



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

SPORT WORLD

Francisco Guerrero Vicente

Director: Sofía Seinfeld

Grade: Design and development of video games

Course: 2021-2022

University: UPC CITM

INDEX

INDEX	1
IMAGES INDEX	3
TABLES INDEX	5
GRAPHS INDEX	5
SUMMARY	6
KEY WORDS	6
GLOSSARY	7
INTRODUCTION	9
MOTIVATION	11
PROBLEM FORMULATION	11
GENERAL OBJECTIVES	12
SPECIFIC OBJECTIVES	12
TARGET	13
STATE OF THE ART	13
VR and Hardware	13
ACTIVE VIDEO GAMES AND THEIR BENEFITS	17
MARKET STUDY	18
PROJECT MANAGEMENT	21
PROCEDURE AND TOOLS FOR PROJECT PROGRESSION	21
GANTT	21
Trello	22
GitHub	22
VALIDATION TOOLS	22
DAFO	23
RISKS AND CONTINGENCY PLAN	23
INITIAL COST ANALYSIS	24
METHODOLOGY	24
PRE-PRODUCTION	24
PRODUCTION	25
POST PRODUCTION	25
TOOLS	26
PROJECT DEVELOPMENT	27
GDD DEVELOPMENT	27

DATA REGISTER	27
VR RIG	29
UI interaction	31
HUB	32
User settings	33
Mini-game Info	33
Calendar	34
MINIGAMES	35
Player common info	35
Squats game	36
Cannon Squash	38
Flying game	40
TESTING	42
CONCLUSIONS AND FUTURE	43
GDD	45
TECHNOLOGY USED	45
WORLDBUILDING	46
Story	46
Development of story	47
The Sportans	48
ARTSTYLE	49
3D Style	49
UI	49
SOUND	51
Typography	51
Assets list	52
Models	52
UI	53
DESIGN	53
Controls	53
Score, kcal, money, level and tasks	53
Screens and Menus	54
Start playing	54
HUB	55
Sports Center	56
Missions	56
Mini-games	57
ALPHA CONTENT	59
BIBLIOGRAPHY	60

IMAGES INDEX

Figure 1: HatoraX	14
Figure 2: VR Treadmill	15
Figure 3: Meta Quest 2	16
Figure 4: Beat Saber	18
Figure 5: FitXR	19
Figure 6: RingFit Adventure	20
Figure 7: Trello Screenshot	22
Figure 8: SportPlayer class	28
Figure 9: ActivityDay class	29
Figure 10: Hands from VR Rig	31
Figure 11: VR UI interaction with raycast	32
Figure 12: Mini-game info	34
Figure 13: Activity calendar	35
Figure 14: Plyometric squats example	36
Figure 15: 3rd person game representation	37
Figure 16: 1st person gameplay of "Up&Down"	38
Figure 17: "Cannon Squash" gameplay	40
Figure 18: Lateral raises example	40
Figure 19: The end of Evangelion	41
Figure 20: Flying game gameplay	42
Figure 21: Sportan Village	47

Figure 22: Sportan 3D Render	48
Figure 23: Zelda Wind waker	49
Figure 24: Half life Alyx Gloves	50
Figure 25: Sportan Gloves 3D Render	51
Figure 26: Oculus controller guide	53
Figure 27: Steam VR Home	56

TABLES INDEX

Table 1: GANTT	23
Table 2: Costs	25

GRAPHS INDEX

Graph 1: Obesity	9
------------------	---

SUMMARY

The idea of this project is to develop a virtual reality video game in which the users, through various mini-games, perform cardiovascular exercises playfully to promote sport among young people and without the need to leave the house.

This idea came to me during the pandemic, while being locked down. After several days of being at home, my body needed movement and fresh air, beyond of what my window could provide me.

The main goal of the present thesis is to develop a video game containing various elements that facilitate the immersion and involvement of users in order to enhance their internal motivation of exercising and improving their physical health. There will be other external motivations to maintain the routine of doing virtual exercise like a rewarding system that reflects effort through rewards such as skins, medals or extra score.

KEY WORDS

Virtual reality, sport, physical activity, cardiovascular health, mini-games, routine

GLOSSARY

Beat saber: Is a VR rhythm game where you slash the beats of adrenaline-pumping music as they fly towards you, surrounded by a futuristic world.

Oculus: is a business of Meta Platforms that produces virtual reality and augmented reality hardware and software, including virtual reality headsets such as Quest, and metaverse platforms such as Horizon Worlds.

GDD: A game design document is a highly descriptive living software design document of the design for a video game. A GDD is created and edited by the development team and it is primarily used in the video game industry to organize efforts within a development team.

Kinect: Is a line of motion sensing input devices produced by Microsoft and first released in 2010. The devices generally contain RGB cameras, and infrared projectors and detectors that map depth through either structured light or time of flight calculations, which can in turn be used to perform real-time gesture recognition and body skeletal detection, among other capabilities.

Wii fit: Is an exergaming video game designed by Nintendo's Hiroshi Matsunaga for the Wii home video game console, featuring a variety of yoga, strength training, aerobics, and balance mini-games for use with the Wii Balance Board peripheral.

Inside-out Tracking: Inside-out tracking is a method of positional tracking commonly used in virtual reality (VR) technologies, specifically for tracking the position of head-mounted displays (HMDs) and motion controller accessories. A VR device using inside-out tracking looks out to determine how its position changes in relation to the environment. When the headset moves, the sensor readjusts its place in the room and the virtual environment responds accordingly in real time.

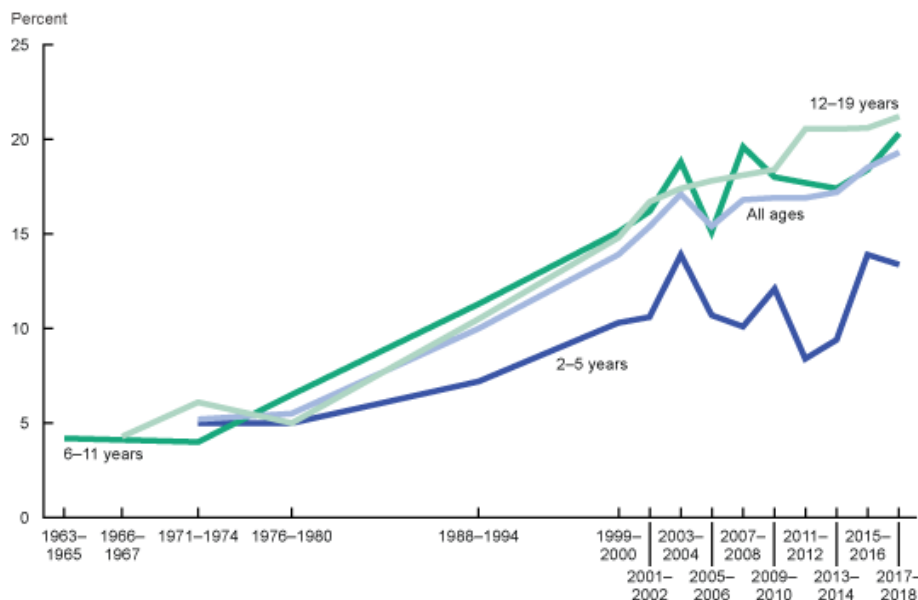
SLAM: *Simultaneous localization and mapping*, approaches tracking by constructing and updating a map of an unknown environment while simultaneously keeping track of the user's location within the environment.

Air Link: Oculus internal application that allows you to connect the stand-alone device to a PC without the need for cables, using the Wi-Fi network.

MET: Calculators have an activity MET (metabolic equivalent for task) built-in. This number estimates how much energy the body uses during a specific activity. It varies based on activity and is standardized so that it can be used across the board for different people and so that it's easier to compare different activities to each other.

1. INTRODUCTION

In today's society, one of the most common diseases, especially in young people, is overweight due to poor diet and lack of sport in everyday life. There is a yearly increase in the percentage of obese people, partly due to the wide variety of entertainment that encourages sedentary lifestyles. According to the World Health Organization, obesity has reached epidemic proportions globally, with at least 2.8 million people dying each year as a result of being overweight or obese.



Graph 1: Obesity per year

As part of my final degree project, my aim is to develop a virtual reality application/video game that encourages the user to do sport through fun activities and reduce adolescents' sedentary lifestyles. In this way, the user will be able to lose weight without the need to go to the gym and at the same time he/she will be playing.

The name of this software is Sport World because my intention is that there is a wider diversity of exercises in which to participate, since most of the products I have seen in the Oculus shop repeat the same formula as games like "Beat Saber" in which musical rhythms are used to guide the players into eliminating virtual blocks that float in mid-air and approach them. Therefore, the player has to constantly move his arms to destroy the

virtual blocks, and sometimes he will also have to duck and move to avoid walls that cause damage.

To motivate the user to maintain an exercise routine, based in the article of the Ludwig Maximilians, L. (2017) [How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction.](#) I will use various gamification methods of engagement such as rewarding the user with various items such as collectibles for his avatar to make him feel successful and create a relationship with the avatar that makes him keep playing the game.

Since without additional weight it is quite difficult to gain muscle, the mini-games will focus more on cardiovascular exercise like with Beat Saber. Even so, the different movements will be isolated by tags depending on the muscle blocks they want to exercise, since for a user who goes to the gym and lifts weights to hypertrophy this is not very useful, but for a more sedentary user it can be perfectly useful to tone a specific area of the body. Thanks to these tags, in Sport World you will be able to do different routines so that every day you can involve a different part of your body and so that every day you can do sport in the best conditions. This is a new feature that is not in any other VR game I have seen.

There will also be virtual rewards, with which the user will be able to personalize their avatar and their training room.

1.1. MOTIVATION

From the age of 8 to 13 I was a child with obesity who suffered in physical education classes for not being at the level of the rest. At the age of 14 I decided to go running with a friend with whom I shared the same physical shape. I was finally starting to see my body change and I felt better about myself both physically and psychologically.

At 18, I joined the gym and to this day I still train 4-5 times a week, not only as a physical exercise that improves my health, because physical activity reduces my stress and allows me to isolate myself from problems.

