Effectiveness comparison of Third-Person and First-Person camera perspectives in VR for conventional and gamified tasks

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Master’s Thesis

STUDENT REPORT
AALBORG UNIVERSITY

Aalborg University Copenhagen

Semester:

MED 10

Title:

Effectiveness comparison of Third-Person and First-Person camera perspectives in VR for conventional and gamified tasks

Project period:

Spring 2023

Semester theme:

Master's Thesis

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Abstract:
The popularity of emerging virtual reality (VR) technology encourages further research into alternative methods of interaction and the effects that alternative camera perspectives may have on VR experiences. This report covers a comparison of effectiveness between Third-Person camera perspectives in VR and First-Person perspectives. These are compared using conventional and gamified tasks to test both user preference and perceived level of effectiveness in virtual environments.

Contents

Chapter 1

Introduction

Virtual Reality (VR) has seen rapid advancements in recent years, with its applications extending beyond entertainment to fields such as education, training, rehabilitation, and emergency management [1] [2] [3].

The choice of perspective in VR, whether first-person or third-person, may significantly impact the user's experience and performance of an application. Both perspectives have unique advantages and potential applications, and their effects have been studied in various contexts, from embodied interaction to virtual training and exposure to virtual threats [4] [5] [6] [7] [8].

In a first-person perspective, users view virtual environments from the viewpoint of a virtual avatar. This perspective has been shown to induce a stronger sense of embodiment, particularly in terms of self-location and ownership, leading to more accurate interactions [4] [6]. For instance, when users are exposed to a virtual threat, their subjective body ownership and reaction to the threat are generally stronger in a first-person perspective [4]. This perspective has also been used to generate a radical illusion of body transfer, altering the normal association between touch and its visual correlate to create the illusory perception of a fake limb as part of the user's own body [8].

On the other hand, a third-person perspective, where users observe their avatar from an external viewpoint, provides better spatial awareness and has been used effectively in virtual training methods [5] [6]. Interestingly, research has shown that the performance of participants' post-third-person perspective training is similar to their performance post-normal perspective training, indicating the viability of this perspective in training applications [5].

Moreover, studies have shown that the sense of embodiment can be achieved in both first-person and third-person perspectives under congruent visuo-motor-tactile conditions, however that third-person tends to result in an decreased sense of embodiment, suggesting that while there may be potential for flexible perspective alternation in VR applications, it may come with challenges to the user's sense of presence, which could impact other key aspects of the experience [4] [8] [9].

As such, both first-person and third-person perspectives may offer unique advantages in VR applications, and the choice between them should be guided by the specific objectives and requirements of the application. This report sets out to compare usage of these two camera modes within the confines of conventional gaming standards, and provide insight as to the preferences and perceived effectiveness of each, under sets of specific tasks.

Chapter 2

Analysis

This section will introduce the main research topic, perspective in VR games, and will also include research on game design principles and techniques, as well as state-of-the-art VR games utilizing a third-person camera view. Once the research will be satisfactory, it will be easier to compose a solid Final Problem Statement, which will help us conclude the study.

2.1 Perspective in VR games

Based on the findings of multiple studies, there are indications that the choice between first-person and third-person perspectives in VR has significant implications for user experience and performance. [5] [9] [4] [6]

2.1.1 Adaptation using First-Person / Third-Person

For instance, in a study by Patrick Salamin, Daniel Thalmann, and Frederic Vexo in 2010 [5], the researchers focused on quantifying the differences between the effects induced by training participants in third-person and first-person perspectives in a ball-catching task, designed in such a way that the ball would travel towards the participants from a fixed origin at three different final distances on each side (left and right) [5].

The results of the experiment showed that the performance of participants' post-third-person perspective training was similar to their performance post-normal perspective training, while performance post-first-person perspective training varied significantly from both third-person and normal perspectives [5]. This suggests that the perspective used in VR training can have a significant impact on performance outcomes. The researchers also recorded response times and error rates, finding that while some stimulus trajectories showed a minimal difference, there were stimulus trajectories that indicated a significant difference between 3PP-1PP (Third Person Perspective - First Person Perspective) and baseline-1PP perspectives [5]. However, with little effect found between 3PP and baseline, this suggests that participants performed similarly for these two perspectives, demonstrating potentially quicker adaptation of distance evaluation using 3PP over 1PP [5].

2.1.2 Embodiment in VR

In a study by Valeria I. Petkova and H. Henrik Ehrsson in 2008 [9], researchers conducted a series of experiments on the perceptual illusion of body swapping. These experiments made use of a HMD device and external CCTV cameras upon mannequins or another test participant to simulate and mimic the visual stimuli of another body [9]. Through the course of experimentation, it was found that test participants could perceive another human's body to be their own given the appropriate circumstances, this even extending to that of an artificial humanoid body [9]. This, however, focused on the adoption of first-person perspectives, and did not demonstrate the potential of the illusion to extend to that of a third-person perspective of the simulated body [9]. On the contrary, one of the experiments focused on having the user shake hands with another participant, while viewing themselves from a camera mounted upon the secondary participant's head [9]. Seeing themselves while having to shake hands with another person from the opposite point of view seemed to result in conflict in perceived body ownership, and according to their results indicated that the critical determinant in that scenario being visual perspective [9].

However, a more recent study by Henrique Galvan Debarba, Sidney Bovet, Roy Salomon, Olaf Blanke, Bruno Herbelin and Ronan Boulic in 2017 [4] found that embodiment could be achieved in the third-person, albeit with more difficulty than the first-person, as it did consistently score lower where a sense of agency, body-ownership and self-location is concerned, as is consistent with other research on the matter [4] [6] [9]. It is notable that conditions that increase the performance of these aspects seem to be increased audio and tactile-based feedback [4]. As such, it can be relevant to ensure as much tactile and audio-based feedback to player interaction in game environments as possible, to ensure the best possible results in regards to embodiment and presence [4]. Even still, the inherent nature of visual detachment that third-person perspectives bring will lend itself to creating difficulty in obtaining similar results to first-person [4] [9].

The presence of the illusion of altered body ownership and the results of the experiments support the notion that a sense of embodiment can be achieved in first-person and to an extent in third-person, provided the presence of congruent visuo-tactile conditions [4] [6] [9]. This suggests that users can feel a sense of ownership over a virtual body, provided that visual, motor, and/or tactile feedback are aligned [4] [6]. While this consistently applies to first-person, it indicates a greater sense of detachment and disembodiment in third-person, which could influence results on aspects such as embodiment, interaction, perception, presence and cybersickness, especially given the correlative negatively related link between presence and cybersickness, as was further evidenced and supported by a study review by Séamas Weech, Sophie Kenny and Michael Barnett-Cowan in 2019 [10], investigating previous studies on the matter [4] [6] [9]. Here, after discussing and weighing current research and studies at hand, it was found that the general balance of evidence seemed to favour the interpretation of presence and cybersickness having a negative relation to one another, which raises valid considerations on ensuring measures to increase presence being implemented into VR experiences [10].

Together, this data supports which considerations need to be paid attention to when approaching a study of this nature. The methodologies used should factor in aspects such as embodiment, effects on and from interaction, presence and eventual cybersickness.

2.2 Game Design

Game design is part of the game development process and refers to using creativity and design to create an entertaining or educational game, which also incorporates creating stories, characters, rules, objectives, and challenges for players [11]. There are different responsibilities that game designers have [11]:

- Developing the storyline, dialogues, and character's origin story
- Developing gameplay, rules, and the scoring system
- Deciding the level of difficulty
- Building environments and interfaces
- Level and world design
- Programming and scripting
- Digital editing
- Image Rendering
- Testing

A game designer can be thought of as an advocate for the player, his first and foremost role is to look at the world of games through the player's eyes [12]. There are many factors that game designers have to focus on, but the most important one that excites players is solid gameplay [12]. Game designer also has to possess great communication skills to clearly deliver a story or message that engages players and motivates them to progress, and it is crucial for them to be able to express simple ideas, convince people of the ideas, and give them appropriate feedback on their actions [11].

2.2.1 Formal Elements

Tracy Fullerton describes formal elements as those, which form the game structure. When those elements are missing, it is not a game at all [12]. A strong understanding of the following essential elements is the foundation of the game design: players, objectives, procedures, rules, resources, conflict, boundaries, and outcome [12].

Players

First of all, the player should be adequately invited to play the game and it has to make him interested in even starting the game, and once the proper invitation to play is in place, the number of players is another factor to be taken into account [12]. Game design differs depending on how many players the game is made for [12]. There are multiple player system considerations: single-player vs. game, player vs. player, multiple individual players vs. game, unilateral competition, multilateral competition (in battle royal games), cooperative play (CO-OP), and team-based competition (for example CS:GO) [12].

Objectives

Objectives specify what players are trying to accomplish in the game, and they should be challenging but at the same time also achievable [12]. In games, objectives can be found as the main objective, partial objectives, and mini-objectives, which help the player to accomplish the main one [12]. Usually, objectives are incorporated into the story of the game but it is not a requirement [12]. Objectives can be split into several categories [12]:

- **Capture** - this objective is to capture or destroy something from the opponent's side while managing to survive or prevent being captured [12]. For example Warcraft or Command & Conquer.
- **Chase** - the objective is to catch the opponent or evade one when you are chased. Games with such objectives can be single-player vs. games but also player vs. player, or unilateral competition [12]. Such games are for example Need for Speed: Hot Pursuit 2, where the player uses physical dexterity and speed.
- **Race** - the goal of the game is to reach a goal before other players do [12]. For example F1 2022.
- **Alignment** - a requirement in this kind of game is to arrange or order the game pieces in a certain spatial configuration or create another conceptual alignment based on the specific task [12]. For example Solitaire.
- **Rescue or escape** - the goal is to get certain elements or elements to safety, which is usually combined with other partial objectives, for example, accompanied by puzzles, etc [12]. Examples of such games are Mario Bros. and Prince of Persia.
- **Forbidden Act** - this game type is not usually found in digital games, however, it includes forcing other players to make mistakes, to break rules by laughing/talking/letting go, or making the wrong move [12]. An example of such a game is example Twister or Operation.
- **Construction** - the objective is to build, maintain, or manage objects in the game [12]. Such games usually incorporate resource management or trading system as a core gameplay element [12]. Such games are for example Minecraft, SimCity, or The Sims.
- **Exploration** - the point of the game is to explore the environment, which is usually supplemented with different goals to create competitiveness [12]. For example, games like the Zelda series, incorporate puzzle-solving and combat scenarios as well.
- **Solution** - the goal is to solve riddles or puzzles to either win the game or to progress [12]. For example Tetris.
- **Outwit** - an objective is to gain and use the knowledge to defeat an opponent [12].

Procedures

Procedures are methods of play and the actions that players can take to accomplish game objectives [12]. These in board games are stated in the game rules, but in digital games, they are integrated into the control section of the manual because they are usually accessed via the controllers [12]. It can be explained as on the controller, the button "A" will make your character jump, while the button "B" will make your character prone. It is important to keep in mind the limitations of the environment in which the game will be played [12]. When the game is digital, the game designer has to decide what input/output devices will be used. Will it be played with a mouse and keyboard, or with a controller? [12]

Rules

In digital games, rules can be explained either in the manual or they might be implicit in the game [12]. Rules can prevent players from doing certain actions because there is for example no such function bound to the controller, or the rules close up loopholes in the game system [12]. There are different rule categories such as **rules defining objects and concepts**, **rules restricting actions**, and **rules determining effects** [12]. All rules have to be clear to the player and should not be very complicated, because the less the player understands the rules, the less meaningful choices he can make [12].

- **Rules defining objects and concepts** - objects in games are different from real-life objects, even if they seem to look similar [12]. Game objects can be completely fabricated, or are based on real-life objects [12]. However, while they might look similar to real-life objects, their rules and nature have to be defined inside the game [12]. In digital games, game objects can consist of a complex set of variables, that define the object's state and behavior [12]. Usually, the player is not aware of the whole tracking of variables, because it is tracked behind the scenes [12]. For example, the cost of a unit, hit points, damage, armor, sight, speed, and range.

- **Rules restricting actions** - these rules restrict players from using certain elements of the game, either conditionally or unconditionally [12]. Looking into chess rules, it is known that the player cannot move their King by more than one field, or that they cannot move their King into check position, preventing them from accidentally losing the match [12].

- **Rules determining effects** - such rules can be described as conditions - "if" this happens, then "XYZ" outcome will take place [12]. These rules can create variation in gameplay because they are not always applicable, therefore they can bring excitement and difference when it comes to the player's experience [12]. Another use is that it can bring players back on track, for example when a player uses all their mana, it will take some time to regenerate it, and therefore they for instance cannot use spells [12]. They are punished, they are weaker in combat, but they do not die because of losing all of their mana.

Resources

Resources in games play an important role because players are forced to come up with various strategies and use such resources wisely [12]. They must have both utility and scarcity inside the game system [12]. If utility is missing, then the specific resource is useless for the player [12]. Similarly, if the resources are too powerful, they will lose their value in the game system. Resources can be categorized as: [12]

- **Lives** - it is a classic example of a scarce resource in games [12]. If a player loses all their lives (in an arcade game), they have to start again from the beginning [12]. On the other hand, if they do well, they might earn their lives back [12]. Usually, more lives mean that the player has a higher chance to finish the game.

- **Units** - if the player is represented by more than one object, they usually have units at their disposal to use [12]. For example in strategy games, you can have different warrior units to play with [12]. Often such units have predetermined costs, which can also be tricky to set right for the game to be balanced [12].

- **Health** - it can be an individual resource in the game or it can be incorporated into the life system of the game [12]. Usually, if the player loses their health, there should be a way to regain their health back (regeneration, medical kits, food, etc.) [12].

- **Currency** - Currency is one of the most influential resources in any game [12]. With in-game currency, players can buy more powerful items, trade items, or just simply buy something that helps them progress in the game easier [12].

- **Actions** - in some games, a move or turn can be considered a type of resource [12]. For example in the Fire Emblem player has limited moves or attacks in his turn. Another example can be a "focus" mode that is used in games utilizing sniper rifles for more steady aiming (Sniper Elite), or a "nitro" boost in car racing games (Need for Speed).

- **Power-ups** - specific objects in the game, when interacted with, can give a player boost, which will increase some or all their in-game stats [12]. Usually in arcade games, such power-ups are scarce, so when the player finds one, it will not make the game too easy [12]. Power-ups are also usually temporary, holding effect for a short time, or limited in number [12]. An example can be mushrooms in Super Mario Bros. or Red Buff in League of Legends.

- **Inventory** - in some games players are allowed to collect items, which creates their inventory [12]. These objects help players to progress in the game and accomplish goals in the game [12]. Usually, all items in the inventory have to have utility and scarcity, so that players can make meaningful choices while keeping their items as part of their inventory [12].

- **Special Terrain** - this kind of resource affects mainly games that use ma-based systems, such as strategy games [12]. For example in Age of Empires 2, you can mine gold/stone/-wood only from location-specific areas.

- **Time** - some games utilize time as a resource-restricting player action either by time or game phases [12]. An example of this can be Counter-Strike: Global Offensive, when enemies planted the bomb, defending team has only limited time to defuse the bomb to win the round.

Conflict

Conflict develops from the players trying to progress in the game or accomplish the goals set within its rules and constraints [12]. Usually, procedures offer players fairly inefficient means for them to accomplish in-game goals [12]. These means should challenge players by forcing them to use a specific skill or mix of skills [12]. While inefficient, it should be also enjoyable for players to progress in the game, to also increase their sense of achievement from playing the game [12]. Three main categories of conflicts are **obstacles**, **opponents**, and **dilemmas** [12].

