<VR Puzzle Game>

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Digital Systems Project



# Abstract

**Your Abstract**

# Acknowledgements

**Just want to give credit to friends and my supervisor who helped me develop ideas.**

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# Introduction

In this paper I will design and build a VR game that involves puzzles. More specifically the 8 queens puzzle, and other such chess related puzzles. The game will be created using a game engine, in this case unity, the language of choice is c#. The chosen platform is the quest 2 which uses a version of the android operating system. Both the headset and its operating system were developed by Meta formally known as Facebook. To add further complexity, I will develop a website a long side the game to display scores submitted by players. This paper will contain the research for said project, design information, testing and research.

# Literature Review

## Chapter introduction

This chapter of the report contains my research on VR technologies, web technologies and other such things that I will require to design and build my VR game.

## Introduction to VR

VR technology or early versions of VR have been around for decades. This writer brakes down the key elements of VR.

There are four key elements of virtual reality experience (Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003):

A virtual world is the context of a medium(Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003). In this case the case of this project this would refer to the game world. This will also tie into the writers next point regarding immersion. This is because the virtual world, if created correctly helps give a sense of immersion and improves the experience of the player.

It must have immersion, Immersion into a different reality or another point of view(Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003). It must have both Physical and mental immersion, this can be split into two, mental immersion can often be referred to as having a mental presence within the world (Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003) and physical immersion, a body entering into a medium (Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003). Both of these points apply today, If the VR experience will be greatly affected if immersion is broken, so during development I must pay extra attention to this as one of the major causes of braking immersion is frame drops whilst playing a VR game, therefore it is imperative that my code is optimised.

It must have Sensory feedback, “VR allows participants to select their vantage point by positioning their body and to affect events in the virtual world” (Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003). This refers to moving your arm for example in the VR worlds and have it match up with the real world. Technologies to make this more accurate already exist, with the rise of full body tracking for certain headsets. Sensors are placed on the body and tracked by the headset allowing for more accurate tracking of limbs creating the illusion of the player actually being in the virtual world.

The final key element according to the writer is, Interactivity. “For virtual reality to seem authentic, it should respond to user actions, namely, be interactive” (Sherman, [B.Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), 2003). In the case of current day VR this could be seen to be tied to the act of a user performing an action and getting a reaction. For example, a player pushes a box with there in game hand and the box moves back in response.

## Early Virtual reality headsets

### Sensorama

An early example of a VR headset was the Sensorama( [Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), [R. Sherman](https://learning.oreilly.com/search/?query=author%3A%22William%20R.%20Sherman%22&sort=relevance&highlight=true),  [D. Will](https://learning.oreilly.com/search/?query=author%3A%22Jeffrey%20D.%20Will%22&sort=relevance&highlight=true), 2009). This piece of literature describes early VR technology. “The Sensorama was the brainchild of cinematographer and inventor Morton Heilig” ”( [Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), [R. Sherman](https://learning.oreilly.com/search/?query=author%3A%22William%20R.%20Sherman%22&sort=relevance&highlight=true),  [D. Will](https://learning.oreilly.com/search/?query=author%3A%22Jeffrey%20D.%20Will%22&sort=relevance&highlight=true), 2009). As described by the writer of this literature the system “was lacking a major component of the modern virtual reality system: response based on user’s actions” ”( [Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), [R. Sherman](https://learning.oreilly.com/search/?query=author%3A%22William%20R.%20Sherman%22&sort=relevance&highlight=true),  [D. Will](https://learning.oreilly.com/search/?query=author%3A%22Jeffrey%20D.%20Will%22&sort=relevance&highlight=true), 2009). Early headsets were very basic, this simply means that the system did not allow a user’s actions to have any impact on the virtual world unlike modern day headsets that allow a user to interact with the virtual world using controllers or in some cases the users’ hands.

