Objectives

- To design and render a realistic 3D beauty salon.
- To implement objects of various shapes, including curved and textured objects.
- To apply appropriate lighting techniques for enhanced realism.
- To create dynamic elements that exhibit animations.
- To utilize fractals to replicate natural patterns like trees and other repetitive structures.

Introduction

The "Beauty Salon" project is a 3D graphics application that simulates the interior of a modern salon using OpenGL. It demonstrates advanced concepts in 3D modeling, texturing, lighting, and animation. The project incorporates various geometric primitives such as cubes, cones, cylinders, spheres, and Bézier curves, alongside dynamic animations and fractal patterns, to create a vibrant and visually engaging virtual space. This project highlights technical artistry while meeting the objectives of realistic rendering and dynamic interactivity.

Object Modeling

Object modeling forms the foundation of the "Beauty Salon" project. By using geometric primitives and advanced modeling techniques, the project creates a detailed, realistic virtual environment. Below is an expanded description of the components and techniques used:

Geometric Primitives

1. **Cubes:** Cubes are the primary building blocks for the salon's structural elements. They were used for walls, floors, furniture, and decorative items. Walls and floors were scaled and textured with high-resolution images such as wooden panels and tiled surfaces to create realistic interiors. Cupboards and tables were constructed by combining and transforming multiple cubes to form intricate shapes with drawers and shelves.

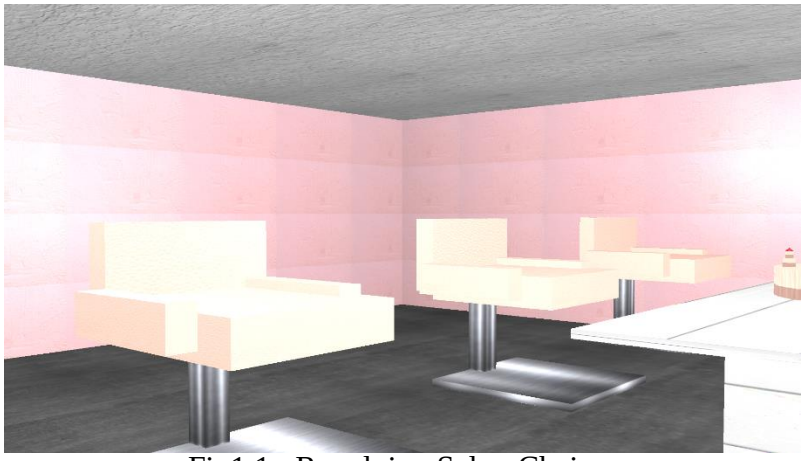

Fig1.1 : Revolving Salon Chair

Fig1.2 : Cupboard

Fig1.3 : Dressing Mirror

Fig1.4 : Waiting room sofa and tea table

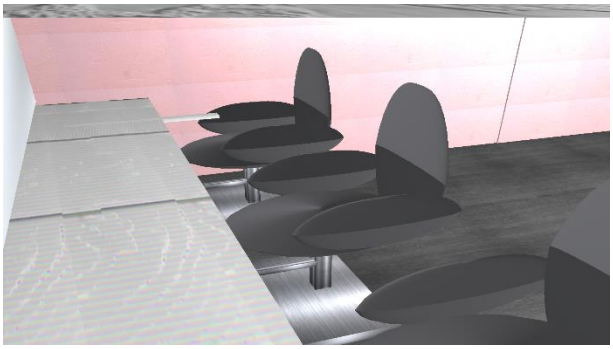

Fig1.5 : Dressing table

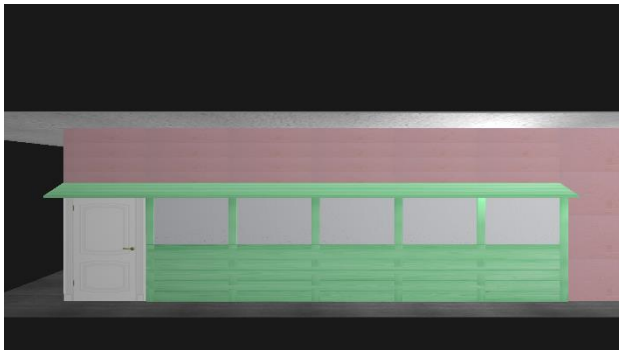

Fig1.6 : Door and entrance interior

2. **Cones:** Cones were used to model objects like makeup sponges and the tips of lipsticks. Makeup sponges were modeled with smooth shading to mimic their soft and curved surfaces. Realistic sponge textures were applied to enhance their appearance. The lipstick tip was created by combining a cone with a cylinder base, and vibrant textures were mapped to give a polished cosmetic look.

