Introduction to 3dsMax

TNM061/TNGD25 Lab 3a: Path Tracing

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1 Path Tracing

Over the last decade or so, ray tracing has become commonplace in production rendering, and old school "scanline rendering" with a local illumination model is going out of fashion, simply because the short-cuts offered by these simpler rendering methods are no longer as dearly needed to get the work done in reasonable time. Local illumination rendering is still the norm for real time rendering, but even there, the recent introduction (2018) of the NVIDIA RTX architecture has made real time ray tracing possible, if not yet common. Furthermore, in recent years (from 2015 onwards), the general speed of computers and the invention of new and improved rendering algorithms has made it possible to use an even more physically accurate rendering method: *Path Tracing*. The method is similar to ray tracing, but instead of just shooting rays from the eye (camera) into the scene and tracing their reflections and refractions until they reach a diffuse surface, path tracing attempts to trace rays that connect the eye with light sources through a number of intermediary bounces. The tracing is performed both ways, so to speak. This makes it possible to capture diffuse interreflections and caustics, the kind of effects that need to be added as an afterthought to traditional ray tracing algorithms. Path tracing is a lot more computationally expensive than ray tracing, and the images are computed in a statistical fashion, which makes them appear noisy unless you spend quite a lot of time on rendering. Nevertheless, path tracing is a nice way of simulating how an image is formed in the real world. It is capable of capturing all the effects of illumination that occur in real life situations, and because of that it has gained popularity. It's still a slow method compared to ray tracing, and it's not always advisable to use it, but it's available, and you might want to consider it.

1.1 Path Tracing Renderers

A path tracing renderer is available already in 3dsMax 2017: the renderer called **ART renderer**. ART is an acronym for "Autodesk Ray Tracer", but despite its name it's actually a path tracer. The ART renderer is still available in 3dsMax 2019, and it's fairly popular.

Another path tracing renderer is **Arnold**, which is a product from the company Solid Angle (www.solidangle.com). The name is a nod to the famous bodybuilder-turned-superstar-turned-governor Arnold Schwarzenegger, as it is considered a "brute force" renderer, choosing accuracy and computational effort over cheats and tricks to get its job done. Since 2017, Arnold has been shipped with Maya, and from 2018 it's bundled with 3dsMax as well. Arnold has been used in several animated feature films and lots of visual effects productions.

Using a path tracer is discouraging at first. The images you get look noisy and bad, and they take longer to render. However, it is possible to get really good images in reasonable time. All it takes is some with some tweaking and a little bit of patience. Which parameters to adjust, and how, depends heavily on the scene, the illumination and, if the scene is animated, the motion, and it can be frustrating at first. However, learning how to adjust the settings of a path tracer and seeing the beautiful images that come out of it is a rewarding experience. Hence this brief introduction.

1.2 A simple scene

If you have done the third lab exercise, feel free to use the scene with the wine glass for these experiments. You can also create a simple scene with a floor and two walls made from *Box* objects, and a single *Tube* object on the floor, as shown in Figure 1. To make the Tube object slightly more interesting and illustrative for our purposes, uncheck the box *Smooth* in its settings, make it have only 8 or 10 sides, and add a *Chamfer* modifer to it to make the upper and lower rims smooth, while keeping the angled appearance for the sides.

