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BA research question : Facilitating user interaction in an immersive environment. How do we relate to the gestural control of sound objects in an immersive 3D environment?

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Declaration

I hereby declare that I wrote this written assignment / essay / dissertation on my own and without the use of any other than the cited sources and tools and all explanations that I copied directly or in their sense are marked as such, as well as that the dissertation has not yet been handed in neither in this nor in equal form at any other official commission.

Table of Contents

Introduction

The research project proposed is an exciting opportunity to investigate, understand and create an immersive audio experience for virtual reality on the Oculus Rift; facilitating user interaction in an immersive environment to create audio experiences in a filed in which audio will play an important role in years to come. In the last two years virtual reality has been a major topic of discussion in new media technologies. The acquisition of Oculus Rift by Facebook last year and major media corporations entering the virtual reality industry, such as Sony and Samsung, prove that VR is a growing platform for new media and creative content in the future (Carmack in Oculus, 2015).

Most interestingly, audio for virtual reality is something not yet conquered and open for experimentation. Oculus Rift audio engineer, Brian Hook, in his last key note in May 2015, announced a major audio software platform (audio SDK) for their virtual reality platform. During his keynote, he stressed the fundamental role of professional high quality Audio to enhance immersive virtual experiences, inviting Sound Designers, Engineers, Producers and creatives alike to start making immersive, interactive audio experiences for Virtual Reality (Hook in Oculus, 2015). The Oculus licensing deal of Real Space 3D audio (a company specialising in spatialised audio), followed by the release of their own audio SDK, has been a statement of their commitment to provide developers and users the right set of tools for creating professional Audio for better virtual reality experiences. The questions that come to mind are: What is Audio for Virtual Reality ? How do we relate to the gestural control of sound objects in an immersive 3D environment ? How much can we interact with audio in a immersive 3D environment? Which audio theories are no longer relevant when we are fully immersed in a virtual world, not simply observing or listening to it? How are we planning to modify such audio theories in order to apply them into a field that is still unknown ? Will our current knowledge of audio be enough to deliver a full-on immersive experience? How do we facilitate 3D audio? Such questions are also on the agenda for Oculus Rift CFO John Carmack, who, in his recent lecture at University of Texas in Dallas, quoted, “there is so much more that can be done with audio” (Carmack in Oculus, 2015), an open invite for audio professionals and passionates alike to take virtual reality as the next big platform for mass entertainment. The world in which we make music, and the way we interact with

sounds, is down to the physicality of our environment. By creating an immersive environment, we become free from the confines of it, removing physical restriction.

This will be a BA project - The research project will be 50% practical and 50% written analysis. It will be based on creating an immersive interactive 3D environment using Open Graphics Library (OpenGL) and Max/MSP patches running on the Oculus Rift (OR), implementing gestural control of sound objects via the Leap Motion (LM) device. The user will be immersed in a interactive virtual world in which head tracking data (OR) and gestural control (LM) will provide the user with a new approach to composition, gestural control of sound and sound perception within a virtual world. The system will be tested by users to gather qualitative data which will help us to understand new methods of working with interactive audio in virtual reality. This will eventually answer our research question: How do we relate to the gestural control of sound objects in an immersive 3D environment ?

Rationale

Being a music producer and a music lover, I have always been fascinated by the discovery of new sounds, most importantly, how sound design and creative manipulation of audio signals can enhance our sonic experiences. Experimenting with sound design techniques, pushing boundaries, combining different art forms and giving the audience a totally immersive audio-visual experience (such as live video and images in music) has always been my main interest. Making electronic music for the past 15 years and constantly researching new media platforms to showcase my music has lead to an interest in making immersive interactive content for virtual reality. The reason I have chosen the Oculus Rift as a platform for my project is because I believe it is an exciting and new technology that will expose the audience, and the creator, to a new form of entertainment, combining listening, watching, interaction and creation. With such a project, my aim is to achieve the technical knowledge needed to be able to enter the virtual reality audio industry, by creating an immersive, interactive audio experience on such a new platform.

I believe this research project will also inspire other students, and those passionate about audio, to combine their knowledge of audio engineering, production and digital art to create realism and interaction in music composition, performance and other forms of virtual reality audio-visual experiences. In film, music, advertising and live music, user interaction and 3D audio have become essential elements to enhance high end visual content creation, making the overall experiences more credible, realistic and immersive. Binaural techniques reproduced via headphones are capable of delivering high end 3D audio, and they have become the standard format implemented by audio engineers working within the virtual reality industry. With an increasing number of companies, such as Microsoft, Google, Sony and more, investing in virtual reality as a future platform for entertainment, there is an ever increasing demand for audio engineers who are capable of implementing 3D audio.

