THE QUIET WALK: SONIC MEMORIES AND MOBILE CARTOGRAPHY

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ABSTRACT

This paper presents The Quiet Walk, an interactive mobile artwork for sonic explorations of urban space. The goal of TQW is to find the "quietest place". An interface on the mobile device directs the user to avoid noisy areas of the city, giving directions to find quiet zones. Data collected by the system generates a geo-acoustic map of the city that facilitates the personal recollection of sonic memories. The system is comprised of 3 components: a smartphone running a custom application based on libpd and openFrameworks, a web server collecting the GPS and acoustical data, and computer in an exhibition space displaying a visualisation of the sound map. This open-ended platform opens up possibilities of mobile digital signal processing, not only for sound art related artworks but also as a platform for data-soundscape compositions and mobile, digital explorations in acoustic ecology studies.

1. INTRODUCTION

In the Handbook for Acoustic Ecology, Barry Truax defines acoustic ecology as "the study of the effects of the acoustic environment, or soundscape, on the physical responses or behavioural characteristics of those living within it"[1]. One of the key concepts in this field is the "soundscape", the sonic image of a particular environment (natural, artificial, or mixed). Soundscape is a term that has been defined several times in the history of sound and social science. According to Paul Rodaway, it is,

the sonic environment which surrounds the sentient. The hearer, or listener, is at the centre of the soundscape. It is a context, it surrounds and it generally consists of many sounds coming from different directions and of differing characteristics… Soundscapes surround and unfold in complex symphonies or cacophonies of sound. [2]

For R. Murray Schafer, a soundscape is made up of three main elements, which are the *keynote sounds*, *sound signals* and *soundmarks* [3]. This terminology aids us in establishing a lexicon to describe a sonic image related not only to a place but also to every aspect of sound in everyday life. According to Schafer, keynote sounds are those that are part of an acoustic image and are always or very often present in a scene. They can be consciously or unconsciously heard but their presence defines the general tonality of the sonic image. Sound signals are sonic events that disrupt the normal soundscape and which take on immediate meaning, for example alarms or people screaming. In general they are sounds that solicit the attention of the listener. Finally soundmarks are sounds that belong exclusively to a specific place.

This vocabulary reveals an attempt to define an auditory world independent of musical traditions, and is the basis of activities like making sound maps or creating soundscape compositions.

Augoyard and Torgue criticise Schafer's concept of soundscape to be a "miraculous, qualitative and hedonistic concept"[4]. Their focus instead is on the effect that sound causes to other agents of the reality, not blurring a static image but a dynamic complexity of actions, causes and effects. Brandon Labelle describes Augoyard and Torgue's notion of 'sonic effect" as a

paradigm of a multi-sensorial, multi-disciplinary, multi-dimensional and relational concept for describing the production, transmission and reception, on a physical, cultural and informational mean, of the sound [5].

For Labelle, sound is a multiple entity, due of the multiplicity of its relational affordances. Sound is a trajectory, a vehicle of information, a network and a model for interaction of bodies in their private and public spheres. This perspective reinforces the consideration of sound as a relational medium, analysing its effect on urbanity. According to LaBelle,

the city, as a particular sonic geography, highlights sound's inherent dynamic to "disintegrate and reconfigure", bringing forward its spatial and temporal particularities.[5]

1.1 Soundmaps

One key activity in the field of acoustic ecology is soundmapping. Soundmaps are visualisations of sonic activities related to geographical place. According to Schafer's definition of soundscape, the more soundmarks phonographers are able to record, the more effective a soundmap is. While this approach is the most widespread, as John Krygier writes, it is not the only one:

Our sense of hearing, which has until recently been underappreciated as a means of representing data, can be used to expand the representational repertoire of cartographic design....Sound, in other words, provides us with more choices for representing data and phenomena and thus more ways in which to explore and understand the complex physical and human worlds we inhabit. [6]

1.2 Soundwalks

The soundwalk is defined by McCartney as "an exploration of, and an attempt to understand, the socio-political and sonic resonances of a particular location via the act of listening" [7]. More practically, a soundwalk usually implies the use of a capture device, which could be a sound recorder or a notepad. The act of recording, capturing and storing the sonic information of an experience is at the basis of the modern approach to environmental sound explorations.

The exchange between the perception of space and place in the human experience is one of the key points of acoustic ecology theory, and forms the essence of the soundwalk experience.

This step-by-step experience, for Labelle, "initiates a supple and frictional topography of the contacts, giving meaning to the here and now" [4].

