



SAPIENZA
UNIVERSITÀ DI ROMA

Artificial Intelligence and Robotics

Interactive Graphics: final project

Paintball Arena Zombie Edition

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ABSTRACT

Have you ever noticed that regardless of the scenario, the zombies are slow and unarmed? The game developed is a First-Person Shooter set in an arena, but instead of two teams, the player is alone against a heard of zombie. To keep the environment the least violent possible, everyone uses paintball guns. The player can move and shoot using the traditional commands (WASD and the mouse).

Code fundamentals and main libraries

The code is mainly in JavaScript, html, and CSS. Everyone of the game's dynamics is done through the JavaScript files, while the home page, settings, and game over page are done through an HTML file with some CSS.

The main libraries used are:

- THREE.js: it is a JavaScript library use to create 3D contents on web based on WebGL,
- CANNON.js: it is a physical engine for 3D graphics in JavaScript,
- TWEEN.js: it is a JavaScript library that enable to create smooth animations,

Each object or entity in the scene can be a THREE object, CANNON object, or both. The main process to add a new object in the game, was to generate its shape as a THREE object, and then give him a physical body with CANNON. If the object had to be animate, TWEEN was used to create and attach the animation.

Architecture

The application contains different files, to keep the responsibilities separated as well as avoid a monolithic structure. In particular, the system has monitor files, administrator files and other THREE files.

Main

This is the central files. The Main administrator is present In the Main file, the former contains every static information (the ones that don't change during the game), so it communicates with the settings menu of the game. The function that generate the map (so also the generation of all the entities), and the load model function are also herein defined.

Index.html

It is responsible of the first user interface. Moreover, it manages the interaction between the player and the different menus and settings. One of the main functions is to manage the setting changes by the user and send them to the JavaScript files.

PersonFarm

This file contains the definition of the player's and enemies' structures and animations, as well as the settings of the weapons (the firing rate for example).

Monitors

There are three different types of monitors, one for each fundamental aspect of the game:

- **AIMonitor:** it has the role of defining the mechanics of enemies' movements. At the start of the game, the zombies are in a resting position. Their movements then depend on the position of the player with respect to them. If the player is in a close distance, the zombies will begin to take aim and shoot them, as well as moving around them to hinder the player's aim. If the player shoots the zombie from a further distance, the zombie will notice this and begin to move towards the player until they are close enough to begin shooting them.
- **InputMonitor:** Has the role to decode the keyboard and mouse inputs into game actions.
- **PersonMonitor:** Is the monitor of each of the player's possible actions and admitted states. In this file the reloading and shooting methods are defined.

Administrators

- **BulletAdministrator:** It is the main actor of the bullets' behaviour. It defines the parameters of bullets as well as their colour and dimension.
- **EntityAdministrator:** It is the file that define every entity inside the game, in fact every entity has its parameters, but with a common base.
- **ScoreAdministrator:** It manages the dynamic statistics as well as the number of lives or the number of enemies still alive during the game. These parameters are updated during the game by the score administrator and displayed thanks to the ScoreAdministrator.

Environment

The environment includes: the map, enemy entities, and the player. To build the map some 3D models are also used, so that the map will be uniquely generated for every new match. After the generation of the map there is the spawn of enemies (in random positions) and the spawn of the player (in the middle of the map). The environment also includes a skybox. The user can choose the type of skybox before the beginning of the game. The options include a morning, evening, or night time.



Map

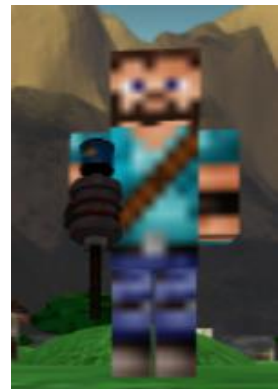
As mentioned above, the map is generated at each match thanks to a homemade Algorithm. For each new object to place in the map the possible randomly generated position is compared to the position of the objects already present in the map, if the possible position is next to one of the already present objects, the placing is skipped. The algorithm allows some overlapping between objects. In the generated world there are three different types of geometries:

- Walls: a parallelogram with the attached texture of a spotted brick wall.
- Hills: created by a sphere placed under the ground with an attached grass texture.
- Trees: they are 3D models loaded thanks to GLTF.Load(). These models don't have a physical body, so it is attached to them after their placing. The choice among the type of tree is made randomly.
- SpotLights: four 3D model of a spotlight at the four corners of the map are placed in the generated world, the user can choose before the start to turn these spotlights on or off.



Player

It is a hierarchical structure of a human: two legs, a torso, two arms and the head. It has a texture attached and a walking animation. On his right arm the player holds the weapon; the initial weapon is fixed, and the user can change it during the game with other two types of weapons (the weapons are described below). To the main character are attached also three types of cameras: first person camera, zoomed in camera and third person camera, also in this case the player always starts the game with the same type of camera and then during the game he can change the vision.

