IOR RECTIFICATION

INTRODUCTION – THE DIELECTRIC-INSIDE-DIELECTRIC PROBLEM

In an environment where we have multiple dielectrics and refractors, users generally configure the index of refraction (ior) for the interior of these materials. Nevertheless, trying to accurately ray trace these kind of scenes we usually lack the knowledge about the index of refraction for the exterior volume. Such information is needed for correct tracing of the environment since the actual refraction does not depend on the ior of the interior but on the relative index of refraction between the interior and exterior space.

Thus, it is usual for ray tracers to render a modified scene as if the users were giving the relative index of refraction and not the actual one. This is not really problematic until we have to deal with more complex cases such as the global medium ior is not assumed to be exactly 1 or dielectrics are contained within other dielectrics. In such cases, the scene is no longer rendered correctly.

A PARTIAL SOLUTION – RENDERING USING A STACK

To deal with the above case, several ray tracers of commercial quality, use a stack. Whenever we hit a refractor and trace its interior, we push the entering point to signal a different medium. Whenever we exit a refractor, we pop the medium information from the stack. At any moment, we know – based on the last entries of the stack – what will be the exterior since we had already traced it before. Having the information about the exterior, we can calculate the relative index of refraction.

The above scenario works quite well in most but not all cases. The information about the exterior will be available as long as this exterior has been already traced in the beginning of the random walk (i.e. the tracing procedure). In cases where the starting point such as the camera location or the light sources (in bi-directional transfer) lie inside a dielectric, things will go wrong. There will be no information placed on the stack, and because of this lack of knowledge, relative index of refraction cannot be computed and ray tracing will be incorrect. As a result, rendering using stack information cannot be used as a global solution to our problem.

A GLOBAL SOLUTION – PRE-TRACING AND IOR "RECTIFICATION"

We can actually solve this problem quite easily by simply pre-tracing the environment. For this, we locate all refractors in the scene and we shoot a ray from their surface going outwards to the environment. Tracing this ray, if we hit for a first time a dielectric surface from behind (i.e. like the ray is coming from the interior of this dielectric) then the related information is stored within the original refractor in order to be used during rendering and proper relative ior calculation. If we don't find any dielectric surface intersected from behind, then the ior information related to the global medium is stored within the original refractor. We can shoot more than one rays to verify the results and avoid some rare intersection misses.

This pre-tracing phase, which we call ior rectification, is guaranteed to work correctly, even in the cases where cameras and light sources are located inside some dielectric volume. Even more, the technique simplifies the tracing code by getting rid of the ior stack, and is much more consistent since now all the a-priori knowledge of the exterior is pre-stored and guaranteed to be used in the same way without being recomputed.