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THE 360 VISION GAME PROJECT

– How backgrounds work in video games

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BACHELOR'S THESIS | ABSTRACT

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THE 360 VISION GAME PROJECT

How backgrounds work in video games

The 360 Vision Game is an educational virtual reality game in which the player has to hand tools to a surgeon in an operating room. The tools are chosen randomly by the surgeon with voice prompts to which the player has to react with choosing the correct tool. The project was aimed to train healthcare students to learn and test their knowledge of different surgical equipment. In VR (Virtual Reality) games the player uses a headset that tracks the movement of their head and applies it to the virtual camera in the game. With this feature the game allows the player to immerse themselves better in the virtual environment.

The goal in this thesis was to discuss the challenges of using a 360-degree photo as a background. Using a 360-degree photo as a background makes a game developer's workload smaller and the environment looks more realistic. On the other hand, a 360-degree background photo causes certain problems. The problems encountered in this thesis had to do with lighting, player position, and the movement tracker. The player could not move as one could in normal VR games because otherwise the background would not look right. There were other problems too but they had mostly to do with these three main problem areas.

To resolve the movement tracker issue, the movement tracker was removed from all the other parts except the head. That limited the playing experience but the game could function well for its purposes., The lighting could not be as natural as intended because the lighting in the photo was used as a background. The problem with player position was resolved by having the player´s torso be completely still. The player could not move their body naturally as the background was a still image and it would be noticed if the player could move their bodies as normal.

In conclusion a 360-degree picture of an operating room as a background did not work well with the 360-aspect in this specific game because the environment for which the picture was taken was too small. However, a 360-degree background can work in other settings, for example a larger scale background image.

KEYWORDS:

360-camera, 360 vision, VR (Virtual Reality), VR-game, 2-dimensional, 3-dimensional

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360°:N ASTEEN TAUSTAN KÄYTTÄMINEN VIDEOPELISSÄ

Miten taustat toimivat videopeleissä

Tämän työn aiheena on *360-vision* -niminen projekti, joka tehtiin aiemmin vuonna 2020. Projektissa pääosassa oli virtuaalitodellisuus- (Virtual Reality, VR) peli, joka oli suunniteltu lääketieteen opiskelijoille, jotta he voisivat harjoitella leikkaussaleissa työskentelyä. Pelin tavoitteena on ojentaa oikea työkalu sen mukaan, mitä satunnainen pelinsisäinen äänikomento käskee. Peli oli suunniteltu niin, että opiskelijat voisivat simulaation avulla harjoitella työskentelemään operaatiohuoneissa turvallisella tavalla. Pelin luomiseen käytettiin Unity Engineä, 3ds Maxia, Substance Painter ja Blender-ohjelmia.

Kyseinen peli toimii melko eri tavalla kuin VR-pelit yleensä toimivat. Yleensä tällaiset pelit antavat pelaajien kulkea vapaasti ympäristössä ja olla vuorovaikutuksessa sen kanssa, miten kukin haluaa. Lisäksi ympäristöä voi elävöittää lisäämällä taustalle kuvia, jotka tekevät pelaamiskokemuksesta ja ympäristöstä kiinnostavampia. Tällaiset taustalla olevat kuvat pysyvät aina paikallaan, eikä pelaaja voi koskettaa niitä tai mennä niihin. Meidän projektimme peli käytti 360°:n asteen kuvaa leikkaussalista sen taustakuvana. Tämä tarkoitti sitä, että pelaaja pystyi vain koskemaan tiettyihin esineisiin, jotka loimme peliä varten. Yksi tämän lopputyön tarkoitus on kertoa, mikä toimi ja mikä ei toiminut tässä pelissä.

Jälkeenpäin peliä tarkastellessa on huomattavaa, että taustan kuvan käyttäminen tällä tavalla aiheutti useita ongelmia. Se esti pelaajan liikkumisen pelin sisällä ja siten pelikokemuksesta tuli jäykkä ja epäluonnollinen. Se onnistui saavuttamaan sen, mitä pitikin, mutta hyvin pelkistetysti. Toisaalta sen kuuluikin olla yksinkertaisesti oppimisen työkalu, ja vaikka varaa parannukselle on, se saavutti tarkoituksensa.

ASIASANAT:

360-kamera, 360-vision, kaksiulotteinen, kolmiulotteinen, VR (Virtual Reality)= virtuaalinen todellsuus

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LIST OF ABBREVIATIONS

2D	Two-dimension(al); x- and y-axis
3D	Three dimension(al); x-, y- and z-axis
360 camera	A camera with which one can take 360-degree photo of surroundings
360 Vision	A VR game project whose purpose is to create a game in which medical students can practice being in an operation room
HUD	Head-up display; important information shown on player´s screen regarding for example health, experience etc.
Skybox	The box around the playing area, usually depicted as a sky
UI	User Interface; a menu in games that gives information about a character´s status, a game´s settings etc.
VR	Virtual Reality; used in games it gives the player a feeling of really being involved in the game world

1 INTRODUCTION

Games in general can be an excellent way to learn for they can be more engaging than, for example, reading or simply watching and listening. The gaming approach can offer a way of learning which is really similar to real life situations. Especially VR games have a huge potential in teaching different skills in a way that actually prepares the target audience for real life situations because of the nature of Virtual Reality. They can be used to create simulations that are a great way to learn and prepare oneself for different situations. VR games are discussed further in later chapters in this thesis.

In virtual gaming environment one can train for dangerous and hazardous issues without a risk before going into the real situations. In VR games in general, and in the game presented in this thesis, the player can in a real situation without running the risk of making mistakes and causing any harm whatsoever. VR games can thus be very effective for example in the horror genre in video games. The player can really get the feeling of being a part of the game in scary situations without being in danger.

The aim in this thesis is to present and discuss a VR game called *360 Vision* in which the idea was to practice assisting in an operation room in a hospital. The game was meant for medical students to practice in a hazard-free environment. The player was to hand over the right instrument to the surgeon and then collect points if the instrument was correct. By playing this game, the player would learn the names of different instruments used in operations.

