CSE 4208: Computer Graphics Laboratory
3D Apartment Design with Dynamic Objects

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Contents

1 Objectives

- To create a visually appealing 3D model of an apartment, incorporating realistic dimensions, textures, and materials to simulate a lifelike environment.
- To incorporate animated and movable objects such as doors, windows, and furniture to demonstrate real-time changes within the apartment.
- To integrate advanced lighting models, including ambient, diffuse, and specular lighting, to enhance realism and provide adjustable lighting conditions.
- To optimize the rendering process using techniques such as shading (Phong, Gouraud) ensure smooth performance and realistic visuals.
- To allow users to navigate through the apartment using features like free-form camera control.

2 Introduction

The 3D Apartment Design project leverages computer graphics techniques to create an immersive and interactive visualization of a modern apartment. The project incorporates advanced lighting models, efficient rendering techniques, and dynamic object management to simulate a lifelike experience. Users can interact with movable objects, adjust lighting conditions, and navigate the apartment using a user-friendly interface. This project aims to provide a comprehensive platform for visualizing interior designs.

3 Object Demonstration

3.1 Front View

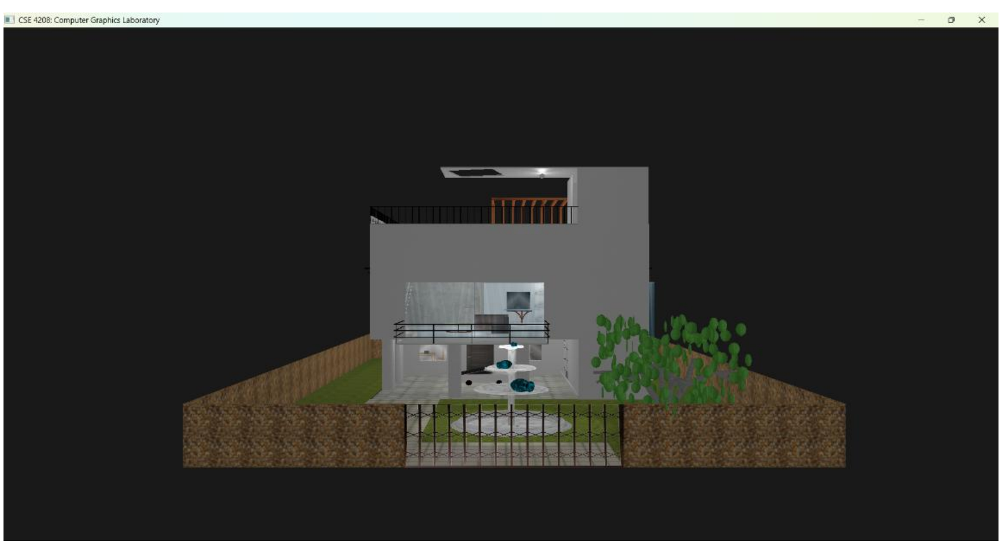

Figure 1: Scene View

This scene shows the front view with lighting on.

3.2 Fountain

Figure 2: Fountain Made using BezierCurve

The Fountain is made with Bezier Curve. The center pillar is a cylinder. There are three pitchers pointing in different direction.

3.3 Tree

Figure 3: Tree Made using BezierCurve

I have given bark texture to the tree to bring realistic vibe. The branches are designed separately. I have created a circle shape and scaled it to make leaf and given leaf texture.

3.4 Car

Figure 4: Movable Car

This is a moveable car. It can go straight as well as take turns.