- **Obstacles** - they are a common conflict in games, while they are more important in single-player games [12]. Obstacles can be physical, such as a tree log on the pathway [12]. Or they can be abstract so that the player is required to use mental skills to accomplish the goal, and they appear mostly in puzzle games [12].

- **Opponents** - Another source of conflict is opponents in multiplayer games [12]. To accomplish the goal or to progress in the game, the player must deal with his competition first [12].

- **Dilemmas** - dilemmas are a powerful source of dilemma in both single-player games and multiplayer games [12]. Usually, players are required to make a choice, which whatever the outcome it is, will have varying consequences on the gameplay [12]. For example, when playing poker, the player can choose to fold or to continue with his hand.

Boundaries

It is important to define the boundaries of the game and how players will enter or exit areas [12]. If there were no boundaries, players could run anywhere where it was not intended and therefore not succeed in the game or progress by exploiting mistakes made in a game or level design [12]. In some games, players have more freedom in movement, and in others, not that much [12].

Outcome

The outcome of the game should be uncertain, to keep players interested and to hold their attention [12]. However, some games do not have a winner, or even an end, because some games are designed to play indefinitely [12]. In the traditional game system, producing a winner or winners is the end state of the game [12]. The outcome is usually related to the player interaction patterns and the objectives [12].

2.2.2 Engaging Players

Player engagement is an important part of the game development [12]. Games are supposed to be a form of entertainment, while good entertainment engages us both intellectually and emotionally [12]. Some players might enjoy pure abstract challenges, but most players require something more that connects them emotionally to the game itself, the character, or the story of the game [12].

Challenge

The key is to keep players engaged with the game and therefore the game's difficulty has to be balanced that way [12]. Games include conflicts and goals, that players have to pass [12]. These conflicts challenge players, creating tension as they progress [12]. While increasing the challenge as the game proceeds, it can cause a rising sense of tension, but if the challenge is too large, it can also cause frustration [12]. On the other hand, if the challenge remains flat or decreases, players might feel that they have dominated the game and quit playing that game [12].

Play

There is a deep connection between games and play [12]. In order to engage with a game system, the player has to play it but play itself is not a game [12]. Playing a game means that the player has to make choices and take action [12]. These activities occur within a game system that is designed to support meaningful choice-making [12]. This way more rigid game systems can provide opportunities for players to use fantasy, imagination, social skills, inspiration, engage in the challenges it offers, or another type of interaction to fulfill objectives within the game[12][13]. Every action player takes results in a change affecting the game system [12][13].

Premise

The premise is used to easier specify or introduce the game [12]. It helps to contextualize choices for players, but it is also a powerful tool to involve players emotionally in the interaction with the game[12] . Tracy Fullerton described the premise as: "In Monopoly the players are landlords, buying, selling, and developing valuable pieces of real estate in an effort to become the richest player in the game." [12]

Character

In traditional storytelling, characters are the medium through which the story is told [12]. In games, however, they can also provide a way for us to sympathize with the situation and 'their' choices throughout the story [12]. Furthermore, they carry our participation in the story, making it easier for us to experience conflicts and various situations [12]. It is a very important element for dramatic engagement in games [12].

Story

The story differs from the premise in its narrative properties [12]. In a premise, we do not need to go from the beginning of the narrative, while stories develop with the progress of the game [12]. The integrated story with play can bring powerful emotional results [12].

2.3 Game Audio

Over the years, audio in games evolved from simple beeps into a big complex number of interactive cues [14]. In the study conducted by F. Andersen et al., they found that audio in games affects a player's gameplay in many ways [15]. Their results have shown that audio in games is crucial, from the smallest sound effects such as shooting a gun, or a character's footsteps to the ambient music that might change the overall experience and mood of the player [15]. They also found out, that sounds don't only affect the gameplay, but the satisfaction factor of doing an action as well [15]. Their final words mentioned that gameplay is not everything, and that game audio is a critical factor to make a good game [15]. Daniel Bernstein explains, that there are three types of object interaction: direct, indirect, and environmental [14].

1. Direct Communication

This type of interaction happens after the game object's direct action [14]. For example, it can be the sound of a ball hitting the ground [14]. It can be regarded as feedback audio because for the audio to play, there has to be a specific cause [14]. For example, a scream when the player hits the enemy, or the creak of a wooden floor when stepped on [14].

2. Indirect Communication

It represents sonic cues that might convey indirect object interactions [14]. That means that if the player does something in the game, something might respond sonically [14]. Examples of that can be when an enemy sights the player, it can trigger a specific sound or voice line like "I see you", etc., or when the player runs out of stamina, then the character might start breathing heavier [14].

3. Environmental Communication

A character or the game object can produce a system of sounds by itself, without direct communication to the player [14]. It is completely based on the character's existence in the virtual environment [14]. It may be just a character talking to itself, swishing blades and a humming engine that represents an industrial fan in the environment, or any location-based environmental sounds [14]. Environmental communication is crucial in reinforcing both character and game objects in their existence inside of the game [14]. It is also important to arrange a consistent set of sounds [14].

2.3.1 Ambient Sound

Ambient sound refers to the type of sound that is played in a specific location in the game environment where the player is located [14]. It is a system of environmental and indirect cues that help to immerse players in the specific game's setting [14]. For example in the real world, there is almost never quiet and there are always some sounds in the background - a complex web of sounds [14]. The ambient sound can be anything from a single sound being looped to a complex audio system based on game object sounds at a specific location in the game environment [14]. Such ambient sounds can fully immerse players into the world that is presented by the game and can have the power to transform the game scene from a virtual one to a believable one [14].

2.4 State of the Art

This section's purpose is to further analyze possibilities for our project. We take a look into already existing games to draw inspiration for various design and implementation techniques.

2.4.1 Moss

This stylized VR game is a single-player action-adventure puzzle game. In this game, players play as a little mouse called Quill, and they have to beat various dangers and solve different puzzles. The game has a very appealing visual style and is interesting to look at. Sound design is another thing that excels in the game, as well as the physics inside the game. More importantly for us, the camera view in this game is in the third-person. At each level, the camera is stationary and the player can look around while moving the character or interacting with game objects. An example of the camera view in the game is in Figure 2.1.

Figure 2.1: Camera view in the Moss VR game

2.4.2 Lucky's Tale

This game is yet another representation of the stylized style platform game that reminds of Crash Bandicoot in a way. There is a lot of running and jumping in the game. It is one of the first VR games utilizing the third-person camera view. The game looks vibrant and brings nostalgic memories of older platform games. The player is usually able to see the world and his character from the side, but unlike Moss, this game uses a dynamic third-person camera. The camera moves according to the character's movement, either left or right and if the character is climbing up, then the camera moves up and slightly changes its angle. On the other hand, similarly to Moss, the game uses a well-implemented sound system, as well as a visual style. An example of the camera view is in Figure 2.2.

Figure 2.2: Camera view in the Lucky's Tale VR game

2.4.3 Chronos VR

It is an RPG VR where the main character has to save their homeland and defeat a great evil. The visual style of the game is less stylized than in previous examples and has a much darker atmosphere. Also, the sound design of the game is well-integrated. Similarly to Moss, this game uses a stationary third-person camera view, where the player can look around. The view transitions into another camera position once the player leaves the location and walks into another one. The example can be seen in Figure 2.3.

Figure 2.3: Camera view in the Chronos VR game

2.4.4 State of the Art Conclusion

Looking into these three representatives of third-person camera VR games, we gain a better understanding of how it might work. We could definitely make use of a static camera to some extent, accompanied by free camera rotation. However, the prototype we are developing will most likely have a dynamic player's character, and we can imagine, that the camera will be attached to or behind the character. Also, game Moss has the closest visual look of what we are looking for, so it might be a subject of further reference.

2.5 Analysis Conclusion

Based on the findings throughout the analysis, it is clear that the design and implementation of the study requires a focus on a few key aspects of facets of development. Namely: Ensuring that factors leading to disembodiment, cybersickness, and lack of presence are mitigated, while factors that improve the user experience and interaction are emphasized [4] [6] [9]. These in particular consisting of effective gameplay and audio feedback mechanisms, alongside an unintrusive approach to swapping camera methods [4] [6] [9] [12] [14].

In addition to this, while other VR games have experimented with the concept of third-person already, it may be relevant to further review and experiment as to where this alternate method of camera orientation may be the most useful, how it may influence the perception of an experience amongst users, and to what extent it may aid or harm interaction, alongside cause or alleviate symptoms of cybersickness, disembodiment and lack of presence [4] [6] [9] [14].

2.5.1 Final Problem Statement

How effective can a third-person camera perspective in VR be compared to first-person, for the purpose of conventional and gamified tasks?

Chapter 3

Methods

In this chapter Design, Implementation, and Evaluation methods are introduced. These methods serve a vital role while they set the right course and practices in all fields mentioned.

3.1 Design Methods

This section introduces the design methods used throughout the project. Utilizing these methods should result in a flawless process to design and implement our 'perfect prototype'.

3.1.1 Brainstorming

Brainstorming was used throughout the whole process of making this prototype, however, it was mainly used in the beginning when we had to decide on the directions of the project and its purpose. We discussed which medium to use and ended up using VR. Afterward, we discussed the whole prototype: from the visual side, and from the coding side, we also discussed in-game audio, interactions, and how to run our testing. Brainstorming is a very powerful tool, yet probably the most natural method to discuss ideas for the project in various stages.

3.1.2 Moodboard

Moodboard is a great tool to be used in the early stages of design to visualize how the final product may look like, or what the desired visual outcome should be. It consists of various reference pictures to guide us in desired visual direction. It also helps to give an idea of how different components from various pictures could be used in the game scene. The final moodboard will be shown in the Design Chapter 4.2.2.

3.1.3 3D Model Workflow

Models created by us were made in a low-poly baked manner in a stylized style to fit the environment. For texturing, PBR workflow was used to achieve realistic light and reflection behavior for stylized models in our prototype.

3.2 Implementation Methods

In order to develop the software needed to properly implement the software necessary to run the study, decisions were made on primarily which hardware devices to target, alongside which engine to develop the software in.

3.2.1 VR Kits

In order to ensure a uniform and consistent experience, the Oculus Quest 2 was chosen as the targeted HMD to develop for, to be used alongside a PCVR application. This was chosen in favor of ease of setup and use, due to the presence of inside-out tracking, along with it being a PCVR application offering more consistent performance on more powerful hardware. The downside present to this solution is through deciding on the use of a cable, or on a wireless connection. A wired connection was chosen for the final implementation, due to the minimal latency and best performance, avoiding sudden packet loss or connection issues. Given the use of a long cable, this was also assumed to mitigate a lot of the issues that otherwise plague the use of wired VR.

3.2.2 Unreal Engine 5

To provide a stable development platform to work from, Unreal Engine 5 (UE5) was chosen as the game engine to develop the application in. This was chosen due to its dominant place in the market and its modern features and implementations that can help facilitate the swift development of performant software. The major features that were desired from this engine were Blueprints, a visual node-based programming method, alongside enhanced input mappings and integrated VR templates which can be used to develop minimum viable prototypes quickly.

3.3 Evaluation Methods

In order to evaluate our experiment correctly and to draw any conclusions, evaluation methods are an essential part of this project. Utilizing these methods should help us answer our Final Problem Statement 2.5.1. This section will introduce elements of the project to conduct an experiment properly, and to make valid data evaluation.

3.3.1 Testing Protocol

In this section, the testing protocol will be described. It clarifies the process of testing and ensures consistency alongside all test participants.

Testing place

The testing is supposed to take place at Aalborg University Copenhagen, in one of the vacant rooms. There is no special requirement for the size of the room, since our prototype testing does not require a lot of space. All it needs is approximately 1,5m x 1,5m play area, with the Oculus Guardian set to stationary. There should be a marking on the ground for the best possible alignment of the player with their virtual character.

Process of testing

The testing would start with participants filling in the pre-test demographic questionnaire. Once they are finished, they will be positioned while standing on the mark on the ground. After that, we will help them get the controllers ready, and once they have them in their hands, the functionality of different buttons and thumb-sticks on those controllers will be explained to them. They will then be asked to put on the HMD. Once they are ready, they will be introduced to what is going to happen - firstly, that they are going to be put into the tutorial environment, where they can experiment with the controls presented to them a few moments ago. They will also be told that this scene has no ending point or set timer, so it is either up to us or up to the participants whether they feel comfortable with controls or they still need a little bit more time. When finished, they will be asked to fill in the post-tutorial questionnaire, and after they are done, we will proceed to the main test. They will once again be helped to put everything on, and then have the concept of the main test explained to them. We will explain that there will be three different scenarios (mini-games) and they will be explicitly asked to try both camera views at least once per scenario. After they try both, they can stick to whichever they like more or keep switching between. During all tests, participants will be observed and helped if needed, either physically or verbally. When finished again, they will be asked to fill in the last part of the questionnaire, which is the post-test questionnaire. After that, they will be thanked for their participation and preparations for the next participant will begin.

3.3.2 Questionnaire

The main method of testing and evaluation for our project is a questionnaire. It will be composed of three parts, a pre-test demographic questionnaire, a post-tutorial questionnaire, and a post-test questionnaire. The pre-test questionnaire will include general questions about participants' gender, age, previous experience with VR, whether they feel comfortable using VR, whether they wear glasses, whether they are prone to motion sickness, and lastly, if they are under the influence of any substances.

The second and third parts of the questionnaire will take minor inspiration from the System Usability Scale questionnaire and will be composed by us [16]. John Brooke composed SUS as a simple, ten-item scale giving a global view of subjective assessments of usability [16]. This inspiration for the questionnaire should help us answer our FPS as we are looking to explore the functionality, usability, and effectiveness of third-person camera usage relative to first-person.

However, the post-tutorial questionnaire will ask questions regarding participants' preference for a camera mode, how they felt about the camera switching mechanic, and whether they felt disoriented or whether it was easy to navigate in the environment. There will also be open-ended questions, which participants can answer with a paragraph, providing us with details that may aid in future considerations and reflection upon review of results.

The last part is the post-test questionnaire, which will consist of questions regarding experience with camera switching, disorientation, whether the swapping camera interfered with their experience, how easy the game was, and what their preference for camera mode was during different mini-games. The next questions will ask separately for each mini-game about the effectiveness of using each camera. There will also be questions about how quickly users learn controls of the switching, how confident they felt while using VR, how consistent the camera modes were, and how comfortable they felt while navigating the environment and interacting with objects. Lastly, there will be open-ended questions asking whether both first-person and third-person introduced any specific problems during their experience, to give further insight as to their final thoughts and perceived experiences. The final questionnaire can be found in the Appendix 11.2.5.

3.3.3 Test Participants

As the study focuses on broad aspects of VR usage, it was decided to not focus on any specific target group. We contacted our acquaintances as potential participants beforehand and scheduled specific dates and times with them. The testing location would be any available room at the university since the testing doesn't require a lot of testing space. Lastly, there might be a potential bias by testing on our acquaintances, but because whether they answer positively or negatively, it is not going to alter our satisfaction with the results of the study we conduct. The reason is that we are conducting a comparative study, and therefore we will be satisfied with whatever results we receive.

3.3.4 Data evaluation

Once the experiment for the study has finished, an analysis on the gathered data will need to be completed. To this end, comparisons ought to be able to be made by calculation of average means, medians, standard deviations and the use of two-tailed paired T-Tests to evaluate the statistical significance of relevant and corresponding data sets to one another. This will help determine whether differences in results between said sets are significant enough to deem their variance from one another correlated to the independent variable.

Chapter 4

Design

The main goal of this project is to develop a high-fidelity prototype using virtual reality, suitable for testing the third-person camera view in VR and answering our FPS. This chapter explains design considerations and decisions.