When the lock-down caused by COVID-19 came, the gym closed, and I was left with nothing to do but stay at home and exercise. Taking walks in the hallway, doing push-ups in my room, and little else. During these days, an idea appeared in my head, a virtual world where I could do sport fun and not have to see the same corridor over and over again. In this world people would keep doing sport while playing, and they wouldn't have to suffer the bullying that I suffered as a child, and it would also promote a healthy routine for all ages. And so the first idea of Sport World was born.

1.2. PROBLEM FORMULATION

The big issue that this project aims to solve is obesity caused by sedentary lifestyles due to the lack of motivation to do sports, prioritizing hobbies with zero caloric expenditure such as watching television or playing computer games.

There are some products that are already trying to solve this type of problem, such as "Power Beats VR", "FitXR" or the "Wii Fit" itself, which is mainly to reduce sedentary lifestyles and get people to play video games while exercising.

We can consider that this problem is partially solved, but they lack a key element for users to stay motivated and want to keep playing every day instead of playing for a week or two and quitting. Obesity is not cured by exercising for two days. In addition to a good diet, daily exercise is required.

That's why Sport World aims to encourage users to play every day by achieving objectives and feeling rewarded. In this way, they will want to stay active, even if it means making their virtual room look nice.

1.3. GENERAL OBJECTIVES

The main goal of the present bachelor degree thesis is designing a game with various gamification elements that promote motivation to continue playing sports in order to internalize a healthy routine and reduce obesity in the young population and develop an alpha version of this game.

1.4. SPECIFIC OBJECTIVES

The aim of this TFG is to develop an alpha version of the full game that clearly illustrates the idea and the potential of what it could become with more development time or with a larger team.

This version of the project will require the following points:

- A GDD.
- At least three mini-games that are clearly differentiated and player tiring, so that the user has several ways to play, and each one is adapted to a different muscle group.
- A system for measuring energy expenditure through movement. To make visible the user's effort while exercising.
- A system of daily exercise and progress logging. To keep the user playing and with new objectives.
- A reward system to motivate the user to continue playing.

- There will be a series of achievements that the player will have to achieve to obtain certain rewards in the form of aesthetics.
- The idea is that in a final version, this will be updated from time to time to keep the user engaged.
- A scoring system to challenge oneself
- A hub in which the user is able to access every mini-game or to configure the settings.

1.5. TARGET

This game is mainly focused on a target of between 13 and 21 years old, since at that age they are mostly students who do not usually work and are not yet old enough to go to the gym or do not have enough money to pay 50€ per month to go.

It is also a perfect age to enter because it is when they begin to devote more time to studies and can not afford to be in an extracurricular activity that does not give them versatility in terms of schedules.

I focus on Occidental culture as it is the one I am closest to, mainly Europe.

2. STATE OF THE ART

2.1. VR and Hardware

Currently, most virtual reality devices are limited to tracking the user's arms, head, position, and rotation. In exceptional cases there are other devices capable of registering the movement of other parts of the body, such as "[HatoraX](#)", a total tracking device launched in Japan and expected to arrive later in the West, but because they are not yet a standard, it would mean leaving out the majority of the public and leaving a very small niche of potential users. Therefore, there is very little development for this type of device.



Figure 1: HatoraX

Another type of device that could be really useful for virtual reality applied to sport would be the VR Treadmill, a platform that holds the user and thanks to special footwear, allows them to run and turn in the virtual world at the same time as they do in real life but without the need to actually move. This device creates a great sense of immersion as the user practically extrapolates all the actions he or she can perform in everyday life to a virtual world. Unfortunately, this type of product is prohibitively expensive for most people and, as in the previous case, would leave a lot of people out.



Figure 2: VR Treadmill Kat VR

Knowing that these technologies exist, since my intention is to target a wider audience, I will focus on how the capabilities of MetaQuest 2 are exploited for exercise.

It should again be emphasized that these devices register hand and head movement mainly by means of controllers and glasses. It also has [inside out tracking](#) in addition to [SLAM](#), so it does not need sensors placed in the room and allows greater versatility and the ease of changing to a convenient environment easily. Another key feature in the Meta quest 2 is that it is a stand-alone device, which allows us not to depend on a computer and does not need to have a cable that can bother us playing, and we will not worry about latency in the hypothetical case that we connect it with [Air Link](#) as the glasses themselves are responsible for running the game.



Figure 3: Meta Quest 2

In this kind of sport-oriented design, space is a requirement, as there are other products where you can play even sitting down. And the more space, the better.

In some cases, the issue of available space is solved in a modular way by adapting the virtual stage to the registered safety space. Therefore, the more space there is, the more the user can be asked to move around in it and the more energy expenditure will increase, in addition to the fact that this space is used to encourage the user to move their legs as well, since as there is no leg tracking, it is difficult to promote their use.

The MetaQuest 2 operating system itself incorporates Oculus Move, a program that records calories burned based on active time and number of movements per minute. It's not an entirely accurate feature, but it's a base you can work with to calculate calorie burn by adding a few more variables.

Finally, one element that can be exploited is sound. Because the MetaQuest 2 has built-in speakers, there is no need to add external supra-aural headphones that add weight and temperature to the head, and music can be used to reinforce the movement to make the user more intense in the cardiovascular activity.

2.2. ACTIVE VIDEO GAMES AND THEIR BENEFITS

One of the keys of video games was that it did not require any physical action form to play them while you could still be a hero, so the concept of video game that requires physical movement as in the case of Wii at the time, Nintendo Switch now or virtual reality in this case can make it completely break with this idea.

Then it is when a new approach appears, especially in 2008 with the release of [Wii Fit](#), which introduces the possibility of practicing sports through various activities and challenges while playing the console. This new way of playing caused skepticism in traditional video gamers, but over time has been gaining followers through the interaction that generates between machine and human, even human to human.

From this moment on, several devices and video games start to come out with a different purpose, as would be the case of Kinect.

There is an established genre for this type of video games, it is called Active Video Games (AVG), since they require the user to execute physical activity. Several studies have been carried out to find out to what extent the aerobic performance of human beings can be improved with these video games.

Among these studies, I highlight [Anders, E. \(2015\). *Improving aerobic capacity through active video games. A randomized controlled trial.*](#) In which structured sport video games are separated (they perform basic exercises without any context such as squats, push-ups or running) and unstructured sport video games (they do not try to copy formal exercises as such but require movement to play leaving the user free, as could be a boxing game).

As a conclusion of this study, it was found that after the fourth week, both groups improved at a fast rate. But in the case of the group with the unstructured exercises, their benefits stabilized and even dropped below the peak. On the other hand, in the structured exercise group, aerobic endurance was maintained after the

peak. Therefore, for consistent aerobic improvement, it is advisable to do structured exercises.

2.3. MARKET STUDY

There are several products in the Oculus store and in Sidequest that are classified as sports games, but that don't manage to create the required physical wear and tear. That is why I have been looking case by case at which products are focused on physical activity or, in another case that we will see, which products have another premise but end up being demanding in terms of cardio.

Beat Saber: This is a game that adapts the mechanics of classic music video games such as Guitar Hero, Taiko No Tatsujin, Osu! Among others. These games are mainly based on making notes appear to the rhythm of the music on the screen that are assigned to a specific button on the keyboard, controller, or mouse and the user has to press them at the right moment.

Beat Saber introduces you to a corridor in which you can move from left to right and in each hand you have a blue or red lightsaber, and you have to cut the notes that are coming towards you in the direction indicated to you. Giant blocks will also appear from time to time, forcing the user to move or duck to avoid being hit, thanks to this the user engages the whole body to move instead of remaining static by moving the arms. As the song gets more bps, the intensity will increase.

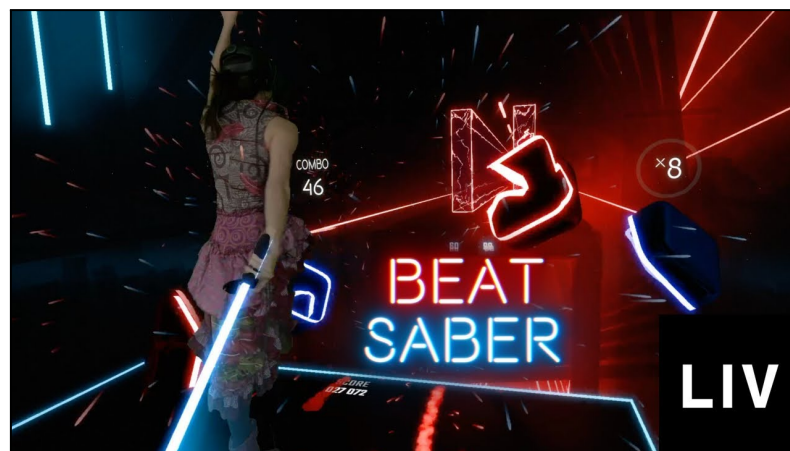


Figure 4: Beat Saber

FitXR: Adapts the Beat Saber formula to boxing, but with a focus on cardiovascular sport. In this game, activity-related values such as calories burned, speed of movement and others are introduced.

The game encourages you to continue practicing sport with scoreboards and objectives.

It has a subscription model as it is constantly updating its content as well as certain directed classes.

It clearly has an adult target.



Figure 5: FitXR

All in One Sports and **Sports Scramble:** Next to these two games, as they have a very similar structure. They are games with several mini-games of different sports and with leaderboards and multiplayer.

The problem with these two games is that some games do not require much effort, and the name "Sport" looks like a skin.

Ring Fit Adventure: This game is not a virtual reality game, but has the structure most similar to the idea of Sport World.

It is a video game developed for Nintendo Switch that includes two peripherals. One of them is a yoga hoop in which you place one of the joycon to measure the force with which the user squeezes the hoop, rotates and moves. The other peripheral is a strap into which you insert the other joycon and attach it to one of your legs to track movement.

Based on this hardware, the game has several modes. The first one is a story mode in which a hero through various mini-games involving physical activity has to save the world.

Another mode is the separate story mini-games to be played at the user's convenience.

Finally, there are exercise routines with repetition targets in a specific time and a record table.

Ring Fit also provides information about the exercise the user has done and allows the user to create their own routines.