3.5 Basin

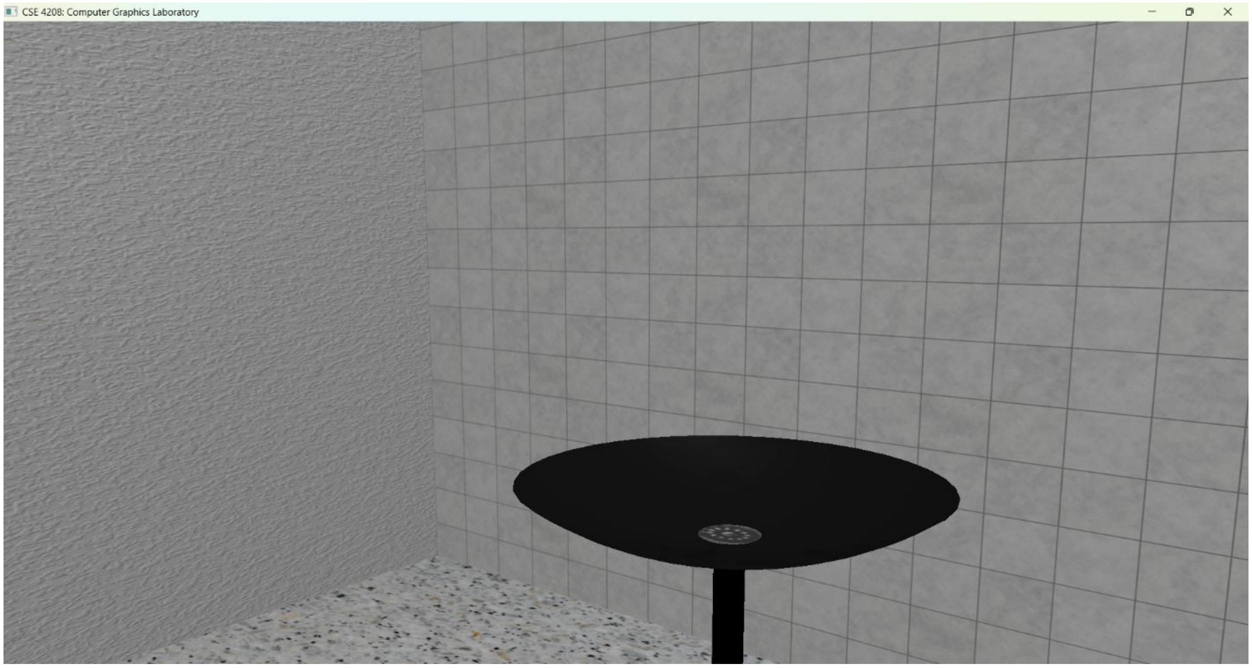

Figure 5: Complex Shape Basin

3.6 Door and Window

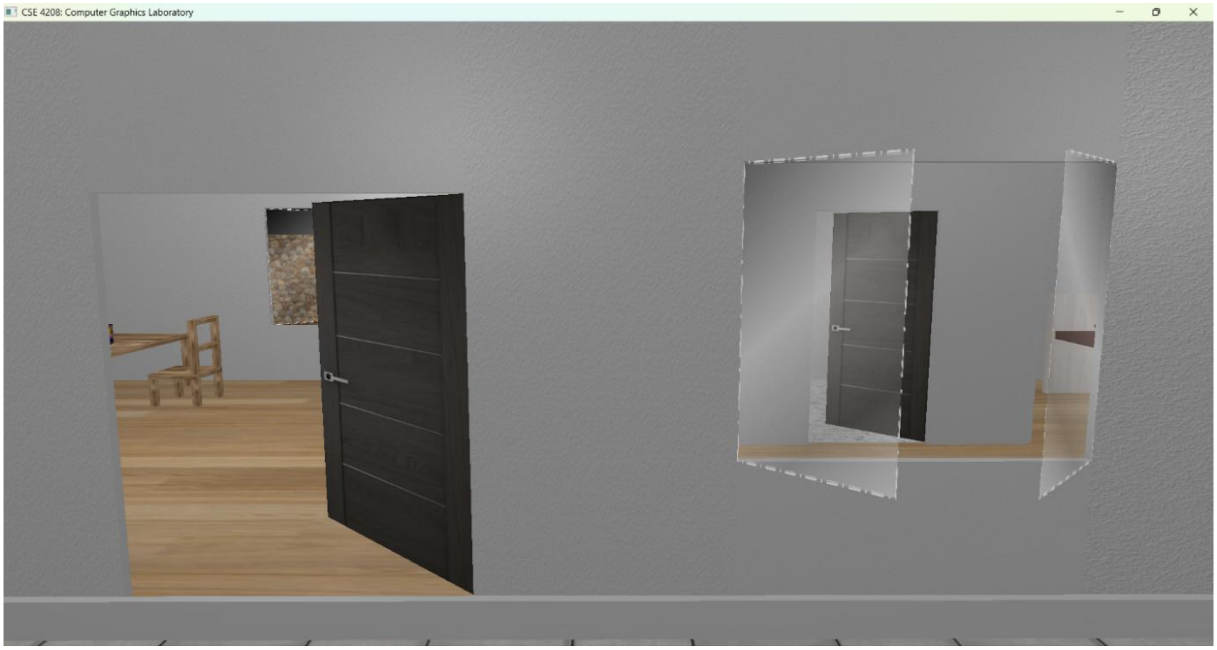

Figure 6: Movable Door and Window

3.7 Collapsible Gate

Figure 7: Made using the Blending Method of OpenGL

Theory Behind Blending Method:

Blending in OpenGL refers to the process of combining the color of a source pixel (the pixel to be drawn) with the color of a destination pixel (the pixel already present in the framebuffer). This technique is widely used to create effects like transparency, anti-aliasing, and realistic lighting.

To bring the vibe of real collapsible gate ,I am scaling the glass from 1 to 0 and 0 to 1 on button press.

