IN YOUR OWN TIME

A Mobile Music Composition

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Declaration

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Abstract

In Your Own Time is inspired by the ubiquity of personal stereos and the opportunity to exploit this as a medium for compositional expression. The piece is an adaptive Mobile Music composition for smartphone that uses the inbuilt sensor technologies to adapt the composition. The composition embraces the listening environment to adapt different material within the music allowing the music changing it each time it is heard. The music integrates the listener and the environment to create a seamless link between them, using context aware music to bridge the gap.

The piece is for a Google Android smartphone using RjDj to run Pure Data on the device. The composition uses different sensors on the device to extract information about the listener and their environment to inform the music. In the case of this composition the listener's walking pace is detected using the accelerometer and transient sounds from their environment are sampled using the microphone.

Acknowledgements

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1. Introduction

> Roger Ebert says that 'no video gamer now living will survive long enough to experience the medium as an art form.' I think interactive music is at a similar stage. The limitations aren't technical, they're artistic. We just haven't evolved it enough, yet.[1]
>
> Robert Thomas

1.1 Introduction

This thesis deals with the field of Mobile Music, which Gaye et al. define as 'a new field concerned with musical interaction in mobile settings, using portable technology.' The musical experience that can be created by Mobile Music is different from recordings as the music dynamically adapts to the listener. This paper provides a survey of the historic and current practice in the field, mentioning areas where there is potential for the artistic practice to be expanded.

The focus of the thesis is a Mobile Music composition for smartphone. This composition will explore the medium of mobile music and address some areas for improvement within the field. This paper provides a summary of the process of creating a composition for this medium as well as some of the pitfalls and advantages of writing music in this way.

1.2 Current Practice

Current practice in the field of locative audio[2] is the convergence of several disciplines. It draws ideas from art, computer science, sociology and music with each discipline bringing a different approach to the medium. Some works, like *Electric Walks,* approach locative audio with artistic ideals, others, like *Tactical Sound Garden,* approach it from a sociological perspective and works like *Sonic City* take a Human Computer Interaction approach. Locative audio is also approached as a medium for musical expression with RjDj and Bluebrain using the medium in this way.

1 From an interview conducted with Robert Thomas by the author, the full interview is available in Appendix A.

2 'Locative Audio = audio with a sense of place'–inferred from the quote 'Locative Media = media with a sense of place' (Gaye 2007)

1.3 Artistic Approach

The convergence of disciplines to create Mobile Music means there are several ways of accessing the success of works within the field. The locative musical experience can at times rely too much on novelty as its unique point with the result that the musical elements are not exploited to their full potential. This happens when the experience is created around some technical aspect, such as the listener hearing an augmented version of their environmental sounds, but without fully exploiting its artistic potential. This creates a scenario where the experience can have an instant appeal due to its novelty, but no sustaining appeal through the music created .i.e. the listener tries the experience and finds it interesting but once this initial excitement has passed the experience does not contain enough to warrant further listens.

1.4 *In Your Own Time*

In Your Own Time is an adaptive composition for smartphone. The piece uses the smartphone's sensors to adapt to the listener and to take account of their environment, creating a composition that is context aware. The music is created from a single melody arranged in mensuration canon and adapts to the listener by matching the tempo of the melodies to the listener's movement and using samples of environmental sounds to create rhythms. The composition uses the smartphone's accelerometer to create a step detector. This is used to calculate the walking pace of the listener and generate a tempo from this. The tempo is then used to adapt aspects of the music to match the listener's walking pace. Environmental sounds are also sampled from the environment around the listener. The sounds sampled are loud sounds from the environment which are saved once they breach a loudness threshold. When a sound is detected it is recorded and saved into the composition, these saved sounds are then used to sequence rhythms.

Due to the interdisciplinary nature of the field of mobile music the creation of the composition and the writing of this thesis had to be approached from several perspectives. Different aspects of the project had to be approached as a composer, engineer, music technologist and musicologist but the primary focus has always been that of a composer composing an adaptive composition using a smartphone as the medium.

1.5 Contribution

The contribution of this thesis falls into three categories: theoretical, technical and artistic. The theoretical contribution is a survey of the field of locative audio. Historical locative audio works are mentioned and a brief discussion of the different conceptual categorisations of Mobile Music is presented along with a summary of the two different compositional approaches within the field. A large number of musical works were examined in preparation for composing a piece of mobile music and the most musically relevant are presented and the compositional approaches currently being used mentioned. The future work section of the paper suggests areas that could be explored and possibilities for the future of the medium.

A technical contribution of creating *In Your Own Time* is the implementation of a step counter on a smartphone to adapt the music to the listener. A step detection algorithm is used to detect the listener's footfalls using this information to infer a tempo. This tempo is used at discrete points within the composition to alter the tempo of individual melodic lines creating music that adapts to the listener's walk.

The final contribution is the Mobile Music composition, *In Your Own Time*, which explores a compositional approach to the medium of Mobile Music. It is presented as an example of making composition the primary focus when working with the medium and deviates from other work in the field that place interactivity as the focus. The goal of the composition is to create music that takes the listener beyond a fixed way of experiencing recordings to a more dynamic musical experience.

1.6 Conclusion

In Your Own Time is a composition for smartphone that builds on the existing Mobile Music practice to create a work that is focused on the musical experience. This chapter has outlined the field in which the work is taking place along with a summary of the work and its contributions. The following chapters expand upon these areas. Chapter 2 presents the field of locative audio and mentions specific works which have informed current Mobile Music practice. Chapter 3 reviews locative audio works that take a Mobile Music approach to the medium and how they exploit current technologies. Chapter 4 discusses the composition works that have inspired *In Your Own Time* along with the technical methods used to create the composition. Chapter 5 covers the realisation of the

project including details of the compositional and technical choices made. This chapter also describes some listening scenarios, so that the reader might get a sense of the experience. Chapter 6 provides a summary of the thesis and areas to be explored in future work.

2. Background

When people walk around town listening to a Walkman, it is a type of sound art.

(Kato 1997)

2.1 Introduction

Locative media[3] art is any art form with a sense of place and is mostly used to refer to art work outside a traditional gallery setting. The work can be either site-specific or mobile, but the term is increasingly becoming synonymous with the latter. Art works in this field have become more prevalent thanks to the increased power, and decreasing cost, of handheld personal computing devices.

This chapter is concerned with a subsection of locative media, locative audio. Locative audio is an artistic practice in which audio is the primary means of communication. Three locative works are presented, illustrating what is meant by the field providing examples of the technology used and the experience provided by the work. The chapter will provide an overview of the field mentioning some considerations and providing a context for a more detailed look at Mobile Music in the following chapter.

2.2 Locative Audio

Locative audio is a subsection of locative media practice in which audio is the primary means of communication. The genre consists of works involving sound art and music, either as mobile or site-specific works. Mobile audio works have been created using different technologies. Some are extensions of personal stereos[4] while others are custom made devices created for specific works.

Two ways of creating locative audio work became apparent while researching the field, locative audio and mobile audio. Locative audio relies on the use of techniques like geotagging and GPS technologies to compose audio. These pieces work using fixed, external stimuli to create, or adapt,

3 'Locative Media = media with a sense of place' (Gaye 2007)

4 Personal stereos are devices that allow an individual user to listen to music anywhere. This term is borrowed from the book *Sounding Out the City: Personal Stereos and the Management of Everyday Life* by Michael Bull.

the audio heard by the listener and could be thought of as site-specific works. Mobile audio works require no external stimulus are self-contained on the mobile device and independent of location. The distinction between mobile and locative works is mentioned here so that the reader is aware of it when reading about specific works. These two methods of working with locative audio will be mentioned in more detail in the following chapter once examples of each have been mentioned.

2.3 Historical works

This section presents three works *Electric Walks*, *Tactical Sound Garden* and *Sonic City.* These are the precursor to modern current audio and by extension mobile music, and it is important to mention them here. These three works have been selected as they provide a broad overview of the field of locative audio and each is presented to illustrate a different aspect of the practice.

2.3.1 *Electric Walks*

Figure 2.1 - Using *Electric Walks* headphones to listen to an LED display

Electric Walks (Kubisch, 2003) allows the listener to hear the sounds of electrical devices that they meet on a daily basis by using custom headphones that can convert frequencies in the electromagnetic spectrum to sound. Kubisch's interest in hearing electromagnetic induction lies somewhere between the aesthetic of the electrical sounds and drawing the listener's attention to the invisible world of electricity around them. The work provides a window into the inaudible electrical frequency spectrum allowing the listener to hear the induction of the electrical devices all around them.

Figure 2.2 - Precursor to *Electric Walks* using speakers instead of headphones

The headphones work by picking up the electromagnetic induction produced by all electrical devices, and amplifying it. In early versions of the project Kubisch created installations with cables, carrying audio signals, running throughout a space. Participants were given a box with a pickup and speaker inside that allowed them to hear the sounds in the cables. Kubisch moved away from fixed installations with *Electric Walks,* developing headphones that allowed the sound of the preexisting electrical devices to be heard. This allowed the participants to use the headphones to go out and explore the sounds of electricity in an area.