Figure 6: RingFit Adventure

Unlike what is currently on the market, in Sport World there will be a clear focus on sport through video games for a teen audience in which there will be a visualization

of burnt energy data which, for the user to understand better, will be translated into motivational messages in accordance with the amount of exercise done in addition to the clear data.

The main aim here is variety, routines, physical wear and tear and fun. All these elements together are only reflected in Ring Fit Adventure which is still a product outside virtual reality, so there is a gap to be filled in this sector and this is the function of Sport World.

3. PROJECT MANAGEMENT

3.1. PROCEDURE AND TOOLS FOR PROJECT PROGRESSION

3.2.

3.2.1. GANTT

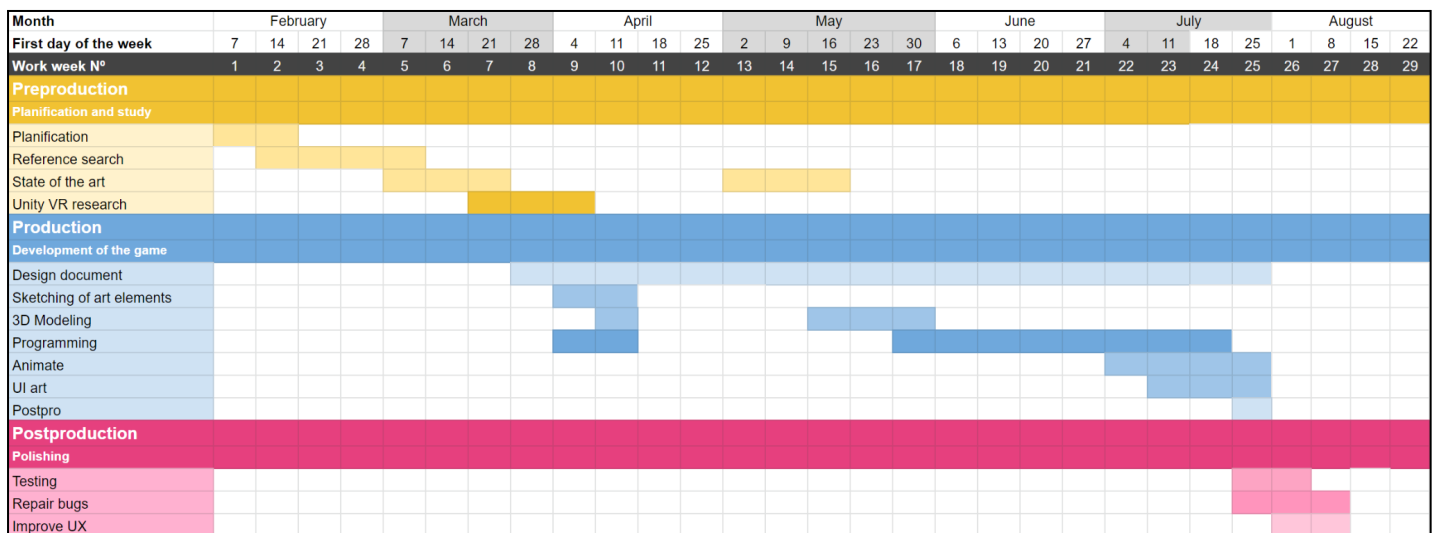


Table 1: GANTT

3.2.2. Trello

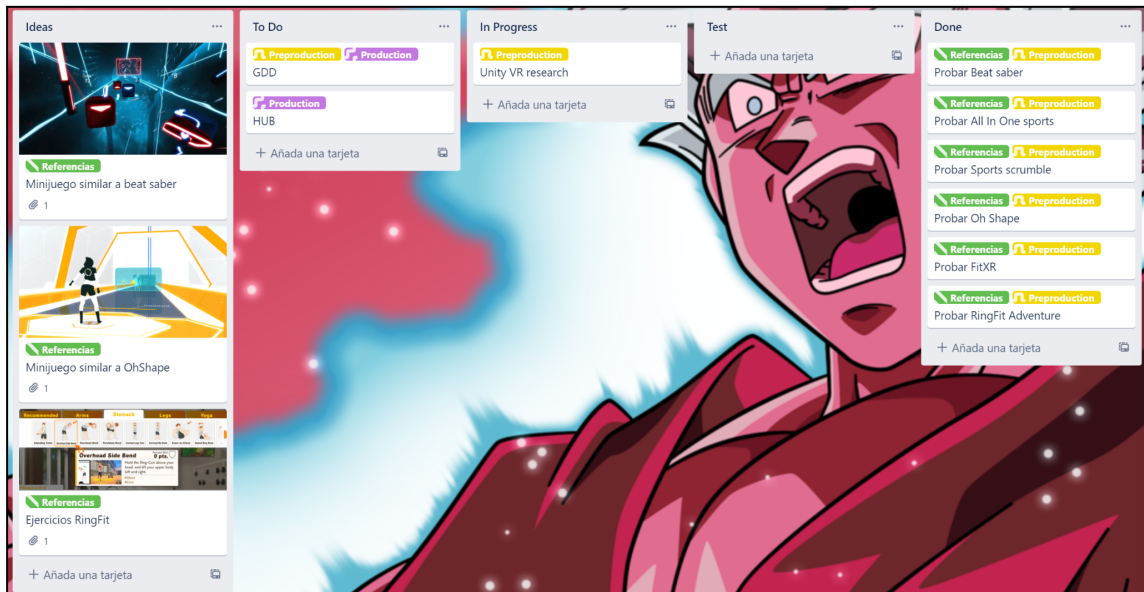


Figure 7: Trello Screenshot

3.2.3. GitHub

https://github.com/FranGV98/TFG_VR_SportGame

3.3. VALIDATION TOOLS

To test the game I will count with the participation of users who are not used to virtual reality or very active users of video games. One user of 13 years old, one of 16 and an adult of 50 to check if, despite its appearance and teen approach, it can still be attractive for a middle-aged user. All users will use the same hardware. A 128gb MetaQuest 2 and will be tested in various environments:

- A 20 m2 living room
- A room with limited space for furniture

3.4. DAFO

Weaknesses:

- There are three clear fields, programming, art and design that have to be covered by one person in a limited time of 3-4 months.
- By making the gameplay dynamic, there is a risk that the user will feel dizzy and more play testing will have to be done.

Threats:

- By basing mini-games on games that are self-sustaining and whose development is 100% focused on a few mechanics, mini-games can fall short compared to the source material.

Opportunities:

- It is an under-exploited niche within virtual reality, with such a clear focus on sports routine through games.

Strengths:

- Having a cartoon aesthetic, the lack of geometric complexity of the models is not a problem in terms of having a game that runs smoothly in Quest 2.
-

3.5. RISKS AND CONTINGENCY PLAN

RISK	SOLUTION
Loss of project development data	Creation of constant backups on different drives
Total breakdown of the development team	Having a second team with which to develop further without any limitations
Problems with build testing equipment (MetaQuest 2)	Having another pair of glasses from someone close to you to borrow
The mini-games make some users more dizzy than others.	Make the design of the mini-games avoiding an artificial displacement like a car or flying. Avoid huge rotations.
Not finishing the project for the deadline	Prioritize what is essential and in case of lack of time, eliminate it.

3.6. INITIAL COST ANALYSIS

Hardware / Software	Price	Months	Cost
MetaQuest 2	350€	1	350€
Unity3D	0€	4	0€
3ds Max	215€	4	860€
Adobe CC	60€	4	240€
		Total	1.450€

Table 2: Costs

4. METHODOLOGY

This project is mainly divided into three main phases of classic video game development. Pre-production, production and post-production.

4.1. PRE-PRODUCTION

In this phase we will organize and study similar cases from which to obtain references and analyze everything necessary to be able to carry out the development of the project.

During pre-production, the GANTT diagram is created to establish which parts will take up which time in order to organize all the phases in the most appropriate way, while the Trello is established as a tool that will be used later during production in order to know what needs to be done and what is done.

In addition, during this phase, the state of the art will be made clear so that we know the basis from which we start and have a clear idea of all the references from which we are going to take an example when developing our design in production.

To establish the design of the video game, we will create a game design document (GDD) in which in this phase we will make clear all the bases, narrative, screen

layout, options and what assets we are going to need at the beginning. However, this document will continue to be expanded and modified during production.

Also during this phase, a research will be made on which software is the most suitable to carry out this project.

4.2. PRODUCTION

During production, we will carry out everything we have learned previously in order to develop the alpha of Sport World VR.

In the first instance, my idea was to do both art and design and programming in parallel. But since this method is too chaotic, and it is not optimal in terms of time since you leave everything halfway through being only one producer, I have established this order of production.

1. It is made clear in the GDD the design of each game and the role of the central HUB with its required assets.
2. The essential 3D assets previously established will be modeled, textured and tested so that there is a coherent aesthetic in the scenery.
3. The central hub will be programmed with its interaction mechanics, followed by a scoring system that will share the mini-games that will be done in the order of technical difficulty previously established.
4. Once the demo is playable, I will add particles, SFX and some animations to make the game more attractive.

The purpose of this order is to have something playable and with a clear aesthetic as soon as possible, and once this is achieved, to add details that make it richer and more pleasing to the eye.

4.3. POST PRODUCTION

Once a playable product is ready. Tests will be carried out with users external to the developer in order to check whether the design decisions are suitable for the target audience, and any errors that appear in both the technical and playable

sections will be noted. This phase tends to be one of the most important ones because, although the product may be considered finished, if the target audience does not enjoy it or does not understand it, all the hours invested in its development will have been for nothing.

4.4. TOOLS

Unity 3D will be used because it is a free engine as well as to facilitate the development due to previous experience with this engine and its aptitude for virtual reality.

The 3D models will be made mainly in 3ds Max, as it is a program that is very intuitive and quick to use for low poly. Except some more organic cases in which we will sculpt in Nomad, iPad software in which you can sculpt very quickly and anywhere and whose cost is a single payment of 10 € so I do not include it as it has been paid previously to the development.

The sketches will be made in Procreate, which is similar to Nomad, being an iPad software whose only payment is 10€.

The interface will be made in Adobe Illustrator thanks to the versatility offered by its vector drawing, and in its final stage it will be passed through Photoshop.

