Moray Caldwell
i7926926
Personal Inquiry
Notes

Topic: An investigation into 2.5D relighting in Nuke from an artist's point of view.

Aims: To define exactly what is meant by 2.5D relighting and what it entails. To investigate what tools are available to the average artist and what higher end tools are being used in the industry today. What exactly can an artist achieve with relighting a subject at the compositing stage, and what are the pros and cons of doing so. Finally what is the future of relighting at the compositing stage?

Practical elements: Relight a subject using free plug-ins available to the average user. See what the strengths and weaknesses are in regards to the final aesthetic of the relit subject, compare and contrast these with the higher end tools used in industry.

Theory:

Roy Seltzer's masterclass on 2.5D relighting

Sourced from the Foundry website:
http://www.thefoundry.co.uk/pkg_training.aspx?ui=CBC2593A-2C9F-4EF9-84BE-C198B0171453

Notes:

On what is 2.5D relighting: Using Arbitrary Output Variables, ie "the by-poroducts of 3D renders", to manipulate the appearance of light in the 2D comp. Because the Normal Pass and the Point Position Pass use 2D images to represent 3D data, and you're using this data to alter an image in 2D, it is called 2.5D, because it's somewhere in between.

On the pros and cons:

Pros:

- "It's painful, especially with a production pipeline, to back into 3D for another render, particularly for rim lights as you never really know how well they'll fit in until you've comped them".
- It's extremely fast to update, which will save time and money.

Cons:

- It's reliant on occlusion information like shadows and ambient occlusion.
- You can't achieve complex shading models such as sub-surface scattering, so is relatively simple compared to 3D lighting.
- Normal passes aren't anti-aliased so there is some erroneous data in the edges, but this can be smoothed over to a certain degree.

Layout: His tools are much more advanced than tools which are available to the average artist. They consist of four different types – a rim light, a point light, a faux-fresnel tool, and a 3D matte tool.

- The Rim Light: Uses a combination of Normal, Point Position and Ambient Occlusion passes to create a subtle rim light which can be moved around the scene instantaneously.
- The Point Light: Uses Spherical Harmonics (see below) to build a complicated fill-lighting set up with multiple lights which can be moved anywhere in the scene, because of the Spherical Harmonics, this updates extremely fast. You can also do the opposite and use this tool to create a negative light, ie suck light out of the scene.
- The Faux-Fresnel Tool: This tool attenuates the reflections on the surface accurately.

- The 3D matte tool: Roy also demonstrated that these tools can be used to isolate a section of an image and alter it in 2.5D space.

Ravi Ramamoorthi and Pat Hanrahan's paper:
An Efficient Representation for Irradiance Environment Maps

Notes:
This goes in to detail about the mathematics behind the Spherical Harmonics techniques used in Roy Seltzer Nuke script.

Quotes:
"Using an analytic expression for the irradiance in terms of spherical harmonic coefficients of the lighting, we show that one needs to compute and use only 9 coefficients, corresponding to the lowest-frequency modes of the illumination, in order to achieve average errors of only 1%. In other words, the irradiance is insensitive to high frequencies in the lighting, and is well approximated using only 9 parameters. In fact, we show that the irradiance can be procedurally represented simply as a quadratic polynomial in the Cartesian components of the surface normal, and give explicit formulae…The key to our approach is the rapid computation of an analytic approximation to the irradiance environment map. For rendering, we demonstrate a simple procedural algorithm that runs at interactive frame rates, and is amenable to hardware implementation."

My Summary: Using spherical harmonics an irradiance environment map can be averaged down to just 9 coefficients. This greatly speeds up calculation time for irradiance environment maps by dividing the number of texels in the map by 9, so for example even at a low resolution of 64x64, with the texels being 4096, the method would be almost 500 times faster.

Johannes Saam's paper:
Creative Relighting in Compositing Based on Z Depth

Johannes, who was on the MSc in 2007, has created relighting tools for the compositing stage, using the normal and point position passes. They are much like the tools used by Roy Seltzer, but understandably a bit more basic as no occlusion and environment map information are used.

Quotes:
"The faster turnaround times in modern vfx productions force companies and artist to come up with ideas to speed up every part of the pipeline and to be able to change the final image fast. One of the most time consuming steps is the rendering step. Once the parameters are set rendering takes place for a long time. Should lighting and surface properties change re-rendering is very expensive and time consuming. Interactive relighting as a part in compositing is very helpful to archive faster turnarounds… The technique we present in this paper is completely based on the depth information of the scene. Depth layers are never anti-aliased and always available because this information is needed for several things like depth of field simulation. We can extract surface normal and point position from a z-Depth and relight the scene with that."

My Summary: Johannes has created some interesting tools by converting the Z-Depth pass, which are not anti-aliased and therefore do not produce erroneous output, into Normal and Point Position passes. He then uses that information to simulate 3D lighting within Nuke. I will use these tools as part of my practical investigation.

Relighting Plug-in Using Normal Pass
Created by

I have been experimenting with this relighting plug-in and have found it to be fairly restrictive as it only uses normal information and so there for you cannot translate the light along the Z plane. Also the Highlights and shadows remain the same no matter where the light is translated so it does not give accurate lighting representation.