The team working on this game consisted of four game development students and a teacher who worked as a supervisor for this project. Each team member all had their own roles and responsibilities in the project . Once a week the team gathered in the school and discussed what had been done during the week and if there were problems, the team members had the chance to discuss them and figure out how to solve them together.

The author's role in the project was a model developer for two different models which were surgeon trolley and table. The objective was to model and texture them and position them into the VR environment.

This thesis presents and discusses the problems encountered during this process as well the solutions to these problems. It goes through them all and discusses also reasons behind them and solutions which were made to make this game fulfil its purpose.

After this introduction chapter the thesis will go on to discuss about background information about video games. It goes through the most important aspects of video games in regards to this thesis. In Chapter 3 the aim and objectives for the project are discussed. There the background for the project

is explained. Chapter 4 is the main chapter of this thesis. It contains discussion and reflection o all the problems faced and solved during the project. Each sub chapter contains one of the problems, reasons behind them and solutions made. After this, Chapter 5 presents thefinal product and the feedback it received. Chapter 6 concludes the thesis

There have been many other studies and theses about VR games and problems with them but most were about motion sickness caused by games. One example is Graeme Barclay´s thesis called *Virtual Reality and Virtual Reality Sickness: Creation of a Virtual Reality Sickness Reduction Tool* (2020). There has also been theses about using VR games in teaching and in another situations where they could be useful. For example, Sami Salmi wrote a thesis about VR games in healthcare in his text called *What virtual reality games could provide to specialized healthcare in Finland?* (2018). The subject in this thesis is quite unique for it is about 360 vision game

2 BACKGROUND

The world is full of all kinds of games. In general, the number of different kinds of games seem endless. One could label different kinds of games according to for example their story, structure, intended platform or intended audience. However, in my thesis it is important to state the differences between 2D and 3D games.

To put it short, in 2D games only X and Y coordinates exist. This means that playable characters can be moved right, left. up and down. It could be described that in 2D games there is a paper on which paper characters are moved. There can be multiple layers of papers but there is nothing to show outside of the papers for they are flat. The illusion could be broken if the game would be looked at in an unsuitable angle. Examples of 2D games are the original *Super Mario*, *Sonic the Hedgehog* and *Castlevania* games.

However, in 3D games there is also the Z coordinate. In this case, characters can be moved in all directions. Unlike in 2D games, in 3D games objects are also 3-dimensional. They can be looked at from different angles. The camera can also be moved more freely in 3D games than in 2D games. There are many examples of 3D games and nowadays most of the new games are 3D games. They can be MMOs (Massive multiplayer online). RPGs (Role playing games) or first-person shooters. For example, *World of Warcraft, Elder Scrolls Skyrim, Legend of Zelda: Breath of the wild* or *Call of Duty* are all 3D games though they are very different gameplay wise.

All games consist of different parts which are needed for the game to work. Characters are one of the most important part in the game at least story wise. The playable character can be a readily made character that player cannot change. It can also be a character which the player can create for themselves. Regardless of whether the character is readily in the game or created by player, in RPG games one crucial part of the game is that the player character is growing stronger as the game goes on. The character's skills and gear get better as the game progresses and as challenges in the game become more and more difficult.

The playable character is not usually the only character in any video game though. In most of the games there are also NPCs (Non-Player Character). They are all the other characters in the game that the player cannot control. But player can interact with some of the NPCs. For example, the player can talk to them to get quests or information about the game world or the story or they can be enemies which the player must deal with. Usually, games have ordinary enemies that are usually quite easy to kill, a little harder enemies and bosses. Bosses often appear at the end of a level, a chapter or some other entity in which the game is divided. They are much harder enemies than ordinary enemies and sometimes the player must use all their skills to defeat this kind of enemy.

There can be multiple bosses, for example, at the end of each level and the final boss, the last boss in the game. The final boss can end the whole game or there can be some sort of epilogue after the final boss fight.

A game can be filled with different kinds of objects. Some game worlds can be quite empty, it depends on the game, but most of the games must have different kinds of objects to make the game world livelier and, for example, move the story onward. Some objects just exist in the game world to be looked at and to make the world seem fuller and livelier and thus immersive and realistic. Some objects cannot be interacted with. But some objects are meant to be interacted with. They can be for example weapons to use in a battle, food, or potions to be consumed or resources used to craft something.

Another important part of a game is UI (User Interface). Story wise, this is not part of the game world. It helps player to interact with the game and gives player valuable information about the world, the character, and the progression of the game. All game menus are UI. In the menus player can change, repair, or modify their character's gear, craft things, sell and buy things, control multiplayer, save their game progress and change game settings (for example lighting, camera or audio). All of these are usually separated in different sections of a menu or in different menus altogether.

HUD (Heads Up Display) is a part of the UI. It can pop up or be always visible on the screen when player plays the game. It shows important information that is usually so important that the player must be able to see it very easily. This important information can be for example how much health the character has left. It is important to know if the player is close to character's health running out so that the player can do something about it. Usually, it is shown simply via a health bar but there can be other more creative ways to show player this. For example, in *Spyro the Dragon*- games the main character Spyro has always a dragonfly named Sparks with him and the dragonfly changes colour depending on how much health Spyro has left.

Other important things HUD can show the player is player's progression in the game. It can show for example how big part of a level player has passed, how many of the certain objects the player has found and collected, and how much game's currency the player is possessing at the moment.