This research project will provide a practical learning method on how to implement 3D spatialised audio, sound design, human computer interactions and visual art using Max/MSP, and the Oculus Rift. It will illustrate how to implement users' gestural control to encourage new compositional methods, as well experimental sound design with a view to enhance musical creativity via binaural audio implementation.

Literature Research:

Bartle, R., A., *Design Virtual Worlds*, New Rider Publishing second edition 2004
A guide for anyone interested in designing Virtual Worlds. It provides a break down of what is needed in terms of planning, managing and maximising time and budgets.

Blum, F. (2007) *Digital Interactive Installations: Programming Interactive Installations Using the Software Package Max/Msp/Jitter*. Germany: VDM Verlag Dr. Mueller e.K.
A guide for programming digital interactive installations using the software package Max/MSP/Jitter.

Cage, J. (1973) Silence: Lectures and Writings. London: Marion Boyars Publishers.
A collection of essays and lectures from experimental composer John Cage. Discussing his theory of sound, silence, and listening.

Cox, C. and Warner, D. (eds.) (2004) *Audio Culture: Readings in Modern Music*. New York: Continuum International Publishing Group.
A collection of essays from the likes of Brian Eno, Karlheinz Stockhausen, Steve Reich, Ornette Coleman and many others. The book covers a wide range of topics such as: experimental music, improvised music, music in the age of electronic (re)production, minimalism and modes of listening.

Dyson, F. (2009) *Sounding new media: immersion and embodiment in the arts and culture*. Berkeley: University of California Press, United States
Sounding New Media investigates the often overlooked role of sound and audio in the evolution of new media theory and practice. This includes new technologies and live performance, with a focus on artistic sound and technological interactions.

Durand R. Begault, *3D Sound For Virtual Reality and Multimedia*, Academic Press inc London 1994
A general guide for creating and applying 3D sound design within virtual realities. Covering topics such as sound theory, binaural recordings, head related transfer function and more.

Kahn, D. (2001) *Noise, Water, Meat: A History of Voice, Sound, and Aurality in the Arts*. United States: The MIT Press.
Explores audiovisual events in literature, music, visual arts, theatre, and film.
This text revisits important artistic questions which inspired modern and post modern art. It discusses the works of Antonin Artaud, George Brecht, William Burroughs, Michael McClure, Yoko Ono, Luigi Russolo, and more, and it also provides an insight in the aesthetic of sound in twentieth-century.

Holland, S., Wilkie, K., Mulholland, P., Seago, A., `Eds. *Music and Human Computer Interaction*, Springer-Verlag London 2013.
A collection of academic essays which provides examples of tested projects, human interaction with music computing and how to facilitate interaction between humans and music software applications.

Manzo, V. J. (2011) *Max//Msp/Jitter for Music: A Practical Guide to Developing Interactive Music Systems for Education and More*. New York: Oxford University Press
Max/MSP/Jitter for Music teaches all of the necessary practical skills for programming custom software for musical interaction.

Noble, J. J. (2012) *Programming Interactivity: A Designer's Guide to Processing, Arduino, and OpenFrameworks*. 2nd edn. United States: O'Reilly Media, Inc, USA
This book covers advanced techniques for producing graphics and animation, including 3D images with OpenGL for interaction design. A guide for turning a user's gestures into input, using Open CV.

Rumsey, F. (2001) *Spatial audio*. Oxford: Elsevier Science
An insight of the fundamental aspects and practicality of spatial sound recording and reproduction. Providing a detailed knowledge on the importance of 3D audio, binaural approaches, conventional stereo and more.

Schaeffer, P. (2013) *In Search of a Concrete Music*. United States: University of California Press.
One influence of this research project, covering topics such as the evolution of sound manipulation, is the accompanying concepts of the Musique Concrète movement, which has heavily influenced many forms of experimental music to this day.

The Khronos OpenGL ARB Working Group, Shreiner, D. and Sellers, G. M. (2013) *OpenGL Programming Guide: The official guide to learning OpenGL, versions 4.1*. United States: Addison-Wesley Educational Publishers
Programming guide for OpenGL functionality and techniques. Covering topics such as processing geometric objects, geometry shaders and advanced data techniques.

