Rendering in XSI

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Introduction:

A huge amount of computer graphics focuses on photorealism to create images which can fool the eye. For a lot of live action/ CG photorealism is indispensable. Since the beginning of the computer graphic industry renderers have been trying capture and render photorealism. Many of the natural lighting phenomenons have been found hard to manage until recent times partly because of lack of good algorithms to compute them and partly lack of computing power. In physical world light and surface interactions just happen, no digital computations are required. But to be able to render in CG is a different matter.

Within past two decades computing power and research have been making impressive progress in this front [1]. Renderers like Mental ray and PR renderman have been leading the industry since late 1980's in creating photo real content. As a plugin in most widely used 3d packages like 3ds Max, Maya and Softimage XSI, mental ray provides outstanding quality and unsurpassed tools to handle complex rendering issues like indirect Illumination. Of all these packages mental ray is well integrated in XSI. XSI shared its architecture with mental ray right from the beginning of its conception as 3d software. Every rendering interface in XSI relates primarily to mental ray and how it works like the shading network, custom frame buffers, everything. There is no other way to render in XSI other than Mental ray. XSI has the best integration of MR[2]

Need for research:

But one of the biggest problems out there for Mental ray is that because it is so complex, and there is no "render beautiful image button", a lot of people give upon it as there isn't really a lot of learning resources on the topic.[7] But it is used so much in movies because people have the time to squeeze every little ounce out of the renderer. It is also true that valuable in depth explanations about rendering with mental and the technology is found to be frustrating. It is necessary to know how things really function behind the scenes so as to improve the workflow in 3d. CG is a creative field but it needs lot of technical know- how to accomplish coherent and well prepared 3d scenes for rendering. As the case with most high end renderers, Mental ray is quite technical. One doesn't have to be physics genius or a programmer to render an average scene. It's fast and reasonably simple to use for everyday renders. But for photoreal film, animation and effects it requires a little more bit of understanding the algorithms and technical aspects of how things work in it. And also there is a widespread idea/ myth that mental ray is slow. It is actually fast if things are done correctly. If not it can be as slow as any other renderer.

My research:

To know how mental ray renders photoreal renders it is necessary to understand how indirect illumination is calculated in it.

Indirect Illumination:

Indirect illumination occurs if light travels from light source to the illuminated points via reflection or transmission by other objects. The technique to capture indirect illumination is called global illumination. It is the simulation of all light interreflection in a scene [3] Rendering with Mental Ray 3rd edition.

Mental ray is loaded with tools to simulate realistic simulation of light surfaces. To generate indirect Illumination mental ray uses three different types of features namely Global Illumination, Final Gather and Irradiance Particles. Although Final gathering is a technique that improves on photon mapping, it can used be alone too.

Mental ray computes GI in two steps, in the first step light in the form of small packets called photons is emitted in the scene and the paths the photons take as they bounce around in the scene are followed. At some point each photon is absorbed by an object or escapes into infinity without hitting anymore object. Each photon is stored at all surfaces with a diffuse component that it hit on its path. All these photons are stored in a three dimensional data structure called Photon map.[3]

In the second step, during rendering the material shaders compute the direct illumination and also add the indirect illumination by collecting nearby photons in photon map and adding their contribution.

If there is sparse photon distribution then illumination computation will have very few photons to work with, and hence it there will less contribution of GI. To address this issue, Final gathering comes in. Final gathering does not look for photons instead it casts huge number of rays into the hemisphere over the illuminated point. Each of these rays measures illumination at its endpoint. And all the results are averaged.

Global Illumination:

Radiosity is the traditional term for global Illumination simulation. It was earlier calculated with sub dividing meshes known as radiosity methods. These methods had large areas of high contrast and worked only with small scenes. It is memory intensive as well.
The photon map method – geometry is decoupled from illumination calculations. With this method, GI can be simulated in very complex scenes with many millions of triangles.
Global Illumination options are examined and can be related to the light options.
Fine tuning the options are also examined. The idea with indirect illumination is to blend enough photons within a given radius so that they appear to form a visually pleasing light simulation.

Final Gathering:

Final gathering is an additional tool for indirect illumination. Unlike GI, FG does not rely on photons to calculate indirect Illumination; it uses raytracing to trace rays from a surface outward into the scene. FG doesn't depend on light source for illumination. It reflects light from various sources that either is affected by a light source or that generate their own radiance by means of a shader.

Understanding how GI and FG works, what are the factors influencing the illumination calculations in these algorithms and how they affect the render time? Addressing issues whether photon mapping and final gathering can be used at the same time, why final gathering is slow, why sometimes images are splotchy.

Irradiance Particles:

The new version of mental ray 3.6+ comes with irradiance particles. The Irradiance Particle algorithm is a method of calculating indirect illumination through importons.[6] Irradiance particles are easy to set up and desirable illumination can be reached much faster than existing global illumination photon tracing combined with final gathering. All the objects in the scene participate in the irradiance particle calculations and hence there is no need to worry about setting up casters and emitters. [4]

A short description of the technique is as follows:
Before rendering importons are shot from the camera. They hit positions, with information on the amount of direct and indirect illumination coming at their position are combined into a map. During rendering the stored particles in the map are used to estimate illumination.

Further study includes:

How irradiance particles work and its set up and the factors influencing the render time? Understanding the parameters on which the irradiance particles work.
Finally after thorough study on these rendering algorithms,

Comparison tests:

My research includes comparative tests between these techniques. The tests were first done on a car modelled by me. As the render times were turning out to be too long, a scene from one of the lighting challenges in CG society was used – namely Natural history Museum scene [5] modelled by Alvaro Luna Bautista and Joel Anderson.. They are mainly in concern with the render quality and render speed.

Rendered with IP [5]

Rendered with GI/FG [5]

Conclusion:

Found this study to be quite useful in understanding the new technique which is comparatively easy to set up and render. Although production quality renders couldn't be achieved in the given time, a little more work on the technique will definitely yield better results. Concluding through the tests is that new irradiance particle technique is indeed faster than the existing GI and FG solutions.

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