The artist Janet Cardiff [8] reconsiders soundwalks by focusing on the experience of walking driven by an imaginary and artificial soundscape. Cardiff records her sound walks with binaural technique and creates a mix of personal narrations and field recordings from the perspective of her ears. These are made available on CD-Audio and MP3, for the audience to listen to as they walk along the pathways explored by the artist. This creates a space for a narrative and immersive aural exploration of urban space.

1.3 Locative media, mobile sound and public participation

Previous artworks have explored the possibilities offered by mobile technologies for creative sonic exploration of urban space and to define public space as a canvas for mobile, participatory music creation.

Tactical Sound Garden [9] is an open source software for generic mobile technology (mobile, PDAs and laptop) to allow the cultivation of "public sound gardens within contemporary cities". The users of TGS could find "sound plants" (sound recordings) left by other participants and listen back to them and add their recordings, thanks to a network of free WiFi hotspot publicly available to use as platform for sharing.

Net_Derive' [10] transforms the city in a canvas for music creation, where the users are active parts of an audio-video installation running in a remote gallery space. The audio input of the mobile devices used by participants is streamed to a web server. This sound material feeds the installation, while location data is used as a parameter for rhythmical control of the musical instrument.

2. THE QUIET WALK

The Quiet Walk is an interactive mobile artwork that allows users to make a walking exploration of urban space, directed by sonic information captured on a smartphone. The goal of this exploration is to find the "quietest place." Instead of using geographical references to navigate around the city, software on the mobile guides the user, encouraging him or her to avoid particular noisy areas of city by giving directions to find acoustically quiet zones.

The data collected generates a constantly changing map of the city according to the amplitude level of its sounds. The experience transforms the user into a temporary cartographer, technologically aided and at the same time detoured, drifted on the thresholds of acoustic territories. The idea proposed by The Quiet Walk is to investigate this relation, the intersections of public and private spaces, defining everyday urban acoustics and creating points where the user can build personal sonic memories of places visited, aided by the generated map.

2.1 Description

The Quiet Walk is based on a purpose-built app for the iPhone which analyses the sounds of the city in real time and suggests for the user to make a deviation if the level of noisiness is too high. As the mobile transmits its GPS coordinates in real time to the project server, a system of routes and trajectories is drawn, creating an acoustical trace of the user's walk. These routes are visualized on a remote computer running an applet programmed in the Processing procedural graphics environment [11].

The visualization displays a map showing the traces of acoustical data measured in decibels translated into traditional notation for musical dynamics (pianissimo, mezzoforte, forte, fortissimo). After completing a walk, the user views the visualization and is able to recollect memories of sounds in specific places, asking himself or herself why a deviation on the walk has been made and reflect on the process of walking focusing his or her attention to the sonic world.

2.2 Interactivity

The Quiet Walk is designed to be an intuitive experience, without the need for detailed instructions. The smartphone interface was designed to reduce the possibility of distractions which may hinder the user's engagement with the work.

TQW is based on two principles of interaction. First, the user deals directly with the smartphone, which asks him or her to take a walk and carry out some tasks. This builds an engaging, game-like experience, which has a start and an end. Second, the interaction is based on a deferred time experience where the user is able to visually recall the previous walk in the gallery exhibition space, remembering the sonic experience of the walk with only visual references.

2.2.1 The Walk with the iPhone

The interaction in TQW consists of the following steps:
1. The user checks out an iPhone at the exhibition space and follows the instructions on the screen.
2. The user is instructed to go into an open space, outside the exhibition building / stand.
3. The user is asked to choose the first place to "listen". S/he presses the START button and the audio analysis algorithm starts to analyse the loudness of the location. Onscreen instructions ask him or her to stay still in their position and listen to the sounds of the surrounding environment.
4. After the analysis, the evaluation is displayed indicating two possibilities: loud or quiet.
5. In the case of a loud place the screen displays a text asking the user to navigate to another place, asking him or her to find a type of place drawn from a list of architectural stereotypes, such as public benches, trees, stairs, gates, green areas.
6. When the user reaches this point, step 3 is repeated.
7. If the iPhone determines that the area is quiet enough, it shows a screen indicating to the user to stop and enjoy the quiet zone. At that point the experience can be considered completed.
8. At the end of the experience, the user returns to the exhibition space and sees the visualisation projected in the exhibition space.

