



VR SOUNDSCAPE

Dzhan Hasan

Dr. Gianluca Memoli

Table of Contents

Introduction.....	2
Objectives and Problems	3
Design And Inspiration.....	3
Sound Delivery	3
Visuals.....	3
Gameplay.....	4
Story.....	4
Technical Information.....	5
Engine.....	5
Platform.....	5
Coding.....	5
Visuals.....	6
Sound.....	6
Gameplay.....	7
Professional and Ethical Considerations.....	9
BSC Code Of Conduct	9
Requirements Analysis.....	12
Usability.....	12
Gameplay.....	12
Accessibility.....	13
Requirements.....	13
Mandatory.....	13
Desirable.....	13
Project Plan.....	15
Gant Chart.....	15
Current State.....	16
References.....	17
Appendices.....	19

Introduction

Virtual Reality is a technology that can upgrade the immersivity and interactivity of the simulated environment with the usage of head-mounted hardware and controllers. It's the next step to the monitor and mouse which has limited visual space and interactivity and have hard limits on the user.

The recent developments of low-cost VR hardware such as Sony PlayStation VR, and HTC Vive has kickstarted an interest in this field. Although the hardware exists the developers are still hesitant about optimizing their products to this new platform because of the lack of an audience and accessibility hence the audience also avoids the platform because they are unable to access the product and recognize what experience makes VR distinguish from a normal pc.



Figure 1: Sony PlayStation VR

Therefore, this project and report are focused on why an average user should use VR technology by creating an easily accessible software that can be experienceable with a monitor, keyboard, and mouse as well as a VR. Both experiences will deliver a different style of audio, visuals, and interactivity to distinguish their characteristics from one another and communicate their differences to the user.

Objectives and problems

A game requires time, resources and a combination of different elements working together to create an experience which is usually handled by different people with different skillset although there are lots of projects developed by only one person such as Stardew Valley. In this chapter required fields for a game on the design level, technical level and how they will interact with each other will be covered.

- **Design and Inspirations**

- **Sound Delivery**

One of the elements that make the experience unique is how the sound is delivered. The sound is crucial for the game as it can manipulate player's emotions by giving them excitement during an action scene or can make them tense by putting creepy ambient noises furthermore can communicate the things that are happening in the environment on the technical level without visuals such as the iconic sound of Metal Gear Solid's "you have been spotted!" is a perfect example for this as it gives the player the feedback of they are in danger and creates a tense environment by playing fast-paced music in the background. This kind of iconic sound design gives the experience characteristic and rememberability of the experience and can create nostalgia in the player whenever they hear that sound or music.

- **Visuals**

The game visuals are also helping the characteristics of the game. the visuals can be photo-realistic or cartoonish as long as they represent some kind of characteristics and sense of familiarity. As an example; Persona 5 does not have realistic graphics or doesn't push the hardware to its limits. but the concept of entering people's subconscious minds and seeing how they perceive the world without needing a single sound or dialogue is a perfect example of this. Visuals include more than graphics such as UI design and environment design on a technical level. UI gives feedback to the

player to see how much health they have left or whether they can interact with an object.



Figure 2: Persona 5

- **Gameplay**

As technology advances and genres started to have repetitive gameplay, a new genre called walking simulator has emerged. This new genre lacks puzzles, enemies, obstacles and even a jump button. It encourages the player to explore through its level design, story and environment and all you can do is walk and sometimes make choices. The Beginner's Guide is the perfect example of this as the player walks around some inexperienced game developer's levels and the narrator gives a psychological analysis of the developer and an explanation of design decisions.

- **Story**

The story is the most important part of the video game as all of the player's struggles or exploration is meaningless without a goal to achieve or having some kind of reward at the end of the game. In the Super Mario franchise, Peach is kidnapped 26 times since the first game, but it takes the player's attention, establishes the enemy, and gives an objective to the player to achieve and a reward at the end without any dialogue nor deep back-story.

- **Technical Information**

- **Engine**

To accommodate these design objectives a game engine has been required so I chose the Unity engine because of its VR support, pre-built packages for spatial sound and for its asset store. It makes the development process easier because the developers can work on the project without using a VR headset or emulate the VR experience with some tweaks on the engine. Furthermore, can build the project on a browser using WebGL which is accessible and playable with just a click of a link and without much of a sacrifice from the desktop version.

