A Breath of fresh air: Development of a video game using Unity

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1 Introduction

1.1 Objectives

The objective of this end-of-degree project is to cover every stage of the development using Unity of a survival 2D video game, from the design to the development part.

1.2 Tools employed

- **Unity:** is a powerful cross-platform game engine. It can be used to easily create 2D,3D,VR and AR experiences that runs on the computer as well as mobile devices, game consoles or Smart TVs. It´s programmed in C++ and allows the game developer to write in C#. Until 2017 it allowed to write in a Javascript dialect called `UnityScript`. Unity is used by almost 3 billion devices worldwide, and were installed 24 billion times in the last 12 months. More than 50 % of the mobile games are powered by Unity.[1]

- **Sketch:** is a design toolkit for macOS. We used it to prototype the user interface of the video game. One of it´s pain points is that it makes easy to reuse the design elements making it easily updatable. Sketch also allows you to make your prototypes interactive without having to code.[2]

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[1]https://unity3d.com/public-relations
[2]https://www.sketchapp.com

1.3   Platform

The original idea was to create a short multi platform mini game where the focus was on the mobile platform. Due to time constraints the game is currently desktop only. We were not able to adapt the interaction of the game to the touch controls of a smartphone/tablet. It shouldn´t be harsh to make it playable on a mobile device.

1.4   Planning

The game was developed in the framework of the `Game Design and Implementation` subject. According to the planning, this subject was developed between March 11th and May 6th with a total number of 36 class hours. The development was divided on different tasks. First, we started with an analysis and design part of the proposal of development made to the tutor. There we discussed about the core gameplay, environment, platform and other elements inherent to the video game like the map, the NPCs & citizens, the smog or the player. After getting the seal of approval of the tutor we started with the modelling and texturing of the game elements as well as the acquisition of Unity assets related to the design of the materials which include the smoke displacement that we later use at the game to represent the pollution. After that we started with the programming phase which included the procedural generation of the NPCs, the movements of the players, the movements of the cameras, daylights cycles or the health. Finally we dedicated the development time to the UI items like the splash screen and the pause menu.

2 Design

2.1 Gameplay

This game was developed on Beijing, one of the most polluted cities on earth and focus on the efforts of the population to avoid the pollution. As a player of this game you will have to interact with different resources and move around the environment to reach a healthy area before your health rans out. The smog clouds will appear in random places and move around the streets. Over time new skills are acquired to deal with the steady increase in difficulty.

2.2 Goal

The game runs either for a specific time- span or runs until all citizens have died. When the decided end state has been reached, the player is scored according to her/his efforts. This allows to increase the competitiveness between different players as they now have the objective to be able to maximise the score of other players.

2.3 Controls

At this moment the game is controlled with the keyboard and a mouse. The player will have the option to use the arrows or the WASD set of keys to move the character. He also will have to use the mouse to click on the inventory in order to use the power-ups previously collected and use them temporarily. The collection of the power-ups is automatic and will happen when the player is on top of the power-up.

2.4   Power ups

There are different types of power ups that can be collected by the players:
- **Mask:** Like in the reality, a mask is an object that contains a filter able to filter the majority of the pollutants. Since the masks are an uncomfortable object that breaks easily, the duration of this power up will be very short.
- **Air purifiers:** is an object that is able to reduce the amount of the pollutants on the environment. When you have access to the air purifier, the AQI level of the game will decrease progressively.
- **Smog-cleaning tower[3]:** One of the latest crazy bets of the Chinese government to fight pollution. It consists on a 7 meter tall tower that allegedly is able to clean 30.000 cubic meters per hour. Despite the unknown cost and effectiveness we decided to use it as an easter egg at the highest levels with a very little chance of appearance. The tower will set the AQI to 0.

2.5   Obstacles

We used badly parked sharing bicycles and food stalls to represent the positions of the map that cannot be reached by the player.

2.6   Difficulty

To make the game as realistic as possible we used the `AQI`(Air Quality Index) to express the level of pollution. The `AQI` is a scale used to easily communicate the level of different pollutants (O_3, $PM_{2.5}$, PM_{10}, CO, SO_2 and NO_2). Depending on the range of the AQI value we assign a level

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[3]https://www.forbes.com/sites/ywang/2016/10/20/can-this-tower-solve-chinas-air-pollution-problem/#7f4075141674

and a colour according to the following table:[4]

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

In order to convert from the concentration of a pollutant to the `AQI` you have to use this equation:[5]

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}(C - Clow) + I_{low}$$

where:

I=the (Air Quality) index,

C=the pollutant concentration,

C_{low}=the concentration breakpoint that is <= C,

C_{high}=the concentration breakpoint that is >= C,

I_{low}= the index breakpoint corresponding to C_{low},

I_{high}= the index breakpoint corresponding to C_{high}

2.7   Interactions between elements of the game

A summary of the interactions between the elements of the game can be found in the following matrix:

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[4]https://en.wikipedia.org/wiki/Air_quality_index#United_States
[5]https://en.wikipedia.org/wiki/Air_quality_index#Computing_the_AQI

	Player	NPCs	Smog	Map
Player	N/A	N/A	Removes Smog when in location of the smog	Player can´t move beyond boundaries of map and buildings
NPCs	N/A	An NPC can´t be in the same place as other	NPCs suffocate after time in smog	NPCs can´t move beyond boundaries of map and buildings
Smog	No effect	No effect	N/A	Smog spawns randomly on map and it´s movable. It can´t move beyond boundaries of map and buildings
Map	N/A	N/A	N/A	N/A

