CS 330

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Final Project reflection

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For my CS 330 final project, I chose to create a 3D Greenery Garden using C++ and OpenGL. The goal of this project was to build a visually appealing and interactive 3D scene that combines both natural and man-made elements. I envisioned a serene garden environment featuring trees, grass, a flowerbed, and a bench. This project allowed me to apply a wide range of computer graphics concepts, including object modeling, texture mapping, lighting, and camera navigation. I wanted to create a project that not only met the technical requirements but also demonstrated creativity and thoughtful design.

## **Design Choices**

The design of my 3D Greenery Garden was inspired by outdoor park landscapes, blending organic forms with structured components. I constructed trees using cylindrical trunks and spherical or conical canopies, replicating real-world tree structures. To simulate ground cover, I applied a grass texture to a large plane, creating a natural-looking garden floor. For additional interest, I included a flowerbed using prisms and cones to represent plant stems and blossoms. To balance the organic shapes, I added a bench composed of rectangular prisms, offering a human-made contrast to the natural environment. This variety allowed me to experiment with different 3D shapes, enhancing both the visual appeal and complexity of the scene.

## **Technical Implementation**

I implemented this project using key OpenGL features such as shaders, transformations, and texture mapping. I focused on modular design by organizing the code into logical functions and classes. Each 3D object was constructed using a combination of primitives like cylinders, cones, and planes. The tree models, for instance, used a cylinder for the trunk and a cone or sphere for the canopy. The ground was covered with a grass texture applied using UV mapping, ensuring a seamless and realistic appearance.  
  
Lighting played a critical role in making the scene visually compelling. I used Phong shading, applying ambient, diffuse, and specular lighting to simulate realistic illumination. A point light and a directional light were strategically placed to ensure all objects were well-lit while maintaining a natural feel. I adjusted properties like shininess and reflectivity for various materials to achieve a balanced and realistic lighting effect.  
  
Camera navigation was another essential feature. I implemented movement using the WASD keys and mouse input for orientation, allowing users to explore the scene freely. I also provided a feature to switch between orthographic and perspective views, offering different visualization perspectives. This functionality was critical in making the scene interactive and immersive.

## **Challenges and Solutions**

Throughout the development process, I encountered several challenges that required creative problem-solving. One of the most significant challenges was managing object placement and ensuring consistent scaling across the entire scene. Early versions of the project had objects that appeared too small or too large relative to one another. I resolved this issue by carefully adjusting the transformation matrices and testing different scale values.  
  
Another challenge was ensuring smooth camera navigation. Initially, the camera's movement felt unnatural due to incorrect sensitivity settings. I refined the camera’s input processing functions and improved mouse and keyboard responsiveness. Additionally, texture stretching caused by improper UV mapping led to visual artifacts. By recalculating the UV coordinates, I ensured that textures were properly aligned and displayed without distortion.  
  
Lastly, balancing the lighting setup was complex. Too much intensity resulted in overexposed objects, while too little caused dark, indistinguishable areas. I iteratively adjusted the light source properties and materials’ shininess to achieve a visually balanced scene.

## **Learning Outcomes**

Working on this project deepened my understanding of 3D computer graphics concepts and practices. I gained valuable experience in modeling objects using basic geometric shapes and combining them to create more complex structures. I learned how to apply transformations effectively, ensuring that objects were correctly scaled, rotated, and positioned in the 3D space.  
  
Additionally, I enhanced my skills in shader programming, particularly in applying textures and lighting effects using OpenGL. Learning to implement Phong shading helped me appreciate how different light components contribute to creating a realistic scene. I also strengthened my understanding of camera navigation, including how to process user input and create interactive experiences.  
  
Overall, this project reinforced my ability to approach complex problems methodically, from design and implementation to troubleshooting and refinement. I now feel more confident applying these skills to larger-scale projects in the future.

Overall, my 3D Greenery Garden project successfully brought my original design concept to life while meeting the technical and creative requirements outlined in the project brief. This experience allowed me to combine technical skills with artistic design, creating a functional and visually appealing 3D environment. The process was both challenging and rewarding, leaving me with a deeper understanding of computer graphics development.