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| University of reading |
| Individual Project Report – Virtual Campus |
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| James Tang – 24015209 – xr015209 |



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**Virtual Tour of Whiteknights Campus for Android Virtual Reality**

School of Mathematical, Physical and Computational Sciences

Individual Project – CS3IP16

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# Abstract

This report discusses in detail about the creation of my Final Year Individual Project, Virtual Campus. Virtual Campus is a Virtual Reality version of University of Reading’s WhiteKnights Campus. The Virtual Tour of Whiteknights Campus is an Android application, which allows users to explore a part of Whiteknights campus using a teleportation based movement. The campus has been built using unity and runs on Nougat Android phones or higher. The android application has been built using Unity and the models of the building was created using SketchUp and users are free to explore a part of WhiteKnights campus. The aim of the Virtual Tour of WhiteKnights Campus is to allow users freely explore campus in a virtual reality setting, this also helps users who wish to come to University of Reading but may be unable to attend an open day, so they can download this app and then explore campus in Virtual Reality.

# Acknowledgements

I would like to personally thank Timothy Threadgold for his support and suggestions for my project. Without his help, half of the implementations in this project wouldn’t be possible without him. His assistance has been supportive and assisted lead the project into the right way.

I would also like to personally thank my mentor Gary Edwards for his continued support and mentoring on my wellbeing. Without his support, this project may have never been completed or been completed but not in the way I wanted it to be.

# Glossary of Terms & Abbreviations

API – Application Programming Interface

FOV – Field of View

GPU – Graphics Processing Unit

GUI – Graphical User Interface

SKD – Software development kit

# Introduction

Virtual Reality has been on the arise of popularity ever since 2010s when Palmer Luckey designed the first prototype of the virtual reality headset called the Oculus Rift. Two years later in 2015, video game developer and digital distribution company, Valve Corporation and consumer electronics company HTC, announced their virtual reality headset named HTC Vive. It featured controllers that allowed the user to interreact with the virtual environment. [1]

Today, Virtual Reality is possible and nearly accessible to anyone who possesses the latest model of a smartphone such as the iPhone or an Android phone (Like the Pixel or Samsung Galaxy) or own a console such as having a PS4 [2]. Virtual Reality headsets are becoming cheaper in general as well, so meaning that virtual reality is becoming more accessible to the public and thus increasing the popularity. [3]

The project is about creating a virtual reality version of WhiteKnights Campus, the application will be created primarily in Unity and all the buildings featured inside the WhiteKnights campus was made using SketchUp, the virtual campus application will be made for Android Devices running nougat or higher and have daydream/cardboard installed on it (The virtual reality software). The aims of the virtual reality campus are Provide users with a comfortable experience of Virtual Reality (Allowing to explore campus at their own pace), learn about the history of each building in WhiteKnights Campus. The App itself should be able to be installed on all phones running Android Nougat or higher and should provide smooth framerates and response no matter the hardware.

The personal motivation to pursue this project is explore and develop skills about virtual reality and how the public can benefit from using Virtual Reality to discover new worlds and experiences that might not be possible in real life. Virtual Reality can be used provide learning skills as it can be used as a training tool for example, using Virtual Reality to explore the human body for the medical sector or travel industry using virtual reality to encourage customers to buy holiday packages. [4] [5]

This report will discuss in detail about the creation of the application, the research made to prefect the Application, the approaches and implementations to create the project. The testing of the project along with its results. This report will also talk about the potential social, legal, ethical and health & safety issues that the project will have. Finally, this report will discuss the personal reflection and outcomes of the project.

# Problem Articulation and Objectives

The problem this project is addressing is many potential students in Sixth Forms/Colleges or postgraduate students may wish to study at University of Reading, however it is a possibility that they are unable to come to an open day, it could be for a variety of reasons ranging from; it could be too far away from them, they couldn’t afford travel to campus, they may be unavailable on the open day for example. Outside users may wish to visit the campus in general to see what it looks like. With virtual reality, it is possible that users can see what campus looks like virtually without them needing to be physically there, it may feel artificial but it should be a good substitute.

This project attempts to address the issue by creating a virtual reality version of Whiteknights campus which users can freely explore around a part of Whiteknights campus by using a ‘blink teleport’ feature where the user points by holding down a button to show an indicator to be teleported to the location specified by the user and then letting go once the user has chosen a location to be instantly teleported to that location. The user can also listen to voiced narration about the building that they are currently near, about what the building is and the history of the building.

