

CMP203 Coursework Report

Study Room

Student Name: Arjun Bhatnagar

1904516

Git Username: arjun01bhatnagar

Introduction

This OpenGL application is a scene/room which is loosely based on my room which I study in. The reason for me choosing this room was because I wanted to replicate something from real life and which was close to my memory as well. This made it more challenging for me as I wanted to replicate everything perfectly. This helped me to keep going and making everything as close to real life as it could be. The scene uses user created geometry, stencil buffer, multiple light sources (which can be controlled by the user), textures and it uses model loading. The scene makes use of hierarchical modelling. The application has a Camera class which can be traversed on every 3d axis and can be fixed inside the room to give an inside view of the room. The application also has the provision of enabling and disabling the wireframe mode.

Why I chose my study room as the focus of my project:

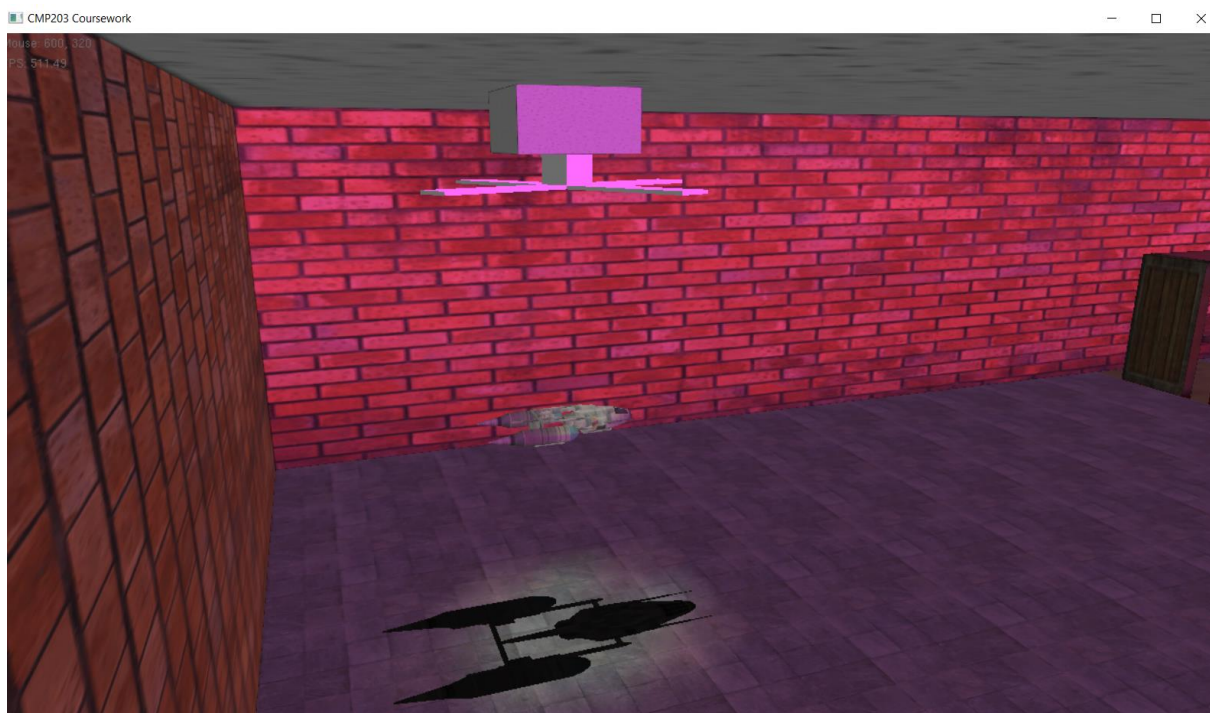
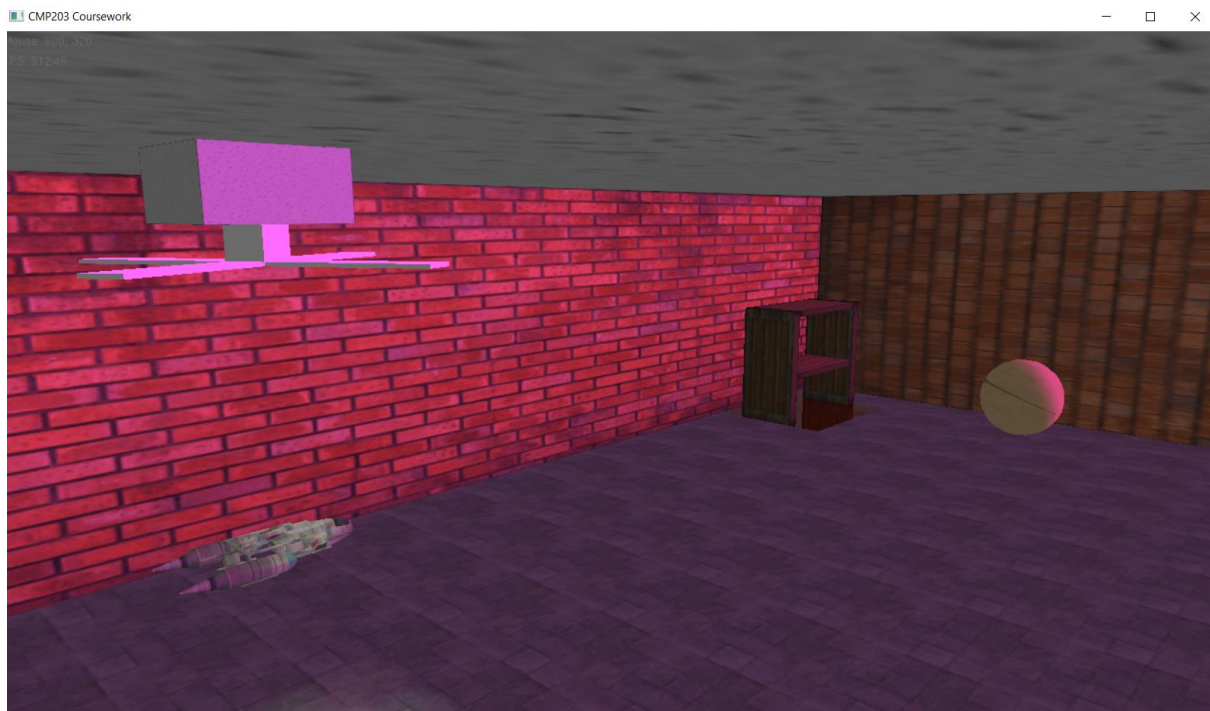
The reasons why I chose my study room as the project are as follows:

