Nottingham Trent University

School of Science and Technology

Simulating Visual Impairments in a Virtual Reality Environment

by

Dominic Peter Reynolds

in

2020

Project report in part fulfilment

of the requirements for the degree of

Bachelor of Science with Honours

in

Computer Science with Games Technology

I hereby declare that I am the sole author of this report. I authorize the Nottingham Trent University to lend this report to other institutions or individuals for the purpose of scholarly research.

I also authorize the Nottingham Trent University to reproduce this report by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

Signed.



Dominic Peter Reynolds

Abstract

Visual Impairments are a hard topic for unaffected people to visualise, and as a result, they are not talked about very often, and the severity and range of visual impairments are not widely understood or known. This led to the investigation of the production of an environment in which Visual Impairments could be Simulated to allow for people to experience the effects of Impairments first-hand, to raise awareness and understanding of the nature of Visual Impairments.

Virtual Reality is a strong medium for building immersion and a sense of being inside of the Virtual World, this makes it the ideal medium to produce a Visual Impairment Simulator as the user will be able to experience the Impairments rather than just see them. This would make the Simulator provide more of an impression and result in a greater understanding of the nature of Visual Impairments.

To produce the environment, Unreal Engine will be utilised as it provides many pre-made utilities for creating projects within a game-style world, especially for Virtual Reality. Unreal Engine also has many built in features to assist with the production of Post-Process Materials, which will be used to simulate the Visual Impairments.

This project concludes that Producing a Visual Impairment Simulator is very viable within a Virtual Reality Environment and that Virtual Reality is a significantly stronger tool for this use than other methods, due to the first-hand immersive experience of the Impairments. The participants who tested the Simulator also reported a greater appreciation for Visual Impairments and those afflicted with them.

Acknowledgements

yeet

Table of Contents

[Abstract ii](#_Toc38890242)

[Acknowledgements iii](#_Toc38890243)

[Table of Contents iv](#_Toc38890244)

[List of Figures vi](#_Toc38890245)

[List of Tables vii](#_Toc38890246)

[CHAPTER 1 1](#_Toc38890247)

[Introduction 1](#_Toc38890248)

[CHAPTER 2 3](#_Toc38890249)

[CONTEXT 3](#_Toc38890250)

[2.1 Introduction 3](#_Toc38890251)

[CHAPTER 3 4](#_Toc38890252)

[New Ideas 4](#_Toc38890253)

[3.1 Introduction 4](#_Toc38890254)

[CHAPTER 4 6](#_Toc38890255)

[IMPLEMENTATION or INVESTIGATION 6](#_Toc38890256)

[4.1 Introduction 6](#_Toc38890257)

[CHAPTER 5 8](#_Toc38890258)

[RESULTS / DISCUSSION 8](#_Toc38890259)

[5.1 Introduction 8](#_Toc38890260)

[CHAPTER 6 9](#_Toc38890261)

[CONCLUSIONS / FUTURE WORK 9](#_Toc38890262)

[6.1 Conclusions 9](#_Toc38890263)

[6.2 Future work 9](#_Toc38890264)

[6.3 Legal, Social, Ethical and Professional Issues 9](#_Toc38890265)

[6.4 Synoptic Reflections 9](#_Toc38890266)

[ReferenceS 10](#_Toc38890267)

[Bibliography 11](#_Toc38890268)

[Appendix A 12](#_Toc38890269)

List of Figures

List of Tables



Introduction

Virtual Reality immerses the user inside of a different world outside of our own, in which they can be whatever they want to be or what the designer wants them to be, I can use this to my advantage. I can use this medium to instead of showing them how Visual Impairments can affect you but let them experience and feel how Visual Impairments can affect you. I believe this would be a significantly better method of conducting this project, as it will lead to more successful results of people being more aware of the difficulties of living with a Visual Impairment.

Visual Impairments are a very common yet hard to understand disability. There are many different forms, which tend to be bundled into groups and people do not know the differences between them and how they affect you differently. I will be building a simulator inside of a virtual reality environment which will let me simulate as many symptoms of Visual Impairments as I can so that the effects and complications of each can be demonstrated.

People in the care or design industry without visual impairments may struggle to incorporate consideration for people with visual impairments (*Goodman-Deane, Langdon, Clarkson, Caldwell, Sarhan, 2007*) into their job and routine, which can cause issues for their clientele. For example, if a designer does not take into account people with colour-blindness and uses the wrong colour scheme, then their product may be completely unusable to people with that type of colour-blindness, or if text is too small or hard to read, it may cause issues for people with poor eyesight. Also, if people in the care industry do not consider their patients’ eyesight there may be risks of the patients not knowing of a danger or not being able to live their life properly.