The project was made using Unity and all buildings featured inside the campus was made using SketchUp. To create the virtual reality programming of the campus, a google cardboard/daydream SDK was used for allowing virtual reality to be enabled inside the project [6]. This project is made people using Android devices running Nougat (Android version 7.0) or higher with Daydream/cardboard installed (The software the android uses for virtual reality). The reason why I choose android devices instead of using Computer or Apple devices, is because Android devices are cheaper for virtual reality as most android devices today meet the suitable specifications for virtual reality [7]. This also helps University of Reading open days members who may wish to bring the virtual reality campus to open days on other schools or colleges because it would be easier to bring a smartphone with a virtual reality headset rather than carrying a computer/laptop with a headset.

The stakeholders that were identified of this project during development are: The first stakeholder is myself, as I am responsible for the development of the Virtual Campus application throughout the project’s development life cycle. The second stakeholder is my project manager, Timothy Threadgold who aided and recommended features that the project should have in terms of tools for aiding virtual reality creation and quality of life changes to the end user. Finally, the final stakeholder of the project is the end user, which is any potential student who owns an android device and wishes to study at the University of Reading who maybe is unable to attend an open day for a variety of reasons.

## Objectives

The objectives of the project will have to fulfil to meet the following technical specifications are:

* Provide users with a comfortable experience of Virtual Reality (Allowing to explore campus at their own pace).
* Learn about the history of each building in WhiteKnights Campus.
* The App itself should be able to be installed on all phones running Android Nougat or higher and should provide smooth framerates and response no matter the hardware.

# Literature Review / Initial Research

For the project to be created to the best potential, research was made on this project beforehand. The research topics that was scoped out for virtual reality are; which platforms (Such as, PC, Mobile devices or consoles) has virtual reality and what platform the virtual campus will run on, the programs that would be using to build the virtual campus and finally user comfort in virtual reality, this topic is mostly about the types of teleports and what teleport will be used.

## Platforms for virtual reality

To begin the project, research was made on which platforms has virtual reality compatibility and which virtual reality platforms that has the most users on.

### What platform will virtual campus will be run on

In the end, the platform virtual campus will be running on is: Android devices running Nougat or higher with cardboard/daydream installed. The reason why I chose this platform is because most people today own Android Devices that meet the suitable requirements for running virtual reality applications and it would be easier for a university of reading open day member, who wishes to bring a virtual campus to an open day in college or school, it would be easier to bring a smartphone with a virtual reality headset than carrying a computer/laptop with a headset. As well in most cases it would be cheaper as well.

## Programs used to build the virtual campus

### Initial Research

#### Unity

#### Sketchup

#### Blender

#### Unreal

### Programs used

## Teleportation

To choose the movement type of moving around the virtual campus, I had to research the possible types of movement in virtual reality. The three movement types that interested me were:

1. Teleport based movement (Or blink teleportation)
2. Free movement
3. Waypoint movement

### Teleport based movements (Or blink teleportation)

Teleport based movements was the first movement that I researched after watching VR games that used this movement. Teleport based movement allows users to point at a location they wish to transport to via an indicator appearing. They press a button to instantly be teleported there, they can teleport to any place that they wanted granted they have permissions to do so.

### Free movement

Free movement allows users to move in a direction that they want, without needing to pause. This allows for the most realistic movement of virtual reality however it causes the most motion sickness as their eyes believe that they are moving however their body in real life isn’t. So, in the end I won’t be using free movement as not many people have been exposed to Virtual Reality.

### Waypoint movement

Waypoint movement allows users to choose a node or a point on the screen, that the programmer specified and the user can look at the node and then press a button to be teleported to that node. It allows the safest amount of moment for Virtual reality as compared to teleport based movement, users can potentially find errors and glitch by teleporting out of bounds by mistake, however it is the least restricted out of the three movement types are users are limited to moment by the nodes specified.

### Conclusion

In conclusion, I chose teleport based movement because in the end, teleport based movement allows for the freest movement type of out of the three and it’s the movement type that will cause the least amount of motion sickness to the user and the user only moves when they want to move and it’s done via teleportation instead of free movement.