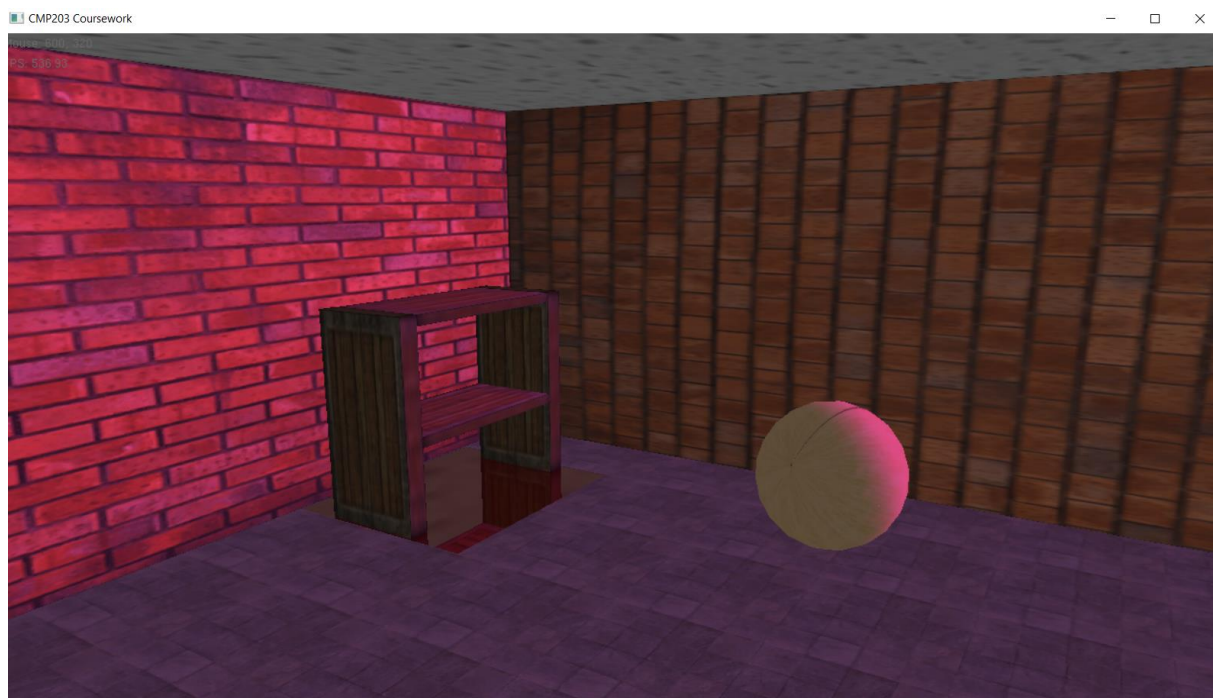
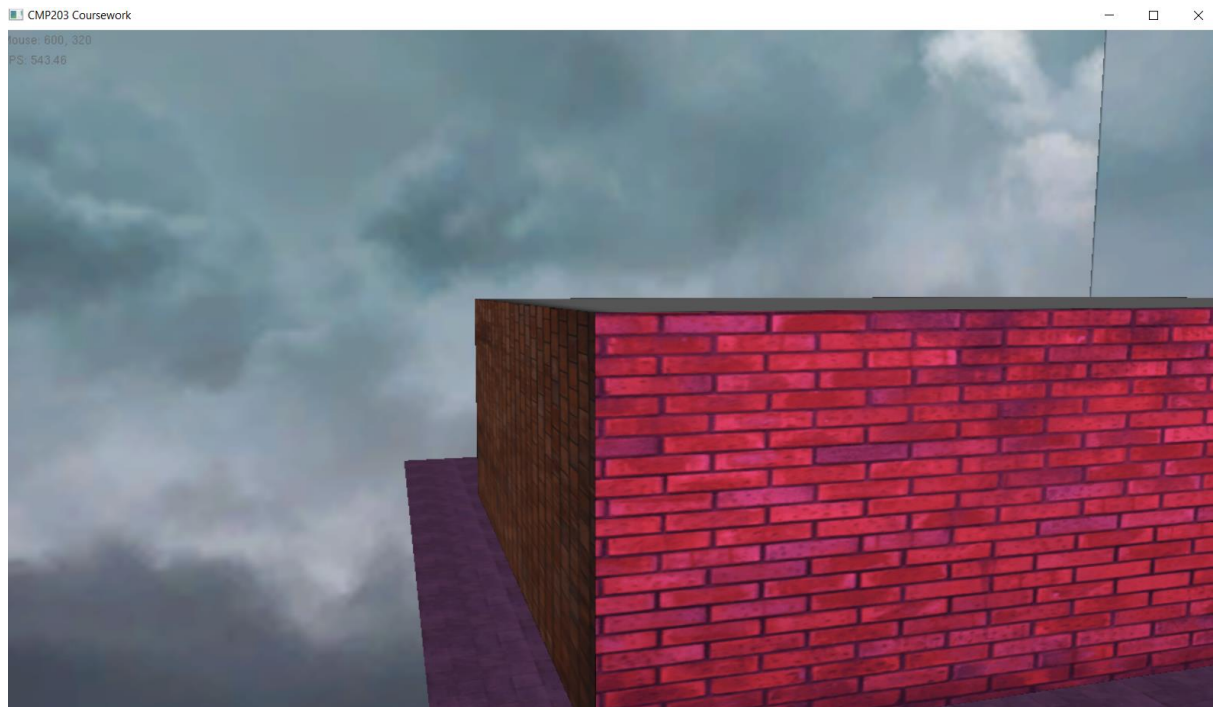
- My room had had a lot of features which could help me complete almost every task provided in the coursework brief.
- I didn't have any ambiguity of how I wanted my project to end up like as I had a reference of my room from the beginning which didn't let me waste my time deciding as to what to replicate for the OpenGL application.
- If something is personal and embedded in your memory from your childhood, you tend to work harder towards replicating it as close to real life as possible. This helped me to fine tune the project even more and keep going on even when I encountered any major problem.