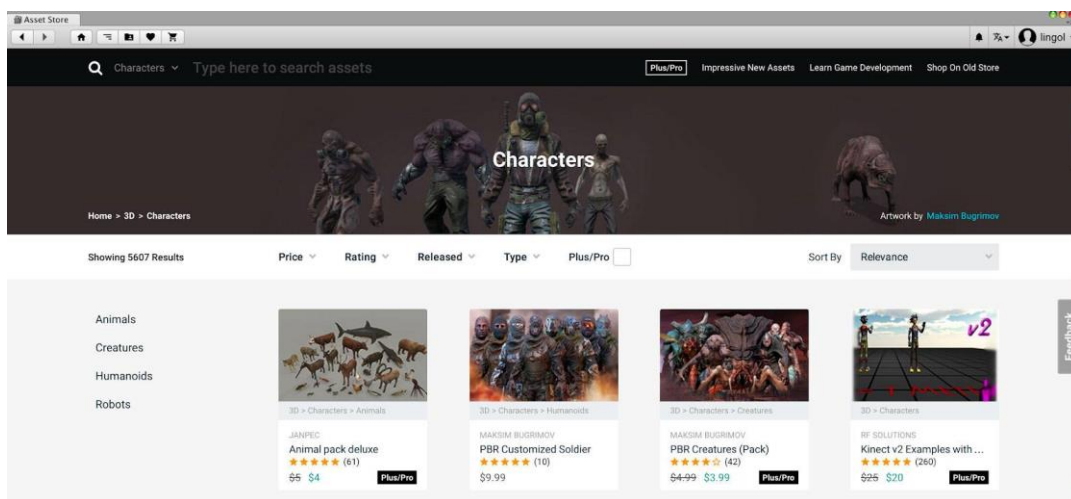


Figure 3: Unity Asset Store

- **Platform**

To make the project accessible from anywhere, using the browser to run the project is decided although it comes with a limitation which is it is only playable on Mozilla Firefox. So only %3 of the browser users will have direct access to the project without installing 3rd party software. Even if the browser limits the user from accessing the product the project will be playable with a mouse and Keyboard as well as VR which gives the player more flexibility in the way they play.

- **Coding**

Unity uses a modified version of C# coding language which is like Java furthermore it has pre-built packages for camera, graphics, physics etc. which lifts off some of the hard work. The game won't require much coding because the VR platform already has

a pre-built package and the player will have limited movement such as walking around and pressing the action button to interact with the objects around them. In the later stages, some event triggers can be added which will result in the action event being turned on without the player interacting with an object.

- **Visuals**

Visuals will be the most time-consuming part in these parts discussed because the game won't have much gameplay so the player will focus on the environment as well as sound and will expect high immersivity to feel the atmosphere. To make the development much faster and more agile 3D modelling tools Cinema 4D will be used because of its compatibility with unity and easy-to-learn Interface. Although modelling is only for the most important objects in the game, all other models will be downloaded from the unity asset store. And to make the environment more interesting shaders can be used which is a way to animate the textures on the model to make them more interesting such as moving the water on the surface of the sea.