### Myron Krueger’s Videoplace

“Krueger’s artificial reality provided a second-person view of a virtual world in which participants could watch themselves within the world” ”( [Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), [R. Sherman](https://learning.oreilly.com/search/?query=author%3A%22William%20R.%20Sherman%22&sort=relevance&highlight=true),  [D. Will](https://learning.oreilly.com/search/?query=author%3A%22Jeffrey%20D.%20Will%22&sort=relevance&highlight=true), 2009). [Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), [R. Sherman](https://learning.oreilly.com/search/?query=author%3A%22William%20R.%20Sherman%22&sort=relevance&highlight=true) literature also talks about another early VR headset such as Myron Krueger’s Video place. This headset gave the user a “second-person point of view” of themselves. No games could be played on this headset and the user did not have any devices or other sensors attached to their body( [Craig](https://learning.oreilly.com/search/?query=author%3A%22Alan%20B.%20Craig%22&sort=relevance&highlight=true), [R. Sherman](https://learning.oreilly.com/search/?query=author%3A%22William%20R.%20Sherman%22&sort=relevance&highlight=true),  [D. Will](https://learning.oreilly.com/search/?query=author%3A%22Jeffrey%20D.%20Will%22&sort=relevance&highlight=true), 2009) unlike some modern-day VR headsets that use full body tracking that require sensors to be placed all over the user’s body including head, legs and arms depending on what degree of tracking you want.

## Game engines

Game engines are sets of tools that allow a programmer to, perform game related tasks like interpretation and physics related tasks and for focusing on the niceties that make the game great([Mishra](https://www.ijimai.org/journal/bibcite/contributor/5998), [Shrawankar](https://www.ijimai.org/journal/bibcite/contributor/5999), 2016).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ASSESSMENT OF ENGINES ON PERFORMANCE ASPECTS** | | | | | | |
| Game Engine | Platforms | Language Support | AI Engine | Physics Engine | Forward Compatibility | Backward Compatibility |
| CryEngine 3 | Win, X360, PS3, Wii U | C++, Visual Script, Lua | Lua-driven AI | Soft body | No | Yes |
| Hero Engine | Win | Hero Script | AIseek | PhysX | Partial | Yes |
| Source 2 Engine | Win, Mac, Xbox 360, Wii, Linux, Android | C++ | AI Director | Ipion | No | Partial |
| Unity 4 | BlackBerry, Win Phone, Win, OS X, Android, iOS, Apple TV, PS3/4, PS Vita, Xbox 360, Xbox One, Wii U, Wii | C#, JavaScript, Boo | RAIN | PhysX | Partial | yes |
| Unreal 4 Engine | Windows, OS X Linux, Xbox 360/ One, PS3/4, Wii U, Android, iOS, WinRT, PS Vita | C++, C#, GLSL, CG, HLSL | Kynapse | PhysX | Partial | Yes |
| Vision Engine 8 | Windows, Xbox 360, PS3, Wii, Wii U, iOS, Android, Win Phone, PS Vita | C++ | Kynapse | Bullet, ODE, PhysX | No | Partial |

Figure 1 ([Mishra](https://www.ijimai.org/journal/bibcite/contributor/5998), [Shrawankar](https://www.ijimai.org/journal/bibcite/contributor/5999), 2016).

As can be seen from figure one CryEngine, Hero Engine don’t support nearly as many platforms as the other four. Furthermore, Hero engine does not support any of the more popular programming languages like C++ or C#. In addition to this Hero Engine, Unity and unreal only have partial forward compatibility.

Unreal Engine has Blueprint Visual Scripting” (Chu, Zaman, 2021). It was created to support the workflow of designers and artist by giving them access to tools normally only accessible to programmers (Chu, Zaman, 2021). Blueprints is object oriented visual programming system which is used to create gameplay elements (Chu, Zaman, 2021). Other engines also have these capabilities, such as unity. A recent example of plugins that allow unity to obtain this functionality include, FlowCanvas, playmaker, Bolt and Amplify shader editor (Chu, Zaman, 2021).