4.1 Design Requirements

Design requirements help to determine what the final prototype should consist of, listing both functional and non-functional requirements, and defining both what the system should do, and how the system should behave. It also helps to narrow down the design process.

4.1.1 Functional Requirements

- The prototype must run smoothly without any performance issues
- The prototype must feature consistent environment elements for each test participant
- The prototype must utilize the third-person and the first-person camera view
- The tasks must be easy enough for players to progress the game to test every scenario

4.1.2 Non-functional Requirements

- Feedback from tasks must be obvious to the user
- The prototype should make use of a narrator to better explain what is required from test participants
- Navigation through the environment should be easy and intuitive
- Must be designed for use with VR technology
- Tasks should be completable with both camera views
- The player's character should be visible from the third-person view
- Testing environment must be safe for users using Guardian technology in Oculus Quest 2

4.2 Design Ideas

In this section, we summarize initial ideas, design choices and further designing process working towards the final prototype.

4.2.1 Overall Idea

By the end of this project, we should be able to deliver a functional game consisting of different scenarios to test whether players like or dislike the third-person camera view in VR games. The game should be set in a stylized style, with a nice and vibrant atmosphere, and should include various sounds for better gameplay, as we found that sounds play a huge role in immersion in games, Game Design chapter in the Analysis 2.2. We decided to set the Japanese theme of the environment and utilize a narrator for the storytelling part of the game. In order to make a game suitable for testing, the game will make use of the third-person camera view that will be bound to the player's character and will move with him.

The game will be split into three mini-games, each being focused on a different type of game genre. Looking into Steam statistics of the peak number of players per VR game, we can see that games with the highest traffic fall primarily into categories of action games, adventure games, exploration games, and lastly, racing games and simulators [17] [18].

We have thought of the first mini-game being combat, where players will have to fight enemies in order to progress to the second level. Using a Steam database for statistics, VR games with fighting themes also show a trend of being popular within the medium [17]. Players will experience some elements such as playing as a character who will follow a small linear story to complete a set of tasks within its narrative, in order to create a full game experience to run the experiment within, within which these tasks will take place.

As we found that puzzle games make up a relevant portion of games within the medium and are a departure from the first task, we decided to include such a task in this prototype as well [17] [18]. In the second level, players will be presented with three boxes, one will be full of balls of two different colors and the two other boxes will be empty with markings of the specific color of the ball. Players will have to collect these balls and sort them into the corresponding boxes, only then they will be able to progress in the game.

We also found, that games that allow users to explore open worlds are quite popular in VR, where one of the best-rated games is The Walking Dead: Saints & Sinners [17]. Therefore, we decided that the last task will take players for a walk in the maze, where they will have to find a big statue in order to finish the game.

4.2.2 Moodboard and Inspiration

At the beginning of the process, we gathered as many references as we could. Our moodboard consists of references to Japanese nature and building structures. Those were the starting point to start thinking about possible model structures and future textures for models, and for what we should be looking for to download as well. After having the board set, we were able to start putting the environment together and start prototyping. The moodboard is shown in Figure 4.1.

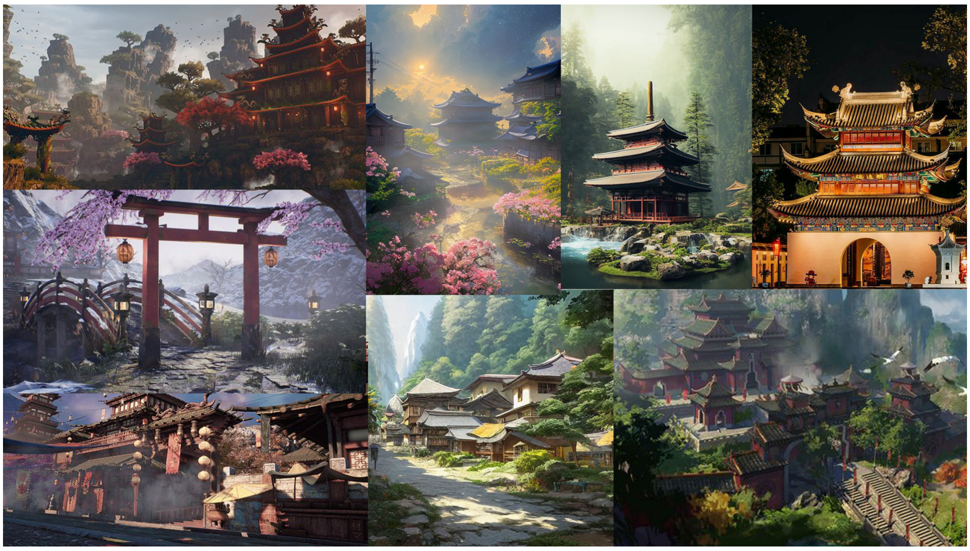


Figure 4.1: Japanese style moodboard

4.3 Game Design

In this chapter, we discuss our considerations for the game design of our prototype, and also our final decisions. It will be mostly based on the findings in the Game Design section in the Analysis Chapter 2.2. Specifically, we will mainly consider findings about game objectives, rules, conflicts, boundaries, challenges, and game audio. In Figure 4.2 below, our initial design board is shown, where we tried to decide on the theme, atmosphere, tasks, weapons, characters, and choice of 3D models.

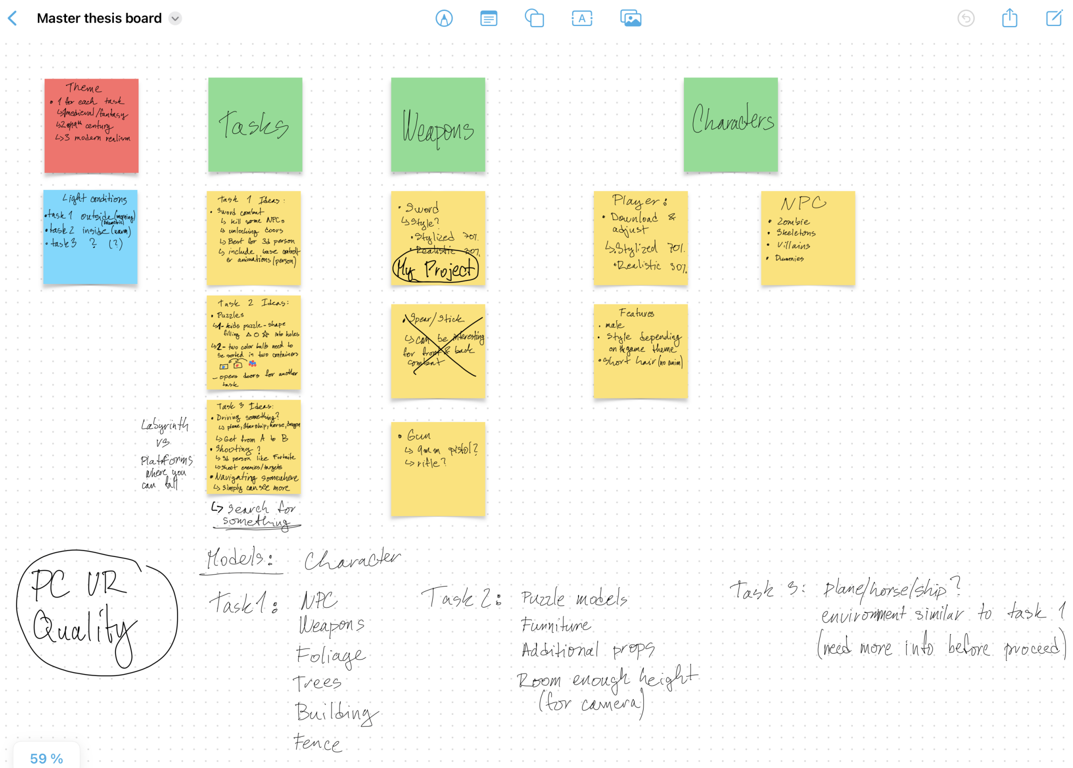


Figure 4.2: Game design board

4.3.1 Player Input and Base Mechanics

Movement and Interaction Controls

When utilizing Oculus Quest 2, players are wearing a VR headset and holding controllers in both hands. We decided to limit the player's movement in the virtual environment by using only the left thumb-stick, to limit any miss-alignment with the character seen in the third-person view. Furthermore, it would make the testing easier since the test would not require a big room for walking around. Next, players will be able to grab objects in VR by using the Grip triggers on both controllers.

Camera Control

To rotate the camera, players will make use of the right thumb stick, which should help them to look around in the first-person view, but more importantly, to rotate the camera with their character in the third-person view. Other than that, players will have the possibility to switch between the first-person camera and the third-person camera, and this functionality will be bound to the button "X". They can press it and make use of switching cameras as many times as they like.

Base Mechanics

As mentioned before, players will be standing still while playing the game and will be moving only by using the thumb-stick on the controller (they can crouch or make a little step to either side, but then it was required for them to return back on the mark on the ground). To relocate players after finishing each mini-game, we decided to use a teleportation technique, where the game will automatically relocate players to the new location defined by us.

Another mechanic players will be required to use is sword fighting. They will be presented with a sword with which they will have to kill enemies. The player is supposed to grab the sword with their controller and hold it. They will swing the sword with their hand movement and when the collision is registered, the enemy dies.

The last mechanic used in the game will be object interaction used in the second task, players will simply make use of the Grip triggers in order to finish the second task. Once they release the trigger, the object they were holding will drop down.

4.3.2 Designing mini-games

Mini-games are the main subject for testing our third-person camera view in VR and whether participants would like to use it or not. We picked different styles of objectives for each of the tasks.

The first task is meant to represent a combat scenario, in which the player is required to slay enemies that are chasing the player. The task is meant to be easy to finish in order for the player to progress to the next level. To achieve that, we decided that we will not include damage and health system in the game. Players are only required to collide a weapon they are wielding with an enemy character in order to kill it. Once the player slays all five enemies, which looked like the best ratio to keep it simple as well as fairly quick to progress, the player should be relocated to the second level's location by teleporting them.

The second task was chosen to represent a puzzle-solving game, also introduced in the Game Design Analysis section 2.2. Players would be left a clue by our narration system and they would have to figure out what to do. However, the task is very simple in its nature. Players will be presented with a box consisting of 6 red balls and 6 blue balls. These balls have to be sorted and delivered into corresponding boxes with red and blue markings on them. The purpose of this task is to find out whether close interaction with game objects is suitable or effective in the third-person view. After players finish this task, they will be teleported again to the new location.

In the last task, players are introduced to the corridor system, where they have to navigate through and find a big statue. The statue is an element of motivation that players have to find, but first, they have to find a way out of the maze. This task was chosen as a representation of the exploring game genre. Once players find the statue, the game will be finished.

4.3.3 The Narrative

We decided to make use of the story in the game for better immersion and to guide players on their journey in the game. It was meant to be suited to the overall virtual environment theme, which is Asian - Japanese style. We decided that the narrator will be the player's character, who will be talking to himself and thinking out loud. These thoughts should give players an idea of what is going on, who they are, and what is required of them to do. The short script and its desired implementation into the gameplay are shown in the following Figure 4.3. Below the Figure, the original narrative transcript is shown as well, however, minor changes were made while recording it with the free text-to-speech AI software downloaded from https://filme.imyfone.com/voice-recorder/.

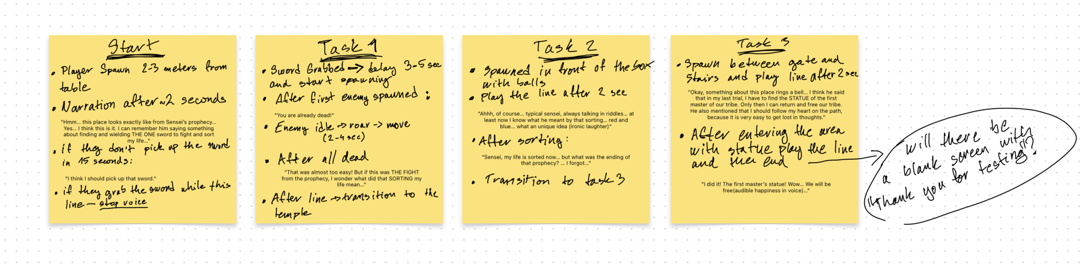


Figure 4.3: Narrative sketch

- "Hmm... this place looks exactly like from Sensei's prophecy... Yes... I think this is it. I can remember him saying something about finding and wielding THE ONE sword to fight and sort my life..."
- "I think I should pick up that sword."
- "That was almost too easy! But if this was THE FIGHT from the prophecy, I wonder what did that SORTING my life mean..."
- "Ahhh, of course... typical sensei, always talking in riddles... at least now I know what he meant by that sorting... red and blue... what a unique idea"
- "Sensei, my life is sorted now... but what was the ending of that prophecy? ... I forgot..."
- "Okay, something about this place rings a bell... I think he said that in my last trial, I have to find the STATUE of the first master of our tribe. Only then I can return and free our tribe. He also mentioned that I should follow my heart on the path because it is very easy to get lost in thoughts."
- "I did it! The first master's statue! Wow... We will be free..."

4.3.4 Audio System

To make this game more believable, we decided to make use of various sounds throughout the game. The game should consist of environmental sounds and ambient audio, feedback audio, as well as indirect audio.

Environmental Sounds and Ambience

The environment should feel real and therefore we will include sounds of nature looping in the background, as most of the mini-games should be located outdoors. Depending on the game objects and elements inside the environment, corresponding sounds will be included in the environment, for example, birds singing, water flow sounds, wind whistling, etc. The first mini-game will also make us of some fighting music to set the mood for the fight. For the indoor mini-game, there should be environment sounds less audible or not audible at all, however, there will be ambient music included.

Feedback Audio

To provide players with an even better experience in the game, feedback sounds are something to be considered. Such sounds should make it more natural for them and make it easier to understand whether their actions made an impact on the game. We considered including sounds when the player hits an enemy with their weapon, and then the enemy would roar (from the caused pain) and die. Other sounds considered were the swooshing sound of swinging the sword around, and the sound of grabbing items from the environment and dropping them on the floor. The same principle applies to the balls from the second mini-game. We also thought of including the footsteps of the player, but we decided to skip it in the end.

Indirect Audio

Sounds from this category should make the feel of the game whole. We considered using various sounds in combination with animations for the enemy character. Once it is spawned, it will follow the player, and while doing that, there would be various animations and sounds played. For example, when the enemy is spawned, it should roar before it starts moving, then while moving toward the player, there should be very audible footsteps. Once the enemy reaches the player, it might try to attack the player, and there should be the sound of the hand's swoosh. Lastly, when the enemy dies, it should play a death cry/roar sound.

4.4 Environment Design

In this section we introduce the ideas for our virtual environment, and later the process of assembling everything together in Unreal Engine 5.

4.4.1 Virtual Environment Design and Style

As it was mentioned earlier and also shown in the moodboard 4.2.2, we decided to create a virtual environment consisting of Asian stylized modular pieces, various lighting, and sounds. Here is our initial list of items we thought will be useful for the environment, which in the end was also our final one:

- Nature - grass, mountains, a river, a waterfall, various trees, and bushes
- Buildings - walls, stairs, houses, temple, shops, and supplementary props
- Mini-game system - including 3 tasks: a combat scene (an outdoor arena), problem-solving mini-game (an indoor environment), and a labyrinth (outdoor)
- Virtual boundaries - to restrict players from walking where not intended
- Lights - use of ambient light, as well as additional point lights in the scene
- Ambient sounds - usage of ambient nature sounds, waterfall sounds, wind sounds, and Asian music
- Sound effects - multiple sound effects are used: grabbing and dropping an item, sword hit, enemy roar, enemy death roar, enemy slash, enemy footsteps
- Other sounds - fight music, fight countdown, narrative speech

4.4.2 3D Models

For the creation of the environment, we found and downloaded a premade Stylized Eastern Village package from the Unreal Engine marketplace. This package consists of various highly usable modular assets that were very useful throughout the whole process of the virtual environment. The complete set of assets can be seen in Figure 4.4, and the reference link in the Appendix 11.2.

