Interactive Spatial Sound Intervention: A Case Study

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Abstract. Bodily positioned intervention art creates some remarkable challenges for the conception, development and achievement of interactive, electronic sonic works. Analysis of multiple spectators, habitat reactiveness, display modes, socio-political impact and planning strategies are considered through a case study of my own artwork. I trace the challenges in this field using a recently installed interactive piece, *Sonic Space #05*, which unfolds as a functional interrelated system with undetermined pathways to real-time sound creation. This case study provides an investigation into the demands made by the physical world upon intervention art and the subsequent results.

Keywords: Sound · Interactivity · Field recording · Intervention art · Public performance · Sonic art · Urban interventionism · Media arts · Embedded electronics · Physical computing

1 Introduction

With the appearance of affordable and repeatedly accessible distribution systems, the aim of interactive media arts has enlarged in order to comprehend a wider spectrum of methodologies and outcomes. For instance, there have been a number of radio broadcasts and, more recently, web-based projects including my work [8], which communicates across great distances to large audiences. Advanced omnipresent technologies, such as smartphones, have also played a role in a console mix for intervention art based on sonic narrative and metanarrative [4, 5]. Nonetheless, for the objectives of this paper, I confine myself to a typical representation of intervention art and investigate the challenges posed by the achievement of bodily positioned works, which are directly approachable and openly accessible to public spectators/citizens. Intervention art, in this sense is located outside of traditional art settings and intended to engage a public audience that might not otherwise seek art experiences. In addition, as this work does not live in a virtual or broadcast environment, it is subordinate to site-specific assets in the real world.

Previously, there have been considerable artworks that explore alternative spaces outside the traditional location of indoor, private exhibition space. For instance, Edwin Van Der Heide's recent work, *Fog Sound Environment*, functions as an example of using environmental space as a sculptural element, engaging spatial interactive sound art that talks to a wide audience by incorporating electronically generated interferences [10]. Although the work demonstrates a powerful and architectural structure, it does not

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deal with the challenges of an interactive outdoor exhibition domain. Sound artist and composer Max Neuhaus has achieved a considerable number of outdoor sound installations [2]. While these pieces initiate environmentally perceptive sonic experiences in outdoor spaces, they do not create an appropriate apparatus for audience interaction. Artists such as Susan Philipsz have used sound spatialization as a medium in permanent and temporary installations [3], which give the listener the impression of a three-dimensional world layered upon an existing public environment, even when the audio is clearly not indigenous to the context. These works have been influential in developing my own attitude to intervention art focused on sound and public urban environments. However, they are not completely audience interactive and do not face challenges posed by the strategic usage of electronic sound production systems.

In my own recent work, I have achieved public interventions that involve sound, sourced objects/materials and physical computing elements [7]. This work has been exhibited in different places, such as indoor and outdoor project spaces, with different outcomes including a video piece. However, it was conceived for a public encounter by addressing the question of how interactive sonic art can create an alternative perception of public urban environments.

This paper highlights a procedure for bodily positioned sound interventions, which focus upon the construction and achievement of innovative frameworks for interactive sound production. In the next section, I identify tasks for interactive, spatial sound intervention. The third section analyses a case study of these points through my recent work, *Sonic Space #05*. Finally, I evaluate my results and provide some tentative conclusions.

2 Intervention Art Tasks

Sonic art is currently experiencing an increasingly positive reception from private exhibition spaces, such as galleries and museums, where artists, curators, and directors are striving to find new strategies for the exposition of this work. Even in the relatively contained atmosphere of these locations, spectators might consider sound to be a stimulating experience as it subverts many of the rules and conventions of exhibition participation. Yet, interactive art has an experiential reputation for being frequently exasperating and defeating to even the most experienced audiences in museums. [1]. In this context, the exhibition outside a traditional gallery setting might be seen as holding different benefits and limitations. On the one hand, audiences will not be bound by expectations of conventional venues. On the other hand, the artist can avoid usual assumptions regarding the public's knowledge within the sphere of interactive sonic arts, and artists can create work that is responsive to these circumstances.

