Mental health therapy through virtual reality

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PREFACE

“Mental health therapy through Virtual Reality”, a dissertation that has been written to give a deeper insight into how virtual reality (VR) creates the possibility of being a tool in mental health care and therapy. From January 2021 to May 2021, Ilham Jillani, engaged in researching and writing this dissertation and creating a prototype for a VR application in Unity. The research conducted was supervised by Weiqin Chen, a professor at OsloMet – Oslo Metropolitan University.

I would like to thank Professor Weiqin for being a great supervisor and motivating me while I was developing and writing for my master dissertation.

I hope this research will benefit many lives and create a good reading experience. Enjoy!

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Ilham Jillani
Student s315314
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Oslo, 14-05-2021

ABSTRACT

In the current COVID climate many people have been affected by mental health challenges. Hence, a proof-of-concept dissertation that aims to showcase and prove how VR can be used for mental health care and therapy was developed. In order to prove this, a VR game, a survey, and user testing were conducted using a smartphone that could run the application on a Android smartphone. The smartphone can also be used with a headset if preferred for a better VR experience.

Furthermore, the development of the VR application was with the multiplatform game-engine *Unity* and also the main framework of the whole idea. To create the different objects in the application, the open-source 3D creation suite, *Blender*, was used, which is also supported by *Unity*. Additionally, the platform *Mixamo* to create character rigs and animations. Furthermore, *Blendswap* and the Unity asset store for readymade 3D objects and assets. Moreover, *Github* was used for version control, and *MeisterTask* in order to work more agile with a Kanban board similar tool.

After reading the dissertation, one may feel that the tools that were used together with the application could be because of a limited budget. In fact, this is also one of the main purposes of the application. The application should be affordable, usable and cost-effective for anyone who has a smartphone. Nevertheless, the application was user tested with only a smartphone, which can be placed into a simple VR headset if preferred for a better VR experience by the user who was participating in the user testing.

Finally, for future work, more advanced VR headsets with better view angles will also be used to see if there is any difference in experience and how it affects the behaviour of the user. This will also be valuable for the research community because there is limited information and research conducted in the area of behaviour change of VR users.

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1.0 Introduction

In March 2020, the world faced a new pandemic that changed millions of lives and caused a global lockdown. Mental and psychological problems started to increase, and psychologists and therapists received more consultation requests than they could handle. Norwegian newspapers reported that more than 50.000 appointments were postponed and cancelled at Norwegian hospitals (Ronny Berg, 2021). These appointments may also include people who were affected mentally. Moreover, 173 million people were living with mental health disorders in China. Also, reports from China in February 2020 about 50 Covid-19 cases among inpatients from the psychiatric hospital in Wuhan, reported concerns over the role of mental health disorders in the pandemic transmission (Xiang, Yu, Sartorius, Ungvari, & Chiu, 2012). According to Yao, Chen, and Xu (2020), when these inpatients got infected, it resulted in exposure to more barriers when trying to access timely health services for them. The authors also say that this was because of discrimination against people with these mental health issues in health care settings. This also appears to be common in health settings (Thornicroft, Rose, & Kassam, 2007). Hence, the pandemic has worsened an already existing mental health issue for many people. For instance, some of these patients require to travel in order to get evaluated and get prescriptions, which has been stopped due to regulations and quarantine rules for travellers. (Yao et al., 2020).

Furthermore, the pandemic affected many diffrent people. In Denmark, Sønderskov, Dinesen, Santini, and Østergaard (2020) conducted a survey to compare and measure how the general public has been affected mentally and psychologically after the pandemic with the data that is available before the pandemic started. Interestingly, their results showed that females were more affected than males after the pandemic occurred. However, in another longitudinal study, where up to 333 people were followed up, there was not revealed any difference in mental health, compared with the periods where many recovered and where new cases of the pandemic occurred (Vindegaard & Benros, 2020).

Moreover, students in high schools and universities faced many challenges and uncertain situations when their usual routine got changed suddenly from March 2020 (Thakur, 2020). In

addition, many students live alone. As a result, the risk of mental health issues were increased due to loneliness and social isolation. Not only was loneliness a reason for increased risk, but also many schools played the role of a protective layer of mental health support. Therefore, schools and universities being closed reduce the activity which normally was a part of the student's routine. Additionally, the government regulations on travelling to either another country to visit one's family or by just taking the train to another state damages the situation even more (Savage et al., 2020). Consequently, it contributes to worsening the mental health of many students. For instance, Geirdal et al. (2021) examined how the mental health and quality of life among students were affected by the COVID-19 outbreak through a survey. The survey was conducted in Norway, Australia, the US and the UK. 50-74% of 3810 participants from these four countries indicated that they were affected on a high level.

Nonetheless, Virtual reality (VR) can help with mental health care because it can remove both barriers and improve the quality of mental health care (Torous, Myrick, Rauseo-Ricupero, & Firth, 2020). VR can be looked at as audio-visual communication, which also creates the possibility for doctors to reduce the face to face interaction with the infected pandemic patients (Singh et al., 2020). Moreover, many researchers looked at how VR could be used in order to fight the different mental health challenges and creating treatment strategies under the pandemic ((Riva et al., 2020) (Gao, Lee, McDonough, & Albers, 2020) (Zhang et al., 2020) (Herrero, Garcia-Palacios, Castilla, Molinari, & Botella, 2014)). However, these studies have been more or less on a theoretical ground and not on a practical level as presented by Singh et al. (2020). Moreover, Singh et al. (2020) described the different types of applications where VR could be used as a tool. Singh defined VR applications for 10 different contexts, such as mobile based Covid-19 application as VR for professional health care training.

Furthermore, while lockdown had already begun, the VR market went through a big uphill curve of sales. Since the whole world was in lockdown people needed other ways to pass time and enjoy their everyday lives. Reports said that the VR markets grew by 108% during the first months of the pandemic (Alsop, 2020). This indicated that the general public has become more

familiar with how VR works, and can already provide more feedback on how new VR applications could be prepared to prevent usability issues (McGill, Boland, Murray-Smith, & Brewster, 2015).

Additionally, many of the general public gather information visually. For instance, by watching YouTube on their "smartphone" which is easily accessible and affordable. About 4 billion devices are being used worldwide (STATISTA, 2020). Many people also do watch YouTube for their mental health care, as it becomes a natural way of support (Naslund, Grande, Aschbrenner, & Elwyn, 2014). Thus, many YouTubers can contribute to influencing many people and making them aware of VR. For instance, Sidemen, A YouTube channel with over 10 million subscribers, has a sub channel called SidemenReacts. On this channel, the creators published a video (SidemenReacts, 2021), under lockdown, where they were reacting to the world's only 7-star hotel, in Dubai. Since the creators were not able to travel to the hotel, they said the following in the video: "*Can we Just live in VR for a second and pretend we are here?* "

This dissertation will address the challenges related to the lack of activities that can affect people mentally under lockdown, not only travelling but also social gatherings and outdoor activities such as sports using VR technology. Furthermore, it will contribute to self-mental health care and improve the quality of self-care by developing an application under the concept of VR for mental health therapy. Also, the artefact from this dissertation could play an important role particularly in the lockdown and isolation/prolonged home time (Firth et al., 2019). Finally, in order to close the disparities between people that may not have access to advanced and expensive technology including VR gear or headsets or have low income (Hoffman et al., 2020), the artefact will be developed for use on a simple smartphone. Also, we can see that people with mental illnesses or misunderstood conditions do face many different challenges in their life. Still, they do manage to cope with some of them by using medication, remedies or some sort of therapy. In order to make it easier for people to access quality health

care in form of therapy, VR can open new doors of easy access for it (Wiederhold & Wiederhold, 2005).

2 Background and Literature review

In this section, an introduction of mental health and VR will be presented, and some related work will be showcased and reviewed in the area of Mental health and VR.

2.1 Mental health

The World Health Organization (WHO) in 2001 defined mental health as "a state of well-being in which an individual can realize his or her own potential, cope with the normal stresses of life, work productively and make a contribution to the community." (WHO, 2005), which have been debated throughout the years by researchers (Huber et al., 2011). For instance, Aaron Anotnovsky, a sociologist and an academic, in 1974 described the "sense of coherence" as a major factor for mental health, as it creates the "capacity to cope, recover from strong psychological stress, and prevent post-traumatic stress disorders". In addition, it "includes the subjective faculties enhancing the comprehensibility, manageability, and meaningfulness of a difficult situation" (Miller, Matarazzo, Herd, Weiss, & Weiss, 1984). Furthermore, Aaron Anotnovsky continued his research and finalized a scale for the sense of coherence which was used in relation to measuring the quality of life (Eriksson & Lindström, 2007).

Nevertheless, there are over 200 different mental health illnesses and 5 major categories of mental health, which are Anxiety, Mood, Schizophrenia, Dementia and Eating disorders, as mentioned by the Mental health association (MHA) and by the People health institute in Norway (FHI) which surveyed mental illnesses among Norwegian adults[1]. All these are ranged on a continuum from mild to moderate to severe (MHA, 2021). Also, MHA has presented the different treatment ranges of success for Schizophrenia, Major depression, Bipolar disorder and panic disorder. The different success rates were as following; Schizophrenia having 45 percent to 60 percent, Major depression having 65 percent to 80 percent, Bipolar disorder having 80 percent and lastly panic disorder having 70 to 90 percent. Additionally, the Substance Abuse and Mental Health Services Administration (SAMHSA) conducted surveys among U.S adults in 2019 (SAMHSA, 2020). As a result, the survey revealed that about 20.6 percent of all adults in

[1] https://www.fhi.no/en/op/hin/mental-health/psykisk-helse-hos-voksne/

the U.S. suffer from mental illness, as illustrated in Figure 2-1.

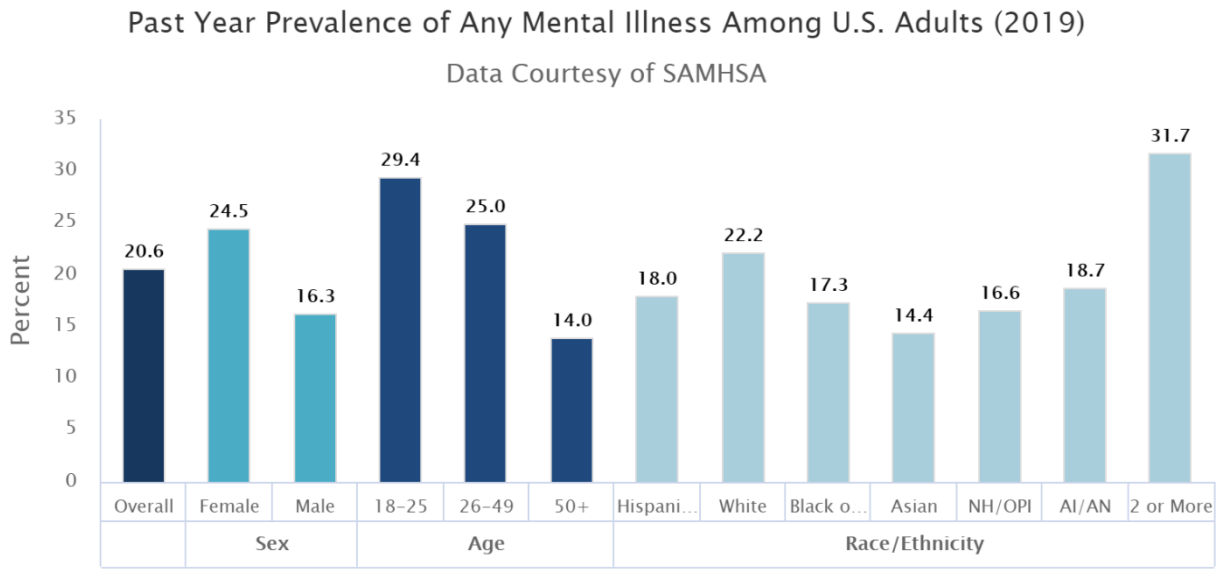


Figure 2-1: Prevalence of Any Mental Illness Among U.S. Adults in 2019

Furthermore, to see how people with mental illness are living, VICE (2020), a Canadian-American magazine, made a web series called “My life with”, where they spent time with people who live with mental illnesses every day. In addition, they did this in order to remove the stigma against people living with misunderstood conditions. One of the people VICE spent time with was Tracey Carnazzo, who suffers from crippling anxiety and Germaphobia, which is being afraid of germs. When the news arrived about COVID and the many outbreaks, Carnazzo became more afraid, and all her fears became more relevant than ever. Nevertheless, alongside her fears, Carnazzo is a professional podcaster and comedian. She studies different ways to kill all the germs and then her notes are then used in her podcast. However, Carnazzo does get help from a therapist from BetterHelp[2], which is mental health service, where she undergoes cognitive behavioural therapy once a week, which is helping her change the way she thinks and how she behaves.

[2] www.betterhelp.com

2.2 VR and the Reality-Virtuality Continuum

In our lives, we face different challenges in different situations. These challenges or hurdles can be met in different environments we grow up in or get adapted to. Furthermore, these environments can become our social bubble (Connor, 2021). Sometimes these social bubbles can create more than a reality for people who live inside many social bubbles. For instance, you can be at school in the real world, but you might be daydreaming about something else, that is imagined and picturized inside the mind. Similarly, an imaginary world that is or can be connected with the physical attributes of a person can be used as a definition for VR, but VR is not only for social purposes. However, in a virtual world that can be seen through a mounted head display, the physical laws are not applied in addition to time and material properties (Milgram, Takemura, Utsumi, & Kishino, 1995). For instance, in the virtual world, a person can do what he was daydreaming about. Such as being able to realize the daydream or being able to fly with wings. In other words, do stuff that was not possible beforehand or could be illegal or prohibited in a country. For instance, in the time that we now live in, some countries are under lockdown and it is not possible to travel on vacation or visit family members that live in another country. Therefore, VR can be used as bridge between an imaginary and a real world, where these rules and regulations do not matter.

In fact, Milgram et al. (1995) demonstrated how the real world and the virtual world are not really two different concept or two opposites, but rather as a whole can be seen together in a continuum that represents a continuum. Where one end of the continuum is the real-world environment, and the other end is the virtual environment. Put together in the continuum it represents a mixed reality, but the continuum itself is called a Reality Virtuality Continuum. To see how VR is perceived and defined, we can look at how different researchers have tried to define it. For instance, Isdale (1998) preferred the definition “Virtual Reality is a way for humans to visualize, manipulate and interact with computers and extremely complex data”. Moreover, Laurel (2016) presented a more detailed definition where she stated that “VR is an immersive “virtual” experience that convinces the participant through sensory and technical means that they are in fact in another place”.

Lastly, Sherman and Craig (2003) in their book explained VR by first demonstrating how VR matured historically. They said that the "virtual world is something that can be conveyed from one person to another via the technology of pigment on stone". Meaning that that VR is a medium for effective ways of communicating with others. Furthermore, Sherman and Craig (2003) build their definition up further by looking at the dictionary from Webster's New Universal Unabridged Dictionary (Webster, 1981), which looks into both words, virtual and reality. For instance, Webster defined "virtual" as "being in essence or effect, but not in fact", and reality as following; "The state or quality of being real. Something that exists independently of ideas concerning it. Something that constitutes a real or actual thing as distinguished from something that is merely apparent." As a result, Sherman and Craig concluded that VR is "a place that exists and that we can experience".

2.3 VR for Mental health

According to Jerdan, Grindle, van Woerden, and Boulos (2018), each mental health illness can be treated with different types of therapy methods. Which would mean that these conditions could be "modified upon intervention" (Jerdan et al., 2018). Since VR is being defined as an immersive experience or as Jerdan et al. (2018) would say "an illusion of reality", VR and Mental health can be combined together, where VR would work as the intervention for the different misunderstood mental health conditions. Similarly, since VR is "immersive", meaning that it gives a sensation of being in an environment, it can therefore lead to a "mental immersion". As a result, it can apply a "state of being deeply involved" (Sherman & Craig, 2003). Thus, working as an intervention for mental health conditions.

Furthermore, to see how VR as an intervention would work in the mental health care domain, alongside the recent advances in technology, and to compare how VR systems have advanced and improved since 2013, Jerdan et al. (2018) compiled 82 studies that made use of VR as head-mounted devices in their research. Similarly, Torous et al. (2020) observed the increase of interest in telehealth, which is how health care services are delivered via remote technologies

(Catalyst, 2018), such as VR, during the Covid-19 pandemic. From the observations of Torous et al. (2020), they saw that the curve of interest needed to be bent in the right direction. Meaning that there needed to be an increase in scalability and access to quality care, and at the same time improved efforts to increase the security, evidence, and implementation regarding these digital tools, as illustrated in Figure 2-2.

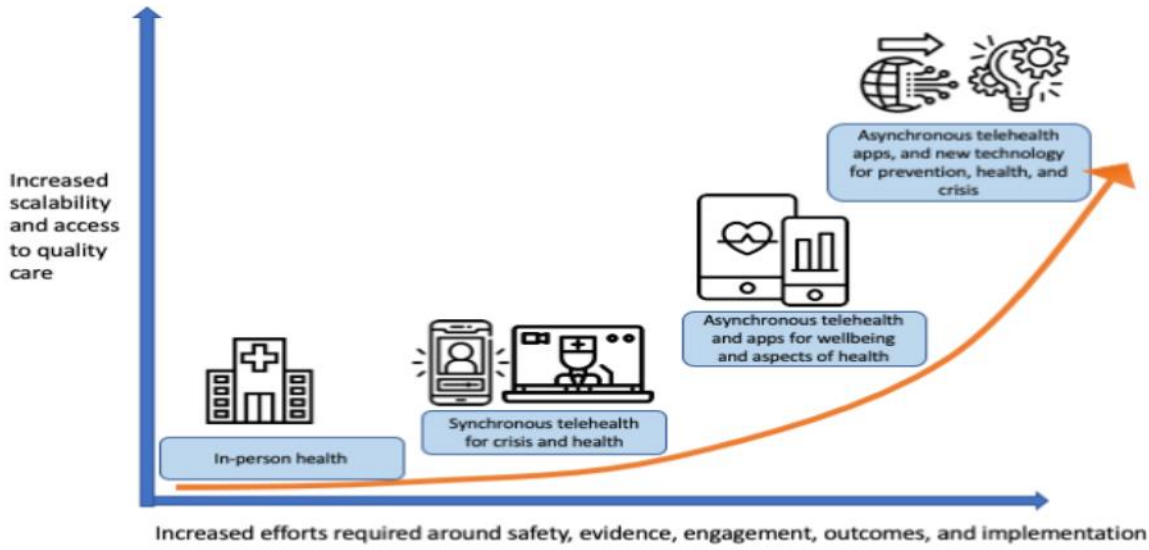


Figure 2-2: Telehealth interest increase during Covid-19

Additionally, Torous et al. (2020) observed many clinicians and patients who now are realizing the full potential of these digital tools, as they are forced to, for the first time, utilize them to socialize because they cannot meet in person at the moment.

For future development in this field, Torous et al. (2020) studied different digital therapy programs to look for pros and cons. They saw that VR systems do have great potential to improve quality care. Similarly, the usage of apps in combination with the current care has shown an increase in the effectiveness of the app mediation (Weisel et al., 2019). However, there is an issue regarding scalability and how quality care can be put against quantity in terms of how many people can receive quality care at one time. In addition, many studies had a high risk of bias, because of limited evidence of behaviour change and self-help in mental health.

In addition, Torous et al. (2020) looked at usability issues and different areas that could be underdeveloped in apps. Hence, they looked at various different apps, with their own open-source app tool which is also available on the market for free (Torous et al., 2019). Some applications were also evaluated to see if the claims about the quality regarding mental health care met the app store descriptions. However, some applications only used "science" as a way to attract users (Larsen et al., 2019). Whereas the main concern and aim of the apps are to provide the best self-care regarding mental health (Baumel, Muench, Edan, & Kane, 2019).

Also, Torous et al. (2020) point out that the patients of these quality care systems are not the only people in the picture. The medical staff, support, trainees etc are a critical part of quality care when using digital tools because they are going to deliver the "care" in these scenarios. Therefore, they need to be included when designing or testing these systems. Their inclusiveness can prevent workflow integration issues and low uptake. However, there are already frameworks in place for these competencies such as the ACGME framework (Hilty, Chan, Torous, Luo, & Boland, 2020).