# Technical Specification

# Research

# Solution Approach

# Design

# Implementation

# Testing

# Discussion

# Social, Legal, Health & Safety & Ethical Issues

# Conclusion and Future Improvements

# Reflection

# References

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## Assets used for the project

# Appendices

## Project Initiation Document

**Individual Project (CS3IP16)**

**Department of Computer Science**

**University of Reading**

**Project Initiation Document**

**PID Sign-Off**

|  |  |
| --- | --- |
| **Student No.** | **24015209** |
| **Student Name** | **James Tang** |
| **Email** | [**Xr015209@reading.ac.uk**](mailto:Xr015209@reading.ac.uk) |
| **Degree programme** (BSc CS/BSc IT) | **BSc CS** |
|  |  |
| **Supervisor Name** | **Timothy Threadgold** |
| **Supervisor Signature** |  |
| **Date** |  |

### SECTION 1 – General Information

**Project Identification**

|  |  |
| --- | --- |
| **1.1** | **Project ID**  (as in handbook) |
|  | 150 |
| **1.2** | **Project Title** |
|  | Virtual Campus |
| **1.3** | **Briefly describe the main purpose of the project in no more than 25 words** |
|  | Create models of parts of the campus using SketchUp or blender which can be explored using a robot and explored in unity |

**Student Identification**

|  |  |
| --- | --- |
| **1.4** | **Student Name(s), Course, Email address(s)**  e.g. Anne Other, BSc CS, a.other@student.reading.ac.uk |
|  | James Tang, BSc CS, xr015209@live.reading.ac.uk |

**Supervisor Identification**

|  |  |
| --- | --- |
| **1.5** | **Primary Supervisor Name, Email address**  e.g. Prof Anne Other, a.other@reading.ac.uk |
|  | Timothy Threadgold, timothy.threadgold@reading.ac.uk |
| **1.6** | **Secondary Supervisor Name, Email address**  Only fill in this section if a secondary supervisor has been assigned to your project |
|  |  |

**Company Partner (only complete if there is a company involved)**

|  |  |
| --- | --- |
| **1.7** | **Company Name** |
|  |  |
| **1.8** | **Company Address** |
|  |  |
| **1.9** | **Name, email and phone number of Company Supervisor or Primary Contact** |
|  |  |

### SECTION 2 – Project Description

|  |  |
| --- | --- |
| **2.1** | **Summarise the background research for the project in about 400 words. You must include references in this section but don’t count them in the word count.** |
|  | The background research I have done for this, I have researched various ways to control how the user would move and view around a virtual space, I primarily used Google Maps Street view, Google Cardboard and Google Earth VR as my background research.  I used Google Cardboard’s Tour guide feature, which my primarily inspiration for voiced guide tours, Google Maps Street views which allows you to explore inside of some buildings on the map gave me inspiration for moving around inside buildings to view what the inside of a building looks like.  Inspiration I got for moving around the map was primarily from watching footage of VR games, where the user just points to a location and teleports to it. |
| **2.2** | **Summarise the project objectives and outputs in about 400 words.** These objectives and outputs should appear as tasks, milestones and deliverables in your project plan. In general, an objective is something you can do and an output is something you produce – one leads to the other. |
|  | The objectives and outputs are:   * Get photos of the campus buildings such as: structures of the building, inside of the building including most of its rooms. This allows for modelling the outside of the building and inside the buildings as well. * Get photos and map of the campus grounds (Half of Whiteknights campus including the lake) to model the outside parts of campus. Once this is done, then the buildings can be successfully placed on the outside areas (Once they are modelled). * Model the buildings using SketchUp, once the buildings have been modelled then use SketchUp again to model the outside areas. * Once both have been completed, use unity to place the buildings and outside map areas together to form the basis of the virtual campus. * Add in voice lines, which reads out loud to the user about information about the current area they are in. * Use unity to code the virtual reality part where users can move around and interact with the environment (such as guided tours, or information about the buildings/area). * Once all is completed, test the virtual reality out and test for bugs/potential problems users may run into. |
| **2.3** | **Initial project specification - list key features and functions of your finished project.** Remember that a specification should not usually propose the solution. For example, your project may require open source datasets so add that to the specification but don’t state how that data-link will be achieved – that comes later. |
|  | * Fully explorable central white knight’s campus, from Chancellor buildings to Halls to the lake. * Users can explore inside of most of the buildings, there is some interactive elements (Mostly buttons users can press which gives out information about the current building that they are in). * Some parts of the buildings can be interacted with. * Guided tours of the campus, users can select one of three tours (May be more in the future) which gives them a personal tour of each part of the campus, with a pre-recorded guide tour.     *Figure 1 Purposed plan of explorable area which the virtual campus tour would be like* |
| **2.4** | **Describe the social, legal and ethical issues that apply to your project. Does your project require ethical approval?** |
|  | None of that I know of, possible legal issues are required permissions to take pictures of campus and permissions to use information about the campus. |
| **2.5** | **Identify and lists the items you expect to need to purchase for your project. Specify the cost (include VAT and shipping if known) of each item as well as the supplier.** e.g. item 1 name, supplier, cost |
|  | * Vive set, Vive, £599 or Oculus Rift + Touch, Oculus, £499   + Used for Virtual reality testing * Google SketchUp, Google, Free (But may possibly need the pro version, $695) or Blender   + Used to create models of the campus * Unity, Unity, Free (May need to purchase the pro features to access the virtual reality features, in this case it is $125 per a month)   + Used to code in the virtual reality parts |
| **2.6** | **State whether you need access to specific resources within the department or the University e.g. special devices and workshop** |
|  | Need access to virtual reality tools (such as oculus rift or Vive) and a room to test out the virtual reality parts. |