5. PROJECT DEVELOPMENT

5.1. GDD DEVELOPMENT

The first thing to do before starting programming is to establish how the game is going to be developed, in order to have a project with defined bases and to maintain them by using the GDD as if it were just another tool.

Because the project is more ambitious than what can be developed in this time, a GDD will be made of what the final product will be like, separating as alpha what will be developed in these months. This document is available [here](#).

5.2. DATA REGISTER

Previously in the GDD it has been established that the whole project revolves around the user's progress, the accumulation of calories spent, time spent, the score and the challenges.

Therefore, before starting to develop any of the mini-games, the user is created in the form of a class.

To do this, a script is created with the serialized SportPlayer class so that it can be accessed later when required.

This class contains the following information:

```
public class SportPlayer
{
    public string name = "user";
    public double weight = 80;
    public int age = 13;
    public int UID = 0;
    public List<MiniGameInfo> MinigamesInfo;
    public float TodayBurntKcal;
    public float TodayActivityTime;
    public int KcalObjective = 10;
    public List<ActivityDay> ActivityRegister;
    public int numMinigames;

    1 referencia
    public SportPlayer()
    {
        name = "User";
        weight = 50;
        age = 20;
        UID = 0;
        TodayBurntKcal = 0;
        KcalObjective = 400;
        numMinigames = 0;
        MinigamesInfo = new List<MiniGameInfo>();
        ActivityRegister = new List<ActivityDay>();
        ActivityRegister.Add(new ActivityDay());
    }
}

[System.Serializable]
4 referencias
public class MiniGameInfo
{
    //Minigames: [0] Leg, [1] Racket, [2] Flying
    public int UID;
    public int MaxScore;
    public float MaxTime;

    1 referencia
    public MiniGameInfo(int uid)
    {
        UID = uid;
        MaxScore = 0;
        MaxTime = 0;
    }
}
```

Figure 8: SportPlayer class

Some data are not used in the alpha but are set because they will be needed for the final product, such as the UID and name for online registrations and the age for the age-based recommendation of routines.

Weight is necessary for the alpha as it is used to calculate calorie burn.

There is also another subclass that is MiniGameInfo which function is store the maximum score and maximum time on each mini-game. To differentiate the different Mini-games, there is an UID that will be given in each scene by the Player.

Finally, there is a list of a class called ActivityDay that records all the work outperformed in a day. During the current day the user will see his progress and when changing the day, this progress will be stored in the list to be accessed later and the new day's progress will be reset.

```
[System.Serializable]
8 referencias
public class ActivityDay
{
    public int day = 0;
    public int month = 0;
    public int year = 0;

    public int EnergyBurnt = 0;
    public float ActivityTime;
    public bool ObjectiveReached = false;

    2 referencias
    public ActivityDay()
    {
        day = DateTime.Today.Day;
        month = DateTime.Today.Month;
        year = DateTime.Today.Year;

        EnergyBurnt = 0;
        ActivityTime = 0;
        ObjectiveReached = false;
    }
}
```

Figure 9: ActivityDay class

In order to have this information saved and maintained regardless of whether we close the application, it will be stored in the form of a JSON file. In each scene, a SportPlayer will be created and loaded with the data from the JSON file.

5.3. VR RIG

In order to interact with the virtual reality environment, it is necessary to have a VR Rig to manage our movements with the virtual reality goggles and controllers.

Although the project is intended for Meta Quest 2, it will be developed for all virtual reality PC to test it without having to build the game every time we want to test it.

Before starting to assemble the VR rig, we have to import the XR Interaction Toolkit package and in the project settings, in the XR plug-in Management option, we will activate the XR plug-in Management in oculus providers for PC and android. In Player options, activate XR Settings in the Virtual Reality Supported box and add the Oculus SDK for both PC and android.

To start creating the VR Rig we add to an empty game object the component XR Rig where we assign the game object itself to Rig Base Game Object and in Tracking Origin Mode we assign Fl. Inside the VR Rig we create another game object in the position 0,0,0 that will serve as camera offset which is assigned as Camera Floor Offset Object in XR Rig. Inside the offset, we will create a camera that will be assigned to the XR Rig and will serve as the player's eyes by adding the Tracked pose driver component.

This would be the player's head with which a 3D environment could be visualized.

The next step would be to create the player's hands, as without them the interaction would be very limited.

Two Game Objects are created, one for each hand, and the XR Controller (Device-based) component is added to them, where the controller Node will be assigned to each hand.

Next, an XR Direct interactor is added to the game objects of each hand to be able to interact with the objects on the stage in addition to a sphere collider with Is Trigger activated.

To have custom interactions, a script will be created with the inputs from the controllers. It is necessary to type using Unity Engine. XR at startup to access the XR components.

Now you would need a model of a hand to represent it visually and assign it to Model Prefab.

For this, a rigged hand model will be used with various animations that will change depending on the pressure exerted on the triggers.

In the Start() the hand model will be instantiated in the position of the game object and the animator of that hand will be assigned. Update() will pass the Trigger and Grip values to the animator in real time.

With this, the base of the VR Rig is done.

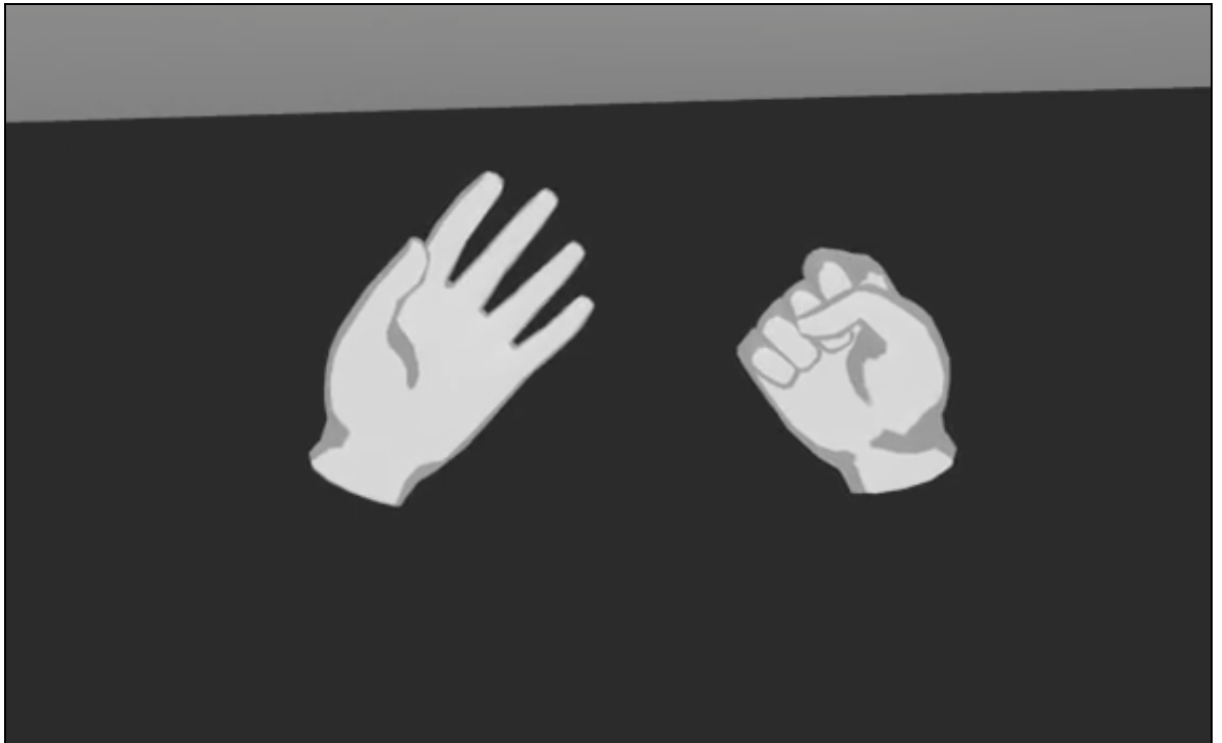


Figure 10: Hands from VR Rig

5.3.1. UI interaction

In order to be able to give values to the user, switch between scenes and stop the game, it is necessary to be able to interact with the interface. To do this, several elements are necessary, which we will see below.

Firstly, to interact with an interface, you need an interface. To do this we create a Canvas by right-clicking on the hierarchy and in XR create a UI Canvas to which we will add a Tracked Device Graphic Ray caster to detect the ray that we send from our hand.

We add in the scene an Event System containing XR UI Input Module and an empty object with an XR Interaction Manager. These elements are needed whenever UI interaction is required.

Finally, inside the VR Rig, child of the Camera Offset we create a Ray Interactor that will contain an XR Controller as with the hands and in the Controller Node we choose which of the controllers will be used and which button will be used to interact. To this we add an XR Ray interactor in which we put in the Interaction Manager the one previously created.

Finally, a Line Renderer and a Line Visual XR interactor are included to visualize the ray that will be used to interact.