**Talk about web APIs first and then talk about web frameworks as we use web frame works to make APIS**

## APIS

To break down what an api is, we must first learn what it stands for, its stands for application programming interface([Uzayr](https://learning.oreilly.com/search/?query=author%3A%22Sufyan%20bin%20Uzayr%22&sort=relevance&highlight=true), 2016).

## Web frameworks in python

### Django

Django is a collection of python modules designed for building web applications (Yudin et al., 2020). The Django framework can map URLS to methods, it can also render HTML webpages and it can handle cookies, session and also web security (Yudin et al., 2020). Django can also support things like relational databases using object-relational mapping (Yudin et al., 2020). It has a build in database solution, known as SQLite (Yudin et al., 2020). It also contains tools that allow easy authentication and authorization (Yudin et al., 2020). It is also widely used, namely these websites use it, YouTube, Spotify and also many others (Yudin et al., 2020).

### Flask

Flask is a small framework and is small enough to be called a micro framework (Grinberg eta al., 2018). Flash was designed to be extendable, and you can pick and choose what you need to avoid bloat (Grinberg eta al., 2018). Flash has a few dependencies, including the routing, debugging and web server gateway (Grinberg eta al., 2018). However, it does not have support for accessing databases, validating web forms or authenticating users (Grinberg eta al., 2018). This is an issue for this project as we require a database to store score data from the game, also a way to authenticate users.

Comparing Django’s and Flasks features, Django is the most logical option as it allows the use of an SQLite database and has user authentication and authorization features which is lacking in the Flask framework.

## Rest API

## WebSocket scripting

# Requirements

This section of the report will contain 20 requirements in total. 10 Functional and 10 non-functional. I will be using MosCoW to illustrate the Priority of each of the requirements.

Must – The system must have this, and this is the highest priority

Should – The system should have this, this is mid priority

Could – This system could have this, however it is not necessary

Would – This could be added in the future

## Functional Requirements:

|  |  |  |
| --- | --- | --- |
| Requirement No. | Priority | Requirement |
| FR1 | Must | The game must allow input from both controllers and hand tracking |
| FR2 | Must | Must have an algorithm or algorithms that can detect when a puzzle is solved when a button is pushed |
| FR3 | Must | The game must have two puzzles for the user to play, 8 Queens etc |
| FR4 | Must | The game must save past puzzle solutions onto the headset solved by the user |
| FR5 | Must | Push high scores to a website |
| FR6 | Should | Allow users to login to the website |
| FR7 | Should | Allow users to manage their leader board data, I.E delete, change their name etc |
| FR8 | Could | Store games save data on dedicated server and pull data when game is loaded |
| FR9 | Could | The game will provide a hit if a user does not make a move within a given time frame |
| FR10 | Would | Allow multiplayer – Allow users to join other user to solve the puzzles. |

## Non-functional Requirements:

|  |  |  |
| --- | --- | --- |
| Requirement No. | Priority | Requirement |
| N-FR1 | Must | The game must have a way to select between different puzzles in the form of a UI |
| N-FR2 | Must | Allow for the addition of new puzzles |
| N-FR3 | Must | Must run on the Oculus Quest 2 |
| N-FR4 | Must | Must be simple to maintain both quest 2 app and website |
| N-FR5 | Must | Be able to check a solution within 1 second |
| N-FR6 | Must | Multiple users must be able to use website at the same time |
| N-FR7 | Should | Be able to send data to the website from the headset and update it within 1 second |
| N-FR8 | Could | Use |
| N-FR9 | Could |  |
| N-FR10 | Would | The website would not be down for more than 5 minutes during a fault |

# Methodology

# Design

# Implementation

# Project Evaluation

# Further Work and Conclusions

# Glossary

# Table of Abbreviations

# References / Bibliography

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# Appendix A: First Appendix