3.8 Stair Railing

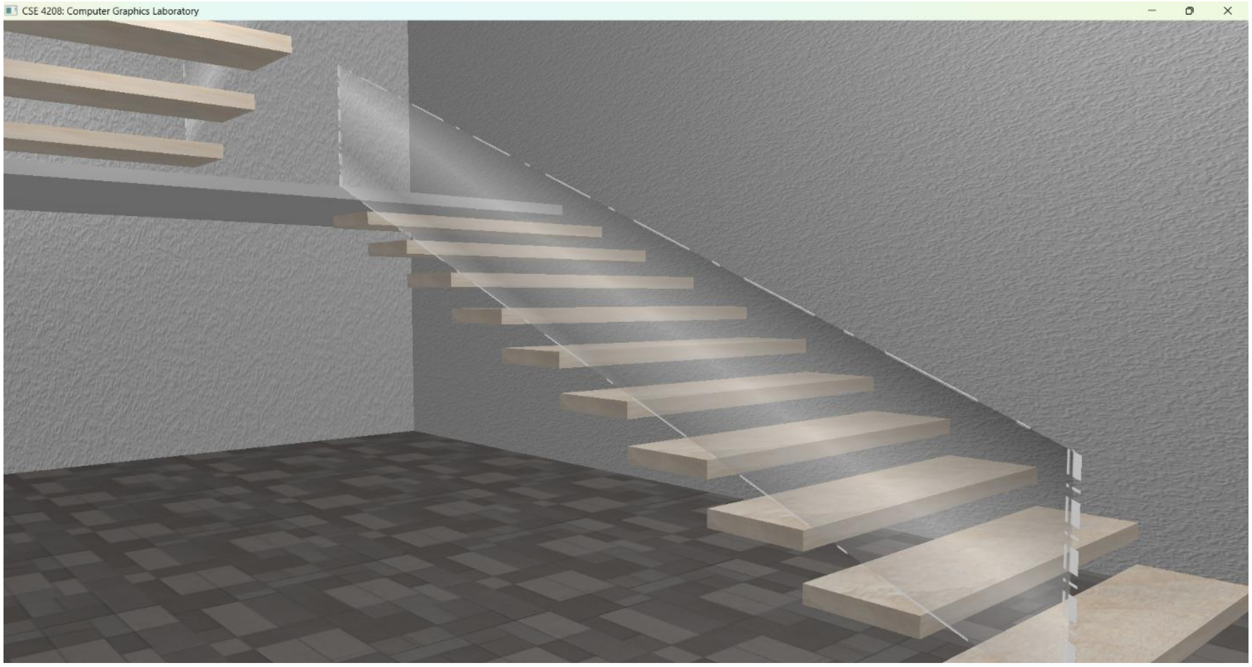

Figure 8: Made using the Blending Method of OpenGL and Performed Shearing

3.9 Transparent Lift

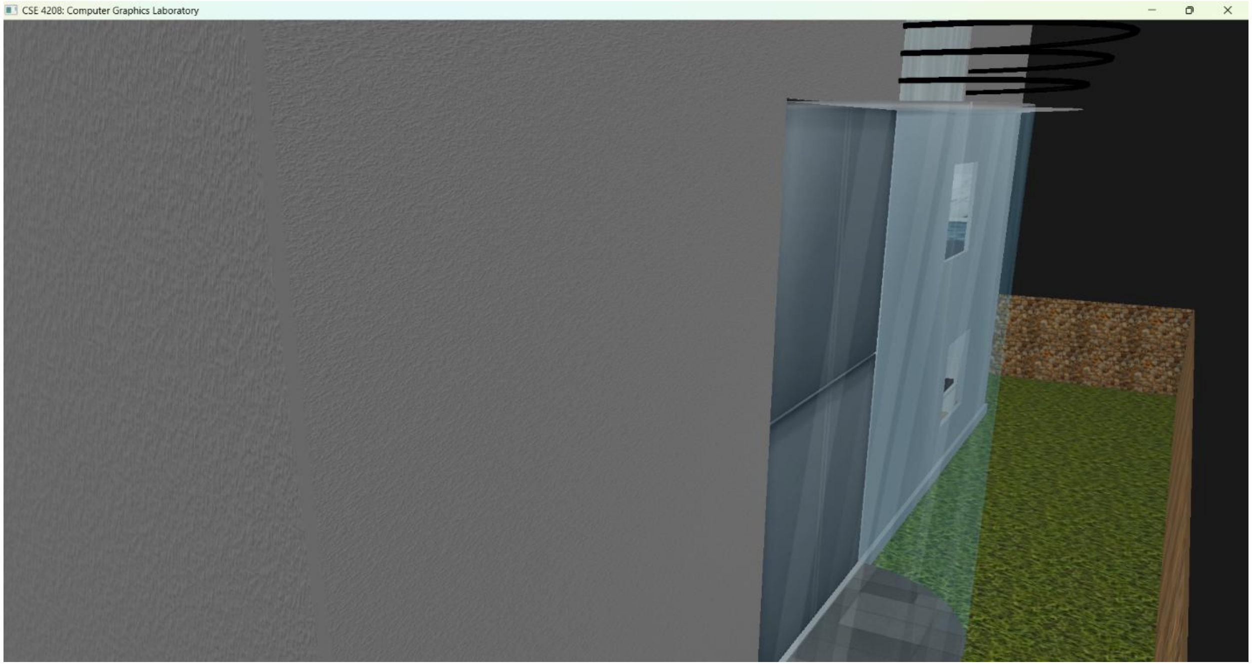

Figure 9: Made using the Blending Method of OpenGL

3.10 Lift Door

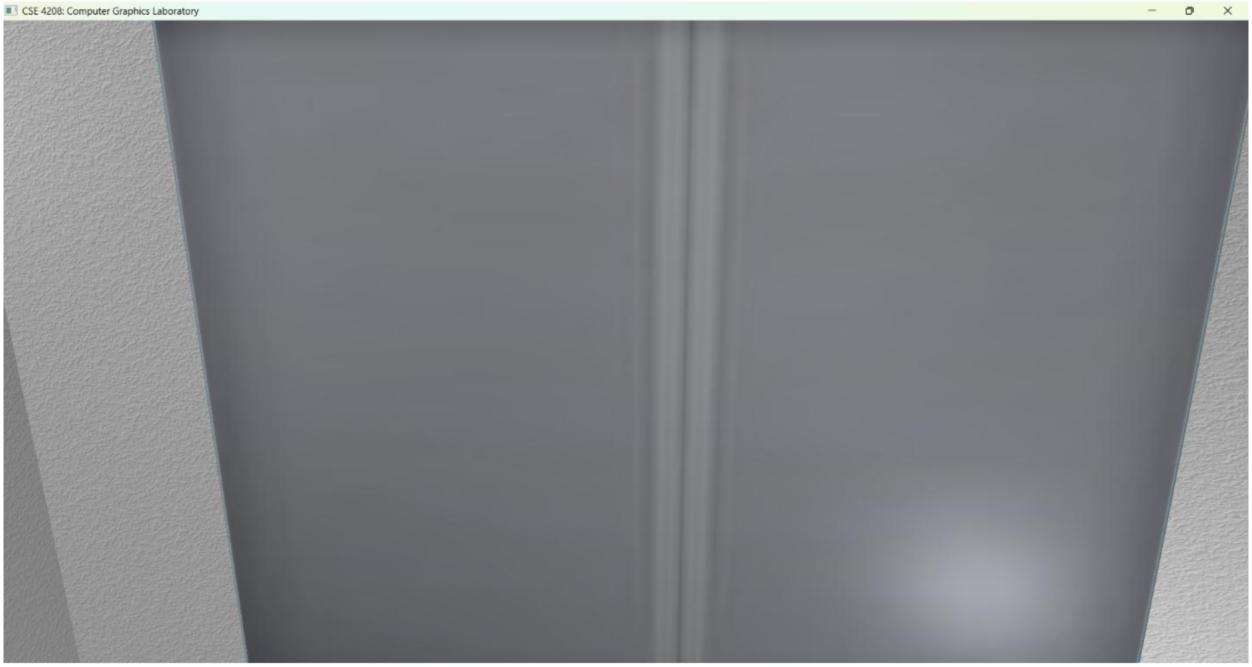

Figure 10: Movable Lift Door

3.11 Wall Clock

Figure 11: Made using the Blending Method of OpenGL and Implemented Real Clock Mechanism

The clock is synchronized with the system and the angle for the second, minute and hour dial is calculated from the value retrieved from the system.

