UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

FACULTAD DE INGENIERÍA

Laboratory

Computer Graphic Human-Compute Interaction

FINAL PROYECT

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Proyect Shrek's Swamp

Abstract

The informatic field of Compute graphics it's growing exponentially since few decades ago, specially with every single progress of advance hardware at the reach of the common people.

This changes are being obvious in topic of entretainment with videogames or CGI movies like ToyStoy. The development in computer graphics was first fueled by academic interests and government patronage. However, as the truly worldwide applications of computer graphics (CG) in television and film proved a viable alternative to more traditional special effects and animation techniques, commercials have increasingly financed the advancement of this field. .

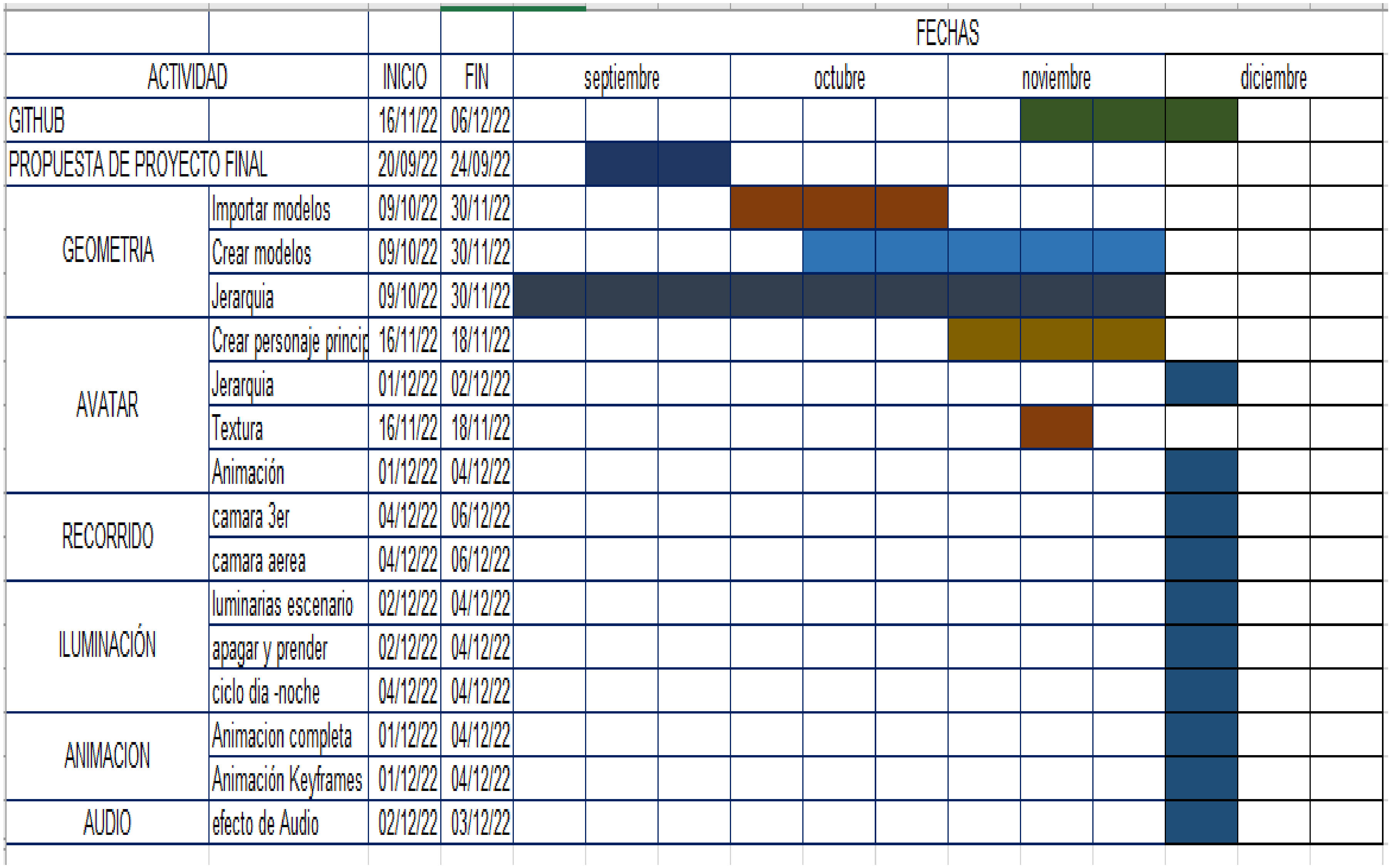
Objective

The student will combine diferent basics techniques learned in laboratoy practices to produce and tri-dimentional enviroment with static and dynamic models, animations and sound effects.

Fundamentals

The student should choose a residential build and a space, these could be que real or fiction, with reference image of the scenario and recreated in a 3D enviroment using OpenGL. Also, must recreate 7 items with the greatest resemblance possible.

