**CMPE 360 - 01**

**PROJECT 5 – REPORT**

***Problem Statement and Code Design***

With this assignment, we tried to improve a custom ray tracer created in Blender with Python which is capable of simulating realistic lighting and shading effects, with the primary goal of modeling complex lighting to achieve accurate rendering. The main issue was to integrate complicated light interactions like reflection, Fresnel effects, and transmission into the current framework while utilizing Blender's 3D capabilities as well as Python scripting. The aim of working with reflection was to use recursive ray tracing to properly show how light bounces off reflecting objects while also capturing the intricacies of the environment in these reflections. This required an in-depth knowledge of light pathways and surface interactions. In short, in this project we aimed to understand the other principles of light interaction in computer graphics like reflection, Fresnel effects and transmission with the application of these principles in a practical, software-based environment.

***Implementation, Functionality, Testing***

We will explain my code's functionality while we describe how we implemented the two JavaScript functions to apply transformations as per the given task.

***Part 1: Implementation of Reflection***

We successfully created an image demonstrating the reflection effect on the hemisphere at the top of the scene. Using recursive ray tracing, the hemisphere now replicates the entire picture, providing depth and realism.

To produce the reflection, we modified the hemisphere's material attributes to be reflective. The reflectivity and specular characteristics in the SimpleRTMaterial settings must be adjusted. Each ray from the camera was traced as it bounced off the globe in the SimpleRT render engine, capturing the scene's reflection. Therefore, the environment is represented in a dynamic and realistic manner, improving the visual appeal of the image, and exhibiting the potential of reflection in 3D rendering.

***Part 2: Image with Fresnel***

WE created another picture, this time emphasizing the Fresnel effect on the ground plane. The reflection on the ground is greater at grazing angles, as seen in the image.

To simulate the Fresnel effect, we changed the material parameters of the ground plane to increase reflectivity dependent on the viewing angle. As the angle between the view direction and the surface normal neared 90 degrees, the reflectivity was set to increase. This method gave the image a more realistic and dynamic aspect, especially at grazing angles, by making the ground appear more reflecting and strengthening overall realism.

***Part 3: Image with Transmission***

We converted the black block into a glass-like substance for the transmission effect, allowing the green truncated cone behind it to be visible through the block. This transmission effect is seen in the produced picture.

To get the transmission effect, we adjusted the black block's material qualities, changing its transparency and refraction indices to simulate glass. Light could travel through the block, twisting and refracting like it would through genuine glass. The green truncated cone, visible through the newly transparent block, brought another layer of complication to the image, demonstrating the complexities inherent in depicting transparent materials and light transmission.

In a recent project, we added reflection, Fresnel, and transmission effects to my custom ray tracer in Blender by editing the given script. To produce precise reflections on surfaces, WE used recursive ray tracing on a hemisphere positioned at the top of the scene. This required careful modification of the ray's path when it contacted reflecting surfaces, ensuring that the reflected rays faithfully recorded the environment's characteristics. In the material settings, we paid close attention to the reflectivity characteristics, modifying them to obtain a genuine mirrored appearance.

The Fresnel effect was used to improve the realism of reflections dependent on the angle of incidence. We provided that reflections grew more obvious at grazing angles by altering the material qualities of the ground plane, following to the physical principles of the Fresnel effect. This not only brought realism to the image but also emphasized the fluid nature of light-material interaction. For the transmission effect, WE changed the characteristics of a black block such that they resembled those of glass, allowing it to refract and transmit light. This enabled the detailed representation of the green truncated cone visible through the block, showing the challenges that come with reproducing transparent materials and light behavior. Throughout this project, WE deepened my understanding of ray tracing principles and their practical applications in rendering realistic 3D scenes.

***Final Assessments***

In conclusion, this project was partially successful in achieving its objectives, showing both technical capability and a deep understanding of computer graphics principles. It served as an excellent opportunity to apply theoretical knowledge in a practical setting, resulting for deeper understanding for other raytracing and path-tracing concepts like reflection, Fresnel, and transmission in computer graphics.