Modern Virtual Reality Headsets also contain eye-tracking capabilities, which I will be able to use to more accurately simulate Visual Impairments such as Diabetic Retinopathy, in which, areas of vision may be completely lost or Floaters appear in the vision. Using the eye tracking, I can make these follow the user’s eyesight instead of being stationary, which would allow for the user to simply look around them and not provide a strong simulation of those Visual Impairments. Certain Headsets also contain front-facing cameras, through which I may be able to simulate the Visual Impairments, to allow for the user to experience a situation that they are used to through the eyes of a Visual Impaired Individual.

The goal of this project is to provide a strong tool for people to use to see how Visual Impairments can affect the Quality of Life for individuals afflicted, and to raise awareness and consideration for the Visually Impaired. The simulator could also be used by people in the Design or Care industries for them to be able to more accurately work with people with Visual Impairments as to not exclude them from their services and help them more.



CONTEXT

## Introduction

This chapter will contain a Literature Review, in which similar and adjacent projects will be analysed to discover if there were any shortcomings or gaps which could be touched upon with this project. The methods used within the reviewed projects will also be used to ensure that the methods used by this project provides a different view and to reduce, as much as possible, overlap between projects.

## Literature Review

Literature review paragraph;

* Reference
* Method + results
* Pros
* Cons
* What was learnt/ shall be adapted



New Ideas

## Introduction

As a result of your 'Context' chapter you should have narrowed down your area of research. This 'focussing' of attention on one aspect of the field will have been aided by reading about other peoples' work in the field. You may be proposing a development of one of their ideas or perhaps an idea that came to you that differs from anything tried before.

For a software development you might include an explicit list of the requirements, a description of investigation of requirements ( if appropriate), and a discussion of how requirements relate to Background research.

For a research-based investigation you might include the planning for the process (methodology) to be adopted, the criteria to be used for evaluation, and a discussion of reasons for this process and comparison with alternatives.

The proposed development or investigation must be realistic bearing in mind the entire project is supposed to take 400 hours of your time. Thus, evidence of project planning must be included in this chapter; estimates of work load for the various phases, setting these in context with other estimated workloads (e.g. course work and revision) and other deadlines. This should allow you to establish your project timetable (perhaps in the form of a Gantt chart) showing the interaction of these various factors and the set objectives/milestones. In your planning you should include contingency planning to allow for the unexpected disaster. Various project planning tools are covered in the course to allow you to do this.



IMPLEMENTATION or INVESTIGATION

## Introduction

Here you give details of the development or investigation of the new material proposed in 'New Ideas'. This must be done in a business-like manner. The development of any software must follow a suitable analysis and design methodology. There are CASE tools available to you for some methodologies, others will have to be a 'paper' design. An investigation must also follow a suitable methodology and use appropriate techniques and tools.

Software-based projects, requiring the production of a software solution for a set of requirements, should demonstrate that the software development has undergone appropriate analysis, design, project management, structured programming and testing. Research-based projects, requiring an investigation of a research question or client’s requirements, or being used to test a hypothesis, should demonstrate that the investigation has been properly conducted, is based on scientific principles and uses appropriate tools, techniques and standards. An investigation must produce a technical outcome from some development (software or hardware (e.g. networks, displays)) or testing (e.g. of system/network performance, system security, HCI/usability analysis). Sometimes a software prototype or a testing framework will be produced for the evaluation or testing of the research or hypothesis. Work based purely on literature review is not acceptable.

Some projects aim to provide software for general use as their final product and these must include relevant aspects of HCI (Human Computer Interaction) and address such features of usability such as 'user friendliness' and most likely employ GUI (graphical user interface) standards such as Windows.

In any case, students often ask what should go in this chapter, how to describe what they have done, what is relevant, how much of existing work to include, what to include from what they have done, etc. The simplest and surest way is to refer to your diary of the work you have done and report on it in chronological order.

The complete requirements analysis, problem analysis & design of software must be done rigorously and included in full in an appendix. Avoid cross-referencing it too often, thus causing the reader to keep flicking pages back and forth, rather reproduce sections that you wish to draw the reader's attention to. That is, highlight the parts that you found particularly difficult to implement and feel rather proud of having solved. Do not include lengthy descriptions of standard techniques or methodologies, simply state that 'such-and-such was designed using such-and-such technique (give a reference, not just 'SSADM' but 'SSADM [James 1996]' where the reference is a standard text on the technique!)' and highlight where you found shortcomings in the technique that didn't quite cope with your particular problem. Highlight exceptions to the standard.