Gantt diagram

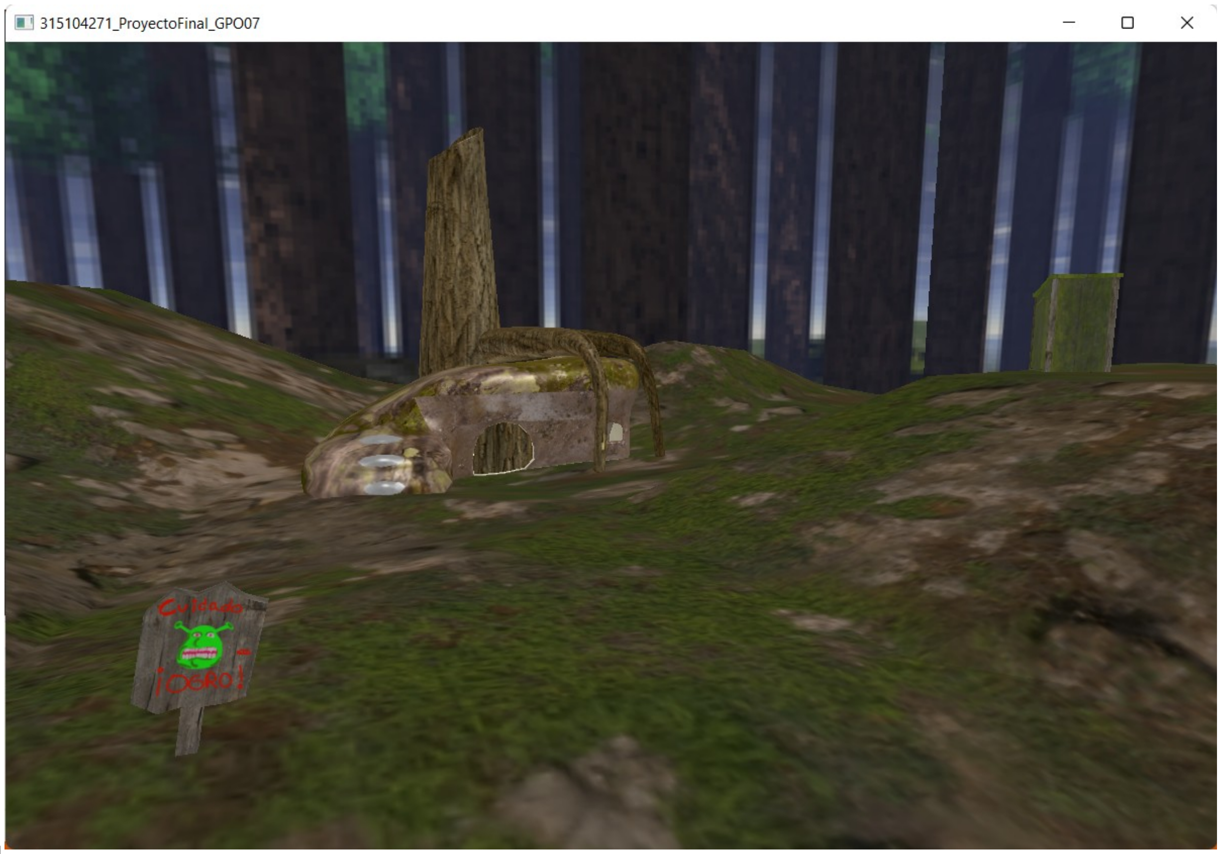


				FECHAS											
ACTIVIDAD		INICIO	FIN	septiembre			octubre			noviembre			diciembre		
GITHUB		16/11/22	06/12/22								🟩	🟩	🟩		
PROPUESTA DE PROYECTO FINAL		20/09/22	24/09/22		🟦	🟦									
GEOMETRIA	Importar modelos	09/10/22	30/11/22				🟫	🟫	🟫						
	Crear modelos	09/10/22	30/11/22					🟦	🟦	🟦	🟦	🟦			
	Jerarquia	09/10/22	30/11/22	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛			
AVATAR	Crear personaje princip	16/11/22	18/11/22							🟨	🟨	🟨			
	Jerarquia	01/12/22	02/12/22										🟦		
	Textura	16/11/22	18/11/22								🟫				
	Animación	01/12/22	04/12/22										🟦		
RECORRIDO	camara 3er	04/12/22	06/12/22										🟦		
	camara aerea	04/12/22	06/12/22										🟦		
ILUMINACIÓN	luminarias escenario	02/12/22	04/12/22										🟦		
	apagar y prender	02/12/22	04/12/22										🟦		
	ciclo dia -noche	04/12/22	04/12/22										🟦		
ANIMACION	Animacion completa	01/12/22	04/12/22										🟦		
	Animación Keyframes	01/12/22	04/12/22										🟦		
AUDIO	efecto de Audio	02/12/22	03/12/22										🟦		