In his article, Lennart Nacke speaks of games as systems and there he listed four system elements that are essential for games (Nacke 2014). They are the following:

Objects

Attributes

Internal relationships

Environment

Although it is not necessarily important to talk about games as systems in this thesis, this list in my opinion summarizes quite well what is needed in a game world. Different kinds of objects are needed to interact with and make the game world fuller and livelier as was stated before. Attributes in Nacke's article were described as qualities that different objects have. So, attributes tell us about what the different objects are like in video games. They tell for example what size the objects are, if they are essential for the game´s plot or not, if they have qualities that lets them stand out from the world or not, for example if they have something special in them that player can interact with or if they are just part of the background. These features and much more are the things that attributes tell us about. Internal relationships on the other hand talk about how for example the different objects in the game are related to one another. This can, for instance, be how characters are related to other characters, how objects are related to other objects or how characters are related to objects.

In addition to the aspects listed above, game world is also the environment where everything related to the game happens. It means the concrete places included in the game's story. They can be really different depending on what kind of game it is. It can consist of multiple places or just be one larger place. Some games may have quite a small world, even just one room. It all depends on what kind of a game we are talking about. The world can consist of multiple complex levels or just multiple places that the player has to move back and forward in. Moving in a game world is not always supposed to be straightforward.

All of the elements listed above are part of the game world. A game world is not only a place, although it is that too. A world cannot only be an empty place, it has to have substance and different layers to make it feel like a world where player can feel they really are part of the gaming experience.

All the elements that are included in game worlds need a background to exist. Background is something that is behind every game world. Without it the game world would exist in a void. The player cannot go there or interact with it for it is only a background. They are created and work differently depending on if the game is a 2D or a 3D game.

Everything in a game takes place in a game world. To put it simply, game world is the world in which everything related to the game exist. Both 2D and 3D games have some sort of skyboxes. Skybox is a box where everything in a game is. They are just built differently and they look different in games. In 2D games players can only see one side of a box. Everything that happens in 2D games is inside a box, but the box is just much smaller and flatter than in 3D games. In 3D games, on the other hand, players can see five or six sides of the box at all times. Player literally moves inside a box all the time. Depending on the size or the structure of the game there can be multiple skyboxes in one game. During loading-screen the player can be moved to a different skybox.

Often several skyboxes surround the game world. Many elements are needed for the game world to function and interact between its different parts. The game world must be consistent in its own rules. It does not have to work according to the rules in our own world, for example according to the physics or biology in our world for often games take place in for example fantasy settings where artificial rules can be created.

In this thesis the 360 vision in video games, especially in VR games, is essential and this will be discussed more later. 360 vision in this subject matter is about the background images used in video games. These images may vary from skyboxes to 2D backgrounds depending solely on the type of game that is being made. Skyboxes are most simply just pictures of the sky that video games use to represent the sky. The sky is applied to a box which the game world is inside of. This way the sky is around the game world. Skyboxes are used to increase the immerse of the game and it has a great impact on the feeling of the game (Clare 2013).

Skyboxes are usually used to save the computer memory and to shorten the loading time because the player would not be able to have a closer look at the clouds themselves anyhow. For this reason, it is just easier to use a simple 2D picture of the sky. The skybox itself may be a little bit animated in this instance, so that the clouds themselves seem to move around naturally.

In Figures 1 and 2 it can be seen what the skybox in our game was. The room where the 360-degree photo was taken can be seen and the box indicated the space that was used in the game. This is the space in where the player moved and handed out instruments. So, the space where everything in a game happens is literally shaped like a box.