Figure 2.3 - *Electric Walks* headphones

The sounds of electrical devices vary with each device and Cox compares the sounds experienced to minimal techno artists Alva Noto and PanSonic.[5] Kubisch herself has said that listening to some sounds for extended periods is similar to La Monte Young.[6] Sounds from local infrastructure, trams and metros, contribute to the sonic characteristic of the city and give each city its own sonic character (Cox 2006). Audio examples from different *Electric Walks* installations are available on *Cabinet Magazine*'s website[7] and provide an idea of what might be heard, but part of the experience is open to the listener exploring the invisible sonic landscape and cannot be translated to a recording.

Part of the purpose of *Electric Walks* is to allow the listener to hear the electromagnetic noise of their everyday life and to be aware of the invisible electromagnetic frequencies around them. When *Electric Walks* are hosted, Kubisch provides the participants with a map of areas of interest in the vicinity but the listener is not required to follow the map and encouraged to explore using the headphones. The audio is an aleatoric experience with the listener able to control the audio experience through their movement.

2.3.2 *Tactical Sound Garden*

Tactical Sound Garden (*TSG*) (Tactical Sound Garden 2012) is an open source platform that facilitates community 'sound gardens'. The platform piggybacks on existing wireless networks to facilitate members of the community to 'plant' sounds by geotagging them to a location. Other members of the community can then experience these sounds by listening to them on a wireless device. The care of the garden is left to members of the community who are able to tend the garden by 'planting' or 'pruning' sounds or to simply enjoy the garden. This work is an example of using GPS technologies to create a locative audio experience.

5 Alva Noto and PanSonic are minimal techno artists.

6 La Monte Young is a minimalist composer know for his drone-based music.

7 http://www.cabinetmagazine.org/issues/21/kubisch.php

Figure 2.4 -Representation of a possible sound garden

The project was created to harness the power of WiFi hotspots within cities to create community sound gardens. Any device enabled with WiFi technology is a conduit for the sound garden and allows the user to listen and maintain the garden. The aim of the platform is to facilitate a technological mediated community experience.

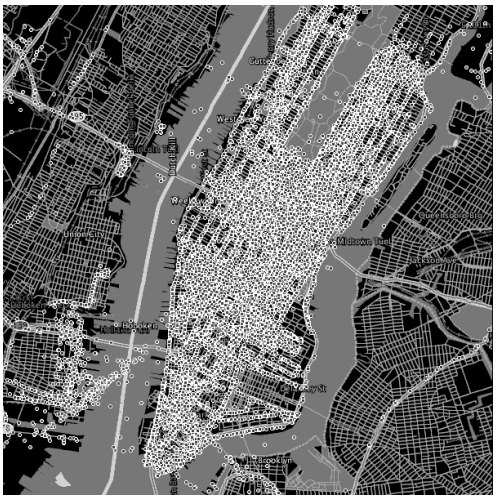

Figure 2.5 -WiFi mapping of New York City (Tactical Sound Garden 2012)

The individual user's devices act as network client and when they enter the sound garden and open the *TSG* application they connect to a web server with information about the garden. The device downloads the sounds for the garden and they are played back as the user walks through the mapped locations. The programme also allows the user to 'plant' their own sounds or to 'prune' existing sounds while leaving a note for the original planter. When 'planting' or 'pruning' the sounds the gardener has the option to specify a time when the sound is heard or how often it is repeated.

Figure 2.6 - *TSG* user interfaces

The experience of this project has two aspects, the listener experience and the community experience. Any member of the general public can listen to a garden. Once they open the *TSG* programme and connect to the server they can access the audio and mappings allowing playback. Listeners are able to hear the sound garden created by the communities and enjoy the fruits of their labour. As well as the sonic experience there is a community experience with the users able to participate in creating and maintaining the garden. This provides the opportunity for the users to be creative with their personal sonic experience and to create something that can be enjoyed by the community as well.

TSG is an interesting take on the locative audio experience. Shepard, the creator of the project, is an architect as well as an artist and his interest in community space was the motivation to create this project. The project is a unique approach to locative audio, creating a community-maintained sonic garden. The project has an interesting sociological aspect 'How do users interact and relate to an intangible community space?'. A discussion of this is beyond the scope of this paper but it is note-

worthy that *TSG* and *Electric Walks* can be viewed as both having taken a sociological approach to the medium.

2.3.3 *Sonic City*

Figure 2.7 - *Sonic City*

Sonic City (Gaye and Holmquist 2003) is a custom hardware and software device that allows the user to 'play' their surroundings. This is achieved by fitting a user with sensors that detect information about their environment such as: light level, noise, temperature and user movement. The information is then used to control the music heard by the user, allowing them to create a musical experience by interacting with their environment.

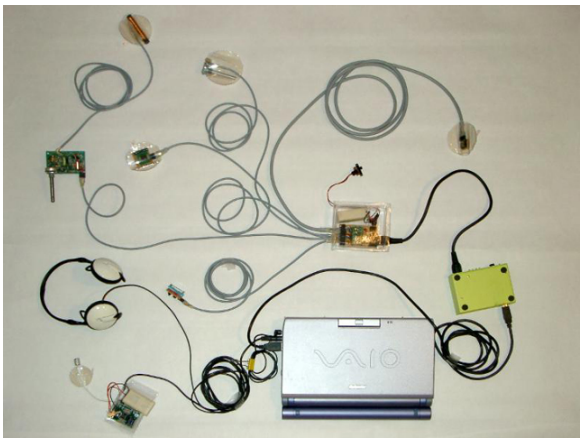

Figure 2.8 - *Sonic City* hardware

The project was created using custom hardware and software, consisting of a collection of sensors connected to a laptop. The laptop is worn in a backpack or, in later versions, embedded in a jacket. The sensors consist of light, sound, metal, heat and pollution sensors along with an accelerometer and microphone. They are placed at different points about the body and information from them fed into a Pure Data (PD) patch on the laptop.

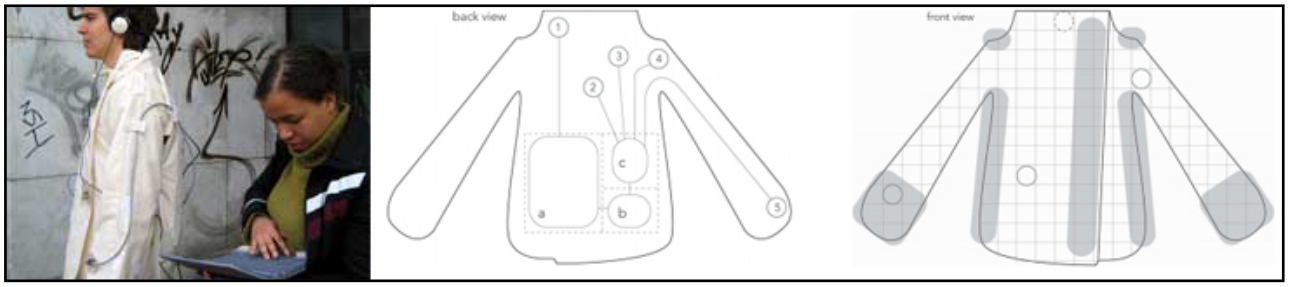

Figure 2.9 - *Sonic City* jacket

The music is created in PD using a series of modular digital signal processing (DSP) operations. Audio from a microphone is fed into the patch and processed using several modules in parallel. The sensor information controls the processes and determines which are audible, as well as affecting other sonic parameters. The sensors drive the processing of the environmental sound in realtime to create live, interactive music allowing the user to interact with their environment in a musical way.

The sensors create an experience in which the music has a direct relationship to the user's activity and their interaction with their surroundings. Walking in a darkened area, living in a polluted city and ambient noise all have an effect on the musical output. An interesting aspect of the project is that almost all sound stops when the listener is not moving. It is only through movement that the sound is heard.

User experience was an important aspect of the project and a small sample of user studies was undertaken. Each listener varied in their engagement with the system. Some actively sought to cause sound while others enjoyed being immersed in the sound created by their surroundings. Only one user did not enjoy the experience, due to feeling uncomfortable wearing the bulky equipment in public. The participants' take on the *Sonic City* experience gives an idea of what an ordinary user

might think of Mobile Music and provides a starting point for other projects. *Sonic City* is one of the earliest examples of Mobile Music which will be covered in detail in the next chapter.

2.4 Conclusion

The works outlined in this chapter give an idea of the types of work in the field. These works give a reference point for the field of Mobile Music as they demonstrate the various ways that audio can be used in a locative context. The works mentioned have taken several approaches to the medium and have been particularly influenced by sound art practice and human computer interaction. The musicality of the medium has not been fully exploited by the works mentioned and the next chapter will discuss several locative audio works that have taken a more musical approach.

3. Review

Music is what life sounds like.

Eric Olson

3.1 Introduction

Mobile Music echoes Olson's sentiment by creating music that takes its sound from life. The music is directly influenced by the listener and their environment creating a realtime musical experience from everyday life. It is a subsection of locative audio that uses a musical language, as opposed to a narrative or sound art language. *Electric Walks* in the previous chapter used an indeterminate sound art language for the work and other works have used story telling as part of the locative practice.