Intervention art exhibitions in outdoor locations require an concerted environmental cognizance. Primarily, sonic art works should be encapsulated in the audible background without shattering the living soundscape. Major work by Schafer and Traux, among others, have attempted to pinpoint causes and facets of noise pollution in specific communities. Theirs research reports that societal recognition of the purpose of the fount might play a big role in the identification of sound as problem [6, 9]. Interactive sonic arts, as an unfamiliar presence in the environment, should be primarily conscious to both

noise levels and properties of sound to avoid being reduced to a source of diversion or irritation for spectators/citizens. Intervention sonic art in shared acoustic places should be built and achieved with meticulous attention to particular exhibition unsettlements. In particular, climate and wreckage present hazards to this work, notably with fragile electronic components. Legal liability issues along with regional/national health and safety building requirements also need to be considered when presenting interactive sonic art in a public built up area rather than a private gallery space.

Lastly, artists should pay attention to relevant operational challenges including conservation, durability, and the enduring quality of their work. All this presents a unique challenge for interactive electronic works, given that many current technologies are still in their inception thus necessitating accurate monitoring to guarantee steady operation. Mindful scrutiny should be given to material selection, planned in all respects to establish a practicable life of the piece that requires a minimum amount of after care.

3 *Sonic Space #05:* A Case-Study

Over the course of the 3rd Edition of HaPoC Science Conference in Pisa, I designed, built, and installed an intervention art piece entitled *Sonic Space #05.* This was part of my personal research on sound, space and interactivity that I have conducted since 2010, both as an artist and academic. The work had been presented in Brighton, Berlin, London and Turin, in different contexts and urban places. Location played an important role in the final intervention and Pisa represented the fifth actual outcome of this research project. The work is a lively, interactive sonic intervention, rooted in symbolic gestures sketched from people's physical transit within a given space. Therefore, the environmental context of the work is critical to its success. In the next section I use this newly achieved work as a case study to analyse tasks and plans for interactive spatial sonic art interventionism.

3.1 Description of Audience Experience

As a person approaches the outdoor gardens of the *Ex-Macelli* area, they discover three iron benches, one wall surface and a flat metal ramp that stores specific pre-recorded sounds/noises. Afterwards, spectators discover that these sourced architectural objects are instruments of physical interaction, not just temporary sonic transmission. Essentially, people peak into the sounds by touching the wall surface spot, walking over the metal ramp or tapping on the benches, separately. Although the piece is on, these objects/materials remain silent, even when an audience approaches the space.

As the person comes into contact with a bench, their presence is detected and a boom of sound is played back from another speaker. As the transit audience grows and another person moves towards a new bench, freely exploring the way in which any single bench initiates a specific noise in another speaker, a new person approach the third bench. The three 'actors' play together, exploring how their movements can trigger simultaneous sound sources that resonates across the building of the garden.

Furthermore, as individuals walk over the ramp, a flowing sound is played back from a new loudspeaker. Similarly, as the public audience taps on the wall surface a new burst of sound will propagate through the adjacent loudspeaker. The five persons can decide to play at all times or not and intensify their awareness of the urban soundscape which previously went inaudible (Fig. 1).

Fig. 1. Sonic Space #05 onsite

The work seeks to engage visitors on different levels. Firstly, the piece stimulates them to be physically active, naturally inquisitive about what is going on, moving through the space exploring the sonic possibilities of the piece through playful interaction. Secondly, the work invites them to co-create the sonic space by listening attentively to what they are activating and composing. Lastly, the piece stimulates them to question greater concerns regarding the interrelation of our bodies and the role of public spaces in joining us, the purpose of new technologies in contemporary society and our shifting consciousness of what is, arguably, a constant acoustic world.

3.2 Motivation and Aesthetic Ideas

With the conceptual framework of an interactive public art intervention, I was aware of the innumerable challenges and the influence of social contexts. In addition, I wanted to create an action that was instantly connective but involves a wide range of public participants. As a research project relevant to the physical transit of people in a liminal public place, the work is motivated by artistic objective that are concerned primarily with the audio experience an audience with have. Secondary concerns are the historical, socio-political context of the space in which I plan to exhibit my work. However, a critical aspect of developing the final piece is to interact with the space as an observable locality where people, objects, can be listened to and better understood in terms of their creative value.

Application to Attentive Listening. The proposed work is experienced by the mode and function of listening in public places, led by a mindful practice of sound recording, re-listening and accurate sound editing. This influence is shown in the spatial layout of the piece, and in the way the pre-recorded sounds/noises multiply across a given space,

connecting sections of previous acoustic fields through objects/materials and explicit modes of movement. I expect that my re-location of the field recording invites spectators/citizens to consider alternative ways in which everyday experience of space can shape different sonic diagrams of our physical world, and how we might better inhabit our neighbourhood composed of cultural, social and intellectual organs.