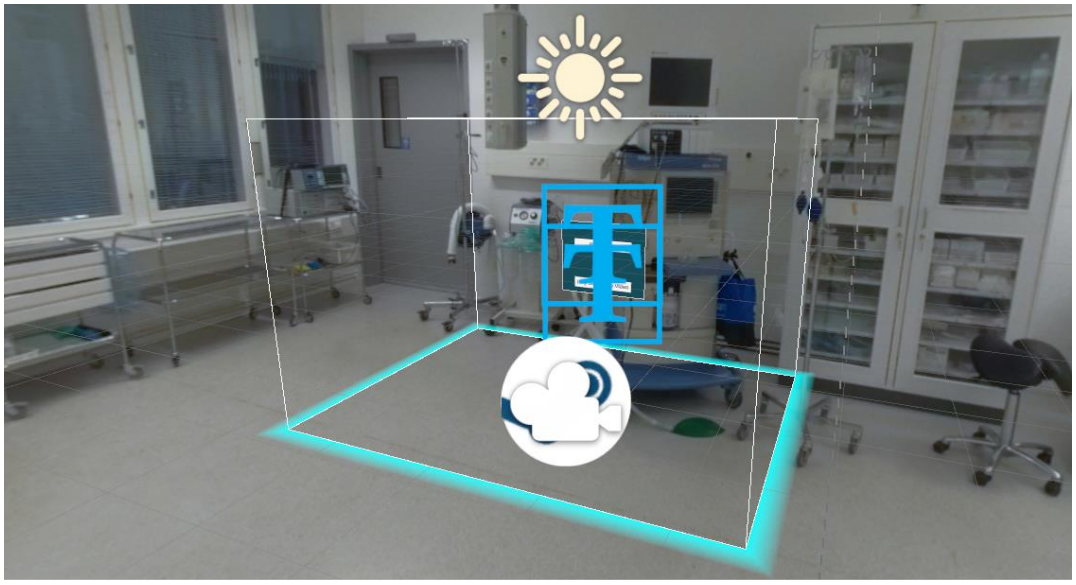

Figure 1: The skybox in relation to the picture taken of the operating room

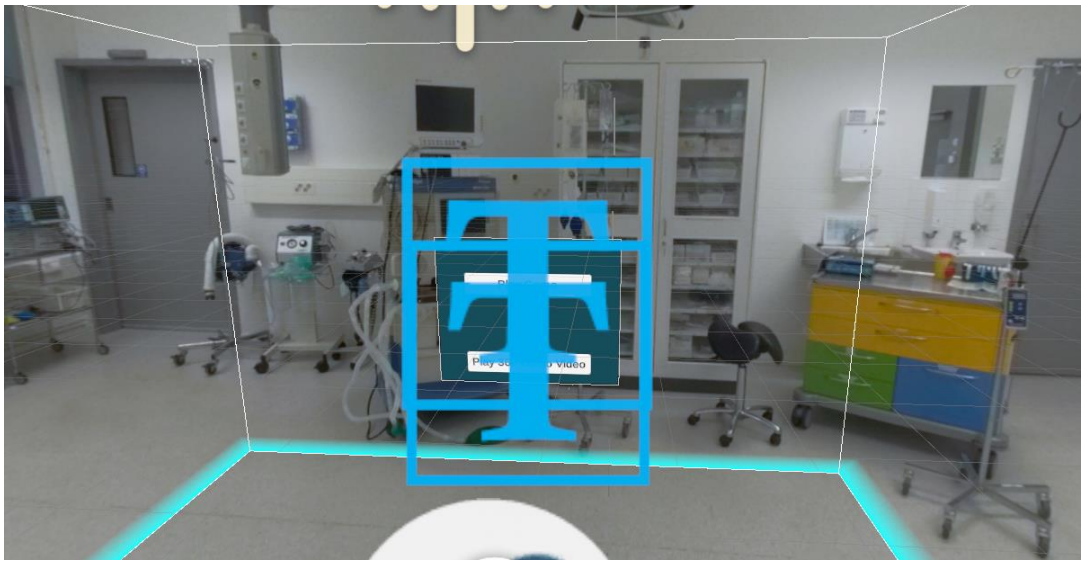

Figure 2: The skybox in relation to the picture taken of the operating room, another angle

In Figure 3 is shown what all the sides of the skybox look like. This could be folded to a box, which would be the skybox. The purpose of this figure is to show the structure of a skybox that was used in our game. This also shows what skyboxes look like in other games too, though in other games the skyboxes are usually much larger than in our game.

Figure 3: Structure of the skybox used in our VR-game; modelled after the image from here https://www.realityisagame.com/archives/1776/what-is-a-skybox/

2D backgrounds are often still images used in 2D games. They cannot be walked in for they are just flat pictures. In 2D games, because one can only move in X or Y coordinates one would never walk into the background. That is why it can just be a still image behind the actual game.

2D backgrounds could be used in 2D games, which are most often platformer games. A good example of this kind of game is Super Mario, because the background in that game is just a 2D image. In the older games the pictures were just still images made with pixels, but in the newer titles (which are still 2D) the games have animated 2D backgrounds to give the illusion of a living world behind the player, even though the game would technically work just fine even without a background. Even though it might seem that the game world would continue the player cannot walk towards it for it is just picture of a vivid world. Thus, the game world seems more versatile without having to create that big of a world.

2.1. Virtual Reality games

Because VR (Virtual Reality) games are in an essential role in this thesis, it is important to discuss them in general. VR is a sort of game where the purpose is to make the player to feel like they are really in the game world. It is not only about sitting still and holding a controller, but you have to make the same movements as the character would do in the game. Some sort of virtual reality technology has been talked about for a really long time, but the current VR technology started in 2010 when the first VR headset was created. That would later be developed into Oculus Rift (Dredge 2016).

VR games require a headset and controllers. Headset covers player's eyes and by moving their head the player can look around in the game world as if they really were in the game world. In addition to that, player uses controllers. They are different than controllers that are used for consoles. Controllers in VR are in two pieces, one in each hand. In addition to using them for moving the character around, they are also used to make movements the same way one would in functioning in real life. For example, to crab something in a game the player needs to move their body and the controllers to crab it in the game. This allows the player to feel more immersed in the game world.

Because the movements made in VR game's world are for the most part same than in real world, it can be easier to make the experience feel more real. This is why VR is great to use in different kinds of simulations. They can help to simulate different situations in a safe way. This technology can also help to train different real life situations. Learning new things is not only listening or watching others but it requires practice. Practicing with a simulation helps to get in the mindset of a real-life situation and it can be more effective than reading about it. It can help to support learning effectively. That is

one of the reasons the project presented in this thesis was made and why it is discussed in this thesis.

VR games have for the most part the same elements as any other 3D game. They too need the same basic elements as 3D games. Like in 3D games, backgrounds can be made in many different ways. Backgrounds can be created from scratch, using the help of some game engine or for example taking a picture of a real-life place and making it that background. Backgrounds can also be variants of all of these. It all depends on what kind of game is in question and what one wants to accomplish with it.

As any other 3D games, VR games also require a skybox. In our project we created the skybox by taking a picture of an operating room with 360-camera.