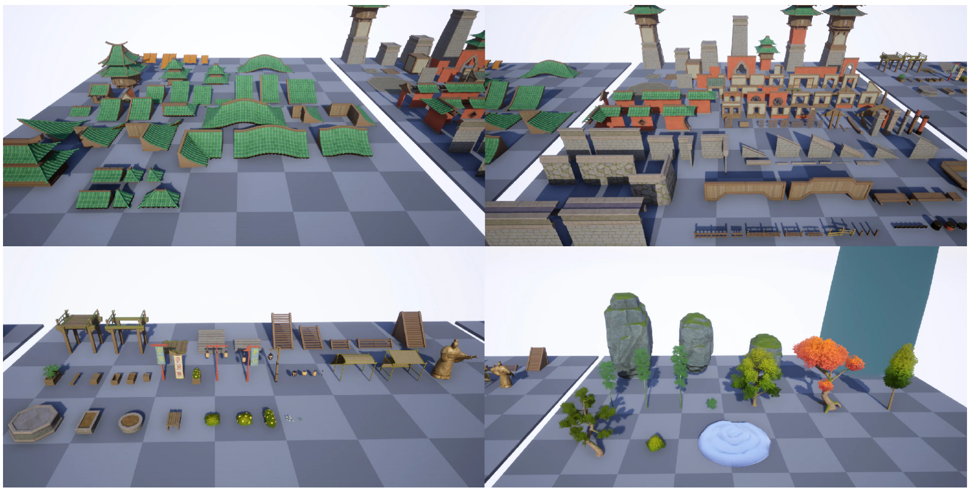


Figure 4.4: Stylized Eastern Village modular package from Unreal Engine marketplace

We also needed the model for the player's character, we decided to just download a free model from the internet. The one we got is an Elf character, and the reference can be found in Appendix 11.2.5. It is also good to point out, that there is no specific meaning behind choosing the Elf model instead of something else. A simple explanation is, that we couldn't find any other more suitable models for free. The model was, however, adjusted in Maya, and hands were deleted, which will be explained later why. See Figure 4.5.

Figure 4.5: Elf model for player's character

However, we also needed a model for an enemy character, and that one was also downloaded. Reference can be also found in the Appendix 11.2.5. The model represents the Japanese demon Oni, which suits the scene nicely. This model was slightly adjusted and re-textured in Substance Painter since it had some flaws. More about the enemy model will be covered in section 5.1. The model can be seen in Figure 4.6.

Figure 4.6: Japanese Oni enemy character

Another model we used in the game was Fantasy Stylized Sword, which is being used in the first mini-game to kill Oni enemies. This model was created by Richard as his project, so we decided to use it in our game. The sword was created based on the concept made by Mauricio Carrasco. This model was created with high-poly to low-poly technique, using Maya, ZBrush, and Substance Painter. We created a blueprint out of this model and added a GrabComponent to it, so it can be grabbed with VR controllers during gameplay. Model can be seen in Figure 4.7

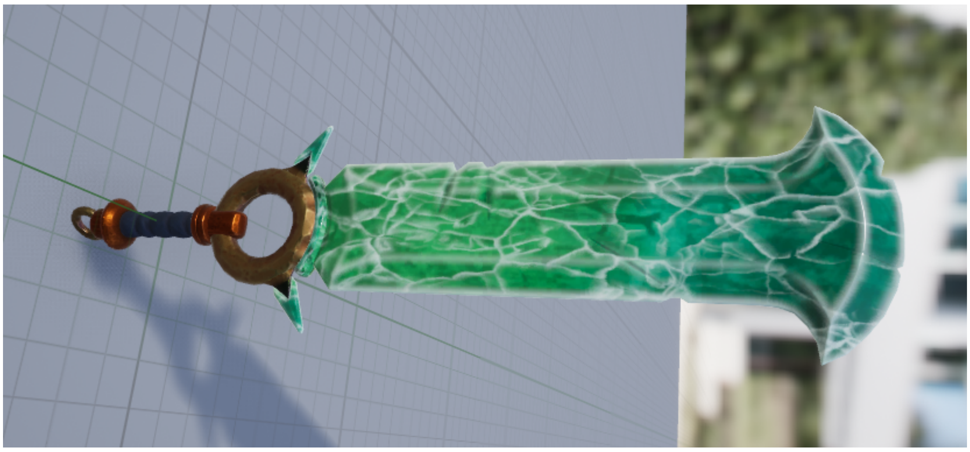


Figure 4.7: Fantasy Stylized Sword used in the first mini-game

We also needed to create items from the second mini-game, so we used Autodesk Maya 2024 and Adobe Substance Painter. It is just a simple sphere model, with 2048 pixel resolution UVs, and the same texel density. In Substance Painter, the wool-ish material for the ball was created and colored blue, and the next texture was red. The boxes were made similarly, it is a simple low poly box, textured with wood material and painted blue and red markings on the surface, so the players can see them. Similarly to the sword, we created a blueprint out of the ball model and added a GrabComponent to it. The results can be seen in the following Figure 4.8.

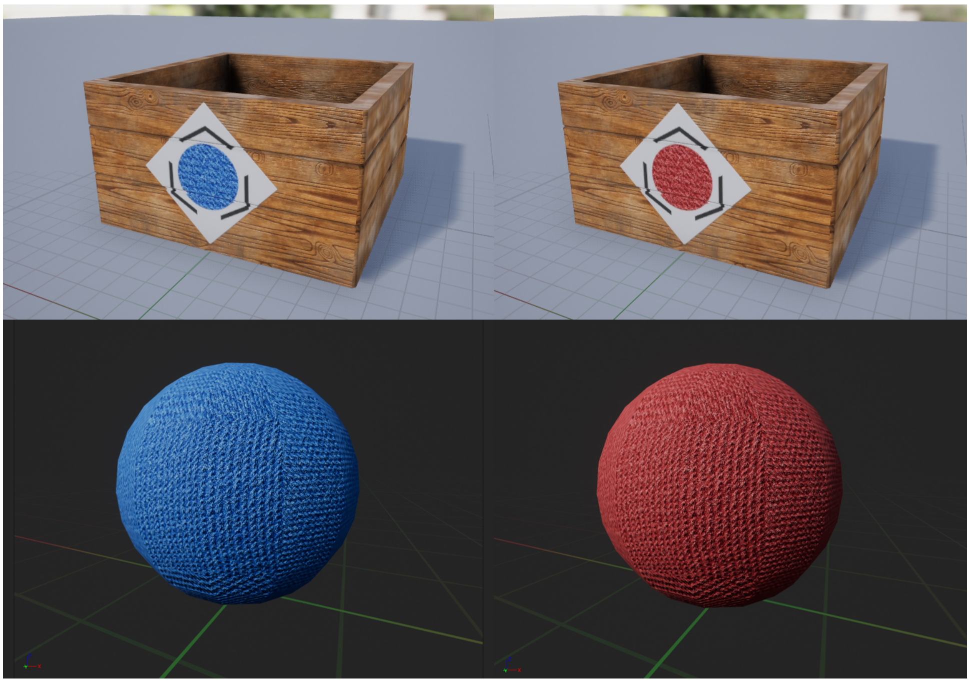


Figure 4.8: The second mini-game models

Chapter 5

Implementation

In this chapter, we will show the process of the scene assembly based on the Design chapter 4.1.2, and also the work with blueprints and code.

5.1 Game Scene Assembly in Unreal Engine 5

5.1.1 Environment Structures

As already mentioned, the environment was built with modular assets and with specific needs for each mini-game. However, it was also important to create believable surroundings for mini-game locations. As such, we created a set of mountains outside the arena, a river with a waterfall, a bridge, some houses, and plenty of trees. This setup can be found in Figure 5.1.

Figure 5.1: Screenshots of the environment outside of mini-game areas

The first mini-game area is a semi-enclosed outdoor location, build with walls around it and supplementary props. The idea of it was to create enough space for players to move around but also not too big. The arena has an invisible wall on the riverside so players would not walk out of the arena. This area was also made with a backup plan in case the teleportation doesn't work, so that players can navigate towards the second mini-game area, through a corridor. Both areas can be seen in the following Figures 5.2 and 5.3.

Figure 5.2: The arena layout

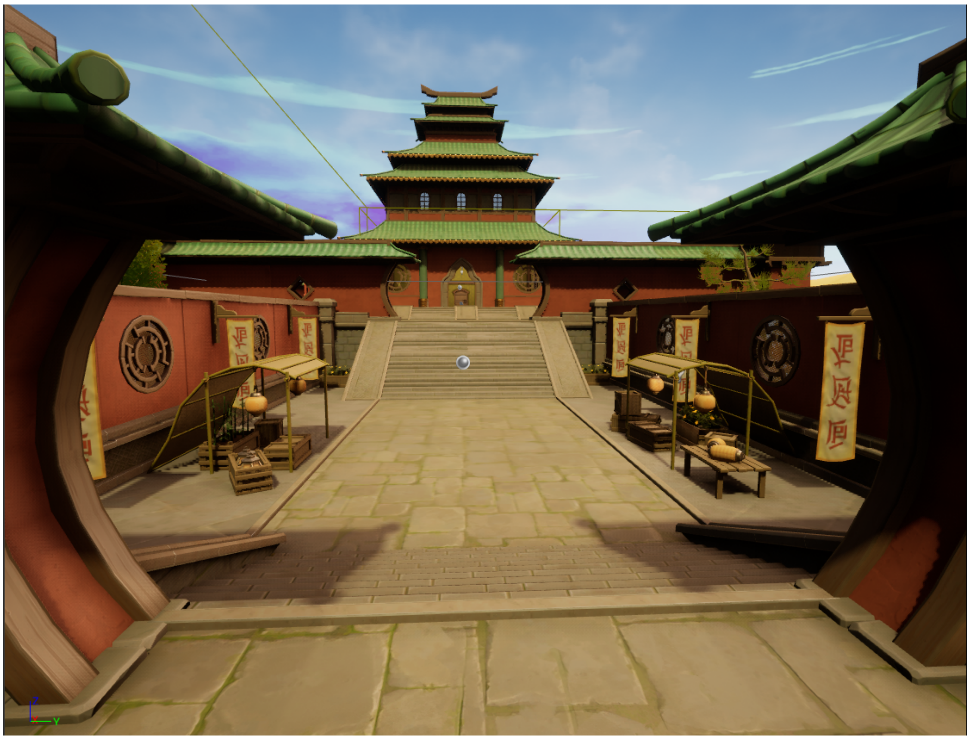


Figure 5.3: The corridor connecting the arena with a temple, where the second mini-game is located

The second mini-game is inside the temple, where players have to sort balls by color. The inside of the building was also created big enough for players to be able to use the third-person camera, without any issues or unnecessary camera collisions with walls. The surrounding area of the temple was also created for aesthetic purposes, as well as for the backup plan in case teleportation does not work. Players would be able to walk out and pass around the building to progress to the last mini-game. In the following Figures can be seen the surrounding 5.4, and the inside of the temple 5.5.

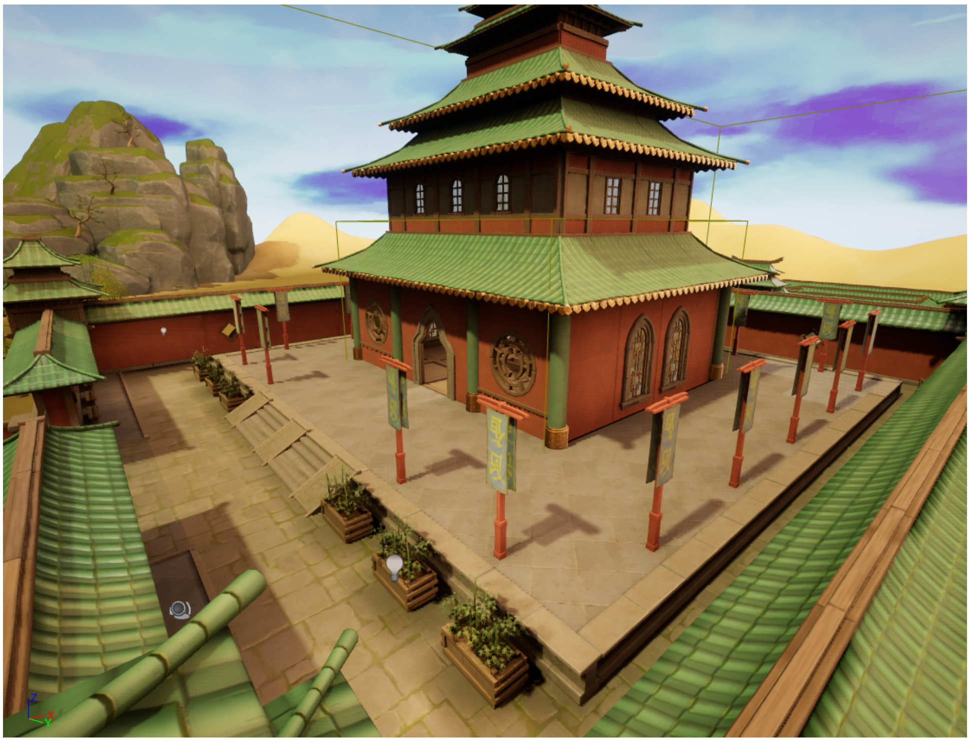


Figure 5.4: The outside area of the temple

Figure 5.5: The interior of the temple - the second mini-game area

The last mini-game is a labyrinth task, and it was created by using and connecting different walls. The walls are tall enough so the third-person camera does not collide with the roofs on the walls. The maze was created to be fairly easy so that it is not too difficult to finish the game. Inside the maze, there are multiple dead ends, where supplementary props are placed. The end of the maze is another square-like area with a big statue in the middle. Players are also instructed that they should be looking for the statue and once they cross the TriggerBox game object, the game will trigger finish. The entry point to the maze, the layout of the maze, and the finish can be seen in Figures 5.6, 5.7, and 5.8.