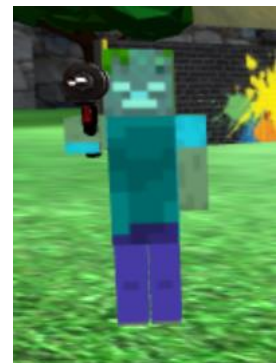


Enemies

During the game it is possible to meet two different types of enemies:

- The Small Zombie with a small number of lives and a simple texture
- The Giant Zombie one with a bigger number of lives and a more complex texture.

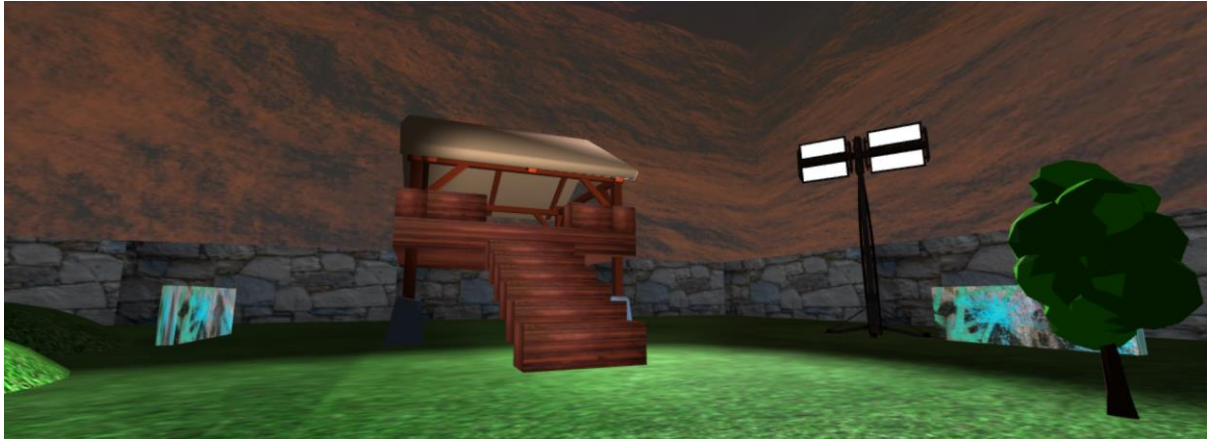
Every enemy has their weapon which is chosen randomly. Both the enemies are sensitive to the player actions (shot) and position. As previously mentioned, if the player is inside a determined range of them, the enemy automatically starts to attack them. The number of enemies may be chosen by the user and there is a balanced switching between the two different enemies. The enemies have two animations: the walking (an animation that give the impression of a rapid walk) and the death (after some hit the enemy collapses to the floor and then despawn).



Map interactions

There is a particular zone in the map. The shelter is a homemade structure made by using THREE, CANNON as well as an imported model of a roof. In the shelter the player can recover a significant number of lives once per match. The recovering is done by dynamically checking the player's position: in detail, if the player reaches

the shelter and jumps over the aid box (an imported 3D model in the middle of the floor of the shelter) placed inside the shelter they recover five lives.



Weapons

Both player and enemies have the opportunity to take advantage of three types of weapons. These weapons are 3D imported models, and every weapon has its own parameters. The player can, during the game, change weapon, instead the enemies have a random fixed weapon among the possible three.

Pistol

It is the weakest weapon (low bullet velocity, mass, and range) with the lowest ammo and firing rate, but its time of reloading is the shortest.



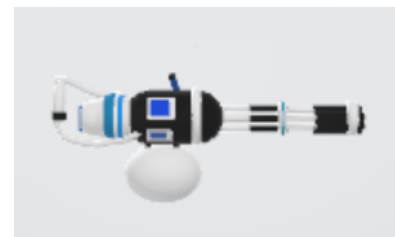
MP5

It is the most versatile weapon, it has a quite good ammo, firing rate, and range with an acceptable reloading time.



Minigun

From a ballistic point of view, it is the strongest weapon, but it has a very high time of reloading.