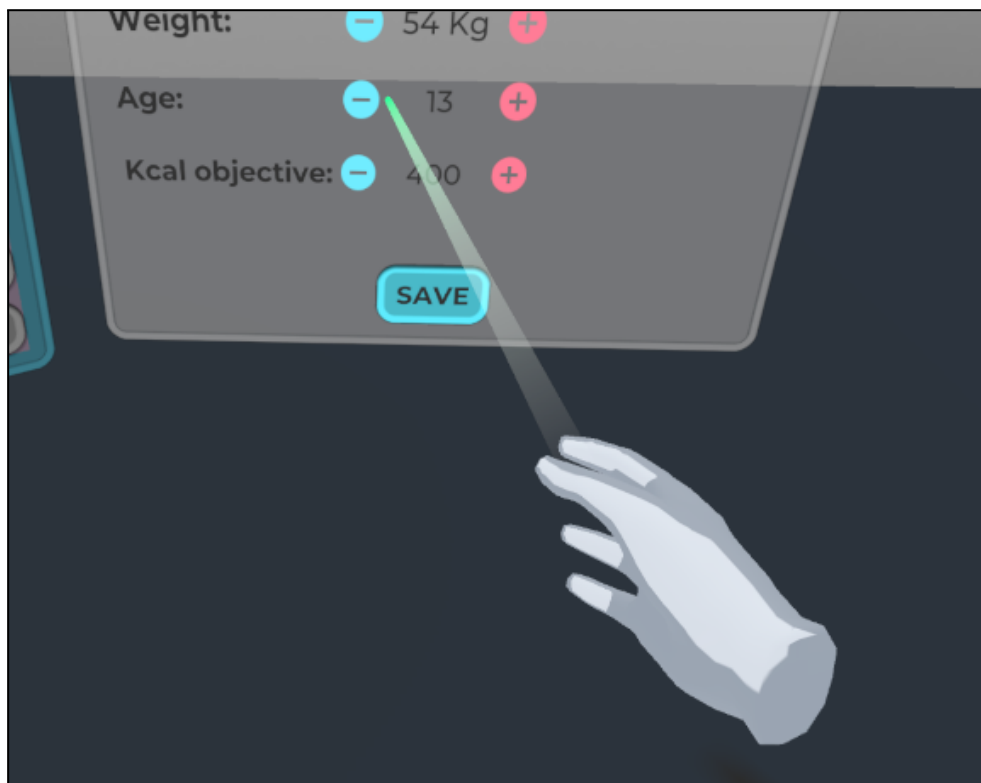


Figure 11: VR UI interaction with raycast

5.4. HUB

The Hub is the place where the user will configure their settings, view their progress and switch between mini-games.

In this version the Hub is an empty space in which there are several screens similar to the interaction with a computer. In the future, this Hub will be a room and each

option will have its own visual and interactive value. But for now this was not a priority, so the visuals have been cut back in favor of functionality.

Each time the application is started, the program will look for the JSON file with the player's information. If nothing is found, it will send it to the user configuration screen. Otherwise, it will be in the usual screen where you can select a game and see the progress of the day. It also displays the level of the player, which in this version consists in giving 50 XP every day the player reached the objective of kcal burned. Every 150 XP, the player upgrade its level by one.

5.4.1. User settings

On this screen the user will set weight, age, and daily calorie target. When saving, the JSON file will be created or updated with all your information.

The freedom of configuration is limited and adapted to the interaction allowed by the XR control.

5.4.2. Mini-game Info

When the user taps on the mini-game button, a panel appears with the info about the game. This panel has a screenshot of the gameplay, a figure that represents which muscles are involved in this exercise and the maximum scores and time in this game.



Figure 12: Mini-game Info

5.4.3. Calendar

In this version, I at least wanted to have a challenge registration system. The best way to do this is to have a calendar where it is marked when we have reached the achievement of calories burned.

To create the calendar, [this calendar](#) has been taken as a reference from [ETAD Lab](#).

A green color is assigned to this script when creating the day button, if the day being created has the calorie goal boolean is true.

Each time you go to the Hub, the day of the last record is compared with the current day of the system to know whether to create a new day or to continue with the data of the current day.



Figure 13: Activity calendar

5.5. MINIGAMES

The [GDD](#) specifies what each [mini-game](#) will look like. But in order to arrive at these designs, certain exercises that are usually done in the gym or in some classic sports that try to exercise a specific muscle group have been used as a basis.

5.5.1. Player common info

All mini-games have certain variables and functions in common, so it is best to create a script that is the base player and then independently create a script per mini-game that complements the base script for the corresponding mini-game.

This script is responsible for loading the data from the JSON file that has to do with the activity time and calories burned, in addition to applying the MET formula that calculates the calories burned depending on the weight and intensity of the mini-game in question.

It is also in charge of the base interface and game pause management and part of the scene management together with the Menu Manager.

5.5.2. Squats game

This mini-game is an adaptation of the exercise “Plyometric Squats” which consists of doing squats and jumping, so it is an exercise in which the user does eccentric and concentric strength as well as cardio exercise. Of the 3 mini-games developed, this is the most intense,

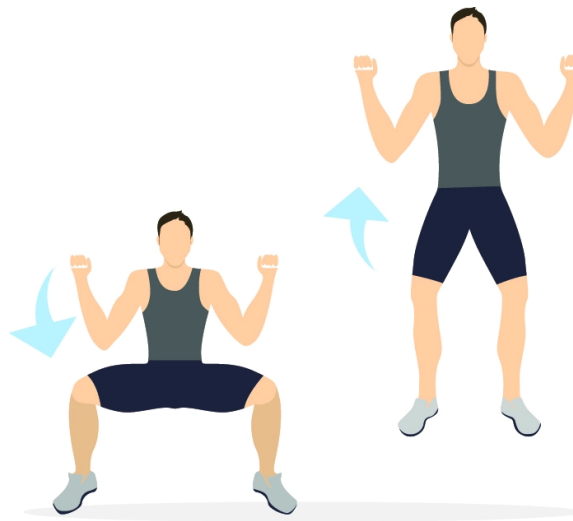


Figure 14: Plyometric squats example

In terms of gameplay, a script is created that takes care of the game loop.

We need a timer and a game object to which we will assign the prefab of the obstacle that the user will have to avoid.

In this version, to save time in the implementation of a complex level design, it will be done procedurally.

Inside the update(), every time the timer reaches 0 from 3 seconds, the assigned prefab will be instantiated and given a random height between a minimum and a maximum value.

Initially, 1.8 meters was used as the maximum value reference, but after having done game testing with several users of different heights, in the first

seconds of the game, the user's height is captured and that height is applied as the maximum value.

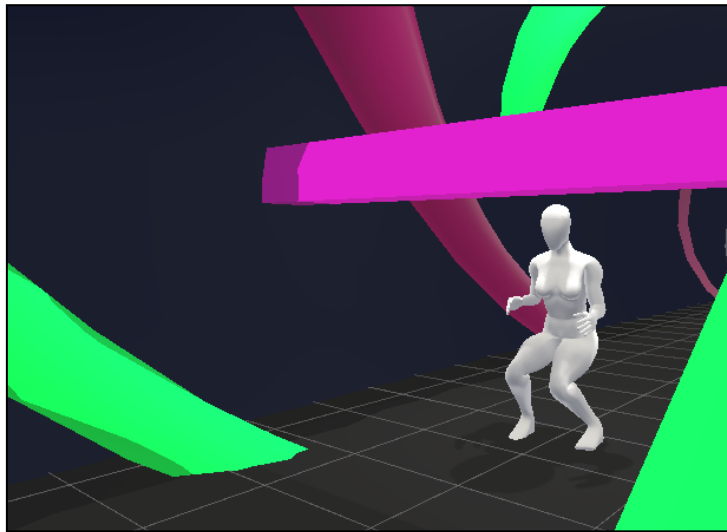


Figure 15: 3rd person game representation

A random width is also applied to the obstacle so that the user has to maintain the squat in some cases by performing an isometric squat.

Because obstacles appear randomly, it can happen that various obstacles appear at the same height, so to promote variety, a collider is added above the obstacle and another one below it, and every time one of them is hit, a counter is added for objects below and above. In case the value of 2 is exceeded, an obstacle will be instantiated at the height of the user at that moment, forcing him to move.

As for the visuals, there is a tunnel with colorful spiral stripes that rotate at a speed.

In the script, a list of tunnel materials and obstacles is added, and each time the user overpasses an obstacle, the color changes randomly and inversely between them.

To detect when an obstacle hits the player, a collider in the camera is used, so the player will only lose if the head hits the obstacle.

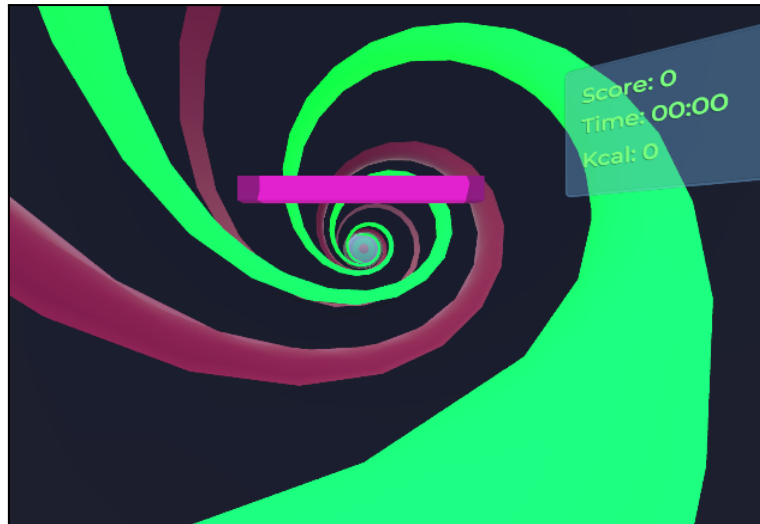


Figure 16: 1st person gameplay of "Up&Down"

5.5.3. Cannon Squash

This mini-game is intended to exercise the core and arms, but above all it is a cardio exercise.

We start with the physical elements that are needed, as we will refer to all of them in the development.

Of the following elements there is a blue and a red version, all modelled and textured by me: 2 rackets, 2 cannons and 2 balls.

There is also a net and a football goal in addition to the court.

We start with the development of the physics of the rackets. Both appear in front of the user and to attract them we have to press the trigger and the grip to grab them, in case they get loose we can attract them again. Basically this works by nullifying the rigidbody velocity of the rackets by setting the three-dimensional vector to 0 and with a MoveTowards with constant velocity depending on the force with which we pull the trigger in the direction of the corresponding hands.

```
_go_Racket.GetComponent<Rigidbody>().velocity = new Vector3(0, 0, 0);
```

```
_go_Racket.transform.position =  
Vector3.MoveTowards(_go_Racket.transform.position, handPos, triggerValue * 10 *  
Time.deltaTime);
```

To hit with the racquets it is not as easy as simply adding a collider to the object and that's it, because being in the player's hand, the rigidbody's speed is 0, and it does not apply the physics well with respect to the ball. So we create an external collider in the shape of a cylinder, with a collision that is larger than realistic compared to the size of the racket, since we are making an arcade game, not a simulation game.

This external collider will follow a point in the center of the racket at a high speed and will hit the ball with that speed. All this with a script.

The red racket can only hit red balls, and vice versa with the blue racket.

Now that the ball hitting problem is solved, the cannon functionality is created.