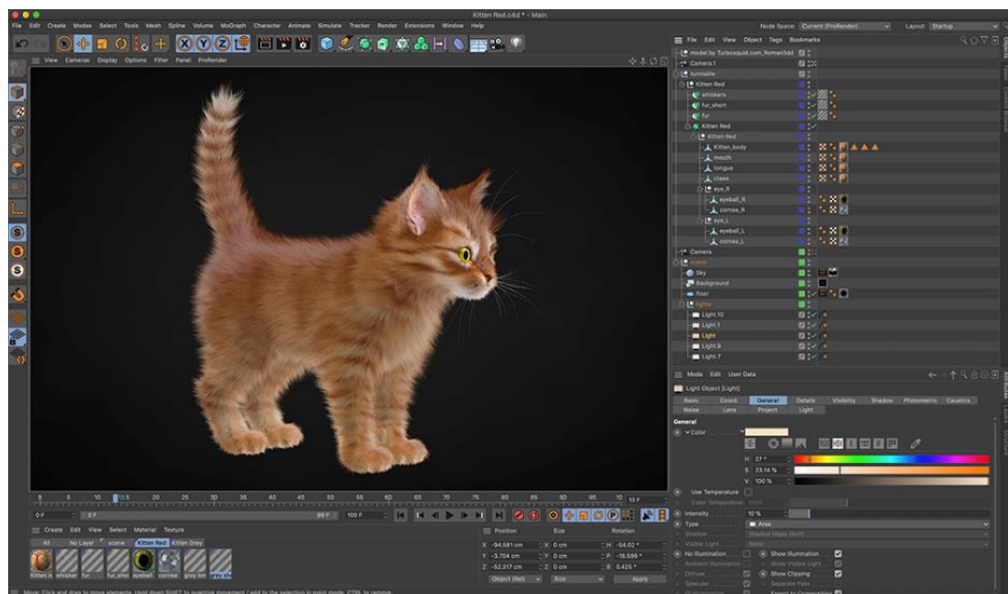


Figure 4: Cinema 4D

- **Sound**

The sound will be the most interesting and innovative part to develop as the game will use spatial sound for the environment and objects which enhances the immersivity and makes the localising of the sound much easier for the player. Unity has built-in audio spatializer SDK which helps the developers to attach the sound files to objects

and makes the development process for audio much easier. Although converting stereo sound files to spatial sound is crucial, mixing and creating these sounds is also important. For the creation and mixing of music and sound effects, there are Digital Audio Workstations (DAW). For this Project, Reason 11 Lite is chosen because of my experience with it. In the long term, the sound and visuals must complement and balance each other to create the atmosphere of the game thus, it will be my biggest priority for the development.



Figure 5: Reason 11

○ Gameplay

The game will be a walking simulator so there won't be any obstacles, enemies or dying. The Player's only objective will be to explore their surroundings and interact with the objects. So, this makes the visual and sound delivery the most important aspect of the game to keep the player engaged and make sure they have fun while playing. Meanwhile, the game's aim is going to be to educate the player about some subject. Three themes for the game have been considered history, geography, and philosophy.

To push the development in a more abstract and theory-based direction philosophy was considered. A typical environment for this topic would be a philosopher's theories represented visually in an abstract way as an art form to educate the player. Kid Amnesia: Exhibition is the best example of this as it gives an abstract visual representation of Radiohead's songs in an exhibition and can be explored in any direction with lots of secrets to be found. Although this sounds exciting in VR, down-

side of this theme would be lots of research about philosophy and thinking about how to represent them in a way that can communicate the idea to the player would be time consuming



Figure 6: Kid Amnesia: Exhibition

Thus, combining geography and history has been decided as it's a fact-based theme and there are already lots of assets already made which shortens the development cycle. For the project designing an open-air museum is decided as it combines all the elements required. As an inspiration for the project, I choose the oldest open-air museum in the world, Swedish Skansen which is a town from Middle Ages that have a zoo with local Nordic animals. As a country with rich history, habitat and architecture Poland is chosen for my personal choice.

For the gameplay, the player will explore a town from Poland-Lithuania Commonwealth with a zoo inside of it. The player can walk in any direction they want and turn back to the previous locations they visited like real life museum experience. They can also read information about the animals and hear the noise they make in spatial audio format. Finally visit the houses, and workshops and learn which profession played which role in the empire.

Professional and Ethical Considerations

BSC Code Of Conduct

- **Public Interest**

- **have due regard for public health, privacy, security and wellbeing of others and the environment.**

The game does not store any data about the player and does not contain any distressing images or other elements to risk the user's or others' well-being.

- **have due regard for the legitimate rights of Third Parties.**

The game has limited usage of third-party content and when used, it fulfils the licence criteria, and the creator is referenced for their content.

- **conduct your professional activities without discrimination on the grounds of sex, sexual orientation, marital status, nationality, colour, race, ethnic origin, religion, age or disability, or of any other condition or requirement.**

The game does not contain symbols, language or trait that discriminates any group

- **promote equal access to the benefits of IT and seek to promote the inclusion of all sectors in society wherever opportunities arise.**

There will be efforts put into the project to include people with special needs.

