**CS330 – Comp Graphic and Visualization**

**Thanh Nguyen**

**Instructor: Prof. Malcolm Wabara**

**Design Decisions for 3D Scene Development**

1. **Introduction**

For my final project in CS 330, I have created a 3D scene using OpenGL to replicate a 2D image of a working desk. This project involves designing low-polygon 3D objects, applying textures and lighting, and enabling interactive navigation. This document outlines the design choices made during the development process and explains how various elements of the project were implemented.

1. **3D Objects and Shapes**

The 2D image I selected depicts a working desk with several items, including an iMac, a mouse, a keypad, a coffee cup, a stack of books, and pen holders with pens. To create low-polygon representations of these objects, I used the following basic shapes:

* Macbook: Macbook was modeled using a rectangular prism for the main body and a plane for the screen. This combination of shapes allowed for a simple yet accurate representation.
* Coffee Cup: A simple cylinder was used for the coffee cup, with a plane representing the liquid level inside.
* Stack of Books: Each book in the stack was represented by rectangular prisms, arranged at slight angles to create a realistic appearance.
* Pen Holders and Pens: The pen holders were modeled as cylindrical shapes, while the pens used elongated boxes with tapered cylinders and cones for the pen tips.

By using these basic shapes, I ensured that each object was composed of well-spaced and connected polygons, keeping the polygon count under 1,000 triangles per object.

1. **Textures and Lighting**

Textures were applied to two objects in the scene: the iMac and the coffee cup. For the iMac, a high-resolution image of a desktop background was used to texture the screen, giving it a realistic appearance. The coffee cup was textured with a royalty-free image of a coffee cup design, ensuring the texture resolution was 1024 by 1024 pixels or higher.

Lighting was crucial for creating a polished visualization of the 3D models. I included two light sources in the scene:

* Directional Light: Positioned to mimic sunlight, this light source illuminated the entire scene, casting realistic shadows and highlights.
* Point Light: Placed near the coffee cup, this colored light added depth and visual interest to the scene.

Both light sources utilized the Phong shading model, incorporating ambient, diffuse, and specular components to enhance the overall visual quality.

1. **Object Placement and Navigation**

Objects were carefully positioned using the X, Y, and Z coordinates to match the layout of the original 2D image. For instance, the iMac was placed centrally on the desk, with the mouse and keypad arranged nearby. The stack of books and pen holders were positioned to the side, creating a balanced composition.

Camera navigation was implemented to allow horizontal, vertical, and depth movement around the 3D scene. The WASD keys controlled forward, backward, left, and right motion, while the QE keys controlled upward and downward movement. Additionally, the mouse cursor was used to change the camera's orientation, enabling users to look up, down, right, and left. The mouse scroll adjusted the speed of movement, providing fine control over navigation.

1. **Perspective and Orthographic Views**

To offer different viewing experiences, I implemented perspective and orthographic displays of the 3D world. Users can switch between these views with a keyboard key, allowing them to explore the scene in both 2D and 3D perspectives. This functionality was achieved by dynamically changing the projection matrix based on user input.

1. **Best Practices and Modularization**

Throughout the project, I adhered to coding best practices, ensuring the program code was well-formatted, commented, and logically structured. Functions were used to encapsulate repetitive tasks, promoting code reusability and efficiency. For example, custom functions were developed for creating basic shapes, applying textures, and handling camera movements. These functions improved the modularity and organization of the code, making it easier to manage and extend.

1. **Conclusion**

In summary, the design choices made for this 3D scene were guided by the need for simplicity, accuracy, and interactivity. By using basic shapes, applying textures and lighting effectively, and implementing comprehensive navigation controls, I was able to create a realistic and engaging 3D representation of the original 2D image. This project not only demonstrates my understanding of 3D graphics development but also showcases my ability to apply best practices in coding and design.