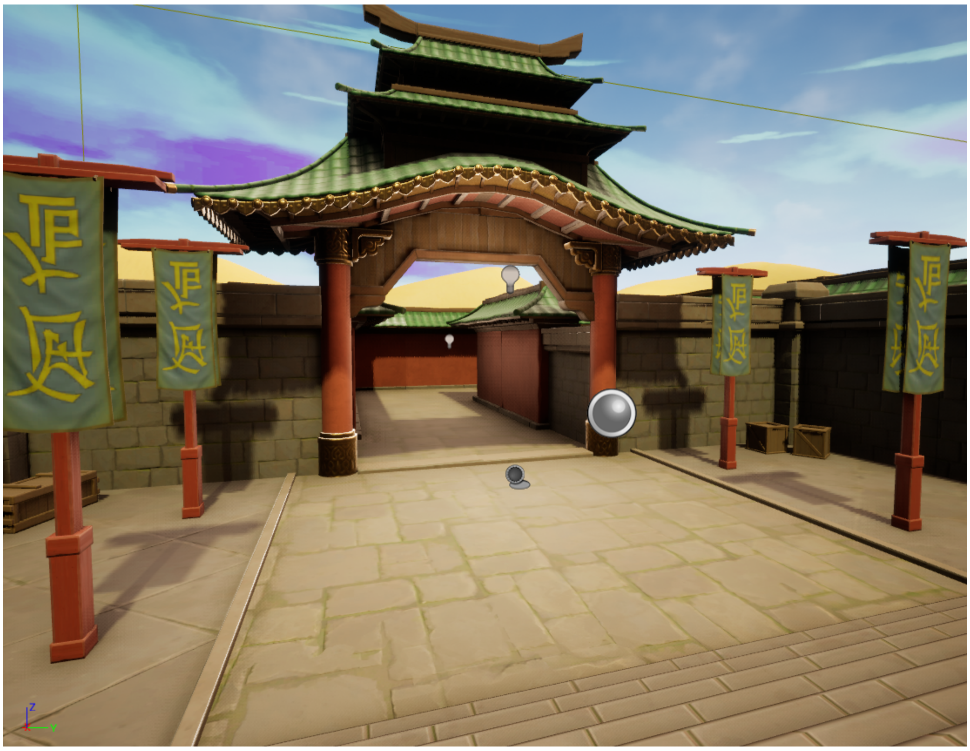


Figure 5.6: Starting point of the third mini-game

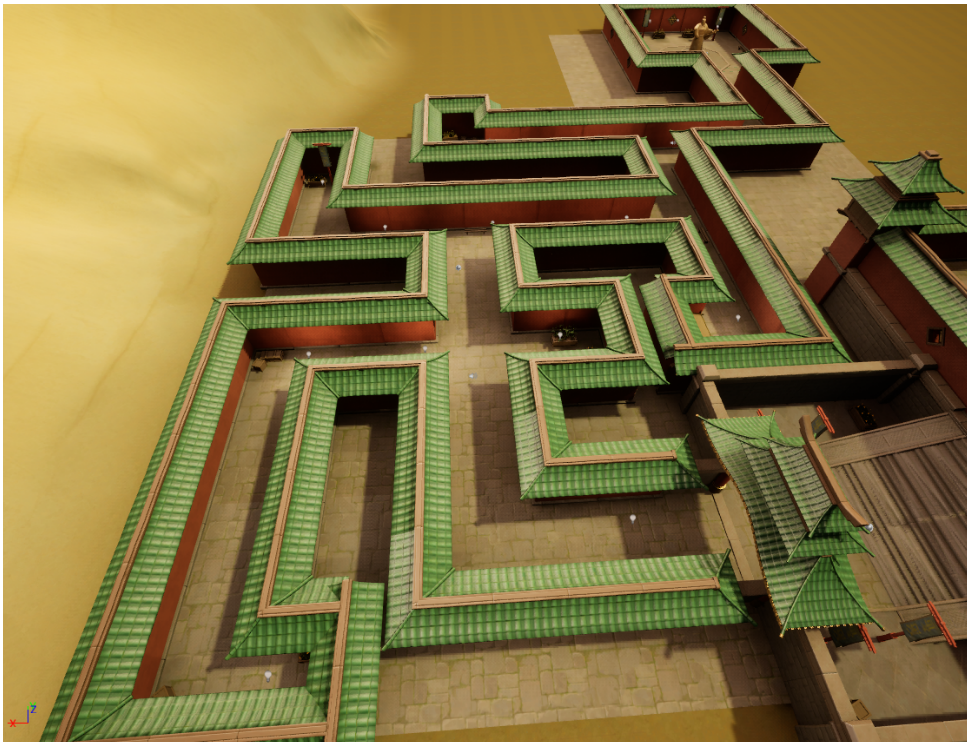


Figure 5.7: The layout of the maze

Figure 5.8: The end area with the statue

5.1.2 Environment Lighting

The lighting process was quite straightforward, the scene consists of the main "Sun" directional light, with a warmer temperature. In addition to that, we added an ambient light from the skybox, to light up parts of the scene not affected by the directional light, but also to add a little bit of color tint to the scene.

To even further light up various elements or indoor areas, we used point lights. They were very useful for creating fake lighting, but also realistic ones. We shaped point lights into rod-like shapes in the maze, so they could light bigger parts of walls because they were very dark. Other elements we used, were sphere reflection capture objects, and LightmassImportanceVolume, which tells the game engine which part of the scene is the most important. We also used sky atmosphere object to add more detail to the sky and lighting condition.

5.1.3 Animations

To make the experience of the third-person camera more real, we decided to animate the player's character. We created an IK animation system for the character blueprint so that the arms of the character are moving in relation to the VR controllers. For hands, we are using original XR Hands from the Unreal Engine 5 VR template, for ease of use, and hand animations are already implemented. That is the reason why we deleted hands from the Elf model. It is also good to mention, that the character is only visible from the third-person view, in the first-person view, players can only see XR hands. Unfortunately, we were not able to make proper animations for the legs, so only the upper body is currently responsive to animations. The graph editor screenshot combined with the animation blueprint is shown in Figure 5.9.

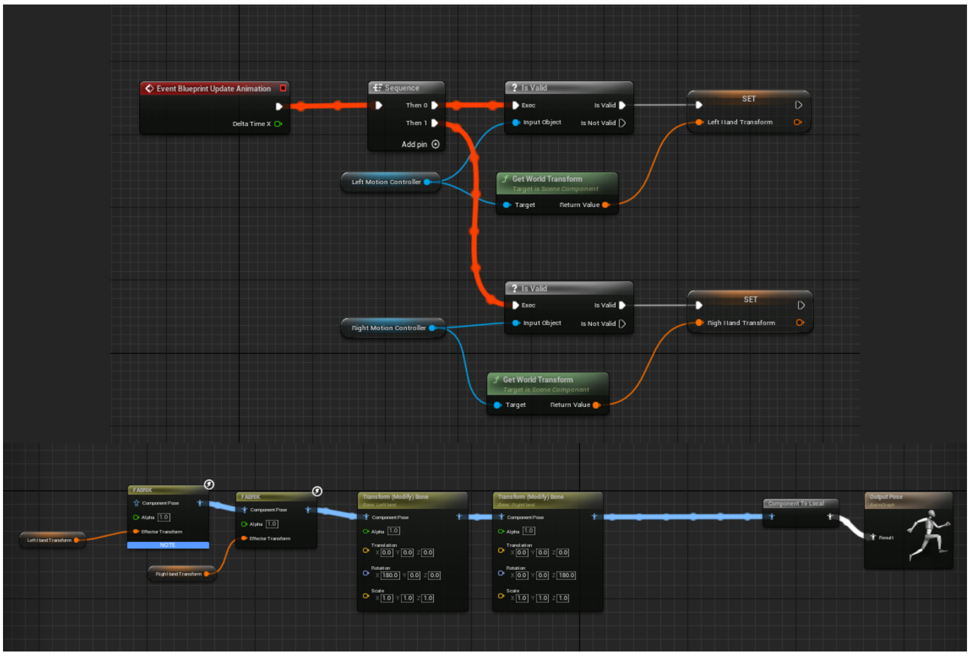


Figure 5.9: The setup of the third-person character animations

We also designed animations for the enemy character. We made use of Mixamo, where we imported our model, it was rigged automatically, and we chose animations we wanted to use for this character. After gathering all of them, we started implementing them into an animation blueprint. The animations should be as follows:

- When spawned, it should spread arms
- Shortly after, it should start walking towards the player - walking animation
- Once the enemy reaches the player, it swings its hand on the player - attack
- After an enemy is hit, it will die and fall to the ground - death

We also created blend animations which should differentiate animations depending on the speed of the enemy. Unfortunately, animations for enemies were not working in the final prototype. However, animations are ready in the system, but not being used since they did not work.

5.1.4 Audio

As in many games and experiences, the background is never totally quiet, and that's why we brainstormed what sounds would suit best our environment. We included sounds from the decision-making and designing process, and the references to them can be found in Appendix 11.2.5.

Environmental sounds

We used sounds of nature for the scene ambiance, this sound is looped and played in the background without a specific 3D location. The specific sound for the first mini-game we used is the waterfall sound. This sound is location-based and has an attenuation set so that the sound of it is the most audible while being close to the exit from the arena. Another sound specific to this location is fight music, that is being played while players are in combat with enemies.

In the temple area, we made use of the AudioVolume object, and it helps to imitate indoor conditions. Therefore, the sounds of nature are audible, but the volume is set to only 20%. To make it more interesting while playing the second mini-game, we added ambient music into the scene, that is audible only inside the temple.

The third location makes use of nature sounds and also location-based sounds of the wind. These sounds have two origins and have set attenuation, and the wind is not audible everywhere in the maze.

Narrative

We made use of the narration system as it was described in The Narrative section 4.3.3. The sounds are being played based on the event system integrated into a game controller. So to play the sound, players for example have to complete the task or walk and trigger specific cues.

Sound Effects

We are using various sound effects. Starting with the sound of the sword hitting flesh, this sound is integrated into the event system inside of the sword blueprint, and when it collides with an enemy, it will play the sound. Another similar approach was taken to the grabbing and dropping of items, those sounds are also integrated into the items' blueprints. The next sound is just the word "fight" that is being played at the beginning of the fight when the player grabs the sword. Lastly, there were also sounds included in the enemy's animations, but since animations are not working, neither are sounds. However, the sounds were as follows:

- Idle roar when spawned - accompanied by spreading arms animation
- Heavy footstep sounds
- Hand attack sound - swoosh
- Death roar

5.2 Code Implementation

In order to develop and implement the test application, a project was established using Unreal Engine 5.1.1 with its VR template, to import default assets that could be used to test during an early prototyping phase. Following this, scenes were created for use in our two-step test protocol, and Blueprints were set up to facilitate our needs of first- and third-person camera views, the option to toggle between them, smooth locomotion, alongside tasks for users to complete.

5.2.1 VR Pawn BluePrint

Each scene has a 'Player Start' actor, which will spawn in whichever default player actors are chosen within the World Settings editor. As the project requires only a single-player actor in any of the given scenes, a single Blueprint is needed for the main player controller.

Incorporated into the VR Template is a Blueprint for a VRPawn, the player controller intended for use with HMDs. While an initial version of this is supplied by the Unreal Engine VR template, this was extended upon to facilitate 3rd person view, toggleable camera input, smooth locomotion, and other necessary changes needed for the test.

First of all, in order to allow the use of third-person, a new camera component was added to the Blueprint, alongside using a SpringArm to keep it bound to the character and prevent clipping into walls when walking in narrow pathways or up to a collider. The Blueprint setup can be seen in Figure 5.10.

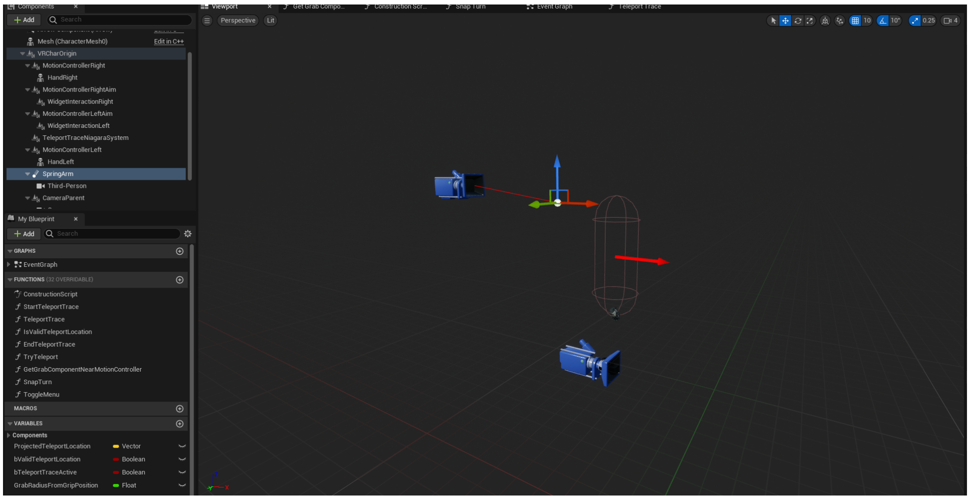


Figure 5.10: Attached camera in the VRPawn Blueprint

In order to swap between the two methods of camera usage, a new input action was added to toggle the camera method, using a simple flip-flop operator to toggle the active status of each camera component respectively. See Figure 5.11.

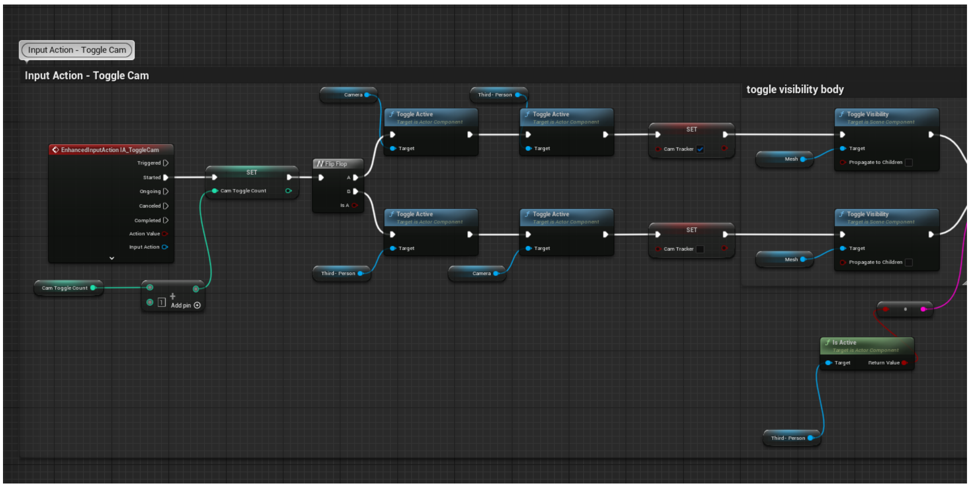


Figure 5.11: Toggle function between cameras

Then, to swap over from the movement method of teleportation towards using smooth locomotion, 2 more input actions were added: Locomotion on a horizontal axis and movement on a vertical axis, to move side-to-side or forwards and back respectively. This implementation is performed by firstly getting the value assigned from the input manager which ties the input to the value of the thumb-stick on the left controller by default, updating the capsule position, before finally adding the movement input to the active camera's forward vector. This does so by the scale value specified through math operators between the thumb-stick's value from the input action and the movement input node. See Figure 5.12.

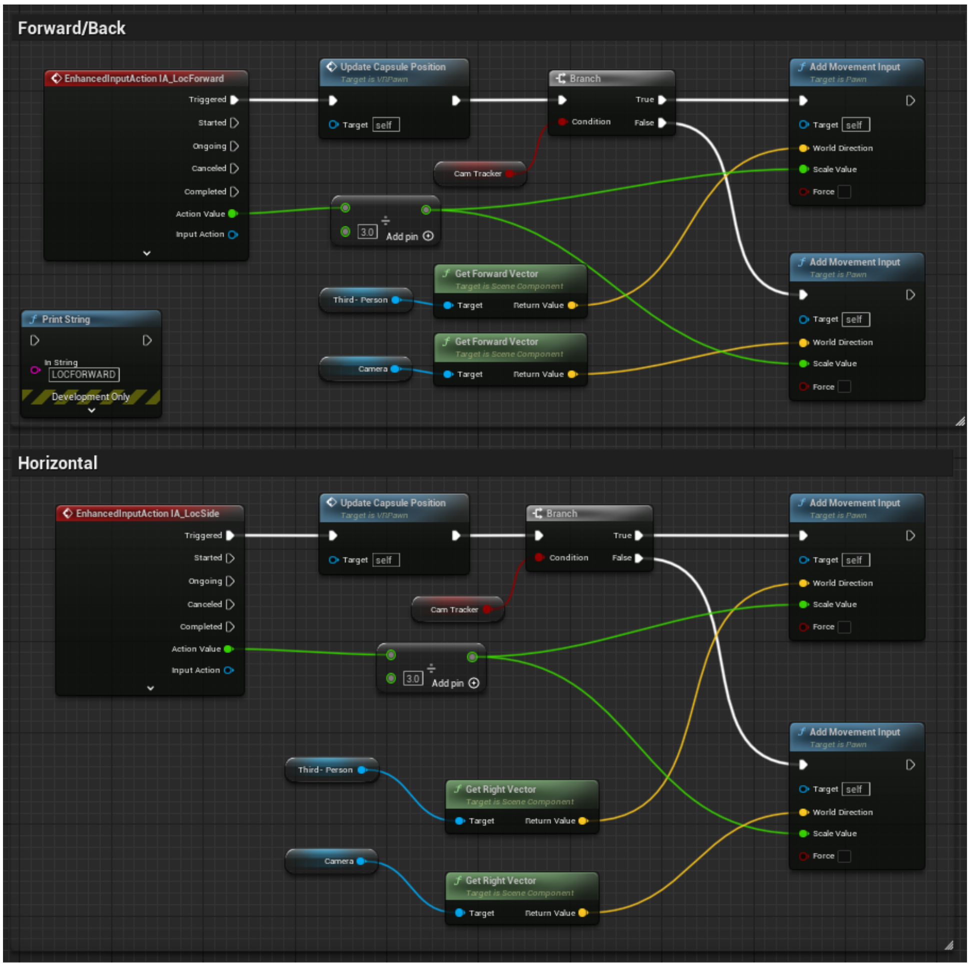


Figure 5.12: Smooth locomotion function

Additional input was added to ensure snap turn functioned as well. This was set to a default value of 15 degrees per turn input. This simply checks if the thumb-stick input is positive or negative (I.E left or right), and then forwards the default value either as a positive or negative float to a yaw rotation input, rotating the character controller's yaw by a given amount. Camera turn function can be seen in Figure 5.13.

