

Software Requirement Specification Document for Hand Tracking VR Computer Role-Playing Game (CRPG)

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Table 1: Document version history

Version	Date	Reason for Change
1.0	26-Nov-2022	Half of the sections done
1.1	12-Dec-2022	System description & design constraints done
1.3	15-Dec-2022	Added remaining sections

GitHub: <https://github.com/bilal-tamer/CRPG-VR-Game>

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Abstract

Our project aims to create a CRPG Virtual Reality Game which will take advantage of the hand-tracking technology provided by the Oculus Quest 2 headset. In the beginning, the player will have to choose between two different classes, each with its own stats and weapon. After choosing the class, the player starts in one of the two dimensions. The first dimension is a college campus that was abandoned by an unknown disaster and the second being the campus before the disaster. The plot will advance based on exploration and puzzle solving, which in turn will gradually expose the mystery of the events to the player. The class the player chooses at the beginning of the game and the battles he engages in along the way will both affect how the gameplay goes forward, since winning the battles will earn him experience points that he may use to upgrade his attributes or gear.

1 Introduction

1.1 Purpose of this document

The Software Requirements Specification (SRS) document's purpose is to help make a clear outline for both developers and stakeholders whether they are internal or external. This will act as a guideline for the expectations, requirements and limitations of the CRPG virtual reality game. Its contents will present the application's features, class diagram, interface, and how users will interact with it in addition to clarifying the functional and non-functional requirements for the developers [1].

1.2 Scope of this document

This document first covers the introduction which gives a general outline of the project and who are its stakeholders, it states related works that were made previously on VR games and similar business applications that have been built, it describes what the game mechanics are, the details of its main functionalities, as well as the different types of constraints and limitations. The SRS also contains the non-functional requirements that the game must have, and the game's scenario, it provides the initial class diagram, some of the user scenarios, in addition to an overview of the project plan like the project phases and the responsibilities of each member, then at the end it includes the appendices for unfamiliar definitions and supportive documents.

1.3 Business Context

This game is a good place to start for those who want to use hand tracking technology in general [2] for example in educational programs in schools and universities, as was done in paper [3], or even in simulating some professions and crafts that require manual practice, like dentistry or auto mechanics, due to its use of this technology and the dearth of games and programs that can exploit its complex and fast mechanics.

2 Similar Systems

2.1 Academic

Academic learning is obviously beneficial, but after time its efficacy decreases and it becomes monotonous and repetitious. In their research work [4], Samira Yeasmin and Layla Abdulrahman Albabtain examined this issue. Video games, especially virtual reality games that totally immerse the player, are in their opinion one of the most effective methods for learning. As a result of this discussion, they decided to contribute to and create a virtual reality game called "Escape The Countries: A VR Escape Room Game" a puzzle game whose idea is based on the concept of the escape room, so the game offers a number of rooms, each bearing the theme and personality of a particular country, with only three types of puzzles in all rooms: puzzles based on math, puzzles based on patterns, and puzzles requiring players to arrange various objects (Some Puzzles Pseudo codes showed in figure 1a and 1b). In their research, they cited several sources of inspiration, including Resident Evil 7 VR and Fatal Frame VR, and explained the difference between their project and the projects mentioned that all the puzzles in their game will be directly related to the story as each room will have its own story and the player must infer the solutions to the puzzles from the story furthermore of removing the traditional movement system Because the traditional movement in VR games can sometimes lead to VR Sickness.

A. Math Puzzle

1) Pseudocode of "Player enters input"

Algorithm 1 Player enters input

1:	Input via keyboard
2:	Output puzzle solved
3:	Start timer
4:	chance \leftarrow 3
5:	if input = expected result
6:	return puzzle solved
7:	stop timer
8:	else
9:	try again \leq chance
10:	if try > chance
11:	return game finish
12:	else
13:	keep trying
14:	return puzzle solved
15:	stop timer

(a) Math Based Puzzles Pseudo code

B. Arrangement Puzzle

1) Pseudocode of "Get the correct position of an item"

Algorithm 3 Get the correct position of an item

1:	Input move items in all possible directions
2:	Output puzzle solved
3:	Start timer
4:	chance \leftarrow 3
5:	if input = expected result
6:	return puzzle solved
7:	stop timer
8:	else
9:	try again \leq chance
10:	if try > chance
11:	return game finish
12:	else
13:	keep trying
14:	return puzzle solved
15:	stop timer

(b) Arrangement Based Puzzles Pseudo code

Figure 1: Puzzles Pseudo codes

In the paper [5] their main focus was to investigate what the people wanted to see in a VR game in order for the VR gaming experience to feel and be more palatable for the general public and how a good VR game utilizes the intractability of the game, they also came to the conclusion that using the unity game engine that is based on the C# language would be satisfactory as tool to develop a first person shooter game and that would help in building up the immersive game-play by utilizing the VR technologies to elevate the game-play so that the game adds a layer of intractability with the surrounding environment to induce this immersive game-play feeling, by including in their game the ability to switch weapons and having different shooting animations, the enemies are smart enough so that they can find a way to reach the player and start attacking him and even having the ability to pick up tools that can be found all around the game and also adding different sound

effects for different weapons. As for making the game feel more realistic they made a night and day cycle, utilizing so that both the game and the game-play feel more dynamic.

They came to also conclude that there are 3 main aspect for making games more enjoyable according to the analysis of what the players want, which are which are immersion, intractability and utilizing the human imagination and these three aspects can be met by first making the environment more dynamic and intractable, and that making NPC's that you can interact with by having different characteristics which leads to the players being interested in discovering the environment of the game. Figure 2 describes how the general game system should be.