Environmental Effect. My work investigates potential behavioural changes brought about by an interactive sonic artwork and how pre-recorded sounds/noises can impact upon our understanding of space. Inspired by the ephemeral aspect of public place, it is a changing environment that is used and abused over time. Yet, which is rich in meanings and interpretations of which the architect has no control. I pursued a recreation of a stage for a sonic interactive journey of this environmental continuum we experience in our three-dimensional world. The dichotomy between natural and architectural environment constitutes a central point in my work as the intervention achieved in Pisa demonstrates. Although I could have installed the piece indoor where the museum takes place, I chose to place the work within the body of the garden. Enclosed by Italian architecturally refined buildings and the large form of a secular solid tree, the outdoor environmental space functions as powerful scenery for a disruptive sonic intervention powered by computational sensing and monitoring.

Location-Based Applicability. I aimed to incorporate site-specific issues, multi-layered sound facets and geographical investigations into the styling of *Sonic Space #05*. The intervention site is positioned along a major eighteenth century ex-abattoir industrial area in Pisa where the HaPoC conference occurred. In view of the fact that the entire zone is currently a centre for the regeneration of art & science activities, of which the Museum for Computer Machinery is part of, I have enacted an interactive cartographical diagram that conveys the potentiality of sound in public domain. Given that the notion of noise acts as a fundamental character in the piece, I operated towards an expansion and enhancement of an audible language/narrative that mutually feeds and mirrors the sonic atmosphere of the chosen area. I initially invested my time in attentive listening and mindful sensory analysis of the sonic peculiarities of the site, where I physically checked prototype sounds in the space to confirm that the sounds were engaging; expressive yet provocative. In addition to the melodic tones that were present in the tested prototype, I developed a wide mixing plate of sounds including interferences, voices, rhythmic footsteps, slams and concrete sound events investigating the acoustic biodiversity of founts in the public urban environment. The sonic mixing plate of the piece is illustrated in depth in Sect. 3.3.3.

3.3 Design Plan and Actual Achievement

At the very core of the piece is an invisible analog-digital apparatus that uses an extensive live coding programming language called Pd where software called ‘patches’ are developed graphically. Algorithmic functions are represented by objects connected together with cords and data flows, which perform both very low-level mathematical operations and complex audio functions. In this regard, the patches I developed for the piece work in conjunction with a system of sensors and audio diffusion components.

Five big loudspeakers are mutually positioned along with five architectural objects/surfaces within a 5.1 multi-channel sound system. Essentially, each sounding object is attached to a piezo-transducer vibration sensor that detects contact and allow interaction. A laptop with five Pd patches monitors circuitry for separate sensing and playback through an adjacent external audio interface (M-Audio Fast Ultra Track) where sensors are plugged. Consequently, each Pd patch stores five different pre-recorded sounds/noises, one for each single object/surface. In order to play them back separately in the outdoor space, a multi-channel console mixer and proper amplifier are connected to the entire apparatus through jack/xlr wires, extension cables and extensive outdoor loudspeakers for accurate audio diffusion. In this section I illustrate the achievement of this work and debate my solutions, as related to the challenges of producing intervention art.

3.3.1 Physical Implementation

Sonic Space #05 is set up in an outdoor environment that demanded we be extremely aware of the challenges of wrecking, rigid weather conditions, and conservation issues in sketching the tangible body of the work. Additionally, I aimed to create a work that was visually welcoming to the public, as well as actually interactive (Fig. 2).

Fig. 2. Close view on interactive ramp on site

Wrecking. To protect against illegitimate entries to the main visible electronics, I arranged substantial items indoors, by an inner windowsill facing the garden that allowed most of the structural lacing points to go outside. Basic locks for laptop and audio interface were exposed, and the remaining equipment was enclosed within painted wooden boards to avoid accidental damage by visitors. The outer layer of wiring appears nearly invisible, with rubber cable protectors in the direction of loudspeakers and coloured gaffa tape for attaching the piezo-transducers on to surfaces. The entire system allowed sounds/noises to easily emerge from the loudspeakers locked into metal poles. They added a subtle visibility to the sensors inserted on the benches or ramp/wall surfaces, while the window provided an adequate threshold between the inside and the outside.

Weather. Rain poses a risk to any outdoor intervention, particularly in the later winter months. Rubber cable protectors and gaffa tape, while mounted, had enough solid

surfaces to divert most rainwater from entering the piece and causing a short circuit. Each contact microphone I used as a vibration sensor was accurately coated with special waterproof paint that prevented dysfunctional degrees of interactivity. Materials for the intervention were chosen with rain in mind. As a consequence, I selected waterproof loudspeakers, which are similar in structure and function to those currently used in many outdoor interactive sound pieces. However, during the night they have to be covered with a plastic material (Fig. 3).