Proposed table of Content

Introduction to a virtual world

- From Science fiction to the Oculus Rift
- The human definition of reality
- Brief history of immersive audio

Music Computing and Human interaction

- The development of gesture in musical composition
- Human-computer interaction
- Expressive gesture interaction
- The role of the human in an immersive environment.

Designing an immersive 3D Audio experience

- The building blocks of an immersive 3D environment
- OpenGL and Max/MSP: Creating an Oculus Rift patch
- Designing sound objects: Removing physical restrictions
- Changing the focus point: Implementation of Oculus Rift head tracking data

Personalising gestural control of sound objects

- What is sound for virtual reality: Enhancing perception of space, distance, space and presence
- Advanced sound spatialisation: Head tracking, Distance, Directions (Head-related transfer function)
- Interactive sound design via gesture control: Leap Motion implementation
- Facilitating user interaction in an immersive environment: Personalising gesture control

How do we relate to gestural control of sound objects in an immersive 3D environment ?

- Testing our immersive 3D environment: The user experience
- Evaluating users feedback: Optimise immersive Audio experiences for better interactive virtual realities

Conclusions

- What have we learned
- Going forward

Methodology

The proposed research question will require an experimental methodology consisting of 50% practical work and 50% written analysis. A written introduction of the origin of science fiction, the human definition of reality, human-computer interaction and gestural control will present the reader with examples of legacy immersive 3D experiences, which led to modern interpretations of music-computing interactions and virtual reality.

I will consult industry professionals, such as audio programmers, digital art designers and audio engineers in order to help me to pursue my work in the right direction. These people will help me develop ideas that are relevant for the project and will advise me on possible issues. Together with regular sessions with my tutor, I will also seek the feedback of industry professionals to help me further understand how to implement the practical work.
To further develop my research into how people could possibly relate to sound in a 3D environment, I will organise two focus groups, one made of consumers and the other made of audio professionals. The two different focus groups will serve as data gathering which will give me the opportunity to compare different experiences of immersive audio and user interaction within a 3D environment. The similarities and differences between consumers and professionals will serve as an important part of the study that could improve the overall experience and help to identify the important aspects required to optimise the project.

To create/build an immersive 3D interactive sound environment I will use Open Graphic Library (OpenGL) and Max/MSP for designing the objects and sound design. For the gestural control and real time sound spatialisation, I will use the Leap Motion control and Head tracking data from the Oculus Rift. Data will be sent in real time to the Max/MSP patch via LibOVR 0.4.4 runtime/driver from Oculus. This will allow the user to interact in real time with the sound objects, experiencing sound spatialisation via interaction within an immersive 3D sound experience. The theoretical report will guide the reader through each step of the design and implementation, as shown on the proposed table of contents.

A final user test will be required to gather qualitative and quantitative feedback data in order to optimise the user experience, helping us to answer questions such as: How do we relate to the gestural control of sound objects in an immersive 3D environment? What is audio for virtual reality? How much can we interact with audio in a immersive 3D environment? Which audio theories are no longer relevant when we are fully immersed in a virtual world, not simply observing or listing to it? How are we planning to modify these audio theories in order to apply them to a field that is still unknown ? Will our current knowledge of audio be sufficient to deliver an immersive 3D audio experience ?

Resources

Research & Writing

- Libraries
- Internet/Digital Sources

Immersive 3D environment

- Home Studio (iMac, laptop, external instruments)
- OpenGL, MAX/MSP
- Oculus Rift
- Headphones

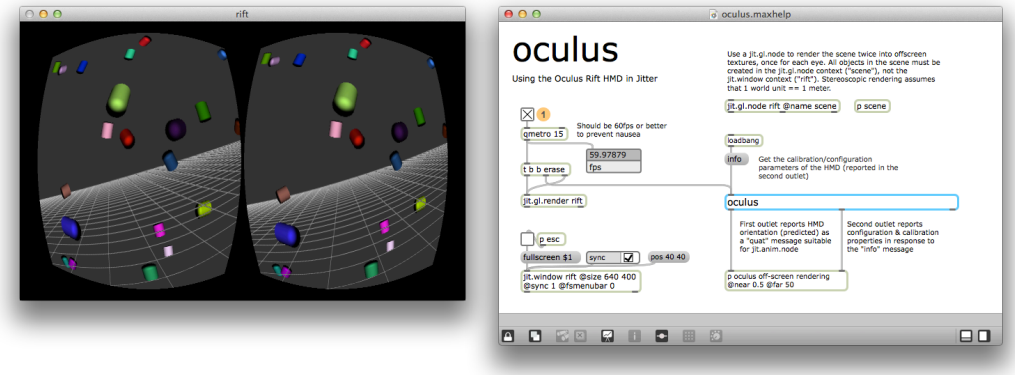
Gesture control and Sound Design

- Home Studio (iMac, laptop, external instruments)
- OpenGL, MAX/MSP
- Oculus Rift
- Leap Motion
- Headphones