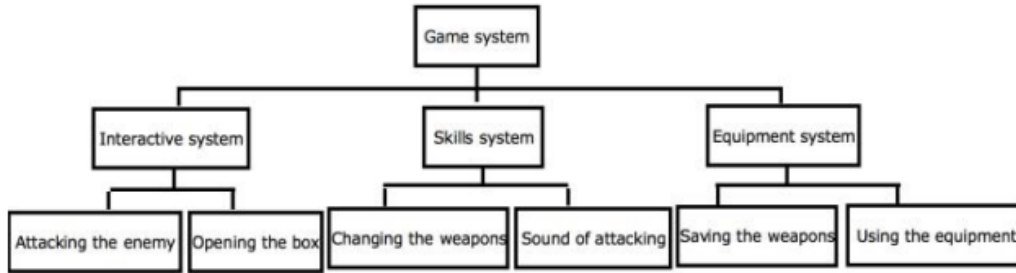


Figure 2: VR game function module.

A critique of this paper would be that in the game-play section it doesn't mention anything about how to make the players come and play their game again by making game-loops and that's a big downside, since all modern games include that essential element to their games in one way or the other.

In virtual reality one of the main and most important aspects is being able to convey the feeling of being in a different world or environment, as discussed in [6], however many people experience Virtual Reality Sickness (VRS) especially in games or fast-paced environments. The authors aimed to discover which techniques could be used to combat the sickness by performing an experiment comparing teleport, 2DVR and 3DVR. The game used was a traditional First-Person Shooter (FPS) taking place in a maze where the player needs to navigate the maze, defeat enemies while making sure not to get hit by them. The sickness was measured using multiple questionnaires which had nausea, oculomotor and disorientation as metrics, the results showed that 2DVR proved do better than 3DVR and teleport when it came to nausea and oculomotor but it did cause more disorientation. Nonetheless teleport and 2DVR techniques seemed to have similar trade-offs when it came to minimising VRS but overall the authors recommended 2DVR as the best solution for VRS as it was low-cost and can be used for making FPS games.

2.2 Business Applications

1. Elixir

Elixir is seeking an experienced lead sorceress's apprentice. You'll join our team located somewhere in the nether world to feed, wash, and document mysterious creatures (applicants inexperienced with dragon vomit need not apply). The apprentice will also maintain various

delicate contraptions while experimenting in an unstable alchemy lab. Constant praise of the sorceress's brilliance is expected. Shown in figure 3.



Figure 3: Elixir Game

2. Waltz of the Wizard: Natural Magic

An experience unlike any other that gives you powers to change the world with a word and wave of your hand, as if by magic. Create and enjoy fun activities, discover secrets and speak to curious creatures. Interact as if you're there using cutting-edge VR technologies that amplify sense of reality. 4.



Figure 4: Waltz of the Wizard: Natural Magic Game

3 System Description

3.1 Problem Statement

Virtual reality is the future and the next step in technological advancement [7], it can be used for educational purposes, tourism or for entertainment. Role-playing games (RPGs) are one of the most loved game genres with countless titles out there but developers have only recently started

making them for virtual reality headsets. However, currently a lot of VR games were originally made for a PC (personal computer) or console then got adapted for VR, which could affect the immersion of the experience, while only some games are being made specifically for a VR headset.

3.2 System Overview

The player wears the Quest 2 to start playing and as soon as he wears it and starts the game he begins to manipulate the UI using his hands to choose the class he wants to play with. After choosing the class, the player starts in the game's introduction, which is a short tutorial whose main goal is to present the world and the story and teach the player how to deal with basic mechanics using hand-tracking such as movement and how to travel between dimensions and how to explore and collect items, then the player enters a combat scenario to learn the basics of fighting with the enemies who will deal With the player based on his decisions and actions using RL to make these scenarios more fun and lively. After successfully completing this scenario, the player will gain some experience points to upgrade his stats. After completing the introduction, the player begins the events of the game and starts to explore, finish quests and solving riddles through to the game's conclusion, as shown in figure 5.

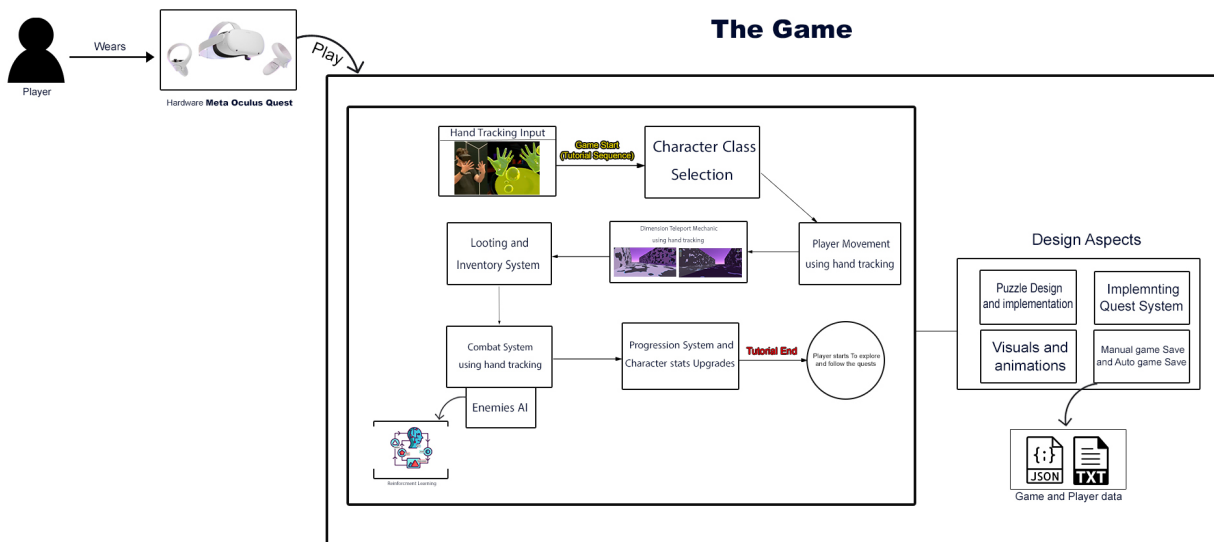


Figure 5: System Overview

3.3 System Scope

The game will cover the use of VR Technology and Hand Tracking which has not been used a lot in video games specifically in a single player narrative driven role-playing game that will allow the player a lot of different and varied options, whether in exploration or in combat. And it will cover

the use of Reinforcement Learning algorithms [8]. The game will be deployed on Meta Quest store [9] with English as the primary language.