RESULTS / DISCUSSION

## Introduction

The technique developed in your project is supposed to show improvement on techniques previously available. Therefore, it may be necessary to spend time investigating whether this is true. Perhaps you need to set up some sort of quantitative test and do a little statistical analysis to confirm the improvement. This chapter will provide evidence, from the tests that you carry out, of the outcomes of your project.

Explain the success and limitations of your work and show how this relates to the aims and objectives set out in the introduction.



CONCLUSIONS / FUTURE WORK

## Conclusions

Whatever it was that your results showed should be summarised here. Your project or may or may not have achieved all that you set out to at the start.

This is your opportunity to conclude whether the project was a ‘success’ and how it might have been tackled differently in hindsight.

## Future work

In either case there should be some reference to future work, either to forward and expand on the successful outcome or to test ways of overcoming the shortfall in your ideas that didn't work out quite as expected but there should be something that shows you can see further implications of what you have achieved.

## Legal, Social, Ethical and Professional Issues

This section should include a discussion of the four LESPIs and the way in which you project has/will/could impact on each.

## Synoptic Reflections

This section will comprise of a reflection on the project in relation to employment aspirations and the skills that you have developed towards this through engagement with the project.

ReferenceS

Goodman-Deane, J., Langdon, P.M., Clarkson, P.J., Caldwell, N.H. and Sarhan, A.M., 2007, October. Equipping designers by simulating the effects of visual and hearing impairments. In *Proceedings of the 9th international ACM SIGACCESS conference on Computers and accessibility* (pp. 241-242). ACM.

Bibliography

Vogt, C. 1999. Creating Long Documents using Microsoft Word. Published on the Web at the Nottingham Trent University.

Coote, H., Dobbs, B. & Jones, C. (1996). Defining databases. Wiley: Melbourne.

Applications and Science in Soft Computing, Lotfi, Ahmad; Garibaldi, Jonathon M. (Eds.) 2004, X, 346 p. Springer, ISBN: 3-540-40856-8

Association for Computing Machinery. (2018) Association for Computing Machinery Code of Ethics and Professional Conduct. [online] Available at: https://www.acm.org/code-of-ethics [Accessed 30 Oct. 2019]

Brettel, H., Viénot, F. and Mollon, J.D., 1997. Computerized simulation of color appearance for dichromats. *JOSA A*, *14*(10), pp.2647-2655.

British Computer Society. (2015) British Computing Society Code of Conduct. [online] Available at: https://cdn.bcs.org/bcs-org-media/2211/bcs-code-of-conduct.pdf [Accessed 30 Oct. 2019]

Institute of Electrical and Electronic Engineers. (2014) IEEE Code of Conduct [online] Available at: https://www.ieee.org/content/dam/ieee-org/ieee/web/org/about/ieee\_code\_of\_conduct.pdf [Accessed 30 Oct. 2019]

Goodman-Deane, J., Langdon, P.M., Clarkson, P.J., Caldwell, N.H. and Sarhan, A.M., 2007, October. Equipping designers by simulating the effects of visual and hearing impairments. In *Proceedings of the 9th international ACM SIGACCESS conference on Computers and accessibility* (pp. 241-242). ACM.

Korolov, M., 2014. The real risks of virtual reality. *Risk Management*, *61*(8), pp.20-24.

Lewis J., Brown D., Cranton W. and Mason R. (2011). Simulating visual impairments using the Unreal Engine 3 game engine. In *2011 IEEE 1st International Conference on Serious Games and Applications for Health (SeGAH)* (pp. 1-8). IEEE.

Appendix A

The content of these will differ with the different types of project. Any design and analysis charts/diagrams will be included here in full. In projects where software has been developed there will be an appendix for this. Our departmental requirement is that a CD, DVD or USB memory stick of all source code is submitted to your project supervisor. The appendix contained in the report will refer to this CD, DVD, or USB memory stick, provide a directory style listing of the files submitted and instructions for rebuilding and running the software. This might be source code of programs written in high level languages (C, C++, etc) together with any pertinent files ('make' files, non-standard libraries, etc). Alternatively, or in addition, you can place some or all of the source code in the appendix. In any case the source code needed to reconstruct any software you have developed must be submitted in its entirety in the CD, DVD, or USB memory stick. (Any code that has been used from a third party should reference the original developer).

Hardware designs will require schematics/circuit diagrams, PCB layouts, simulation tests and pin outs.

Most projects will require some form of user documentation to explain how to use the software/hardware produced. A researcher following up the work may wish to utilise the work of the original author and an appendix laying out the format of input files and how to interpret the output is required.