On the other hand, Jerdan et al. (2018), demonstrated the potential Torous et al. (2020) was presenting of VR, by using an immersive VR system for the main core of interventions in their research, that existed of 82 compiled studies. The VR system contained a computer that generated an image, a display system for projecting the image, and a tracker to update the image based on the user interactions. Generally, this setup was more traditional and expensive, as it was used and limited to laboratories. However, in today's market, a more affordable setup is available for the general public. For instance, a smartphone with a gyroscope is good enough with and without a Head-mounted display (HMD), that displays an image or a game. As an example, the iPhone 4S. Nevertheless, Jerdan et al. (2018) also validated and presented why the use of VR could be beneficial for the mental health care department. They said that "contextually relevant virtual worlds can be created that are used to enable systematic exposure to feared stimuli. The ability to precisely control stimuli has allowed VR ecological validity in its assessment of behaviours, emotions, and cognitions. As a result, established

effective psychotherapeutic approaches, such as cognitive behavioural therapy (CBT)". Moreover, their research indicated that even though the patients know that VR is a computer environment that is not real, they would still perceive it as real because of how the different images and sounds are processed by the brain.

Additionally, for the comparison of diffrent VR systems, Jerdan and his team looked at key concepts. These key concepts included quality, refreshing rate and field of view for previous and recently introduced VR systems, such as Oculus, HTC and PiMax, and were used to observe the user experience.

Undoubtedly, the observation provided interesting findings. More specifically, the refresh rate as frames per second (FPS) showcased that more frames per second gave more fluidity to moving images, which again lead to more realistic movements and a better user experience. Furthermore, if the refresh rate was below 90 FPS, it could likely induce nausea and disorientation. However, Jerdan and his team emphasized that severe illnesses were excluded in this study as they do require a more complex treatment. In addition, the state of their research suggests that VR cannot be a clinical tool itself, but the content it provides a platform for could be the way towards succeeding.

Overall, these studies provided great info towards the pros and cons of the different interventions with VR and what combination can provide a better way of treatment. Moreover, it validates that using VR for different areas in society such as health care, travelling, social events, and maybe even in the real-estate domain, and many more. However, for the treatment of mental health patients, it may require more research to look for behavioural changes. For instance, since the brain tricks the patients who would eventually use VR as a method of treatment, by sound and images. It could also mean that the treatment could affect their mental health negatively, as the VR environment is perceived as real, even though it is not.

2.4 VR for Virtual tourism

To demonstrate the current travel experience and restrictions on international travelling, Flaherty and Nasir (2020) observed the different travellers and their journey from point A to B. Furthermore, the authors saw that the different restrictions on international travel has started

to ease out and become less restrictive. Moreover, the main experience is still cumbersome and cut short by “fewer available flight routes, frequent cancellations, reciprocal travel corridors, travel green lists, health declarations, passenger locator forms, pre-arrival viral screening and post-arrival quarantine in both the destination and, in some cases, the traveller’s home country.” However, all these hurdles are for a better route towards unrestricted travel. Additionally, many people prefer waiting for a vaccine and be on the safer side. Moreover, on the student side universities have moved towards video conferences, which also contributes to lessen the number of exchange students. These changes were made because of the fear of becoming ill while being abroad and not knowing how the health care and travel insurance would cover any unexpected barriers.

However, to address the anxiety levels of travellers during and post travel, a focus towards “travel-medicine” could be a solution. However, not a medicine which the traveller would consummate, but rather a consultation where VR would be used for identifying risk travellers before the journey even starts. Additionally, making anxious travellers aware of unfamiliar environments in a safe pretravel setting.

Therefore, the authors suggest that in the near future VR sessions would be a great prescription made by travel medicine practitioners, to coup up with travel anxiety and to actualize “a greater understanding of the factors that create a resilience across the travel spectrum”.

As a result, for this dissertation, the observation provided a new perspective of how the VR experience can be enhanced so that VR plays a “prominent role in changing the current state of travel where the anxiety levels are heightened, with a far healthier wanderlust” (Flaherty & Nasir, 2020). Lastly, it would make people feel safe enough by tentatively going through these VR sessions and hence, resuming normal international travel.

3 Method

In this section, the iterative development process will be presented along with the different tools that were used. Additionally, the first questionnaire survey in the planning phase will also be described. Figure 3-1 displays the development process in this dissertation.

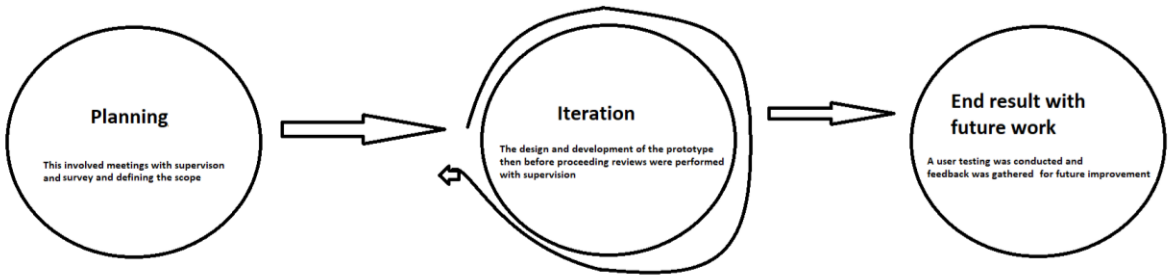


Figure 3-1: the development process

3.1 Planning phase

The planning phase focused on the scope and the ideas or alternatives discussion for further development under supervision. Firstly, the scope of the development project and the idea was discussed to create a feasible timeline where a prototype could be developed. The predefined requirements that were inaugurated through the discussions, made it easier to create a more realistic scope and the timeline for the prototype. Also, the development process focused on having a stand-up and retrospect meeting on the same day each week in order to have a more agile approach. Nevertheless, the predefined requirements involved developing a method for mental health care with the use of VR. Furthermore, extensive research was conducted on the many different mental health conditions or “illnesses”. As a result, 5 major categories and 200 mental health illnesses were collected. Moreover, the scope was further narrowed down for more focus on a smaller target group. Namely, students and the mental health issues that have come into sight in recent pandemic times. Additionally, to investigate and gather information about what the students are going through and what they would like to see in a virtual reality app based on mental health care, a survey was conducted.

Next, to keep track of the development progress, have an overview of sudden ideas and in order to create an agile environment with a backlog of tasks, the app, MeisterTask was used.

3.2 Survey

To conduct the survey, a simple questionnaire was created with Google Forms that consisted of 6 different questions with different answer types. The survey was conducted with people who either are students or have recently graduated and could associate themselves with a student's life. The survey had 10 participants. This is in fact, very limited now that the survey was conducted under lockdown and more people are online at home. All the participants were not asked of their names and therefore remain anonymous. However, they were asked general questions about gender and age, so that the data could be more organized and structured.

Table 3-1: Google survey questions

Survey question
Gender?
Age?
How has the lockdown and Corona period affected your mental health?
During lockdown, what do you do in order to not feel unhappy/sad?
During lockdown, what else do you want to do, if possible? This is where VR can help
During lockdown, what do you wish to have in a VR application, in addition to what is asked above?

3.2.1 Demography

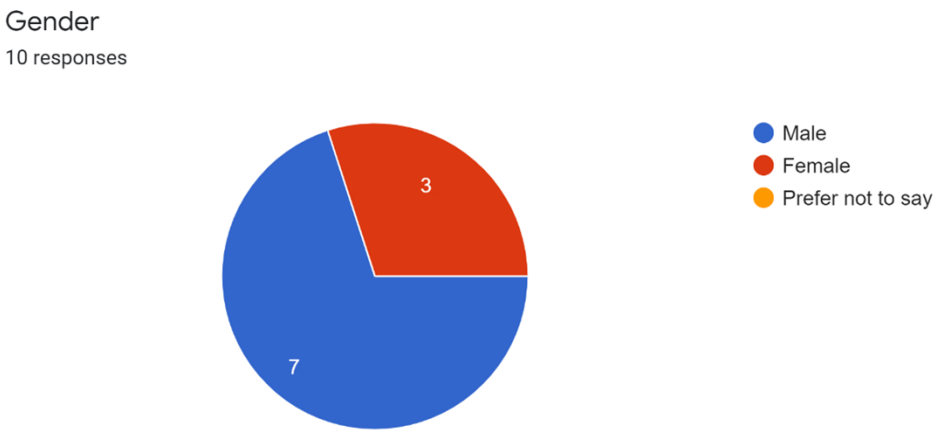


Figure 3-2: Gender percentage of the number of participants, retrieved from Google form survey

The survey revealed that there were more males than females that participated. There were 7 male and 3 female participants, as illustrated in Figure 3-2. Moreover, 9 of the participants were between 25 and 40 years old, whereas only 1 was under 18 years of age, as illustrated in Figure 3-3.

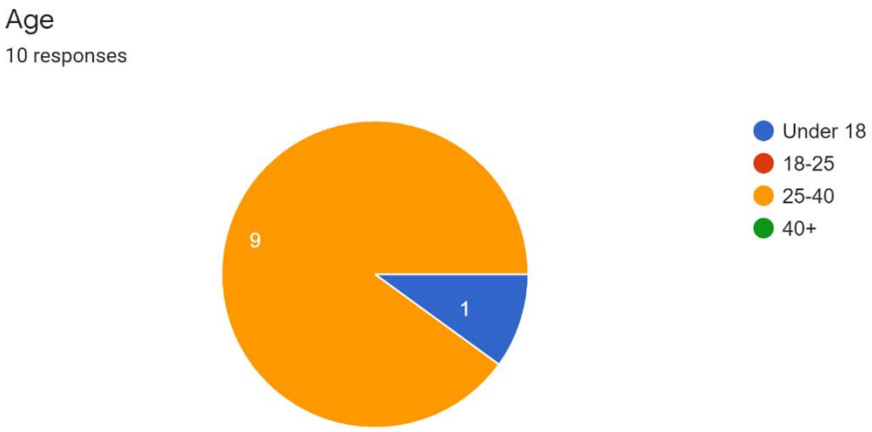


Figure 3-3: Age group percentage from the participants

3.2.2 Lockdown influence on mental health

To see how lockdown had affected the mental health of the participants, a scale from one to five was given. The higher the number the larger the effect on mental health, where one is minimal effect and five being a large effect. The survey revealed that 7 of the participants said that they were “just in the middle” about how much the lockdown had influenced them. The rest of the participants were divided on a scale of 2, 4, and 5, as shown in Figure 3-4.

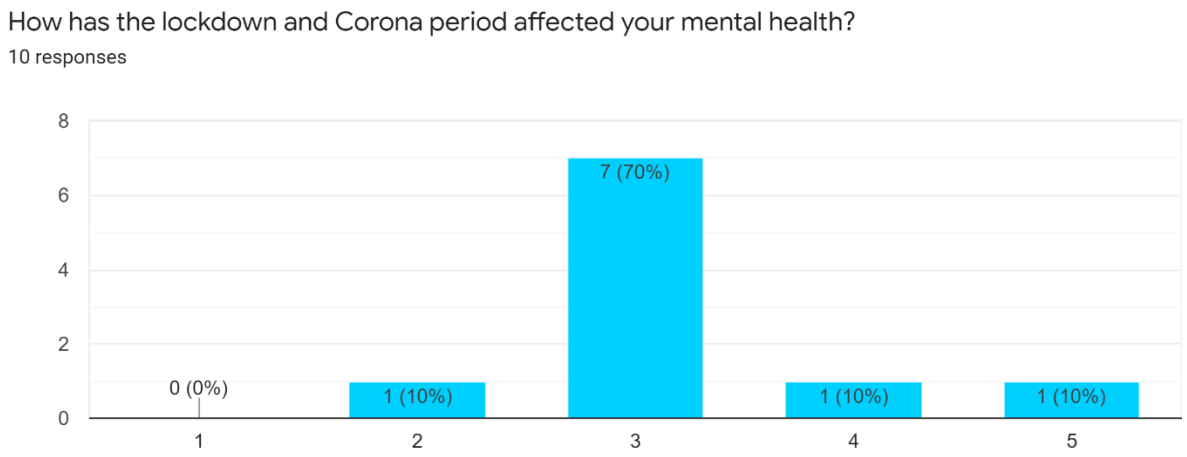


Figure 3-4: Chart for lockdown effect on the mental health of the participants

Since there were only 10 participants in this survey, a conclusion can not be given that the lockdown did not influence many people. However, from this survey, only 1 person said that lockdown had a large effect.

3.2.3 Activities for own self-care during lockdown

To see what the participants did in order to feel happy during lockdown this question was asked, “During lockdown, what do you do in order to not feel unhappy/sad?”. The responses to this question revealed many different answers. However, many participants tried to exercise in order to feel happy during the lockdown. They were also the largest group with 4 respondents. On the contrary, the other 6 respondents gave different answers which included yoga,

meditation, spending time in the garden, sing songs, play games or drawing, cooking food, working, checking social media platforms and etc, as illustrated in .

Figure 3-5: Happy activities under lockdown, retrived from Google form

3.2.4 Activities to do under lockdown in the virtual world

When the participants were asked what they wanted to do in addition to the alternatives in the previous question the two largest groups of 8 in total either wanted to play a sport or travel the world in order to not feel unhappy. The last 2 participants were divided between Going to social events and shopping, as these alternatives were also restricted in some areas under lockdown, as displayed in Figure 3-6.

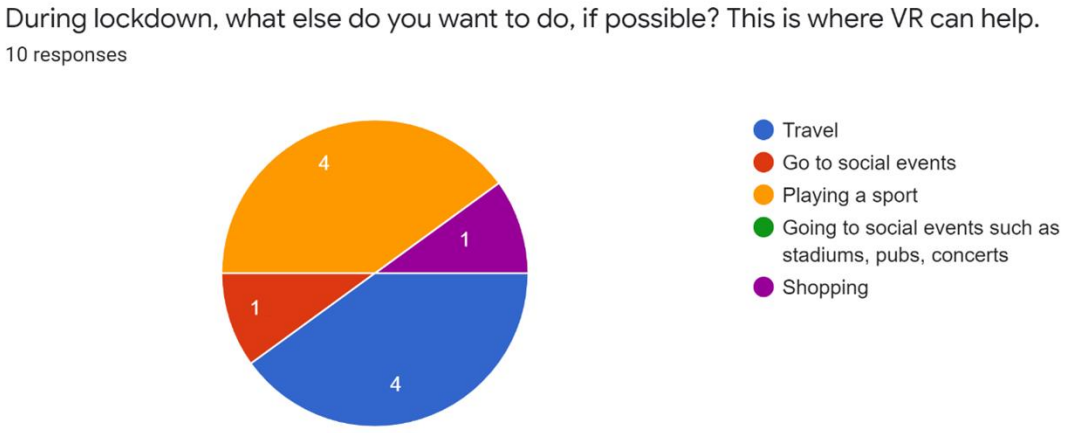


Figure 3-6: Activities possible in VR, but not in the real world at moment

3.2.5 Participants wishes on what to include in the VR app

Since this dissertation was about developing a VR application and one of the main design principles, while developing, was to have the user in focus. Therefore, the participants were asked if they could give some suggestions on what they wanted to include in the final prototype. However, not all participants of the survey gave an answer to this optional question. 2 of the participants did not respond to this question and 2 did not wish for anything.

Table 3-2: Participants wishes on what to include in the VR application

Wishes for features in prototype
Connecting with friends and family
Socialize
I don't necessarily wish for anything.
Educational vlog, video, feel like sitting in actual classroom lectures.
Nothing, thanks
Wedding
An option to learn something new.
If you have used social media or electronic media more frequently as you were using before lockdown, if yes, than spot a light on fact that it has negative or positive impact on mental health?

3.3 Development

In this section, the development process will be presented together with how the game came into existence with a storyboard.

3.3.1 The development environment

In the development process, many challenges and decisions were made, followed by a lot of "trials and errors". To start developing either the Unity Engine or Visual Studio could be used. However, the Unity Engine was much more user-friendly for VR development and was, therefore, the optimal choice for development. Next, to start developing in an environment that met the needs of VR development, a decision between project template in the Unity Engine was performed. The project template that was selected provided an advantage for VR systems in 3D as shown in Figure 3-7. The advantage is that a 3d environment provides a more realistic environment for the end-user, which means an "illusion of the reality" is created (Jerdan et al., 2018).

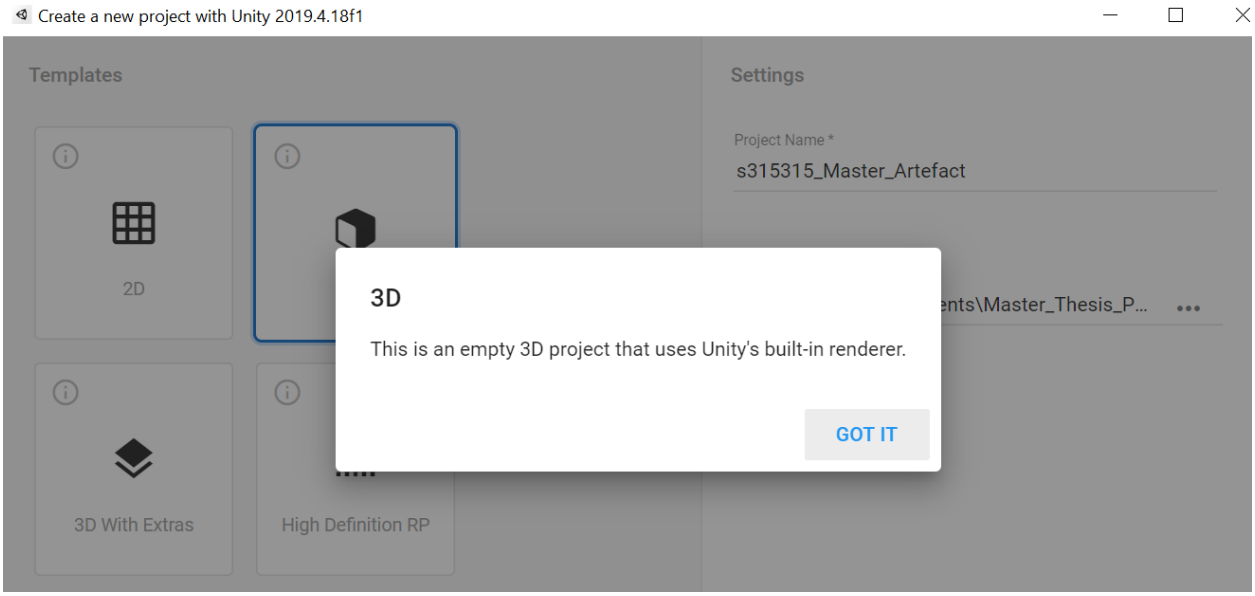


Figure 3-7: New 3D project creation in Unity Engine

Furthermore, to have the tools that make it easier for VR development a XR toolkit was imported and installed, as shown in Figure 3-8. The XR toolkit provides two different types of Virtual Camera rigs, one which is static and another which is dynamic. For this dissertation, the static XR rig was selected as the user does not need to move physically in order to move in the

virtual world. The static XR rig includes a Device simulator and an interaction manager, as illustrated in Figure 3-9. The device simulator is the in-game camera, which is connected to the interaction manager, that makes it possible for the user who uses the VR headset or mobile to interact with the different objects.