The goal of the application is to bring the user to "a quiet place". As there is a possibility that the user only encounters loud places, the maximum number of places that a user can explore is limited to 5. If there are no quiet zones, the phones displays the following message:

There are no quiet areas here. Maybe if you come back later in the night, or another day, you will find one. Sometimes the city is just loud. I suppose that if you try to call in your mind the memory of a quiet place around here, you will find one. I bet you can even remember the sounds of that place.
Thanks for the journey.

2.2.2 The Visualisation

The visualisation builds a sound map of the city, a deferred time representation of the walk, showing the acoustic information of the places passed by the visitors, creating a series of landmarks to evoke personal sonic memories of the participant who took the walk.

The visualisation in TQW is a standard topographical map of the city, showing the locations explored by the participants and their amplitude level. This sonic information is represented using standard musical notation for dynamics. The symbols used ranges from pp (pianissimo) for quiet to ff (fortissimo) for loud areas. The adoption of this system was chosen for its standardised use across many types of music. It was hoped that the characterization of place through standard musical representation would help the user to recollect the sonic memory of the area visited.

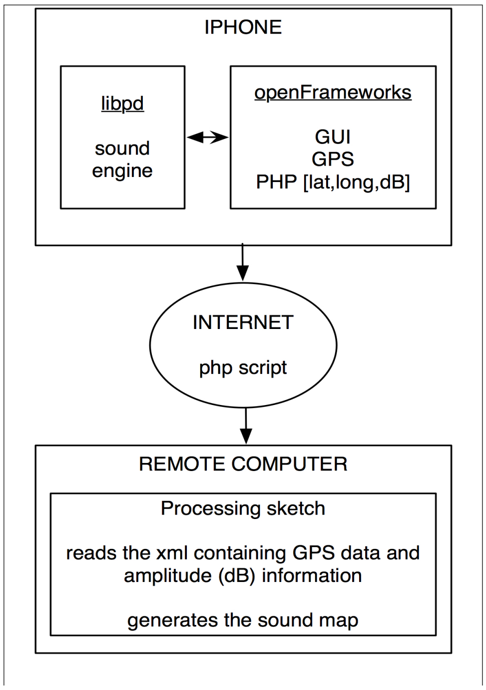

Figure 1. The Quiet Walk, technical implementation diagram. 3 part system: iPhone, Web, Remote Computer.

3. IMPLEMENTATION

TQW consists of three components (figure 1):
1. A custom mobile application running on an iPhone with sound engine and graphical user interface (GUI);
2. Web server A PHP script running on for collecting the data generated by the iPhone and the transmission to a remote machine;
3. A visualization of the map built in real time by a Processing sketch running on a remote machine.

3.1 iOS

The TQW app was developed on Apple iOS 4. The main software libraries used for the development of TQW are libpd [12], for the sound engine, and openFrameworks [13] for the designing of the GUI and the implementation of GPS and WEB functionalities. The integration between the sound engine and the GUI has been realized using an openFrameworks addon, ofxPD, developed by Dan Wilcox [14]. This allows running an instance of PureData within the OpenFrameworks application.

3.1.1 Sound Engine

The Sound Engine for TQW was built in Pure Data and embedded in the iOS app using libpd. (While libpd also runs on Android, it runs with significantly higher latency than on iOS.) The sound engine performs the following tasks:
1. Take audio input from an external microphone and communicate with the main interface programmed in openFrameworks through specific sends and receives;

2. Perform a FFT analysis of the audio input (using the fiddle~ object);
3. Manage a schedule of data events to be triggered to the main application and calculate the number of times within a period of time an amplitude threshold is exceeded (dB events).
4. Send the individual and long-term average acoustic amplitude data to the main application.
5. If the number of dB Events is greater than a predetermined value it send a bang message to the receiver "LOUD", otherwise it send a bang message to the receiver "QUIET".

The FFT analysis runs for 40 seconds, waiting a time interval of 10 seconds in the beginning and 10 at end. This behaviour was designed in order to minimize noise artefacts from device manipulation on the algorithm.

Another feature of the sound engine is to produce an audio notification of the evaluated state. A short impulse of white noise is generated and sent to the smartphone speaker if the result is "loud", while a pure tone is played back if it is a quiet area. This was designed in order to recall the attention of the user to the smartphone screen when his or her input is required.