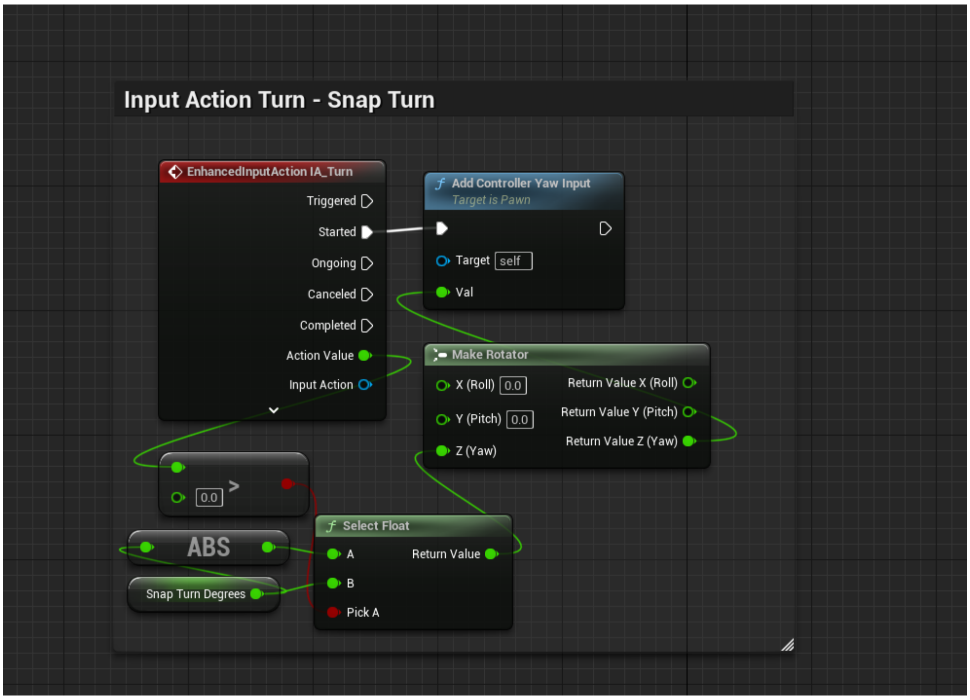


Figure 5.13: Camera snap rotation function

5.2.2 Game Manager

Alongside the player controller, a game manager Blueprint was implemented, to keep track of the game state and properly note when the user has completed each task, to teleport them to the next area to complete. Upon the game initialization, the screen fades in from black, and following a scripted series of nodes, a sound clip plays of the narrator's voiceover, followed by the sword spawning in for players to begin the combat section. See Figure 5.14.

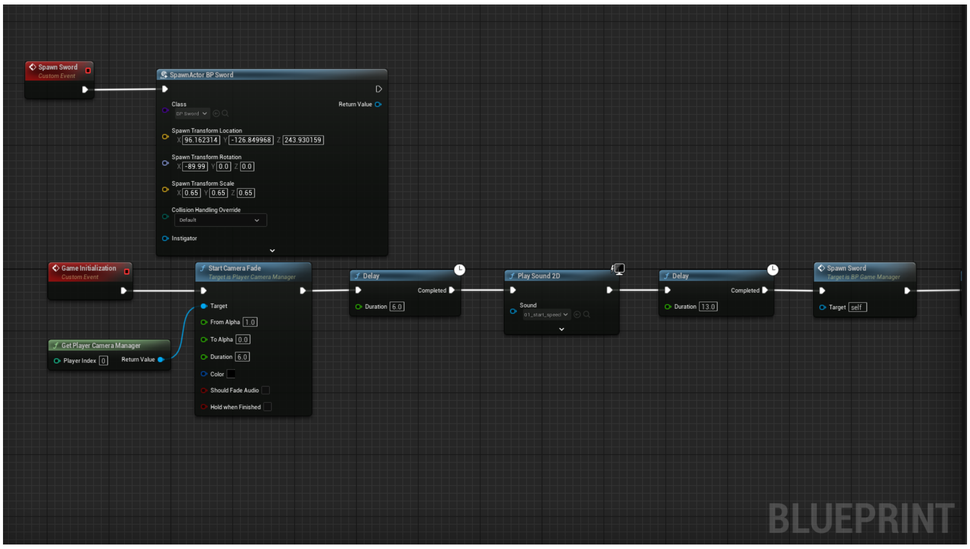


Figure 5.14: Game initialization

The enemies during this first section are pre-spawned in and their visibility is activated on a timed delay, giving the player enough time to hear the narration and pick up the sword before they begin slowly moving towards the player's position. See Figure 5.15.

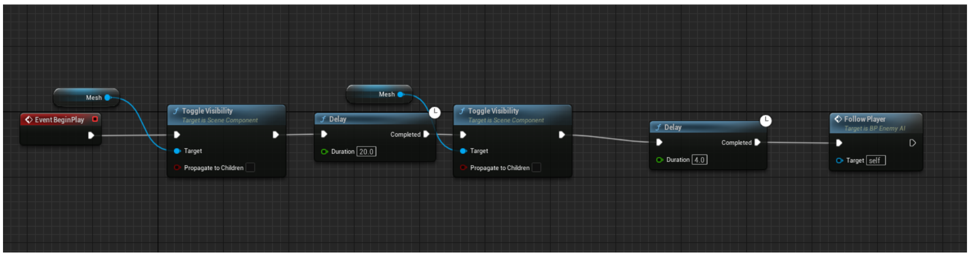


Figure 5.15: Enemy delay script

Once each enemy (noted as demons in code) is hit by the sword, they increment an integer keeping track of the number of demons killed by 1, through a variable in the GameManager Blueprint. This then triggers a quick check for whether or not all the demons have been killed, and once enough have been killed for the check to complete, the section is considered finished, and the script to move onto stage 2 is run. This plays narration for the player, fades their screen, and teleports them to the next location, before unfading and completing with a last bit of voiced narration, informing them of what to do for the next task.

The second task similarly follows suit of the balls each having an appropriate Blueprint attached to them, incrementing 2 integers and keeping track of blue and red balls in the game manager. Once the balls fall into contact with the collision box of their correlating sortable boxes, they add to the counter. Likewise, if one is removed, it subtracts from the counter. Each time a ball is added, a check is run to see if all balls have been sorted correctly. Once the total count of each colored ball meets the criteria, the event is run to trigger the last stage of the game: The maze. The Ball Blueprint is shown in Figure 5.16.

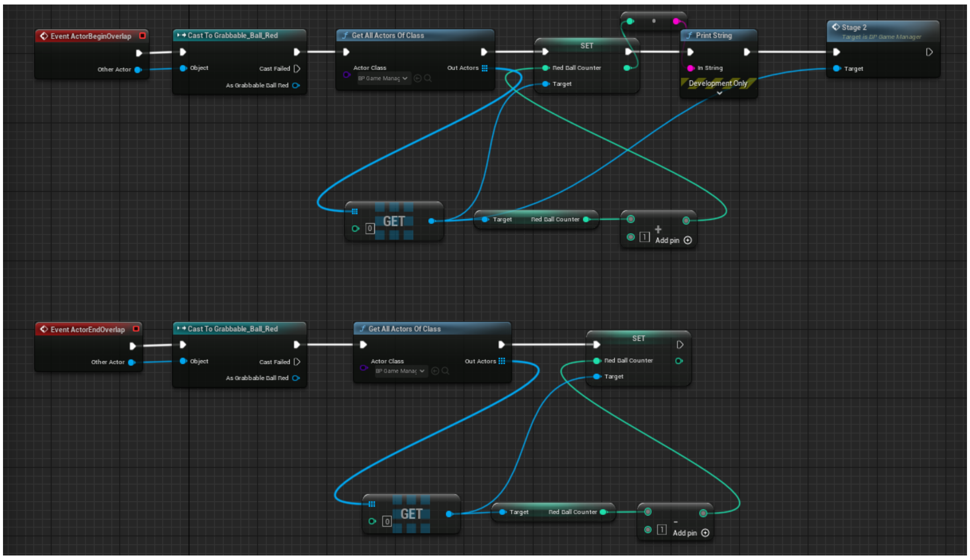


Figure 5.16: Enemy delay script

This, once again, fades the screen for the player after playing narration for them, teleports them, fades the screen in again, and plays an introductory voiced narration to help inform them what task is expected of them to perform. The maze does not require much in the way of technical implementation, merely awaiting the player controller to collide with an invisible collision box near the end of the maze. Letting them traverse at their own pace, once they reach the end of the maze and trigger the last part of the script, a last bit of voiced narration plays, before fading the screen to black and exiting the application.

Chapter 6

Results

This chapter will include the results of the experiment we conducted. The data will be analyzed and graphs will be attached accordingly to corresponding categories. The interpretation and discussion of this data will be written in the Discussion chapter 7.

6.1 Demographics

The following questions shown below were posed in order to obtain demographic information about the user, to later draw any correlations with their results:

- "Gender"
- "Age"
- "How familiar are you with VR?" (Regular usage, Occasional usage, Tried it once or twice, Never tried it before)
- "If you have experience, how comfortable do you find using VR to be?" (1 = Very unpleasant and 5 = Very comfortable)
- "How prone to motion sickness, or similar symptoms, would you regard yourself as being?" (1 = Not at all and 5 = Very sensitive)
- "Are you currently under the influence of any substance?" (None, Coffee (in the last 6 hours), Alcohol, Hangover, Other)
- "Do you use glasses? (Under any circumstances)"
- "If so, what strength?"

Participant	Gender	Age	VR Fam.	VR Exp.	Motion Sickness	Substances	Glasses
1	Female	23	Never tried	N/A	1	Coffee	-1
2	Female	23	Never tried	N/A	1	Coffee	-1.25
3	Male	26	Occasional usage	4	1	None	N/A
4	Female	32	Tried it	3	1	None	N/A
5	Male	34	Occasional usage	4	1	None	-3.5
6	Male	20	Never tried	N/A	1	Alcohol	N/A
7	Male	21	Occasional usage	5	2	None	N/A
8	Male	34	Never tried	N/A	1	None	-3.25
9	Female	24	Tried it	4	1	None	N/A
10	Female	26	Never tried	N/A	2	None	-1.75
11	Male	34	Tried it	3	4	Coffee	2
12	Female	32	Tried it	4	2	None	0.5
13	Female	23	Occasional usage	5	1	Coffee	1.25
14	Female	22	Tried it	4	2	None	N/A
15	Female	24	Tried it	5	1	None	N/A
16	Female	22	Tried it	4	3	ADHD meds	3.5
17	Male	19	Tried it	2	1	Coffee	-3
18	Male	21	Regular usage	4	5	Coffee	-2
19	Male	28	Tried it	3	2	Coffee	-3.75
20	Male	28	Occasional usage	4	3	None	N/A
21	Male	24	Tried it	4	1	None	1.75
22	Male	61	Occasional usage	3	1	None	2
Mean Avg.		27.3		3.8	1.7		-0.6
Median		24		4	1		-1.75

Table 6.1: Demographic results

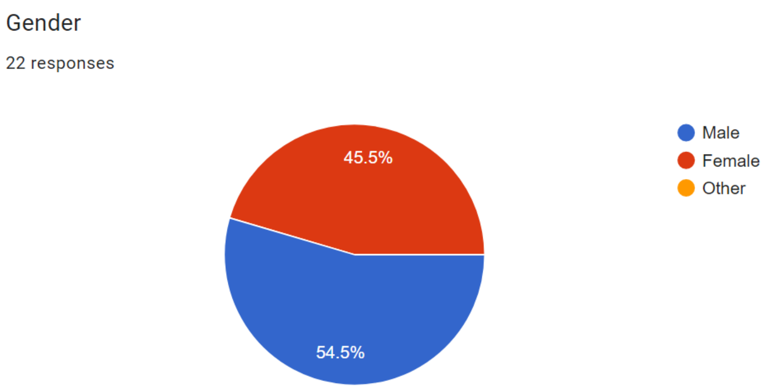


Figure 6.1: Gender diagram

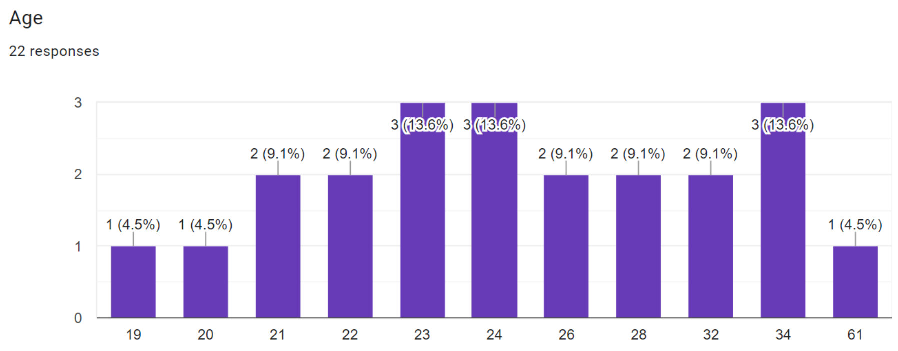


Figure 6.2: Age diagram

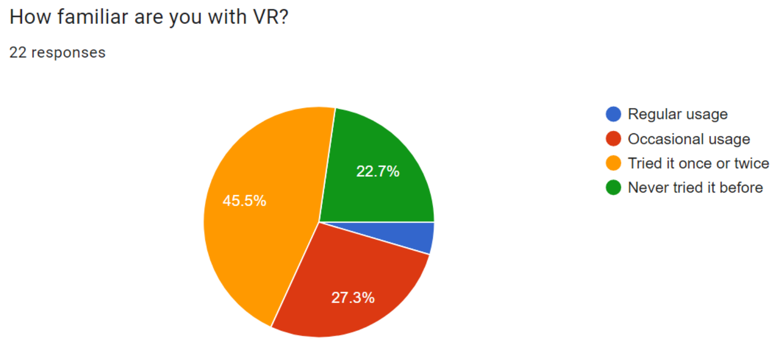


Figure 6.3: Familiarity with VR diagram

6.2 Post-tutorial Results

The post-tutorial questionnaire drew some inspiration from the SUS questionnaire as mentioned in the Evaluation methods 3.3. The composed questions in the questionnaire are as follows:

- Did you have a preference for a certain camera mode, in general? (First Person, Third Person, No preference)
- How easy did you find swapping between the two camera modes to be? (1 = Very hard and 5 = Very easy)
- How disorienting did swapping between camera modes feel? (1 = Very disorienting and 5 = Very coherent)
- Is there any particular reason that it made you feel that way?
- How disorienting did the two camera modes feel? **First Person** (Very disoriented, Much, Somewhat, Slightly, Very coherent)
- How disorienting did the two camera modes feel? **Third Person** (Very disoriented, Much, Somewhat, Slightly, Very coherent)
- How easy was it to navigate your surroundings, using the two camera modes? **First Person** (Very difficult, difficult, fair, easy, very easy)
- How easy was it to navigate your surroundings, using the two camera modes? **Third Person** (Very difficult, difficult, fair, easy, very easy)
- Did the usage of switching between camera modes give any difficulties or confuse you somehow?