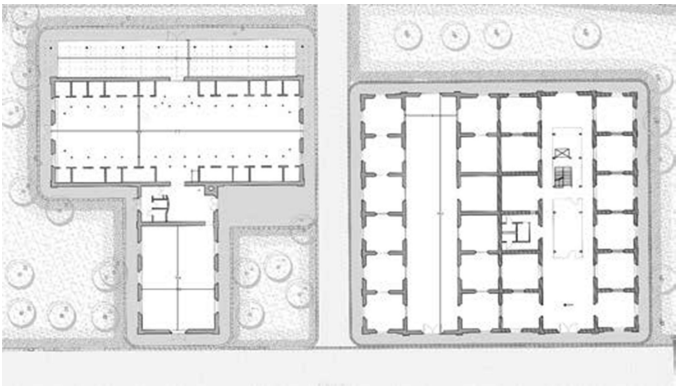

Fig. 3. Topography of Ex-Macelli area

Conservation. The electronic components of the work were designed to be exchangeable such that even if an element were damaged, it would not affect the overall function of the piece. If one of the sensors should fail for some reasons, it could promptly be extracted, fixed and replaced. Funds were budgeted to cover repair and replacement of any damaged components. During the initial steps of the project, which lasted for a month, I scheduled daily visits to the site so as to inspect for any damage. In case the intervention should be extended I had also planned for continued maintenance.

3.3.2 Sonic Interaction Design

The work's interaction module created both audience engagement and environmental responsiveness. A diffused system of vibration sensors covered a very small part of the entire object. Yet, these contact microphones held excellent sound pressure over a very small surface, permitting a conductive three-dimensional surface to resonate. Each piezoelectric could be 10 mm up to 25 mm diameter, of which the resulting vibration is proportional to speaker density.

In order to engage all sorts of audiences, I wanted to foster an instinctive and alive framework for interaction that was evenly suitable for adults and children of any level of education and experience. Furthermore, I wanted to engage both individuals and small groups by facilitating contemporaneous and synergetic interactions.

The piece made it easier for participants to orbit multiple interactive sonic structures that were both unexpected and multi-layered. For instance, if a person stopped by the bench, this initiated a specific sound/noise played by a positioned loudspeaker. Conversely, if a person, instead of sitting on that bench, walked over to the metal ramp, he/she would activate a diverse sonic fragment in another single positioned loudspeaker. This happened for the other two benches, at the spot on the surface wall and the remaining three speakers. The duration of each single playback depended upon the scale of the vibration, which was determined by the material and the amount of space between various surface areas.

I was also concerned about adapting the piece for people with visual impairments, who would have less choice about their movement within the exhibition environment but experience perhaps more sensitivity towards a range of sonic variations. As such, people with visual impairments might find much to engage with in terms of sounds and vibrations within the piece that otherwise may not be available to them in other interactive art examples (Fig. 4).

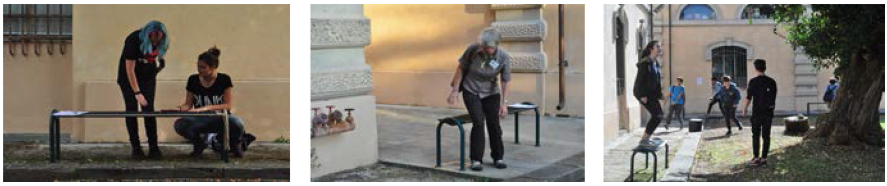

Fig. 4. Audience engagement

3.3.3 Interactive Sonic Genesis

With this work, I have distinctly scrutinised two aspects of sound design. Firstly, I took into account the soundscape level of the location to safeguard that my work would not cause a noise pollution threat. Secondly, I worked to design a strategy for unexpected interactive sounds that would produce a multi-layered result by using noises and field recordings that involved a wide range of spectators.

Sound Ranks. In view of the fact that the work is in an open environment, I first considered the sound design in relation to the existing soundscape, to make certain that my piece would not dominate the surroundings. The intervention site is at the edge of an enclosed area, isolated from big roads, not far from the river yet close to a railway. Initially, I evaluated the noise level at the site in both the morning and the afternoon. At these times, the sounds emitted by the piece were fine up to 24 dB at proximity 60 cm (stimulating a listener who is interacting with the piece). Additionally, it was noticeable that the sounding objects were not founts of noise pollution for users. This was because the work is utterly low-pitched at a distance and so only audible when there is user interaction.