Proyect Reachs

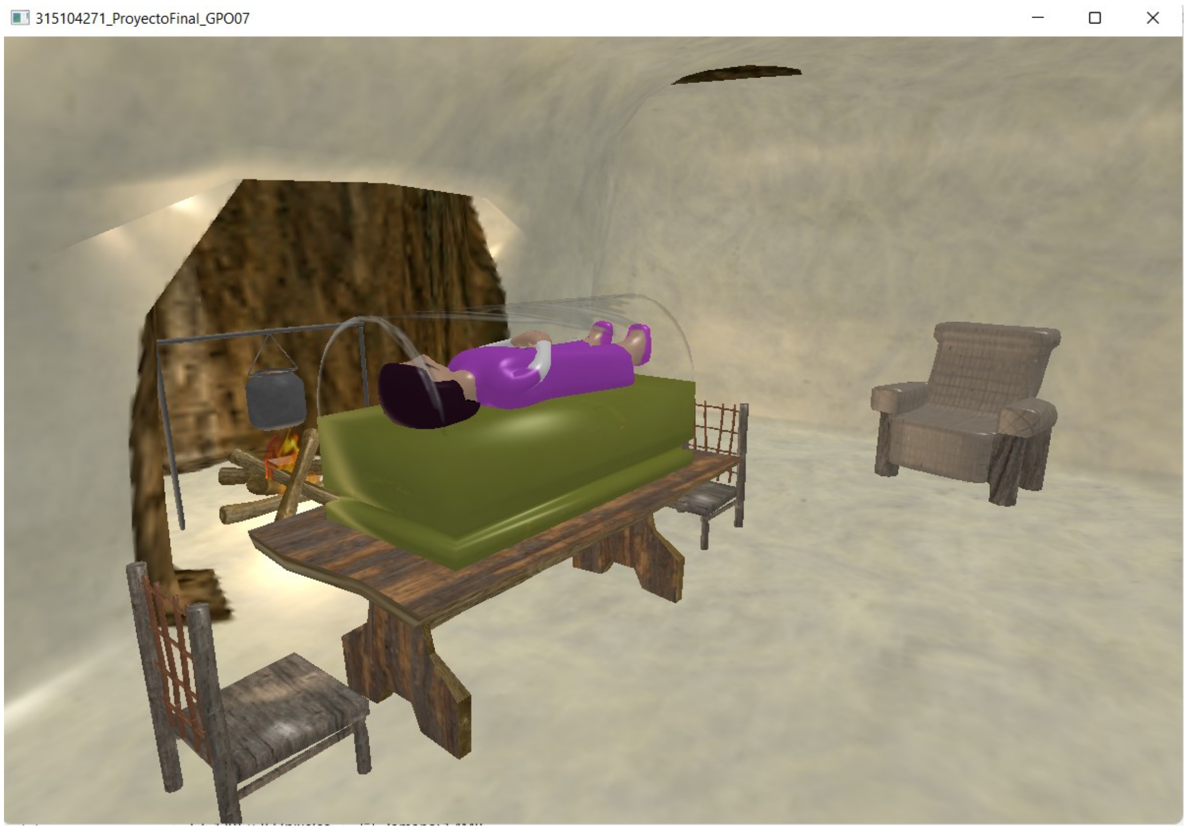
Reference Image

Shrek’s House



Elements to Replicate

1. Main Table
2. Chair
3. Coach
4. Firepit
5. Cristal Coffin
6. Outside Restroom
7. “Warning Ogre” Sight



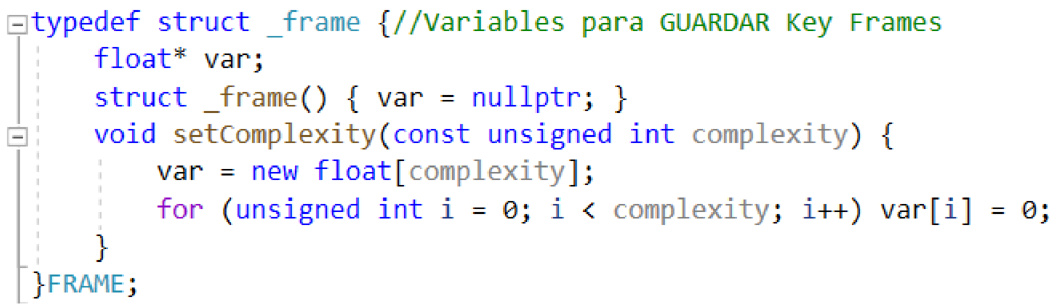
Document Code

At the start of the production, the proyect was being purgue and optifine removing every foreigner item, such like Images, Models/Personaje folders, as the same, inside the main code, removing unnecessary calls to objects, etc.

The shaders have been renamed in order to get a better understanding in the function, cuz the name of lamp or lightning there's no more a good description for a standar or single model.

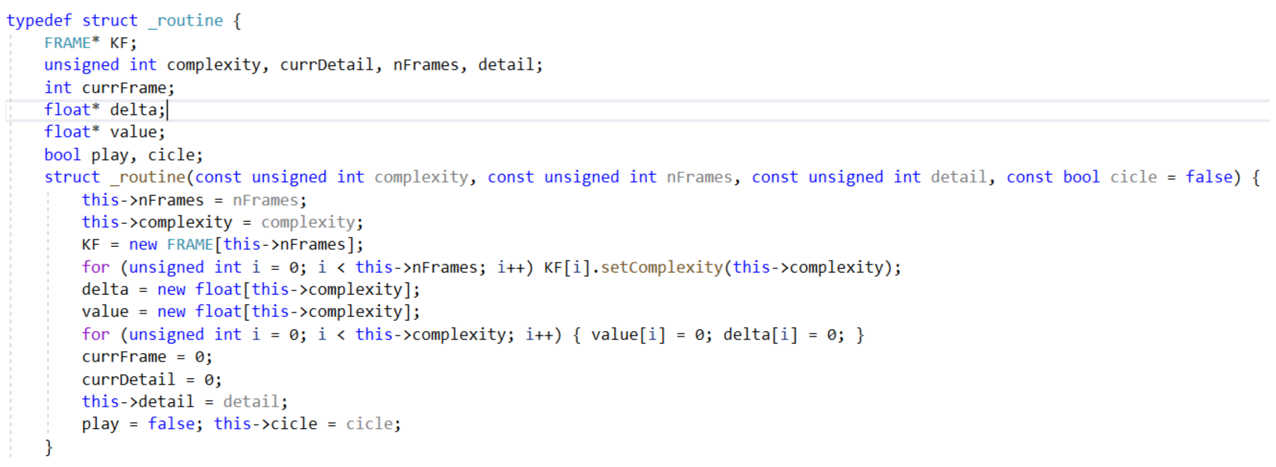
Putting out pretty much instructions of the main while for save resources and time, specially in the illumination configuration, only a single lightpoint would be use, and no reason for changing more that once most of the static values.

Now with proper faculties of the program, lets begin with the re-sctructure and improving of the animation KeyFrame System.



```
typedef struct _frame {//Variables para GUARDAR Key Frames
    float* var;
    struct _frame() { var = nullptr; }
    void setComplexity(const unsigned int complexity) {
        var = new float[complexity];
        for (unsigned int i = 0; i < complexity; i++) var[i] = 0;
    }
}FRAME;
```

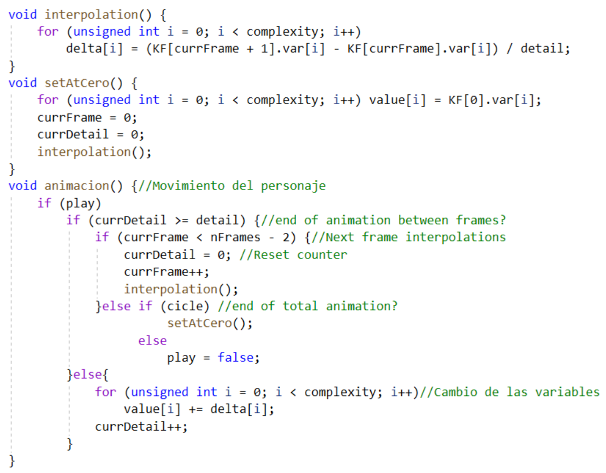
The structure has a floating vector of dynamic size to store the parameters that need to be animated, from 3 parameters for the 3 axes of a limb, 4 parameters (position vector and angle of the Y axis) for the manipulation of a model. All interior components.



```
typedef struct _routine {
    FRAME* KF;
    unsigned int complexity, currDetail, nFrames, detail;
    int currFrame;
    float* delta;
    float* value;
    bool play, cicle;
    struct _routine(const unsigned int complexity, const unsigned int nFrames, const unsigned int detail, const bool cicle = false) {
        this->nFrames = nFrames;
        this->complexity = complexity;
        KF = new FRAME[this->nFrames];
        for (unsigned int i = 0; i < this->nFrames; i++) KF[i].setComplexity(this->complexity);
        delta = new float[this->complexity];
        value = new float[this->complexity];
        for (unsigned int i = 0; i < this->complexity; i++) { value[i] = 0; delta[i] = 0; }
        currFrame = 0;
        currDetail = 0;
        this->detail = detail;
        play = false; this->cicle = cicle;
    }
```

The real administrative change is in the routine structure, since it contains all the necessary values that may be needed from the version provided by the laboratory. The advantages of this administration are the choice of the complexity of the KeyFrames, the number of these and which detail interpolation operations are performed, such as the possibility of repeating in a loop. (Although the system does not gradually transition between the last position and the first).

It contains a vector of Keyframes, a float vector for changes and one for the current value of the animation, as well as indicators of the tween and current frame, such as boolean play or cycle flags.