6.2.1 Quantitative Results

In this section, we will present quantitative data gathered from the questionnaire after tutorial testing. It will include tables with values and will display some graphs as well.

For space management purposes, the First-Person will be regarded as **FP and the Third-Person as **TP***

Participant	General Pref.	Swapping ease	Swapping disorientation
1	First Person	4	3
2	First Person	3	4
3	Third Person	5	5
4	First Person	5	5
5	First Person	5	5
6	First Person	4	2
7	Third Person	5	4
8	First Person	5	3
9	First Person	5	4
10	First Person	5	4
11	First Person	5	2
12	First Person	5	4
13	First Person	5	5
14	No Preference	5	5
15	First Person	5	5
16	First Person	5	3
17	First Person	5	3
18	No Preference	5	4
19	No Preference	5	5
20	Third Person	4	4
21	First Person	5	3
22	First Person	4	3
Mean Avg.		4.7	3.9
Median		5	4

Table 6.2: The first part of the post-tutorial results

Participant	Disorientation FP*	Disorientation TP*	Navigation FP*	Navigation TP*
1	4	4	4	3
2	5	4	4	4
3	4	4	5	4
4	4	4	3	3
5	5	5	5	5
6	5	3	5	4
7	5	5	5	4
8	3	3	5	5
9	5	4	5	4
10	5	5	4	4
11	4	2	5	5
12	5	3	3	2
13	5	5	4	5
14	5	5	4	4
15	5	5	4	4
16	3	4	4	5
17	5	4	2	5
18	4	3	5	3
19	4	3	3	5
20	4	5	5	3
21	5	2	4	5
22	5	4	5	5
Mean Avg.	4.5	3.9	4.2	4.1
Median	5	4	4	4

Table 6.3: The second part of the post-tutorial results

	Disorientation caused by cameras	Navigation ease
p-value	0.0119	0.7240

Table 6.4: p-value of the disorientation and navigation questions

6.2.2 Qualitative Results

This section will present and categorize qualitative data we obtained from testing participants after the tutorial test.

When participants were presented with this question: ***How disorienting did swapping between camera modes feel?***, there was a follow-up question for people, who wanted to elaborate more upon that topic - ***Is there any particular reason that it made you feel that way?***

One participant responded, that they were trying VR for the first time, so they did not know what to expect, while another mentioned that the third-person camera was farther than they expected it to be. However, it was also mentioned that it was less disorienting than expected and that switching views felt pretty natural. We also got an answer, that the swapping was smooth and that it was quick to get used to the third-person perspective. Also, it was stated that the third-person perspective made a participant less motion sick than the first-person perspective. On the other hand, there were also some negative comments. One of the statements is that it was difficult to adjust skills in order to pick up objects. Another participant mentioned, that while they have quite high resistance towards motion sickness, the tutorial scene made them slightly sick, however, they did not mention which camera mode specifically. Lastly, one participant mentioned that the elevation while swapping cameras made them disoriented.

Another question we asked was: ***Did the usage of switching between camera modes give any difficulties or confuse you somehow?***

Two respondents mentioned that switching itself did not cause any problems, but it was more difficult to grab items in the third-person perspective, however, they stated that they could get used to it pretty quickly, and they had problems only the first few moments. 17 respondents answered that they did not have any difficulties or did not get confused while switching cameras. There was another comment that the camera swapping was very smooth. From the negative comments, they stated that grabbing objects was difficult in the third-person view, because they could not see in front of them, and one participant also stated that switching made them more motion sick.

6.3 Post-test Results

The post-test questionnaire, similar to the post-tutorial questionnaire, drew some inspiration from the SUS questionnaire. The final questions in this questionnaire are as follows:

- How easy did you find swapping between the two camera modes to be, after trying the full application? (1 = Very hard and 5 = Very easy)
- How disorienting did swapping between camera modes feel? (1 = Very disorienting and 5 = Very coherent)
- Is there any particular reason that it made you feel that way?
- Did swapping cameras interfere with or improve your experience in any particular way?
- How easy was completing the application? (1 = Very difficult and 5 = Very easy)
- Did you have a preference for any of the camera modes, for each of the tasks? **Combat** (First-Person, Third-Person, No preference)
- Did you have a preference for any of the camera modes, for each of the tasks? **Sorting** (First-Person, Third-Person, No preference)
- Did you have a preference for any of the camera modes, for each of the tasks? **Maze** (First-Person, Third-Person, No preference)
- How effective did you find using each camera mode for the first task? (Combat) **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How effective did you find using each camera mode for the first task? (Combat) **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How effective did you find using each camera mode for the second task? (Sorting) **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How effective did you find using each camera mode for the second task? (Sorting) **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How effective did you find using each camera mode for the third task? (Maze) **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How effective did you find using each camera mode for the third task? (Maze) **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)

- How quickly did you find yourself getting familiar with each of the camera modes? **First Person** (Very slowly, Slowly, Moderately, Quickly, Very quickly)
- How quickly did you find yourself getting familiar with each of the camera modes? **Third Person** (Very slowly, Slowly, Moderately, Quickly, Very quickly)
- How confident did you feel using each VR camera mode? **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How confident did you feel using each VR camera mode? **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How consistently did you feel each of the camera modes worked? **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How consistently did you feel each of the camera modes worked? **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How comfortable did you feel moving around using each of the camera modes? **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How comfortable did you feel moving around using each of the camera modes? **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How comfortable did you feel interacting with objects using each of the camera modes? **First Person** (Not at all, Slightly, Moderately, Very, Extremely)
- How comfortable did you feel interacting with objects using each of the camera modes? **Third Person** (Not at all, Slightly, Moderately, Very, Extremely)
- Did the First-Person camera option present any specific or particular difficulties in any of the tasks?
- Did the Third-Person camera option present any specific or particular difficulties in any of the tasks?

6.3.1 Quantitative Results

This section, will present quantitative data gathered from the questionnaire after main testing, and it will include tables with values and display corresponding graphs as well.

Participant	Swapping ease	Swapping disorientation	Game difficulty
1	3	3	3
2	5	5	5
3	5	4	5
4	5	4	4
5	5	5	5
6	5	5	4
7	4	3	5
8	5	3	5
9	5	5	5
10	5	5	5
11	5	4	5
12	5	3	5
13	5	5	5
14	5	5	4
15	5	5	4
16	4	4	5
17	5	4	5
18	5	5	5
19	5	4	4
20	4	4	5
21	5	4	4
22	5	5	4
Mean Avg.	4.8	4.3	4.6
Median	5	4	5

Table 6.5: The first part of the post-test results

Participant	Preference (Combat)	Preference (Sorting)	Preference (Maze)
1	No Preference	First-Person	First-Person
2	First-Person	First-Person	Third-Person
3	Third-Person	First-Person	Third-Person
4	First-Person	First-Person	Third-Person
5	No Preference	First-Person	Third-Person
6	First-Person	First-Person	Third-Person
7	First-Person	First-Person	Third-Person
8	First-Person	First-Person	First-Person
9	First-Person	First-Person	Third-Person
10	First-Person	No Preference	First-Person
11	First-Person	First-Person	No Preference
12	No Preference	First-Person	Third-Person
13	Third-Person	First-Person	No Preference
14	No Preference	Third-Person	Third-Person
15	First-Person	First-Person	Third-Person
16	No Preference	First-Person	Third-Person
17	First-Person	Third-Person	Third-Person
18	First-Person	First-Person	Third-Person
19	First-Person	First-Person	No Preference
20	First-Person	First-Person	Third-Person
21	Third-Person	First-Person	No Preference
22	First-Person	No Preference	First-Person

Table 6.6: The second part of the post-test results

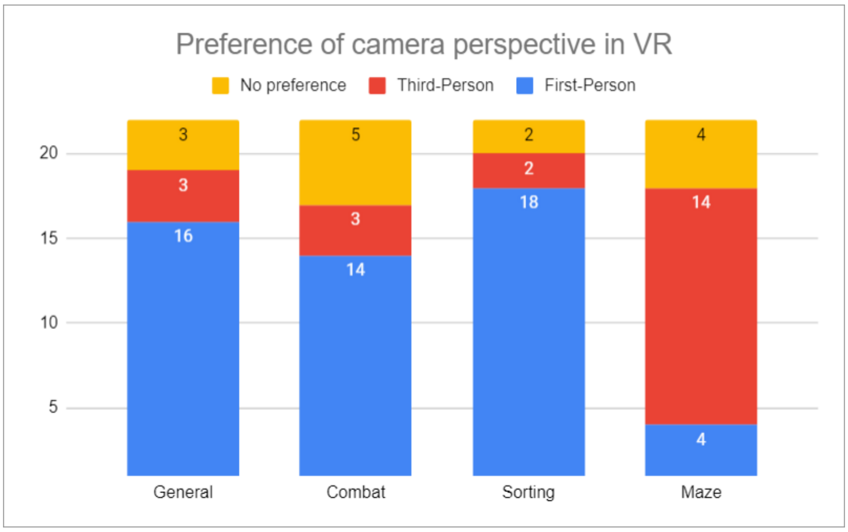


Figure 6.4: Diagram of the camera preference in general, for the combat, sorting, and the maze

Effectiveness of camera modes in each mini-game						
	Combat		Sorting		Maze	
Participant	FP*	TP*	FP*	TP*	FP*	TP*
1	4	4	4	1	4	4
2	4	3	4	3	3	5
3	3	5	5	3	4	5
4	5	4	5	3	5	5
5	5	5	5	1	4	5
6	4	4	4	4	4	4
7	3	4	4	3	4	4
8	4	4	3	4	4	4
9	5	3	5	5	3	5
10	4	4	4	4	5	5
11	5	4	5	1	4	3
12	4	4	5	1	4	5
13	3	5	5	3	3	5
14	4	5	4	5	4	5
15	5	4	5	3	3	5
16	4	3	4	1	3	4
17	5	3	3	4	3	5
18	4	3	5	1	3	5
19	5	4	5	3	4	5
20	5	3	5	4	4	4
21	3	5	5	1	3	4
22	5	4	5	5	5	4
Mean Avg.	4.2	4	4.5	2.9	3.8	4.5
Median	4	4	5	3	4	5

Table 6.7: The third part of the post-test results

	Combat	Sorting	Maze
p-value	0.3145	0.0003	0.0012

Table 6.8: p-value of the effectiveness questions

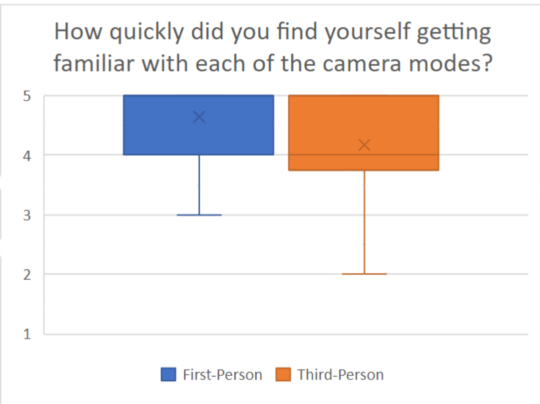
Figure 6.5: Box plot diagrams of both camera views for each mini-game

Participant	Camera learning speed FP*	TP*	Confidence while using camera FP*	TP*
1	4	2	3	4
2	5	5	4	4
3	5	5	4	4
4	4	4	4	4
5	5	4	4	4
6	4	4	4	4
7	5	4	5	4
8	5	4	5	5
9	5	5	5	5
10	5	5	5	5
11	5	3	5	4
12	5	3	4	3
13	5	5	5	5
14	3	5	4	4
15	4	4	4	4
16	4	3	5	4
17	5	5	5	5
18	5	3	5	5
19	5	5	4	4
20	5	5	5	5
21	5	5	4	3
22	4	4	5	5
Mean Avg.	4.6	4.2	4.5	4.3
Median	5	4	4.5	4

Table 6.9: The fourth part of the post-test results

	Camera learning speed	Confidence while using different cameras
p-value	0.0379	0.1035

Table 6.10: p-value of the speed of learning and confidence questions



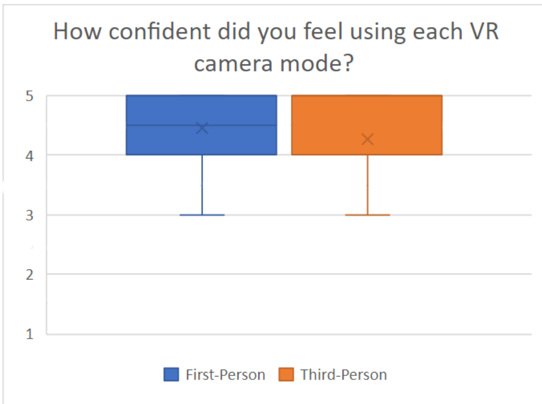


Figure 6.6: Box plot diagrams for learning speed of camera switching, and confidence of using different camera perspectives

	Camera consistency		Comfort while moving		Comfort while interaction	
Participant	FP*	TP*	FP*	TP*	FP*	TP*
1	4	3	4	3	4	4
2	4	4	4	4	4	4
3	4	3	3	4	4	4
4	5	4	4	5	5	4
5	5	4	5	5	5	4
6	3	4	4	4	4	3
7	4	3	5	4	4	4
8	4	4	5	5	5	5
9	5	4	4	5	5	3
10	5	5	5	5	4	3
11	4	4	4	4	5	1
12	5	3	5	3	5	1
13	5	5	5	3	5	4
14	5	5	1	4	4	3
15	5	5	5	5	5	5
16	4	4	4	5	4	4
17	5	4	5	5	5	3
18	5	3	3	5	5	4
19	5	4	4	4	5	3
20	4	4	4	4	5	4
21	4	3	4	4	5	3
22	5	5	5	5	5	5
Mean Avg.	4.5	4	4.2	4.3	4.6	3.5
Median	5	4	4	4	5	4

Table 6.11: The third part of the post-test results

	Camera consistency	Comfort while moving	Comfort while interacting
p-value	0.0023	0.5757	0.0003

Table 6.12: p-value of the camera consistency, comfort while moving and interacting questions