3.4 System Context

The main vision of the game is to create an experience that can immerse the player in its imaginary world through its story and visual level, in addition to providing a smooth, easy and comfortable user experience for the player, especially as we are talking about game mechanics that will be fully controlled through hand-tracking, such as exploration, puzzle solving, fighting enemies and dealing with The UI, and for this, one of our most important goals was to ensure the speed of the hand tracking response, as well as choosing comfortable and uncomplicated gestures for the player, especially those that will be used often throughout the playing period, such as the movement gesture.

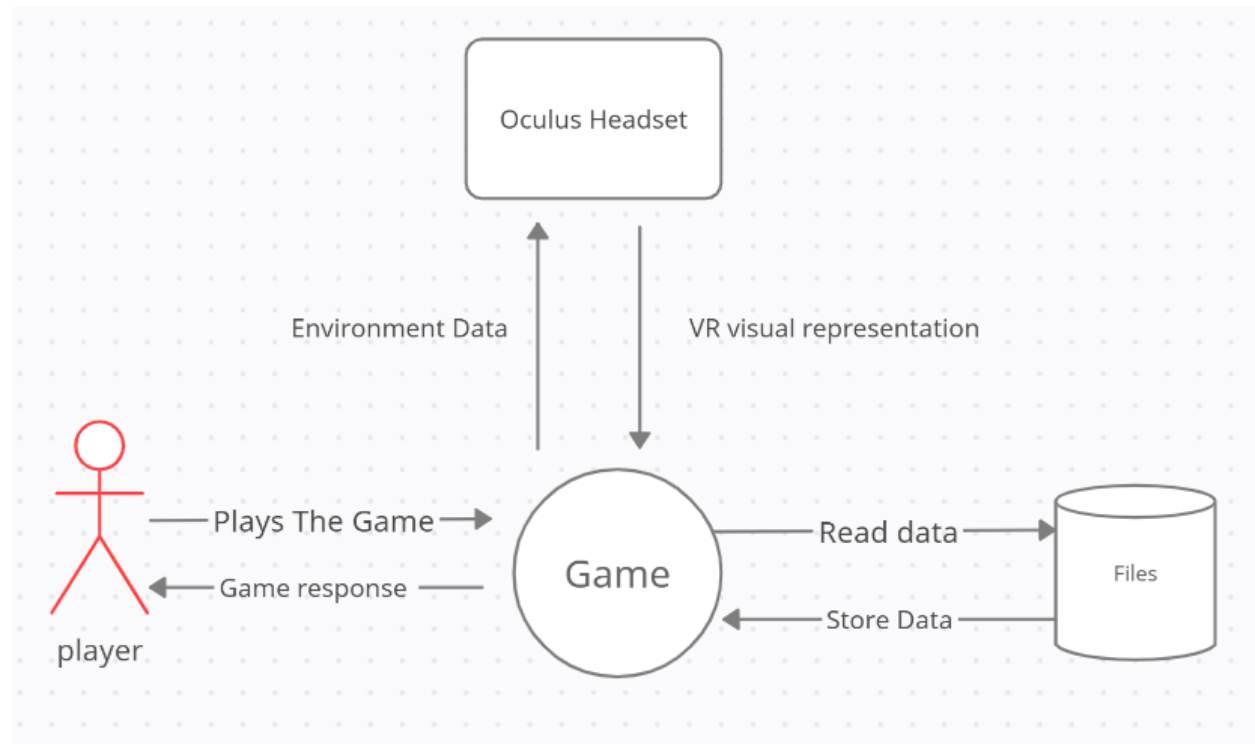


Figure 6: System context

3.5 Objectives

- The Player must be able to :
 - interact with the game UI using hand tracking technology
 - pick a character class
 - explore the environment
 - travel between dimensions

- use the hand tracking to preform actions in combat
- use the hand tracking to interact with items and solve puzzles to collect clues to reach the final area
- The Enemies Shall :
 - utilise reinforcement learning to beat the player
- The Health stat of the player shall determine how many Hit Points (HP) does the player have
- The Strength stat of the player shall control the players ability to carry heavy weapons and determine how strong the player's attacks is against an enemy using heavy weapons
- The Tech stat of the player shall control the players ability to carry fire weapons and determine how strong the player's attacks is against an enemy using fire weapons
- The charisma stat of the player shall determine how the non-player characters react to the player

3.6 User Characteristics

The users of this application will be the developers and testers of the game, as well as anyone with an interest in RPG games with access to a VR headset. They require basic knowledge of RPG games and VR applications to be able to experience the game to its fullest, the expected users age-group will be teenagers and higher.

4 Functional Requirements

4.1 System Functions

1. The player shall be able to explore and interact with different elements in the environment. (EVR01)
2. The player shall be able to move freely with some movement constraints being applied upon him. (T01)
3. The player shall be able to combat enemies (PRR02)
4. The player shall get rewards from killing enemies. (ER01)
5. The player can get killed and if his HP (Health Points) reaches zero he shall die. (PRR03)
6. Enemies can kill the player if the player's HP reaches zero the player shall die. (ER02)
7. If the player gets killed by an enemy he shall be re-spawned to the nearest safe area. (PRR04)
8. The player can upgrade his stats making him stronger and able to progress more easily in the game. (PR05)
9. The player shall be able to solve puzzles by finding clues around the world. (PRR06)
10. The player shall be able to finish quests and get rewards for doing so. (PRR07)
11. The player shall be able to interact with NPCs. (PRR08)
12. The player shall be able to access his inventory. (PRR09)
13. The player shall be able to switch his weapon. (PRR10)
14. The player shall be able to select one of two main classes. (PRR11)
15. Enemies shall use reinforcement learning to try and kill the player. (MLR01)