2.8 Flow diagram

The first screen when the game starts will be the `Main Menu`. Then, the player can go to the screens: `Options` (to select the game controls option and the game mode) and `Play` (to start a new game). Back to the menu is possible from all these screens. In the case you choose to play not as an endless game you won´t be able to go back directly to the menu, but you will have the option to go to the `Pause Menu` that also allows you to change the controls. When the game ends it will automatically direct to the `Main menu` showing your score. It is only possible to close the game (in a civilised way) from the `Main menu` and the `Pause menu`.
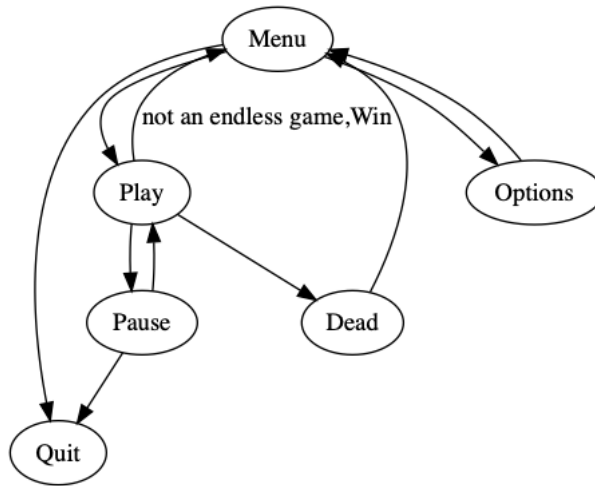
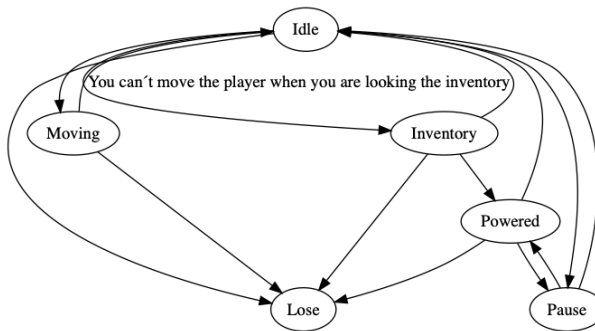Figure 1: Flow diagram of the game

Figure 2: Flow diagram of the player

The possible states of the player are `Idle`, this is the initial state, the player will be in this state when it´s not moving. When the player decides to move around the map, it will switch to the `Moving` state. Another possible state is when you are checking the `Inventory`, you reach this state by clicking the inventory area with the mouse and you are not able to move the player when you are looking at the inventory. When you are looking the inventory you will have the possibility to select a power up, then you will transition to the `Powered` state (where you will have the ability to move or stay still but with the power up activated), when the power up time slot finish, the state will transition to `Idle` again. You will have the ability to access to the `Pause` state (where the `Pause menu` is shown) from the `Idle` or the `Powered` state. Finally you are likely to die (and move to the `Lose` state) in all states except the `Pause` state.

2.9   User interface

2.9.1   Main menu

The main menu will have three options:
- **New game:** It starts a new game.
- **Exit:** Closes the application.
- **Options:** It allows to see and change the game controls and the game mode (Time or lives based)
It will also show the `score` of the last game played.

2.9.2   Pause menu

It includes the same options as the main menu.

2.10   Graphical design

The game objects are 2D models and the textures and designs proceed from the Unity Assets Store.

3   Implementation

3.1   Game assets

Game assets include everything that can go into a game, including 3D models, sprites, sound effects, music, code snippets, modules and even complete projects.[6]They are usually used to make game objects(objects that can be utilised in the game scene). In order to develop this project we used these types of assets:

- **Materials:** It includes the textures used to control the visual appearance of the game objects.

- **Scenes:** They contain the environments and menus of the game.

- **Scripts:** They are used to model the behaviour of the game objects.

- **Prefabs:** It acts as a template from which you can create new object instances in the scene. If you modify a prefab, every instance of that prefab will reflect that change (if you change an inherited object, the changes will be reflected only in this inherited object). A prefab is especially useful when you want several instances of a particular game object.

- **Sprite sheets:** Is an animation technique that consists of several smaller images on different states that change fast enough to look like a continuous movement. We used to animate the movements of the player.

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[6]https://gamedevelopment.tutsplus.com/articles/how-to-fund-your-games-by-creating-and-selling-game-assets–cms-24380

3.2 Construction of game levels

Over time, the difficulty of the game is increased in a linear way. After a certain period of time, the degree of damage per second that the smoke make to the human increases, also the obstacles will appear more frequently and in more zones of the map and there will be less safe areas. Since the chances of survival decreases, the score will also increase faster (the increase in the factor of the difficulty(damage, obstacles, decrease of safe areas) will be the same as in the score).

4 Conclusions

4.1 Possible future lines

There are a series of improvements that we think could be implemented:

First of all the mobile development is not finished, since this is a short task and one of the initial core objectives, we think the future development of this game should start with this. We also think we could have more than one scenario for the game so we should add other polluted cities to represent it like Mexico City or New Delhi. Another addition to the game could be a saving system, this would be specially useful on the endless modality. Finally, we think that adding a sound track and music effects to the player would be great to make the game more enjoyable.

4.2 Personal reflection

The aim of this project was to create a survival 2D game with the Unity game engine and the experience gained with this work has been very

satisfactory at a general level.

Developing a video game with Unity having a Software Developer background is not as obvious as it may seem. The Unity process of development is not focused on writing lines of code but on linking together different assets. Thanks to this project, I learnt how to take advantage of the integration of model, level and script design in Unity.