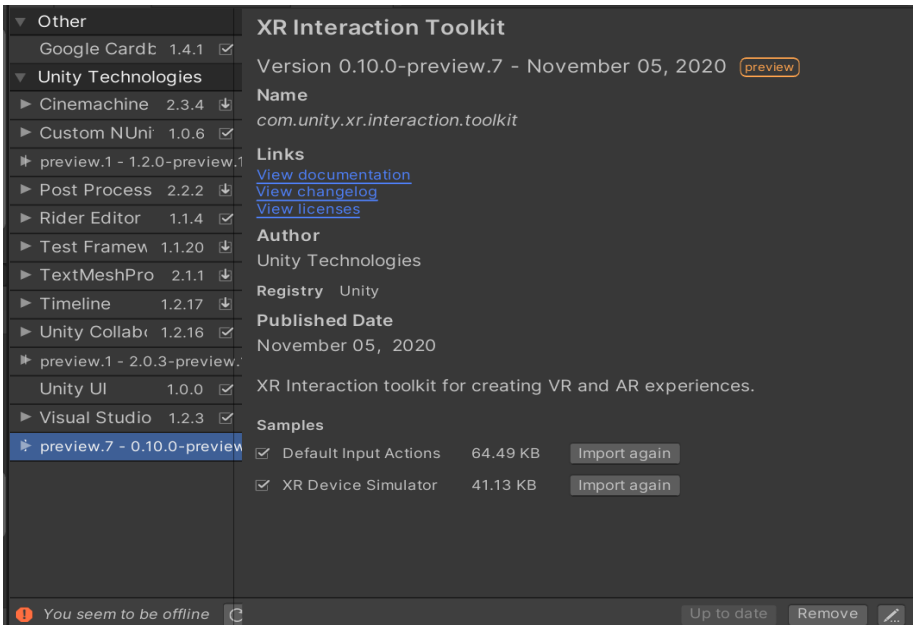


Figure 3-8: XR Interaction toolkit package for VR development

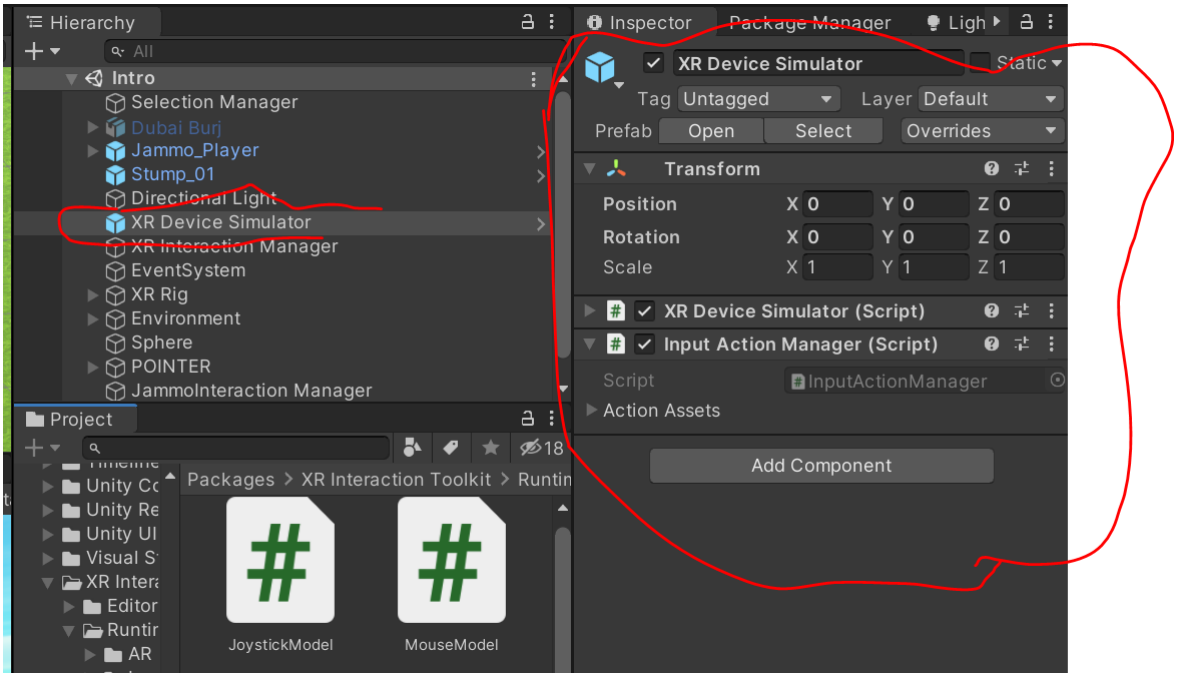


Figure 3-9: XR Static Rig

3.3.2 The storyboard

Now that the Environment was in place, an idea for how the game should be developed was created with a storyboard. The storyboard consisted of the main scenes in the game and further descriptions and details of what different interactions and background sounds should be in place.

Since the unity project was “a game”, a menu was included. The menu would provide a first impression for the user and “a natural pause” so that the user is not directly thrown into the game[3]. Therefore, the first main scene was an intro with a menu, as displayed in Figure 3-10.

[3] https://www.gamesradar.com/the-hidden-value-of-video-game-main-menus-and-the-design-secrets-that-compel-you-to-hit-play/

Figure 3-10: The first Storyboard scene "The Intro"

3.3.3 The development of the first scene in the storyboard

In the initial startup phase, when the project was launched in the Unity engine program a default scene was given in order to start developing. This scene included a “main camera” and a “directional light”. The “main camera” is what the end-user sees through his smartphone and the directional light is a light beam to put focus on different objects in the scene, as illustrated in Figure 3-11.

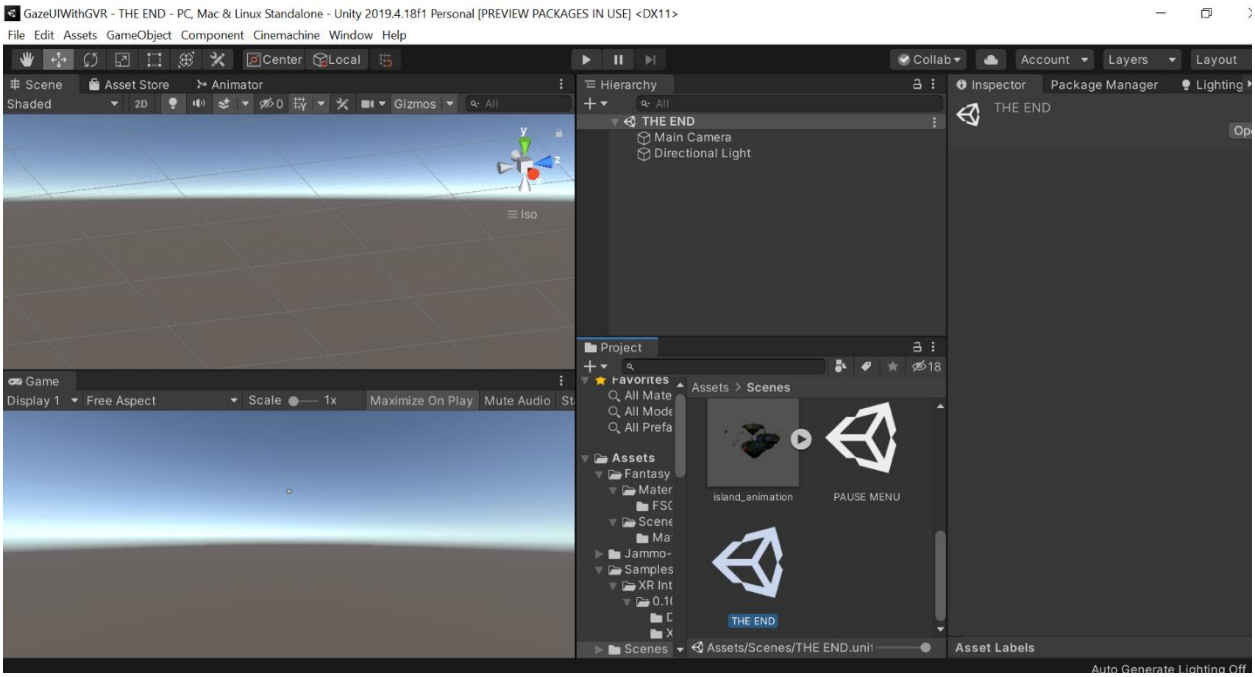


Figure 3-11: First default scene layout in the UNITY engine for development

Next, since the first scene was supposed to be an introduction, a simple green floor prefab was developed. To develop the green floor first a cube object was created by right-clicking inside the hierarchy window and selecting “3D object” and then “Cube” from the Menu, as displayed in Figure 3-12.

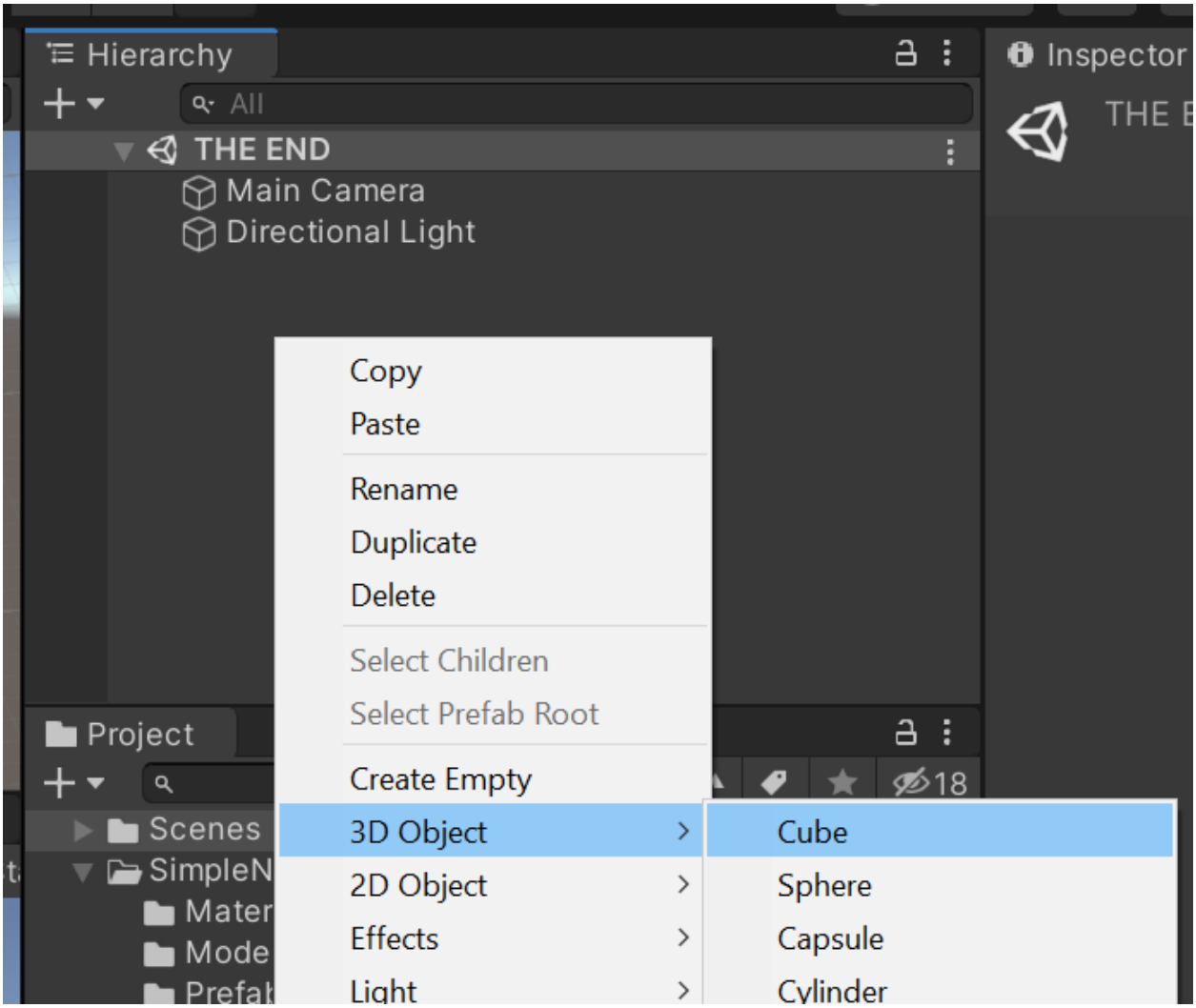


Figure 3-12: Creating the initial cube for a floor object

When the cube object is placed on to the scene, the sizes and dimensions of the cube are changed so that it becomes a floor. To see how the final floor object looks like the “main camera” view in the scene was panned out to make further changes, as displayed in Figure 3-13.

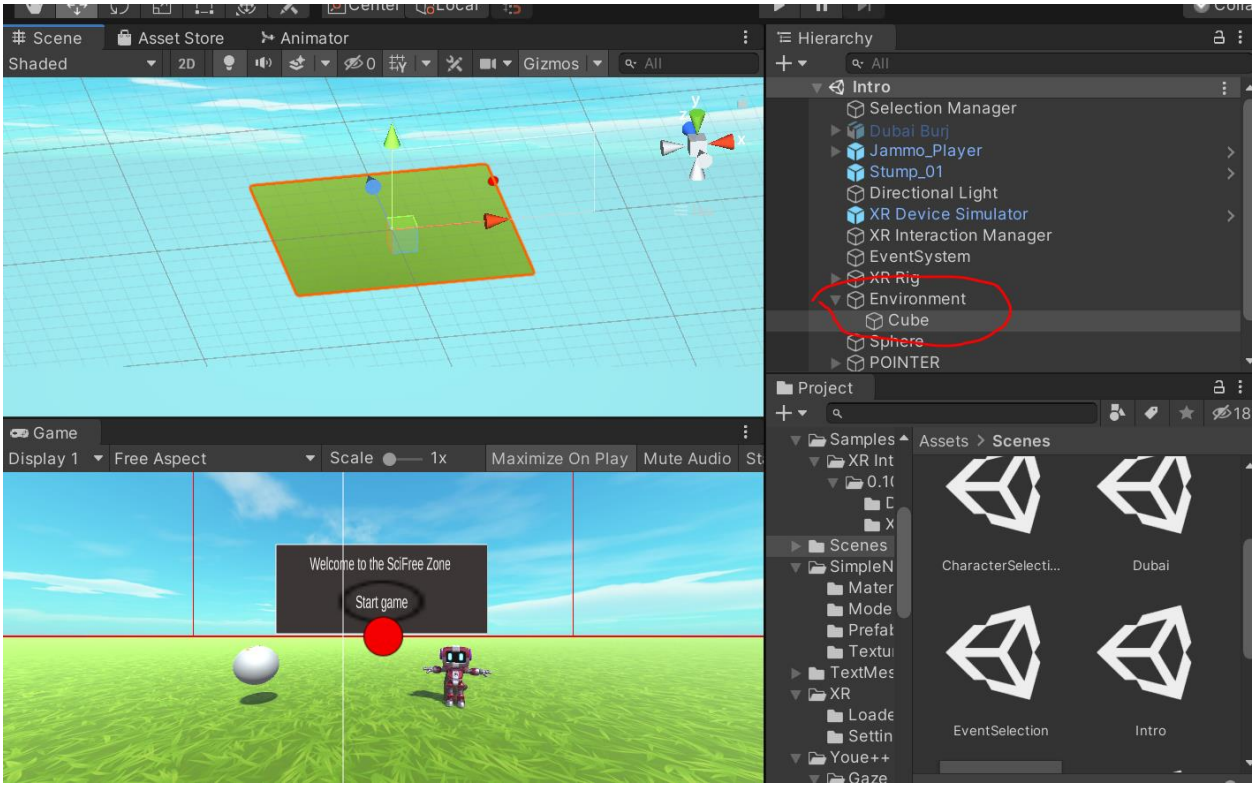


Figure 3-13: The final floor object with green grass material added

Furthermore, a menu was needed for the first scene. This could be done in different ways. It could be done by creating a cube again and changing the position parameters, so it floated up in the air. However, this could cause more complexity than needed because of other psychical attributes in the game, such as colliders which applies gravity inside the game on the object. The object could then go through the grass because of gravity. Therefore, an image object with text and button objects inside is much easier to interact with for the user, as illustrated in Figure 3-14.

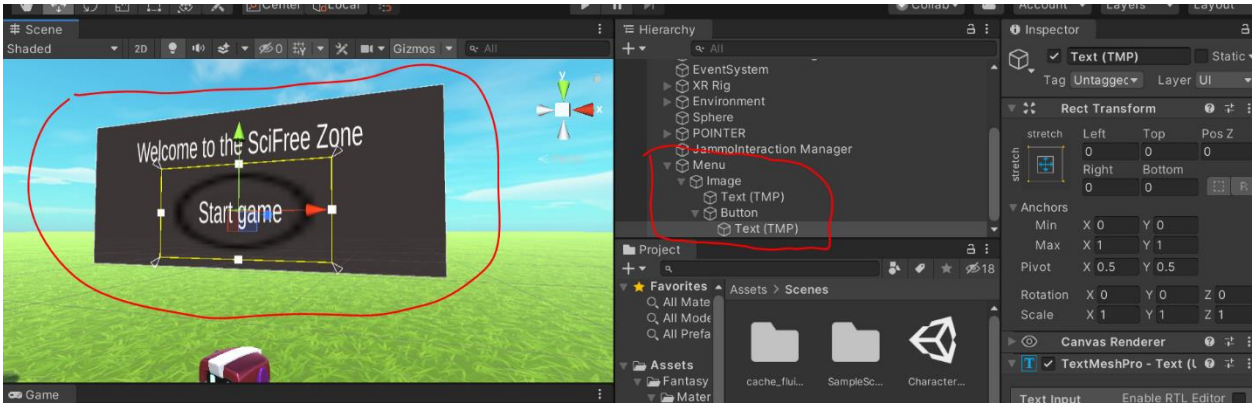


Figure 3-14: Menu object in Unity inside the first intro scene

Next, to make it easier for the user to understand and so that the user can calm down when entering the game, a friendly character with a calming voice was placed on to the scene. This character was already available for free from the Unity Asset store and was called Jammo[4], as illustrated in Figure 3-15.

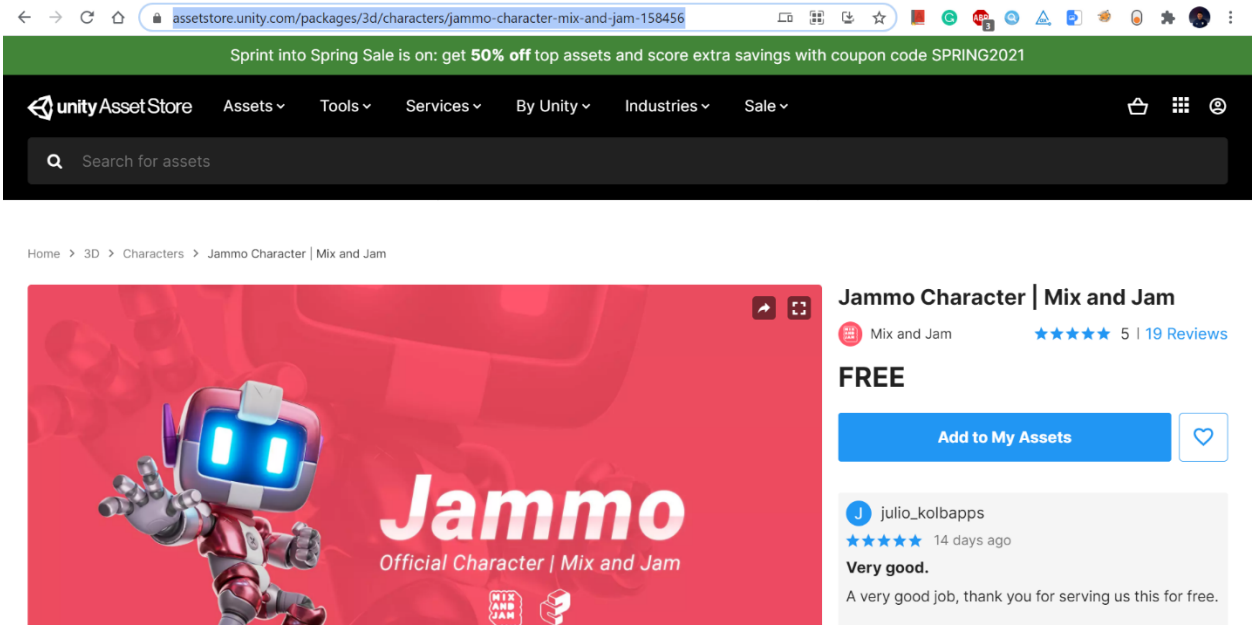


Figure 3-15: Jammo, free character package from the asset store

Jammo was an already developed character and included some animations, in other words an asset. However, since a voice and some other animations were needed, further development on Jammo was performed. In order to place Jammo onto the screen, the character package from

[4] https://assetstore.unity.com/packages/3d/characters/jammo-character-mix-and-jam-158456

the asset store was downloaded and the Jammo was placed directly onto the screen, as presented in Figure 3-16.