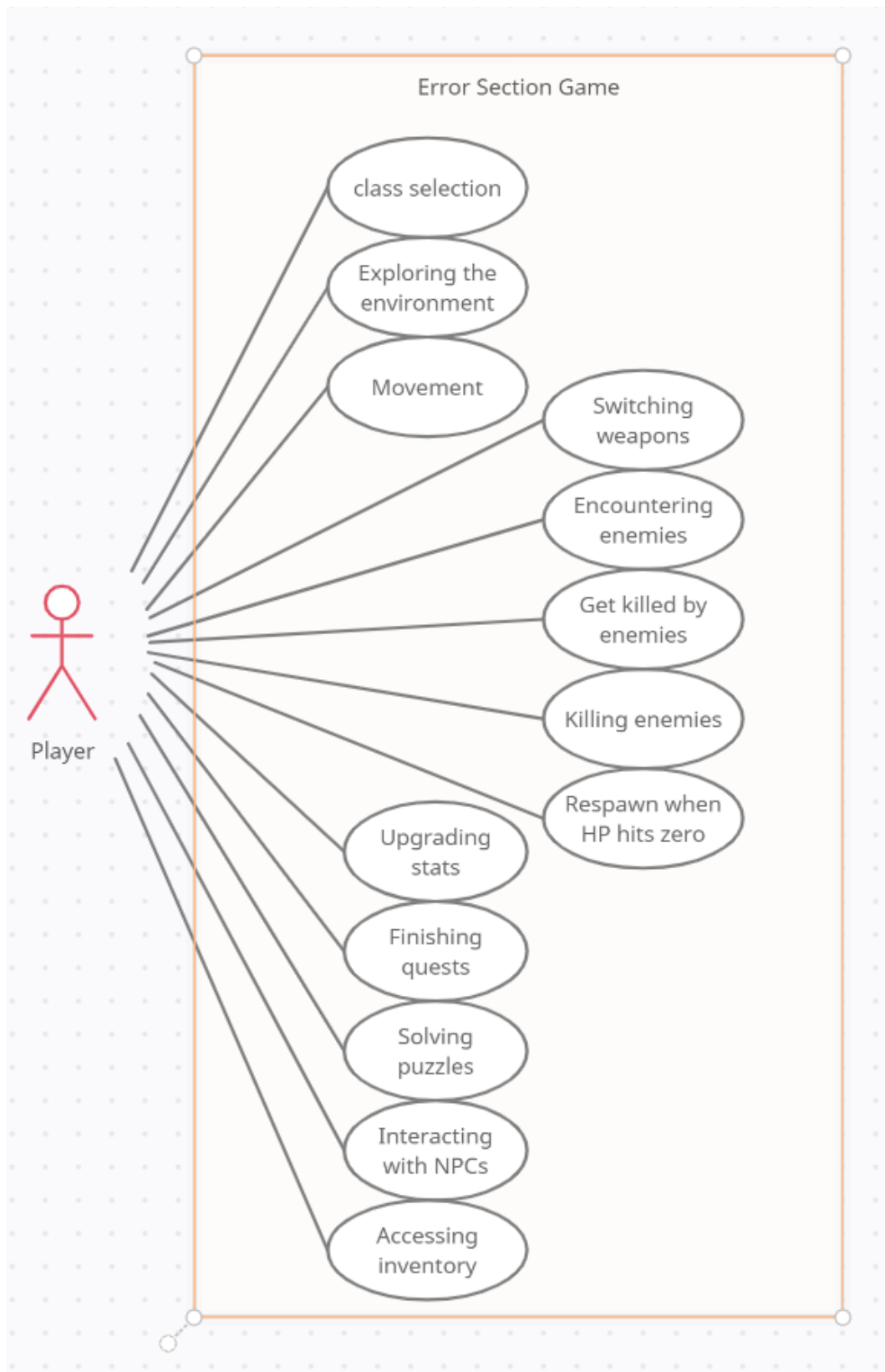


Figure 7: Use case diagram

4.2 Detailed Functional Specification

Table 2: Gesture Detection Function Description

Name	GestureDetector
Code	G01
Priority	High
Critical	Overall, for the system, it is important because it is the main game-play functionality
Description	Measure the difference between bones of current hand skeleton and the recorded gestures
Input	OVR hand model.
Output	Specific hand gesture.
Post-condition	It triggers a script depending on the current known gesture.
Dependency	List of configured gestures
Risk	Conflict may happen when getting recorded gesture if the current hand gesture isn't accurate enough.

Table 3: Teleportation Function Description

Name	Teleport
Code	T02
Priority	HIGH
Critical	
Description	It's the main function for teleporting the player through the game environment.
Input	Void
Output	
Pre-condition	FF01
Post-condition	The user is logged into his account or the account is created if it doesn't exist.
Dependency	Depends on Boolean variable if the user is in the motion state or not. It also depends on the first hit location of the raycast
Risk	Raycast may not detect position on ground if the surface model in a specific scene isn't considered a layered ground.

Table 4: SetSkeleton Function Description

Name	SetSkeleton
Code	G02
Priority	HIGH
Critical	
Description	It's the main function for Populating the private list of finger-bones from the current hand we put in the skeleton
Input	Void
Output	Populated List of Hand Skeleton Bones
Pre-condition	Unitys Start() Function
Post-condition	
Dependency	Depends on the OVRSkeleton

Table 5: PlaceAtSocket Function Description

Name	PlaceAtSocket
Code	S01
Priority	Medium
Critical	
Description	place the Target Object in the Socket (attach)
Input	Void
Output	Destroyed HoverObject and Place the current object in the socket
Pre-condition	wasInSocket = false , count=0
Post-condition	wasInSocket = true , count=1
Dependency	DestroyHoverObject()

Table 6: CheckForDestenation Function Description

Name	CheckForDestenation
Code	T03
Priority	High
Critical	
Description	Its the function responsible for casting the ray that points to where the player should teleport
Input	Void
Output	A Ray pointing to a location & Teleport Indicator
Pre-condition	Casting Ray Bool = false
Post-condition	asting Ray Bool = true
Dependency	Unitys Ray Class

5 Design Constraints

5.1 Standards Compliance

The most important criteria that we will adhere to are the quest store criteria [10], which clarified the most important conditions that must be met in the application for its acceptance. The application must be of high quality and polished, and it exploits the distinctive technologies provided by the oculus quest as much as possible, in order to create unique and enjoyable experience to the fullest, after sending a request to publish the application with them, which will be a PowerPoint presentation consisting of 3 slides discussing the concept of the application, the team's experience, the investments related to the application, after their review of the application, and whether the application matches their standards, as they stated in their blog they will decide whether to publish or not.