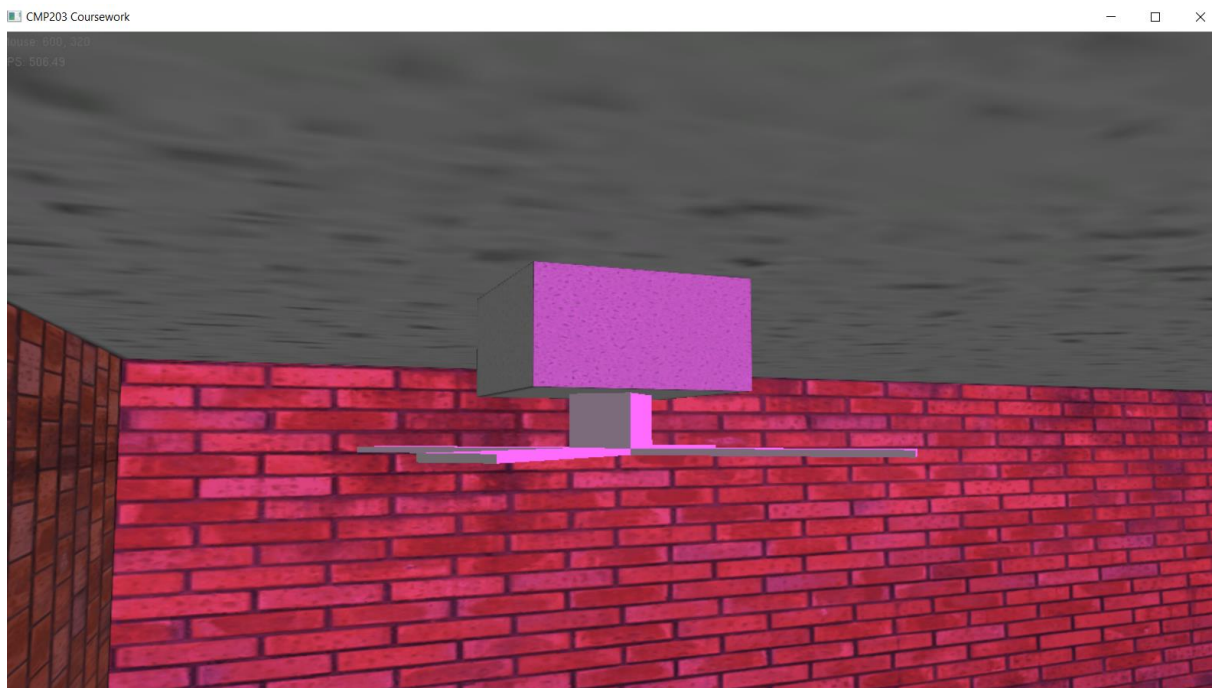
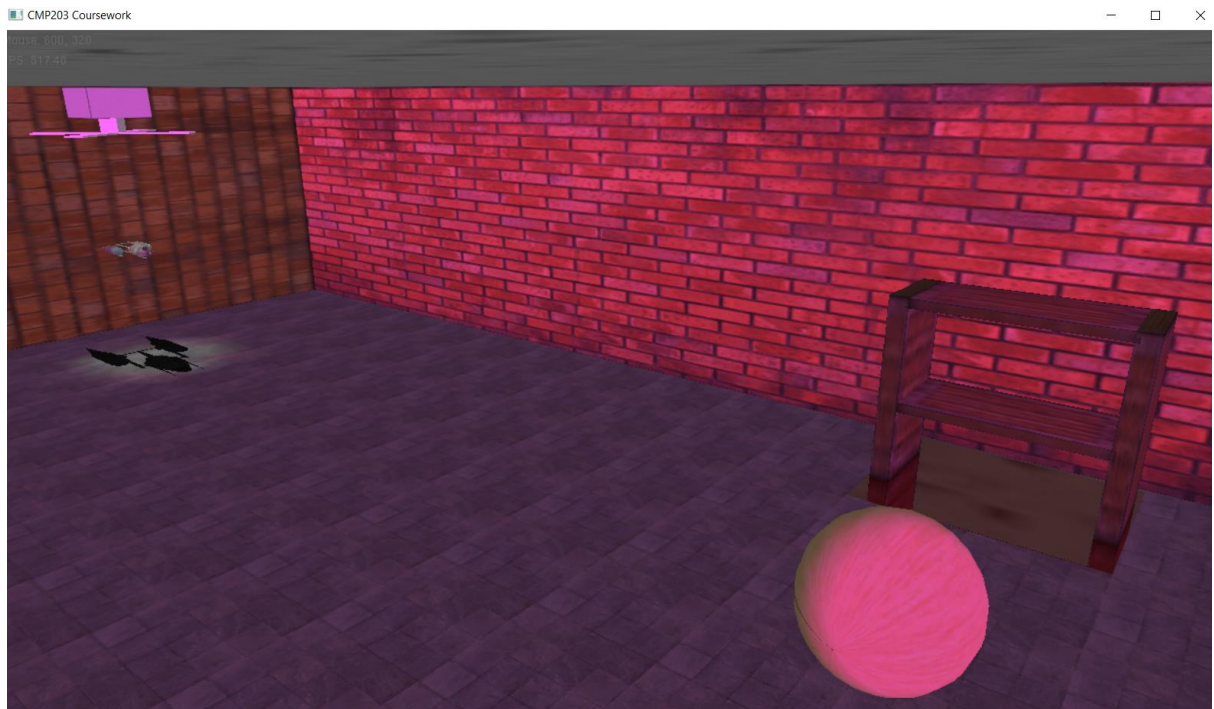
Controls