Following the general overview of locative media and locative audio in the previous chapter this chapter will focus on Mobile Music works. It examines the state of the art in the field mentioning three recent works, *Ambient Addition*, *Inception The App* and *The Violet Crown*. *Ambient Addition* is a stepping stone from *Sonic City* towards present-day mobile music and the other two works represent the most recent incarnations. *Inception* and *The Violet Crown* are app[8] based works that use the existing technologies in smartphones to realise their ends. The chapter will conclude by summarising the different approaches taken within Mobile Music.

3.2 Mobile Music

Mobile Music is an emerging field whose practice is an evolution of the field of locative audio discussed in the previous chapter. A community around Mobile Music was stimulated at the NIME06 conference with a paper documenting the field and providing workshops to facilitate the growth of the community. This paper was presented before the mass adoption of smartphones when mobile music involved creating hardware and software. This is no longer necessary, but with any emerging field there is exploration to find the best way to work with the medium. Mobile Music is still processing how to balance the possibilities of the medium with listener expectations.

8 In this case 'app' refers to an application for smartphone.

While there are few artists or groups composing Mobile Music, there are several approaches that have being taken. Three main strands that composers are using include Mobile Music as instruments, games and music. These three strands represent the conceptual challenge of working in this field. That work in this area can be either an instrument, music or a game or can fall between these definitions.

Some locative and mobile work fall into the category of musical instruments. There are instruments for mobile devices, simulations of Moog synthesisers and pianos, but an application like RjDj allows the listener to take an active part in the music. *Atsuke* is a work that allows the listener to sing along with a generative composition and have their voices manipulated in realtime. Another work, *Moovz,* allows the listener to interact with the music, using the phone's accelerometer, so that they are manipulating the audio being played back. *TSG*, mentioned in the last chapter, facilitates a distributed user composition, but this work might also be thought of as a communal instrument. As mentioned by Thomas once the user is required to have direct interaction with the music then the piece moves away from being a composition and towards being an instrument.

RjDj are a company specialising in developing mobile music apps. Their latest app, *Dimensions*, focuses on the use of musical game play to create musical experiences. *Location33* (Carter & Liu 2006) adds an element of game play to the work by using the lyrics of the music to provide clues to the listener to where the next audio point is mapped. Apart from using game play as part of the Mobile Music experience, some of the technical and conceptual aspect of video games are being borrowed as well e.g. *TSG* used a game engine to map sound to locations.

Much of the work currently being done in procedural audio for games is also applicable to Mobile Music. *Game Sound* (Collins, 2008:139-166) discusses composing dynamic music for games and *Designing Sound* (Farnell 2010) covers the aesthetic considerations of composing procedural audio and non-linear sound for games. Many of the concepts of non-linear music, dynamic music, and action driven sounds are as applicable to Mobile Music as they are to games. As the focus of this thesis is on the creation of a Mobile Music composition that is intended to be experience as a piece of music, three works are now presented that demonstrate the musical practice within the field.

3.3 *Ambient Addition*

Figure 3.1 - *Ambient Addition* headphones and chip

Ambient Addition (Vawter 2006) is an early example of Mobile Music that was inspired by *Sonic City*. It took a more streamlined approach to Mobile Music hardware and using an audio-based paradigm to create music from the listener's environment. The hardware was created from a programmable chip connected to a headset with a pair of microphones attached to the headset. The chip analyses the environmental sound and uses it to generate music. The sounds that the listener hears are abstracted versions of the sounds happening around them.

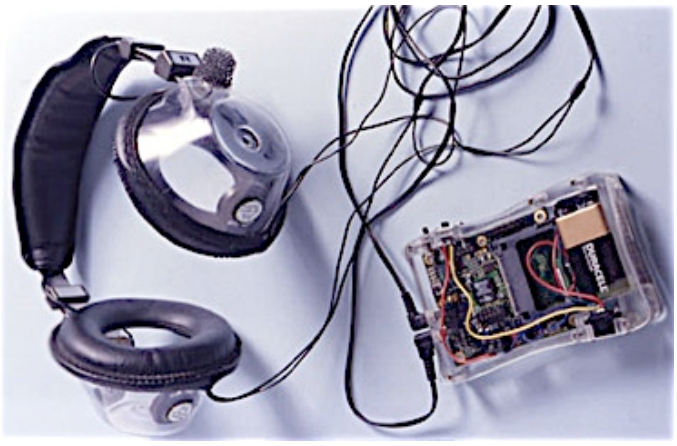

Figure 3.2 - *Ambient Addition* hardware

The audio entering the microphone is analysed for two musical characteristics: pitch and rhythm. A Fast Fourier Transform (FFT) constantly monitors the ambient sound for a fundamental pitch and a

predefined chordal pattern is then tuned to this pitch. All the environmental sounds coming into the mic are phase-vocoded with this pattern.

Any transient sounds happening in the environmental sound are detected and captured on the chip. These are then used as the sound of predetermined rhythmic patterns, creating rhythm from transient environmental sounds. The hardware for the project was largely custom made. In his thesis Vawter speculates about using an iPod for the project but dismisses it due to its limitations at the time.

Mediating the environmental sound makes it unfamiliar enough that the listener starts to take notice of the sounds that are happening around them. That the re-synthesis draws their attention to everyday sounds that might otherwise be ignored is interesting. Using environmental sounds in combination with pre-programmed musical material Vawter has created music that is linked to the sounds at the listener's location. The following works, *Inception* and *The Violet Crown*, have been released in the last twelve months and are a departure from the piece covered so far as they are both commercially available as apps for smartphone.

3.4 *Inception*

Inception is a mobile music app created by *RjDj* and Hans Zimmer using the music from the *Inception Original Soundtrack* and realtime manipulation of environmental sound. The app is a Mobile Music representation of the soundtrack that uses musical loops together with augmented versions of environmental sounds. The app provides the listener with *dreams*, which are augmented sonic experiences created using signal processing and information from the phone's sensors. The listener is able to unlock different *dreams* by using the app in different situations. There is a traveling *dream* if the listener is traveling over 120k/h, Sunny *dream* if the listener is using it in good weather and an Africa *dream* if the listener is in Africa.

Figure 3.3 - *Inception* screenshots[9]

The technology behind the app is the RjDj sound platform, which is a platform that allows sound artists and composers to create DSP patches that will work on a smartphone. RjDj is based on the PD audio programming language, which can run on smartphones using *libpd*. The PD patches of one of the *dreams*, *Overture,* were analysed to see how the music is created.

The patch uses eight short audio files of music and recordings along with a delay effect, to create the music within the app. There is a global clock and the delay effect is triggered at irregular intervals to augment the listener's environmental sound. Each time the delay is triggered its parameters are randomly changed affecting the delay repeat, time and pitch of sound from the mic. The affected sound is interspersed with the audio files, which are mostly music from the soundtrack but also include a sample of a train. All the audio is passed through a reverberation effect and combined with the output.

The sound heard is mostly the effected environmental sound, with the music and samples appearing and disappearing. The music from the soundtrack and the processed audio compliment each other with the reverberation giving a sense of space while tying the elements together.

9 Image sourced from: http://www.techeblog.com/index.php/tech-gadget/inception-app-hits-the-iphone-ipod-touch

3.5 *The Violet Crown*

Bluebrain are a musical group who have created locative music albums using geotagging[10] composition techniques. The albums are site-specific musical apps for central Austin Texas, the main Washington thoroughfare and Central Park, New York. *The Violet Crown,* for Austin Texas, was examined as an example of the composition methods using locative techniques.

Figure 3.4 - *The Violet Crown* poster[11]

It is delivered as an application for Apple iPhone and uses the GPS capabilities to map sections of music to different areas within Austin. The music plays back as the listener walks through the mapped locations and crossfades from one section of music to another when the listener moves between mapped nodes. Several audio files can also be played simultaneously if there are sub-mappings– when audio is tagged to a small node within a larger node–within the nodes.

10 Geotagging is the adding of geographical metadata to media (Wikipedia 2012), in this case audio.

11 Image sourced from: http://bluebrainmusic.blogspot.com/2012/02/violet-crown-austin-texas-third.html

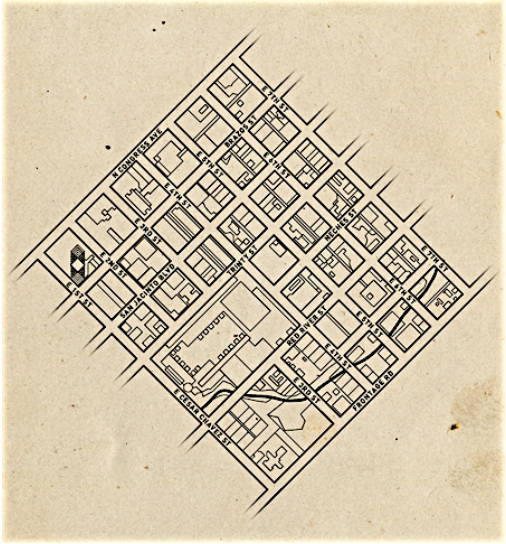

Figure 3.5 - The area of Austin mapped by *The Violet Crown*[12]

The music is experienced by walking through the mapped area. The composition evolves as the listener moves through the space and experiences the changing music. Once you are within the mapped area, music is always present and you create a personal structure by moving through the different musical nodes. The app was analysed to examine how the music is put together and to get a sense of how it might be experienced. By examining the musical material one can get a sense of how the mapping and music relate to each other.