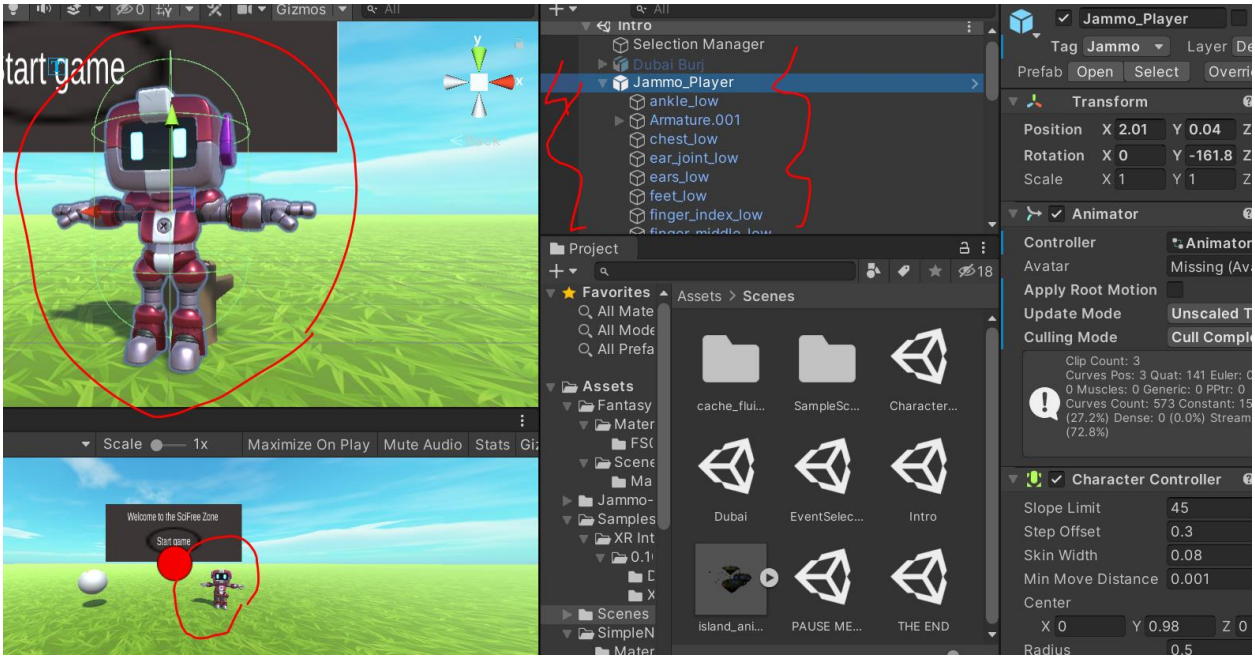


Figure 3-16: Jammo, a character from the Unity Asset store

Next, Jammo needed to look more welcoming and animated. Therefore, animations were added from the software tool Mixamo. At first, three different animations were added, “Happy sitting”, “SittingLaugh” and “Victory Idle”, as presented in Figure 3-17. Then the animator tool in Unity was used to create triggers that changed between the animations depending on where the “user” is looking. Furthermore, since Jammo could be unfamiliar for some users, a change of character can also be performed. This character selection scene can be entered if the user looks at Jammo and selects to change character. The newly selected character is then set as the new guide for the game and is replaced with Jammo.

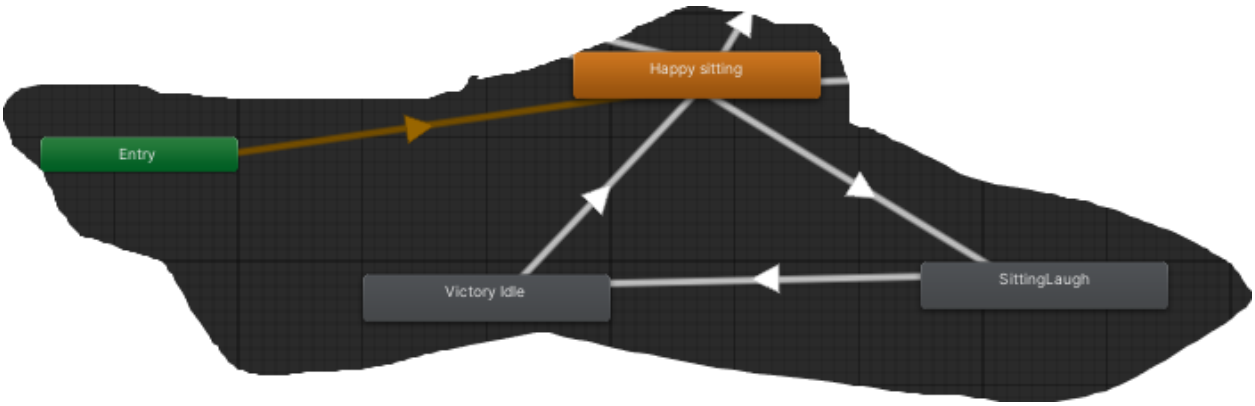


Figure 3-17: Animator tool first three animations of NPC character Jammo in the Unity project

Finally, to make it easier for the user to understand how to interact and continue on with the game, a Gaze UI control was implemented. The Gaze UI works as a Raycaster which is placed in the middle of the scene, then the raycasting point would function as the user's eyes. The different objects would then respond if the raycasting point interferes with the coordinates of the object inside the scene. For instance, the "start game" button in the menu changes the background colour when the user looks at it. Similarly, the guide character, currently Jammo, jumps up in happiness when the user looks at him because he is waiting patiently for the user to look at him. Jammo then also provides the option of changing character, by asking if the user wants to meet his friends, as illustrated in Figure 3-18.

Figure 3-18: option of changing character

3.3.4 The character selection scene

After the user has said yes to meet Jammo's friends, he is then moved into the character selection scene, as presented in Figure 3-19.

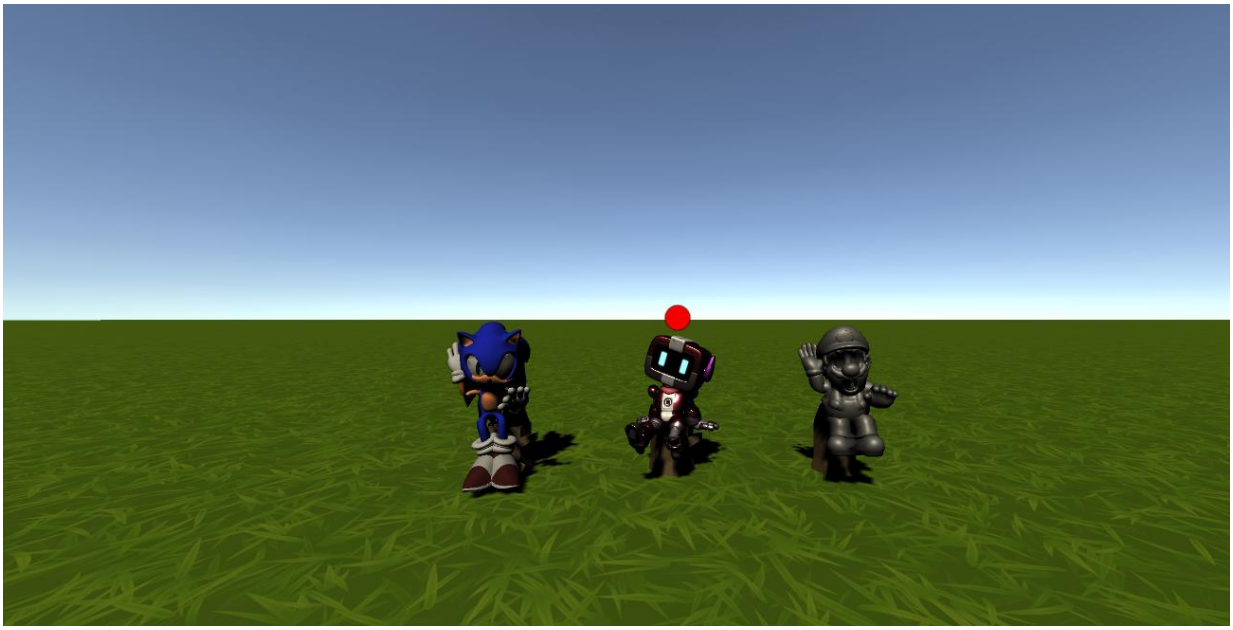


Figure 3-19: The character selection scene

In the character selection scene, the user can focus on the different characters and each character will wake up and introduce himself and ask if the user wants the character to join him. Some of these characters are from popular cartoons, such as Mario and Sonic the hedgehog. These characters were included so that the user can be a bit more familiar with the guide character for the game. When the user has selected a character, he will get moved back into the "Start game" scene.

3.3.5 First scene after the "Start game" scene

When the user has started the game, he is met with a new set of options for what kind of activity he can do, which is "not possible under lockdown" in the real world, as illustrated in Figure 3-20.

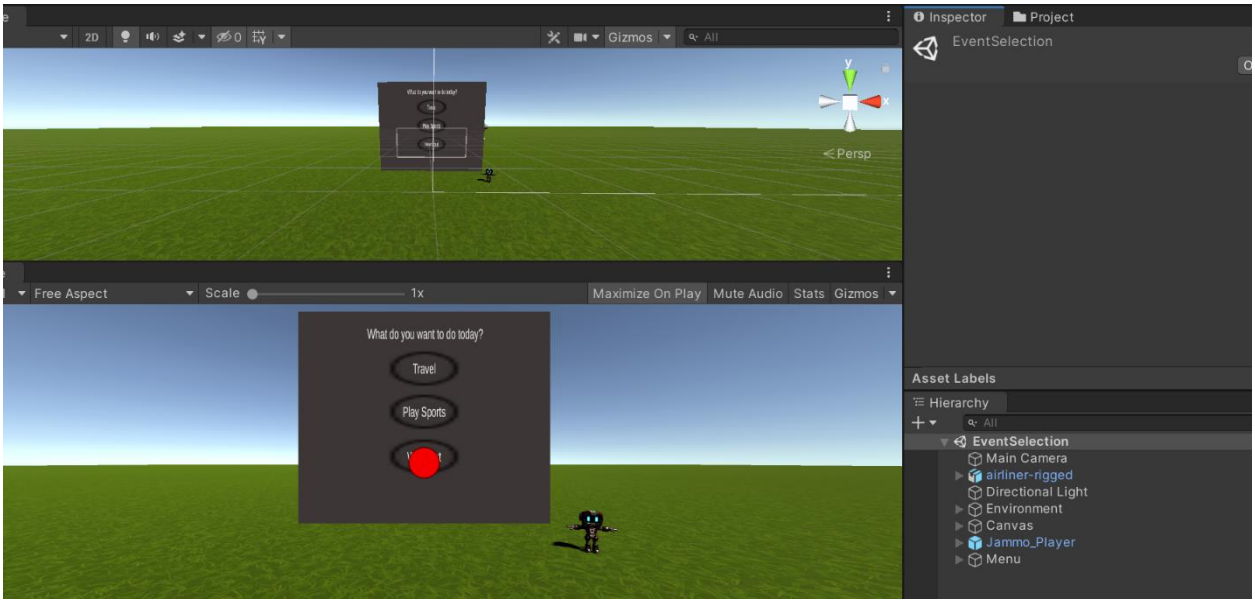


Figure 3-20: Activities that cannot be done in lockdown

In the current stage of the development, the user can only select the “Travel” option, because that is the only developed “storyline”. Moreover, the other options are disabled and would not be interactive options in the menu. However, when the user selects the “Travel” option, the menu disappears and Jammo will take “the user” onto a plane for travelling to a destination, as showcased in Figure 3-21. The only destination for travel, however, is only Dubai. Jammo will then jump up in the air and into the plane and “the user” will then be “restationed” in front of the Burj Khalifa in the next scene.

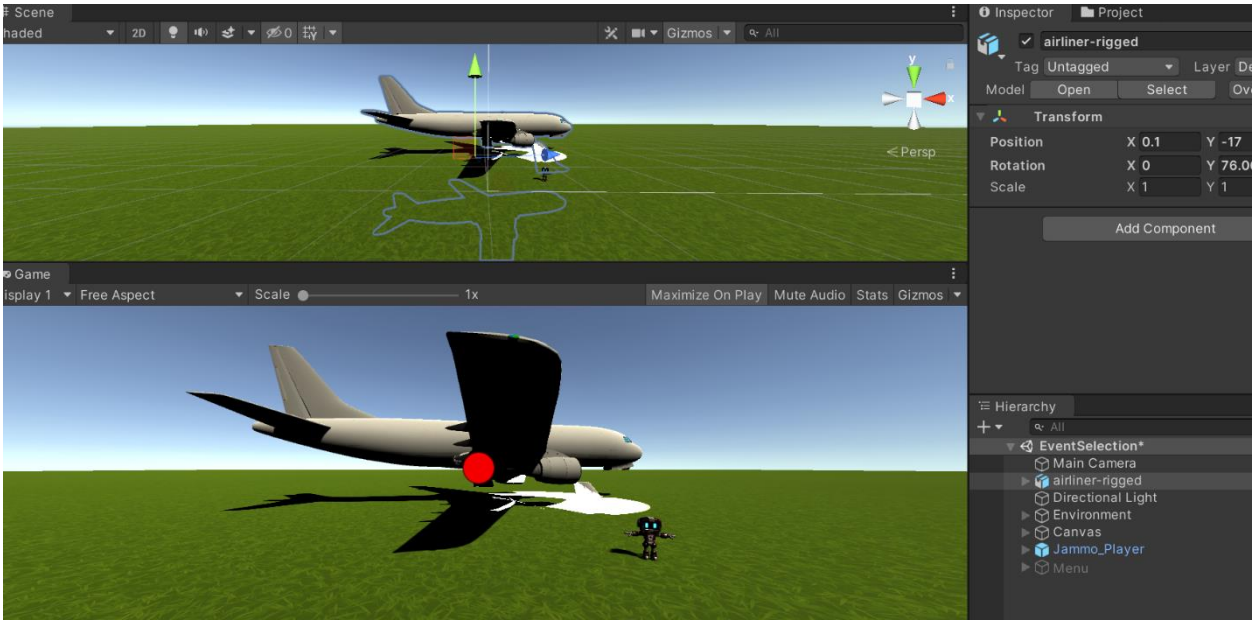


Figure 3-21: Plane landing for travelling with Jammo

3.3.6 Final destination Dubai

In the final scene, the user will land in Dubai, where the user will see that Jammo jump down, walks up to "the user" and introduces the destination, as presented in Figure 3-22.

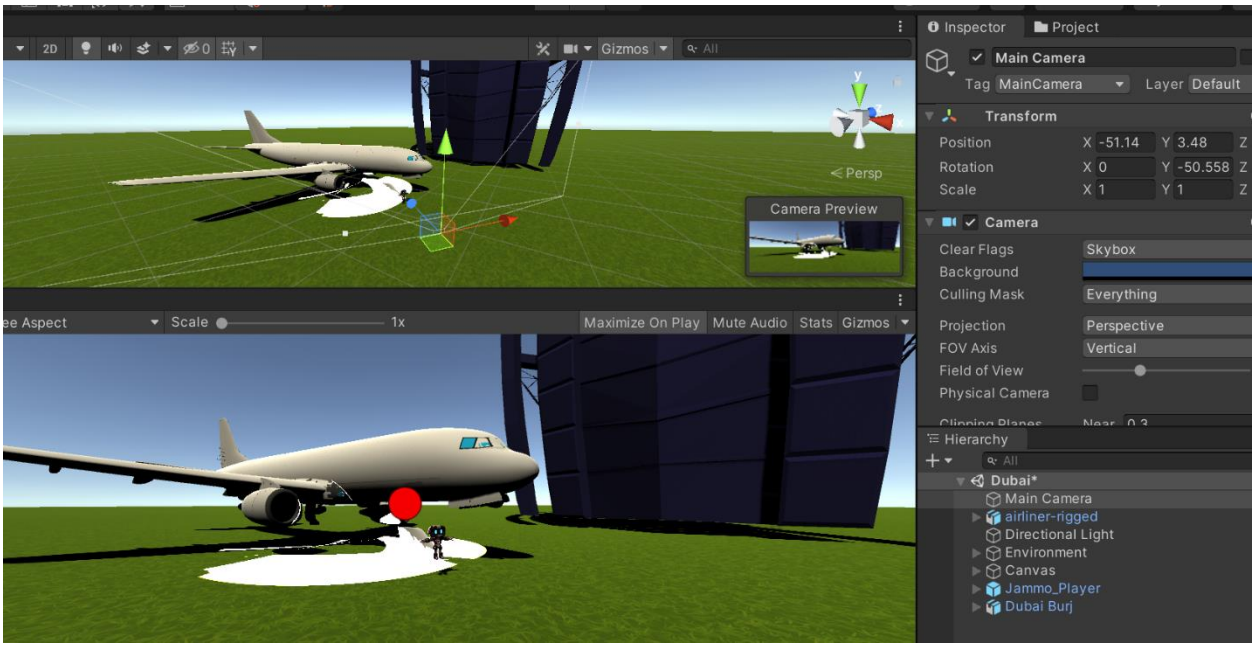


Figure 3-22: Dubai, just the building Burj Khalifa

For the time being, the destination is very simple and does not have any additional factors that can create an environment that assembles the area surrounding Burj Khalifa.

On the other hand, in order to get the Burj Khalifa into the game, a long route was taken. Firstly, the Burj Khalifa was downloaded from BlendSwap. Secondly, since the format of the download file from BlendSwap was in Autodesk format, it had to be converted into FBX format which is a format supported by the unity Engine for assets. However, since the latest version (2.92) at the time being, had removed the support for Autodesk file formats, an older version of blender, more specifically older than 2.9, needed to be downloaded in order to unlock the feature of converting from Autodesk into the FBX format. Finally, the Burj Khalifa asset was imported into the Unity project, as presented in Figure 3-23.

Figure 3-23: Burj Khalifa asset in Blender before exporting to unity

3.3.7 The Gaze UI

In order to have fully functional scenes and transitions, a control mechanism was needed for interaction. Since the XR Interaction tool did provide XR Ray casting tools and scripts, they were implemented into the Unity project. Firstly, the XR Rig object was created in the hierarchy of the Unity project, as illustrated in Figure 3-24. Furthermore, this XR Rig provided a Left-Hand and a Right-hand controller, because the XR Rig is meant to be used with expensive VR headsets such as the Oculus Rift with two additional controllers which are handheld. However, since this prototype in this dissertation is meant to be low-cost and does not need to have any expensive headsets or handheld controllers, a simple Ray caster as a form of interaction with only the use of “the user” camera view was used.

