motion trajectories are no longer limited.

tactile.space is to being used in a series of concerts at the NZSM throughout 2012. One of these concerts features the diffusion of second year student compositions by the students themselves. Another will feature diffusion of works by the first author and other senior sonic arts students from NZSM. A new piece being developed specifically for *tactile.space* explores the freedom that *tactile.space* gives a performer/composer to improvise with the space of the concert hall. Using *tactile.space* as some what of a sonic tool for conducting, instrumentalists are situated around the room and respond to the real time improvised movements of sound through the space, taking their cues from the positioning of electronic sound sources.

5. FUTURE RESEARCH

At the time of writing the project is still in the developmental stage. There are many directions the project could take in the future, a lot of which will come from spending more time testing the instrument and talking to composers and performers about its strengths, weaknesses and the new possibilities it presents for diffusion. Further development of gestural recognition would allow the interface to become a more virtuosic instrument that would allow users to learn an array of multi-touch gestures that could be intuitively linked to sound motions.

Whilst the strengths of ambisonics is in the accurate depiction of entire sound fields rather then real time source positioning. Multi-touch gestures could add a lot to the real time manipulation of sound field operations. Hybrid diffusion systems have been successfully developed in the United Kingdom that allow ambisonic decoding at the same time affording a performer control of individual speaker gains. [1] This is defiantly something that will be visited with in the project in the near future.

tactile.space was always intended as a performance tool rather then a studio tool. However it has been suggested that it could have merits in the fixed media spatialisation of multi-channel works, as proven by a project been developed concurrently by the reacTable team at MTG. [3]

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[6] Please refer to the Wilson and Harrison 2010 paper for examples of pieces composed in stems in this fashion.

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