Fig1.7 : Makeup sponge using cone

Fig1.8 : Tip of the lipstick using cone

3. **Cylinders:** Cylinders were employed to create platforms, bases, and other cylindrical objects, adding variety to the scene. Dressing platforms featured a rotating cylinder to showcase items like lipsticks. Textures such as marble and polished wood were used for the platform's surface. Cylindrical objects were also used in structural designs, such as the base of the chandelier.

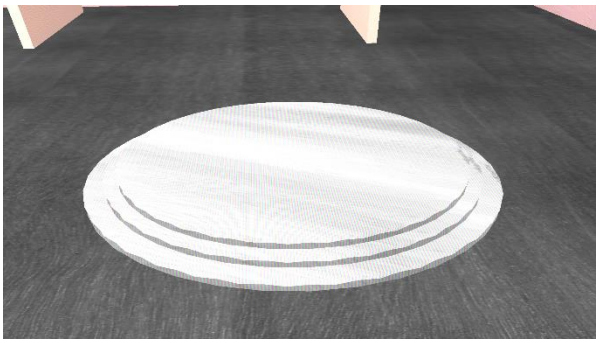

Fig1.9 : Cylindrical dressing platform

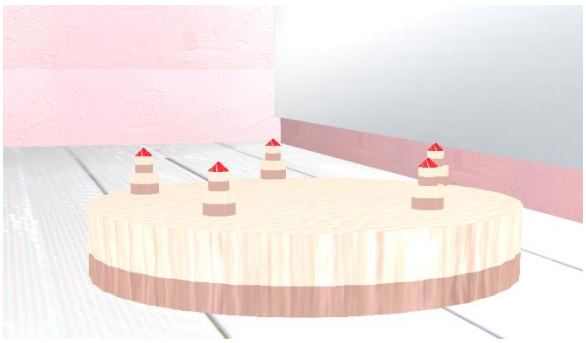

Fig1.10 : Rotating lipstick platform

4. **Spheres:** Spheres were primarily used for decorative elements, such as chandeliers. The chandelier design incorporated spheres with reflective and polished textures to create a glowing effect when illuminated. The lighting properties further enhanced its appearance, making it a focal point of the scene.

Fig1.11 : Rotating chandelier

5. **Bézier Curves:** Bézier curves were employed to create smooth, freeform surfaces for curved objects like salon chairs and stools.The curves were calculated using mathematical control points, ensuring precision in the modeling process. Salon chairs featured ergonomic designs, and textures such as leather were applied to replicate luxurious seating. The stool in the dressing room used a combination of Bézier curves and texture mapping to provide a realistic, polished look.

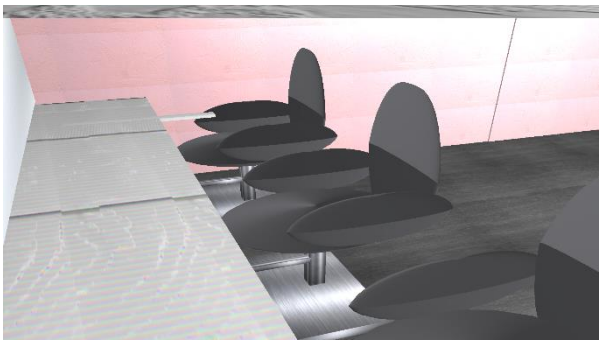

Fig1.12 : Curvy Salon chair

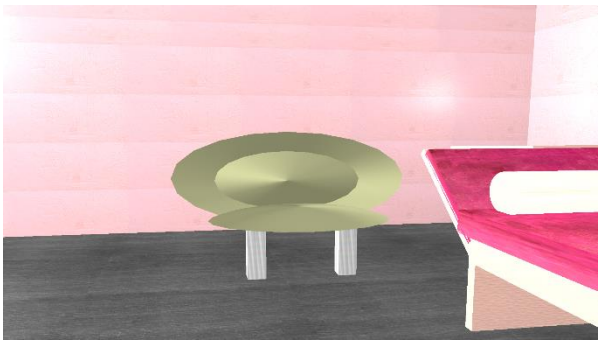

Fig1.13 : Dressing room stool

6. **Fractals:** Fractals were implemented to model natural objects, specifically an indoor cactus tree. Recursive algorithms generated smaller branches, mimicking the growth pattern of a real cactus. Green and brown textures were applied to the cactus for realism. The fractal approach allowed the creation of a visually appealing and detailed object with minimal manual modeling.