3.1.2 Graphic User Interface

The GUI of the mobile application was designed to communicate simple instructions to the user in a simple, unobtrusive way. This was made with the specific intention of letting the users focus less on the visual aspects of the app, and to encourage attention towards the acoustic space beyond the borders of the iPhone screen (fig.2). The user interacts with the app through a single onscreen gesture. The user is aware that s/he can only tap one time, using one finger. This design approach aided to avoid interferences or distractions to the experience of walking. The user is aware that s/he can only tap one time, using one finger. The GUI was developed using openFrameworks (OF).

3.1.3 GPS

GPS data is sent by the iPhone to the web server over a 3G mobile broadband network each time the audio analysis of a single place is completed. The data sent from the mobile to the web server are the GPS location (latitude and longitude) and the average of the amplitudes recorded, measured in decibels. The location data is not transmitted continuously, but only when the user has arrived at a location to analyse, resulting in a series of single positions rather than a continuous trajectory. The reason for this is twofold: from a technical, point of view, this saves power and consumes less 3G bandwidth. More importantly, from an aesthetic point of view, the data focuses on points rather path trajectories, encouraging users to build the sonic memory of specific locations. This generates the map viewed in the exhibition space after the end of the walk.

This approach augments standard geolocalisation data with acoustic data. The data syntax sent to the PHP script on the server is open-ended and could be extended in the future to include other kinds of sonic information such as frequency.

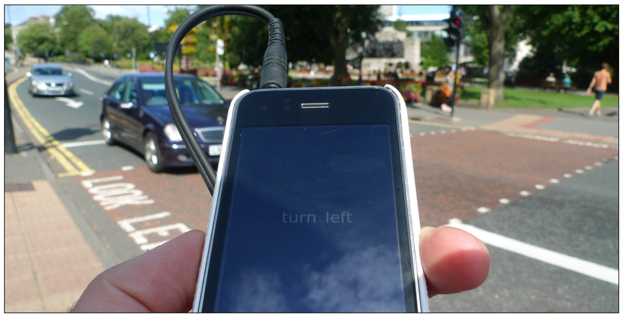

Figure 2. The Quiet Walk GUI.

Decibel range	Symbol
dB < 50	pp
50 < dB < 60	p
61 < dB < 65	mp
66 < dB < 70	mf
71 < dB < 75	f
dB > 76	ff

Table 1. Mapped scale

3.2 Webserver

The web server runs a PHP script that collects the data sent from the iPhone and generates an XML file for each session. These files are renamed and indexed on the FTP server, according to date and time of the walks. They are formatted to be readable by the Processing sketch running on the computer in the gallery space.

3.3 Processing Visualisation

The visualisation in the exhibition space overlays standard geolocalisation information with acoustic data. A Processing sketch queries the xml files on the web server in order to extract the indexed latitude, longitude and average decibel level for each point analysed in each walk.

The amplitude data is mapped from values below 50 dB to those above 76 dB (table 1). The map (fig.3) is created using the Processing/Java library Unfolding [15]. Unfolding is specialised in interactive and thematic maps, with specific functions to draw map-tiles and manage geographical markers.

It supports different map providers such as Google Maps, Microsoft Aerial and others. For The Quiet Walk, OpenStreetMap [16] was adopted. The map style chosen is plain and generic to allow the users to easily recognise the locations explored and to mark their associated sound data.

4. EXHBITION AND RESULTS

The Quiet Walk was presented in 2011 as part of the media art exhibition "Render 11" at Culture Lab, Newcastle University. The exhibition component of the piece was located near the entrance of the building with a table to

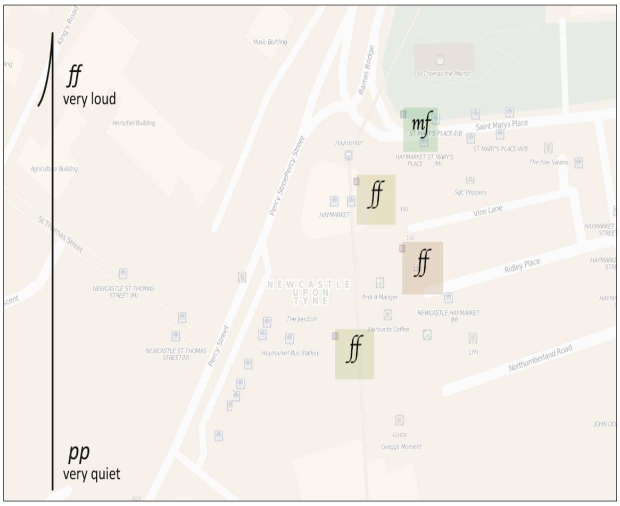

Figure 3. Example of the map generated and visualised in the gallery space, showing three loud locations (*ff*) and a medium loud (*mf*).

check out the mobiles and a large LCD screen to display the visualisation.