Interactive Spatial Sound Articulation. One of the challenges when building an interactive sonic work for a large user audience, is the amount of time I spend – sometimes weeks at a time – in the exhibition space before I even begin to introduce

my field recordings. Although I aimed to create distinct and shifting sonic pathways through the work for insiders who might daily stop over at the garden, I also hoped to make safe some certain volume of shared experience for the wide range of the audience who might perform the work. All sound in this piece was generated via multi-bit digital to analog conversion using the enclosed Pure Data patches. Formulas for sound generation and DSP parts were developed and accurately programmed from scratch into the blank Pd patch.

First I analyse the performance of sound within an individual unit. As described in Sect. 3.1, when a person touches the object surfaces of any vibration sensors, different sounds emanate from nearby loudspeakers to the triggered sensors. Due to the fact that each unit works autonomously, sounds could be played back at the same time as persons synchronously initiate multiple units.

I have designed five classes of sound events:

(1) analog synth background melody
(2) low-frequency radio pulse with interference
(3) abrupt noise of mechanical machine
(4) high-pitched beat with human voice
(5) resonant water-edge loops

These sound categories were sketched to embed and impact upon the sonic environment, by a nonlinear unfolding of a sensory sonic journey at the site. Articulations of modular synthesizer (Cat 1) symbolized notions of analog data processor in a public space. Low-frequency pulses (Cat 2) considered the dynamic physical space of the FM network. Powerful noises (Cat 3) connected to human activity and production, whereas high-pitched beats recalled the abstract motion of the brain. Finally, the water-edge loops melted into sound like the snort of a distant train.

There are unlimited phases for each of these sound events that modulate the rhythm and period of an event. For instance, phase 1 of a high-pitched beat states frequencies between 90 Hz and 200 Hz with constant brief peaks. Phase 2 states frequencies between 300 Hz and 500 Hz with long peaks. When a given vibration sensor is activated, the sound event for that PD patch will be played back in each of the five ordered loudspeakers. For instance, an abrupt noise can arise from speaker 1 in a consecutive row. The equivalent abrupt noise will progressively originate from speaker 5. By triggering each single vibration sensor, the patch stores in a parent window an interaction history counter that streams the sum of triggers. As a patch advances from zero to infinite triggers, the generated sound will progress through a rooted cycle of sonic events, frequencies and periods.

Now I delineate how sound multiplies through the space. Pure data patch intersection nodes happen when the diagram of speakers system has a ‘touching’ speaker. See Fig. 5 for a plan of speaker mixing and example intersections. As a sound transits within an individual patch, when the sound extends an intersection, via inserted serial *Bonks*, an event will be activated and conducted to the next. Bonks takes an audio signal input and looks for ‘attacks’, defined as sharp changes in the spectral envelope of the incoming sound. The receiving patches will alternately playback the sound in the same manner. Thus, sound will augment from the point of initial source across a

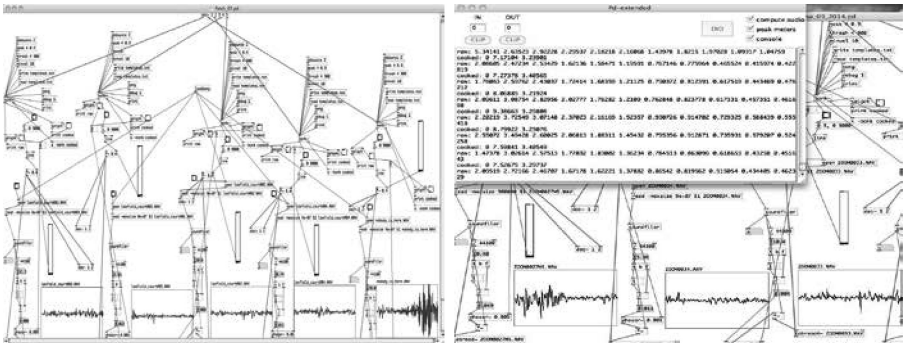

Fig. 5. Pd patch & parent window

portion of the object. A 'velocity' feature that depends on the interaction history counter limits the square roots of the amplitudes that will relay the originating sound.

Specifically, when a new sound category is showed, this velocity will run to a maximum of 1000 ms. With more interaction this velocity declines until the bang is at a minimum of 250 ms. The fluctuating velocity concedes a mosaic of sonic events that emanate depending on how many people are involved with the sourced architectural object.