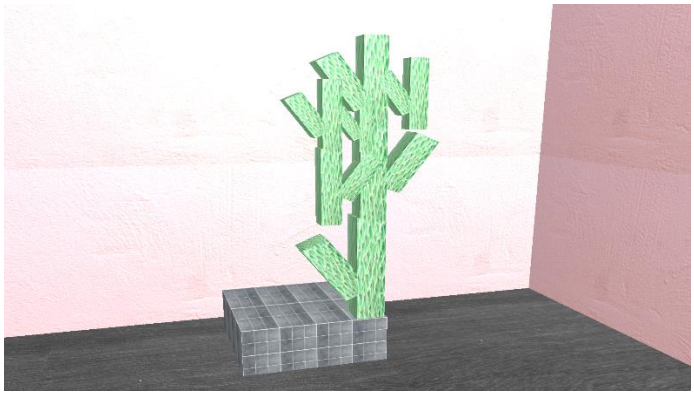

Fig1.14 : Indoor cactus

Lighting Types

1. **Point Lights:**
    - **Implementation:**
        - Four point lights are strategically positioned in key areas:
            - **Waiting Room:** Positioned near the ceiling above the sofa and tea table to provide general illumination.
            - **Makeup Room:** Placed near mirrors to highlight the dressing area and objects like makeup sponges and lipsticks.
        - Each light is adjusted with specific intensity and attenuation values to simulate the natural falloff of light.

- **Impact on the Scene:**
  - In the waiting room, the point light softly illuminates the furniture and the cactus tree, ensuring even lighting without overexposure.
  - In the makeup room, reflections on the mirrors and glossy surfaces, such as lipstick tips, enhance realism.

2. **Spotlights:**
   - **Implementation:**

     Side Table: A narrow spotlight highlights small decorative objects, drawing attention to intricate textures.

   - **Impact on the Scene:**
     - The spotlight on the dressing table creates a focal point, making the area stand out. Shadows cast by the objects add depth to the scene.

Dynamic Elements

Dynamic elements add liveliness and interactivity to the "Beauty Salon" project. By incorporating moving parts, rotations, and transformations, the scene becomes more engaging and realistic. Below are the practical details of these dynamic elements:

1. Moving Parts

- **Doors:**
  - **Implementation:**
    - The entrance door can open and close dynamically, simulating a functional aspect of the salon.
    - A transformation matrix with translation along the X-axis was used to animate the door's motion.
    - The door's movement is controlled by user-defined variables, allowing it to slide open or close smoothly.
  - **Visual Results:**
    - The texture of the door (e.g., wood grain or painted surface) remains aligned during motion, ensuring a consistent look.
    - Shadows cast by the door change dynamically, adding to the realism.

Fig 1.15 : Door opens

- **Drawers:**
  - **Implementation:**
    - Drawers in tables are animated using translation transformations along their respective axes.
    - The drawers slide in and out smoothly, simulating real-world functionality.
    - The objects in the door is lifted up with keyboard instruction.
  - **Visual Results:**
    - The detailed wooden textures on the drawers enhance their appearance as they move.
    - Subtle specular highlights shift with the lighting, emphasizing the movement.

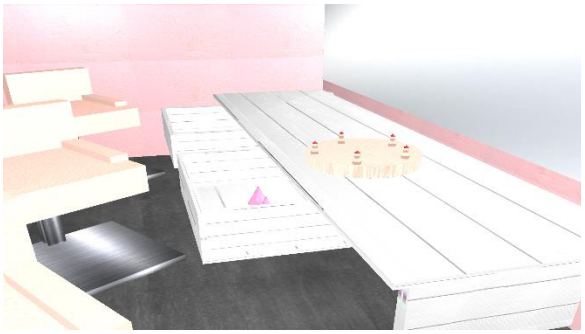

Fig 1.16 : Drawer opens

Fig 1.17 : Object floating

2. Revolving Platforms and Chandelier

- **Lipstick Platform:**
  - **Implementation:**
    - The lipstick platform revolves continuously around its central axis.
    - A rotation matrix is applied with the Y-axis as the pivot point.
    - The rotation speed is adjustable, controlled by a time-dependent variable (deltaTime), ensuring smooth and consistent motion.
  - **Visual Results:**
    - Lipstick objects placed on the platform maintain their position relative to the platform while the entire setup rotates.
    - Specular highlights on the lipsticks change dynamically, creating a polished and eye-catching effect.