5.2 Hardware Limitations

Oculus Quest 2 is limited by mobile hardware when it comes to standalone games. It runs on an android operating system and uses Qualcomm® Snapdragon XR2 CPU with 6GB of memory which makes its power bounded compared to PCs and gaming consoles.

6 Non-functional Requirements

6.1 Performance

Switching between dimensions shall be smooth and easy without long loading times, while interactions with objects shall be responsive.

6.2 Reliability

The game shall be stable and smoothly functional, where it shall not crash while running and interrupt the player's experience.

6.3 Maintainability

The application shall be built to be easy to maintain and allow ease of addition or removal of features.

6.4 Scalability

The application shall have the ability to extend any future functionality additions without greatly affecting the performance.

6.5 Usability

- The user interface shall be intuitive and responsive.
- The enemy combat and stats system shall be simple to grasp
- Interactions with objects in the environment shall be intuitive

7 Game Story / Narrative

In a post-apocalyptic world, after most humans implanted super intelligence chips in their brains, fearing the development of frightening artificial intelligence, it is now artificial intelligence that takes care of human beings. In 2023, after the world suffered from the scourge of economic disasters and the collapse of entire countries, the idea of a joint government arose, which brings together a council of senior businessmen, scholars and influencers, each of whom has a voice and no voice is louder than theirs. With time, the joint government began to expand little by little until it included nine tenths of the world, so there was no fly left that did not carry the flag of the government and glorify its name while flying over the piles of garbage. In those days, what was known as buying and selling changed its concept completely. The amount of what you touch does not determine what you are able to do, but rather the amount of what is presented, for whom? To the council...to the government...to the archduke! who is that? Oh, sorry, I forgot to tell you that the same council now issues its decision with the signature of a person called the Archduke, who does not have a specific name. Excuse me, I went a little farther, but its worth it... I promise you, with the passage of time the Archduke issued a compulsory order that all those over twenty-five should implant electronic chips, and those under that age would only be satisfied with implanting miniature copies of those chips, provided that they are replaced at the age of thirty with suitable ones. To them, you will not fly to carry money anymore, and you will not need a mobile phone, you can be whoever you want wherever you want, but there is a small price for that, those chips, my dear, determine your location and carry with them the strict rules of the government that if you do not follow them, you will not wait for the police to arrest you, Oh, a moment I forgot to tell you that they are no longer needed in the first place. When you break one of those laws, electricity will run through your veins to paralyze you until government drones choke, it's that simple. My grandfather was laughing, remembering his grandfather who used to say to him (everything beautiful has an end). His neck and the last of his feet have grown, there are those whose eyes swelled until they became larger than their head itself, but the damage occurred only to those over twenty-five it seems that a malfunction occurred and that someone had played on the main computer with the adult chips, but fortunately the children's chips were in a server completely separate from them, so they were not affected. The few remaining humans have invested in what is more lasting, developing robots with only one goal, keeping the young alive. While the numbers of those over twenty were decreasing, the number of robots was increasing and even lengthening. The first robots realized that young people would be terrified of the forms of iron machines that are not equipped to care for children. Computers have skins, voices and feelings. They have become human in every sense of the word, but they are still under one rule. Namely, "preserving the human race." The robots quickly built bases in which they collected children according to their age, and those bases became a haven for every human child wanted to survive. Unfortunately, the

last generation of humans did not provide these machines with orders to end these monsters, and they focused on the survival of those who remained, and now inside those buildings a new plot is being hatched in secret. Not all children's slides are intact. In the end, what was implanted for children were miniature copies, and the government's interest in them at the time was much less than that of adults, so there was a percentage of them that were damaged, or what was later known as the "Error Section". The robots automatically classified the children and separated those with healthy chips from the defective children, who in turn had no connection to the server responsible for activating the chip services.

The story begins when a child from the Error Section wakes up in an urgent call, it seems that the shadows of the past are starting to return again and that an event has hacked the children's main computer and it is only a matter of time until they turn into monsters like their predecessors, soon a robot enters to evacuate the children from the Error Section To safety whose whereabouts only a few robots know.

