



SAPIENZA
UNIVERSITÀ DI ROMA

INTERACTIVE GRAPHICS - FINAL PROJECT

MineGL

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Introduction

MineGL is an exploration 3D browser game realized as final project for Interactive Graphics course. In it, the player can explore the world, encountering some animated creatures during the day and night. It is based on a popular game called Minecraft, where the goal of the user is to explore the world. The project has been tested on Google Chrome and in order to properly run it, the user needs to have a web browser that supports WebGL 2.0 and an up to date javascript interpreter since classes are used in the source code.

Implementation

The project is realized in WebGL 2.0 (Web Graphics Library). It is a Javascript API for rendering interactive 2D and 3D graphics within any compatible web browser without using plugins.

Third-party libraries:

- simplexNoise.js: used for random generation of the map, library which allow us to have a lower computation complexity during a generation of a well-defined and continuous gradient (almost) everywhere.

As introduced before, this is a program inspired by the famous video game called Minecraft where the player controls a character in a randomly generated world starting from a seed. MineGL does exactly the same thing: when the web page starts, a javascript function, `Date.now()`, is called in `main.js`. The returned value is then used to set the seed of a multidimensional noise function, the Simplex Noise function:

```
const openSimplex = openSimplexNoise(Date.now());
```

This particular function has the characteristic of being a smooth function. This means that we can use it during the terrain generation, where such behavior is needed. Using a normal RNG, in fact, there would be a sudden change in terrain values, making the scene more like a hellscape rather than a natural scene. The classic RNG function (`Math.random()`) is used instead where a smooth change of values is not necessary, for example in the code related to artificial intelligence, where which animation to execute next is decided.

As for the generation of the terrain, the original idea was to create an infinite world. For this we created a `chunkT` function that generates a piece of terrain, and we used this function to create 9 objects of this type, arranging the 9 terrains in a three-by-three conformation. What we intended to do was to dynamically generate new terrains as the player explored the world, while simultaneously erasing old unused terrains. While we haven't been able to implement this in time, the code still has the basic structure to be able to add this functionality. As we will see, the abstraction necessary for the development of the undeveloped feature has complicated not a little the writing of the rest of the code.

Structure

The code has been splitted into several files, each one with a specific task.

- `index.html`: File which contains both vertex and fragment shader. To open the game, user has to run the HTML file.
- `main.js`: the file that manages the scene and the generation of the world.
- `horse.js`: the file that contains all the functions used to create and animate a generic horse.
- `spider.js`: the file that contains all the functions used to create and animate a generic spider.

Scene

The rendered scene is divided into two parts: the terrains and the entities. These two types of objects are rendered differently, but they use the same program. Since terrains use instances, while entities do not, we decided to arrange everything using two model matrices: one matrix of type "attribute", used during instancing, and the other of type "uniform", used in rendering of the entities. When rendering of an object, the mismatched matrix is set to the identity matrix. Although it is not the most elegant solution, it is certainly the fastest to implement when you have two different codes to integrate. And best of all, it works. A more efficient solution would have been to change the rendering of the entities, to make them also use instancing. This would not only make the code more consistent, removing the need for two model matrixes, but also increase the overall program performance. This is one of the first points to review for a possible future development of the project.

Models

For the creation and animation of the animals inside the world, no external libraries have been used. A classical hierarchical model was computed as represented in the figure:

