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**Final Project**

The development of the 3D scene was centered around creating an accurate representation of a real-world arrangement while maintaining computational efficiency. The objects chosen—a block of cheese, sliced cheese, a cup, and sausage slices—were selected because they provided a variety of primitive shapes to demonstrate OpenGL rendering techniques. By constructing these objects using fundamental shapes such as boxes, cylinders, and planes, the program adheres to best practices in computational graphics, where low-polygon models are optimized for rendering efficiency (Angel & Shreiner, 2020). Additionally, applying transformations such as scaling, rotation, and translation allowed precise object positioning within the scene, ensuring a realistic approximation of the reference image. The texturing process involved mapping high-resolution textures onto surfaces using UV coordinates, ensuring that materials such as cheese and wood appeared natural. To achieve a polished visual presentation, the Phong shading model was implemented, utilizing ambient, diffuse, and specular lighting components, with a yellow point light simulating warm table lighting to enhance realism. The inclusion of a cheese wedge and a summer sausage roll was intended to add diversity to the representation of food items while still adhering to the fundamental primitive shapes available in OpenGL. Additionally, switching the cup to a styrofoam material simplified the rendering process while maintaining visual accuracy.

Navigation within the 3D scene is designed to be both intuitive and functional, allowing users to explore the environment fluidly. The movement system was implemented using standard input controls, where the WASD keys enable movement along the X and Z axes, while the Q and E keys adjust vertical positioning. This configuration ensures smooth traversal across all three dimensions. Camera orientation is controlled using mouse input, with yaw and pitch adjustments allowing for dynamic viewing angles. The scroll wheel modifies movement speed, granting users finer control over navigation. To further enhance interactivity, the scene supports both perspective and orthographic projection toggling using the 'P' and 'O' keys, enabling users to switch between a realistic depth-based view and a parallel projection for precise object alignment. The integration of these controls ensures that users can fully examine the 3D objects from multiple angles while maintaining an immersive experience.

To enhance modularity and maintainability, custom functions were developed to streamline rendering and transformation processes. Functions such as SetTransformations() centralize object manipulation, handling scaling, rotation, and translation within a single reusable structure. Similarly, SetShaderTexture() ensures efficient texture application by dynamically binding different textures to objects without redundant code duplication. The ProcessKeyboardEvents() function encapsulates movement logic, enabling straightforward updates to user input configurations. By designing these reusable functions, the program follows software engineering best practices, reducing code redundancy and improving readability (Shirley, 2021). The modular structure not only simplifies future modifications but also ensures that additional objects or interactions can be seamlessly integrated without extensive rewrites. This approach aligns with the principles of scalable graphics programming, where abstraction and encapsulation contribute to a well-structured and efficient codebase. Additional improvements to modularity would include mesh implementation using for loops. This could allow for placing multiple similar objects throughout the scene rather than creating blocks of code for each individual shape. The decision to not follow this was due to the low overall shape count as well as initial planning and testing that were considering using different texture and lighting settings for each instance of a similar shape. More unform lighting techniques were employed to timelier deliver a final polished product. Included below this paragraph is the final 3D rendering of the scene as well as the source material image. Pay special notice to the extra inclusions of a cheese wedge, roll of uncut summer sausage, the cup material swap for Styrofoam, & the simpler layout of cheese and sausage slices.

**A board game with cheese and a cup on it

AI-generated content may be incorrect.**

**A cheese and meat on a cutting board

AI-generated content may be incorrect.**

**References**

Angel, E., & Shreiner, D. (2020). *Interactive computer graphics: A top-down approach with WebGL*. Pearson.

Shirley, P. (2021). *Fundamentals of computer graphics*. A K Peters/CRC Press.

*Images included were captured by the author and used for project purposes.*