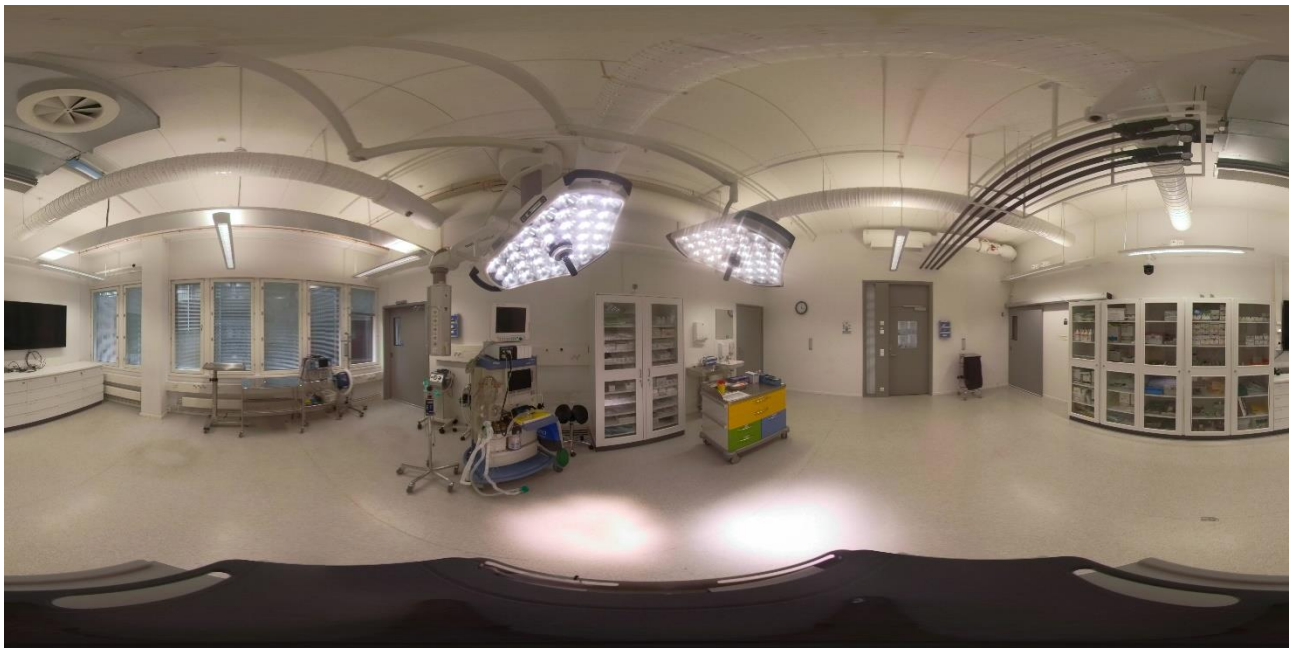

Figure 4. A 360 picture of the operating room.

So, our game's world was a place in real life. For our game's purpose that is to be a simulation of operating room. That's why we used a real operation room to make the scenario as realistic as possible. In our project we used 360-camera to make the skybox. 360-camera is a type of camera that can take pictures from all directions at the same time. It is also known as omnidirectional camera. The pictures taken with it can be used as a whole or partly by cropping a specific part of the picture. For the most part, 360-cameras are used to cover big areas. For example, for Google Maps 360-cameras are used to get footage for street view.

However, in this very specific scenario, this thesis is about a 360-degree background for a virtual reality (VR) project. The author a member in a project earlier in 2020. In the project we were asked

to use a 360-degree camera to take a picture of a room and use it as a background for the whole project.

3 AIM AND OBJECTIVES

In the project in Spring 2020 a VR game for medical students was made. The purpose of the game was to prepare medical students to practice in an operating room. For the game the project group used a 360 camera to take a photo of an operating room. This photo was used as a a skybox in the game. There were two reasons for this decision. First of all, using the picture made the project easier. The background did not need to be created from scratch but instead this ready picture could be used as the background. Otherwise, it would have taken much more time to design and create the background and that was not the wished focus and a thing intended to spend that much time on.

Second, using a photo of a real operating room made the game seem more realistic. Using a photo would lessen amount of work for the group and this was the primary reason. But at the same time, it would actually be a good idea for the purpose of the game. The idea of the game is that the medical students can practise assisting in an operating room. VR setting can make this feel quite realistic compared to for example a console game. It helps simulate the real situations. So, making the environment also realistic and familiar to the players it can help them even further to learn. Most medical students are already familiar with operating rooms, so a familiar environment can also make learning easier.

The commissioner of this project was a research unit at Turku University of Applied Sciences (TUAS). This project was part of a scheme called 360VISI and the main idea for the subject of the game became from health care teachers in TUAS. The purpose in our project was to create a VR-game in which medical students can practice their duties while assisting in an operating room setting in a safe manner. Situations in real life operating rooms can be really stressful and thus practicing in different ways is really important. Also, by practicing via a game real instruments do not have to be used and so practicing does not consume invaluable resources.

4 METHOD

The project started in January 2020. The group consisted of eight students and one teacher who supervised the project. One of the students was our project leader. Even though the group had a leader in practice, all the decisions were made together in a collegial way. The author and three other students designed models for the game and two of our group made the code for our game. The rest of the members assisted in where it was needed.

For the project the group used Discord in which it was discussed how each part of the project was coming along and informed each other if there were any problems or issues to deal with. Discord is a messaging platform originally created for gaming, but it has been trying to rebrand itself to reach a wider audience. It is similar to Skype for it can be used for messaging or video calls. It allows people to create channels for different things and to share files between each other. Every week the group also met in school premises and discussed what each had done during the past week. The teacher was also always there supervising the progress, and he was also kept up to date on the project. During these meetings there was also had a chance to discuss all the possible problems, challenges, or new ideas one might have.

In April the final meeting was held and there the group checked that everything worked, and all parts were in place. After that s Showroom gathering was organized where all groups showed their products that they had worked on during the Spring. Anyone could come and try out our game there. The group also answered questions that people had about the game and showed them how it worked.

As mentioned earlier, a Discord group which helped the group communicate with each other. There were also weekly meetings but otherwise all different parts of the project were worked on individually by each member of the group either at home or at school. The project was divided in parts that could be worked on independently when it was suitable for each individual's timetable.

The author's job was to model a tool table and a trolley (Figure 5). The tool table was used to hold all the tools the two other modelers made for the project. From the tool table the player could pick the specific tool that was required for the task in the game. This table became the centre piece for determining suitable lighting in the scene because this is where players would focus the most. The trolley had no other purpose than to make the environment more versatile and immersive. The player could not interact with it. After finishing with my models, they were sent to the members of the group who were responsible for coding so that they could place them in the game environment. For some reason when the author tried placing them, they were never saved to the project. In the end all parts of the project were combined to make a whole product.

Figure 4 shows the operation tables that the author made for our game. This was the part of the project provided to the author. The models were made after the real operation tables present in the room where the 360-degree picture was taken.