Within the app there are several musical loops of the same length that share the same melody but use different instrumentation or timbres. This creates a scenario in which, as a listener walks from one node to another, they crossfade between audio files that share characteristics creating a timbral or textural change in the music. The consistency of melody creates a sense of musical continuity as the user moves through the composition, while the timbre or instrumentation is altered to maintain interest. A challenge of writing music in this way is the planning that needs to be done. The music needs to be thought out so that each zone links to all the ones around it and overlapping zones synchronise creating a mesh of sound (Bluebrain 2012).

12 Image sourced from: http://blog.iso50.com/26845/the-violet-crown-app-at-sxsw/

3.6 Mobile vs. Locative

As mentioned in the previous chapter there are two main categories applicable to Mobile Music, locative music and mobile music. Both of these are equally valid ways of working with music that offer different challenges and possibilities for creating musical experiences.

Locative techniques are evident in pieces like *The Violet Crown* and *TSG* and are good at creating meaningful links between the area and audio. In *Listen to the Light* for Central Park, a Bluebrain album, a section of the music was recorded on an organ in a New York church. This music was then mapped to the end of the park where the church is located. The ability to create these kinds of meaningful links between the audio, mapping and listener experience is one of the strengths of locative techniques allowing the composer to create direct connections between the area mapped and the musical experience.

Several other works use this type of mapping to create meaningful locative experiences. *Location33* (Carter & Liu 2006), a work for Culver City, California, uses locative techniques to create a narrative between the lyrics of the music and the filmmaking history of the area and *Viking Ghost Hunt* (Paterson et al. 2012) uses locative techniques to link historical significance of an area to the audio. These types of linked meanings are possible through using fixed external stimuli to adapt the audio.

Mobile music by contrast is not reliant on external stimulus to create music. The music can be created just on the mobile device and used anywhere, providing an experience that is closer to the conventional personal stereo use. Works like *Ambient Addition, Electric Walks*, *Sonic City* and *Inception* fall within this category. *Ambient Addition* and *Inception* use the microphone to create interactivity between the listener, their environment and the composition. *Electric Walks* uses a similar technical implementation except the sounds picked up are from electromagnetic environment instead of sound, while *Sonic City* uses a variety of sensors to create interactivity between the listener and their environment.

3.7 Conclusion

Following from the locative audio works mentioned in the last chapter, this chapter has looked at locative audio works that take a musical approach to the medium. The increased level of musicality has been achieved by using a more conventional palette of musical sounds and composition techniques and creating adaptivity around them. *Inception* and *The Violet Crown* use musical samples as part of their composition. *Ambient Addition* uses predefined chordal and rhythmic patterns to structure the music. These features move away from the more indeterminate musical language used by works like *Electric Walks* to a more conventional language that incorporates musical adaptivity. The compositional indeterminacy of the medium is still present but the language used to describe it has changed.

In spite of this move towards a more musical language for Mobile Music, structure is an aspect that can sometimes be lacking. Many of the pieces are not of fixed length and their interactive and generative processes will continue indefinitely until the listener switches them off. In *The Violet Crown* the music has been structured over space allowing the listener to create their own structure. The balance between musical indeterminacy and composition is a distinguishing feature of Mobile Music and will ultimately come down to an aesthetic choice by the composer. The aim of the composition for this thesis is to create an experience that is closer to conventional personal stereo listening but that allows space for the composition to adapt each time. The following chapter will look at compositional and technical techniques suitable for composing *In Your Own Time*.

4. Methodologies

Technical skill is mastery of complexity, while creativity is mastery of simplicity.

Erik Christopher Zeeman

4.1 Introduction

Mobile Music requires balancing the musical ideas against the limitations of the medium. This chapter outlines the different compositional approaches and concepts that provide the inspiration for the composition as well at the technical methods used to realise them.

4.2 Composition Methodologies

Simplicity of musical ideas was an important consideration when beginning this composition. Concise musical ideas, making maximum use from a minimum of material, is part of the author's musical aesthetic and it was important that this be part of the musical language. This conciseness was sought in several areas of the composition, including the form and timbre, and interwoven as a tenet of the concept of the composition.

The composition techniques used have all been chosen with the medium in mind but without compromising the intent. This section outlines the inspirational works that informed the composition along with the techniques these have suggested.

4.2.1 Music as Cerebral Background

Erik Satie coined the phrase furniture music to describe his idea of a musical background music to be heard but not heard:

> There is a need to create furniture music, that is to say, music that would be apart of the surrounding noises and that would take them onto account. I see it as melodious, as masking the clatter of knives and forks without drowning it completely, without imposing itself. [13]

Erik Satie

13 Bertaud, P. 2011 Erik Satie: Furniture-music [online], available: http://www.philippebertaud.com/erik-satie-furniture-music [accessed 08 May 2012]

Satie's intention with furniture music was music that was not the focus of attention, music that could be at the edge of the listener's consciousness and forms a background to the environment. Music on the opposite end of the spectrum to the dramatic music of the romantic period, which does not 'impose itself' on the listener. (Bertaud 2011) This idea of music as a background has been taken up by Brian Eno with the creation of Ambient Music. (Eno 2009)

Describing the multiplicity he saw for ambient music Eno wrote: 'Ambient Music must be able to accommodate many levels of listening attention without enforcing one in particular; it must be as ignorable as it is interesting.'[14] He has also spoken about how it is possible to produce music that can act as ambience without compromising its integrity. This duality of purpose for the music, both as art and function was a motivation while composing. The author's current work explores the idea of music that does not have to be consciously attended, which can act as a cerebral background for the listener.

To create music that is as interesting as it is ignorable Satie and Eno use a simplified musical language. The *Gnossiennes* and *Gymnopedies* by Satie stand out as music that holds true to the concept of 'furniture music'. Arvo Pärt is another composer who creates music from a concise language. Writing about Pärts's music Paul Hiller said: 'He uses the simplest of means...and with them creates an intense, vibrant music that stands apart from the world and beckons us to an inner quietness and an inner exaltation.'(Hillier, 1989:134-137) The approach for this composition sought to emulate the simplicity and conciseness of music by Pärt and Satie's music and that does not demand the listener's attention.

4.2.2 Canon

The canon form was chosen as a compositional technique that would allow simple melodies to be expanded to create an extended work. Several canons were examined in preparation for this composition including *Symphony of Sorrowful Songs* by Henryl Gorecki, *Spem in alium nunquam habui* by Thomas Tallis, and *Cantus: In Memory of Benjamin Britten* by Pärt. Of these the most influential was *Cantus: In Memory of Benjamin Britten* due to its use of mensuration canon.

14 From the liner notes of Eno, B. 2009 Ambient 1: *Music for airports*, Virgin.

Mensuration canon is a technique used by Pärt when he wishes to create more ‘expanded, continuous utterances’ (Clarke & Pärt 2012). It is the canonic technique of repeating the same melodic contour in different lines at different rates blurring the use of canon to the listener. In *Cantus: In Memory of Benjamin Britten* Pärt begins with a single voice in the highest register and slowly expands the register downwards to encompass all the instruments of the string orchestra, colouring the canon using textural additive process. This is the building of a musical texture through the addition of independent lines and is evident in all three of the canons mentioned. A perspective view of the first three pages of *Spem in alium nunquam habui* (fig 4.1) shows how Tallis builds the musical texture by adding individual voice.

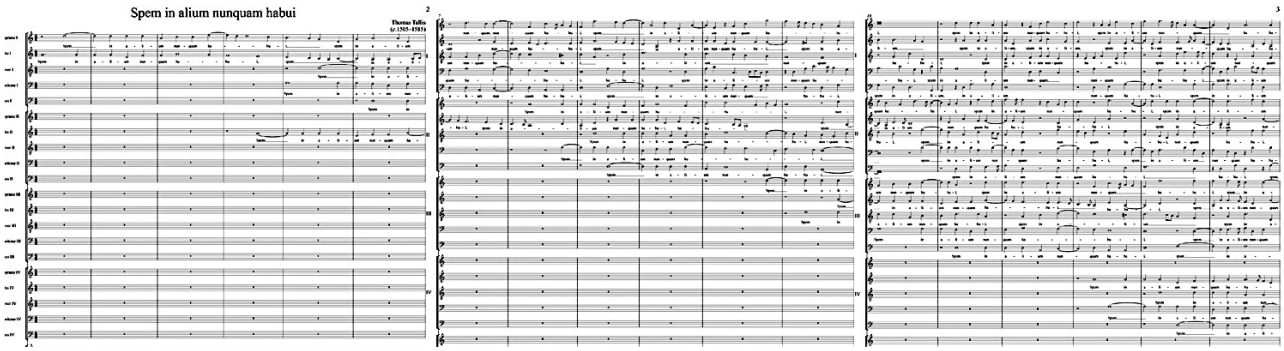

Figure 4.1 - Textural build up in *Spem in alium nunquam habui* by Tallis

This gradual addition of voices is used to create a dense textural mass of sound and the addition and subtraction of voices is used as part of the compositional language. For example in *Symphony of Sorrowful Songs* Gorecki begins with the music in the lowest register and gradually ascends through the voices. By contrast in *Cantus: In Memory of Benjamin Britten,* Pärt starts with the music in the upper register and then moves down through the register. The entry of the voices is as much part of the process as the texture created.