- **Professional Competence and Integrity**

- **only undertake to do work or provide a service that is within your professional competence.**
- **NOT claim any level of competence that you do not possess.**
- **develop your professional knowledge, skills and competence on a continuing basis, maintaining awareness of technological developments, procedures, and standards that are relevant to your field.**

The project is parallel to my course, and it's within my competence

- **ensure that you have the knowledge and understanding of Legislation* and that you comply with such Legislation, in carrying out your professional responsibilities.**

I will make myself familiar with the legislation and will not do anything to break it

- **respect and value alternative viewpoints and, seek, accept and offer honest criticisms of work.**

I will respect my supervisor and other people's honest and constructive feedback to improve the project

- **and avoid injuring others, their property, reputation, or employment by the false or malicious or negligent action or inaction.**

I will not do anything malicious to harm someone else's reputation or property

- **reject and will not make any offer of bribery or unethical inducement.**

I will reject and discourage bribery and unethical inducement

- **Duty to Relevant Authority**

- **carry out your professional responsibilities with due care and diligence in accordance with the Relevant Authority's requirements whilst exercising your professional judgement at all times.**

I shall carry out my professional responsibilities with care and in accordance with the university's requirements while exercising my professional judgement

- **seek to avoid any situation that may give rise to a conflict of interest between you and your Relevant Authority.**

I shall avoid any situation that may cause conflict between me and the university by following the project plan, objectives and requirements of the university.

- **accept professional responsibility for your work and for the work of colleagues who are defined in a given context as working under your supervision.**

I accept all the responsibility for my work and the project as it's chosen according to my competence

- **NOT disclose or authorise to be disclosed, or use for personal gain, or to benefit a third party, confidential information except with the permission of your Relevant Authority, or as required by Legislation**

I shall not disclose any sensitive and confidential information and refuse to do so without any permission outside of the relevant authorities and by legislation.

- **NOT misrepresent or withhold information on the performance of products, systems or services (unless lawfully bound by a duty of confidentiality not to disclose such information), or take advantage of the lack of relevant knowledge or inexperience of others.**

I shall share all the progress and information about the project with the relevant authority according to my knowledge and shall not take advantage of others because of their inexperience.

- **Duty to the Profession**

- **accept your duty to uphold the reputation of the profession and not take any action which could bring the profession into disrepute.**
- **seek to improve professional standards through participation in their development, use and enforcement.**
- **uphold the reputation and good standing of BCS, the Chartered Institute for IT.**

I shall accept my duty to improve the standards during the development of the project and follow the BSC Code Of Conduct rules.

- **act with integrity and respect in your professional relationships with all members of BCS and with members of other professions with whom you work in a professional capacity.**
- **encourage and support fellow members in their professional development.**

I shall respect my professional relationship with all members of the BSC and the members of the university and encourage their professional development.

Requirements Analysis

- **Usability**

Video games are playable with different age groups with different hardware settings. This project will be a walking simulator and its aim is going to educate the population thus will not require much effort to learn the controls and will not have any obstacles to overcome hence it appeals to all the age groups that are interested in this subject. And for the recommended system the game won't appeal to hardcore gamers which means it will not require high system settings, so my laptop (Lenovo Y520) can be the baseline for the recommended hardware.

- **Gameplay**

The game is set in a village so all the key locations must look and feel different from each other. And animals' sounds should be distinguishable from each other and easy to locate as this is where spatial sound has the most important part. Furthermore, the player can hear different things in different parts of the map so even the town visually feels the same, because of the sound it will have a different atmosphere and cause less boredom for the player and enhance immersivity.

- **Accessibility**

As the game is playable for every age group people with special needs should not be ignored especially people with learning disabilities. People with autism spectrum disorder tend to get lost in large environments and feel overwhelmed by the number of options. They are more prone to audio queues rather than visual although the amount of noise shouldn't overwhelm them. Visually the game will not overwhelm autistic players so there is no need to implement anything for it. And finally, for dyslexic users, a narrator option can be included. As this is an educational game at least one accessibility setting must be included in the game.