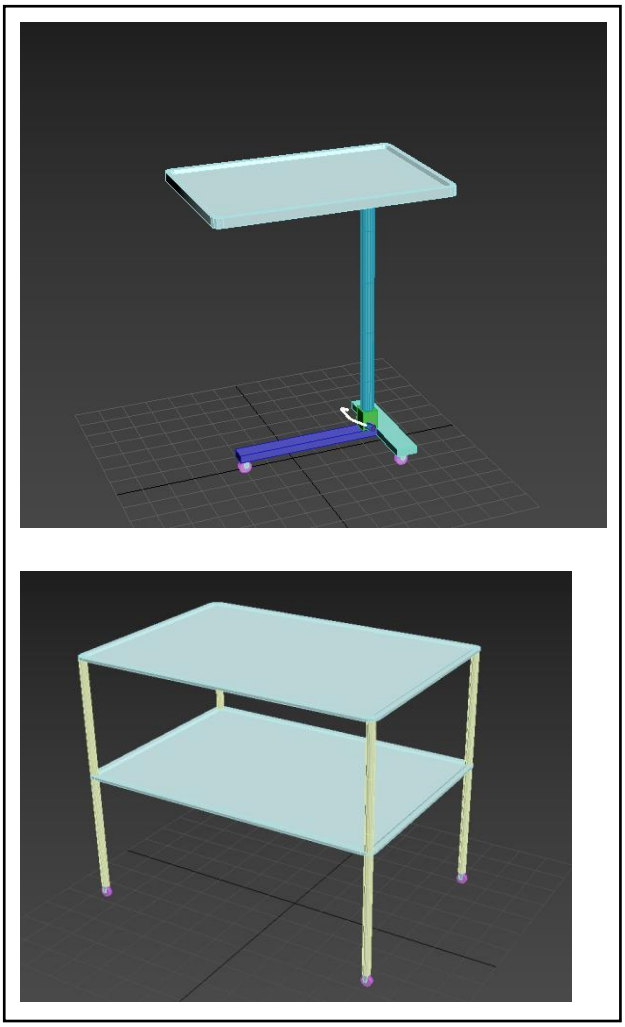

Figure 5: Operating room tables made with Unity

The game was made using Unity Engine. It is quite usual tool used in making games because it is flexible and free. Unity Engine is the base in which the whole game is built on.

One important tool in our project was Steam VR. Steam VR is a program that allows easy access to Virtual Reality controls and how to adjust them. One needs to download it from Steam, which is an online game store and game launcher.

Other tools used in this project were 3ds Max and Blender. 3ds Max is a program that can be used to make 3D animations, models, and images. It is over twenty-year-old program that has been

developed and updated countless times. For the author's role of the project, it was the most important tool. Using 3ds Max a shape of an operating table was made and Substance Painter was used to paint a suitable texture for the table. Substance Painter is a flexible texturing app that is very easy to use to make good quality textures on 3D models.

4.1. Problems faced during the project

This thesis about the game for which the result was meant to be a game about teaching surgical instruments to medical students in a virtual environment. The plan was to have one player to use a virtual reality headset and controllers with which they would interact with tools and hand them to a surgeon depending on which one they asked for, after which they would inform the player if the instrument is the right or the wrong one.

The player would be scored depending on their knowledge of which instrument is which. The scoring was determined by how many times the player gives the correct instrument to the surgeon. Negative points would be given if the wrong instrument is handed to the surgeon. This way the teacher will have an easier time to find out if the students do lack in their knowledge of instruments.

From the menus the player was able to navigate to either play the surgical instrument game or watch a video of students showing how a surgical operation works. It was designed so that all the menus were always visible, but during the game itself and the video the menus were located to the left side of the player so that they would not be in the way. This was made such a way so that it would be easier for people who had not really used virtual reality or played games in general that much to navigate between the game scenes without having to press too many extra buttons.

A 360-degree photo of the operating room was used as the background for the game. This was to speed up the process of making a more realistic-looking background. This was made by making the background into a ball to surround the scene and placing all the objects used for the project inside it. Also, all the menus were built inside this background system, although for the menus the background was different.

4.1.1 Problems with lighting

Optimizing the background for the scene was surprisingly easy, although there was a problem with the lighting that could not really be fixed in the game. The problem was that the operating room was supposed to be dark only with a surgical light shining on to the patient, this is normally the only real light source in the room during an operation. But the picture used already had a light source that

remained unaffected because it is a photo. The problem the group ran into was how would one create lighting for the game, that would look natural in the environment we were building. It would not look normal if a light source would just be added on the top of the scene, because it would not change that the picture did not have any light in it, or it might have too much light depending on the picture. In the end, the group ended up going with a background picture that was taken in a well-lit room so that we did not need to deal with this problem.

Another lighting related problem that appeared was how would the objects look without shadows. There was no way for real shadows to form in the scene because even if a light source would be added to the scene the objects would not have a physical ground to cast their shadows onto. This was because there was no real floor in the game environment. This will be further discussed during another problem later in this thesis. The solution to this problem was that there would be an empty plane where we use editing software like photoshop to paint fake shadows for all the different objects in the scene. It was quite a lot of work, but the group was satisfied with the result.

A bigger background could help solve the issue of lighting, because if the picture has changing lighting or a specific place where the light is supposed to come from it is easy to just place a spotlight on that spot.

On the other end of the spectrum, if the place is dark or very dimly lit you need to be more careful about the placement and the strength of the light in general. A very weak light source that illuminates the whole area just barely could work in this situation.

4.1.2 Problems with player position

One of the requirements for the project was that the group needed to make the player unable to move their body position in the space. This was because the background itself was not moving, so the players body position would need to be fixed for them not to break the illusion of the project. This also meant that all the models were just floating in the air, but this was not really a problem because the players were unable to see this to themselves due to the games intended limitations.

There were also ideas of adding a few different points between which the player could switch their place but ended up not to add that dimension because there was not time to take that many working 360-degree photos of the surgical room. There were also plans to make it for the video, but it was

scrapped too because it would have been too much work to get the students to act out the same scene again in a way that worked.

There were quite a few problems with the project. The issues could all be tied down to the fact that the group tried to use the 360-degree photo as the background. A 360 photograph was attempted because it was thought that it would be a more efficient way to produce a realistic background image. The alternative would have been to create the environment in a 3D modelling tool – this would have cause significant project delays. The fact that one could not move one´s body in the virtual space while using the headset felt off putting and weird to us while testing prototype versions of the product.

