

Mastering the 3D Experience

Track: Designing Rich Content



The 2005 Macromedia Conference



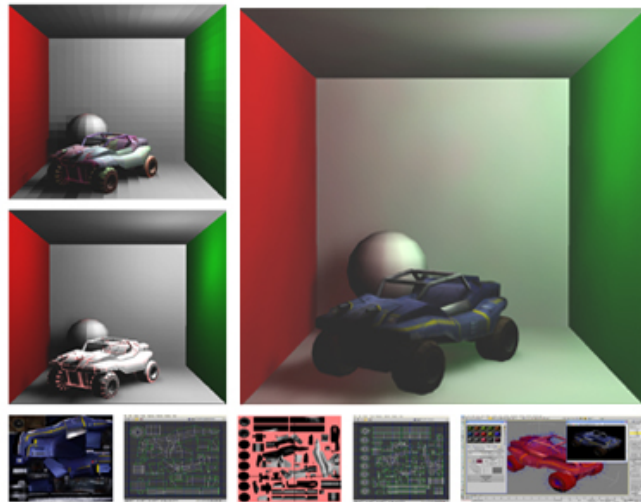
A Demonstration of a Shockwave 3D Authoring Tool at Macromedia MAX 2005

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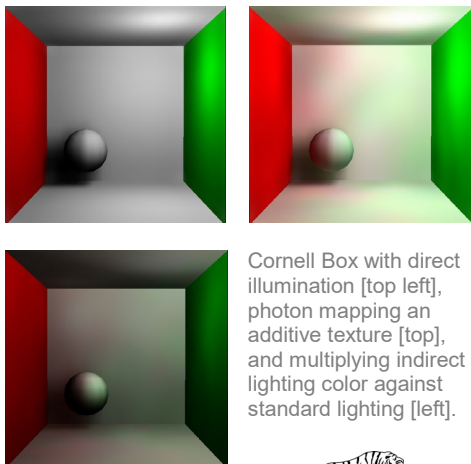
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“Lightmapping” refers to the concept of pre-rendering a light/shadow map into the texture of an object, and then using this texture instead of, or in addition to, the normal scene lighting. Typically, these maps are done to display shadows, which are notoriously expensive on all but the latest graphics cards (and even then, the typical methods of stencil shadow volumes are exceedingly more expensive than a simple texture map). While the generation of a lightmap can take hours, the performance of the end-user is not affected at all, beyond the slight penalty of additional graphics memory overhead. This technique has been a staple of the games industry for quite some time, and has been extensively documented. [1][2][3]



In addition to shadows, lightmapping can simulate a number of other lighting effects, all of which can be pre-baked into the object’s texture map. The rule of thumb is that if a given technique is non-view-dependant (diffuse lighting, standard bump-mapping, etc), then it can be adapted to the lightmapping algorithm. Effects that rely on the user’s view orientation (specular lighting, mirror reflection, etc.) cannot be easily simulated in this fashion.

The lightmapper demo here makes use of a relatively new technique called “photon mapping” which simulates the transport of light from surface to surface, and which was introduced by Henrik Jensen. [4] As light strikes a given surface, there is some probability that instead of being absorbed, it will be reflected. The exact angle of this reflection can either be randomly assigned or (more accurately) described through a Bi-Directional Reflectance Function (BRDF) for the material. Each unit of light that is cast out from a light source and reflects in this fashion around the scene is described as a *photon*. To render a given point in the texture of an object, the world-space coordinate of that point is obtained, and direct illumination measured through standard diffuse lighting equations. Note that by smoothly interpolating across the triangle at each texel relative to the vertex normals, a much smoother shading implementation can be derived than the standard lighting pipeline used by Shockwave 3D, as real-time calculation is not a concern.[5]



Cornell Box with direct illumination [top left], photon mapping an additive texture [top], and multiplying indirect lighting color against standard lighting [left].



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Next, the photons that have been absorbed into the surrounding surface are sampled for their relative power, where the reflection of the absorbed photon is greater than one (ie where the light is bouncing from an indirect source). The direct and indirect lighting are added, along with an ambient component, to produce the final values that are written to the texture map. This map is then used in place of the default lighting generated by Shockwave 3D, and any other textures for a given material are simply multiplied on top of, or blended beneath, the lightmap. The demo provided shows a standard “Cornell Box” [6] with one red and one green wall such that color bleeding can be observed, where light strikes a colored wall and is then reflected back into the scene.



A jeep model with standard 3D lighting (top left), smoothed diffuse lighting (top middle), a default texture (top right), indirect lighting (lower left), the sum of direct and indirect lighting (lower middle), and the final composited lighting and texturing layers (bottom right). A detailed final view is shown to the right.

| Purpose of Control | |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <p>LIGHTMAP RESOLUTION: 4x4 Pixel Maps 8x8 Pixel Maps 16x16 Pixel Maps</p> | Select the resolution of the maps generated. Maps are stored in the “Lightmaps” cast after generation. |
| <p>BLUR LEVELS: 3</p> | Select the number of times a Gaussian filter is applied to the maps. |
| <p>PHOTONS: 1000 50</p> | Set the number of photons emitted per light (the first number) and the number of photons sampled per lumel. |
| <p>USE PHOTON MAPPING: <input checked="" type="checkbox"/></p> | Whether or not to use photon mapping to measure indirect lighting in addition to direct lighting (slower). |
| <p>CASTING PHOTON: 999</p> | Render all objects into lightmaps, store the lightmaps in the appropriate cast, and display the scene. |
| <p>ACTIVE LIGHT: 2</p> | See a low-res set of lightmaps that were rendered in advance using this tool. |
| <p>OBJECT: Wall6</p> | See a high-resolution set of lightmaps that were rendered in advance using this tool. |
| <p>LUMEL X: 15 Y: 15</p> | |
| <p>PIXEL X: 15 Y: 15</p> | |
| <p>RENDER ALL LIGHTMAPS</p> | |
| <p>PRE-RENDERED LOW-RES</p> | |
| <p>PRE-RENDERED HIGH-RES</p> | |

| Files contained in this demo: | | |
|-------------------------------|-----------|-------------------------|
| File | Directory | Description |
| LightmapDemo.dir | Source | Director source. |
| Lightmapper.pdf | Doc | This documentation file |

Andrew Phelps regularly publishes work at the Macromedia DevNet Center and the Director Online article repository [www.director-online.com], and is the editor for the Director column in the MX Developer’s Journal.

[1] Miller, Kurt. “Lightmaps (Static Shadowmaps)” FlipCode. August 16th, 1999. Available Online: http://www.flipcode.com/articles/article_lightmaps.shtml

[2] Robbins, Brian. “Generating Lightmaps for Director / Shockwave 3D Using 3dsMAX 5” Macromedia MAX 2004, New Orleans, October 2004. <http://www.dubane.com/cons/max2004/helpers/lightmapping.html>

[3] Hodorowicz, Luke. “Advanced Lightmapping.” FlipCode. March 12th, 2001. Available Online: http://www.flipcode.com/articles/article_advlightmapping.shtml

[4] Jensen, Henrik. *Realistic Image Synthesis Using Photon Mapping*. 1st Edition. AK Peters, Ltd. July 2001.

[5] Dutre, Phillip, Phillippe Bekaert and Kavita Bala. *Advanced Global Illumination*. AK Peters, Ltd. July 2003.

[6] Cornell University Program of Computer Graphics. “The Cornell Box.” January 2nd, 1998. Cited August 2005. Available online: <http://www.graphics.cornell.edu/online/box/>

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