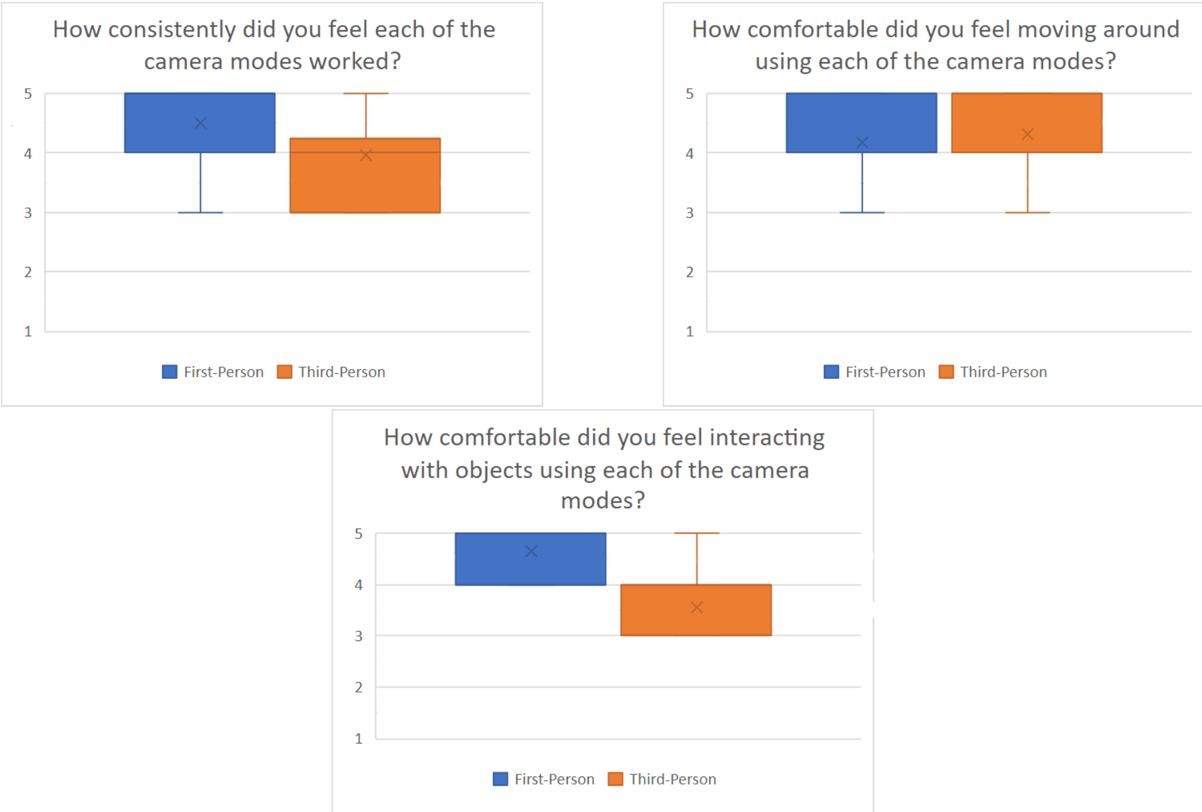


Figure 6.7: Box plot diagrams for camera consistency, comfort while moving, and comfort while interacting

6.3.2 Qualitative Results

This section will present and categorize qualitative data we obtained from testing participants after the tutorial test.

The questionnaire contained the same set of questions as in the post-tutorial questionnaire, participants were asked: ***How disorienting did swapping between camera modes feel?***, with the follow-up question - ***Is there any particular reason that it made you feel that way?***

In this section, we received answers that while walking, the third-person view was coherent, but when they tried to sort things, they were a bit lost. Someone mentioned that the only thing that happens, is that when they changed the camera, they might experience immediate disorientation. Another participant noted that the transition between cameras was very smooth, so it did not have any negative impact on their experience. We also received notes on the ease of orientation and that the first-person camera was a better choice for object interaction, while the third-person was a better option for walking around. It was also stated that quick camera snapping did not cause motion sickness and that the third-person camera usage was very intuitive. As for some negative feedback received, users complained again about the elevation between the camera modes, that it was difficult to align the player's character with the camera in third-person perspective, and that switching to the third-person perspective took one participant around 1-2 seconds to get used to it.

The next qualitative question asked was: ***Did swapping cameras interfere with or improve your experience in any particular way?***

More participants mentioned that the first-person felt more natural, while the third-person felt like playing games on a console. Another comment was regarding the forward movement based on the camera pointer. A participant mentioned that it felt natural, but it was quite nauseating from the third-person perspective, however, they also added that in general, the third-person made them feel more at ease in regard to nausea. Another note was on the third-person view and its immediate understanding of the environment around, while it was also more difficult to control hands because they lacked finer details. Some of the participants mentioned that swapping cameras definitely improved their experience and that it was very useful in several situations. Multiple participants also mentioned that it was explicitly useful while navigating the maze, so they could switch to the third-person perspective and have a better overview of their surroundings. Some participants also mentioned that it was good because they felt less motion sick in the third person. However, some people mentioned again that it was difficult to pick up items and someone also mentioned that they felt more dizzy in the third-person perspective.

The last two qualitative questions asked whether there were any difficulties with each camera perspective, starting with the first question: ***Did the First-Person camera option present any specific or particular difficulties in any of the tasks?***

Participants mentioned that it was easier to do a sorting task and combat because it felt as if they were actually in the scene. One participant stated that it did not present any problems because it worked well with all tasks. Another participant mentioned that they did not use a first-person view in the maze because they had a better view of the whole surrounding. Participants also mentioned that it was much more difficult to navigate inside the maze and that rotating was a bit disorienting. Some also mentioned that it made them motion sick when interacting with objects as well as while moving, therefore they rather used the third-person view. They also stated that it was more difficult to see and too hard to get a larger overview of the world.

As mentioned before, the last question will be similar to the previous, while asking about the third-person: ***Did the Third-Person camera option present any specific or particular difficulties in any of the tasks?***

Many participants unanimously stated that interacting with objects in the third-person was either very difficult for some or impossible for others. One participant also suggested, that if there was a possibility to control the distance and height of the camera in the third-person, it might solve such issues. Some participants also mentioned that they experienced hands disconnecting from their virtual body, due to their physical position being different from their starting position. Some also noted that it was more difficult to figure out the distance between them and objects or enemies.

Chapter 7

Discussion

7.1 Demographics Review

With a fairly even distribution in gender between male and female, there seemed to be no particular difference in results gathered from participants on this front, having fairly consistently identical results. In terms of age, the primary age group of test participants were young adults, ranging from early 20's to early 30's, with a single outlier of 61.

Beyond these factors, a majority listed themselves as being not particularly affected by motion sickness, and coffee was the most frequently listed substance that participants were under the influence of. However, only a minority of 7 listed themselves as having had coffee, and of which there does not seem to be any particular affectation upon the results as a consequence of this.

7.2 Post Tutorial and Main Test Review

The post tutorial questionnaire seemed to demonstrate some initial comfort in making use of the camera-swapping system, with a mean average of 4.7 and a median of 5 for ease of use, ensuring fewest possible interaction issues, albeit with a disorientation score of 3.9 mean average and a median of 4. With a standard deviation of 0.97, this question seemed to be one of the most mixed among this series of questions, as individuals seemed to take to it very subjectively. It is notable that comparing this to the main test questionnaire, however, the score improved by a fair margin, increasing up to 4.27 mean average, retaining a median of 4, and the standard deviation lowering to 0.76. If one were to calculate a two-tailed paired T-Test to obtain a p-value in comparing these two results, it would result in a value of 0.095, which would not be statistically significant under conventional regards. However, it is relevant to note that after exposure to the full main test, no participant noted worse disorientation, and scores only either remained static or improved. This could hesitantly be assumed to indicate that there may be the potential for such discomfort or disorientation to improve over time with use.

Beyond this, similar scores to one another were reported regarding navigation for first- and third-person, with close enough similarity that one can assume there to be little influence from camera perspective upon the user's ability to navigate and traverse the virtual space. The qualitative optional questions did not yield much input on difficulty or confusion from switching camera modes, besides one comment on potentially additional motion sickness, one on lack of visibility and one on difficulty of grab interactions within third-person.

7.2.1 Task comparison

From the results of the questions comparing camera usage in the three tasks there seemed to be a clear indication of preference towards a first-person camera perspective for most of the application, with the exception of the single last task.

In specifics: For the combat task, there did not seem to be a large difference in rated effectiveness between first-person and third-person, respectively having mean averages of 4.22 and 3.95, however there did seem to be a clear trend toward first-person by participants' preferred camera perspective with a majority of 14 people preferring first-person over 5 having no preference, and 3 preferring third-person. Considering the consistency of answers and standard deviation between the two separate conditions, resulting in a p-value of 0.31, it would be fair to deny any plausible statistical difference between the two conditions on their perceived effectiveness at completing the task, however it is still notable that the majority had a preference towards first-person regardless.

The sorting task had the most stark and significant difference, with the mean average being 4.5 and 2.86 for first- and third-person respectively, a resulting p-value of 0.0003 indicating clear statistical significance, alongside an incredibly clear preference towards first-person, with 18 people preferring it over 2 having no preference and 2 preferring third-person.

Lastly, standing out from the other tasks, the maze task had a better perceived effectiveness of third-person, with a mean average of 4.54 compared to 3.77 from the first-person perspective. The p-value resulted in 0.0012, indicating a statistically significant difference in perceived effectiveness for this task. In addition to this, the trend of preferring first-person seemed to be excepted from this task, where participants instead opted primarily for a preference towards a third-person perspective, with a majority of 14 preferring it, 4 having no preference, and 4 still preferring first-person.

Given this data, we consider it fair to state that the general sentiment towards the experiment seemed to consider first-person to be the overall better experience for both of the tasks containing elements of interaction and small-scale movement, while the task that was solely focused on navigation and more movement with locomotion fared better with the use of a third-person perspective. Through the qualitative data gathered, some statements were made on feeling less nauseated and disoriented in using third person, alongside it providing a better overview and spatial awareness of the last task.

Chapter 8

Conclusion

In conclusion, to answer the problem statement of:

How effective can a third-person camera perspective in VR be compared to first-person, for the purpose of conventional and gamified tasks?

While some underlying causes of results may be open to interpretation, we feel secure in drawing the conclusion of third-person remaining a viable option for conventional use in VR experiences and games. The data gathered seems to indicate a preference towards it when using smooth locomotion to navigate larger virtual areas under the right circumstances, albeit at the cost of reduced effectiveness of fine interaction and visibility. Solutions to these issues may be further experimented on and developed, but as a baseline the option of using alternative camera methods to the conventional use of first-person in VR may be a plausible direction in improving the usability and comfort for some players where navigation is concerned.

Chapter 9

Future Work

9.1 Implementation Reflection

This project turned out fairly well from the implementation side, but there are some things that could improve upon it. To start with, the animations for the player's character would be great to be functional. That means, having a lower body animated based on the thumb-stick movement, then hands being not separated from the main body. These, however, would have to be fully animated from the beginning for all interactions within Unreal Engine 5 and its XR kit. Another visual and experience-altering part was our enemies, which did not function as intended. For another experiment, these should be fixed, to increase overall impression. Lastly, as it was mentioned in our results, test participants did not think that the third-person view was effective to use while interacting with items. This could potentially be fixed by decreasing the opacity of the player's character and maybe giving a possibility to players to either zoom in and out the camera, or to move it up and down.

9.2 Future Testing

For future testing, it would be rather interesting to try out and implement different variations of the third-person camera to compare. First, the camera could be implemented with smooth thumb-stick rotations. The observations could be done whether it makes any changes in regard to cybersickness and ease of use, in comparison to the camera rotations with snapping. Another experiment variation could include testing of the third-person camera, which will have rotation around the character based on the rotation of the HMD. These types of experiments could bring new perspectives on the implementation of third-person camera usage in VR, and may result in alternative results that may yield unique conclusions to base further research upon.

Chapter 10

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Chapter 11

Appendix

11.1 Questionnaire

11.1.1 Pre-test Demographic Questions

1. Gender - Female/Male/Other
2. Age - short answer
3. How familiar are you with VR? - choice answer, regular usage, occasional usage, tried it once or twice, never tried it before
4. If you have experience, how comfortable do you find using VR to be? - 1 to 5 answer, 1 meaning "Very unpleasant" and 5 "Very comfortable"
5. How prone to motion sickness or similar symptoms, would you regard yourself as being? - 1 to 5 answers, 1 meaning "Not at all" and 5 "very sensitive"
6. Are you currently under the influence of any substance: None, Coffee (within last 6 hours), Alcohol, Hangover, Other - Checkbox answer 7. Do you use glasses? (Under any circumstances) - Yes or No
8. If so, what strength? - short answer

11.1.2 Post-tutorial Questionnaire

1. Did you have a preference for a certain camera mode, in general? - first person, third person, no preference
2. How easy did you find swapping between the two camera modes to be? - 1 to 5 answer, 1 meaning Very hard and 5 Very easy
3. How disorienting did swapping between camera modes feel? - 1 to 5 answer, 1 meaning Very disorienting and 5 Very coherent
4. Is there any particular reason that it made you feel that way? - long answer
5. How disorienting did the two camera modes feel? - multiple choice question consisting of two rows - first person and third person - answers - Very disoriented, Much, Somewhat, Slightly, Very coherent
6. How easy was it to navigate your surroundings, using the two camera modes? - multiple choice question consisting of two rows - first person and third person - answers - Very difficult, Difficult, Fair, Easy, Very easy
7. Did the usage of switching between camera modes give any difficulties or confuse you somehow? - Long answer

11.1.3 Post-test Questionnaire

1. How easy did you find swapping between the two camera modes to be, after trying the full application? - 1 to 5 answer, 1 meaning Very hard and 5 Very easy
2. How disorienting did swapping between camera modes feel? - 1 to 5 answer, 1 meaning Very disorienting and 5 Very coherent
3. Is there any particular reason that it made you feel that way? - long answer 4. Did swapping cameras interfere with or improve your experience in any particular way? - long answer 5. How easy was completing the application? - 1 to 5 answer, 1 meaning Very difficult and 5 Very easy
6. Did you have a preference for any of the camera modes, for each of the tasks? - multiple choice question consisting of three rows - Combat, Sorting, and Maze - answers - First-Person, Third-Person, and No preference
7. How effective did you find using each camera mode for the first task? (Combat) - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
8. How effective did you find using each camera mode for the second task? (Sorting) - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
9. How effective did you find using each camera mode for the third task? (Maze) - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
10. How quickly did you find yourself getting familiar with each of the camera modes? - multiple choice question consisting of two rows - first person and third person - answers - Very slowly, Slowly, Moderately, Quickly, Very quickly
11. How confident did you feel using each VR camera mode? - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
12. How consistently did you feel each of the camera modes worked? - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
13. How comfortable did you feel moving around using each of the camera modes? - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
14. How comfortable did you feel interacting with objects using each of the camera modes? - multiple choice question consisting of two rows - first person and third person - answers - Not at all, Slightly, Moderately, Very, and Extremely
15. Did the First-Person camera option present any specific or particular difficulties in any of the tasks? - Long answer 16. Did the Third-Person camera option present any specific or particular difficulties in any of the tasks? - Long answer

11.2 Other References

11.2.1 Modular package downloaded from Unreal Marketplace

- **Stylized Eastern Village -** `https://www.unrealengine.com/marketplace/en-US/item/84f7065144444ac6a22521743a0e1205`

11.2.2 3D models

- **Japanese Oni Revamped -** `https://sketchfab.com/3d-models/japanese-oni-revamped-4170cc39fdbd40d29eaee8982e69eda8`
- **Stylized Moon Elf -** `https://sketchfab.com/3d-models/stylized-moon-elf-ebe8252f8e5f4167a43265e9690f3063`

11.2.3 Audio

- **Dance of the Demons 1 Hour of Japanese War Drums - Oscar Graae Madsen - Dance of the Demons**
- **Giant footsteps -** `https://orangefreesounds.com/giant-footsteps-sound-effect/`

11.2.4 Audio downloaded from Mixkit.co - free sfx library

- Forest Waterfall
- Sounds of Nature
- Monster Attack
- Monster Death
- Sword Swing
- Sword Hit Flesh
- Angry Beast Roar

11.2.5 Audio downloaded from Pixabay.com - free sfx library

- Fight Countdown
- Grab Item
- Ball drop