8 Preliminary Object-Oriented Domain Analysis

Initial Class Diagram

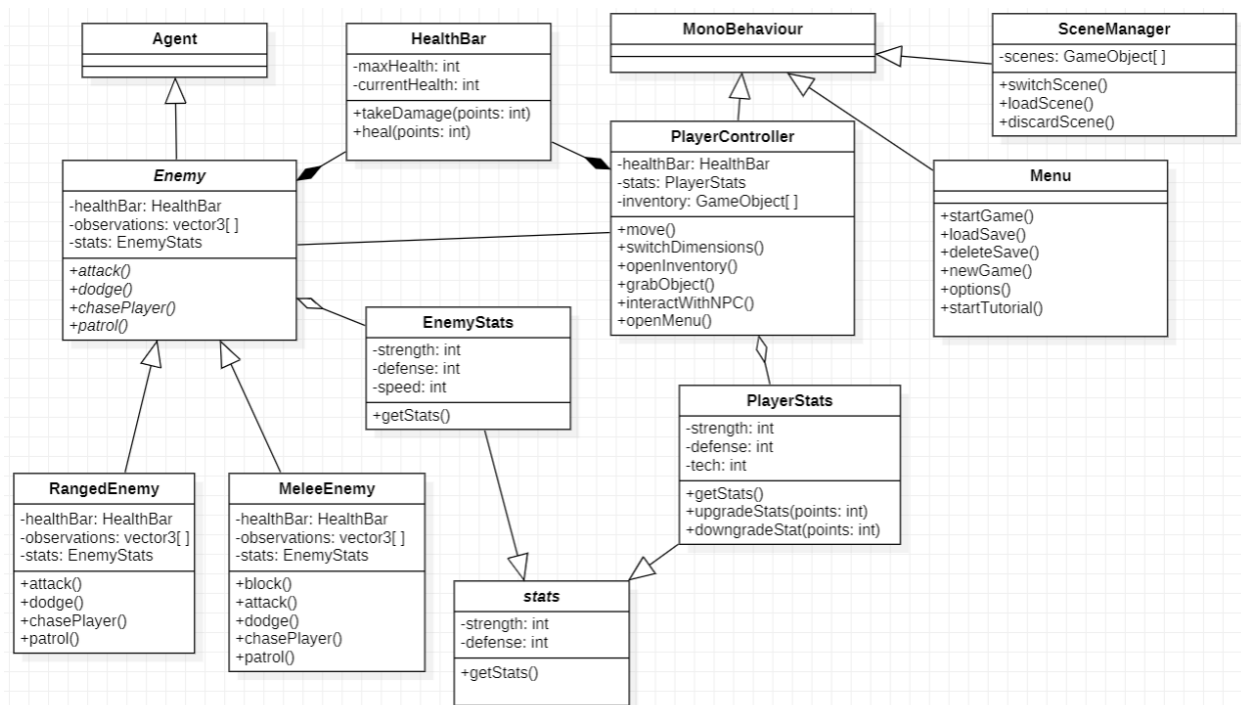


Figure 8: Class diagram

9 Operational Scenarios

Playing Quests

Initial assumption	The player has finished playing the tutorial and to unlock a specific quest all preceding quests must be completed first.
Description	<ol style="list-style-type: none"> 1. The player shall be able to play a quest once its started. 2. The player shall be able to go to the quest location. 3. The player shall solve the puzzle(s) that he encounters during his quest. 4. The player shall be able to use traveling between dimensions in certain areas to solve certain puzzles. 5. The quest shall end once the player has finished his required tasks.
On completion	The player shall receive rewards upon quest completion.
What can go wrong	<ol style="list-style-type: none"> 1. The player doesn't accept the quest, then the player can't progress properly in the game. 2. The player might die if his HP reaches zero, then he shall be sent back to the nearest safe-area. 3. The player might not solve the puzzle correctly, then he can't finish the quest unless the puzzle is solved.
System state on completion	The player shall be able to start the following quest once the current is done.

Combat

Initial assumption	The player enters the range of vision on an enemy.
Description	<ol style="list-style-type: none"> 1. The player shall have complete freedom of his movement. 2. Enemies shall be able to dodge and block some of the player attacks. 3. the player shall be able to dodge enemy attacks. 4. The player shall be able to hit enemies using any of his weapons thus decreasing the enemies HP. 5. The enemies should be able to hit the player thus Decreasing his HP, if the player's HP reaches zero the player will die resetting him back to the nearest safe-area. 6. The player shall be able to kill the enemy.
On completion	The player shall be able to gain rewards .
What can go wrong	<ol style="list-style-type: none"> 1. The player keeps running from the enemies. 2. The player runs too far from the enemies. 3. The player might not have his weapon equipped thus not being able to deal damage to the enemies.
System state on completion	The player shall be able to carry on with his quests.

Inventory system

Initial assumption	knows how to open the inventory.
Description	<ol style="list-style-type: none"> 1. The player shall be able to open/close his inventory. 2. Player shall be able to add/remove items from his inventory. 3. The player shall be able use items found in his inventory as clues for solving some puzzles.
On completion	The player shall be able to access and remove items from his inventory .
What can go wrong	<ol style="list-style-type: none"> 1. The player doesn't interact/grab the inventory elements properly. 2. The player doesn't get the items close enough to the inventory thus the elements don't get grabbed by the inventory. 3. The camera doesn't detect the player's gesture because of bad lighting conditions or because the player's hand is not visible to the camera.
System state on completion	The player shall be able to carry on with his quests.

Player movement

Initial assumption	knows how to enter movement mode.
Description	<ol style="list-style-type: none"> 1. The player shall be able to enter movement mode using a specific hand gesture. 2. There shall be an indicator to the place the player can move/teleport to. 3. Player shall be able to instantly teleport/move to the desired location specified by the indicator. 4. The player shall be able exit teleportation mode using the same gesture as that makes him enter the teleportation mode.
On completion	The player shall be able exit/enter teleportation mode.
What can go wrong	<ol style="list-style-type: none"> 1. The player use the a wrong gesture. 2. The camera doesn't detect the player's gesture because of bad lighting conditions or because the player's hand is not visible to the camera.
System state on completion	The player should be able to move to his desired location based on the movement constraints.

Interacting with environment elements

Initial assumption	The object is intractable.
Description	<ol style="list-style-type: none"> 1. The player shall be able to interact with the environment using his hands. 2. There player shall be able to apply force to the environment intractable objects and the objects should simulate some of the real world physics. 3. The player shall be able to use interacting with objects to solve some of the puzzles that can be found thought the game and kill enemies.
On completion	The player shall be able to interact with intractable objects in the game.
What can go wrong	<ol style="list-style-type: none"> 1. The player doesn't interact with objects properly. 2. The camera doesn't detect the player's interacting gesture because of bad lighting conditions or because the player's hand is not visible to the camera. 3. The player's hand is not close enough to the object that he wants to interact with.
System state on completion	The player should be able interact with the desired intractable objects and use these objects in different ways.

Stats upgrading system

Initial assumption	The player knows how to access their stats .
Description	<ol style="list-style-type: none"> 1. The player shall be able to upgrade his stats based on the stat points he has. 2. There player's interactions with the world shall differ based on his stats. 3. The player will become stronger by upgrading his stats and is able to deal more damage and have more HP.
On completion	The player's stats should be upgraded.
What can go wrong	<ol style="list-style-type: none"> 1. The player doesn't have enough exp to upgrade the desired stat.
System state on completion	The player should have his character strengthened by the stats upgrade thus making game progression much easier.