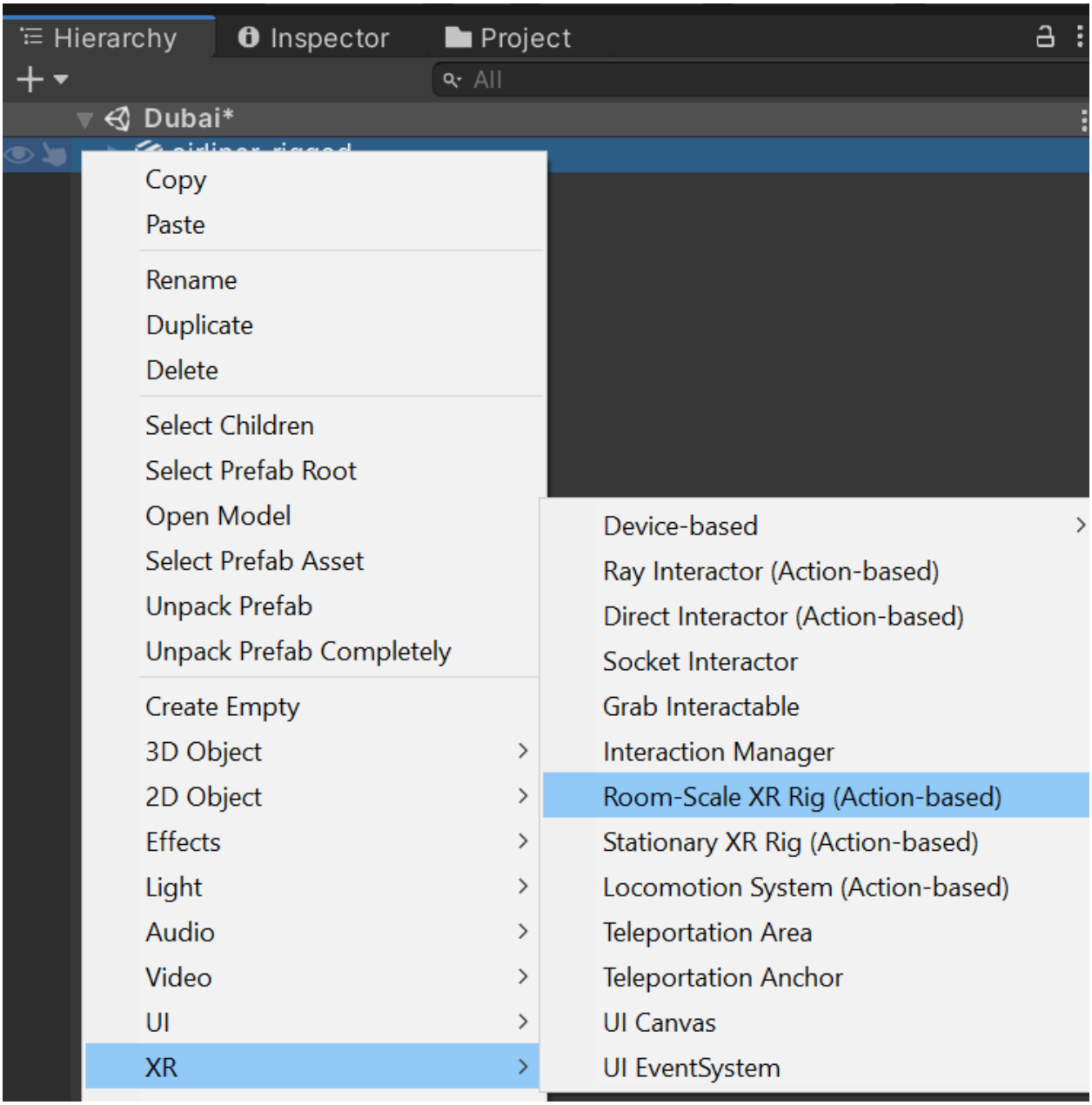


Figure 3-24: Inserting the XR Rig into the unity project hierarchy

Secondly, to make sure that the different objects responded to the ray caster hitting them as targets or interfering with their current position, an XR Interaction Manager was needed. Additionally, a raycasting "gaze" point for "the user" was created so that he knows that a control mechanism is in place. To make the raycasting point, a simple circle image asset was created from the UI menu on a Canvas. The canvas is a parent object, thus the circle image is created inside the canvas object as a child object, by doing as illustrated in Figure 3-25.

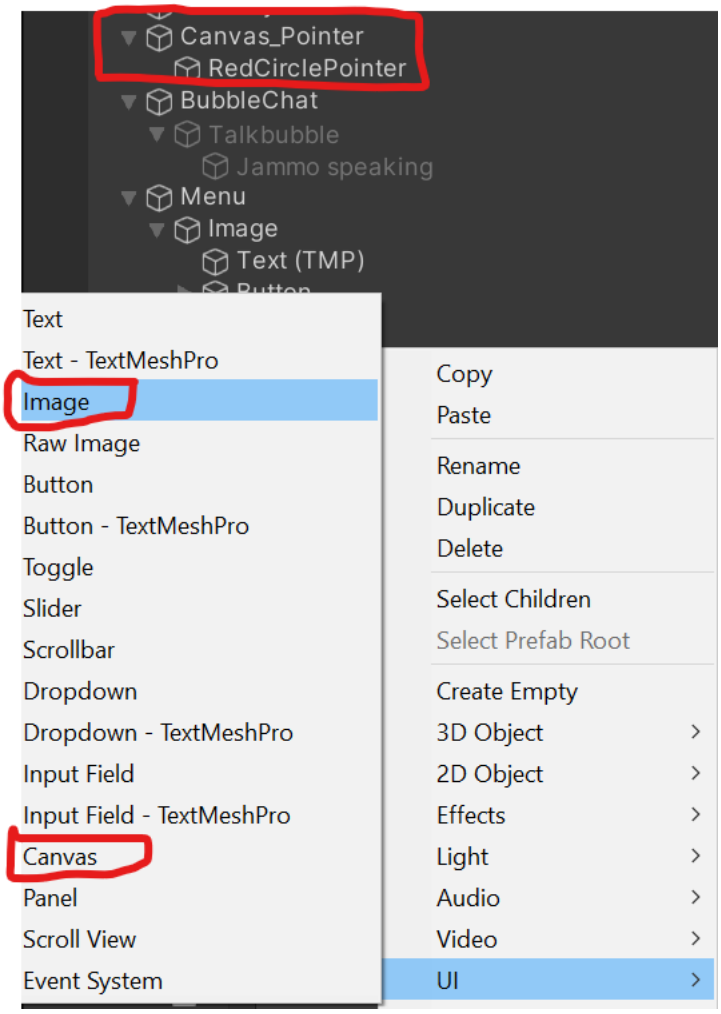


Figure 3-25: Red Pointer created on a Canvas

Furthermore, since the pointer was meant to be in a circular shape and an animation needed to be added to simplify the response of a target, the image was made radial so that the fill of the image became circular, as shown in Figure 3-26. Moreover, to create the animation, the fill amount was used as an illusion, which only transitions from 1 to 0 in a 1-second timeframe, which resulted in Figure 3-27. Nevertheless, the animation was created in the Animator tool provided in Unity.

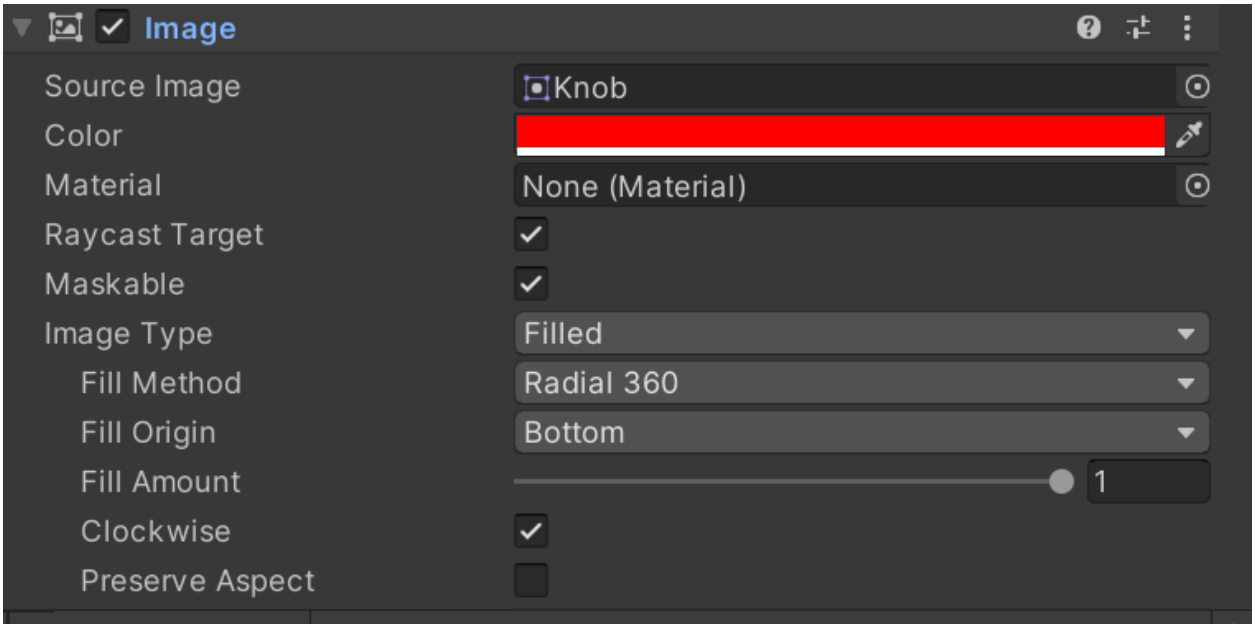


Figure 3-26: Radial Pointer image

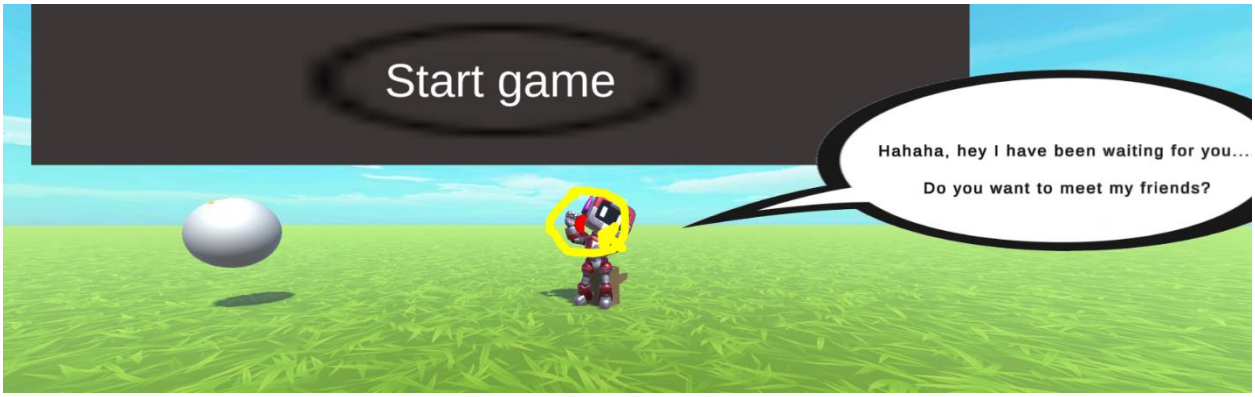


Figure 3-27: Radial pointer animation activated

3.3.8 The Animator Tool

In Unity, the animator tool can be used to change between different states of an object by using transitions. These transitions make the illusion of the animation. For instance, the radial ray casting point has 2 states, one which is “idle”, and no target is hit, and another where a target is hit. These 2 states can be used as demonstrated in Figure 3-28, where the idle state is default and if a condition is met, the default state is transitioned into the other state. Furthermore, different animations can be triggered when parameters are met, such as Boolean parameters. For example, when the ray caster hits a target, the parameter “RayHit” is set to “True”, and the animation is then activated, as illustrated in Figure 3-29.

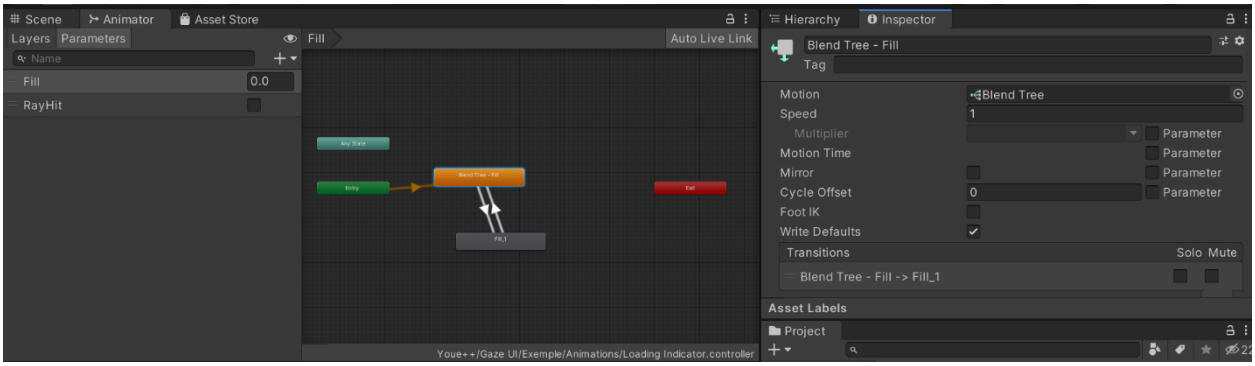


Figure 3-28: Animator tool state for the pointer

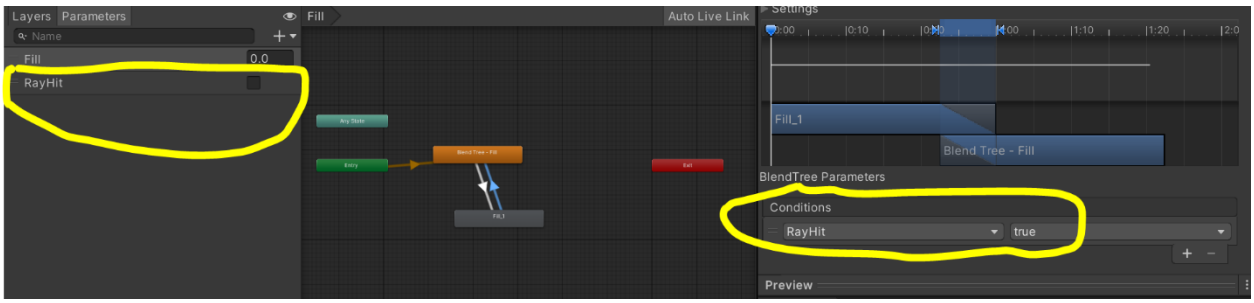


Figure 3-29: Animation conditions

The animator tool is also used for the different cutscenes between the different game scenes in order to create a “loading” effect.

3.3.9 The Scene Manager

The scene manager in Unity is a tool that loads and activates the different scenes. Firstly, all the different scenes need to be inserted inside the screen manager by changing the build settings. The build settings can be changed from the menu in Figure 3-30. Secondly, a button or an object needs to be used as a way of going to another screen. For instance, the “start game” button. That button then has a script added which needs to load the next scene, either asynchronously or synchronously, and unload the currently active scene for the change to happen, as developed in the following lines:

```
SceneManager.LoadSceneAsync(SceneEntry);
SceneManager.UnloadSceneAsync("Intro");
```

To make the transition more user-friendly, a loading image is used between the scene change. For a smoother transition, the asset “LeanTween”[5] from the asset store was also used on the loading screen image, which covers the whole “Camera view” of “the user”, and scales down to 0 again when the next scene has loaded.

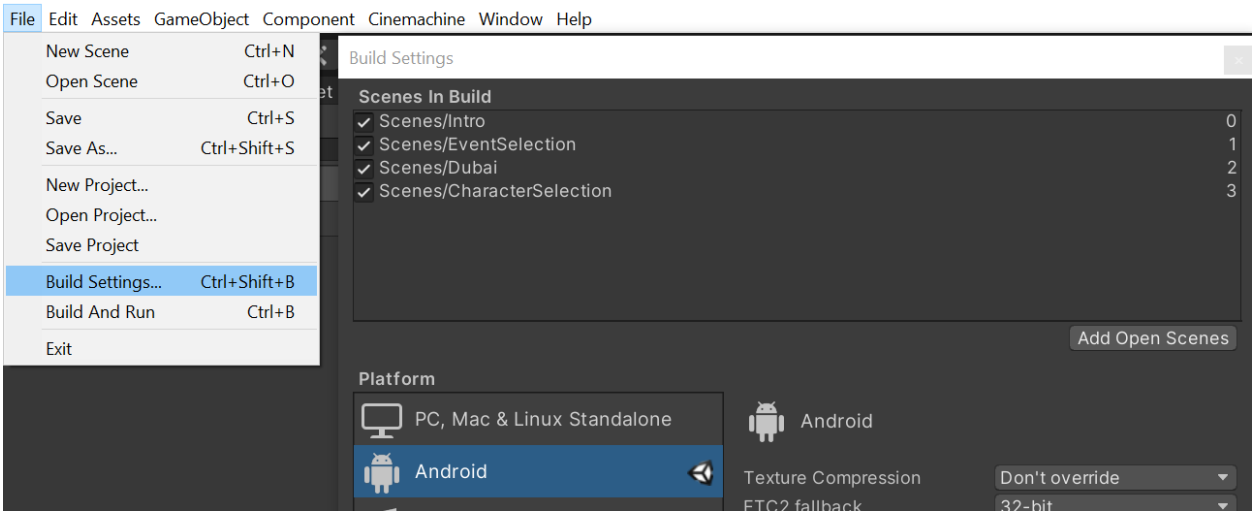


Figure 3-30: The Scene manager in build settings

3.4 Tools used in the development

3.4.1 MeisterTask

MeisterTask is a collaborative Kanban Board and can also become a simple to-do list or a board for random notes and ideas. MeisterTask lets u create columns with their own names, colours and icons. The board for this dissertation consists of the following columns: “Open tasks”, “In Progress”, “Done”, “Questions for Supervisor” and “Review”, as shown in Figure 3-31.

[5] https://assetstore.unity.com/packages/tools/animation/leantween-3595

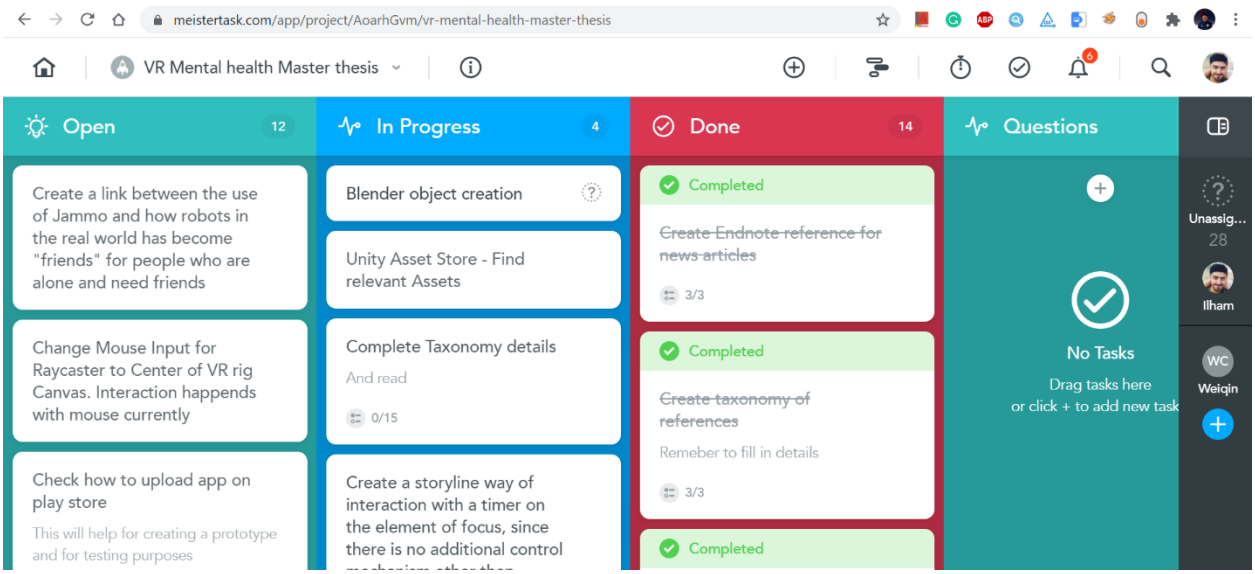


Figure 3-31: MeisterTask board

3.4.2 Unity Engine

The Unity engine, also known as Unity3d (Brookes, Warburton, Alghadier, Mon-Williams, & Mushtaq, 2020), which is a popular software engine for developing 3d games, animations and other applications. Unity is also increasing in popularity in the research domain, by being used in different research studies. For instance, psychology experiments (Bird, 2020), surgical simulation (Pulijala, Ma, & Ayoub, 2017) and rehabilitation systems (Koenig, Ardanza, Cortes, De Mauro, & Lange, 2014). However, it is mostly being used for game development, both commercial and non-commercial. Some of the main features of the Unity engine are animations, rich graphics, and realistic physics.

To see how the realistic physics system works, objects can be placed in the game view with applied rules of physics and colliders. Moreover, the different objects in the engine can be classified as either prefabs, models, or materials. A prefab is a game object which includes all different inputs, settings, models, materials and textures as one asset. Therefore, a prefab can be easily reused when it is saved as an asset. Relatedly, Unity also provides a Unity assets store for prebuilt assets, and many other objects to build an asset. Material is an element that defines

how the object should be rendered and gives specific texture and colour. A model is the main stature of an object, such as a character or a building.

Furthermore, the Unity engine provides two different views for development, one which is the actual game view and the other is the scene where the different object can be moved and changed. Interactions and additional scripts can be added here as well. Unity also provides a good scripting API[6], which can be a good guide for further development.

3.4.2.1 Unity Asset Store

While developing a game, inspiration or a quick solution to an idea might be needed. In Unity, inspiration for different game assets can be found in the Unity Asset Store [7]. The game assets can be everything from a texture to a whole set of prefabs for a specific theme. The assets can also be of the premium version, which can be purchased. However, there are many good freemium options.