Both cannons will share a script that will calculate the angle it has to make to hit a target that it will create randomly every two seconds with a set range and with a constant applied force.

The order to fire will be sent by an external script that is in charge of synchronizing both cannons to prevent them from firing at the same time.

Both cannons will fire at the opposite hand to force the user to backhand and exercise the core.

If any of the balls pass behind the user, he will lose one of his 3 lives. If it reaches 0, the game is over.

Finally, to encourage the user to make the exercise more explosive, the user will only score if the ball goes far over the goal. This will add up to 100 points.

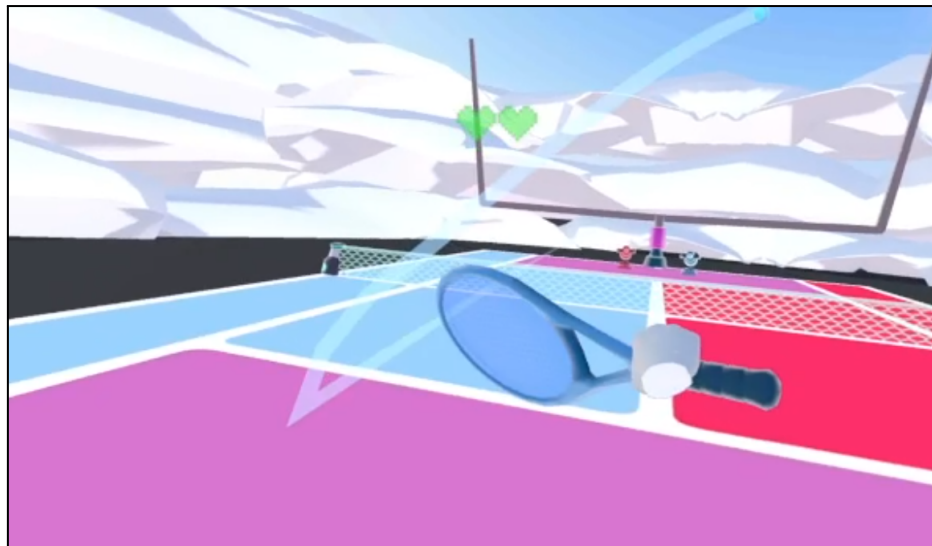


Figure 17: "Cannon Squash" gameplay

5.5.4. Flying game

The last mini-game developed for this version consists of a mini-game of flying and collecting hoops on a stage before time runs out. It is based on the exercise "Lateral raises" which consist in raising dumbbells opening and closing arms.

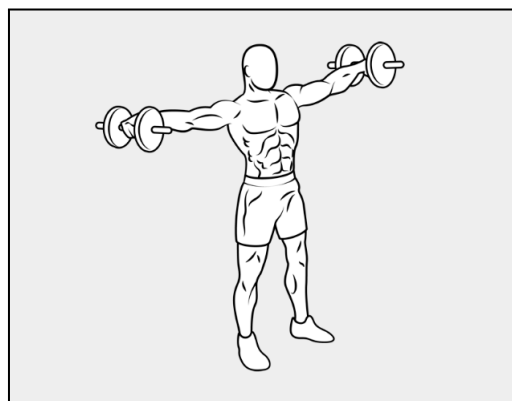


Figure 18: Lateral raises example

Visually, references have been taken from the film "The end of Evangelion", in which Tokyo is seen flooded in a sea of red under a dark sky with reddish clouds. [This free water shader](#) from the Unity store has been used.



Figure 19: The end of Evangelion

As for the main mechanic, which is flying, it is based on lateral elevations. A classic shoulder exercise that consists of raising your arms up and down like a bird flapping its wings.

This is done by taking the negative velocity of the hands and applying positive velocity upwards.

You start by applying a rigidbody to the VR Rig with gravity activated and in the shape of a cylinder. The force is applied to this rigidbody in the Y-axis upwards.

To track the velocity of the hands, there is the same problem as in the racket game. So we reuse the previous code and create a follower of the hands, from which we extract the velocity of the rigidbody in the y-axis.

When the player is falling, the velocity of the hands is added to the velocity of the player plus that of the hands. To solve this, we subtract the velocity of the body from that of the hands to obtain only the velocity of the hands independently of that of the body.

When the body is falling, there is the issue that since gravity is an acceleration, from a certain point, there is no force that can lift the body. So

the negative velocity of the body on the y-axis is limited to 5. In the same way, so that the player does not rise too high, the positive velocity on the y-axis is limited.

In order for the player to move forward, a small force similar to the Y-axis but towards the front is also applied.

To brake, the other two axes of hand movement are employed. When the user flaps forward, an inverse force is applied to the camera vector.

Regarding the game loop, there is a manager who is in charge of creating a series of floating Halos that look at the user at all times and every time they are all achieved, new ones are created.

Each halo adds up to several seconds and 100 points, and if the timer reaches 0, the game is over.

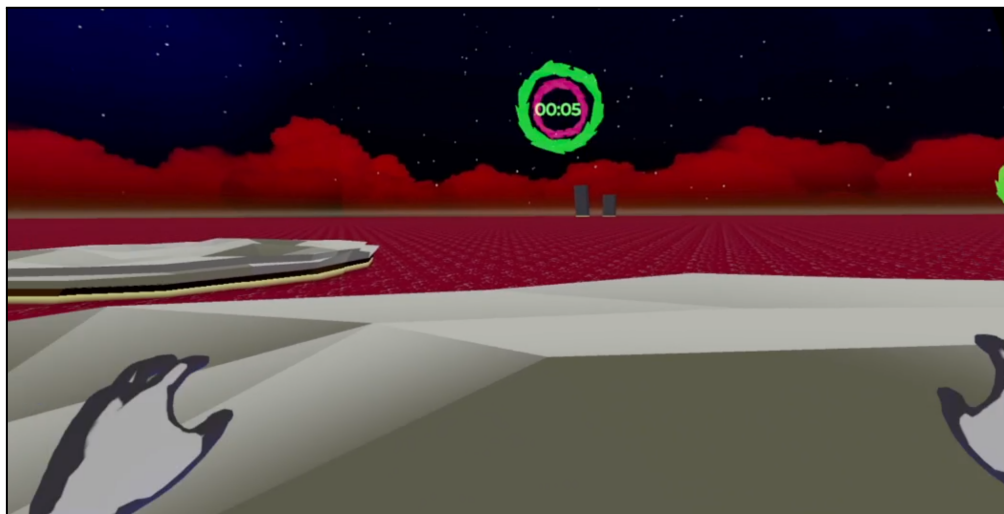


Figure 20: Flying game gameplay

5.6. 3D ART

The most part of the 3D elements are modeled by me. To do that, the workflow was: 3DS Max for modeling → UV Layout to extract the UVs → Substance painter to paint the textures.

This is the list with the models done:

- Tunnels

- Eva 01
- Rackets
- Cannons
- Balls
- Tennis Net
- American Football goal
- Halos
- Clouds
- Soccer goals (not in the game)
- Pet (not in the game)
- Gloves (not in the game)

5.7. TESTING

Because the development has not yet reached a stage where it is finished and can be tested and adjusted. The testing phase has been done in parallel to the development phase, with the developer himself as tester and with two other subjects aged 19 and 51 with heights between 160 cm and 180 cm.

These external testers were mainly used for the first mini-game to adjust the game loop to different heights.

6. CONCLUSIONS AND FUTURE

The main objective of this project was to design a virtual reality game that was able to turn exercise into something fun, using gamification elements. Becoming gym or sports exercises into mini-game mechanics to reduce sedentary lifestyles in the young population by making them see that sport is something fun.

To do this, we had to study several exercises of different muscle groups, study what elements encourage the user to continue playing, taking several references from other products in the sector.

Within this design of a global application, the content has been cut to a feasible version, taking into account that there is only one developer.

Initially, the scope of development was intended to cover a larger part of the final video game. Being unaware of the work involved in both the search for information to design the various systems, and the technical development of the project, without having much experience in immersive virtual reality.

Another difficulty is the limitation of the hardware. Since it consists simply of a pair of glasses and a controller per hand, so the registration of the legs is null and has to look for the movement of these by means of the available devices. All this added to the fact that most effective gym exercises use additional weight for bodybuilding. So you have to resort to more explosive exercises that do not involve this weight or recommend the use of external weight, as in the case of weighted wristbands.

Despite all this, I have been able to verify that no matter how little gamification is applied to these exercises, they are already more fun than normal exercises, since they are based solely on repetition. On the other hand, by playing, goals emerge, there is fun and the perception of time changes, making it more enjoyable to do the exercises. So it ends up being a good alternative because in addition to fun you also exercise your body.

What is new about this game design in the VR sport games sector is the variety and the increase of gamification elements, making it more similar to a normal video game.

After finishing the development. I have seen that it would have been more interesting to invest more time in the development and implementation of gamification systems such as missions, challenges, and rewards with a single mini-game. Rather than developing three mini-games that have been left halfway.

Another element to improve is the calorie burn measurement, using the rigidbody speed to know the intensity of the exercise performed instead of using a constant, as each game can vary in intensity.

However, going forward, this project will continue to be developed to implement all elements of the GDD while expanding this document. Applying online functionalities, deepening the design of each game and polishing them. In addition to all the monetary spending systems that promote the user to keep playing instead of getting bored and stop playing.

7. GDD

7.1. TECHNOLOGY USED

For the development of this video game will use the Unity 3D engine in its version 2020.3 22f1 because it is a version with long time support and is updated monthly until the end of its support cycle, which in this case is in mid 2023, it is also a version in which the packages that I know I want to use work correctly corroborated by previous projects.

As the device for which we are going to develop is the Meta Quest 2, it is necessary to install:

- **XR Interaction Toolkit:** A high-level, component-based interaction system for creating VR and AR experiences. It provides a framework that makes 3D and UI interactions available from Unity input events. The core of this system is a set of base Interactor and Interactable components, and an Interaction Manager that ties these two types of components together. It also contains components that can be used for locomotion and drawing visuals.

- **XR Plugin Management:** Package that provides easy management of XR plugins. It manages and offers help with loading, initialization, configuration and build support for XR plugins.

Both are official Unity packages and completely free of charge.