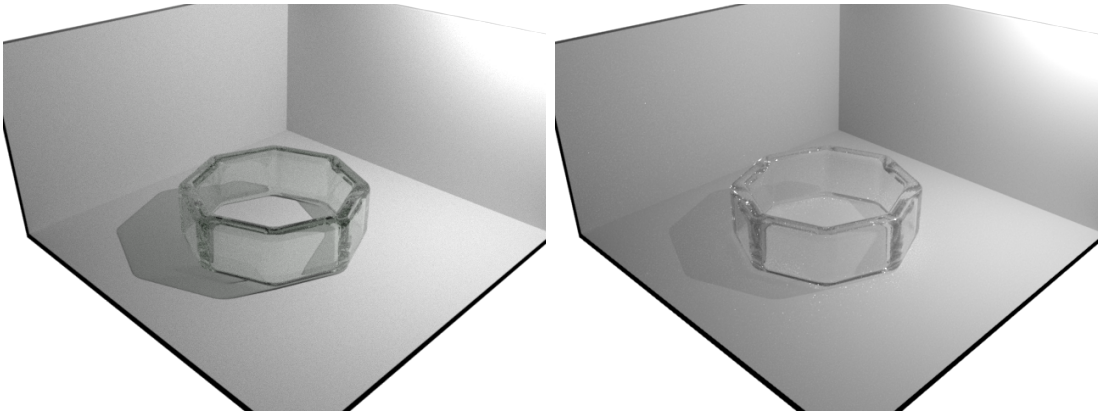

Figure 1: A simple scene for experiments with path tracing, rendered with ART (left) and Arnold (right).

1.3 Using ART

In the Render Setup dialog, switch to *ART renderer*. Put a *Standard* material on the floor and walls, and put an *Autodesk Solid Glass* material on the tube. Place a light source in the scene. Use a *Photometric* light, either a *Free Light* or *Target Light*, and make it shine from above and to the side, so you can clearly see the shadow. Render the image. It will look noisy.

Now, in the *Render Setup* dialog, in the pane *ART Renderer* (second tab at the top), increase the *Render Quality* slider from *Draft* to *Medium* or *High*, and render again. Note how the noise gets less pronounced, but at the expense of rendering time. Try to find a setting that looks OK to you without taking ages to render.

Apart from this general *Render Quality* setting, there are very few parameters to tweak in the ART renderer. This is one of the reasons for its popularity, but it also makes it less flexible. Note how effects like caustics and diffuse interreflections are computed by default, without requiring you to enable them explicitly.

1.4 Using Arnold

Now, change the renderer to Arnold. For this, you need to switch to using 3dsMax 2018 or 2019, because Arnold was not included in 3dsMax2017. It shipped with Mentalray instead.

Arnold has a few quirks of its own that you need to take into consideration. First, you will notice some error messages when you switch from ART to Arnold, telling you that the materials in your scene are not supported. Arnold wants you to use its own material library, which is available in the material/,ap browser under the section "Arnold". Pick a *Lambert* material (diffuse reflection only) for the walls and the floor, and a *Standard Surface* for the tube. To make it look like glass, set its Transmission to 0.9 or something similar. Render.

Note that the image contains no shadow. You can enable it in the settings for the light source, but it won't look right. Arnold prefers its own light sources as well. Replace your light source with an Arnold light (available in its own section in the *Create* panel for lights). Change its type from the default *Quad* to *Point*, and position it to your liking. Now, render again. The image will probably be too dark or too bright, so you will need to either change the exposure setting or adjust the intensity of the light source. When you get the brightness right, note that the shadow is soft. In Arnold, even *Point* lights have a size, which is often nice, but in our case we want to see the caustics, and then we want a small light, basically a single point. Change the *Radius* of the light to something small, like 0.1, and render. Note that caustics are still not visible. You need to enable them. This is done in the material for the objects. Find the checkbox *Enable Caustics* in your glass material (in the section *Advanced*), and check it. Render. Note how the shadow is now lit by rays transmitted and refracted through the glass.

Unfortunately, Arnold is not the perfect renderer for "hard", high contrast caustics. Such effects are best computed by photon mapping, but Arnold doesn't do photon mapping. Its authors consider it a cheat, for good reasons, and they stay away from it. Therefore, caustics will always appear somewhat soft and blurry in Arnold. (There is a possible workaround, but it takes a stupid amount of time to render if you want a high quality image, so let's not try that.)

A very useful feature of Arnold which deserves mention is that any surface can be set to emit light, not just light sources. A *Standard Surface* material can have an *Emission* to make it actually contriburte to the illumination of the scene. This is sometimes better than creating explicit light sources for all the illumination in a scene, but it comes at some cost. Light from ordinary objects will create considerably more noise than the explicit Arnold lights, and high quality images making heavy use of light-emitting surfaces will take longer to render.