- Requirements
 - **Mandatory**
 1. The game shall be developed on the Unity engine
 2. The game shall support VR controls
 3. The game shall support a mouse and keyboard
 4. The game shall work on the browser
 5. The game shall have an average of 30 frames per second while playing on the recommended hardware
 6. The game shall not crash
 7. The game shall have first person view
 8. The player shall walk around
 9. The player shall not encounter any obstacles, enemies or puzzle
 10. The game shall have 10 unique animals with 3D models and spatial sounds
 11. The game shall have 5 unique buildings with 3D explorable interior
 12. the buildings shall have information about their purpose
 13. The town shall have multiple paths to reach every key location
 14. the game shall have folk background music
 15. the game shall have sound effects for the objects
 16. the game shall have realistic history
 17. the game shall have a map
 - **Desirable**
 1. The game should have a Windows version
 2. The game should have a Mac version
 3. The game should have max 60 frames per second while on the recommended hardware
 4. The player should be able to interact with the objects
 5. The game should have 15 unique animals with 3D models and spatial sounds
 6. The game should have 10 unique buildings with 3D explorable interior

7. The town should have people with stories about their daily lives
8. The game should have a remappable control scheme
9. The game should put a tick on the map for the locations already explored
10. The browser site should look unique
11. The game should implement a linear path option in accessibility settings
12. The game should have a narrator option in the accessibility settings
13. The game should have audio queues that call the player to the key locations in accessibility settings
14. The game should have a "press buttons to activate the sound effect" option in the accessibility settings
15. The game should have a colourblind option in the accessibility settings