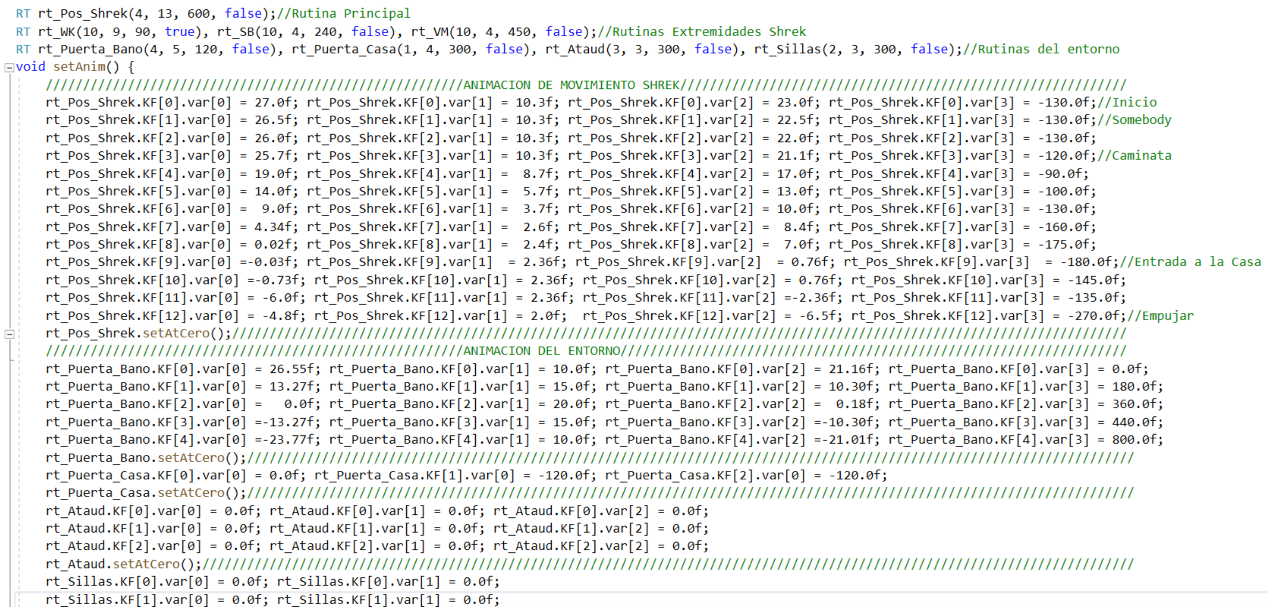
```
void interpolation() {
    for (unsigned int i = 0; i < complexity; i++)
        delta[i] = (KF[currFrame + 1].var[i] - KF[currFrame].var[i]) / detail;
}
void setAtCero() {
    for (unsigned int i = 0; i < complexity; i++) value[i] = KF[0].var[i];
    currFrame = 0;
    currDetail = 0;
    interpolation();
}
void animacion() {//Movimiento del personaje
    if (play)
        if (currDetail >= detail) {//end of animation between frames?
            if (currFrame < nFrames - 2) {//Next frame interpolations
                currDetail = 0; //Reset counter
                currFrame++;
                interpolation();
            }else if (cicle) //end of total animation?
                    setAtCero();
                 else
                    play = false;
        }else{
            for (unsigned int i = 0; i < complexity; i++)//Cambio de las variables
                value[i] += delta[i];
            currDetail++;
        }
}
```

The interpolacion method is the same in terms of arithmetic, it was only modified to be cyclic.

SetAtZero is the formal restart of the animation, returning to the starting position without a transition, setting the flags to zero, and performing the interpolation specified by the original method.

As for the animation, the play control variable was kept so that it would stop executing while still in the main loop. Swapped logic to resolve a last frame playback issue, initial testing showed that the transition to the last frame was needed, so the current frame was ramped up early but before it was interpolated. If the animation had finished, it is asked if it is a loop to restart, otherwise it is prevented from executing this procedure by changing the play variable to false.

And the transition adds up. In a loop format.