The use of this engine is because there is a lot of information about how to develop in VR for Unity and because of all the facilities that the engine itself gives you to develop for Android which is the base operating system of Meta Quest 2 and that is why 60% of VR content and 50% of Android development uses Unity3D.

Another point in favor of Unity3D is the versatility of programming in C# instead of using blueprints, which is the programming system of Unreal.

7.2. WORLDBUILDING

7.2.1. Story

Sport World was a green planet with huge trees and lots of life. There live the Sportans, little creatures with a very long tail and huge ears that they use as wings that build their villages in the trees.

The height of these trees was thanks to the fact that the Sportans are connected to the core of the planet and perform sports to share their energy with the planet. Although it may seem that a tree villa implies that they are made of wood and look like manual cabins, the opposite is true. The Sportans are a very advanced civilization with technology far from ours. This has made the majority of the population very sedentary and spend the day connected to the computer, forgetting that their planet stays alive if they stay active.

To avoid this catastrophe. Scientists who still have some motivation left and Sportans who are not hooked on computers have created a portal that summons humans from earth and gloves based on the system the Sportans used to share their energy with the planet, to use the humans as energy generators to maintain the planet alive.

Each human will have a Sportan who will guide him during his mission to save the planet as a mentor and will inform him about the new missions of the week and about the state of the planet, about the other users, etc.

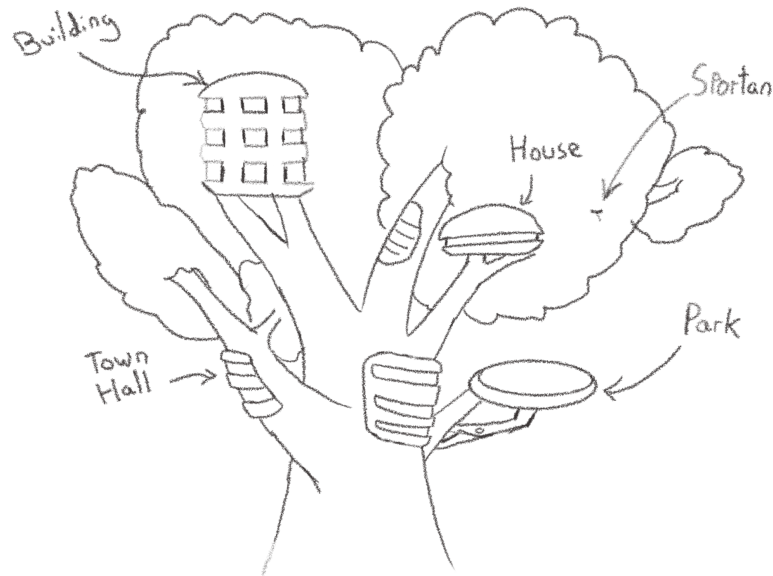


Figure 21: Sportan Village

7.2.2. Development of story

They appear on the planet and the first character they encounter is a Sportan who will introduce himself and tell us to give him a typical Earth name so that they feel closer, since the names in Sportan are unpronounceable for humans.

Once he has introduced himself, he explains to us what our purpose here is and that along with many other humans who have also been summoned, we must save their civilization by generating vital energy through the caloric expenditure that we must make by doing sports so that their trees grow and the planet is healthy since the Sportan are no longer enough to supply the planet since most of them have become sedentary.

At that moment he will give us some gloves, and he will explain that these gloves are in charge of collecting the calories burned and transferring them to the planet.

After this, our Sportan will show us our room and will explain that in other trees there are establishments in which to practice sports and will give us some goals for the day and other weekly goals. He will tell us that he will

reward us with credits that we can redeem our room depending on the goals we meet. These credits can be exchanged in a machine that will offer us objects to decorate the room, how to customize our Sportan mentor or our gloves.

Finally, he will show us the room where we can consult the statistics of other humans, in case we want to beat their records of energy generated.

7.2.3. The Sportans

Sportans are very cute creatures with very big eyes, huge ears, very long tails but a tiny body in comparison. Their fur can be any color, and they can have patterns or spots on their fur.

As for their character, although they are adorable, they are sometimes a bit arrogant and will tease us. Still, they are involved in having a good relationship with us, as we are their only salvation.

They are also a bit tiresome as they love to talk, and they will continually cram us with information and remind us that we still have to complete certain missions if we haven't done so yet.



Figure 22: Sportan 3D Render

7.3. ARTSTYLE

7.3.1. 3D Style

We have to take into account that this video game will be developed for the Metaquest 2, a device that although it gives us a lot of versatility as it is stand alone, it has the disadvantage that it cannot be as powerful as a PC. Therefore, all assets, scenarios, and 3D characters will have to be low/mid-poly and use low resolution textures trying to make the most of flat colors. For that reason, what could be more favorable to the artistic section, would be a cartoon approach and if possible using some shader to give shadows and volume to the models. An example to follow is “The Legend of Zelda Wind Waker”.

The color palette will be mainly with bright and pastel colors. The main colors are pink, light blue and green.



Figure 23: The Legend of Zelda Wind Waker

7.3.2. UI

To make it more immersive, the most part of interface elements will be part of the environment instead of having a menu as such in most cases. Except

for the pause menu, which will be shown right in front of the character's camera, being a classic 2D interface.

An example of the organic interface are the gloves, in which we can see the score of the level and the calories burned on a screen on the back of the hand. A game that does it perfectly is Half-Life Alyx, which integrates with the excuse that the character wears magnetic gloves an interface that indicates the life and resources and in each weapon the remaining ammunition.

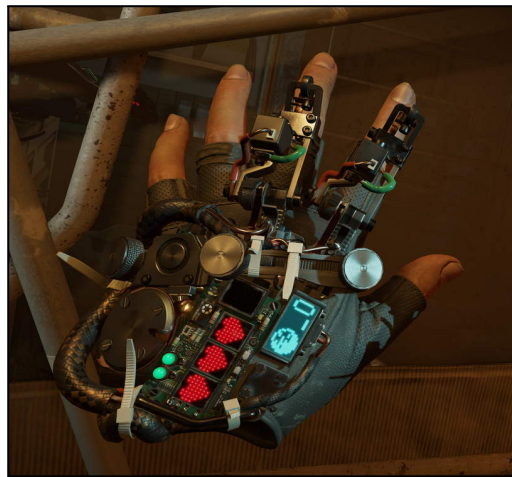


Figure 24: Half-Life Alyx gloves

To consult the rankings, stats and configure a routine or daily objective, we will have a room in which we will have the tables that are updated and another table that we can modify to configure our objectives.

As for the weekly and daily missions, our Spartan will show them to us in the main room.

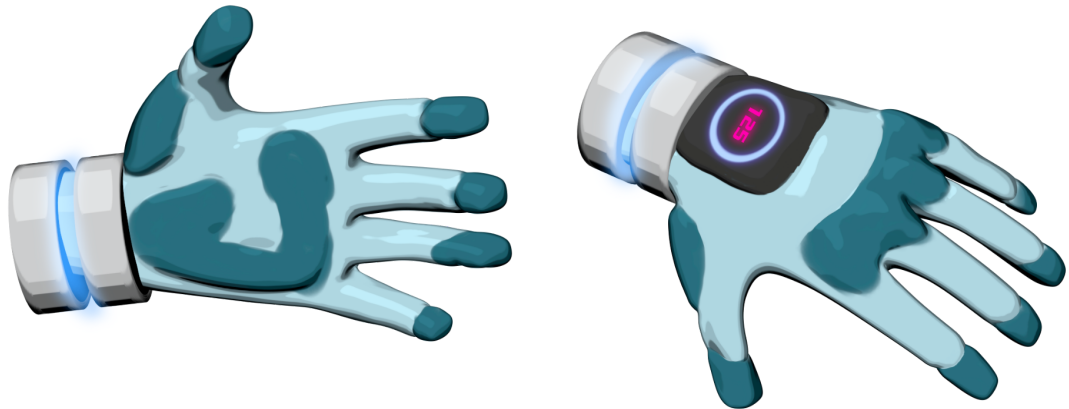


Figure 25: Sportan Gloves 3D Render

7.3.3. SOUND

Due to my lack of training in music production, no composition will be made by me. Reference songs with or without copyright will be used to replace them in the final version with songs with a very similar approach to the one used previously.

As for SFX, in some cases I will do them myself with programs like Audacity or RayLib creator, in other cases I will look for royal free sfx for what is required in order to save time.

7.3.4. Typography

Titles:

Montserrat Bold: <https://fonts.google.com/specimen/Montserrat>

Main:

Montserrat light: <https://fonts.google.com/specimen/Montserrat>

7.3.5. Assets list

7.3.5.1. Models

Each scene shouldn't have more than 800k polys.