1. W-Move forward
2. S-Move backward
3. A-Traverse in the left direction
4. D-Traverse in the right direction
5. H-Enable Wireframe mode
6. J-Disable Wireframe mode
7. P-Turn spotlight off
8. O-Turn spotlight on
9. Z-Locking the camera position inside the room
10. X-Unlocking the camera to roam freely again

Screenshots









Scene explanation

The scene is made with a few classes, but the main emphasis is on 3 classes mainly the Primitives class, the ObjectHandler class. The classes mentioned above help in easy use of shapes by scaling, translating and rotating by use of hierarchical modelling which helps in manipulating the primitives in any way shape or form as I desire. The third-class integral to the working of this application is the scene class. The scene class handles almost everything about what will go on in the scene when the application is run.

This OpenGL application displays almost everything required by the coursework:

- The scene contains user created geometry in the form of cubes, cuboids and sphere where each vertex and normal is defined for perfect texturing and shading of the geometry as mentioned in the brief.
- The scene contains the use of primitives which are procedurally generated and use the correct lighting and texture. For example: The cubes made in the primitives class are then used to make a fan and a bookshelf by using them multiple times by giving them appropriate shape and structure.
- There are two light sources in the scene which help in lighting up the room in different ways:
 1. The spotlight: The spotlight is positioned in the room just below the fan which is then bounced off the plane/floor of the room. The spotlight is yellow in colour and can be toggled on and off by using 'O' and 'P' on the keyboard respectively.
 2. The directional light: This light is near the top corner/vertex of the room which gives the whole room a slight magenta tone because the light is magenta in colour

- The spotlight is user controllable and both the lights blend to give colour to the room.
- The scene contains a working camera class. The camera is made to move around anywhere the user wants to by using the WASD controls and change the camera angle using the mouse.
- The camera can be put in a static state by using the key 'Z' and changed back to a free roam state by using the key 'X'.
- The scene has used hierarchical modelling in rendering different elements of the scene. The matrix stack has helped in transforming the shapes used properly so that it looks like a room. The scene contains a bookshelf made up of cuboids with a wooden texture on them. The scene also uses the sphere function to render a sphere with a wooden texture on it as well which is different from the bookshelf. The drawcube function is also helping in making the fan which has its blades rotating around a smaller cube.
- The scene demonstrates the use of model loading and generating a shadow. The model loaded inside the scene is that of a spaceship which is placed under the spotlight on the fan. The spotlight is pointing down in the negative Y-axis which casts the planar shadow of the spaceship onto the floor/plane of the scene.
- The scene also makes use of the stencil buffer which is placed under the bookshelf. The stencil buffer helps in making a mirror which then reflects the bookshelf and the ceiling above giving an idea of using the stencil buffer. The mirror also gives us a good idea of transparency underneath the room.
- The application uses the buttons 'H' and 'J' to help the user to enable and disable the wireframe mode according to the user's choice.
- The application has made use of classes, some of the important ones are:
 1. Camera: The camera class defines the camera which helps to move around the scene.
 2. Light: The light class is where the lights are defined. It has the spotlight and the directional light which are inside the room.
 3. Model: The model class helps in loading a model from the models provided to us. Also, it helps us loading the texture onto the model which is rendered inside the scene.
 4. ObjectHandler: The ObjectHandler class helps in giving form to the primitives made in the Primitives class so that they can be rendered onto the scene properly.
 5. Primitives: The primitives class is used to define the shapes like quads, cubes and spheres to make them available for use in the scene. The primitives class also has the function to render a cube which is then used to make the skybox with textures.
 6. Shadow: The shadow class is used to render the planar shadow of the model which is under the spotlight. The function receives the given model and flattens it against the floor.
 7. Skybox: The skybox class helps in covering the camera with a giant cube like structure which then translates the camera to the middle of the cube making it look like we are in a floating space.

Conclusion

In the end, I would like to say I learnt a lot about programming in OpenGL and the lectures and the lab slides helped a lot in clearing my doubts at certain points in the project. I learnt how to debug the code by looking at the code again and again which made me realize to comment out some code which was working fine and then looking at the piece of code which was causing the error. Every instance when the code was added and caused an error, I used the above-mentioned method to debug the program. This helped me almost all the time. This made me realize the importance of hierarchical transformation and rendering the different aspects of my scene in the correct order. I was having trouble with the skybox textures and realized the problem was not mapping the texture properly, I had to comment out every face of the cube to find out what was causing the error. I wish I would have a better knowledge on how to implement the shadows as I was having some trouble regarding the shadow of the model which I loaded in the scene. Another bug encountered by me was not lighting up the floor of my room correctly. This made me realize the importance of normal and their direction. At first, I was only using a quad made up of 4 vertices which didn't implement the spotlight properly, upon learning more about it I had to generate a plane of more quads using a loop. Overall, I learnt to be a better programmer and learn the basics of OpenGL and C++.

Things I would like to change

Overall, the project met almost all my expectations but there is still room for improvement. I needed to learn more about vertex arrays and implementing them properly. This would help me a big deal as they can be used to make different types of models and shapes. Also, I would have liked to improve on my implementation of shadows in my scene. I would like to work more and practice coding more so that I can use all the features and data structures as efficiently as I can.