10 Project Plan

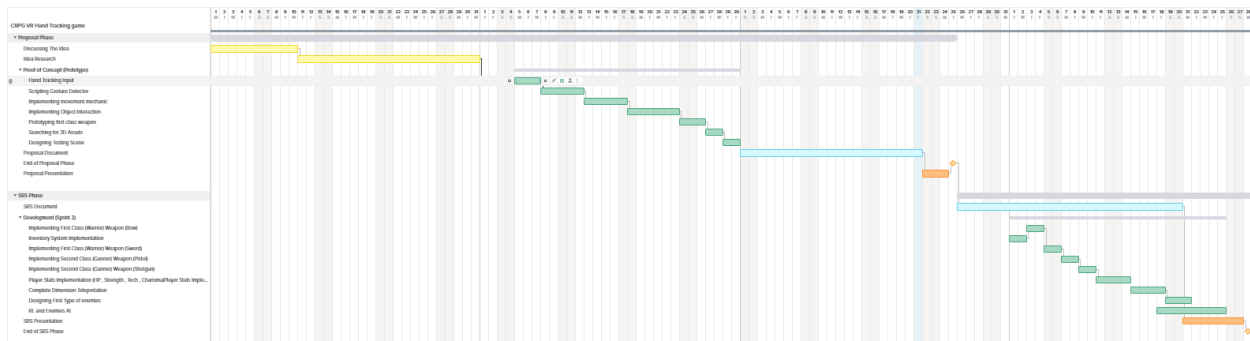


Figure 9: Gantt Chart

10.1 Definitions, Acronyms, Abbreviations

- **RPG** : A role-playing game (sometimes spelled roleplaying game) is a game in which players assume the roles of characters in a fictional setting. Players take responsibility for acting out these roles within a narrative, either through literal acting or through a process of structured decision-making regarding character development.Actions taken within many games succeed or fail according to a formal system of rules and guidelines.
- **Story/Narrative Driven** : Story driven games are characterized for its dynamic change in its game mechanics so they can add to the story plot. Examples of this are games where you find items, unlock special skills and abilities, find special enemies, meet special allies (and maybe they can join you).
- **HP**: Health Points, stands for the amount of health a player or enemy has, meaning the amount of damage they can take before being killed.

10.2 Supportive Documents

10.2.1 Unity Documentation

Main documentation that contains details about the functions and classes that are made by the unity development team.

Link: <https://docs.unity3d.com/Manual/index.html>

10.2.2 Users-Survey

Here are some of the results that came from the survey we made that proves that most of people even non-gamers are interested in playing a VR game with hand tracking technology :

Do you play video games ?

33 responses

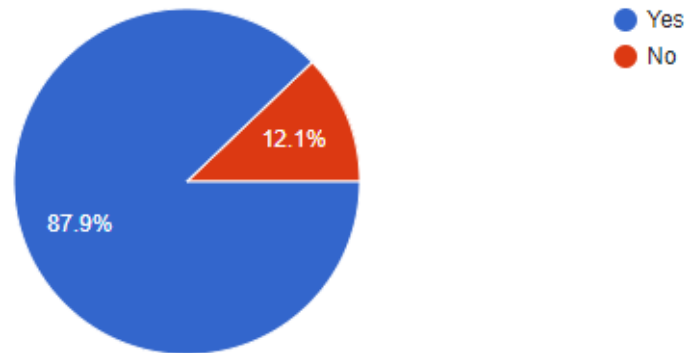


Figure 10: Chart 1

Have you tried VR before ?

33 responses

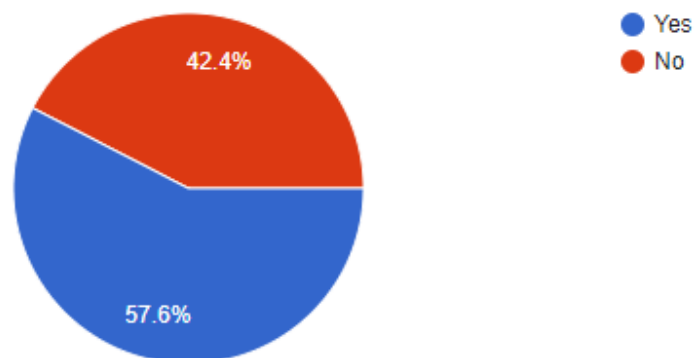


Figure 11: Chart 2

Do you own a VR Headset or know someone who owns one ?

33 responses

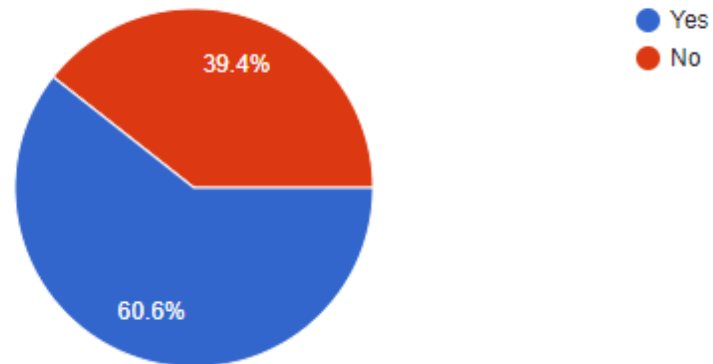


Figure 12: Chart 3

Have you played a VR game that utilizes hand tracking technology before ?

12 responses

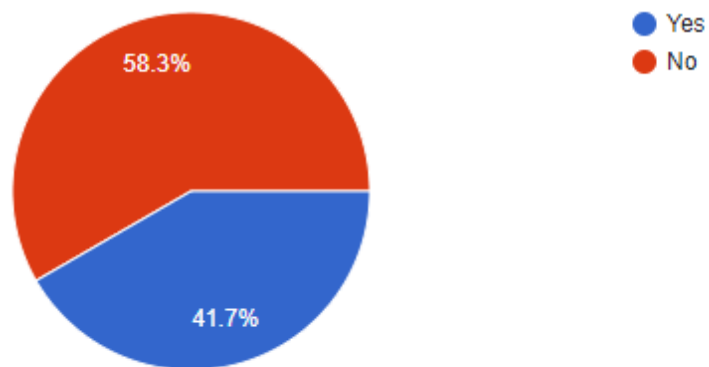


Figure 13: Chart 4

Are you eager to play a game that utilizes this technology (Hand Tracking) ?