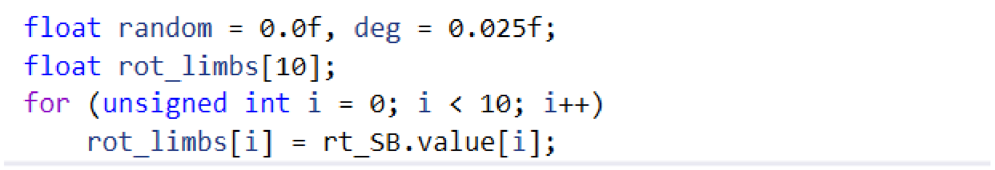
```
RT rt_Pos_Shrek(4, 13, 600, false);//Rutina Principal
RT rt_WK(10, 9, 90, true), rt_SB(10, 4, 240, false), rt_VM(10, 4, 450, false);//Rutinas Extremidades Shrek
RT rt_Puerta_Bano(4, 5, 120, false), rt_Puerta_Casa(1, 4, 300, false), rt_Ataud(3, 3, 300, false), rt_Sillas(2, 3, 300, false);//Rutinas del entorno
void setAnim() {
    ////////////////////////////////////////////////////////ANIMACION DE MOVIMIENTO SHREK////////////////////////////////////////////////////////////
    rt_Pos_Shrek.KF[0].var[0] = 27.0f; rt_Pos_Shrek.KF[0].var[1] = 10.3f; rt_Pos_Shrek.KF[0].var[2] = 23.0f; rt_Pos_Shrek.KF[0].var[3] = -130.0f;//Inicio
    rt_Pos_Shrek.KF[1].var[0] = 26.5f; rt_Pos_Shrek.KF[1].var[1] = 10.3f; rt_Pos_Shrek.KF[1].var[2] = 22.5f; rt_Pos_Shrek.KF[1].var[3] = -130.0f;//Somebody
    rt_Pos_Shrek.KF[2].var[0] = 26.0f; rt_Pos_Shrek.KF[2].var[1] = 10.3f; rt_Pos_Shrek.KF[2].var[2] = 22.0f; rt_Pos_Shrek.KF[2].var[3] = -130.0f;
    rt_Pos_Shrek.KF[3].var[0] = 25.7f; rt_Pos_Shrek.KF[3].var[1] = 10.3f; rt_Pos_Shrek.KF[3].var[2] = 21.1f; rt_Pos_Shrek.KF[3].var[3] = -120.0f;//Caminata
    rt_Pos_Shrek.KF[4].var[0] = 19.0f; rt_Pos_Shrek.KF[4].var[1] =  8.7f; rt_Pos_Shrek.KF[4].var[2] = 17.0f; rt_Pos_Shrek.KF[4].var[3] = -90.0f;
    rt_Pos_Shrek.KF[5].var[0] = 14.0f; rt_Pos_Shrek.KF[5].var[1] =  5.7f; rt_Pos_Shrek.KF[5].var[2] = 13.0f; rt_Pos_Shrek.KF[5].var[3] = -100.0f;
    rt_Pos_Shrek.KF[6].var[0] =  9.0f; rt_Pos_Shrek.KF[6].var[1] =  3.7f; rt_Pos_Shrek.KF[6].var[2] = 10.0f; rt_Pos_Shrek.KF[6].var[3] = -130.0f;
    rt_Pos_Shrek.KF[7].var[0] = 4.34f; rt_Pos_Shrek.KF[7].var[1] =  2.6f; rt_Pos_Shrek.KF[7].var[2] =  8.4f; rt_Pos_Shrek.KF[7].var[3] = -160.0f;
    rt_Pos_Shrek.KF[8].var[0] = 0.02f; rt_Pos_Shrek.KF[8].var[1] =  2.4f; rt_Pos_Shrek.KF[8].var[2] =  7.0f; rt_Pos_Shrek.KF[8].var[3] = -175.0f;
    rt_Pos_Shrek.KF[9].var[0] =-0.03f; rt_Pos_Shrek.KF[9].var[1]  = 2.36f; rt_Pos_Shrek.KF[9].var[2]  = 0.76f; rt_Pos_Shrek.KF[9].var[3]  = -180.0f;//Entrada a la Casa
    rt_Pos_Shrek.KF[10].var[0] =-0.73f; rt_Pos_Shrek.KF[10].var[1] = 2.36f; rt_Pos_Shrek.KF[10].var[2] = 0.76f; rt_Pos_Shrek.KF[10].var[3] = -145.0f;
    rt_Pos_Shrek.KF[11].var[0] = -6.0f; rt_Pos_Shrek.KF[11].var[1] = 2.36f; rt_Pos_Shrek.KF[11].var[2] =-2.36f; rt_Pos_Shrek.KF[11].var[3] = -135.0f;
    rt_Pos_Shrek.KF[12].var[0] = -4.8f; rt_Pos_Shrek.KF[12].var[1] = 2.0f;  rt_Pos_Shrek.KF[12].var[2] = -6.5f; rt_Pos_Shrek.KF[12].var[3] = -270.0f;//Empujar
    rt_Pos_Shrek.setAtCero();/////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
    ////////////////////////////////////////////////////////ANIMACION DEL ENTORNO/////////////////////////////////////////////////////////////////////
    rt_Puerta_Bano.KF[0].var[0] = 26.55f; rt_Puerta_Bano.KF[0].var[1] = 10.0f; rt_Puerta_Bano.KF[0].var[2] = 21.16f; rt_Puerta_Bano.KF[0].var[3] = 0.0f;
    rt_Puerta_Bano.KF[1].var[0] = 13.27f; rt_Puerta_Bano.KF[1].var[1] = 15.0f; rt_Puerta_Bano.KF[1].var[2] = 10.30f; rt_Puerta_Bano.KF[1].var[3] = 180.0f;
    rt_Puerta_Bano.KF[2].var[0] =   0.0f; rt_Puerta_Bano.KF[2].var[1] = 20.0f; rt_Puerta_Bano.KF[2].var[2] =  0.18f; rt_Puerta_Bano.KF[2].var[3] = 360.0f;
    rt_Puerta_Bano.KF[3].var[0] =-13.27f; rt_Puerta_Bano.KF[3].var[1] = 15.0f; rt_Puerta_Bano.KF[3].var[2] =-10.30f; rt_Puerta_Bano.KF[3].var[3] = 440.0f;
    rt_Puerta_Bano.KF[4].var[0] =-23.77f; rt_Puerta_Bano.KF[4].var[1] = 10.0f; rt_Puerta_Bano.KF[4].var[2] =-21.01f; rt_Puerta_Bano.KF[4].var[3] = 800.0f;
    rt_Puerta_Bano.setAtCero();///////////////////////////////////////////////////////////////////////////////////////////////////////////////////
    rt_Puerta_Casa.KF[0].var[0] = 0.0f; rt_Puerta_Casa.KF[1].var[0] = -120.0f; rt_Puerta_Casa.KF[2].var[0] = -120.0f;
    rt_Puerta_Casa.setAtCero();///////////////////////////////////////////////////////////////////////////////////////////////////////////////////
    rt_Ataud.KF[0].var[0] = 0.0f; rt_Ataud.KF[0].var[1] = 0.0f; rt_Ataud.KF[0].var[2] = 0.0f;
    rt_Ataud.KF[1].var[0] = 0.0f; rt_Ataud.KF[1].var[1] = 0.0f; rt_Ataud.KF[1].var[2] = 0.0f;
    rt_Ataud.KF[2].var[0] = 0.0f; rt_Ataud.KF[2].var[1] = 0.0f; rt_Ataud.KF[2].var[2] = 0.0f;
    rt_Ataud.setAtCero();/////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
    rt_Sillas.KF[0].var[0] = 0.0f; rt_Sillas.KF[0].var[1] = 0.0f;
    rt_Sillas.KF[1].var[0] = 0.0f; rt_Sillas.KF[1].var[1] = 0.0f;
```

This is how the information is loaded, first we must define our structures with the dimension of the Frames, the number of these, the quality of the detail and optionally, a boolean that indicates if this will be repeated in a loop or not (By default it is false) and the loading process is similar to a two-dimensional array, where the value of each keyframe is queried.

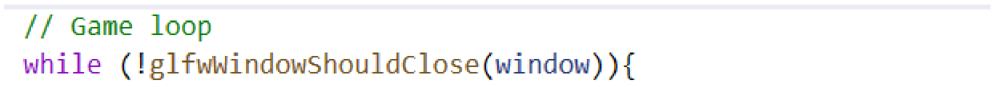
At the end of each value declaration, the setAtCero method of each subroutine must be called to perform the first interpolation.

NOTE: This procedure is not automated, therefore, there is not something that regulates the number of memory accesses, so if access is requested to a number equal to or greater than the size of the complexity or the number of keyframes , this will give an error at the beginning of the program, although all those values that have an assignment will have 0.0f by default.