3.12 Tea Table

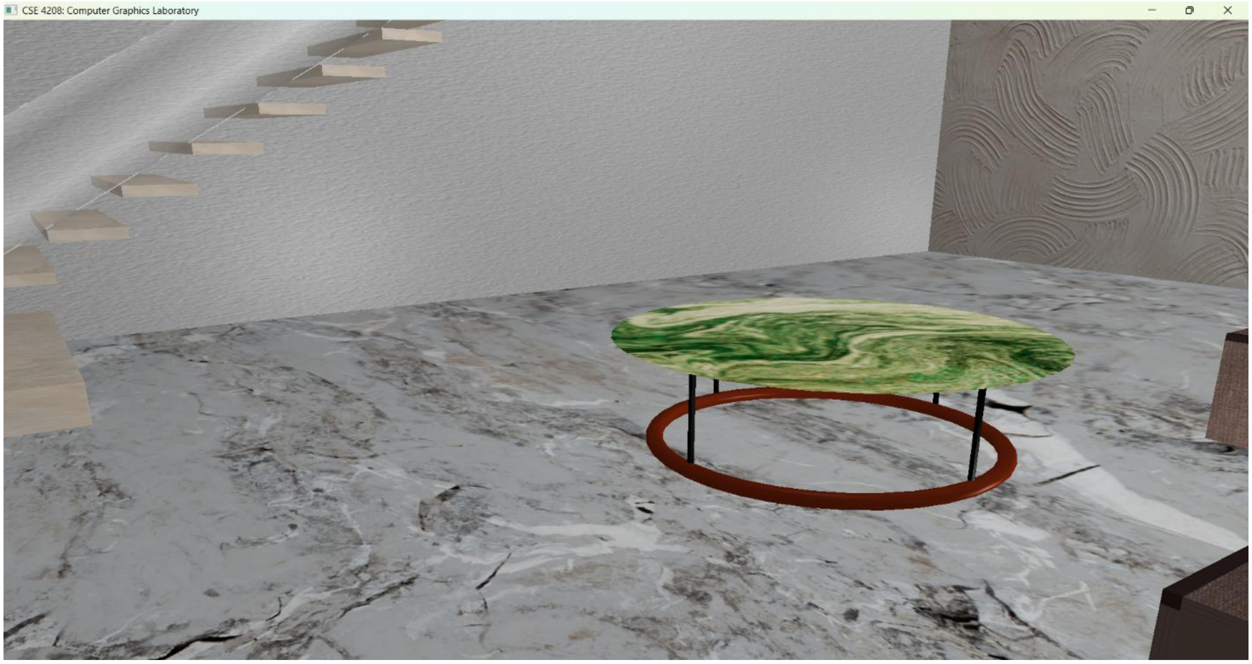

Figure 12: Complex Shape Tea Table

3.13 Dinning Table

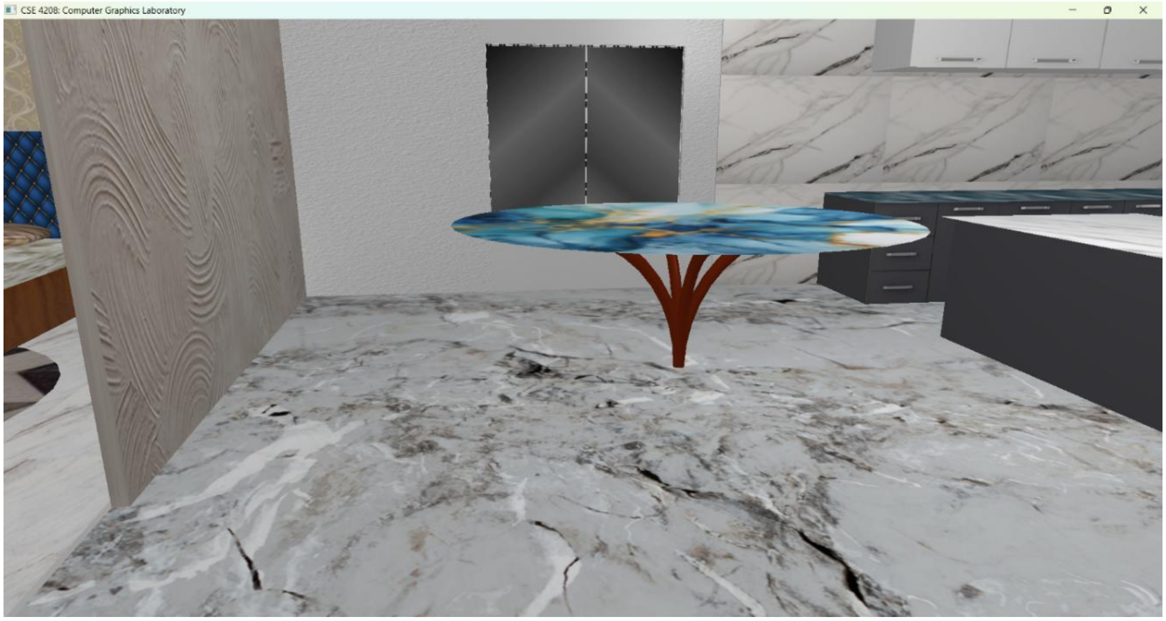

Figure 13: Complex Shape Dinning

One fourth of torus shape is used to make the legs of the table, and above them is a circle shape with texture.

3.14 Freeze

Figure 14: Moving Door Freeze

3.15 Fan

Figure 15: Rotating Fan

The wings of the fan is made by squeezing the circle shape and the fan rotates when specific key is pressed.