12 responses

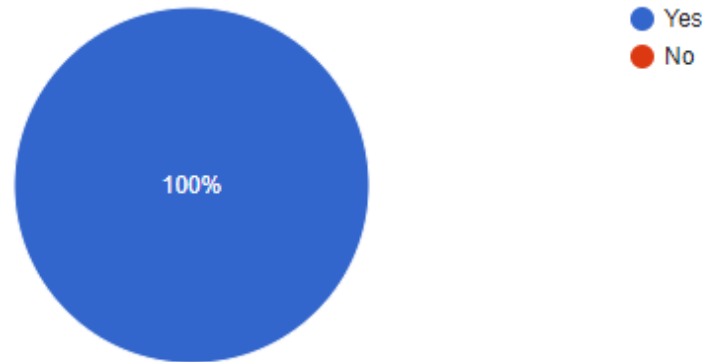


Figure 14: Chart 5

Are you interested in using VR in games ?

33 responses

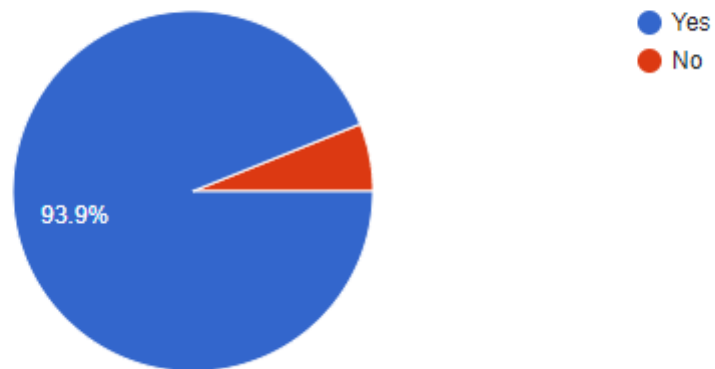


Figure 15: Chart 6

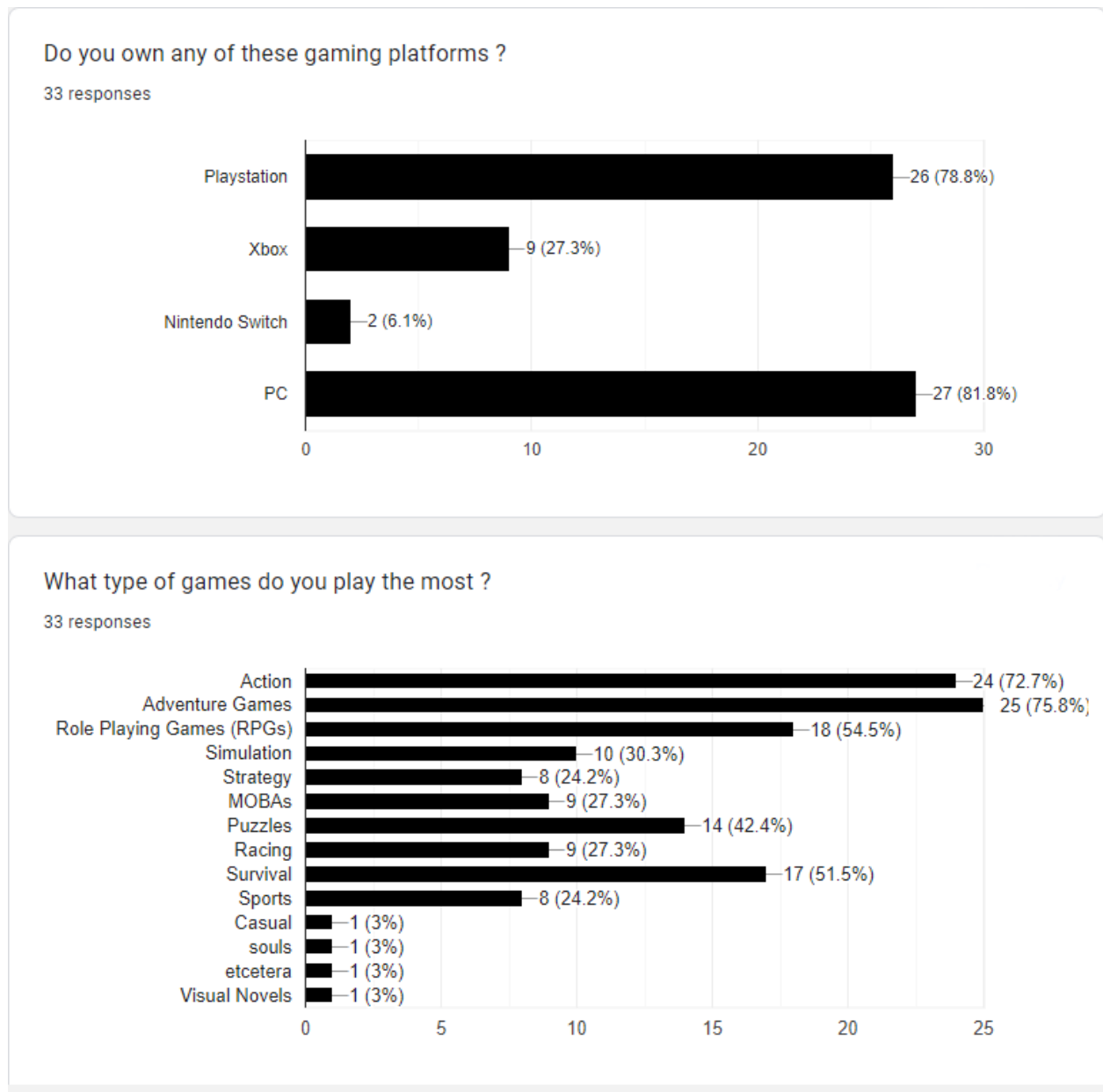


Figure 16: Chart 7 & 8

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