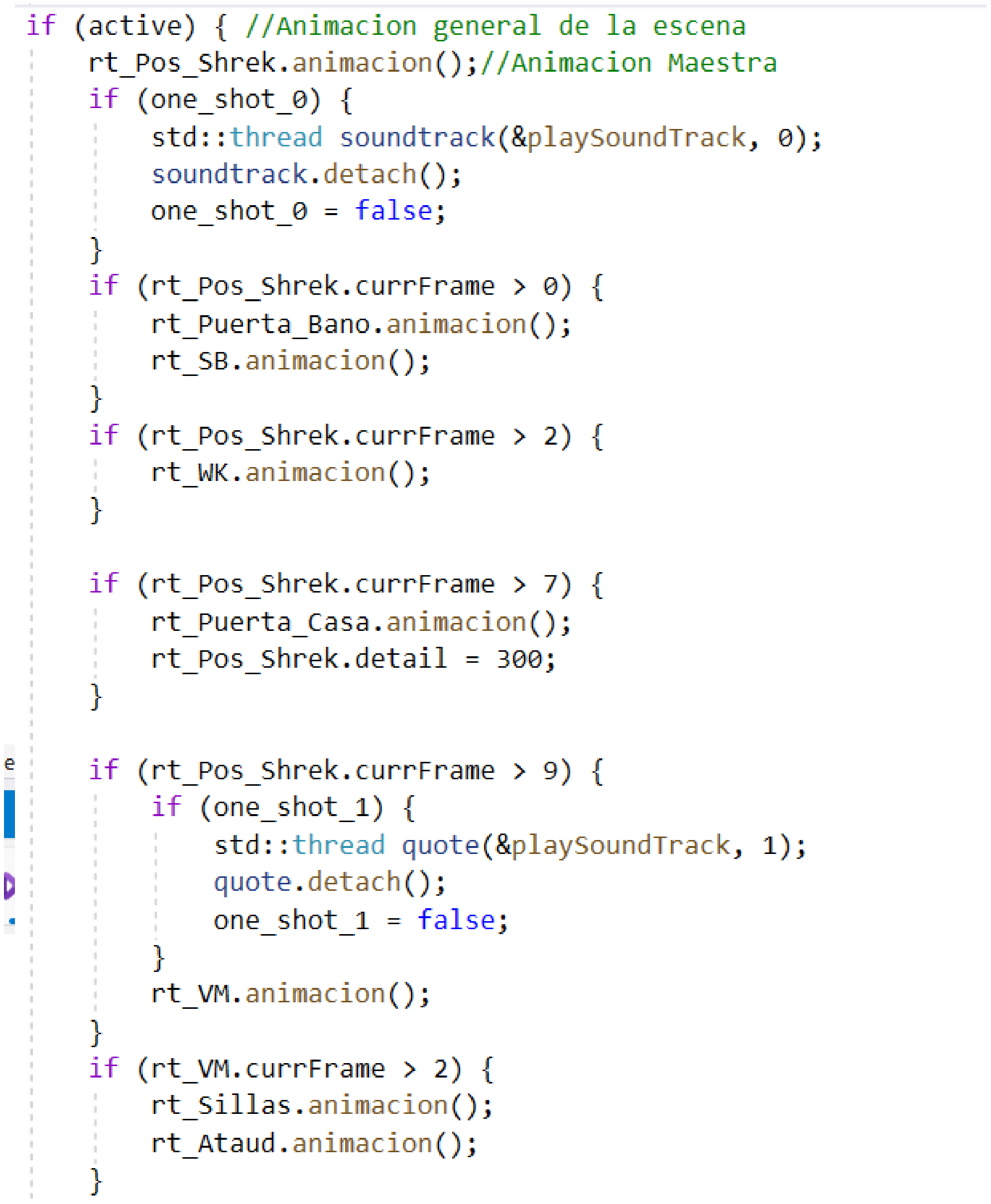
This is how the animation is handled (numerical values may vary, tweaks are still being made), you have a flag set with the "F" key turning True, the master animation will always run, it was decided to use the avatar positioning routine, specifically the frame in which you perform the action to trigger the other routines in the environment.



```
float random = 0.0f, deg = 0.025f;
float rot_limbs[10];
for (unsigned int i = 0; i < 10; i++)
    rot_limbs[i] = rt_SB.value[i];
```



```
// Game loop
while (!glfwWindowShouldClose(window)){
```

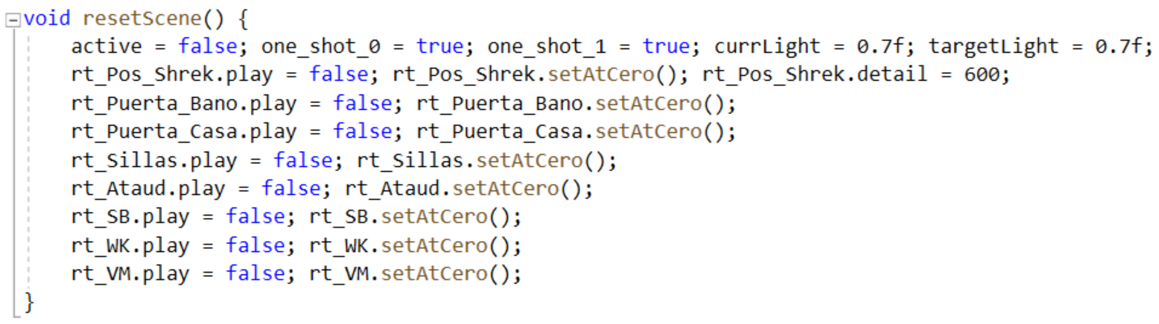


```
if (active) { //Animacion general de la escena
    rt_Pos_Shrek.animacion();//Animacion Maestra
    if (one_shot_0) {
        std::thread soundtrack(&playSoundTrack, 0);
        soundtrack.detach();
        one_shot_0 = false;
    }
    if (rt_Pos_Shrek.currFrame > 0) {
        rt_Puerta_Bano.animacion();
        rt_SB.animacion();
    }
    if (rt_Pos_Shrek.currFrame > 2) {
        rt_WK.animacion();
    }

    if (rt_Pos_Shrek.currFrame > 7) {
        rt_Puerta_Casa.animacion();
        rt_Pos_Shrek.detail = 300;
    }

    if (rt_Pos_Shrek.currFrame > 9) {
        if (one_shot_1) {
            std::thread quote(&playSoundTrack, 1);
            quote.detach();
            one_shot_1 = false;
        }
        rt_VM.animacion();
    }
    if (rt_VM.currFrame > 2) {
        rt_Sillas.animacion();
        rt_Ataud.animacion();
    }
```