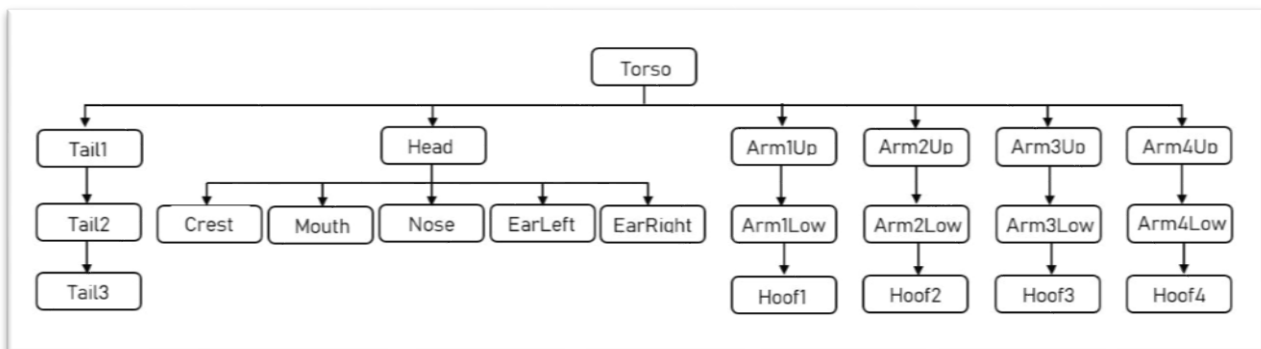


Figure1. Hierarchical model of a horse

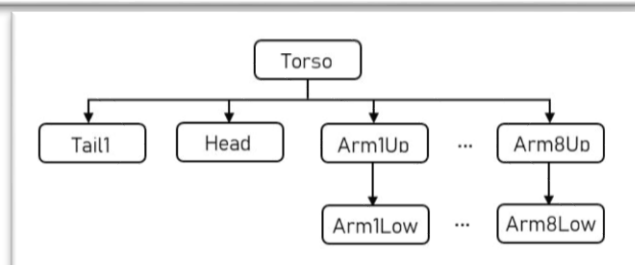


Figure2. Hierarchical model of a spider

Each animal is treated as an 'object', with its own properties. In the class horse.js, each one has its local variables since these are the characteristics that differentiates each horse from another (e.g. position in the world, values of angles of its body). The global variables represents the common characteristics, such as dimensions of bodies or numbers of nodes for every horse.

Every animal has its own animation, which is chosen randomly from 3 available animations (for the horse). They are:

-walking_animation() : Simple animation where the horse moves in a direction given by the file main.js (computed randomly).

-rearing_animation(): Animation where the horse stands up on its rear legs and kicks in front with its front legs.

-eat_animation(): In this animation the horse

There is another animation called standH() which resets all the local variables for the selected animal, so it can be ready to start another random animation. All these animations have been created for this project and no one have been imported from outside.

In the file main.js an array of animals is created, the animals are 'entities' and the type of animal selected is given by entity_id. Since they are 'objects', for every animal of the array a random animation is called as follows:

```
if (entities[entity_id].type_entity==1) {  
    // horse  
    entities[entity_id].animation = Math.floor(Math.random() * 4);    // returns a random integer from 0 to 3  
} else {  
    // spider  
    entities[entity_id].animation = Math.floor(Math.random() * 2);    // returns a random integer from 0 to 3  
}
```

Since we have 3 animations, a random integer from 0 to 3 is created, and if the number 0 is obtained, no animation starts and the animals stands in its position.

Lights

In the fragment shader of html file, a Phong shading interpolation technique was used, combining the Phong interpolation and the Phong Reflection model. To follow the Phong's equation and Ambient, Diffuse and Specular values are computed as follows:

```
// AMBIENT  
float ambient_value = 0.2;  
vec3 ambient = ambient_value*(fs_sunlight_color + fs_moonlight_color);  
  
// DIFFUSE  
float diffuse_sun_value = max(dot(fs_normal, fs_sunlight_direction)+0.1, 0.0);  
float diffuse_moon_value = max(dot(fs_normal, fs_moonlight_direction)+0.1, 0.0);  
diffuse_sun_value = min(1.0, diffuse_sun_value);  
diffuse_moon_value = min(1.0, diffuse_moon_value);  
vec3 diffuse = diffuse_moon_value*fs_moonlight_color + diffuse_sun_value*fs_sunlight_color;  
  
// REFLECTION  
vec3 view_direction = normalize(fs_camera_pos-fs_position);  
vec3 sun_reflection = reflect(-fs_sunlight_direction, fs_normal);  
float reflection_value = pow(max(dot(sun_reflection, view_direction), 0.0), 64.0);  
vec3 reflection = reflection_value * fs_sunlight_color * fs_shading;
```