Textural additive process is also used by current musicians and composers, in *I Know You Are But What Am I?* by Mogwai, a post-rock band. The music starts with a solo piano playing C# crochets. Gradually a bass line is added on the piano, then a bass guitar begins to swell in and out, a glockenspiel enters in the upper registers and finally a drum beat comes in.[15] Each of the instruments play very simple material and it is the texture created from this material that is interesting. Once all the

15 The audio from this piece of music is available in the appendix.

lines have entered and been established, the material played by the instruments changes causing a shift in the texture of the music. These two techniques, mensuration canon and textural additive process, allow simple material to be expanded to create something interesting that fits with the aesthetic of the composition. Now the technical aspects of creating these on a smartphone will be mentioned.

4.3 Technical Methodologies

With the works in the previous chapter, *The Violet Crown* and *Inception,* we saw how the technology is moving towards a more seamless Mobile Music experience. Contrast this with the technical setups of earlier works, particularly *Sonic City*, which required specialised hardware to create the experience and you begin to see how far the technology has moved. The advancement of smartphone technology and seamlessness of devices makes it possible to create adaptive musical experiences that require no more hardware than traditional personal stereo listening.

4.3.1 Smartphone

Mobile and locative music have been possible for a long time but their possibilities have now opened up with the advent of the smartphone. Smartphones differ from manufacturer to manufacturer and model to model but they all contain a basic set of sensors. Typical sensors include: accelerometer, gyroscope, microphone, temperature sensor, metal detector, WiFi, GPS, light sensor, compass, etc. This is not an exhaustive list. This array of sensors opens up possibilities for a large number of applications.

What is interesting from a Mobile Music perspective is using the sensors to extract information about the listener that can be used to create a meaningful musical experience. This type of information include finding out what the weather is like near the listener, how much they are moving or how noisy it is. Some of these have already been implemented in *Inception The App* such the *Sunny dream* for good weather and the *Action dream* when the listener is moving about a lot.

For this composition it was decided to use the accelerometer to detect when the listener is walking and to use this information to alter the music. Step counters have already been created on smartphones as apps to help people monitor their activity and it would be a case of adapting the technology to a musical end. This would create adaptivity affected by the listener, but it was also decided to

use the environment to adapt the music as well. To make the music adapt to the environment it was decided to use Vawter's technique of capturing environmental sounds to sequence rhythms. To achieve this it is necessary to record transient sounds from the environment, store them in memory and then use them as the sounds for a predefined rhythm. As all smartphones come with headphones that include a lapel mic in the cable it would be simply a matter of scanning the audio input for loud sounds and recording and saving these when they occur. These samples can then be used to sequence predetermined rhythms allowing the environment to affect the audio.

4.3.2 Composing for Phone

There are several options available to work with audio on a smartphone but the most obvious was to use RjDj. RjDj is an app that allows PD patches to run on a smartphone. An advantage of using this app is that it is available on both Google Android and Apple iOS. This means that a composition created using a Google Android smartphone can be used on an Apple iPhone and vice versa. The functionality of PD within RjDj is limited to the vanilla release of the software but a developer kit comes with a large library of externals created by Reality Jockey Ltd.–the company behind RjDj.

The developer kit also comes with objects that provide access to the different sensors on the phone so that they can be used to control the music. At present not all sensors are supported by both versions of the app, i.e. for Google Android and Apple iOS, and are limited to ones most common to all devices: the accelerometer, mic, and touchscreen.[16] (Brinkmann 2012) To get access to this functionality it would be necessary to move beyond the RjDj app and program the composition within Google Android or Apple iOS software development kits (SDK). Using the libpd library for Google Android and Apple iOS it would still be possible to use PD as the audio engine of the app. This level of functionality is not required for this particular composition but that additional functionality can be accessed for future compositions. The RjDj app provides a way to prototype a composition on a phone without having to programme in a text-based programming language or commit to a smartphone operating system.

16 The app for Apple iPhone currently support more sensors.

4.4 Conclusion

Considerations such as the composition, aesthetic, the musical adaptivity and the technologies used were covered in this chapter. The compositional methodologies focused on the aesthetic of music as a cerebral background taking inspiration from the works of Satie and Eno. The canonic form was selected as a composition technique suited to creating the music that could be interesting and ignorable. Specific pieces using canon from Tallis, Gorecki and Pärt were mentioned and the technique of textural additive process was also mentioned. The technical methodologies surmises the consideration for using a smartphone as the medium of composition and the software used in the creation of this composition. The following chapter will outline the implementation of the composition, *In Your Own Time*, for smartphone by outlining how the musical and technical considerations were combined and implemented and describing a listener experience.

5. Implementation

> We shall never cease from exploration
> And the end of all our exploring
> Will be to arrive where we started
> And know the place for the first time.
>
> T. S. Eliot

5.1 Introduction

Composing a piece of mobile music is the convergence of the different elements in the previous three chapter. It is a balancing act between the composition, adaptivity and technical limitation. These three different sets of requirements must be reconciled to create a piece of music that provides the listener with an adaptive musical composition. This chapter outlines the steps and decisions taken to realise *In Your Own Time*, detailing the compositional choices made and how the adaptivity is intertwined with the music.

The technical aspects of the adaptivity are covered providing a view into the process of using PD to create music on a smartphone. The listener experience is outlined by describing two listener scenarios. This will allow the reader to get a sense of what it would be like to experience the composition in different situations. These scenarios give an idea of how the music might deal with different circumstances.

5.2 Composition

The quote from T.S. Eliot at the beginning of this chapter sums up the musical form. The piece has an opening section which is deviated from and then returned to in an ABA form.

5.2.1 Material

All the material for this composition is derived from a single melody that started as an improvisation on a piano. The melody is composed to be difficult to predict to allow it become part of the background of the listener experience and allow for it to be heard continuously without causing fatigue. This was achieved by making the melody ascend and descend by different intervals and over irregular time spans. The result is the melody in fig 5.1. Within the phrase in fig. 5.1 there is a repe-

tition of the melody with a slightly different rhythm to add to the difficulty of anticipating the melodic movement.

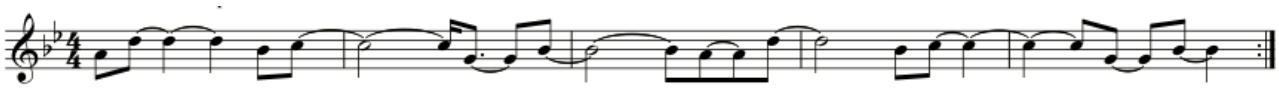

Figure 5.1 Melody

The rhythmic pattern used in Section B is a contraction of the rhythm of the melody. Within PD, different variations of the rhythm of the melody were experimented with to find a suitable rhythm for the section. This rhythm was chosen due to it being asymmetrical, i.e. it uses indivisible numerators for the meter, which makes it difficult for the listener to hear when the phrase begins.

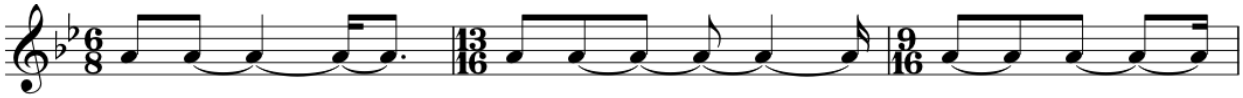

Figure 5.2 Rhythm

5.2.2 Section A

Section A opens with line 1 (fig 5.1) and every twenty-five seconds, the same melody enters at different pitches. All the melodies share the same contour but start in different registers and progress at different tempi. Except for the first line, whose tempo is fixed, the speed of each line is indeterminate and adapts to the listener whenever the composition is played. As each line enters, its tempo is taken from the pace the listener is walking at. As the tempo is extracted from the pedometer it is only used if it is between thirty and seventy-five beats per minute. This was put in place as a compositional choice to shape the aesthetic of the music. Values outside these bounds make the music less predictable. The indeterminate tempi create different relationships between the lines each time the music is heard.