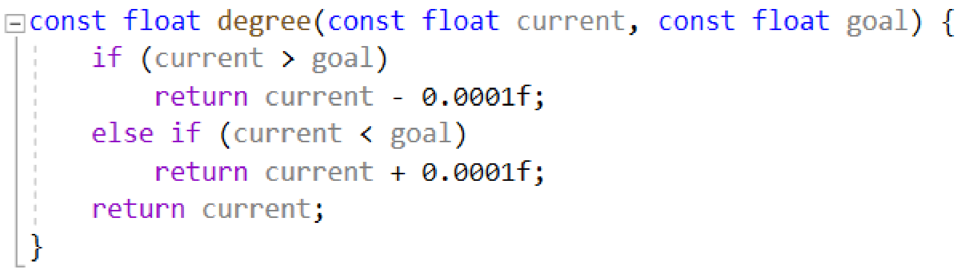
A sound library has been implemented, there is a function to run in parallel (OpenGL couldn't run otherwise) and a flag that only allows one execution at a time is used, in order to prevent conflicts with irrational thread handling. in the program.



```
void resetScene() {
    active = false; one_shot_0 = true; one_shot_1 = true; currLight = 0.7f; targetLight = 0.7f;
    rt_Pos_Shrek.play = false; rt_Pos_Shrek.setAtCero(); rt_Pos_Shrek.detail = 600;
    rt_Puerta_Bano.play = false; rt_Puerta_Bano.setAtCero();
    rt_Puerta_Casa.play = false; rt_Puerta_Casa.setAtCero();
    rt_Sillas.play = false; rt_Sillas.setAtCero();
    rt_Ataud.play = false; rt_Ataud.setAtCero();
    rt_SB.play = false; rt_SB.setAtCero();
    rt_WK.play = false; rt_WK.setAtCero();
    rt_VM.play = false; rt_VM.setAtCero();
}
```

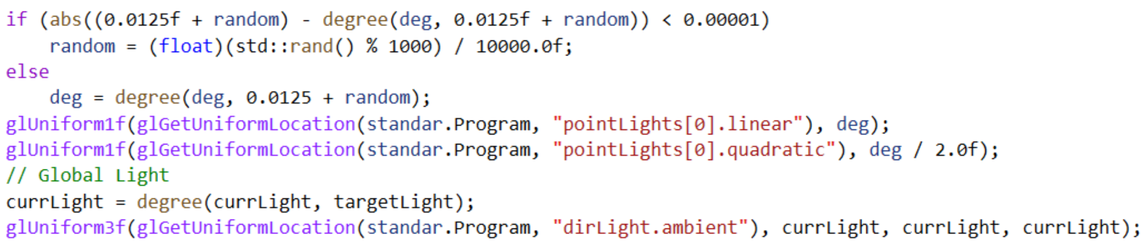
This procedure is made to reset the parameters to the initial value, there is no way to make this a general process due to the particular nature of each routine, such as some other details like the one_shot flags for the audio or lighting values.

WARNING: If the reset key is pressed and the scene audio continues to play, an overexposure effect may be created in the sound or the program may collapse. It is recommended to wait a couple of seconds after listening to absolutely nothing from the program .



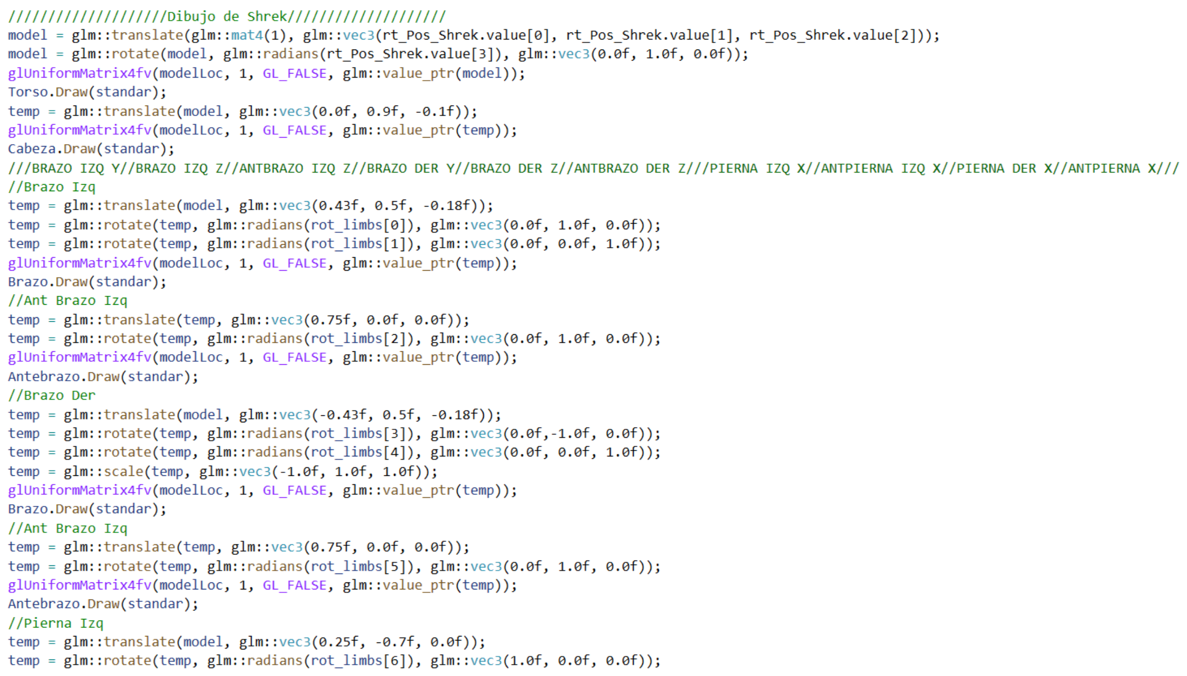
```
const float degree(const float current, const float goal) {
    if (current > goal)
        return current - 0.0001f;
    else if (current < goal)
        return current + 0.0001f;
    return current;
}
```

The degraded function is scheduled to go from a value A to another value B in a length of time. And stop (returning one of the values unchanged) when reaching the destination. These 2 functions are ideal for use in lighting, especially in firepit simulation.