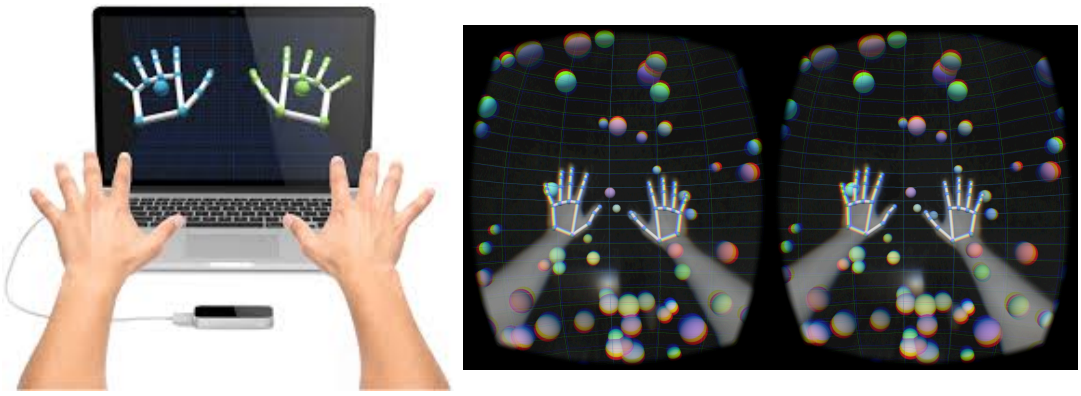
Testing / Focus Group

- Consumers
- Professionals (SAE students, colleagues and fellow artists)
- iMac running the OpenGL- Max/MSP patch
- Oculus Rift
- Leap Motion
- Headphones

Max/MSP
Patch Design



Example of Oculus Rift with MAX/MSP (Hoberman in C74, 2013)



Example of Leap Motion in MAX/MSP (Team Occa, 2015)

Project Timeline

	July				August				September				October				November				December			
	Iteration 1				Iteration 2				Iteration 3				Iteration 4											
MAX/PD design																								
Oculus Test																								
Sounds Design																								
Writing																								
Reading and Research																								
Planning																								
Usability Tests																								

e.g Iteration 1 Objectives
- Validate the stereographic effect using Jitter
- Validate interface between Oculus and Max/MSP
- Validate interface between Oculus, Max/MSP and Leap Motion

Bibliography

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Grimshaw, M. (2014) *The Oxford handbook of virtuality*. Edited by Mark Grimshaw. Oxford: Oxford University Press

grrrwaaa (2015) Grrrwaaa/max_oculus. Available at: https://github.com/grrrwaaa/max_oculus (Accessed: 10 May 2015)

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Oculus (2015) John Carmack at the University of Texas at Dallas. Available at: https://www.youtube.com/watch?v=rBtXMtUNpdE (Accessed: 10 May 2015)

Oculus (2014) Oculus Connect Keynote: Michael Abrash. Available at: https://www.youtube.com/watch?v=knQSRTApNcs (Accessed: 11 May 2015)

Oculus (2014) Oculus Connect: Introduction to Audio in VR. Available at: https://www.youtube.com/watch?v=kBBuuvEP5Z4 (Accessed: 10 May 2015)

Oculus (2015) John Carmack at the University of Texas at Dallas. Available at: https://www.youtube.com/watch?v=rBtXMtUNpdE (Accessed: 10 May 2015)

Real Space 3D Audio Available at: http://realspace3daudio.com/technology/#vr (Accessed: 03 May 2015)

Team Occa - Integrating Revit and Max (2015) Available at: http://fieldsofactivity.com/team-occa-integrating-revit-max/ (Accessed: 20 April 2015) http://fieldsofactivity.com/team-occa-integrating-revit-max/)

VisiSonics (2014) VisiSonics' RealSpace 3D Audio Software Licensed by Oculus for Virtual Reality. Available at: http://www.prnewswire.com/news-releases/visisonics-realspace-3d-audio-software-licensed-by-oculus-for-virtual-reality-278413231.html (Accessed: 09 May 2015)