Image Engine showcase of the tools used in District 9

Sourced from the Foundry Website: http://www.thefoundry.co.uk/

This insightful and interesting breakdown of the Nuke relighting techniques used by Image Engine for the film District 9 talks in detail about the Normal and Point pass techniques used, and also some specially invented tools using the point position……

Questions I put to Shervan Shoghian, Compositing Lead at Image Engine

After watching the video by Shervin on the Foundry website, I decided to contact him and put some question to him regarding Nuke Relighting, here is a copy of the Email Conversation:

I wrote:

Hi there Shervin,
My name is Moray Caldwell, and I am a student studying for a Masters in Digital Effects at Bournemouth University. I am looking into relighting techniques in Nuke as part of a research project and I have been looking into methods of doing this using normal and point position passes. I haven't really been able to find all that much in terms of resources on the subject, so I was delighted to eventually find the case study on the Foundry's website detailing the work you did on District 9 for Image Engine. I found it extremely informative and I am wondering if you will answer a few queries I have regarding
relighting in comp?

First of all, I'll explain a bit about the research project I hope to present: Basically I am looking into relighting in Nuke from an artists point of view as I am not particularly technically minded. So it will basically be an overview of the options that an artist would have in order to relight a subject in comp.

I was wondering if you could tell me a bit more about the techniques you used in District 9 using these and perhaps the pros and cons of relighting at the post production stage?
Are these techniques, or similar relighting techniques extremely technical to implement with Gizmos or do you think an 'artistically' (i.e not very clever!) minded person such as myself could create tools to get similar results with Normal and Point Position passes?
How do you think Nuke compares to Shake in terms of scope and means of relighting subject at the compositing stage?

Finally, do you know of any other effects companies/shows that implemented similar relighting techniques that I could look into?

I realize that you are probably extremely busy right now and may not have the time to give me a blow by blow account of exactly how you achieved your results, but any information you could give me would be greatly appreciated and a massive help towards my project. Thank you very much for your time and I look forward to your reply.

Kind Regards,

Moray Caldwell

Shervan wrote:

Hey Moray,

No problem at all, I would be happy to help.

Well first off, at Image Engine we used a technique of using Normals, Point Position Pass and a Pref pass. We developed a tool inside of Nuke (python, C++) to take these passes and use them in conjunction with Nuke's lights. This way we can move the lights in 3D space and see there effect on the model which was shown as a point cloud system. This made it interactive so the artists could move these lights in world space. The one additional element that is required is the usage of shaders. We had a diffuse shader, specular shader, reflection, bump ..etc. Our RnD team developed these shaders to work with our relighting plugin. In essence we could then apply these shaders and get back a specular render, or diffuse..etc out of Nuke. The shader required quite a bit of programming. And although they worked for our needs they weren't exactly perfect. One major drawback to this system is dealing with more complex shader models..ie we couldn't so subsurface, or shadowing inside of nuke. So our relighting was to touchup the renders and not necessarily redo the lighting. For that you would need a proper rendering program. Although Nuke's scanline render is cool, its not cool enough to render really complex shaders.So can an artist program this stuff with no programming back knowledge and make a gizmo. Probably could make something to get by on. But you would need to dive deep into the nuke API to get the most power out of the tools.
No all this relighting stuff sounds cool, but I would say its going to be quite old once Nuke and Katana merge into one program. The line between 2D & 3D is bluring with every release. Even programs like Fusion are starting to include complex shaders into the comp package. So perhaps relighting won't be an issue anymore. Perhaps an artist would
just light the shots.Nuke far exceeds Shake in every aspect of relighting. Just the inclusion of a proper 3D workspace makes relighting an object more simpler.Pixar and ILM i believe have there own relighting programs. I've seen the pixar tool video floating around somewhere on the web.

hope that helps.

all the best

Shervin.

Article: Foundry Acquires Katana from SPI for Nuke

Sourced from fxguide.com: http://www.fxguide.com/article570.html

Shervan Shogian mentioned that The Foundry had merged Katana with Nuke and I though I would investigate this further. Katana was created by Sony Pictures Imageworks as an in-house Lighting and Compositing package. It started life as a 3D lighting package and it appears that The Foundry acquired it for these features. It looks as if the world of 2D and 3D are merging closer and closer together and the term 2.5D will no longer be needed in the future, as all the lighting will be done in 3D space within the compositor.

Website on Light Interaction, created by John Jattoh

This website, created for the NCCA Symposium 2009, gives a very informative investigation into the properties of light, how it behaves in different situations and how an artist can utilise this. This will be useful in my practical evaluations of the relighting plugins in assessing how good they are recreating different lighting positions.

Other related relighting papers

Researching this topic I have also come across many different ways to relight a subject using alternative 3D techniques, such as Pixars real-time renderer Lpics, Debevec's technique of relighting human subject using 3D scanning and a specialized performance relighting rig, and Nishino and Nayar's novel way of creating environment maps by extracting light information from the cornea of the eye. While these topics have not been exactly what I've been looking for they have given me an idea of the number of different approaches that can be taken to relight a subject.

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