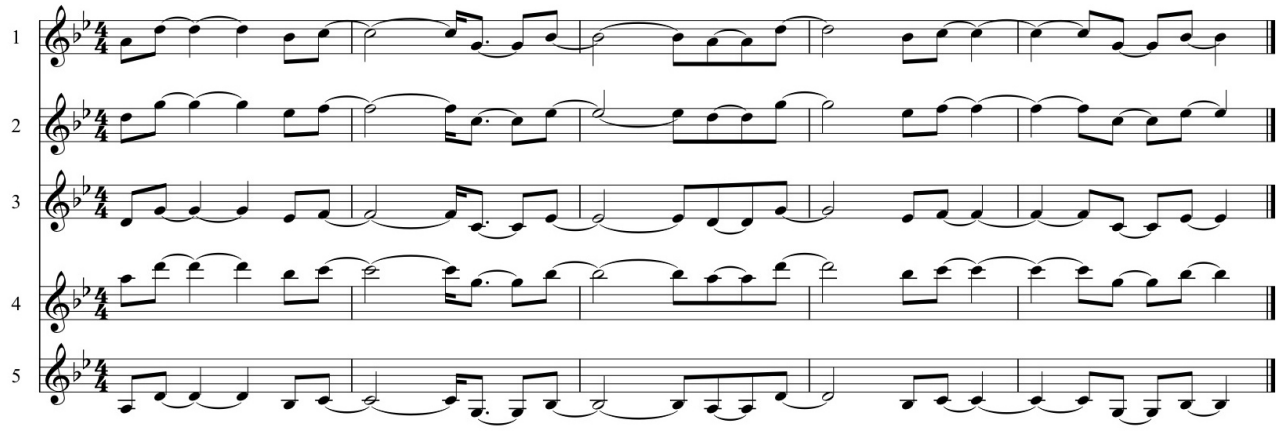

Figure 5.1 The five melodic lines of Section A, the tempi are indeterminate so the lines playback at different rates with each listen

Sine tones were chosen as the sound for this section. Sine tones are the simplest form of musical material which is in keeping with the idea of musical simplicity for the composition and lays the musical material bare. The sine tones were very exposed and delay was used to soften the sound and allow the individual lines to blend better. The delay also adds a subtle harmony from the single melody as it sustains the previous note when the next note enters. In the lowest melodic line this causes beating between two of the notes, an affect which was unintentional but adds to the texture.

The usable register is limited by the medium of delivery, the smartphone. Originally seven melodies were used but small headphones are not good at reproducing low frequencies and the lowest frequency was almost inaudible. If the volume of the line was increased enough to be reproduced it caused the audio output of the phone to clip. It was decided to remove the top and bottom line and using five lines instead.

When all five lines have been established a delay effect, through which all the melodies are fed, is gradually increased over sixty-seconds. This causes the melodic material to become a blurred mass of sound. The music from this section then gradually fades out over sixty-seconds as the next section fades in.

5.2.3 Section B

The B section is based on the combination of five rhythmic lines created from samples of environmental sounds. This section also uses a mensuration of a phrase but the tempi of the lines are predetermined. As all the lines use the same rhythmic phrase at different speeds an asymmetric phrase length was chosen to ensure that the relationship between the lines would not become too regular. Unlike the first section all five of the lines start at the same time and are faded in together.

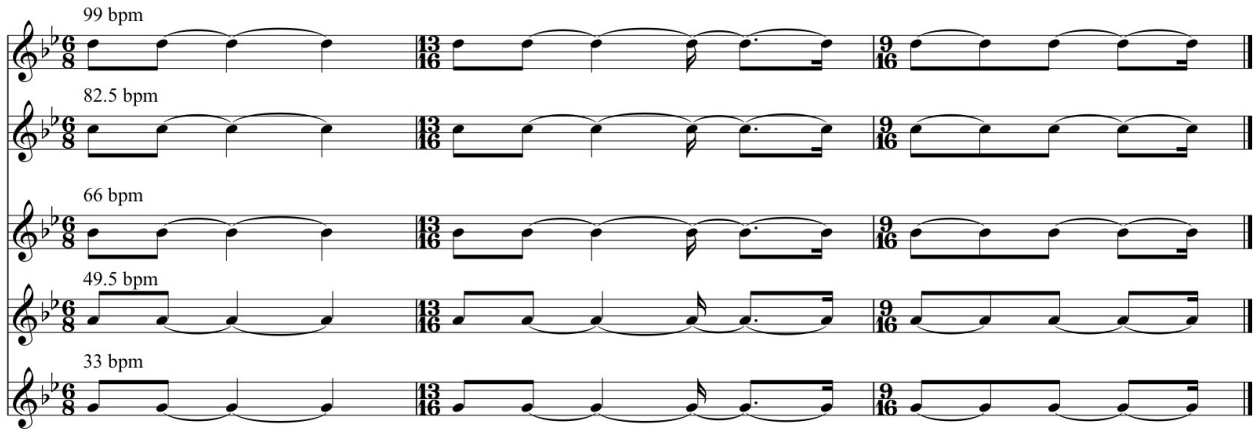

Figure 5.2 The five rhythmic lines from Section B along with their tempi

The indeterminacy of Section B is the timbre of the sounds. By using environmental samples for each rhythm it is not possible to know what samples might be used and allows the composition to adapt to the sounds around the listener. A different form of textural additive process is used in this section created by manipulating the timbre of the individual samples. Each sample is passed through a bandpass filter which can causes the sound to be pitched. Throughout this section the Q value of the filters are changed to modulate the sound of the samples from almost sine tones to the more rich timbre of the original sample and back again. To create a sense of continuity between sections A and B and to maintain a cohesive aesthetic for the composition each sample is filtered taking one of the five pitches, G, A, Bb, C, D, from melody 1 (fig. 5.1) as their centre frequency. This keeps the pitch of the composition continuous and allows for a smooth transition between the sections. At the beginning of this section the samples start filtered almost as sine tones. Once the previous section has completely faded out the Q value of each sample is decreased in turn, staggered over ninety-seconds, to modulate the sound from the sine tone towards a pitched version of the original sound.

Once all the samples have reached the pitched timbre version of the original sample, another filtered version of the same sample is faded in, in parallel with the original. The new filters are a fourth below the original filter. Thus if the original pitch that the sample was filtered at was D then it would now also be filtered at the G below it. This expands the timbre while keeping the samples within the frame of the composition. A filter a fifth above each sample is also faded in. This creates a filtration of the original sound creating a timbral chord of octaves and fifth. This mirrors the relationship between the lines in Section A when they are stacked vertically, octaves and fifths.

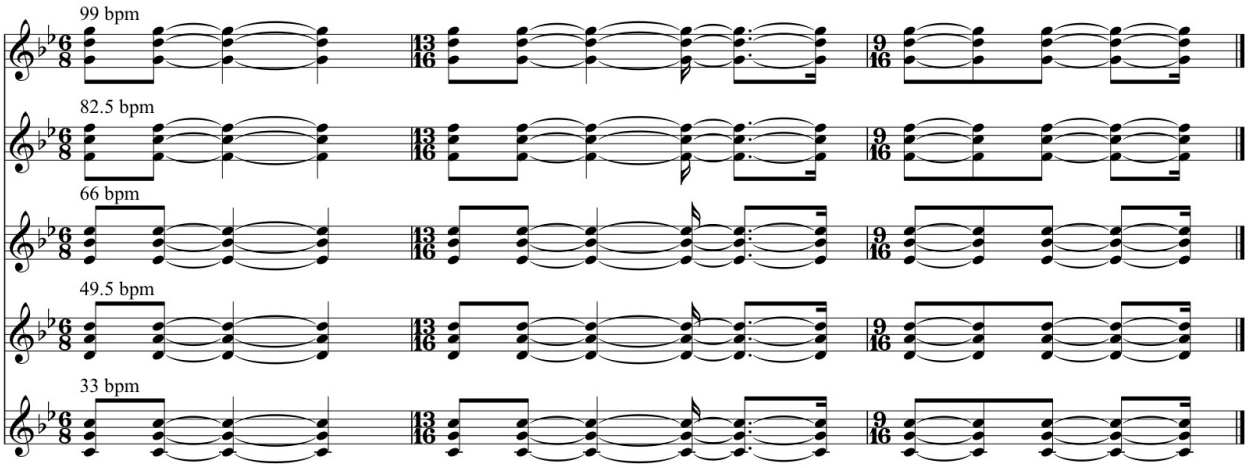

Figure 5.3 The pitches at which the sample from each line is bandpass filtered at

This rhythm with its expanded timbre is left for forty-seconds and then the Q is increased, modulating the samples back towards sine tones. (As there are now three versions of each sample heard in parallel each sample creates a chord see fig 5.3.) At the same time a delay effect, through which all the rhythms are being fed, is gradually increased towards feedback for forty-seconds creating a textural wash from the rhythms. The texture of this section fades out as the texture of the first section fades back in over eighty-seconds.

The final section is a palindrome of the original. The music starts with the sound mass and the delay is decreased over eighty-seconds until the textural mass disappears and the individual lines are audible. Each of the lines then gradually fade out leaving the original melody on its own, until it too fades out.

5.3 Adaptivity

5.3.1 Step Detector

As part of the adaptivity of this composition a step detector was created on the phone. The purpose of the step detector is to detect the tempo the listener is walking at and use this as the tempo of the individual melodic lines. The step detector is created using an algorithm that processes the data from the accelerometer. There is little data about the algorithms used in commercial step detectors on smartphones, probably to maintain a company advantage of using such an algorithm. A paper detailing an algorithm for step detection using a hip-mounted accelerometer was used as the basis of the step counter (Libby 2008).

The step detector works by converting the values from the accelerometer to their absolute values and summing these together. This gives us the absolute deflection of the accelerometer. This value is then averaged to remove noise and differentiated twice to find its acceleration. By using an absolute value for the accelerometer the step detector is independent of the direction of the phone. This is advantageous as the orientation of accelerometers within mobile devices is not standard between manufactures.

Using this value we can approximate when a footfall occurs as the acceleration will change direction. For example when the person's leg is moving forward the phone will have been accelerating in a positive direction. When the foot hits the ground and stops the phone will be accelerating in a negative direction. To get this information from the step detector we say that once the acceleration crosses the x-axis a step has occurred and triggers a bang.