3.16 Veranda

Figure 16: Made using the Blending Method of OpenGL

3.17 Kitchen

Figure 17: Overview of Kitchen

3.18 Guest Room

Figure 18: Used Cylinder to give Pillow like feel

3.19 chandelier and Railing

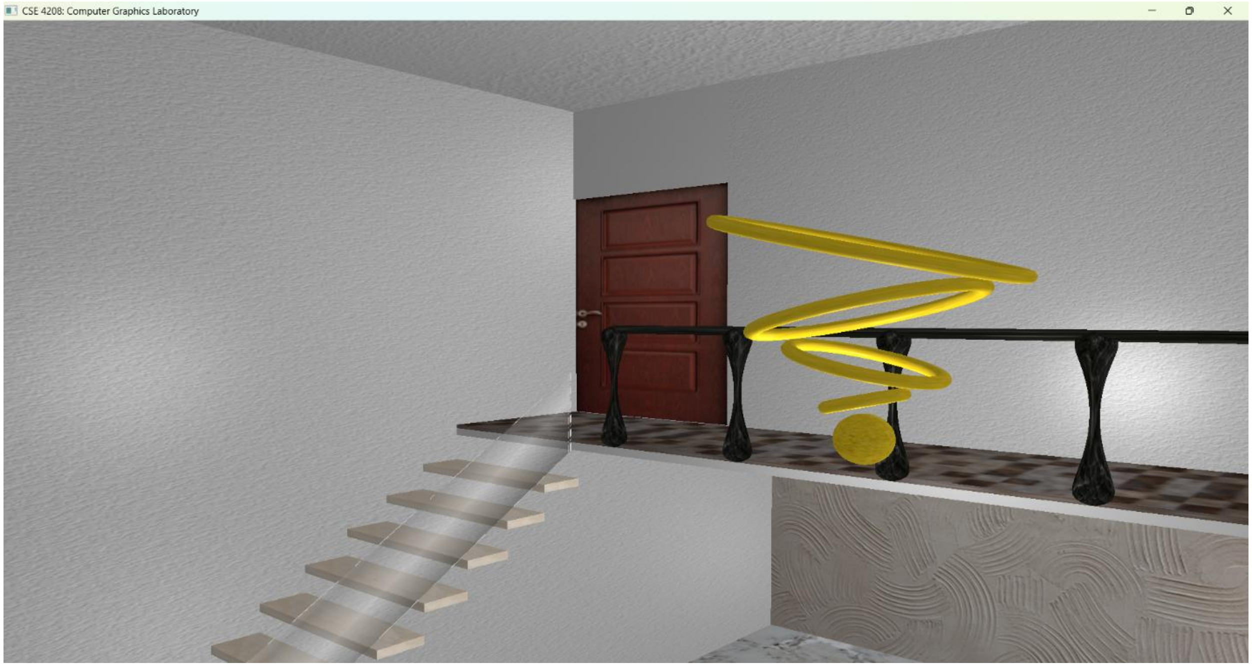

Figure 19: Complex Object

The chandelier is made with torus shape and pillars of the railing are made with Bezier Curve.

3.20 Complex Veranda

Figure 20: Complex Veranda

3.21 Mirror

Figure 21: Mirror

Theory Behind Mirror:

Mirror rendering in OpenGL simulates the behavior of a reflective surface by capturing the scene from a mirrored perspective and mapping it onto the mirror's surface. This involves several key steps:

3.21.1 Framebuffer Rendering:

The scene is rendered from the perspective of a virtual mirrored camera into an offscreen framebuffer. This framebuffer stores the reflected scene as a texture.

3.21.2 Mirror Position and Orientation:

The mirror is defined by its position and normal vector in world space. These parameters determine the mirror's location and the direction it reflects light.

3.21.3 Mirrored Camera Calculation:

The position and orientation of the camera are reflected relative to the mirror plane. The reflected position and direction are computed mathematically to create the illusion of viewing the scene from behind the mirror.

3.21.4 View and Projection Transformations:

The mirrored view matrix simulates the camera's perspective from the reflected position. Combined with a perspective projection matrix, this ensures the rendered reflection has accurate proportions.

3.21.5 Texture Mapping:

The texture containing the reflected scene is mapped onto a quad representing the mirror's surface. This creates the appearance of a reflection on the mirror plane.

3.21.6 Model-View-Projection (MVP) Matrix:

Transformations are applied to position, rotate, and scale the mirror surface in the scene. The MVP matrix ensures the reflection texture aligns correctly with the mirror's orientation and size.