Alpha version:

- Gloves
- Sportan
- Sports Center (Hub)
- Ranking panel
- Mini-games balls
- Personalization booth
- Planification table
- Mini-game 1:
 - Obstacle
 - Tunnel
- Mini-game 2:
 - Floating rings
 - Grass field
 - Sky
- Mini-game 3:
 - Rackets (blue and pink)
 - Energy ball (blue and pink)
 - Cannons (blue and pink)
 - Tennis field
 - Skybox

7.3.5.2. UI

Alpha version:

- Menu base panel
- Dialogue panel
- Buttons for pause menu

7.4. DESIGN

7.4.1. Controls

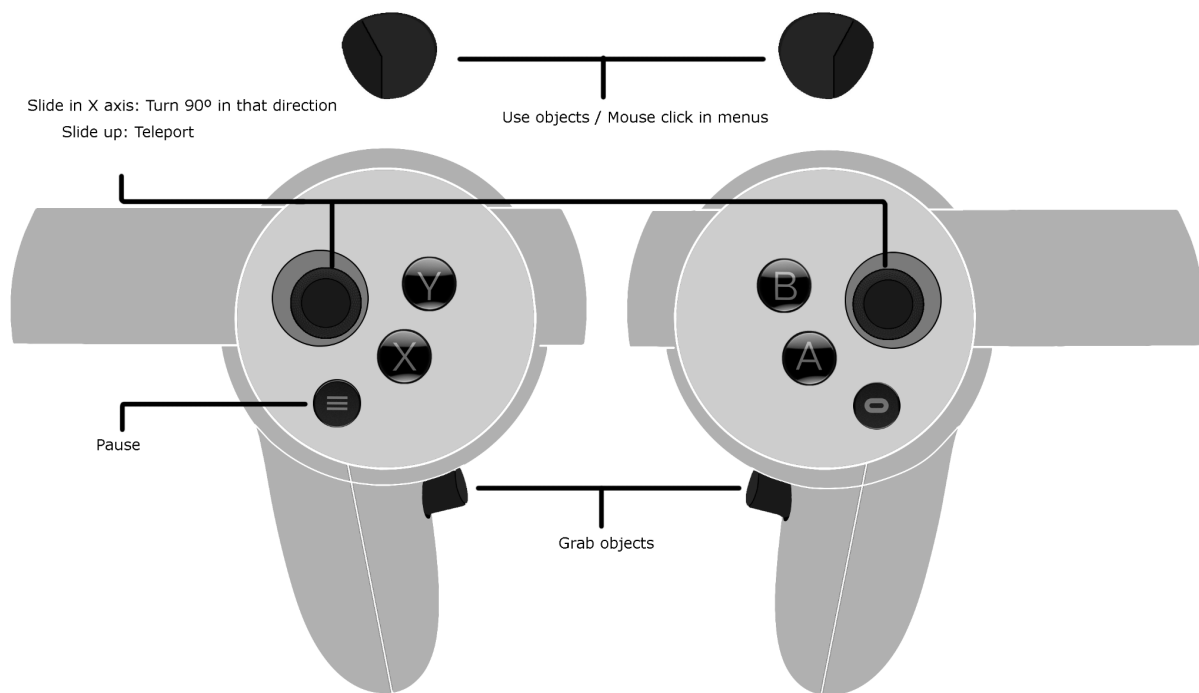


Figure 26: Oculus controller guide

7.4.1.1. Score, kcal, money, level, and tasks

Scoring is unique to each mini-game. Depending on the mode you choose, the score multiplier will be higher (Easy, Medium, Hardcore). This is used to compete with other players and compare with them. The score is calculated mainly by chaining successes in the mini-games that are interrupted when there is a mistake.

In the case of calories burned, in the absence of a system development that monitors through movement and intensity the expenditure made, a simple formula will be used that uses as variables the type of game and the modality played, the user's weight and age.

The calories burned can be exchanged for the Sport World currency, the Spollar. For every 100kcal burned, you get 10 Spollars. They can be used to buy decorative objects and skins.

There are daily and weekly tasks. The tasks mostly offer Spollars when completed, except in exceptional cases that offer objects that can become exclusive for a limited time to motivate the user to meet the objectives that week or else he will not be able to get a certain object again.

The tasks consist of asking the user to reach a certain score in a certain mini-game, to play a certain mini-game as many times as possible, etc.

All these elements will also give to the player some experience to increase the user's level that will give rewards every 5 levels.

7.4.2. Screens and Menus

7.4.2.1. Start playing

The first time the user plays Sport World VR, he will see a splash page with the logo of the game while the content is loading. Then, a fade out from black and the first thing he will see is a Sportan that presents himself and tells the user why is in that world and which is his purpose.

Once the introduction is finished, the Sportan will ask for a name of the user, his weight, and height to calculate how many kcal have to burn and at last a name for the Sportan.

After that, the Sportan will tell the user to start playing in the sports room.

In the alpha version, there is no Sportan, instead there will be some panels to set your info.

7.4.2.2. HUB

The hub is our room, where most of the interactions will take place and which the user will be able to customize as he gets objects. There are several points of interest that are from the beginning to interact.

- **Rankings:** A screen on a wall with which you can interact to check your status in the ranking, your scores in various sports.
- **Planning table:** Here the user can configure his data and adjust the sound and controls if necessary.
- **Personalization booth:** The user will be able to change the coat of his Sportan, his clothes, eyes and also change his gloves.
- **Transportation platform:** This leads from the hub to the sports center.

In the alpha version there will be a hub with basic functionalities to allow the user to go to the different mini-games, configure its data and check the progression and currency. This is done for later extrapolation to an organic hub. So the hub and the sports center will be the same scene with classic interface panels adapted to VR.



Figure 27: Steam VR Home (Hub reference)

7.4.2.3. Sports Center

This center consists of a huge white room with a light-colored tiled floor, influenced by Dragon Ball Z's hyperbolic time chamber. It follows an aesthetic section different from anything previously seen.

Inside there is a leaderboard identical to that of the user's room, and we will also be accompanied by the Sportan following the same role as before to tell us the tasks.

There will be a table with several spheres with a texture that represents the corresponding mini-game. In the center of the room there is a hole that cannot be approached within 3 meters. To play one of the mini-games, you take your ball, and you have to dunk it in the hole in the center, then there will be a fade to black, and you will appear in that mini-game with its corresponding aesthetics changing the room completely.

7.4.2.4. Missions

Many challenges will be set every day in a mission panel that will be the same for all users, in addition to other weekly missions.

These missions will consist of reaching a certain score in a particular mini-game and if at the end of the set time it has been completed, it will be rewarded with items or coins. These items will be cosmetic items that in some cases will be exclusive to that event, so users will do their best to get them for fear of being left without them.

7.4.2.5. Mini-games

There will be a rotation in the mini-game line-up so that users feel that there is variety and don't get tired of doing the same thing over and over again. In fact, the mini-games available will always involve certain muscle groups, as it is not enough to do a completely different routine every week for the exercise to be functional. They will therefore be mainly classified into three blocks: leg, shoulder/arm and core.

These mini-games are classic exercises, gamified for the user to have fun. At the beginning of every mini-game, there will be a little explanation of the game and which muscles are involved to make the user know about that.

Minigame1: "A reason to fight"

Boxing game in which the user has to fight against monsters that launch cube-shaped attacks that are dodged by moving from left to right and ducking. To attack, you will have to hit pink or blue circles depending on whether you need a left or right-handed fist respectively. When the monster's life drops to 0, another one will appear with a different pattern and faster attacks. The game consists of defeating as many monsters as possible before the user's life runs out.

Mini-game 2: "Header master"

A leg mini-game that is based on plyometric squat, a leg exercise in which the user has to do squats and jump.

This game calculate your height at the beginning of the game to instantiate balls a little above the base height to force the user to jump to hit a ball that will come towards him and that will go out in various directions and heights to provoke the game with the legs having to do squats and jumps that will go up in speed over time.

Mini-game 3: “Cannon squash” (Included in alpha version)

In this mini-game, the user will involve the core and arms to hit the ball because every ball goes to the reverse hand.

The user will have two rackets, one pink and the other blue. A Sportan from far away will use two cannons of the previously mentioned colors that launch balls of the color of the cannon, and the user will have to hit it. If the ball is not hit and reaches the user, the user's life will be lowered. In addition, there is an American football goal where the user has to hit the ball to score and floating targets will appear from time to time and the user will have to hit them with a ball before they disappear to get an extra score. The cannons will change angle and speed as time goes by.

The element of the American football goal is included to make the user hit the ball strongly to score and make the exercise more dynamic and intense.

Mini-game 4: “Please give me wings” (Included in alpha version)

A mini-game focused on shoulders and based on the exercise “side raises”. The user can attach weights to their wrists to increase the effectiveness of the exercise and apply more force.

The user's arms become bird wings. To flap, you will have to move up and down and control the direction you move with your head. Some rings will appear around the map and the user has to collide with them before a timer arrives at 0. Every ring gives the user more time and 100 points.

Mini-game 5: “Up & Down” (Included in alpha version)

A leg mini-game that is based on plyometric squat, a leg exercise in which the user has to do squats and jump.

This game calculates your height at the beginning of the game to instantiate obstacles that the user has to avoid to not die.

7.5. ALPHA CONTENT

Because it is an ambitious project with no budget, with only one developer without much previous VR experience and limited time, an alpha version with the main ideas will be developed.

This is what the alpha version includes:

- A central hub unifying the various rooms that the final version would have and distributing the functions in panels.

- User database including name, weight, age, calorie target, score and daily log.

- Calendar that records the user's daily activity in terms of time and calories burned, as well as marking those days on which the target has been reached.

- Three mini-games with developed mechanics and a good level design still to be completed. These mini-games are the ones mentioned above.

- Basic caloric expenditure calculation system based on the [MET](#) formula.

Formula: Total calories burned = Duration (in minutes)*(MET*3.5*weight in kg)/200.

Each mini-game has its own constant.

8. BIBLIOGRAPHY

<https://www.who.int/news-room/facts-in-pictures/detail/6-facts-on-obesity#:~:text=In%202016%2C%20more%20than%201.9,tripled%20between%201975%20and%202016.>

<https://www.niddk.nih.gov/health-information/health-statistics/overweight-obesity>

<https://www.sciencedirect.com/science/article/pii/S074756321630855X>

https://techcrunch.com/2019/11/02/nintendos-ring-fit-adventure-is-a-silly-gentle-way-to-shape-up/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xILmNvbS8&guce_referrer_sig=AQAAAC1p7btJM7ExEAE4KRt0vTfy5VRan96ljldnsl5sL7lrmMG5I9WwTctWLkbpLD_Z3Pbvd1l2RwyOqVm0tgqUmnppqKsGLJq2uUq49FzrtU66vHfKAXEwDSoa8PQutVfxV3FeibYmc3Di_6ms4fQ-5YumPmxQX0_4IRRSwKy9yt

<https://circuitstream.com/blog/unity-vs-unreal/>

<https://www.verywellfit.com/how-many-calories-you-burn-during-exercise-4111064>

9. ANNEX

GitHub with the Unity Project:

https://github.com/FranGV98/TFG_VR_SportGame

Drive link to the APK for Quest 2:

https://drive.google.com/drive/folders/1_gETdyJrIrHQCg7WxicXLUDnMYjPkfXt?usp=sharing

Gameplay:

<https://drive.google.com/file/d/1kYEm8neQnt6ilEslXMWJAU-Sh7QytQyR/view?usp=sharing>

Original GDD Link:

https://drive.google.com/file/d/1jDBQ92SuI8_iNUEr5oCDVMa0P9cHfJRk/view?usp=sharing