### SECTION 3 – Project Plan

|  |  |  |  |
| --- | --- | --- | --- |
| **3.1** | **Project Plan**  Split your project work into sections/categories/phases and add tasks for each of these sections. It is likely that the high-level objectives you identified in section 2.2 become sections here. The outputs from section 2.2 should appear in the Outputs column here. Remember to include tasks for your project presentation, project demos, producing your poster, and writing up your report. | | |
|  | | | |
| **Task No.** | **Task description** | **Effort**  **(weeks)** | **Outputs** |
| **1** |  |  |  |
| 1.1 | **Background Research** | 3 | … |
| 1.2 | Get pictures of buildings | 1 | Models for of buildings |
| 1.3 | Get pictures of campus | 1 | Models of campus |
| 1.4 | Get information about WhiteKnights campus | 1 | Voice lines of guided tours |
| **2** | **Analysis and design** |  |  |
| 2.1 | Design Buildings (insides as well) | 12 | Building models |
| 2.2 | Design outside parts of campus | 3 | Outside models |
| 2.3 | Get voice recordings | 1 | Used for guided tours part |
| **3** | **Develop prototype** |  |  |
| 3.1 | Combine both buildings and campus into one | 3 | Campus set for virtual reality |
| 3.2 | Make the virtual reality part controllable | 6 | Controllable virtual campus |
|  |  |  |  |
| **4** | **Testing, evaluation/validation** | 3 |  |
| 4.1 | Test virtual reality (self) | 1 | Bug fix report |
| 4.2 | Have a group test of the virtual reality | 1 | Bug fix report and feedback |
| 4.3 | Change parts of the virtual reality based on possible feedback | 1 | Hopefully a better version of the prototype |
| **5** | **Assessments** |  |  |
| 5.1 | write-up project report | 2 | Project Report |
| 5.2 | produce poster | 0.5 | Poster |
|  | … |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
| **TOTAL** | **Sum of total effort in weeks** | **39.5** |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SECTION 4 - Time Plan for the proposed Project work** | | | | | | | | | | | | | |
| For each task identified in 3.1, please *shade* the weeks when you’ll be working on that task. You should also mark target milestones, outputs and key decision points. To shade a cell in MS Word, move the mouse to the top left of cell until the curser becomes an arrow pointing up, left click to select the cell and then right click and select ‘borders and shading’. Under the shading tab pick an appropriate grey colour and click ok. | | | | | | | | | | | | | |
| **Project stage** | **START DATE: 06/10/17 <enter the project start date here>**  **Project Weeks** | | | | | | | | | | | | |
| 0-3 | 3-6 | 6-9 | 9-12 | 12-15 | 15-18 | 18-21 | 21-24 | 24-27 | 27-30 | 30-33 | 33-36 | 36-39 |
| **1 Background Research** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Get pictures of buildings |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Get information about WhiteKnights campus |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2 Analysis/Design** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Design Buildings (insides as well) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Design outside parts of campus |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Get voice recordings |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **3 Develop prototype.** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Combine both buildings and campus into one |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Make the virtual reality part controllable |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **4 Testing, evaluation/validation** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Test virtual reality (self) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Have a group test of the virtual reality |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Change parts of the virtual reality based on possible feedback |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **5 Assessments** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **write-up project report** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **produce poster** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Risk Assessment Form**

|  |  |  |  |
| --- | --- | --- | --- |
| **Assessment Reference No.** |  | **Area or activity assessed:** | **The room where the VR headset is currently set in** |
| **Assessment date** |  |
| **Persons who may be affected by the activity (i.e. are at risk)** | **Person is currently using the VR headset** |