In-Game User Interactions



During the game the player interface includes some information, including remaining lives and enemies, available ammo, and time. The user can interact during the match in several way via mouse and keyboard:

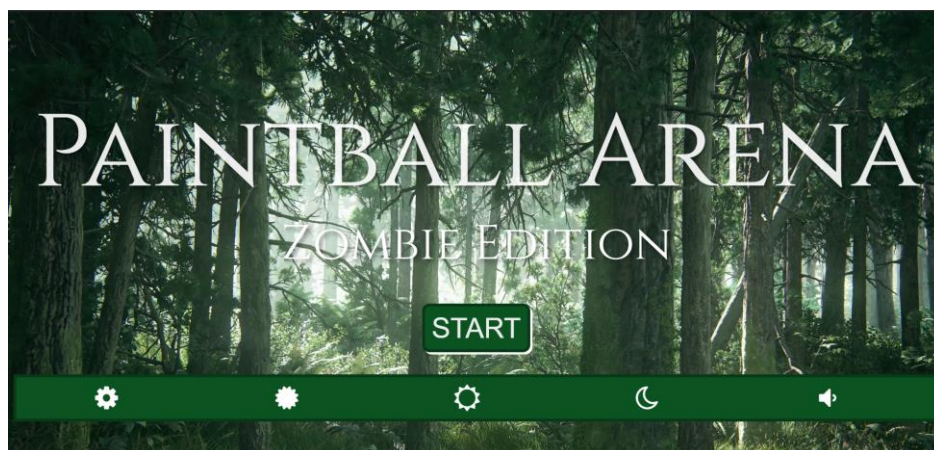
- The user can shoot (left click of the mouse) and change weapons (tab on the keyboard), every time they switch weapon, or they run out of ammos the game automatically recharges the weapons, but the user can also choose to reload the weapon via keyboard (r button),
- The user can change the camera point of view (z button). There are three possible choices: first person, zoomed, and third person.
- The user can interact with one spotlight placed in a way to mimic a torch attached to the weapon. Pressing the “t” button on the keyboard the user will turn on or off said light.
- There are also the classical commands: WASD to move in the four directions and SPACE to jump and holding SHIFT to run.

In case of recharging and recovering lives thanks to the shelter, the game will warn the player with a soundtrack and with a pop-up message in the bottom of the display.



Pre-Match User Interactions

Before a match, the user may change the characteristics of the game (E.g., difficulty, and time of day) thanks to the settings and the home page (buttons and sliders).



Time of the Day

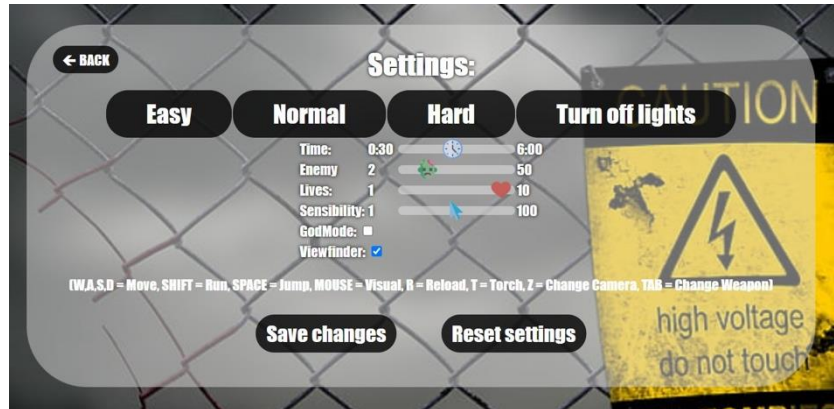
The user can choose the time of the day when the match is going to be played. This choice will influence the skybox, light colour, direction, and intensity. There are three possible times of the day:

- Day: in this case there is a skybox of a morning panorama with a strong directional light placed at noon, coloured in white.

- Evening: for the evening the skybox of a sunset is used. The directional light is placed on the side of the skybox to give the effect of a low sun, the intensity of the light is also lower compared to the one used for the 'daytime' and the colour tends to red.
- Night: for the night option the skybox is very dark and suggestive, the directional light is very weak in such way to mirror a moonlit ambiance.

Arena Lights

The user can turn on and turn off the four big spotlights in the corners of the arena. There are four different strong white spotlights in the corners of the map that aim in the centre of the arena. These lights are independent from the ambient and directional light set in the time of the day selection.



Difficulty

The player can change the difficulty before the game, this choice will influence the number of enemies, lives, and time available. The user can also change, independently from the difficulty, the following parameters: number of lives, number of enemies, sensibility, duration of the match, and he can decide whether to show or not the viewfinder. To make the game a little bit more difficult, in the last minute of the match every enemy is able to see and follow the player from any position of the map.

God Mode

The user can decide to activate God mode in the settings of the game. In this mode the player doesn't suffer damage and kills every enemy with one hit. It has been designed to allow for greater freedom of exploration and play to the user.

Sound Effects

The game also has a main soundtrack. It is audible in the menu by pressing the audio button, during the game there is no background music. During the match the user can listen different sound effects like:

- Hit by an enemy,
- Death of an enemy,
- Shot from the player,
- Jump sound,
- Recharge and change weapon effect,
- Recover full lives in the shelter effect,
- Victory soundtrack,
- Lose soundtrack.