On some of the walks the participants were accompanied by the author.

The author was always present at the end of the walk in the gallery space, available to talk about their experience with the piece and receive direct feedback.

The exhibition of TQW ran for five days with a total of 23 participants. The average time of the walks was 20 minutes, with a minimum and maximum peak of respectively 10 and 40 minutes. The maximum distance covered by participants was 1.1 kilometres, while the minimum distance was approximately 100 meters.

While the mobile application ran smoothly, energy consumption was higher than expected, requiring a full battery charge every 6 hours. This did not affect the exhibition, as a second device was available on a charge station in the gallery space, serving as a backup unit. The system showed a small latency only when the 3G network could not be reached due to signal dropout from physical obstacles such as arches or metal structures. Some users noticed this small lag, however this never caused a total crash of the system and did not prevent the completion of a walk.

The sound engine worked reliably. According to the participants the visualization it generated gave a good representation of what they expected to be a loud place, but it seemed to be more accurate and effective in indicating the quiet one.

The general experience of the walk elicited excitement on the part of the users, to the sudden ability to switch between visual and sound attention, revealing their ability to "see" things introduced by particular sonic events, such as people's steps or seagulls flying, or trying to identify really far events such busses passing. A few participants claimed that this experience gave them a momentary sense of expanded hearing.

One person found the experience of waiting 60 seconds without being able to interact with the phone extremely frustrating, completely distracting from any possible immersion in the aural space.

The screen showing the visualisation of the walk was not self-explanatory and several participants asked for explanations and details in order to understand even the basic connection between their personal experience and what was represented in the map. The fact that the participants could not obtain these maps to read outside the exhibition seemed frustrating to some. It was only after some explanation that the idea of visual landmark for sonic memories became clear for the users**.**

5. CONCLUSIONS

This first version of The Quiet Walk demonstrated that a platform based on libpd and openFrameworks provides flexibility in developing mobile interactive sound works using an integrated development environment for mobile devices. In particular the possibility of using Pure Data as environment for programming mobile sound allows a quicker evolution of ideas from a prototype stage to a more definitive application [17].

During the Render 11 exhibition, the sound engine worked differently according to weather conditions and natural phenomena, such as strong wind, actively affected the acoustic level detected by the system. In such conditions the dB threshold was set manually in a new Pure Data patch before the daily opening of the gallery space. An extreme solution was to adopt an external mini microphone with a furry windjammer, connected directly to the iPhone jack input. This did not represent a problem during the exhibition period. However an extra menu to set a variable threshold, totally invisible to the user, can be designed on the iOS application. The possibility of an automatic threshold detector and calibrator will be evaluated but at this stage this represents a challenge in defining how the system should ignore a specific sound like wind from random loud events in the environment (a truck passing nearby, people shouting). A possible strategy would be an algorithm based on complex FFT-analysis, evaluating spectral components and their relative attack and duration in order to build a sound event recognition system. More specifically, future versions might benefit from the implementation of specialised pure data objects for audio analysis and classification such as TimbreID [18]. This would also extend the portability of the designed sound engine in other mobile projects and generic use applications.

Another aspect that emerged during the exhibition was the unreliability of the mobile broadband network. This represented an issue as every time the loudness of the location was evaluated, the mobile device sent the data to the web server. In case of no signal coverage this would freeze the app until the network would have been available again. The future version will buffer the information locally on the device and upload this data at the end of the walk, as there is no requirement for a real-time update.

If the visualisation made using music notation for dynamic is clear to understand, the problem of overlapping the different walks is a different matter. A new approach is currently under development, using dynamic contour lines, clearly separating the different zones on a rapid scan of the map. More importantly, all the maps would be available on an archival website and the participants could receive a personalised, unique map by submitting their identity to the database from the mobile device. The new project website would instead show all the walks, their location and sonic content on the form of a timed visualisation, from the oldest to the newest. This would create a "silent" sound map of the city, changing dynamically over the time due to the daily activities in the urban space.

Finally the flexibility of the custom designed PHP scripts combined with the code developed in openFrameworks and Pure Data, would open possibilities on mobile digital signal processing, not only for sound art related artworks but also as a platform for data-soundscape compositions and extensively further explorations on acoustic ecology studies.

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