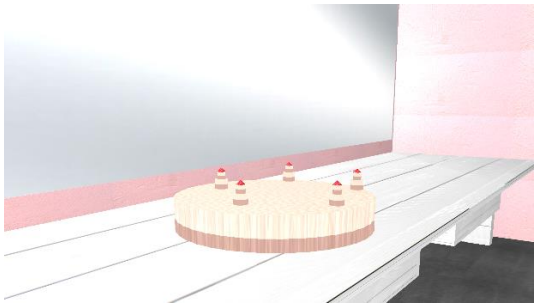

Fig 1.18 : Lipstick Rotating Stand

- **Chandelier:**
  - **Implementation:**
    - The chandelier rotates slowly, creating a subtle sense of movement in the room.
    - Similar to the lipstick platform, a rotation matrix with the Y-axis as the pivot point drives the motion.
    - Multiple light sources interact with the chandelier, producing dynamic shadows and highlights.
  - **Visual Results:**
    - The chandelier's metallic texture reflects light dynamically as it rotates, adding sophistication to the scene.
    - The rotation creates soft, moving shadows on surrounding walls and objects, enhancing the salon's ambiance.

Fig 1.19 : Rotating Chandelier

3. Tilting Chairs

- **Salon Chairs:**
  - **Implementation:**
    - Chairs are designed to tilt backward for a realistic seating experience.
    - A rotation matrix with the X-axis as the pivot is applied to simulate the tilting motion.
    - The tilt angle is adjustable through user-defined parameters, making the interaction customizable.
  - **Visual Results:**
    - The leather textures on the chairs respond to lighting changes as the chair tilts, highlighting the contours and seams.
    - Shadows cast by the chairs shift dynamically, adding depth and realism.

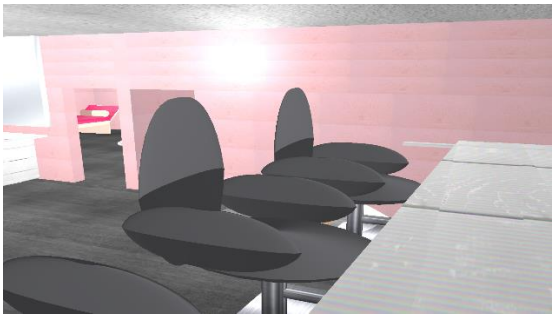

Fig 1.20 : Chair before tilt

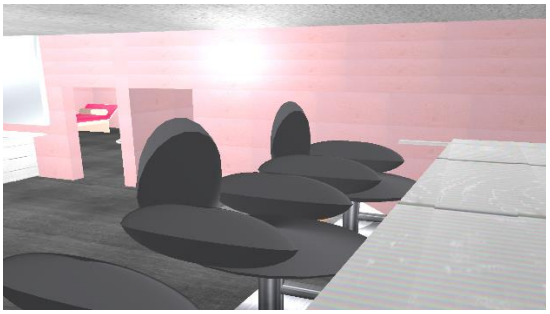

Fig 1.21 : Chair after tilting backwards.

- **Revolving Chairs:**
  - **Implementation:**
    - Chairs can also rotate around their vertical axis, simulating swiveling motions.
    - A combination of rotation and translation matrices ensures smooth movement while maintaining the chair's position.
  - **Visual Results:**
    - The rotation of the chair is highlighted by changing reflections on its polished metallic or leather components.
    - Shadows and light reflections shift dynamically, adding to the interactive feel.

