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CS-330-15022

Comp Graphic and Visualization

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7-1 Final Project Submission

Design Decisions for 3D Reconstruction of Candlelit Table Scene

Kevin Alexander CS-330: Computer Graphics and Visualization

Introduction The goal of this project phase was to refine and extend an earlier OpenGL scene repro-ducing a tabletop arrangement featuring two lit candles flanking a central blue book. My approach balanced faithful geometry replication, material realism, and interactive camera controls. This document outlines the technical and artistic choices that shaped the final scene, covering mesh construction, shader-based lighting, material definitions, and user input handling.

Scene Composition & Modeling Approach I began by analyzing the reference image's layout: a rectangular wooden table supporting two cylindrical candles with subtle tapering and a rectangular book. To model these, I used parametric functions in C++ and GLM. – Table: A simple box mesh defined by eight vertices, with UV coordinates to map a custom wood texture. – Candles: Procedurally generated cylinders—base radius 0.3 units, top radius 0.2 units, height 2.0 units—with a small cone atop each to simulate the melted wax tip. – Book: A flattened box (0.8 × 0.5 × 0.05 units) enhanced with a distinct spine by extruding one edge by 0.02 units.

This modular code design—separate functions for `createBox()`, `createCylinder()`, and `createCone()`—ensured reusability and clarity (Shreiner et al., 2013).

Materials, Textures, and Lighting To evoke realism, each object employed unique material properties in a Blinn-Phong shader:

- **Wood Table**: Diffuse albedo from a 1024×1024 wood image processed via STB Image Loader (v2.27), with ambient = (0.1, 0.05, 0.01), diffuse = (0.6, 0.3, 0.1), specular = (0.2, 0.2, 0.2), shininess = 16.
- **Candle Wax**: Uniform color (1.0, 0.9, 0.8) with low specular (0.1) and high ambient (0.4) to simulate matte surface.
- **Book Cover**: Solid blue material (0.1, 0.2, 0.8) with medium specular (0.5) and shininess = 32.

I configured two light sources: a warm point light above each candle (color = 1.0, 0.8, 0.5; intensity = 1.5) and a soft, neutral ambient light (color = 0.2, 0.2, 0.2) to fill shadows without overpowering the candle glow (Stone, 2013).

Camera & Interaction Controls To explore the scene interactively, I implemented an orbital camera using GLFW callbacks. Mouse-drag updates adjust yaw and pitch, while scroll wheel zooms via radius changes, all clamped to prevent gimbal lock. Keyboard inputs ('R' to reset, '+'/'–' to zoom) allow rapid viewpoint adjustments. The camera's view matrix is computed each frame with `glm::lookAt()`.

Implementation Tools & Workflow

- **Environment**: Microsoft Visual Studio 2022 with C++17, GLFW 3.3, GLEW for

function loading, and GLM for mathematics.

- **Shaders**: Two GLSL programs—a vertex shader for transformation and a fragment shader implementing Blinn-Phong lighting.
- **Textures**: STB Image Library, licensed under MIT, for loading PNG and JPEG maps.
- **Version Control**: Git with modular branches for geometry, materials, and controls, enabling incremental testing and rollback.

Conclusion By combining procedural mesh generation, physically inspired materials, and intuitive controls, I achieved a faithful, interactive 3D scene of the candlelit table. These design decisions emphasize code modularity, visual fidelity, and user engagement—principles that will guide future expansions such as dynamic flame effects or additional scene props.

References Shreiner, D., Sellers, G., Kessenich, J., & Licea-Kane, B. (2013). *OpenGL® Programming Guide: The Official Guide to Learning OpenGL®* (8th ed.). Addison-Wesley.

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