3.4.3 Visual Studio

Visual Studio is an integrated development engine (IDE), which works very well with Unity when writing scripts for different interactions or objects. The unity engine automatically opens up visual studio, if an edit in a script is requested from an object setting window. Visual Studio also provides good development environments for .NET, C# and JavaScript. Furthermore, debugging of code and additional extensions and packages for easier development of different applications (Johnson, 2012).

[6] https://docs.unity3d.com/560/Documentation/ScriptReference/index.html
[7] https://assetstore.unity.com/

3.4.4 Mixamo

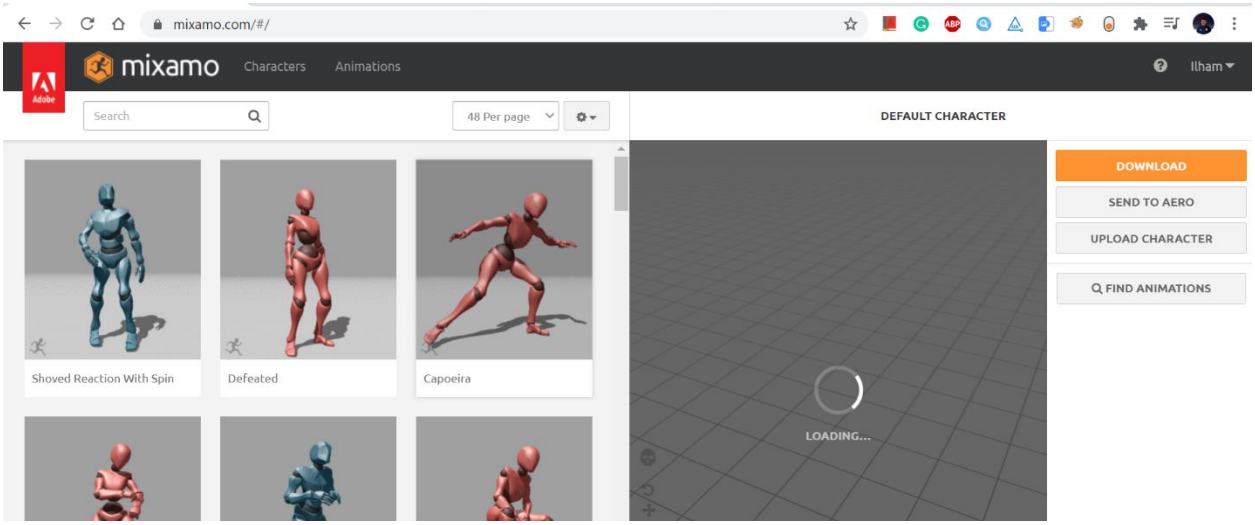


Figure 3-32: Mixamo platform for character animation

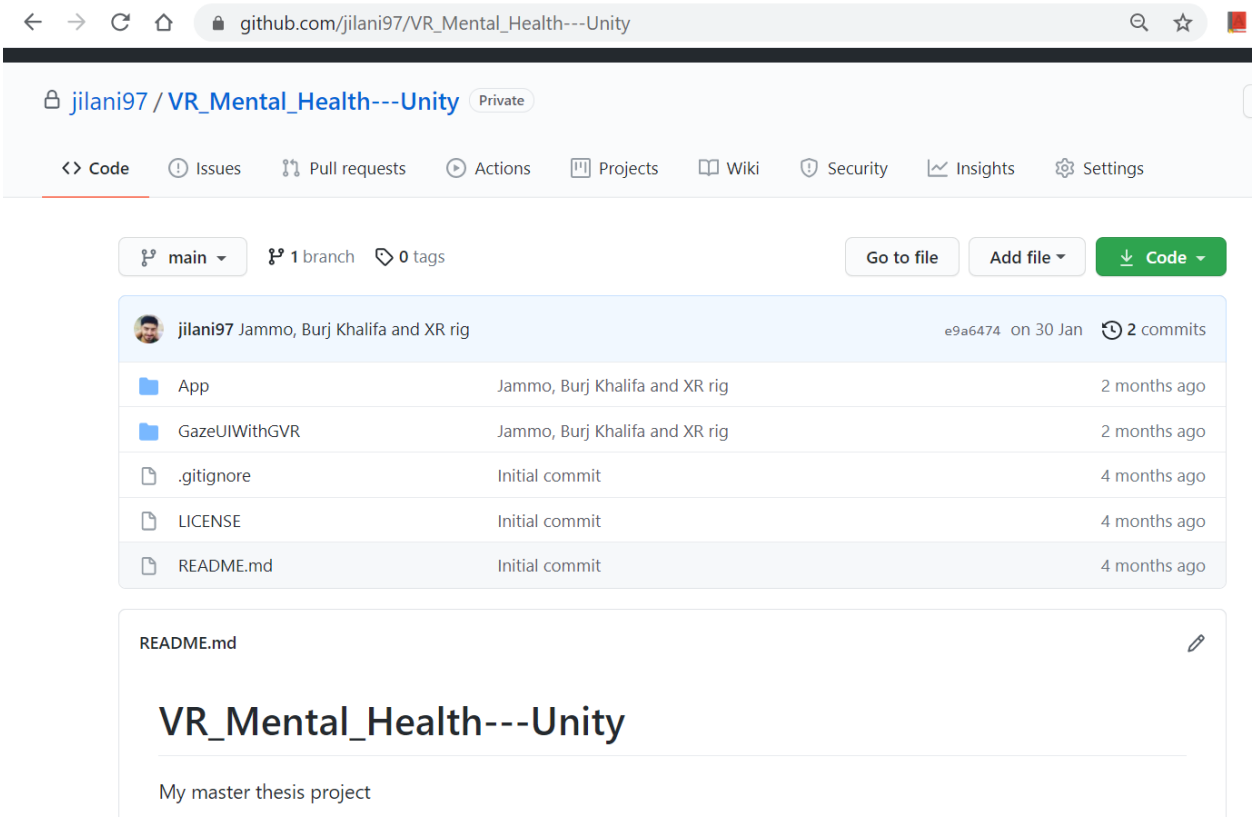
Mixamo[8], a very good software tool if an animation needs to be added to a game character, as shown in Figure 3-32. Furthermore, Mixamo also provides a selection of characters in case "the user" of the platform does not have a 3D character prebuilt already (Blackman, 2014). When an animation is selected, the character can then be downloaded as an asset containing the animations, which can be used in the Unity engine as triggers or default actions of a character. The animations can also be changed in the Animator tool in the Unity engine.

3.4.5 Blender

A software tool that is also used together with Unity is Blender (Mullen, 2011). Blender can be used to develop the main asset such as a game character or just the model of a character. Furthermore, Blender can be used to edit a character that is download from the unity asset store, as well as edit the animations downloaded from Mixamo. Therefore, Blender can be used in many different ways because of all these different functionalities for game development and 3D art. Additionally, Blender can also open different file types which are not supported by Unity such as Autodesk files which are used for prototypes or models of actual buildings. Blender also has the functionality of converting unsupported filetypes into supported filetypes of Unity.

[8] http://www.mixamo.com/

3.4.6 Github



Version control is an essential part of software development, and therefore, Github was used for the prototype in this dissertation. Github provides easy options for collaboration between developers and can also make it easier for developers to contribute to the open-source community (Github, 2016). Furthermore, Github creates the possibility of working on different features of a project simultaneously, by using branches for the different features. When a change is made in development, the other collaborators can also review the changes before it is added to the main branch of development. This makes continuous delivery of a project much easier, and feedback can be given much more often. Furthermore, the development becomes more flexible and agile. Github also provides the feature for connecting pipelines to cloud servers, so by making one change in development it can easily be pushed to the game servers and the end users can see the changes much quicker.

3.4.7 BlendSwap

In Unity, assets could be download from the asset store, similarly, in Blender, Blendswap can be used. Blendswap provides many different 3d models created by many different developers with different programs, such as Autodesk and 3D studio and more. For instance, Burj khalifa can be downloaded from Blendswap, as presented in Figure 3-33. However, it is in a file format that is not supported by the Unity engine, but when the “Burj Khalifa” asset is opened in Blender, it can be converted into a supported file format, and later be used as a normal asset in the Unity Engine.

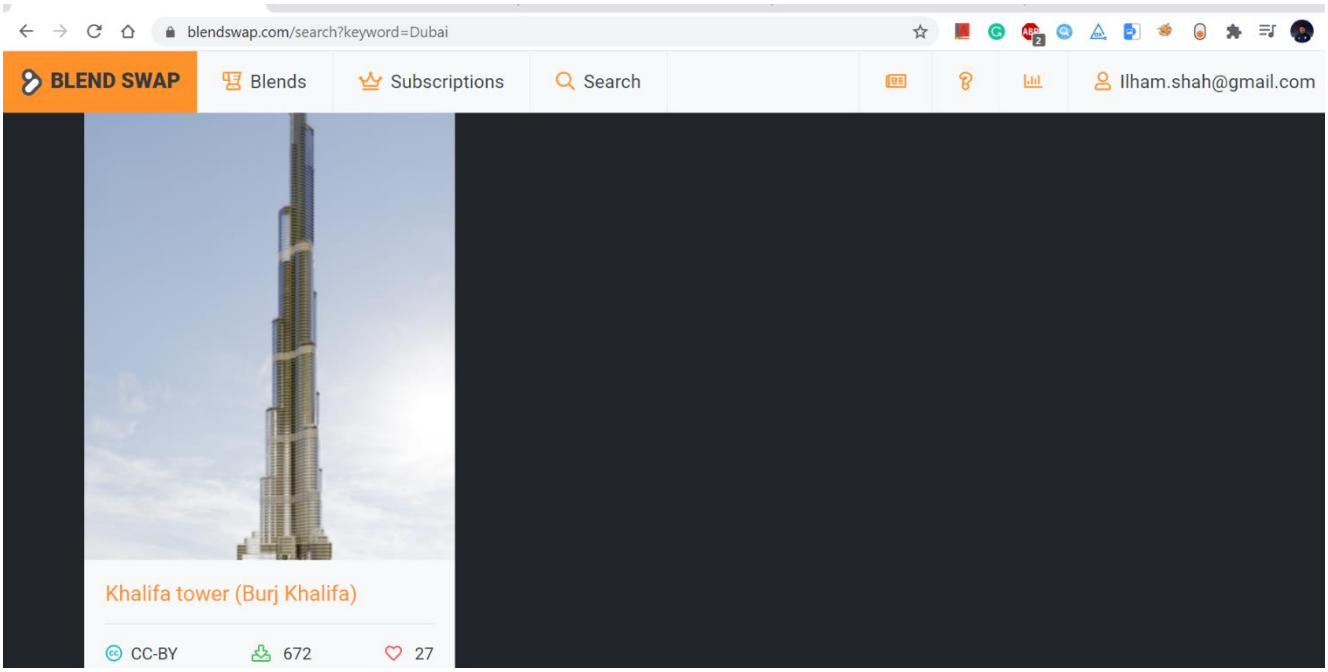


Figure 3-33: Burj Khalifa asset from Blend swap

4 Results

In this section, the end result of the game will be presented, with “the user’s” point of view in mind. Furthermore, a video of the game has been recorded to demonstrate the prototype.

4.1 The user’s journey inside the game

When the user starts the game, he is met with the following objects in the introduction scene, as presented in Figure 4-1.

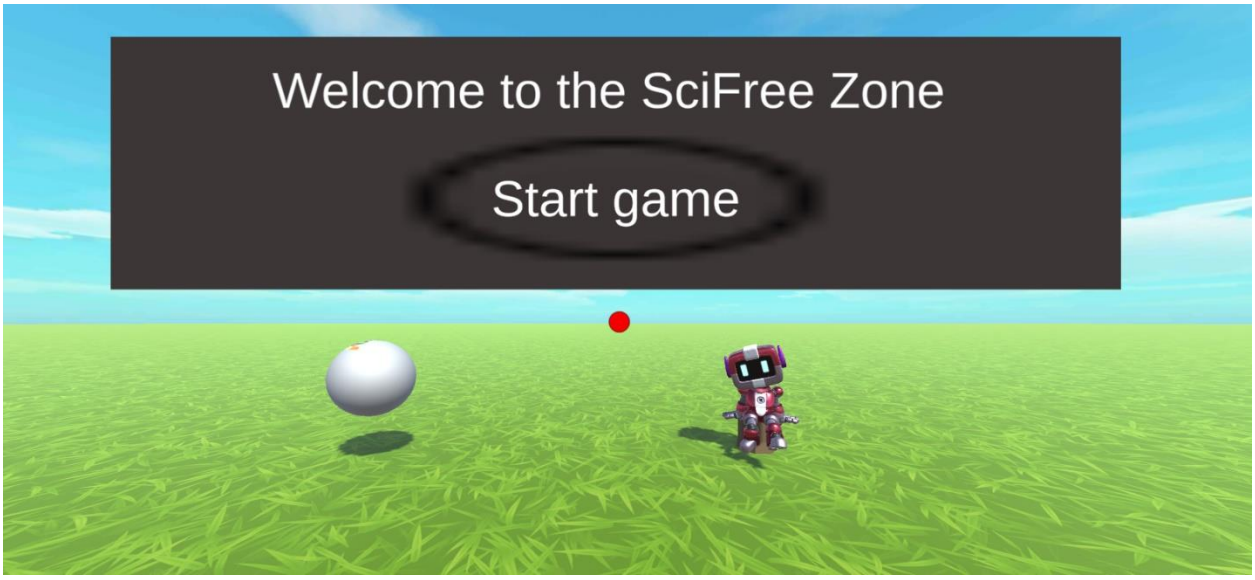


Figure 4-1: The first scene in the user’s journey

In this scene, the user can interact with the white “ball” which is just a decoration, the robot called Jammo, which will welcome the user and asks he wants to meet his friends and the start game button which will take “the user” to the first main game scene. When the user interacts with the start game button, he is transitioned into the scene presented in Figure 4-3. However, if the user decides to meet Jammo’s friends, he is then transitioned into the following scene (Figure 4-2):

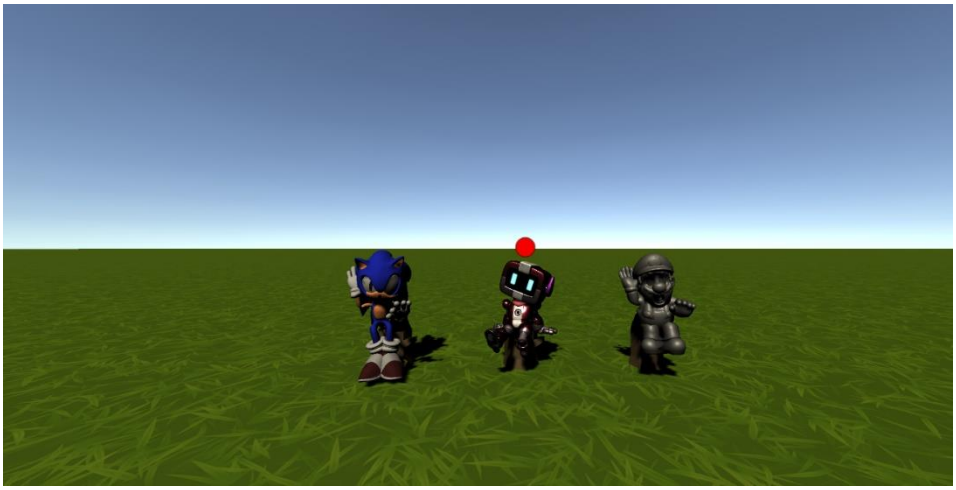


Figure 4-2: The character selection scene

In the character selection scene, the active character will be moving, and the others will be static. When a new character is selected, the user will be transitioned back to the introduction scene, where the new character will welcome him, as in Figure 4-14.

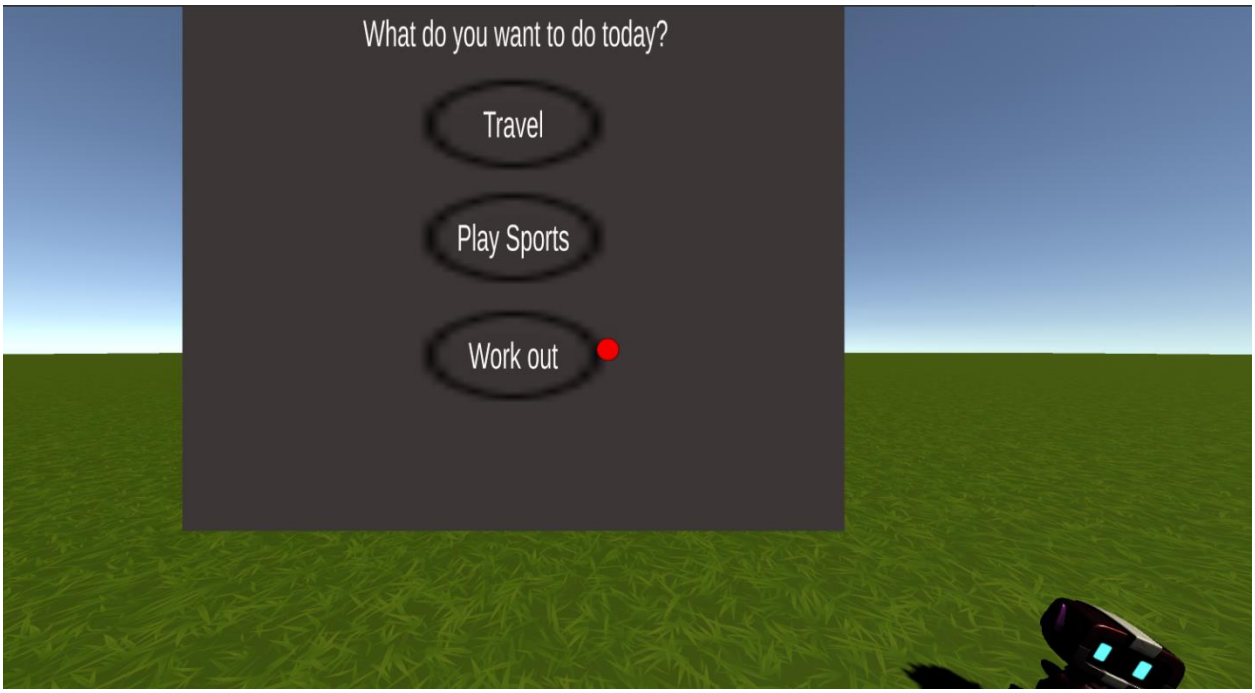


Figure 4-3: The first main game scene

In the first main game scene, the only possible option is “Travel”, which will bring a plane to a scene, where Jammo will go up to the plane and the user is transitioned into the final scene, which is the final scene of the game, as presented in Figure 4-4.

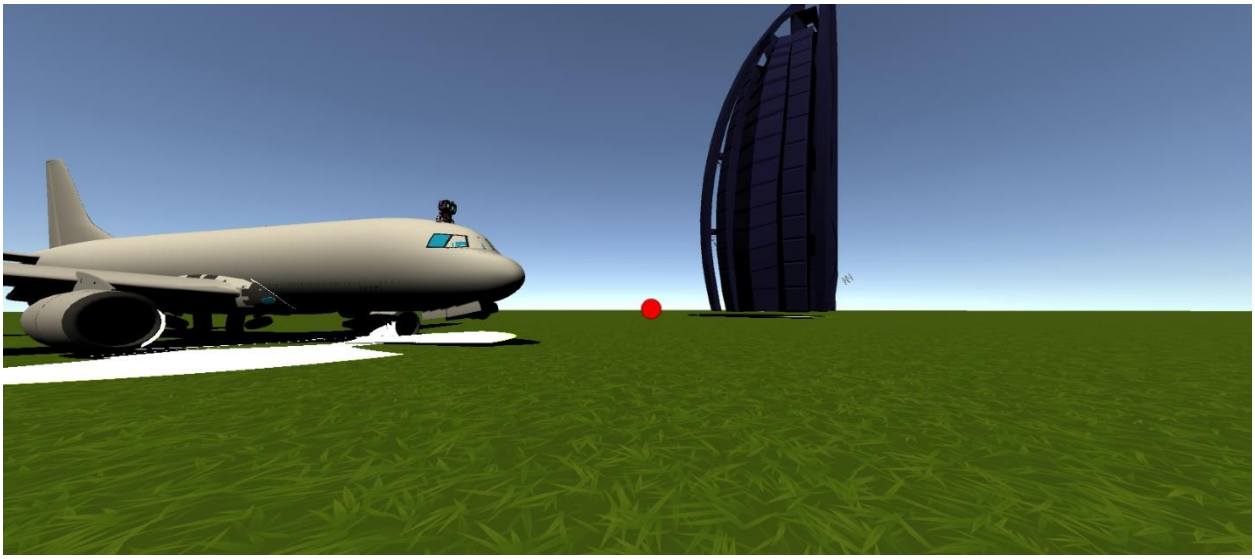


Figure 4-4: The final scene in front of the Burj Khalifa

Jammo, will then walk up to the user and welcome him to the final destination, which is Dubai.