Project Plan

- Gantt Chart

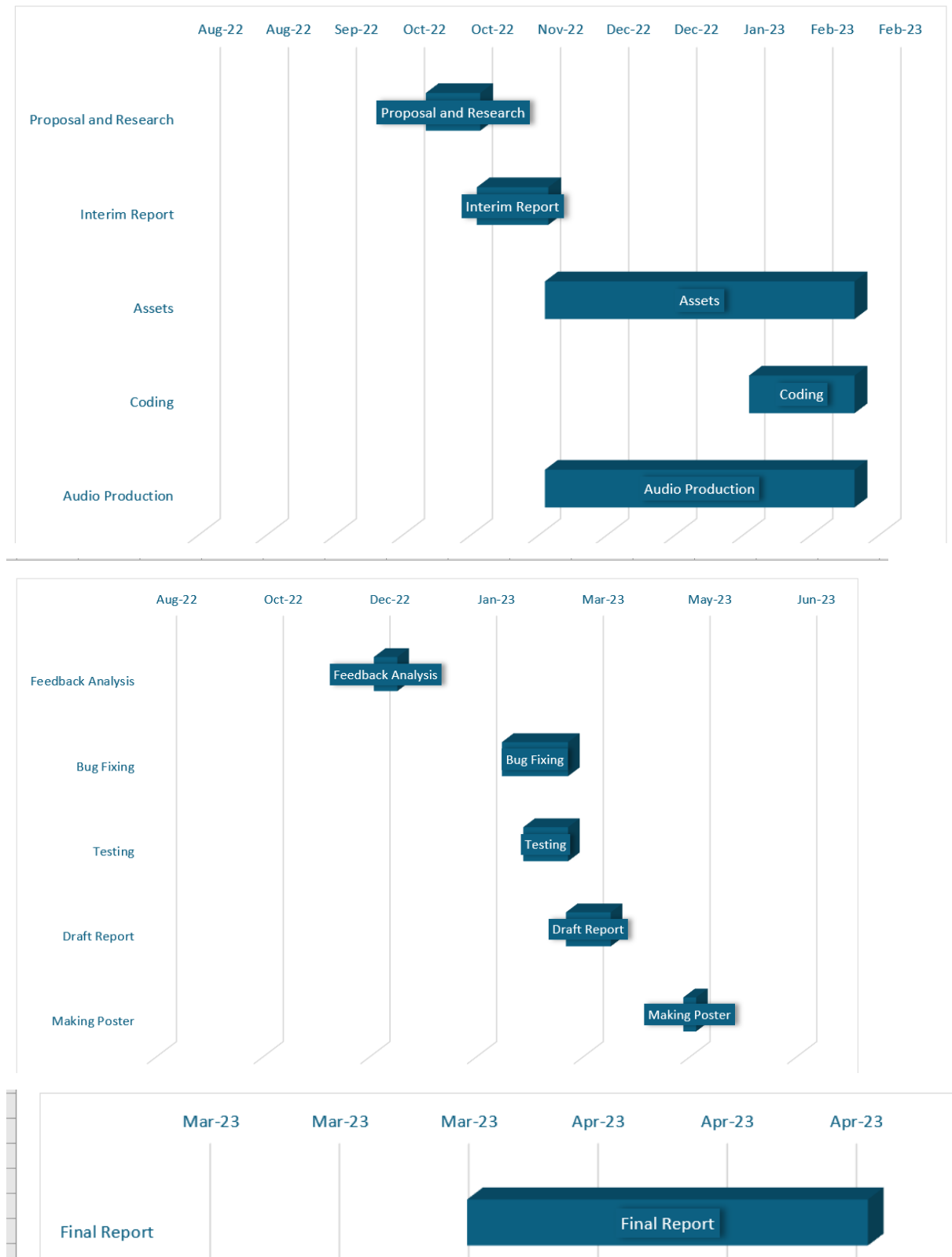


Figure 7: Gantt Chart

Current state

- The project Proposal and related research have been completed and included in the appendices.
- The project is built on Unity and works on the browser

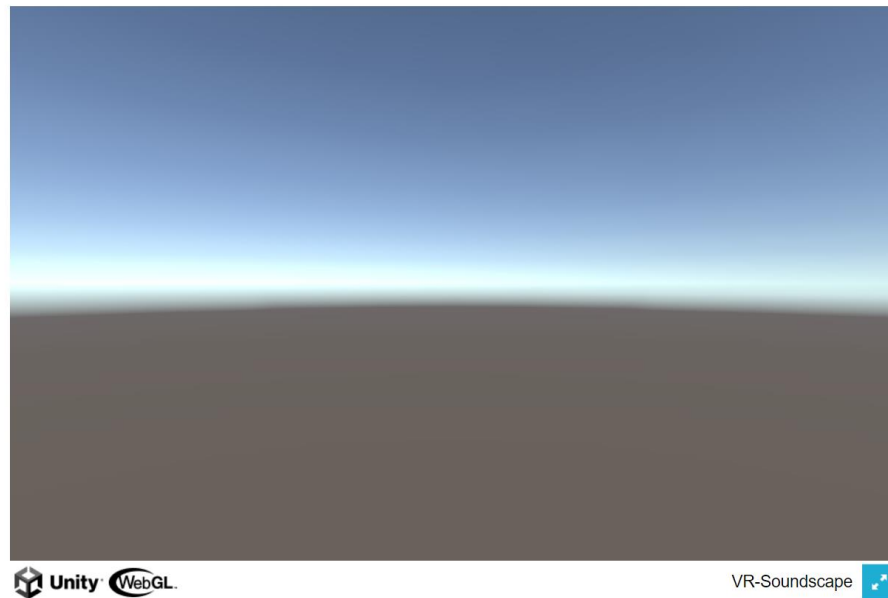


Figure 8: WebVR

- The project is uploaded to GitHub to prevent data loss and to have version control.