At this point any change in direction will cause a bang to be triggered, any movement of the phone will cause a trigger as it indicates acceleration of the phone. This value is then filtered so that triggering only occurs for characteristics indicating footsteps. This involves removing the high frequency acceleration and concentrating on the range of human perambulation, approximately 2Hz. The filtering of the signal to remove the unwanted data was achieved by trial and error, detailed below. The finished algorithm detects each time a step is taken with the leg nearest the phone. This information is used to feed a tap tempo whose output is divided by two to arrive at the steps take by both feet. The tempo created by the walking pace of the listener is fed into the canon patch to con-

trol the tempi of the different lines as they enter the composition. A compositional decision was made to only pass tempi within a specific range to the melodies, providing bounds within which the composition can adapt.

The algorithm was implemented within PD which is not ideal as there is little functionality for getting data out of PD within the RjDj application. The algorithm had to be tested and fine tuned by trial and error. A patch was created that played a short soundfile each time a step was detected. By running this patch it was possible to walk around and hear when a step was detected. The values filtering the range of the acceleration to only detect walking were gradually tuned so that the step detector would only detect data indicative of walking. As such the algorithm is designed using accelerometer information from the author's gait and has not been tested using other subjects.

The composition does not require that there is always a tempo detected from walking data as the tempo is only used at discrete points within the composition. Whenever an acceptable tempo value is received from the step detector it is stored each new value displacing the old one. When a tempo is required to adapt the composition the stored value is used. The step-detect algorithm created is not exact enough to use the tempo as an absolute measure of the listener's walking pace but is perfectly acceptable for this composition. The algorithm might be improved in future versions by writing the composition as an independent app and developing an adaptive step detect algorithm within the Google Android SDK.

5.3.2 Samples

The step detector is used as a way of linking the composition to the listener. A second adaptivity method is used to create a link between the music and the environment. This is achieved by using samples of the environmental sound in the composition.

A method is created that listens to the input from the microphone for loud environmental sounds. Once a loud sound is detected it is recorded into memory to be used as part of the music. There are five sample spaces in memory and the samples are recorded into successive memory slots.

There is a timer on the sampler that stops it from recording samples too regularly. For example if the microphone was making contact with the listener's jacket several times only the first bang is

recorded and then the sampler waits twenty seconds before recording another sound. This was put in place to try to ensure that there would be variety between the samples recorded. It also functions to stop the texture changing too rapidly once the section created from the samples starts.

The sample detection method works by using a threshold and a delay is used to catch loud environmental sounds. Whenever a loud sound is detected by the threshold a record is triggered. A delay runs in parallel with the threshold and the audio is recorded from the delay line.

The function of the samples it to provide a texture to the middle section of the composition. To avoid a stark contrast between the very pure first and last sections and the middle section the samples are band passed.The band pass filter frequencies are the same as those of the notes from the A section. By changing the Q value of the filter it is possible to modulate from a very pure tone to the original tone of the sample.

In this section the samples create an indeterminate timbral mix each time the music is played. The volume of the samples, in relation to each other, also has an affect on which of the rhythmic lines stands out from the others. Also, depending on which sample is the loudest there can different emphasis on the chords created by the very pitched rhythms. When the volume between the samples differs one frequency can stand out more than some of the others to create different voicing of the combined tone created by the mix of rhythmic lines.

5.3.3 Default State of the Music

For both the step detector and the samples there is a default state. If the listener is listening to the composition but not moving around then default values are used for the tempi of the lines. If the listener uses a set of headphones without a mic or there are no loud sounds in their environment then default samples are used. If there is the possibility for the composition to adapt then it will, but if not then it will default.

5.4 Musical Experience

When someone listens to the composition they will hear music that maintains its overall aesthetic on each listen. The details of music are able to vary each time, allowing the relationship between

the material to relate in different ways with each listen. To try to give a sense of the musical experience some possible listener scenarios will be described.

Scenario 1: A listener is walking slowly on a busy street. As they are only able to walk slowly tempo of the melodies in the first section are slow to match with their pace. Environmental noise from the crowd provides a large possible number of loud transient sounds that can be recorded e.g. honking horns, people shouting, engine noises. When many loud sounds are captured the rhythms of the middle section are louder and appear more active. New samples are also recorded periodically changing the timbre while the rhythms are playing.

Scenario 2: The listener might listen to the music while lying down in a quiet park. In this case no tempo would be detected and the music uses the default values for the tempi of the melodies and a single sample is recorded into the composition. As all the prerecorded samples are very quiet, the rhythm created from the recorded sample is much louder than all the other rhythms. It would be heard as the foreground and they are in the background. The harmonic makeup of this section is also affected by the recorded sample. When the rhythms create the more pure sound, the pitch that the sample is filtered at is more prominent within the texture, changing the timbre of the overall harmony created by the rhythmic lines. This means that the timbral voicing of this section is determined by the loudness of the samples recorded. In this case there is one prominent pulsing tone with the other tones adding a background texture.

5.5 Conclusion

This chapter presented the implementation of *In Your Own Time* on a smartphone. It outlined the musical material composed and how musical adaptivity was used within the composition. The different elements of the composition were also discussed breaking down each section to examine the music and explaining how it was composed and the choices made during the composition process. The technical aspects of implementing the adaptivity are also presented explaining how the step detector is implemented within PD and how the samples are recorded from the environment. The final section of this chapter presents two listening scenarios, how the adaptivity would work and what the listener might experience. The following chapter will sum up the work done for this thesis and provide suggestions for areas that could be pursued with future work.

6. Conclusion & Future Work

6.1 Introduction

Following from the implementation chapter this chapter summarises the work that has been undertaken for this thesis. It provides a conclusion for the work presented and suggests areas that could be explored in future work.

6.2 Summary of Thesis

This thesis has documented the research and implementation carried out in the creation of the composition *In Your Own Time.* Chapter One opened with an overview of the work presented and provided a context for the thesis. Chapter Two reviewed the area of locative audio and provided examples of works within the field–*Sonic City*, *Tactical Sound Garden* and *Electric Walks*. This was followed in Chapter Three by mentioning Mobile Music, a subsection of locative audio, and looking at three Mobile Music works–*Ambient Addition*, *Inception* and *The Violet Crown*. The two types of locative audio experience, mobile and locative, were also compared. Chapter Four dealt with the methodologies used to create a Mobile Music composition. It looked at the concept of the composition and the techniques that could be used to create it. How these composition techniques could be used in a Mobile Music paradigm was outlined. Chapter Five covered the implementation of the composition on a smartphone. This chapter summarised the compositional approaches taken and the different techniques used to create adaptive music on a phone. It outlined all the work undertaken to realise the final composition.

6.3 Conclusion

The composition was made available at an exhibition as part of the Music & Media Technologies show 2012. At the exhibition the composition was given to members of the public to experience for themselves. From conversations with the participants it was possible to gauge how people were responding to the experience. At the beginning of the exhibition it was not explained to the participants what the link was between the listener and the music, it appeared that some listeners were disappointed by this. The adaptivity of the music was then explained to each listener who tried the composition. The participants reactions varied from being able to hear the connection and appearing to enjoy the experience to not being able to hear the adaptivity in the music and finding the experi-

ence frustrating. It appears that if the listener is expecting to hear changes in the music due to their actions and do not then it is will cause frustration. In an interview conducted with Thomas he mentioned: 'I think very obscure interactivity can cause frustration in people who are trying to understand it.'

In Your Own Time is a composition, as opposed to an interactive experience, so the listener's understanding of the adaptivity was not the priority. Having heard from listeners about their expectations of hearing more changes within the music an approach that allows for more adaptivity within the music might be explored in subsequent composition. Another option would be to interweave more adaptivity into this composition. Some listeners shook the phone trying to make the music adapt, implementing this type of adaptivity when the phone is shaken would provide something immediate for the listener. This would allow the accelerometer data to adapt the music when walking and when shook and allow for obvious and subtle adaptivity. Adding more layers of adaptivity to the composition might create a better user experience and add to the musical experience.

It was an important consideration to always have music for the listener. Other projects like *Sonic City* rely on listener input to stimulate sound, but an important part of this composition is that it is meant to be experienced as music i.e. in the same way as an mp3. The difference with this composition is the process by which the music is created. With prerecorded music the process is separate from the listener, created earlier. With this composition the music is created in realtime along with the listener. Its aim of creating a musical experience that adapts to the listener and their environment, creating a piece of music that is dynamic, this has been accomplished. Creating compositions that move on from this to create more engaging listener experiences combined with meaningful experiences should be the ultimate goal going forward. Some areas that could be explored with future research and composing in this field are presented below.

6.3 Future work

This project is a demonstration of an idea for a Mobile Music composition. As such there are areas of the technical implementation that could be improved, particularly the step detector. This could be improved by writing the composition as an independent app. This would allow the accelerometer data to be accessed and provide the possibility to test the algorithm and improve its robustness.

Moving the composition would also allow the app to be distributed and this would provide the opportunity to provide it to listeners to test for user experience.

