CS32310: ADVANCED COMPUTER GRAPHICS ASSIGNMENT
2016–2017 — SCENE MODELLING AND NAVIGATION

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Abstract: This report is an explanation on tools and techniques that has been used to create the scene and model rooms of the house.

Keywords: Computer Advanced Graphics, Mesh, Scene, House, Rooms, Interaction, Geometries, Light, Shadow, Objects, GUI

1 Introduction and Scene Modelling

For this assignment, my scene contains approach on creating a realistic environment that has been generated using techniques of computer graphics with the help of WebGL and ThreeJS package such as three.min.js, Detector.js, OrbitControls.js and dat.gui.min.js. These have helped me to model my scene by allowing me to create objects, shadows, lights, camera, controls and also a GUI to interact with the scene. My scene contains a sky and terrain, which represents the background, a house that presents the user with 4 rooms which are living room, kitchen, toilet and bedroom. Each of the rooms has different objects that suit the setting of the rooms to match the objects from the real world rooms. The scene contains lighting and shadows to give it realistic view when the user accesses the scene. The user can access the scene by opening the **Mal30_CS31310_Assignment.html** file and load it in the browser (works best with Mozilla Firefox) and can choose the camera navigation control. The interaction is mostly based on the GUI controls.

1.1 Mesh and Geometries

I have used MeshPhongMaterial for the materials in order to make them look bright and smooth, MeshLambertMaterial in order to make the material look more detailed without overdoing its shininess, MeshBasicMaterial to color the material without any light reflection over the object, MeshFaceMaterial to give material texture to each of the faces of the geometries and ParticleBasicMaterial in order to create material for the particles. I have used THREE.ImageUtils.loadTexture in order to map the texture to the geometries when creating the scene and have used scene.add() function to add the graphics to the scene. In order to model the 3D scene I have mostly used BoxGeometry, but also have used SphereGeometry, CircleGeometry, CylinderGeometry, ExtrudeGeometry and Torusgeometry.

2 Environment

2.1 Sky

For my scene I have used the SphereGeometry in order to create a sky and I have applied a texture to it to create realistic sky. I have used the scale.set(-1,1,1) function in order to make the sky be visible inside out so that the house is displayed with the sky and in order to balance the texture I have used it has been set to be half so that the sky texture is mapped equally on face of the sphere.

2.2 Terrain

For the terrain I have used PlaneGeometry in order to create the ground. I have used two grass textures and have mixed them to create a realistic ground using the help of map and bumpMap where one grass texture is mapped and other is applied as a bump to add more detail. I have repeated the texture to cover the size of the ground.

3 Lights and Shadows

3.1 Spotlight

I have used spotlight in order to give lights to the scene as well as make a realistic shadow for each of the object from their positions. Since the light is emitted in a cone shape I have specifically pointed this light towards the inside of the house in order to give more details of lights and shadows in the scene. I have also used this one of the source of the light in order to make the shadow inside objects stand out more.

3.2 Pointlight

I have used pointlight in order to make a light in the scene. I have focused this light towards the surrounding in order to add more light to the scene. This light emits lights in all direction of the scene to make it brighter and works similar to a light bulb spreading light across the room.

3.3 Directional light

I have used directional light in order to reflect the outside environment so the outside of the house has more directional lighting effect so that the shadow appears to be more natural like the light from the sun.

3.4 Ambient Light

I have used ambient light to make the scene appear natural and also give light to all of the objects within my scene. I have set the intensity of the ambient light to be bright enough and suitable for the scene so that it is not too bright or too dark and will also show the brightness of objects within the scene.

3.5 Shadow

I have used object.castShadow and object.receiveShadow to all of the objects/geometries within my scene in order for my scene to be able to cast shadow as well as receive shadow so that the objects have shadows when the lights passes through it like in the real world.