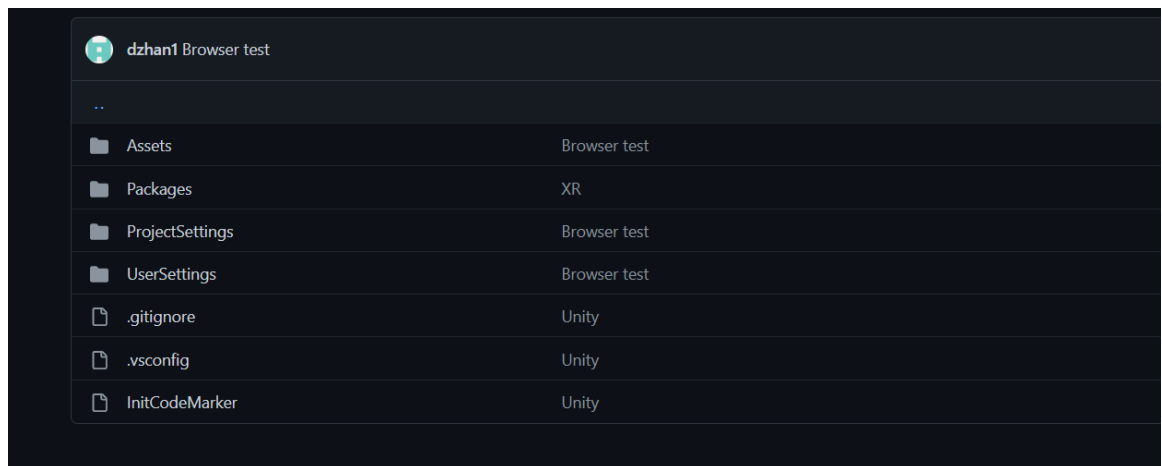


Figure 9: GitHub Repository

- The project plan is created on GitHub and waiting to be filled

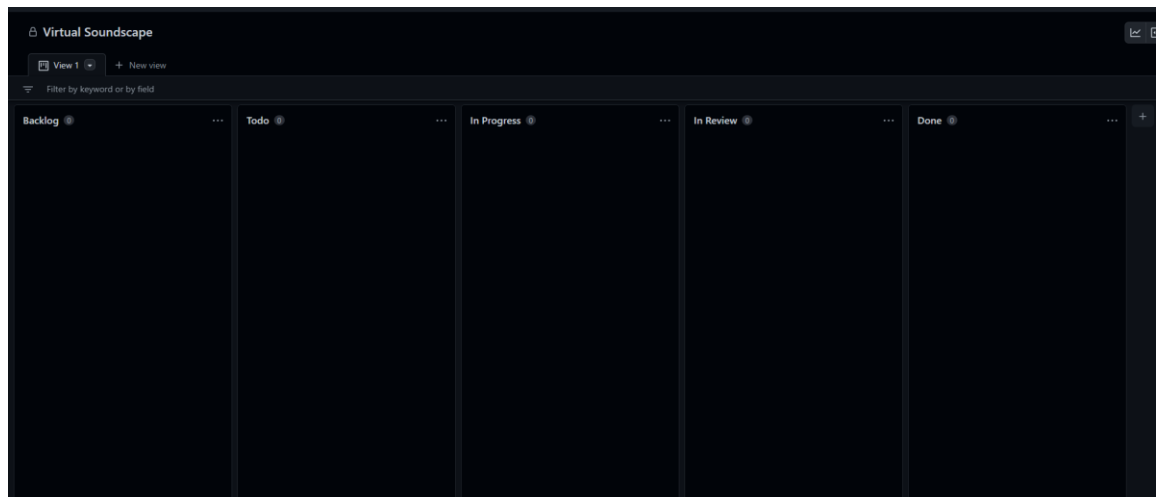


Figure 10: GitHub Project

Referenced Games

Title, Developer, Publisher, Year

Metal Gear Solid, Konami, Konami, 1998

Stardew Valley, ConcernedApe, ConcernedApe, 2016

Persona 5, Atlus, Atlus, 2016

The Beginner's Guide, Everything Unlimited, Everything Unlimited, 2015

Super Mario Bros., Nintendo, Nintendo, 1985

Kid A Mnesia, Arbitrarily Good Productions, Epic Games, 2021

Reference list

Bardi, J. (2020). *What is Virtual Reality?* [online] Marxent. Available at: <https://www.marxentlabs.com/what-is-virtual-reality/>.

Carrozzino, M. and Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums. *Journal of Cultural Heritage*, 11(4), pp.452–458. doi:10.1016/j.culher.2010.04.001.

Cipresso, P., Alice, I., Raya, M.A. and Riva, G. (2018). The past, present, and future of virtual and augmented reality research: A network and cluster analysis of the literature. *Frontiers in Psychology*, [online] 9. doi:10.3389/fpsyg.2018.02086.

Costello, R. and Donovan, J. (2019). How game designers can account for those with autism spectrum disorder (ASD) when designing game experiences. *International Journal of End-User Computing and Development*, 8, pp.29–55. doi:10.4018/IJEUCD.20190701.oa1.

Dedezade, E. (2021). *13 iconic video game sounds that'll take you back in time*. [online] Stuff. Available at: <https://www.stuff.tv/features/13-iconic-video-game-sounds-thatll-take-you-back-in-time/> [Accessed 17 Nov. 2022].

