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Real-Time Physically Based Wet Microfacet Surface Rendering

Summary of Work to Date

Up to this point, I have implemented the Cook-Torrance model in real time using a deferred rendering pipeline. In my implementation, I allow for the loading of an arbitrary model and set of physically based textures from a scene file which is then loaded at run time and rendered with a free move camera.

In addition to implementing the Cook-Torrance model in real time, I have also discussed and adapted the water model proposed in "Wet Surfaces" to include physical accuracy. This proposed model is made up of a few important steps, summarized below:

1. First, surface is modeled as two surfaces, one with an air-water boundary, and one with a water-pbr material boundary.

2. The incoming light first interacts off the air-water boundary, with some being reflected and a portion being transmitted. I propose using a Fresnel function to model realistic behavior.

3. The transmitted light then interacts with the water-pbr material boundary. I propose utilizing the Cook-Torrance model to model this interaction, using a modified light vector and modified view vector that are obtained via Snell's law and the original light and view vectors interaction with the air-water boundary.

4. Finally, this Cook-Torrance output distribution interacts with the water-air boundary, with some of the light distribution experiencing total internal reflection.

Finally, I have begun to modify the Cook-Torrance shaders from the standard, dry surface model of rendering to incorporate the proposed model I just discussed. So far, I have steps 1 and 2 implemented, and have a partial implementation of 3. 4 should follow quickly as it will be modeled as a simple probability of reflectance, though this might need to be modified based on the size of the specular distribution and the angle between the boundary and the modified view vector.

Analysis of Work

My progress toward completing my goals has been good, with an implementation of a physically based model for wet surfaces nearly complete. However, the model itself has been designed and discussed with Dr. Keyser. At this point, we are curious to see the result of an implementation of the currently proposed model. In addition, I have built up a framework to swap scenes relatively easily and am able to test multiple types of materials with ease.

While we are still curious about the modeling of water within the microfacets themselves, I am unsure whether I will have time to fully explore this interaction by the end of the final project. Instead, I believe exploring the extension of the proposed model to model additional bounces of totally internally reflected light to be a reasonable end goal by the end of the project. This more directly builds on the work I have completed thus far, and I am curious to explore the impact that modeling these additional bounces has on the final render. If I am able to complete this on time, I would then like to at least propose a model for the water within microfacet case, and possibly present preliminary results of implementing this model.

Plan for Completion

The first step for completion of work is to complete the basic model I proposed up to the first bounce of light off the material experiencing total internal reflection. I plan to have this completed by next Monday, specifically to show results in the lab's demo day.

Once I have these results, I would like to explore an extension of the model to incorporate additional bounces of light that experienced total internal reflection. I propose that this interaction can most likely be modeled using a probability distribution and an additional Cook-Torrance calculation representing the rest of the light reflections. If I can complete this in a shorter amount of time than anticipated, I would like to continue and explore the behavior of water within the microfacets themselves. However, I do not realistically think that I will get a working model of this behavior by the completion of the project. Instead, I would like to present preliminary results, or propose a method for modeling this behavior.