Finally, to record the game, OBS studio[9], was used.

[9] https://obsproject.com/

4.2 User testing

In this section, information about the user test environment, the feedback from the participant(s), and the bugs found will be presented. Due to lockdown and restrictions, only 1 person participated in this user testing.

4.2.1 The user test environment

To see how the game would work and feel for the end-user, a user testing was conducted. Firstly, to set up the test environment, a build version of the Unity project for either Android or IOS needed to be built. Additionally, the build version would require build settings related to the compatibility of the playable build version of the game. For instance, what the minimum requirement of the Android version needed to be in order for the game to be playable. In the Unity engine version, where the prototype in this dissertation was developed, 2019.4.18f1, the first Android version supported was “Android 4.4 KitKat”. Since one of the aims of this dissertation is to be a “low-cost” VR application, Android KitKat was preferred, as illustrated in Figure 4-5.

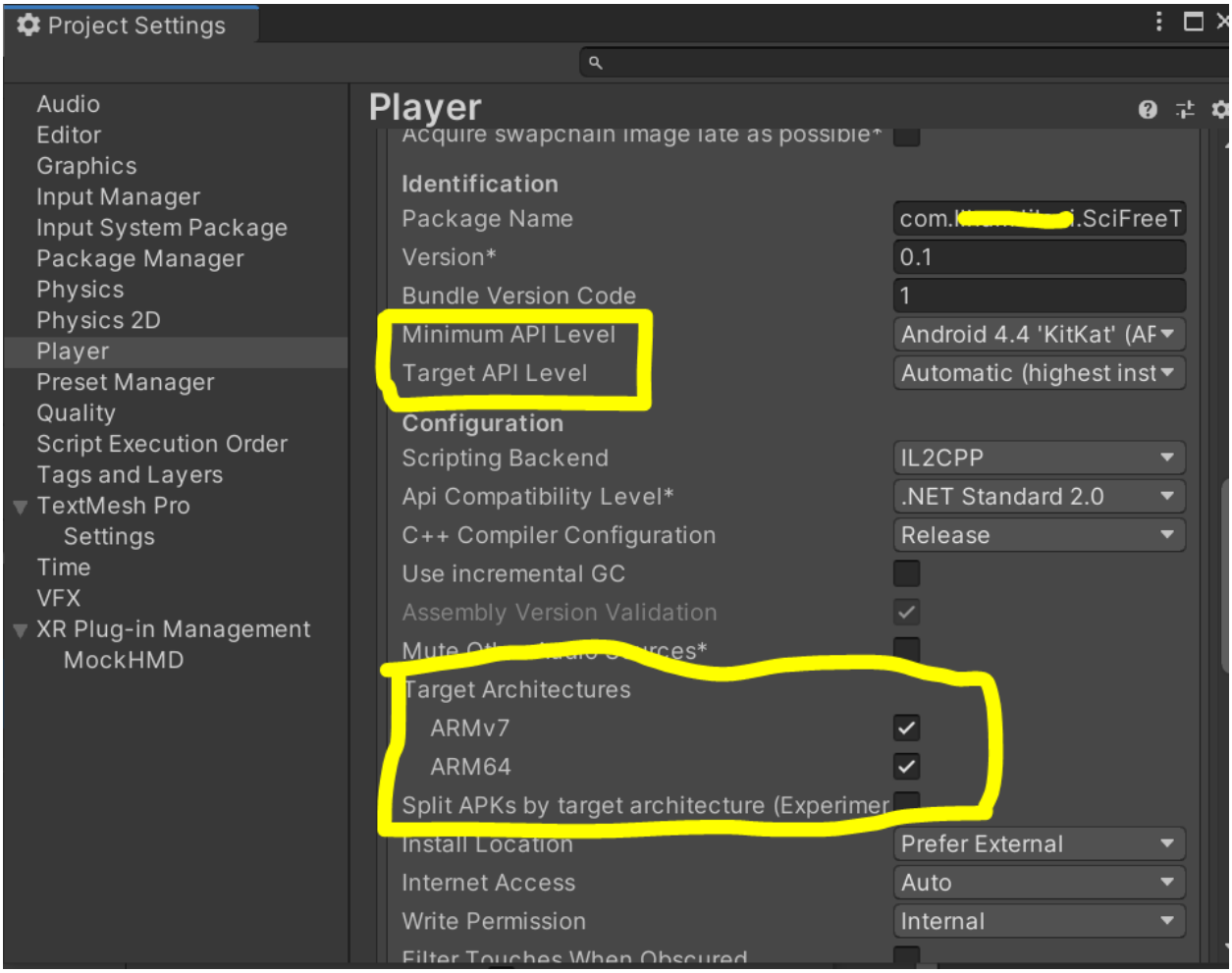


Figure 4-5: Build settings

Furthermore, a VR plugin needed to be included. Therefore, the Google Cardboard SDK was also included. However, the option “None” was also selected if “the user” did not have Google Cardboard Available, as presented in Figure 4-6 and Figure 4-7 which shows how to include the VR plugin if the new Input system is used in Unity.

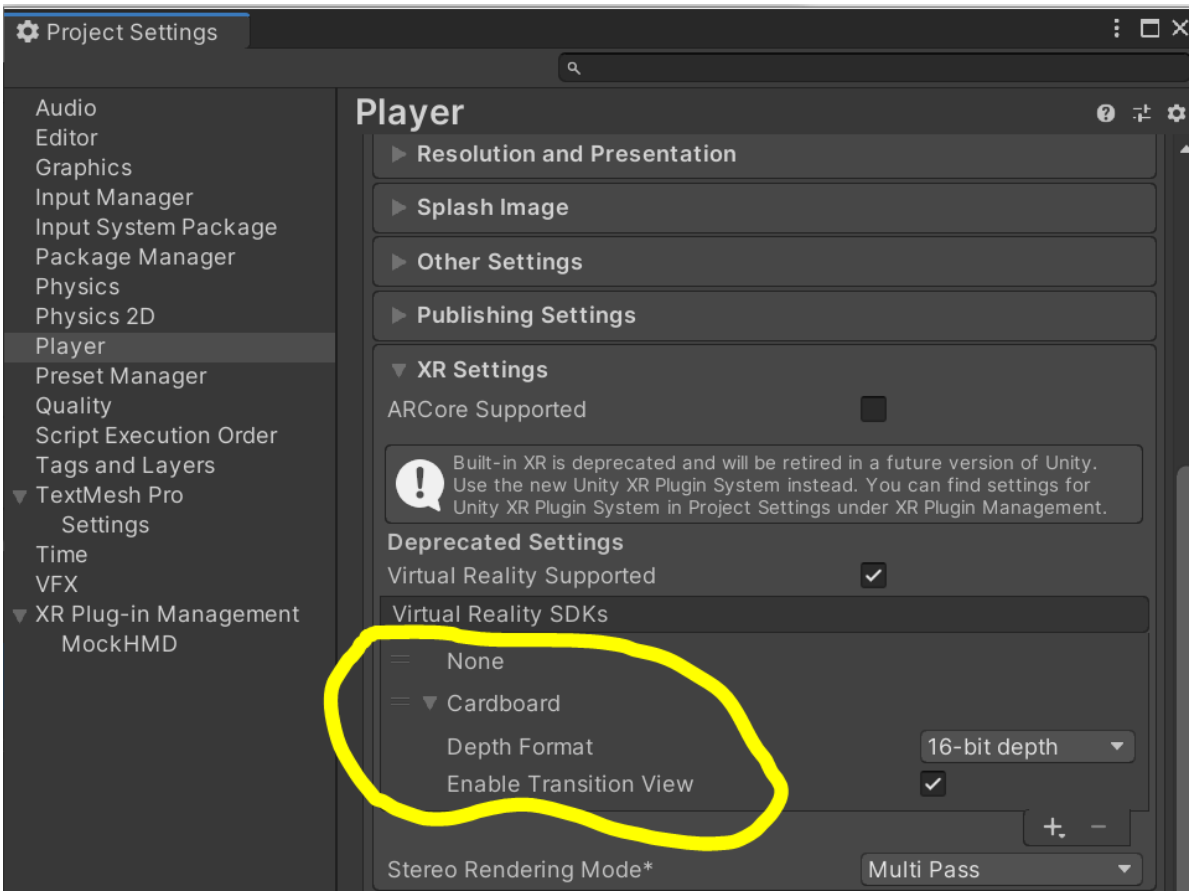


Figure 4-6: VR SDK

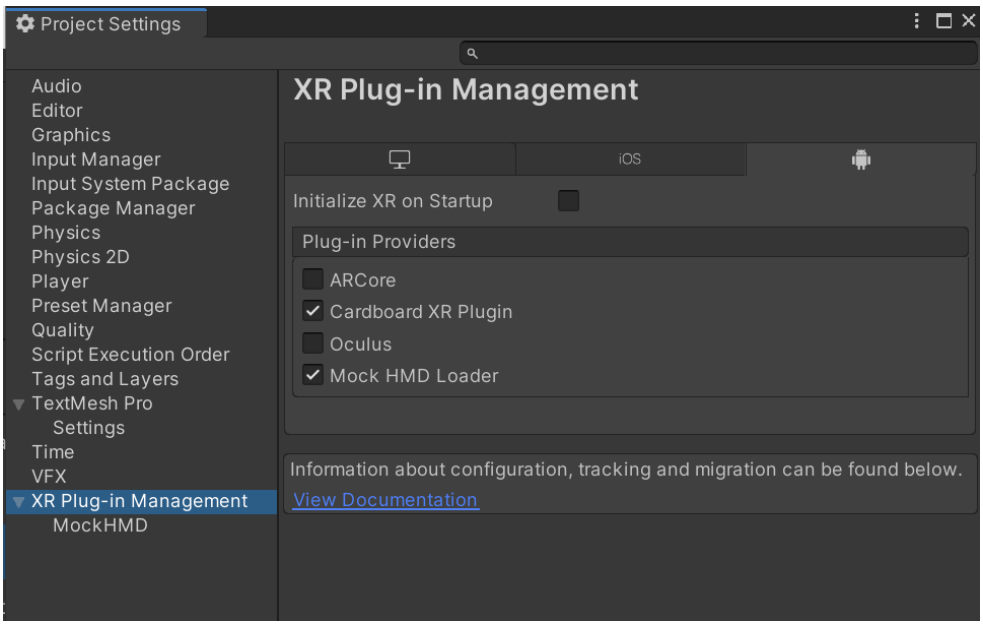


Figure 4-7: Extended Reality (XR) Plug in management

However, when creating the build version for the first time, as displayed in Figure 4-8, the build process ran into an error in Figure 4-9.

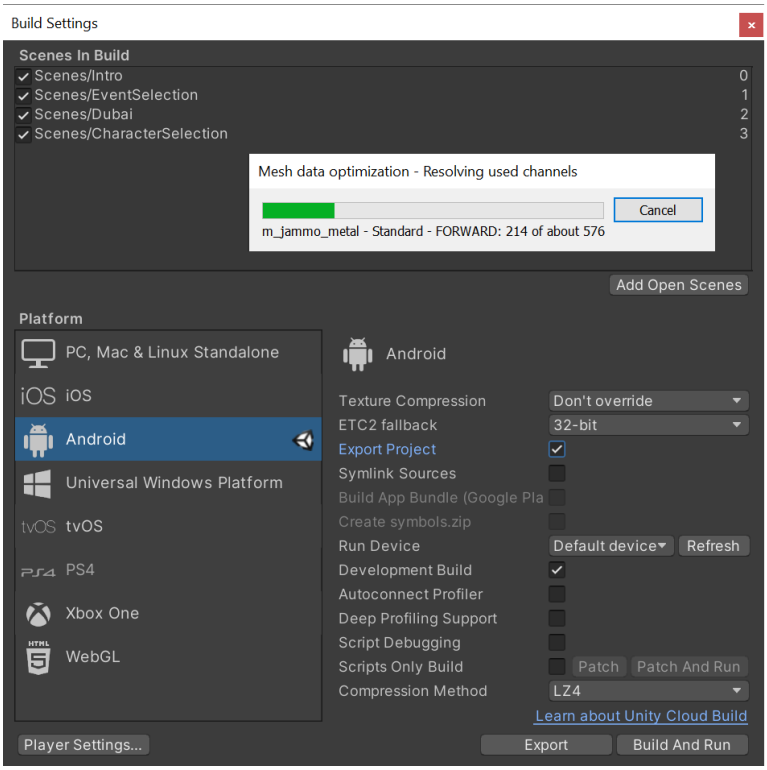


Figure 4-8: First time building

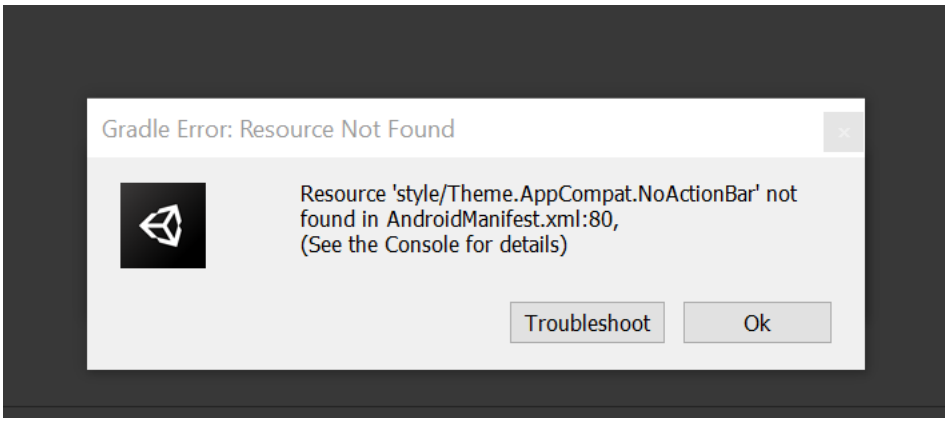


Figure 4-9: Gradle error AndroidManifest.XML first time build

In order to fix the error, the Unity project was exported into Gradle in Android Studio. The error seemed to be a dependency missing for the Google Cardboard QR Code scanner[10], which could

[10] https://support.google.com/cardboard/manufacturers/answer/6321873?hl=en

be retrieved from the support library for Android, by pasting line 11 to 13 inside the build file as demonstrated in Figure 4-10.

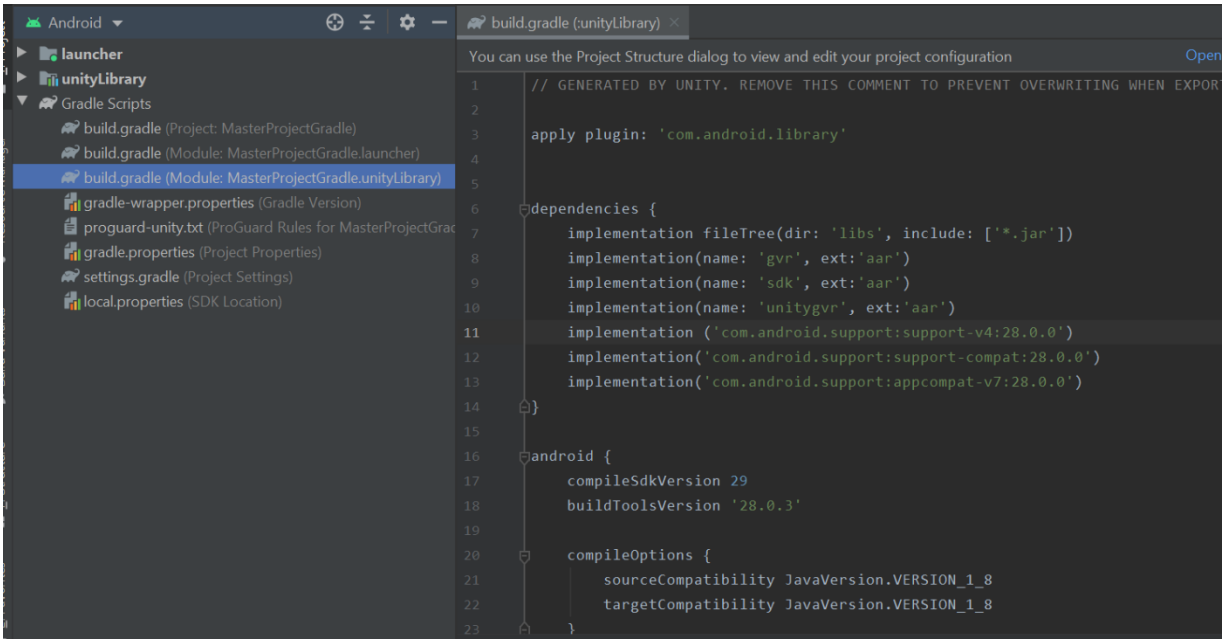


Figure 4-10: Solving the Gradle issue

To start the game on the Android device available, it needed to be connected to the computer running Android studio with a USB cable. After starting the game, there is no longer a need to be connected with a USB, because the game has now been installed on the Android device, with the icon and name from the build settings, as displayed in Figure 4-11 and Figure 4-12.

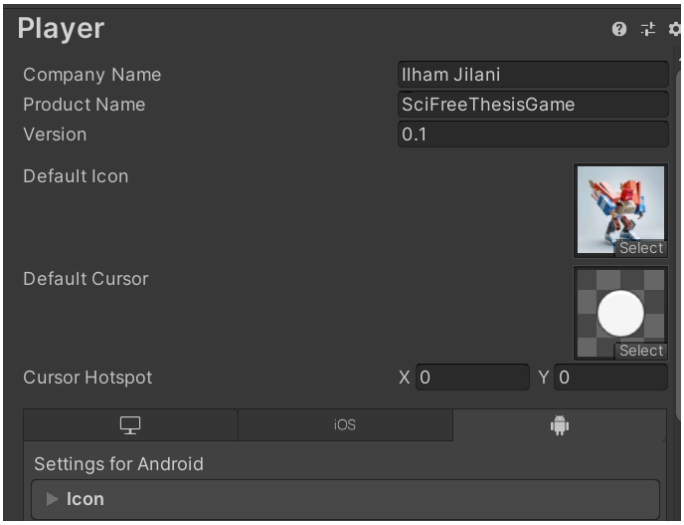


Figure 4-11: Build settings for the game

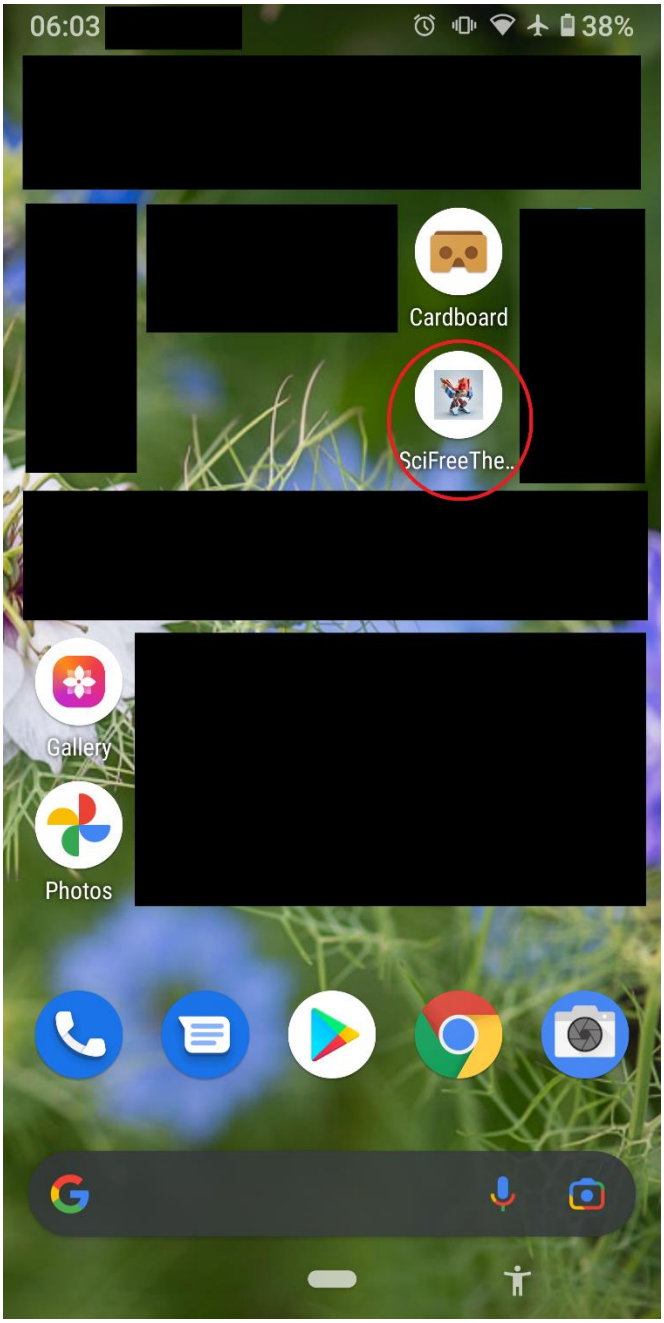


Figure 4-12: Game installed after building with Android studio

Next, when the play button was clicked in Android Studio, the build process was started, and the game was then started on the connected device. For this user testing, a Nokia 9 Pureview running Android version 10 was used, as captured with the camera in Figure 4-13.