As noted earlier in the chapter the subtlety of the adaptivity lead to a disappointing experience for some users due to not hearing changes in the music. Some changes might be made to the existing composition to bring out some of the adaptive elements. Adding adaptivity when a listener shakes the phone would create an immediate adaptive element that would be tangible to the listener. This could be accomplished by causing a melody to skip a note in one of the lines if a certain threshold of movement was breached, allowing the listener to alter the relationship between the lines, if they so wished. Further experimentation with the method for capturing environmental sounds might allow this aspect of the adaptivity to be more apparent. The length of the sample, its envelop and the values of the bandpass filters are all areas that could be explored to accentuate the environment sounds.

The composition of the adaptivity within the music is an important aspect of creating a composition for this medium. Exploring different ways of incorporate adaptivity into the music would be an interesting area to focus on with future work. Future compositions might be created by harnessing user gestures that they make while using their phones or walking around with their phones in their bags or pockets. This might involve studying users interacting with their devices and exploring ways to use some existing gestures to adapt the music. This could lead to a situation where the link between the music and the movement/environment is more intuitively apparent to the listener.

7. Bibliography

7.1 Introduction

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8. Appendix

Appendix A - Interview with Robert Thomas from RjDj

Conducted via email by David Collier 10th April 2012.

When I think about mobile music one of the most exciting/challenging aspects is balancing creating the interactive/adaptive experience with creating something is musical. Do you think about this when you're composing? Is one aspect more important than the other?

Yes I think this is the key challenge really. For me its really about simultaneously thinking as both a composer for listeners and a software designer for users of musical worlds.

The questions which come up all the time for me are :

- How important is the interactivity in the piece?

- How obvious do I want the control to be to the user?

- When do you want to give them control and when do you want to take them somewhere?

For commercial projects, or those aimed at the mainstream, I think its important that the interactivity is very simple and easy to understand. Personally I think this is important in all interactive work. That the user clearly understands their causal relationship with the work. Playing with their understanding, making them think something was caused by them when it wasn't is also interesting. But I think if you go to far in that direction interactive work can become very 'fuzzy' and it loses its unique characteristic. Its a dangerous slope to just creating something loosely interactive which people almost convince themselves into believing was affected by them.

In the early days of creating full interactive music at RjDj we tried lots of very complex musical systems which presented huge scope for the listener / user to control many intricate parts of the music or make it adapt in very subtle ways. The Little Boots app we did was a good example of this

approach. 90% of this was not understood by the users. This was partially due to lack of clarity in our design, but also due to the type of interaction we created.

More recently we have tried to create very simple interactive experiences, which focus on one interactive element at a time. Our use of direct audio input with various DSP manipulations is the most straightforward and effective tool we use. Its very easy for people to understand that their environments interaction with the music is causing different sonic results.

Relying on the environment or their natural behaviour to create variance is also a key factor. This means that the user can remain passive (just like how they listen to normal music) but the music is changed without any direct participation from them. We have found that this is important as :

1. many people like to listen to music in the background as they do other things - requiring them to directly interact can be a big ask - they could be on the subway.

2. many people are too inhibited to interact with music directly - this is often due to their perception of music being something that is done by other people 'musicians' and they are the 'audience'. Breaking down this barrier is hard.

I think its always going to be important that music takes people on emotional journeys. This is just as much true for interactive music as it is for linear music. I think the only difference (although this has vast implications) is that the path through the music is not set. I often think of it as the difference between a film and a video game.

When Mozart wrote the Molto Allegro from the 41st, he created an incredible heaven like filmic narrative of music. Now he could create an interactive world of music much more like a video game.

If I watch Blade Runner, I see different nuances in the same story each time. If I play a game like Deus Ex, I actually experience a different story each time and see completely different narratives. Both are coherent and understandable.

Roger Ebert says that video games are not art. I would agree with him in most cases. More accurately says that "no video gamer now living will survive long enough to experience the medium as an art form." I think interactive music is at a similar stage. Just like with games, the limitations are not technical, they are artistic. We just haven't evolved interactive music enough, yet.

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Mobile music seems to straddle the worlds of sound art and music. Do you consider the work you do to be sound art or music? If you don't think either term does it justice how do you view it?

I'm not sure I really understand sound art to be honest. :) I think interactive music is just a form of music, a way it can be composed, distributed and experienced. Its been possible for a long time, but like everything, technology is opening up vast new areas of possibility, especially recently with smart phones.

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"For commercial projects, or those aimed at the mainstream, I think its important that the interactivity is very simple and easy to understand. Personally I think this is important in all interactive work. That the user clearly understands their causal relationship with the work."

I know there can be a blurred distinction here but is there a danger with this type of interactivity that it stops being a piece of music becomes a musical instrument?

I think there is a danger, but its possible to stay on the side of making a tool for musical navigation and not making an instrument. One example of this is how we treat rhythmic structures in things like the Action Dream in Inception or the Kinetic Dimension in Dimensions.

In both these pieces, the users activity - detected by the accelerometer in the device, is translated into 'intensity' of the drums and percussion in the track. If they are still there are almost no drums, if they walk the drums are engaged, if they run then hectic beats kick in.

For the user the clarity of the feedback makes this very easy to understand how the music is reacting to them and how they control it. However, they don't need to have any musical ability to interact. Also, their interaction performs the same fundamental effect throughout the music (slow = slow drums , fast = hectic drums) - but as the music progresses the rhythms change and evolve as the musical journey progresses.

I think the danger of becoming a musical instrument is much more apparent if the user is required to undertake direct interaction. One example of this is in some of our 'Moovz' scenes in RjDj. These require the user to press buttons and tilt the device to control the music. Each button Synth, Drums, Bass, Guitar etc gives them a certain framework for controlling that instrument. However, Moovz doesn't give them complete freedom. When we worked with Chiddy Bang for instance, we created a synth control which when tilted simply shifted the inversion of chords played by a synth part. This gave the user the opportunity to navigate through inversions of chords, but they were always on the 'rails' of the core chordal sequence.

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You mentioned about breaking down the barrier between audience and musician. Is the intention of some of the scenes to be musical instruments and facilitate the listener as a creator?

Hmm yeah this is complex. I think for me personally its more like giving people a world of musical possibilities to explore with their own innate musicality. In many ways the aim of my work is to augment their natural musicality and let them freely move around within a predefined musical framework. The more fluid and intuitive that interaction is the better. Also the more interesting and nuanced the musical world is the better.

I think in these scenarios, the listener is very creative. They are part of the music. The original creator of the software that runs it all is also very creative. I've had some great experiences listening to people using interactive music I have created, where I felt like they were navigating within the framework to areas I had hidden away, or to areas which I hadn't anticipated. So in this way the creator also becomes the listener too.

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“The Little Boots app we did was a good example of this approach. 90% of this was not understood by the users.”

I have to admit I'm working towards a piece of music and I don't necessarily intend the listener to understand the interactions so I'm curious about this. Using the interactivity in a subtle way. Are you moving away from this type of interactivity as it's a less interesting experience for the listener?

Yes this is a complex balance too, and before I go into it, I'd say I fully understand the temptation to create very subtle and intricate pieces.

The main danger is that users don't value it as being any different from a normal piece of music, they don't understand the difference. After all, without understanding of cause and effect, it IS just a piece of music unfolding over time. This can be extremely frustrating for the creator if the interactivity is a key feature.

I think it really depends on what you intend. If you want people to understand the interactivity, then I think its better to make it clear - so they can feel it. I think very obscure interactivity can cause frustration in people who are trying to understand it.

I think it can also become a creative mask to hide behind - if the interaction is laid bare and easy to understand the artist judged in a very straightforward and open way on how it feels to be in a causal relationship with that piece of music. If the process is obscured and vague, then its easier for the artist to take credit for misunderstandings, or to hide the interactivity within a deep web of subtle interactions.

Overall, I think there is always room for both. While Inception and Dimensions have a surface layer of extremely obvious musical interactions, each of the dreams and dimensions also has much more subtle variances which only become apparent on repeated listens.

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It strikes me that the Inception and Dimensions apps are kind of interactive albums and that they've moved on from what it seemed like RjDj was doing which was releasing singles. These two scenes in album format look to have been a success. Will this be the plan for scenes going forward or what's next for RjDJ?

I think the main difference with Inception and Dimensions is they are holistically designed experiences. Really they are somewhere between an album and a game.

We plan to explore this area of personalised gaming and music much further with future apps.

We also have another project in the works. "Project Now" is an app which detects your current situation and plays the perfect music for it from your own music library - the perfect music for the perfect moment.

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Where do you think mobile music will be in the next 5-10 years?

I hope it will be where video games were in the 90s. At the moment we are where video games were in the 1980s in terms of sophistication.

I think there is a turning of the tide going on with artists getting into releasing interactive music, especially in app form. Bjork's app is an interesting example. We have been approached by a number of artists recently who really 'get' the approach, it will be interesting working with them.

Appendix B - *In Your Own Time:* Patches, Sketches, and Audio Mockup

1_InYourOwnTime.rj – folder containing scene for RjDj or Sceneplayer

2_InYourOwnTime.wav – audio mockup

3_InYourOwnTimePatches – folder containing PD patches

4_InYourOwnTime.pdf – soft copy of thesis

5_InYourOwnTimeConcert – folder containing score and tape for live performance

6_Mogwai-IKnowYouAreButWhatAmI - Music by Mogwai mentioned on pg. 24