Lepouras, G. and Vassilakis, C. (2004). Virtual museums for all: employing game technology for edutainment. *Virtual Reality*, 8(2), pp.96–106. doi:10.1007/s10055-004-0141-1.

Rajguru, C., Brianza, G. and Memoli, G. (2022). Sound localization in web-based 3D environments. *Scientific Reports*, [online] 12(1), p.12107. doi:10.1038/s41598-022-15931-y.

Rajguru, C., Obrist, M. and Memoli, G. (2020). Spatial soundscapes and virtual worlds: Challenges and opportunities. *Frontiers in Psychology*, [online] 11. doi:10.3389/fpsyg.2020.569056.

Software, A. (n.d.). *What Makes Unity So Popular in Game Development?* [online] Arnia Software. Available at: <https://www.arnia.com/what-makes-unity-so-popular-in-game-development/#:~:text=Great%20Graphics> [Accessed 17 Nov. 2022].

Visartech. (n.d.). *Sound Design: Basics, Examples, Costs - Visartech Blog*. [online] Available at: <https://www.visartech.com/blog/sound-effects-in-games-development/#:~:text=Sound%20design%20plays%20an%20important> [Accessed 17 Nov. 2022].

Appendices

221849

Dr Gianluca Memoli

Virtual Soundscape

Aims

The project aims to create a virtual reality environment that uses spatial sound to enhance immersivity and to make it easily accessible from other platforms.

Primary Objectives

- Research on the effects of using spatial sound in a VR environment
- Examine what makes a VR environment graphically immersive
- Decide which 3D modelling tool will be used to create objects and the environment
- Decide which Digital Audio Workstation (DAW) will be used for sound design
- Decide which game engine will be used
- Inspect how a virtual reality environment that inherits sounds can be developed in a game engine
- Explore how to export the project to the browser and make it playable

Extension Objectives

- Making the objects interactable
- Writing a story to make the player feel emotionally connected
- Creating a website to run the game and improve the presentation
- Make a desktop version

Relevance

Because of growing interest in VR-related technologies, (Metaverse, HTC Vive, Playstation VR) need for developers that are knowledgeable about Virtual Reality has

immersed. Though the technology is still in its early stages, soon it might have a similar boom as smartphones when it becomes affordable, lighter, have more developers and more content. As the demand rises, an average developer for social media, games or smartphones might have to consider the VR platform for their products. thus at least a basic knowledge about this new technology is a must to learn.

The course I am taking is hard to put in a few words as all modules are different and diverse from one another and values creativity so this project is the perfect opportunity to demonstrate the skills I have learned such as 3D modelling and programming throughout my studies, meanwhile still learning new hardware technology and new ways express my creative ideas by focusing on the sound, furthermore still keeping it on a technical level and still staying relevant to the current and far ahead technology.

Resources Required

- Professional Headphones – to test spatial sound
- VR headset
- Game Engine
- 3D modelling tool
- Digital Audio Workstation

Bibliography

- Carrozzino, M. and Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums. *Journal of Cultural Heritage*, 11(4), pp.452–458. doi:10.1016/j.culher.2010.04.001.
- Lepouras, G. and Vassilakis, C. (2004). Virtual museums for all: employing game technology for edutainment. *Virtual Reality*, 8(2), pp.96–106. doi:10.1007/s10055-004-0141-1.
- Rajguru, C., Brianza, G. and Memoli, G. (2022). Sound localization in web-based 3D environments. *Scientific Reports*, [online] 12(1), p.12107. doi:10.1038/s41598-022-15931-y.

Timetable

	Mon	Tue	Wed	Thur	Fri	Sat	Sun
09:00	Human Computer Interaction	Work	Work	Individual Study	Work		
10:00							Individual Study
11:00	Individual Study						
12:00							
13:00							
14:00			Visual Effects				
15:00	Programming For 3D			Programming for 3D			
16:00							
17:00							
18:00							
19:00				Human Computer Interaction			
	Lectures						
	Labs						
	Work						
	Individual Study						

Interim Log

13/10/2022

Talked about the scope of the project and established the priorities

17/11/2022

Talked about the outline of the interim report