3.22 Bathroom Object

Figure 22: Complex Object

3.23 Roof View

Figure 23: Roof of the Building

3.24 Swing

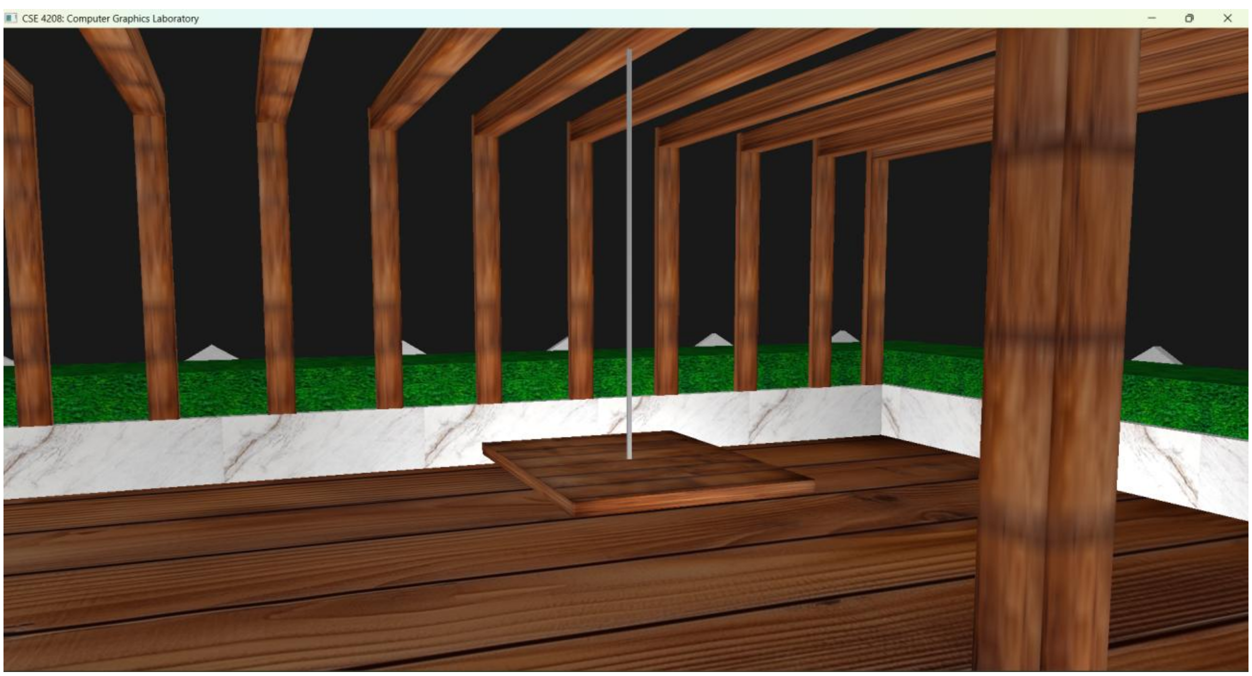

Figure 24: Movable Swing

I have tried to implement real physics for the swing motion. The button pressed the speed of the swing will slowly increase and the speed will also slowly decrease when button pressed.

4 Key Functionality

- Directional Light ON/OFF – 1
- Point Light ON/OFF – 2
- Spotlight ON/OFF – 3
- Swing – 4
- Camera Down – Q
- Camera Up - E
- Camera Forward - W
- Camera Backward - S
- Camera Left - A
- Camera Right – D
- Yaw – Y, U
- Pitch – I, K
- Roll – J, L
- Car Move – G
- Door/Window/Freeze door (ON/OFF) – F
- Fan Move – 5
- Lift Move – 6
- Lower Lift Door/Sliding Glass – 7
- Upper Lift Door – 8
- Collapsible Gate/Main Gate - 9

5 Lighting and Texturing

I have used point lights, directional lights, and a spotlight for the light. I have also used the Phong shading method for color calculations. I have also applied the texture to complex objects and Bezier Curve.

6 Conclusion

In conclusion, the 3D Apartment Design project successfully demonstrates the application of computer graphics in creating a dynamic and interactive virtual environment. By integrating realistic 3D modeling, efficient rendering techniques, and interactive features such as customizable furniture and lighting, the project offers a comprehensive tool for visualizing apartment designs. The user can seamlessly navigate enhancing the overall design experience. This project highlights the potential of computer graphics in design, enabling users to make informed decisions and explore various design possibilities before making real-world changes. It serves as an effective platform for design visualization and interaction.

7 References

[1] learn OpenGL (https://learnopengl.com)

[2] Provided in the classroom