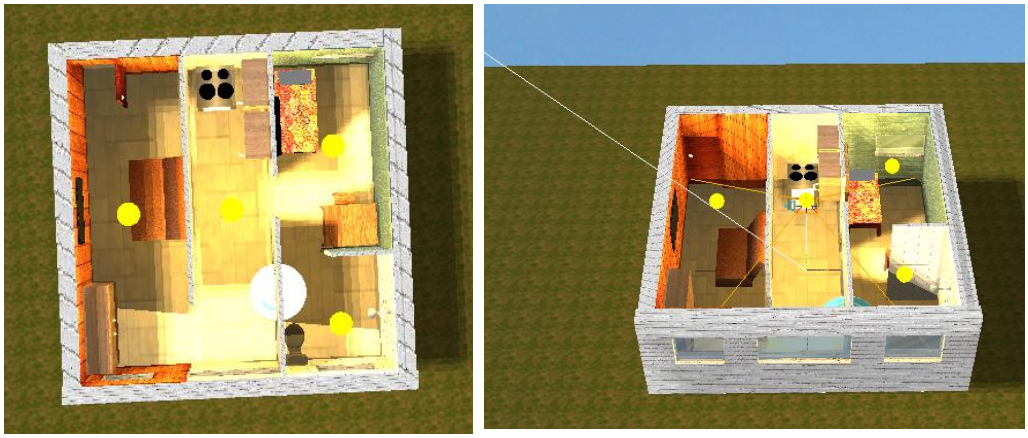


Figure 1 and Figure 2 showing the 4 different rooms inside the house and lighting effect inside the house from the pointlight represented as yellow dots (light bulb) with shadow from spotlight and directional light.

4 Modeling House

To build the shape of the house I have mostly used BoxGeometry and have set its thickness to my preference to give the wall a realistic approach. For the walls I have mostly used the same texture outside but in the inside due to having rooms with different wallpaper I have added the materials into an array for the Box Geometry to have different faces so that I could change the texture of the wall according to my needs. In order to cover up long walls such as the four big ones I have used box geometry to cover up the

part so that it has each of the room has matching wallpaper and not just random wallpaper. However, some wallpaper textures were too big and didn't match. I have managed to fix some by scaling it.

4.1 Roof

To create the roof, I have used triangleShape to create a 2d model of triangle and manipulated it with the help of ExtrudeGeometry in order to turn it into a 3d shape for my roof.

4.2 Living Room

For the living room I have a sofa, TV and a wardrobe. I have used BoxGeometry to create the sofa and the wardrobe and have applied correct texture to make them stand out and distinguish it. I have also used TorusKnot in order to create the handle and have used metal texture. I tried the clipping method to make the handle as half but wasn't able to do it as I found it too difficult so I have placed a full circle and positioned it to look like a handle. For the TV I have imported it through the object loader, which loaded the TV that was in json format. I have rescaled it and positioned it correctly according to the scene.

4.3 Toilet

The toilet contains objects that are related to it. It includes a toilet seat which was imported using the objectloader function from the three.js. The toilet seat had already been created in the json format where I just had to rescale and reposition it in the room. I have included shower where its head has been created by manipulating the coordinates of cylinderGeometry and also have used BoxGeometry to make the body of the showerhead and the valve. I have positioned them where they are suitable and also added metal texture in order to make it look realistic.

4.4 Bedroom

The Bedroom consists of usual objects that are related to it. It includes a bed which has been created using the BoxGeometry to create the legs, frame, mattress and pillow. In order to make the frame wood texture has been used for the bed and also fabric texture has been used for the mattress. Same application has been applied in order to create desk and a chair for the bedroom. It also consists of notice board using BoxGeometry and texture t. I have used the room idea from the assignment example from blackboard in order to create the chair, table and bed frame.

4.5 Kitchen

For the kitchen I have two cabinets, a stove and a sink. I have used BoxGeometry to create the kitchen cabinet and have used wood texture to make it appear like a real version. I have also used TorusKnot in order to create the handle and have used metal texture. I tried the clipping method to make the handle as half but wasn't able to do it as I found it too difficult so I have placed a full circle and positioned it to look like a handle. I have used the clone() function in order to create the same clone of the cabinet and have positioned it to the correct place. To create the stove I have used the BoxGeometry and have added metal texture to make it look like a real one and have used circleGeometry in order to create the top of the stove with black colour. For the front portion of the stove I have used BoxGeometry to create the glass and have added texture in order to make the stove have more detail.

4.6 Window

I have used BoxGeometry to create the window and have used a .png texture and also with the help of opacity which is set to 1 so the glass texture can be visible and also setting the transparent to true to make the glass transparent so that it appears realistic. Each of the rooms contains one window, most which has transparent affect where the user will be able to see the inside of the rooms from outside the house. In order to make the windows for the house I was trying to subtract the wall to create the wall however I thought creating a lot of BoxGeometry to create a square hole for the window was easier for me due to it being simple to use.

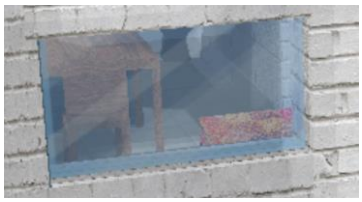


Figure 3 showing the transparency of the window.

4.7 Objects and Positioning

Most of the objects are created using the new THREE Object3d () function in order to group the parts of the object so that they are easier to translate and position within the scene which made it a lot easier as I didn't have to worry about moving each of the geometry that has been used to create the object when I wanted to position it within the

scene. I have also used the clone() function when needed in order to clone the shape/object when I needed it which made it a lot easier to work with since I didn't have to repeat the same process again and could just clone the geometry/shape and reposition it to the right place.