4.1.3 Problems with models

There was also a small problem of finding a good surgeon model for the project. This led the group to not have enough time to animate anything for the surgeon. In the end the surgeon's model is just holding out its hand towards the player expectantly for them to give them an instrument.

The surgeon was not given a physical presence in the game world, so all the instruments fell through their hand. It was also found that one of the options to "give" the instruments to the surgeon was to just throw them at the model. It was suitable for points if any part of the surgeon was touched by the right tool. So usually during testing it ended up with people just throwing as many instruments as possible at the surgeon without really caring to find out which instrument was which for usually the people who tested the game did not know which instrument was which. This would cause the player not to score any points.

4.1.4 Problems with placing the models

The author was creating the models for the table that holds the surgeon's tools and a trolley that was placed for aesthetical purposes. These models were quite simple to make, but due to the background image were a bit challenging to place on the scene so that they would look natural. The issue was that they needed to be positioned floating in the scene.

The background itself would have been quite alright without the lighting too. In the product the background ended up being too brightly lit for what we were going for, and we really did not get the chance to take a photo in natural lighting situation.

It would seem to make it work one should take a photo that is far enough away to work as a background image. To be more exact, the image could be an open field or just the sky. In that case it would not be a problem if the player moved around the environment.

The problems really start when there are objects on the picture. It is easy to notice that those objects are not changing their position naturally according to where the player is moving. This can be quite jarring and for some people even disorienting while using VR.

One fix to this could be if the photo was placed in an angle, so the player could not see the changes with their movement, like for an example a room that the player can only see through a window in the game. This way the player would not be surrounded by these “visual errors” that were talked about earlier.

4.1.5 Problems with movement tracker

The group also had to manually remove the player movement tracker from the virtual reality software, because if the player were able to move freely, or even at all, they could notice that the background did not change naturally, but it only followed them around. In the worst-case scenario this could lead to the player just moving out of the play area completely and leaving all the models floating in the air outside the skybox.

To solve this issue, the movement tracking was removed from everything but the head movement. This caused quite a bit of confusion while testing, because of the expectations on how people could interact in a virtual reality environment. For example, if you moved your body, it would not be noticeable in the game at all.

This was not the case with the controllers though. The controllers had a fixed position in the scene which was not determined by the location of the headset, which caused the problem of them being easily displaced and feeling like your hands are not where they should be. For some people it can cause distortion because their body feels like it is not completely under their control.

This issue was fixed so that at the start people must adjust the general length of the person using it, which is automatically around 160 cm because most of the nurse students are female. So, if the player would be over or under this length the adjustments had to be made inside the game options.

Another thing changed was a limitation to the position. An area where the player would need to stand was marked and the players were told that they should not move from that position because of the mentioned problem of locked down movement for the headset.

Overall, these limitations were more against the project than for it. On the other hand, a real-life operation the nurse has to stay by the equipment trolley. But because the group chose to use the 360-degree photo as the background for the project, it was inevitable and seemed to be the only working solution for it.

4.1.6 Problems with the ground

Another quite comical problem was the fact, that if the player dropped a tool off the table, it would just fall into an endless void and keep falling for eternity. This was because there was no floor in the scene because it would not have fit the background image we had taken for the project. This is also the moment where most of the people would look down and realize the ground is not even there, it is just a picture in which the original ground looks a bit distorted even.

A solution to this groundbreaking problem would be to make an actual ground for the game. Of course, placing it would cause other problems within the game scene. One of these would be of course how it will affect the picture overall.

One solution to this problem is just to cut the background image from the spot where the floor ends and just placing the floor there. In this case you might cut some of the objects that are located on the ground in half depending on from which angle the picture is taken.

In those cases, making a model that would replace the item would be the solution to the problem. Placing it cleverly and if the player is not allowed to move through the area its size can be changed freely to fit in nicely.

4.1.7 Problems with the overall background

Another thing that should be given a thought about is the overall background. First thing that comes to my mind is the objects in the background, which were discussed on earlier. If there are some objects in the background that cannot be removed for one reason or another, models of them should be made on top of them.

This is because these paper-thin items as a background work only if the player is not allowed to do anything else than turn their head around. If they can move around even a little bit, they should be able to see the items from a different perspective, but they do not change at all. Even in the case of not allowing the player to move it is very easy to distinguish between a 3D model and a picture because of how close the items are supposed to be.

This is easily fixable by making 3D models of them because this way it would not matter from which perspective people can see them. How complicated the objects themselves are is another problem, but from my personal experience making objects is not that difficult. Easiest way would be to cut on the details on the individual items because the player most likely would be only able to see them from a distance.

In the author´s opinion, dome like picture would work a lot better as a background than a complete 360-degree picture. This is simply because it would help make the game world more immersive, which is at the end of the day the goal of the game, no matter what game it is.

Especially in a case like this, where the game is supposed to be representing a realistic interaction between a nurse and a doctor. At its current iteration, the background would probably work only on a person who has never tried out Virtual Reality devices or played any games at all.

For someone who is even a bit more experienced in either gaming or Virtual Reality they could easily notice these shortcomings. It would seem one would like to avoid such a situation because it is not really an image that would be preferable to leave in the users' head.

The dome structure would allow a lot more creative freedom, because not just anything works with it. Easiest example of a background that works is a sky-like dome. This would work in most of the situations because sky can be used for many different things. The main reason why it works is because the skybox is so huge that players would never see it up close.

But for example, an indoor space would not work at all in this case because it would look off putting. The skybox dome would be so small that it would not logically cover the area, which leads to problems like the player either accidentally walking out of it or making it too big so that it looks very unnatural.

A 360-degree photo does work in certain very specific situations though. For example, one of these is if it is a background for something much smaller, very much like the dome that was mentioned earlier.