This diffusion algorithm produces several sonic events as people interact through different gestures in various portions of the benches, ramp or wall surface. The *Bang* object activates the event, where it is held until it receives another message where the hold time ends. The hold value controls the length of time that it stays lighted. It will quickly flash again for the duration previously placed in the interruption properties. Thus, *Bang* acts as its own send and receive object/symbol as illustrated in Fig. 5. Also, the physical experience of space in relation to sound will mutate considerably depending on whether individuals or groups engage with the ramp, wall or benches.

Each sonic category event outputs several combinatory systems, in order to influence the impetus amount of sonic events. For example, when water-edge loop sound is transmitted from one patch to another, the frequency of the sound will choose from the main frequency matrix. Frequencies are planned for areas that produce mellifluous associations in combination with other irregular shifts that create moments of sonic pressure and discharge as a result of interaction. This system is intelligible enough in so far as newcomers can easily discover it, although the interaction algorithm supplied numerable orbits to investigate diverse kinds of sounding outcomes. Likewise, as abrupt noises drive from one patch to another, the speed and amount of sound samples are mixed progressively to quicken and slow the sonic events.

4 Evaluation

Sonic Space #05 was installed as a temporary piece in the city of Pisa in October 2015 but is currently under development to be shown in another public space in a new fashion. A potential extension of the length of the intervention in future years could

also be negotiated. I have illustrated a number of challenges demanded by intervention sonic art and have debated my strategies chosen in the achievement of this work. Here I assess the results.

A crucial point is to outline work that is inviting and captivating for a diverse public audience not automatically hunting for an art experience. In view of the extended scenery of the exhibition conditions/situations, public assessment is a demanding task. Despite this, by way of casual users/citizens analysis with colleagues and exact monitoring of audience attendance, it is possible to put forward some tentative conclusions. My earliest audience observations were very promising. My colleagues have been able to experience the work and intuitively interact through effective motions and collective body expressions. Their feedback revealed that the sonic intermittence is acoustically abounding and the brief spatial sonic stream appealing. They noticed that the low-frequency radio pulse sounds are more intriguing in this situation while the melodic texture of the analog synthesized melodies is very powerful. The sonic junction of the abrupt noise fascinates most people, however, only a handful of users engaged with the piece enough to understand how these were created. Most of the time, I guided users in their discovery of the workings of the piece.

Starting from this scripting, the work has not been largely promoted and therefore my evaluation of a broader spectatorship is incomplete. My short inspections suggest that people, in many cases, are not aware that the piece is on, and I suspect that my endeavour to obviate issues of noise pollution in addition to my aim to be as invisible as possible have led to a situation where the work does not fully enable visitors/listeners to experience the piece.

I took great care in the styling of sonic feedback, as designed for this particular location. I have been satisfied with the comprehensive sound layout and have obtained affirmative comments from spectators concerning association with non-linear frameworks. Despite my efforts to avoid a fount of noise pollution, what I perhaps did not realise is that the installed sonic effects would become in of themselves intrusive and disturbing to unexpecting visitors. During the afternoon hours the general sound level of the piece was ideal, even though some visitors were unable to decode all the sonic details embodied in the work.

A considerable design task in my work is to address questions of endurance, conservation and integrity of the work. After several presentations I am satisfied with the effectiveness of the work. I have not encountered any particular deficiency of electronic components, even with unfavourable weather conditions. Finally, I have not noticed any acts of sabotage or mess with the work.

5 Conclusions and Future Works

I have delineated the challenges demanded by environmentally placed interactive spatial sound interventions, and have debated these reasons within the circumstances of creating a new interventional art work, Sonic Space #05. I have been delighted with the outcome of a 5.1 multi-channel sound system and the overall interaction design framework, as well as the solidity of the conceptual grounds for this project. Some of

my funding partners have demonstrated much interest and excitement with the newness of the piece and its singularity within the field of intervention art.

I suppose that the work will eventually benefit greatly from a location in a more active public sound environment. In my future practice, I plan to find a more permanent intervention site that is more accessible and acoustically more suitable. For instance, I have identified a number of outdoor gardens and public parks, in conjunction with bigger streets, which are more densely inhabited where this work might be successfully exhibited.

6 Media Documentation

Substantial records of the conception, progression and final achievement of the piece can be found online at http://elisabettasenesi.me/sonic_install.html. Photos and texts are published featuring all stages of the project.

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