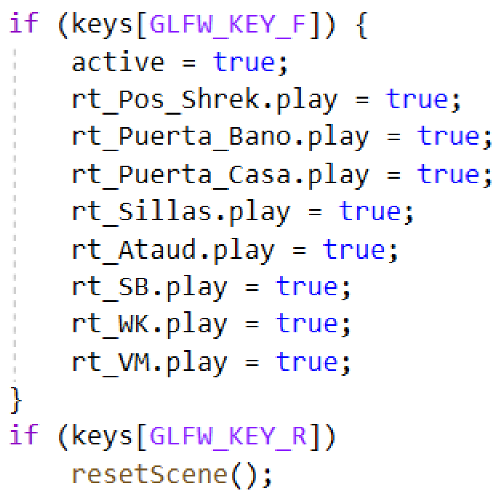
```
if (abs((0.0125f + random) - degree(deg, 0.0125f + random)) < 0.00001)
    random = (float)(std::rand() % 1000) / 10000.0f;
else
    deg = degree(deg, 0.0125 + random);
glUniform1f(glGetUniformLocation(standar.Program, "pointLights[0].linear"), deg);
glUniform1f(glGetUniformLocation(standar.Program, "pointLights[0].quadratic"), deg / 2.0f);
// Global Light
currLight = degree(currLight, targetLight);
glUniform3f(glGetUniformLocation(standar.Program, "dirLight.ambient"), currLight, currLight, currLight);
```

As we can see, we depend on a random value for the scope of the PointLight, to give a smooth finish to the effect, this range is made between 0.0125f as a minimum (maximum light) to a maximum of 0.1024f (minimum light). While the ambient light is subject to the events of the scene, it could perfectly well be subject to a routine like the other events, but it decided to do so because of its simplicity to implement.



```
///////////////////Dibujo de Shrek///////////////////
model = glm::translate(glm::mat4(1), glm::vec3(rt_Pos_Shrek.value[0], rt_Pos_Shrek.value[1], rt_Pos_Shrek.value[2]));
model = glm::rotate(model, glm::radians(rt_Pos_Shrek.value[3]), glm::vec3(0.0f, 1.0f, 0.0f));
glUniformMatrix4fv(modelLoc, 1, GL_FALSE, glm::value_ptr(model));
Torso.Draw(standar);
temp = glm::translate(model, glm::vec3(0.0f, 0.9f, -0.1f));
glUniformMatrix4fv(modelLoc, 1, GL_FALSE, glm::value_ptr(temp));
Cabeza.Draw(standar);
///BRAZO IZQ Y//BRAZO IZQ Z//ANTBRAZO IZQ Z//BRAZO DER Y//BRAZO DER Z//ANTBRAZO DER Z///PIERNA IZQ X//ANTPIERNA IZQ X//PIERNA DER X//ANTPIERNA X///
//Brazo Izq
temp = glm::translate(model, glm::vec3(0.43f, 0.5f, -0.18f));
temp = glm::rotate(temp, glm::radians(rot_limbs[0]), glm::vec3(0.0f, 1.0f, 0.0f));
temp = glm::rotate(temp, glm::radians(rot_limbs[1]), glm::vec3(0.0f, 0.0f, 1.0f));
glUniformMatrix4fv(modelLoc, 1, GL_FALSE, glm::value_ptr(temp));
Brazo.Draw(standar);
//Ant Brazo Izq
temp = glm::translate(temp, glm::vec3(0.75f, 0.0f, 0.0f));
temp = glm::rotate(temp, glm::radians(rot_limbs[2]), glm::vec3(0.0f, 1.0f, 0.0f));
glUniformMatrix4fv(modelLoc, 1, GL_FALSE, glm::value_ptr(temp));
Antebrazo.Draw(standar);
//Brazo Der
temp = glm::translate(model, glm::vec3(-0.43f, 0.5f, -0.18f));
temp = glm::rotate(temp, glm::radians(rot_limbs[3]), glm::vec3(0.0f,-1.0f, 0.0f));
temp = glm::rotate(temp, glm::radians(rot_limbs[4]), glm::vec3(0.0f, 0.0f, 1.0f));
temp = glm::scale(temp, glm::vec3(-1.0f, 1.0f, 1.0f));
glUniformMatrix4fv(modelLoc, 1, GL_FALSE, glm::value_ptr(temp));
Brazo.Draw(standar);
//Ant Brazo Izq
temp = glm::translate(temp, glm::vec3(0.75f, 0.0f, 0.0f));
temp = glm::rotate(temp, glm::radians(rot_limbs[5]), glm::vec3(0.0f, 1.0f, 0.0f));
glUniformMatrix4fv(modelLoc, 1, GL_FALSE, glm::value_ptr(temp));
Antebrazo.Draw(standar);
//Pierna Izq
temp = glm::translate(model, glm::vec3(0.25f, -0.7f, 0.0f));
temp = glm::rotate(temp, glm::radians(rot_limbs[6]), glm::vec3(1.0f, 0.0f, 0.0f));
```

Finally, its implementation in a hierarchical model in which the value of the corresponding subroutine is taken. On the other hand, the static elements such as the house, the sign or the bathroom are directly applied to the translation transformations to optimize resources. To help this practice, all models were scaled and oriented in their export.



```
if (keys[GLFW_KEY_F]) {
    active = true;
    rt_Pos_Shrek.play = true;
    rt_Puerta_Bano.play = true;
    rt_Puerta_Casa.play = true;
    rt_Sillas.play = true;
    rt_Ataud.play = true;
    rt_SB.play = true;
    rt_WK.play = true;
    rt_VM.play = true;
}
if (keys[GLFW_KEY_R])
    resetScene();
```

Animation Configuration

The control keys, only F for the playback of the animations and R for its restart were added.

Camera Configuration

The WASD keys correspond to the movement of the camera in the XY plane and the mouse controls the direction of view.

Bounds

As a second project, many obstacles to overcome and the paradigms that had to be followed to avoid the mistakes that led to the previous failure were known in advance. The vision had to be limited to an already known scenario, there was not enough time or experience to make an original environment, much less exceed the number of buildings or any additional requirements for interior decoration. Taking into account the restrictions such as The Simpsons or Kame House (Dragon Ball), the popular, well-known Shrek Swamp was chosen without asking for too many requirements.

As its elements and animations to present, a comedy approach was chosen as it is the best in which ugly models and poorly detailed movements can offer compared to professional products. The keyframe system was optimized to perform complex animations in a short time and even so we are limited by trial and error production, since we do not have a tool with which we can obtain the exact values with the real behavior of the models at each transformation. .

On the other hand, the audio library used only offers the option to play the audio but not to manage pause or cancel the routine.

Summary

The project has been built with each and every one of the tools taught throughout the course, being a relatively simple path due to the gradual construction of this virtual environment, there were minor inconveniences such as incorrect loading of the texture, the use of various shaders or difficulties as trivial but difficult to see as a minus sign or an incorrect assignment in a variable.

The modeling had to be less than a day's work, because I had to control the bad habit of wanting perfection in every detail, since it required a comprehensive job being a single member to do everything.