A good example of this would be if you had a model for a skyscraper or another tall building in which the game would take place. In this case a background that would consist of a few other buildings or any other view of the city could work wonderfully.

Even if the player can leave the building this could work as a background image because the game scene could be applied with multiple skyboxes, one around the building floors that the player can walk around, and another larger one that the player can only see when they are on the street level. Of course, in this scenario the smaller skybox would be see through and completely invisible to the players eye when they are on the ground level.

Depending on the situation the smaller skybox might not even be required. This all depends on how big and accessible the ground level is going to be created. If it is going to be a huge sprawling city the big skybox will do the job just fine. But if the ground level is a very limited area the smaller skybox helps create the immersion of a big city without having the developers make a lot of unnecessary models that cannot even be seen from close distance. This saves a lot of development time.

This only works though if the city is not supposed to be seen too closely by the player anyway. If the developers want the players to see something specific in the city, they should have the same skybox.

5 PROJECT EXPERIENCES, FEEDBACK AND RESULTS

There has already in this thesis been given a description of the game and a discussion ofwhat worked in it and what did not. It had several problems but, overall, the game worked and performedits function. In this situation it was enough but in a different situation this may have been an insufficient product. The project team did have quite a short time to finish the project and that is why the demands could not have been too high. The main lessons learned are shown in Table 1.

Table 1: Problems and solutions.

Problem	**Solution**
How to add realistic *lighting*	No authentic lighting, the lighting we used was not according to our vision, but it was suitable in the end
Player position in relation to background	Player's torso had to be completely still
Finding or creating a *model* for the surgeon	The surgeon did not have a physical presence, just a model on which players would put the right instrument
Placing the models would make them look unrealistic in relation to the background	Player would not be able to move so then models would only need to look realistic in one angle in relation to the game world
Having *movement tracker* would cause the players to move freely and notice that background was not natural	Removing the movement tracker from everywhere but the head
The game did not have a physical *ground* in the game due to the usage of 360 camera	There was no real solution to this, all possible solutions would have led to even more work with the risk of making the game look unreal
Overall background seemed flat if the player moved their	We tried to minimize this problem by restricting player movement as much as possible, but we could

head in other ways than from left to right	not restrict the head movement, so the problem was still visible

When the project was finished, the final product was displayed in a showroom where anyone could come to watch or try our game. About a dozen people came to try the product. Most of the people who came to the showroom were students and thus also the people who tried the product were students but not all of them studied game technology as we did. There was not very versatile feedback from the people who tried it but all of them said that is was fairly interesting and good enough.

The teacher was pleased with the end result. The project was finished in time and that was an important element as well. The teacher was more of a supervisor in our project. He did not give much feedback during the development. His role was mainly just to see that the group did the project as promised and helped if it was needed. He also organized the weekly meetings so that all would have an opportunity to talk if were there problems. This was also a way to supervise that the project was going forward according to what was settled and according to timetable. Otherwise, he did not intervene in the project and the work had to be done independently.

The commissioner experienced that their wishes had been listened to and the product was like they had asked it to be. They were told what kind of problems the game would have if everything would be done the way they asked. They were aware of the challenges, but they were content that it worked and that it could be used for teaching and learning.

When it came to the group and thoughts of the product, the best had been done in the conditions given. The group had done what the commissioner asked for and though it was difficult sometimes it had succeeded. But the game could have been better too if it were not for certain conditions given. The idea in this project was to make a game that was asked and thus the group did not have the opportunity to be as creative as they could have been.

In different situation different decisions would have been made and the game would have been created in a different manner. If there would have been more time, the group could have also been able to make a more polished result. The end result of the game was really simple and it had several problems as have been discussed earlier. If it would have been a commercial game the end result would have been a prototype.

But overall, the group were content with the project and felt that the mission was accomplished. More experience was gained in making games and working as a part of a group. All of those skills are important for all members of the group for they are important in game industry. Working together in the project group went well. The group managed to suit timetables together and even though there were problems while making the game they were discussed and solved in time. The project was

divided in parts so that everyone would have their own role in the project. The group tried to divide them as equally as possible but as it often happens not everyone's part was the same. In theory dividing the work can seem quite easy but in practice it is not as easy.

6 CONLUSION

Even though the project and the game had several problems, a great deal can be learned from it. The problems that surfaced during the project taught how important many of the aspects often overlooked can be. Most of the problems had to do with the fact that 360-degree photo had to be used as a background. Even though this also served a positive purpose in the game it created many problems for example regarding player movement and lighting. A photo as a background made many of the aspects easier to make but it made movement more difficult for if the player would have been able to move freely the whole game environment would have looked unnatural.

One of the main solutions to these problems was that the player´s movement had to be limited. The player could not move as freely as they could in an ordinary VR game. The player could only move hands and head while playing the game. This made the experience stiffer and maybe even a bit uncomfortable but it helped the game to look as realistic as possible in those circumstances. In this thesis all of the problems and solutions to them were discussed. There were also discussions on how these kinds of problems could have been avoided.

As was previously explained in more detail, the game could have bee we did not have to use background images this way. Now the final product seemed stiff as the player was not able to move naturally. The experience could have been much better and natural had the movement been adapted in a working manner. Now the player could only interact with the tools created As a simple learning tool, the game fulfilled its purpose but the playing experience could have been even better.

As the commissioner wanted the game to have a still image of an operation room, disable movement tracking from Steam VR's code had to be disabled. Usually in VR games this movement tracking is essential as usually in VR games moving around is an essential part of the experience. However, in this situation the focus was on moving the tools and not moving around in a room.

In this situation the product we created/developed was adequately good and games do not need to be polished and complicated to be fun or useful although, as previously mentioned games have a huge potential to be great learning and teaching tools for many purposes.. These kinds of games can be used in many different situations and thus they should be made as well as possible. Games are more accessible for everyone than ever before. They are also very popular among different types of players. They are not just for certain age group or just for people with certain interests.

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