I have used the translate method (e.g. object.translateX ()) and also the position set (e.g. object.position.x = 0;) in order to position the object to its correct place in the scene. I have also use the rotate method in order to be able to rotate the objects. The most time consuming thing was to position each and every single shapes/object in the scene that has been used for this assignment as it took time to place them in their correct places.

5 Camera and Control

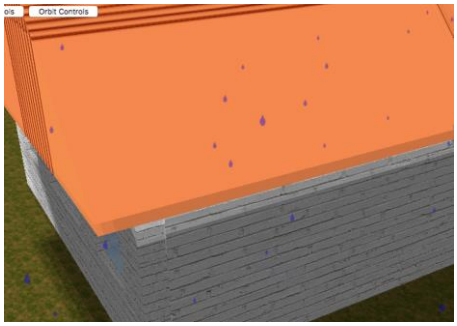
I have used perspective camera to give it a real effect as the human eye where if the camera moves far from the scene it will appear to be small and if the camera moves near the scene it be larger. In order to control the camera, I have used Orbit Controls to drag and move the scene and also zoom on the objects. I have used this control as I found it easiest one to work with and also will give the whole proportion view of the scene with the house. I have also used FirstPersonControls to give a first person view aspect of the scene although this control is slow and difficult to focus the camera with and it may not be perfect when using it. Therefore, user can select between either two, as there are buttons available for them.

Figure 4(Left) and Figure 5(Right) showing the use of orbit control on the left and use of first person control on the right

6 Particles, Animation and GUI Interaction

Using the help of the ParticleBasicMaterials I have created rain to be visible within the scene via GUI. The particles have been set to randomly create within the scene and in

order to animate the particles rotation has been applied to it with the speed of 0.1. However, there is a problem with the particle texture because when it passes through the windows the texture background can be seen visible and due to it being rotated it does not look natural when viewed from far away and there is no collision detection so the particles tend to reach inside of the house. I have used dat.gui.min.js in order to create the GUI so that my scene can be interactive when using it i.e. particles can be added to the scene or the house roof can be removed. The GUI can be used to toggle things on and off within the scene and changes could be seen right away (like lighting and roof). I have also used GUI to animate the door using the checkbox the door closes and opens.



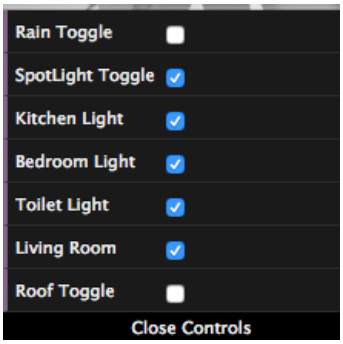


Figure 6(Left) and Figure 7(Right) showing the rain particles and the GUI control interface of the modeled scene.

7 Issues

There were some overall issues when doing the assignment. When trying to test the scene it loaded very slow, had delays and also affected the computer to be slower when rendering the scene. This had a negative impact when working on the assignment since it was time consuming where I had to wait for couple of minutes each time when trying to see the changes I had made to the scene. Sometimes the graphics didn't work properly when loading so I had to refresh my browser often due to it not displaying the graphics. When I tried to open my scene in on chrome the graphics didn't render and the page was blank and I believe it is due to cache issue. I tried using other browser such as safari and Firefox where the graphics loaded perfectly fine. Some of the applied texture either looks big or small as it is not scaled properly within the scene. I couldn't fix it since I didn't have enough time to scale all of the texture correctly. Also the texture looks to be problematic due to it creating patterns where it might be problem due to the lights. I have also got problem with the GUI resizing where if the GUI is resized or closed then it would follow the mouse. It may be due to the problem with the camera, I have tried fixing it with the help of implementing render.domElement to the cameras but the orbit control had the same problem and the camera followed the mouse.

8 Conclusion

Overall I believe that this assignment has helped me to understand how to model graphics using the WebGL and ThreeJS tool. I have learnt how to model objects using geometries and shapes. I enjoyed working on this assignment as it was enjoyable. Even though some things don't work properly I was still able to create a graphics that can be rendered and loaded in a browser which I am satisfied about. I think some things were positive when modelling the scene i.e. casting of the shadow, lighting in the scene, adding the terrain. If I had time to improve I would overall improve the layout of my house and make things spacious and bigger to view and also easier to work with and improve my texture scaling so that it is balanced when displayed in the scene I would improve the camera functionality to give more walkthrough feeling when entering the scene and I would also improve upon casting the lights to make the light appear more natural and also make some use of good smooth animation using the three.js libraries. I would also apply collision detection in order to show the interference between objects.

9 References

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