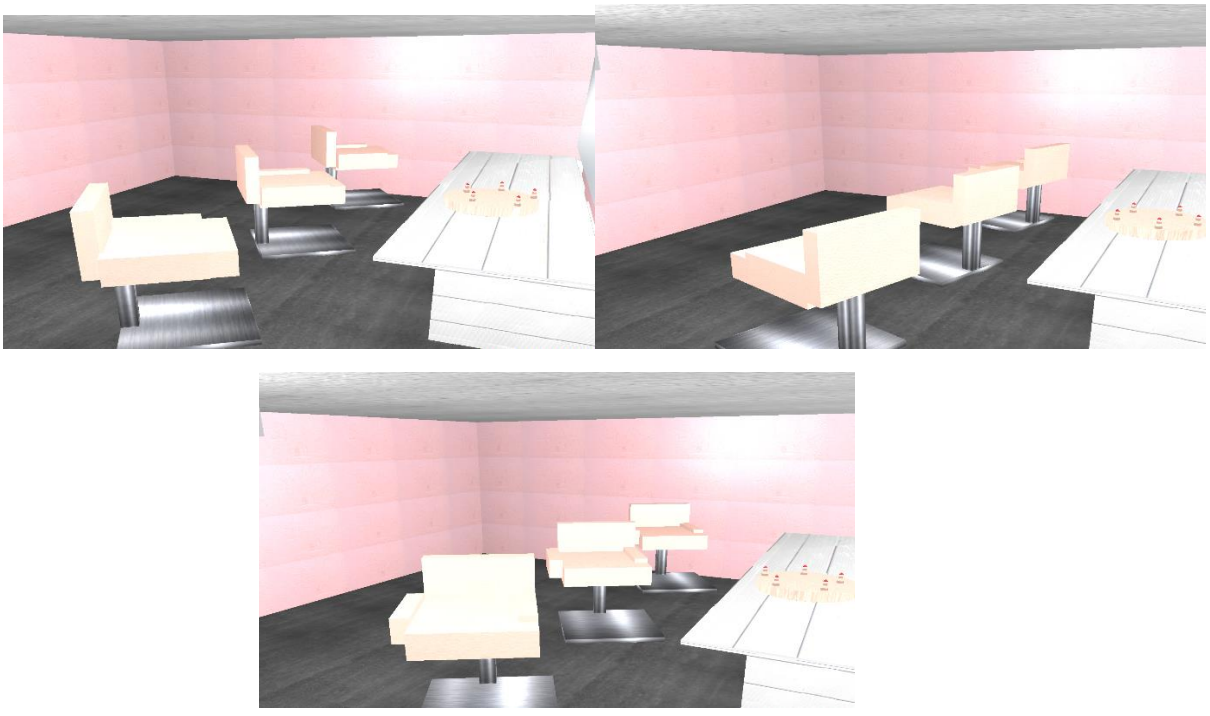

Fig 1.22 : Rotating Chair.

Keyboard Instructions

1. General Controls

- **ESC**: Close the application.

2. Camera Controls

- **Movement:**
  - **W**: Move the camera forward.
  - **S**: Move the camera backward.
  - **A**: Move the camera left.
  - **D**: Move the camera right.
  - **E**: Move the camera up.
  - **R**: Move the camera down.
- **Rotation:**
  - **T**: Pan the camera upward.
  - **F**: Pan the camera downward.
  - **U**: Rotate the camera left (Y-axis).
  - **H**: Rotate the camera right (Y-axis).
  - **I**: Rotate the camera left (roll).
  - **J**: Rotate the camera right (roll).

3. Object Transformations

- **Translation:**
  - **O**: Rotate chandelier.
- **Rotation:**
  - **X**: Rotate the selected object around the X-axis.
  - **Y**: Rotate the selected object around the Y-axis.
  - **Z**: Rotate the selected object around the Z-axis.

4. Dynamic Elements

- **Doors and Drawers:**
  - **1**: Open the front door or raise the sponge (depending on state).
  - **2**: Close the front door or lower the sponge (depending on state).
  - **3**: Open the Almira door.
  - **4**: Close the Almira door.
  - **5**: Drawer open.
  - **6**: Drawer close.
- **Chairs:**
  - **L**: Rotate the chair.
  - **[**: Tilt the chair backrest backward.
  - **]**: Reset the chair backrest to its original position.

5. Lighting Controls

- **Ambient Light:**
  - **7**: Enable ambient light and disable diffuse and specular lighting.
- **Diffuse Light:**
  - **8**: Enable diffuse light and disable ambient and specular lighting.
- **Specular Light:**
  - **K**: Enable specular light and disable ambient and diffuse lighting.
- **All Lights:**
  - **L**: Enable all lighting types (ambient, diffuse, specular).
- **Specific Room Lights:**
  - **C**: Turn on all room lights.
  - **V**: Turn off all room lights.
  - **B**: Turn on a specific point light.
  - **N**: Turn off a specific point light.
  - **M**: Turn on point light 1.
  - **P**: Turn off point light 1.

Conclusion:

The "Beauty Salon" project successfully integrates advanced 3D modeling, dynamic animations, and realistic lighting techniques to create an immersive virtual environment. It features a waiting room with sofas, a tea table, and a decorative cactus, a makeup room with dressing tables and textured walls, and dynamic elements such as rotating chandeliers, lipstick platforms, tilting chairs, and opening doors. Realistic lighting effects, including soft shadows and reflections, enhance the overall experience. Despite challenges like modeling curved objects and implementing smooth animations, solutions such as Bézier curves and frame-based updates ensured seamless execution. Future work could include adding shadow mapping for enhanced realism, post-processing effects like bloom and depth of field, and interactive features such as user-controlled object manipulation. The project stands as a testament to the harmonious blend of technical expertise and artistic creativity, offering a visually compelling and technically rich representation of a modern beauty salon.