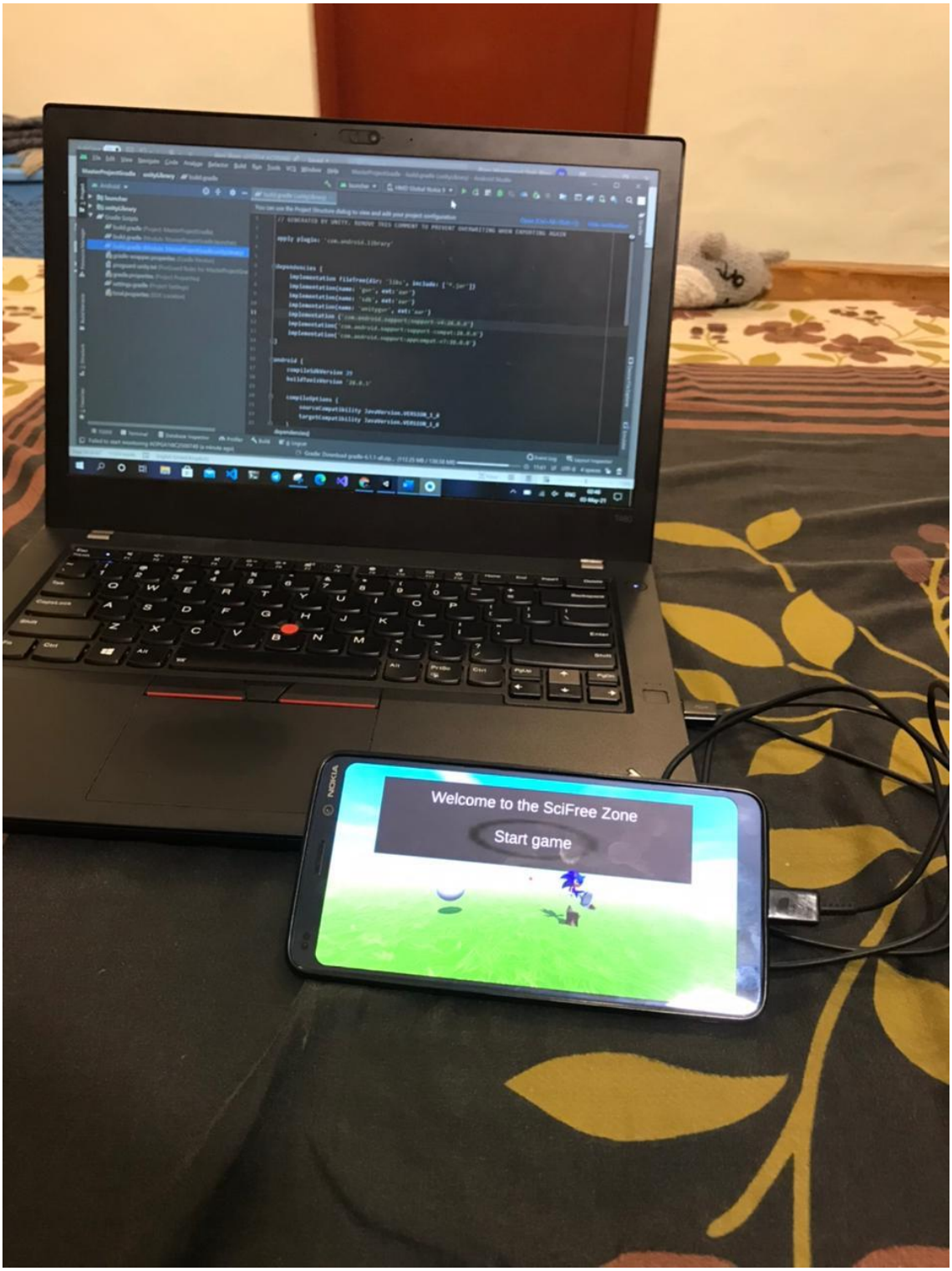


Figure 4-13: User test environment

4.2.2 User testing

The only participant in the user testing had some knowledge about VR and was in the age range of 25-40. Nevertheless, the participant experienced a major issue that was found during the testing. The XR Rig was not working, the participant was stuck on the first introduction scene, as illustrated in Figure 4-14. However, the functionality of the other objects was working as expected with some bugs.

Figure 4-14: XR Rig issue

Therefore, after doing some extensive research and asking in different Unity environments for a solution, the temporary solution resulted in a change of the control mechanism. The temporary solution became the use of the touchscreen. This meant that the user testing was to be conducted with a control mechanism that was lacking the full VR experience.

Nonetheless, the user feedback contained both positive and negative comments. For instance, for the first intro scene, the participant liked the background music and the fact that the non-playable character (NPC) or the “guide” character for the game was familiar to him from childhood. Therefore, the NPC character gave a comforting feeling while interacting with the game. The animations at the intro scene for the different assets were also funny and relaxing. On the other hand, the negative feedback was that the participant did not know that it was possible to change character before interacting randomly with the NPC character through the touchscreen and the talk bubble. Moreover, the first bug was also identified in the intro scene. The talk bubble was outside the screen frame, and therefore, the text on the talk bubble could not be fully read, as illustrated in Figure 4-14. Additionally, when the participant was about to go into the character selection scene, the loading screen started showing up in a loop, as exemplified in Figure 4-15 but stopped when the participant touched the screen.

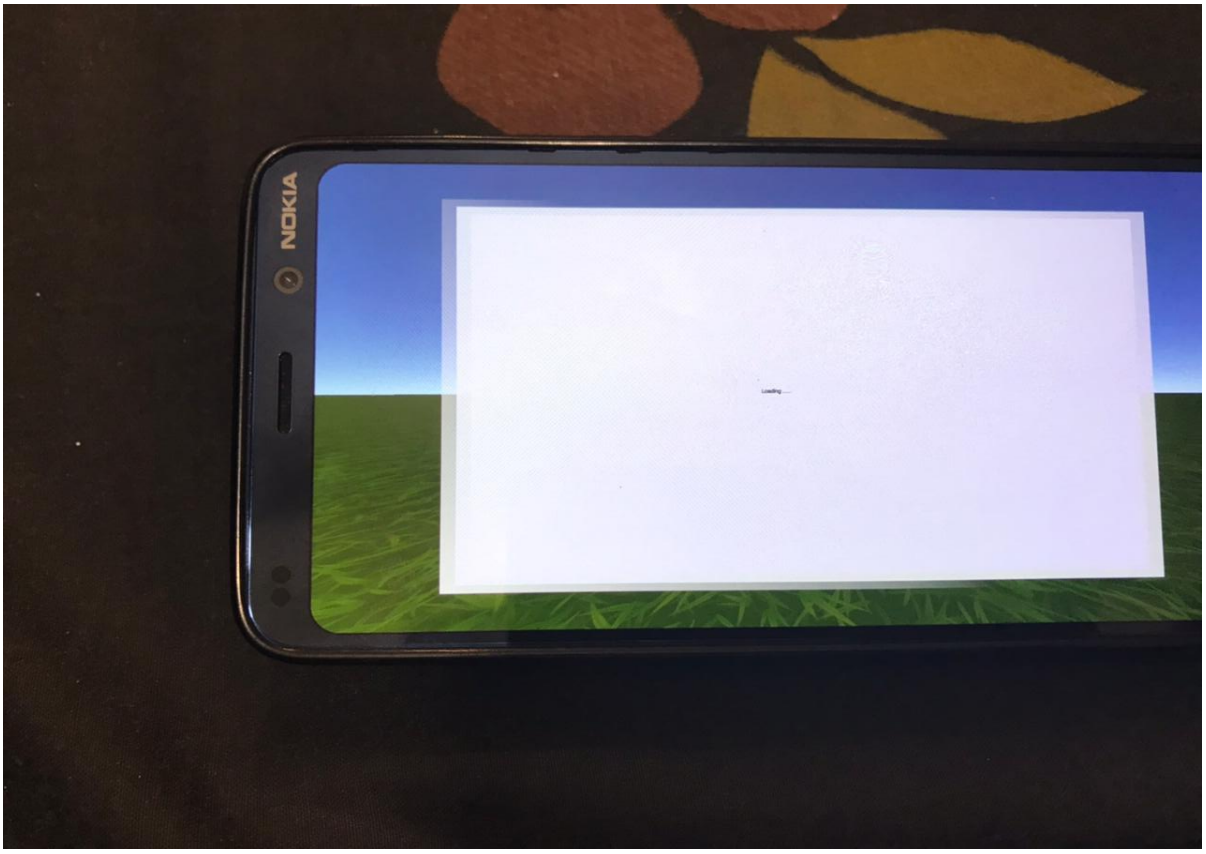


Figure 4-15: Loading rectangle loop

Next, when the participant managed to get to the character selection, as displayed in Figure 4-16, a new childhood memory came back alive, Mario, or more specifically Metal Mario.

Figure 4-16: Character selection scene during user test on Android

However, a new bug was found in the character selection scene. The position of the Mario NPC was wrong, as he was meant to be sitting on the stump and not float in the air, as displayed in Figure 4-16.

When the participant had decided on the preferred NPC, the same loading screen bug reappeared, as demonstrated in Figure 4-15. However, the participant managed to come back to the Intro scene and click the start game button. Next, the participant came to the activity selection screen, as displayed in Figure 4-17. The participant was informed beforehand that only the travel option was selectable. Still, the participant preferred that he was not informed

beforehand, so that the menu user interface would inform him, by design. Thus, a new improvement was needed on this scene.

Figure 4-17: Activity selection scene

In addition, the shader for the plane light fully changed the colour of the grass and put a shadow on the main NPC. However, the participant liked the animations of the NPC, because they assembled the options on the activity menu. On the other hand, the animation transition of the NPC, when the travel button was clicked, had some issues, so the character only posed in a jump position, as demonstrated in Figure 4-18. Still, the NPC was moving correctly into the plane and departing on to the next scene.

Figure 4-18: Sonic animation and plane shader

Now that the next scene was loading, the text on the loading screen, was too small and difficult to read, as exemplified in Figure 4-19.

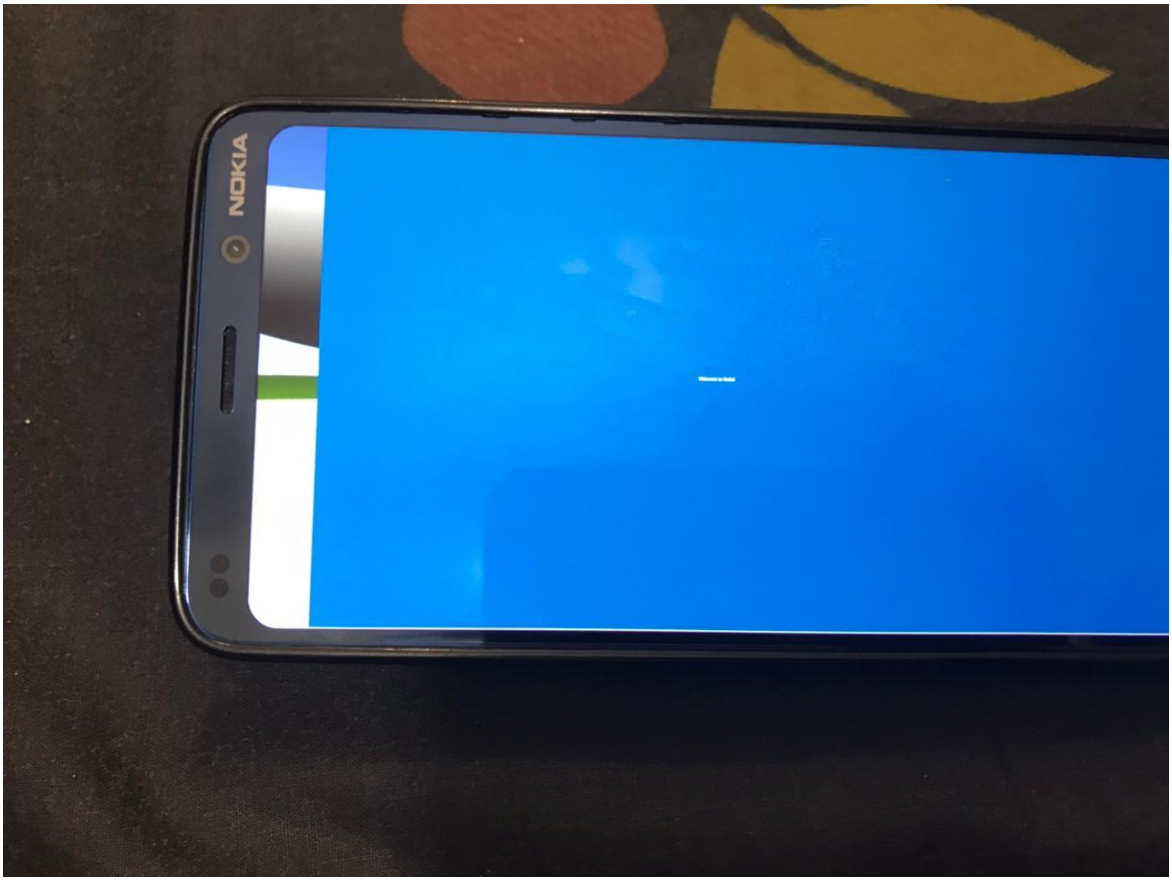


Figure 4-19: Welcome to Dubai loading screen, text too small

Finally, when arriving at the final scene, the plane light's shader was again changing the colour of the grass, and the animation of the NPC was a bit out of position, as displayed in Figure 4-20. Moreover, the NPC ended up inside the talk bubble. On the positive side, the participant was surprised that the game had a good representation of the Burj Khalifa building. Additionally, the participant was able to go back to the intro scene, by randomly clicking the talk bubble. So, a visual cue for that was missing.

Figure 4-20: Final scene in user test

Overall, the participant liked the concept of the game but expected more features and a better VR experience. However, it was understandable for the participant that it would require more time, as the prototype was developed by only one individual and not a whole game company.

5 Discussion

In this section, the game development will be discussed and the extent to which it can be used for mental health therapy, and finally the limitations in the game.

Overall, the game development contains some advanced factors, such as character selection and animations and a control mechanism for VR and touchscreens. Furthermore, it contained three scenes with background music and different animated objects. Also, the prototype did not limit itself only being playable on new and advanced smartphones and expensive VR headsets. However, it lacks some key elements in terms of accessibility in game design, such as visual cues and subtitles for different actions performed in the game. For instance, when the person interacting with an object in the game, he could also have a subtitle on the screen that says what object was interacted with and what the interaction would eventually result into. Moreover, the prototype does not have much content and only one storyline. On the other hand, the prototype development happend in a period of only just under 5 months while new technologies were learnt in the same time span. Additionally, the development process was only handled by one single developer. However, to see if the developed prototype and concept was recognizable, a user testing was conducted in the same time span as well. The participant confirmed that the concept was recognizable but required more development in the area of design and prototype content in order to become more valuable in terms of being a prototype for mental health therapy. Moreover, at the current stage of development and the amount of content, there are very few factors that bring forward the value in which the prototype becomes feasible for mental health therapy. Likewise, the user testing only had 1 participant which does not give enough evidence to support and highlight that the prototype concept is recognizable. Yet, the conducted survey about VR and mental health, which had 10 participants, discloses that there is more curiosity in VR, and therefore, enough data could eventually be gathered. Lastly, the user testing had a limitation in terms of providing the full VR experience for “the user”. As a consequence, this limitation sets the main aim, which is to provide a low-cost VR application, that only needs a smartphone and not an expensive headset to run, to a standstill. However, there is evidence that it is possible, such as low-cost motion-tracking for virtual rehabilitation. (Koenig et al., 2014)

6 Conclusion and Future work

In this dissertation, a very simple low-cost VR application prototype for mental health therapy, for those who are under lockdown and are restricted by their governments to travel, was developed as a proof of concept. Software development tools that are well-known for game development were used, such as Unity, Blender and Visual Studio. Furthermore, the application was exported as a build for publishing version 0 onto the Play Store for Android smartphones. However, due to a shortage of time and publishing on the play store being an option that required payment, the application was not published on the play store. Additionally, only one user test was conducted on the final result of the prototype development. Moreover, the user testing did not provide a full VR experience for "the user" in the testing environment, because of an issue between the Google cardboard software development kit, the version of Unity, and the new Input system in the Unity engine. As a consequence, the decisive conclusion for this research is yet to be finalized, and as a result, a part of the future work. Therefore, what should be done in future work is to have a better way of testing with the participants, so that appropriate usability and "care" is delivered to the end-user, together with a VR environment and not just the touchscreen. Additionally, a result that can be used as evidence for behaviour change in users after long-time use. This would help the research community as well. For instance, a large group of people, about 1 percent of the total population of Norway, who suffer from mental health challenges, as an example, which takes part in a qualitative survey which involves monitoring over a period of time, where the participants are using VR for the mental health therapy, similar to what Flaherty and Nasir (2020) presented with VR consultation for anxious travellers. The mental health therapy in the qualitative survey for the selected one percent would be gamified, similar to what was tried in the prototype of this dissertation with Jammo and the other characters. However, if the prototype developed in this dissertation was to be used in another game project, many improvements may be needed. Therefore, as part of future work, the first element on the list would be to rectify the accessibility issues in the prototype. For instance, more cues when interacting with the objects and arriving at the scenes, such as the NPC character having a voice that speaks the text in the bubble. In addition, a subtitle which explains that the person playing the game, will be going into another scene if he

interacts with an object. These subtitles can stay at the scene while the gaze pointer is hovering over the object. Additionally, the gaze pointer can be given a timer which can be for about 3 to 5 seconds. The specific action, for instance, the switch into another scene will then happen if the person playing the game keeps the gaze pointer at the object for the full 5 seconds.

Furthermore, the different bugs that were found, such as the shader issue and the positioning of some of the NPC characters when running the game on Android, should be addressed. Additionally, the prototype should also be run and built on IOS to see if there are any issues for Apple devices as well. Moreover, there should be produced more game content, such as more storylines, as the activity menu scene after the intro illustrated that there are two more options which “the user” can select, playing sports and attending a concert. In addition, some of the wishes that the participants of the survey wanted to have if they would develop their own VR game, could be included.

Finally, we have also seen that VR is helping the health care sector in increasing the quality of the health care itself, as presented in Torous et al. (2020). Likewise, if VR can be used in more areas such as real-estate, psychologists sessions, prototype development of buildings, and mental health therapy, it would increase the value VR gives to society even more. Furthermore, it is even more important that universal design is implemented in these gamified mental health therapy platforms, so that barriers are not produced, which could lead to a lower concentration or an irritation while “a user” is having a therapy session.

Conclusively, if mental health therapy through VR reaches a stage where it can actually demonstrate the behavioural changes in the patients, it can become an essential way of consultation and treatment for many areas in society, and not just only the health sector.

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