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CS 330

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02 March 2025

**Design Decisions for 3D Scene**

Color and Texture Choices

One of the main objectives in designing this 3D scene was to closely match the aesthetic of the original 2D image. I chose bright colors to reflect the playful and vibrant style of the reference. To achieve this, I applied different textures to key objects in the scene. The Rubik’s cube was initially constructed from 27 smaller cubes, each individually placed. However, due to challenges in properly alternating colors without adjacent colors matching, I opted for a tiled texture that accurately represents the 3x3 cube pattern. The ice cream swirl was given a creamy texture to enhance realism, but in future iterations, I would adjust it to a lighter color to better match the reference image. The donut was textured to resemble dough, but in the future, I would enhance its appearance by layering an additional torus on top, making the upper section look like frosting while keeping the lower section looking like dough. The egg was left with a simple off-white color to match its natural matte appearance.

Object Placement and Scene Composition

The objects in the scene were arranged to match their relative positions in the 2D reference image. The Rubik’s cube was positioned as the largest object, slightly tilted, with a shiny surface to reflect lighting effects properly. The ice cream cone was placed to the right of the cube, and the multi-layered swirl was iteratively designed with eight layers to add depth and complexity. The egg and donut were placed in the foreground, with the egg given a smooth, matte surface to contrast against the surrounding elements. The background consisted of a combination of a light back wall and a slightly darker floor to simulate a realistic table and environment. This helped define the objects within the space without overwhelming the scene with unnecessary detail.

Material Properties and Lighting

Different materials were assigned to each object to reflect their real-world properties:

* Rubik’s cube: Shiny, reflective material to mimic the plastic surface of an actual cube.
* Ice cream swirl: A semi-glossy material to simulate a soft, creamy texture.
* Cone: Matte material to contrast the swirl and give the appearance of a rough, waffle texture.
* Egg: Matte material to maintain a natural, soft finish.
* Donut: Matte finish with texture mapping to reflect a baked dough look.
* Background: A balance between matte and shiny, creating subtle reflections without overpowering the scene.

Lighting was implemented using directional and point lights to ensure proper shadows and reflections. A directional light was placed at an angle to illuminate the objects while preserving depth, and multiple point lights were introduced to enhance the realism of highlights and shadows.

OpenGL Implementation

The 3D scene was developed using OpenGL with careful implementation of fundamental graphics techniques:

1. Adding Objects: Shapes such as cubes, cones, spheres, and toruses were instantiated and transformed appropriately.
2. Positioning Objects: Each object was placed based on relative coordinates, aligning them to match the reference scene.
3. Adding Textures: Texture loading and binding functions were used to apply images to specific objects, ensuring correct UV scaling for accurate representation.
4. Applying Colors: For objects without textures (e.g., the egg), color shaders were used to apply solid shading.
5. Lighting Implementation: Directional and point lights were added with ambient, diffuse, and specular components to create realistic shadows and highlights.
6. Shadows and Reflections: Depth testing and material adjustments were made to ensure shadows were cast correctly while maintaining the appropriate level of reflectivity.

Future Improvements

While the current implementation successfully recreates the 2D reference image in 3D, there are several areas for improvement:

* Better texture application on the donut to add frosting as a separate visual layer.
* Enhanced lighting adjustments to create more dramatic and realistic shading effects.
* Refining the ice cream swirl to have a smoother, more organic shape with a more accurate color match.
* Increasing the resolution of the Rubik’s Cube texture to better align the tile edges with the geometry.

Overall, this project successfully brings together various 3D modeling and rendering techniques to replicate a 2D reference while exploring different material and lighting effects in OpenGL.