**SECTION 1: Identify Hazards -** *Consider the activity or work area and identify if any of the hazards listed below are significant (tick the boxes that apply).*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Fall of person (from work at height) | ✓ |  | Lighting levels | ✓ |  | Use of portable tools / equipment | ✓ |  | Vehicles / driving at work |  |  | Hazardous fumes,  chemicals, dust |  |  | Occupational stress |  |
|  | Fall of objects | ✓ |  | Heating & ventilation |  |  | Fixed machinery or lifting equipment |  |  | Outdoor work / extreme weather |  |  | Hazardous biological agent |  |  | Violence to staff / verbal assault |  |
|  | Slips, Trips & Housekeeping | ✓ |  | Layout, storage, space, obstructions | ✓ |  | Pressure vessels |  |  | Fieldtrips / field work |  |  | Confined space / asphyxiation risk |  |  | Work with animals |  |
|  | Manual handling operations |  |  | Welfare facilities |  |  | Noise or Vibration |  |  | Radiation sources |  |  | Condition of Buildings & glazing |  |  | Lone working / work out of hours | ✓ |
| 1. **55** | Display screen equipment | ✓ |  | Electrical Equipment | ✓ |  | Fire hazards & flammable material |  |  | Work with lasers |  |  | Food preparation |  |  | Other(s) - specify |  |

**SECTION 2: Risk Controls** *- For each hazard identified in Section 1, complete Section 2.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hazard No**. | Hazard Description | Existing controls to reduce risk | **Risk Level** (tick one) | | | Further action needed to reduce risks |
|  | High | Med | Low | *(provide timescales and initials of person responsible)* |
| 1 | User using the VR headset may not be aware of it’s current (in real life) surrounding and thus may trip/fall/bump into an object | Make the room empty and spacious |  | ✓ |  | Have a person supervise the current user using the VR set and support them should they fall. |
| 2 | Prolong use of the VR headset may cause eye strain/damage |  | ✓ |  |  | Have a person supervise the current user using the VR set the amount of time they have been on and warn them to get off once they reach a certain limit (15 minutes for example) |
| 3 | User may get nauseous when using VR (In general or for the first time) |  |  | ✓ |  | Have a person supervise the current user using the VR set and teach them how to use VR for the first time. |
| **Name of Assessor(s)** | |  | **SIGNED** | | | |
| **Review date** | |  |

|  |  |  |
| --- | --- | --- |
| **Health and Safety Risk Assessments** – continuation sheet | **Assessment Reference No** |  |
|  | **Continuation sheet number:** |  |

**SECTION 2 continued: Risk Controls**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Hazard No**. | Hazard Description | | Existing controls to reduce risk | **Risk Level** (tick one) | | | | Further action needed to reduce risks |
|  | High | | Med | Low | *(provide timescales and initials of person responsible for action)* |
| 4 | User may accidentally throw the VR Remotes at someone or something, potentially damaging them | | There are straps on the VR remote | ✓ | |  |  | Make sure the person supervising them enforces the users to put the strap on |
| 5 | Liquids poses a great risk to the VR set & computer running it since it is electrical | | No Liquids allowed signs in the room | ✓ | |  |  | Make sure the person supervising them prevent the user from consuming/bringing liquids. If the user needs to consume liquids, tell them to consume it outside of the room. |
|  |  | |  |  | |  |  |  |
| **Name of Assessor(s)** | |  | | | **SIGNED** | | | |
| **Review date** | |  | | |

## Project Log Book

## Script for buildings

## Map of WhiteKnights Campus



Figure 1 Map of WhiteKnights Campus - link: <https://www.reading.ac.uk/web/files/whiteknights-campus-map-and-keys-2016.pdf>

## GitHub Repository Link

<https://github.com/JamesTang2905/Individual-Project-2017-18> – This shows all the commits uploaded to GitHub, however it does not cover all the updates made before the 21st of February 2018 as this project wasn't uploaded to GitHub before then. Read the project logbook for a more detailed record.