Irradiance caching

Greg Ward, Francis Rubinstein and Robert Clear:
“A Ray Tracing Solution for Diffuse Interreflection".

Idea: Irradiance changes slowly → interpolate.
Box: Irradiance Caching
Box: Irradiance Caching

1000 sample rays, $w > 10$
Box: Irradiance Caching

1000 sample rays, $w > 20$

H. Wann Jensen
Box: Irradiance Caching

5000 sample rays, \( w > 10 \)

H. Wann Jensen
Photon mapping

A two-pass method

Pass 1: Build the photon map (photon tracing)
Pass 2: Render the image using the photon map
Two photon maps

global photon map

caustics photon map
The Rendering Equation

\[ L_r(x, \vec{\omega}) = \int_{\Omega_x} f_r(x, \vec{\omega}', \vec{\omega}) L_i(x, \vec{\omega}') \cos \theta' \, d\omega' \]
The Rendering Equation

\[ L_r(x, \hat{\omega}) = \int_{\Omega_x} f_r(x, \hat{\omega}', \hat{\omega}) L_i(x, \hat{\omega}') \cos \theta' \ d\omega' \]

Split incoming radiance:

\[ L_i = L_{i,d} \underbrace{\text{direct}}_{\text{direct}} + L_{i,c} \underbrace{\text{caustics}}_{\text{caustics}} + L_{i,d} \underbrace{\text{soft indirect}}_{\text{soft indirect}} \]
The Rendering Equation

\[ L_r(x, \bar{\omega}) = \int_{\Omega_x} f_r(x, \bar{\omega}', \bar{\omega}) L_i(x, \bar{\omega}') \cos \theta' \, d\omega' \]

Split incoming radiance:

\[ L_i = L_{i,d} + L_{i,c} + L_{i,d} \]

\begin{align*}
\text{direct} & \quad \text{caustics} & \quad \text{soft indirect}
\end{align*}

Split the BRDF

\[ f_r = f_{r,d} + f_{r,s} \]

\begin{align*}
\text{diffuse} & \quad \text{specular}
\end{align*}
The Rendering Equation

\[ L_r = \int_{\Omega_x} f_r L_i \cos \theta' d\omega' \]
The Rendering Equation

\[ L_r = \int_{\Omega_x} f_r \, L_i \cos \theta' \, d\omega' \]
\[ = \int_{\Omega_x} f_r \, L_l \cos \theta' \, d\omega' + \text{direct} \]
The Rendering Equation

\[ L_r = \int_{\Omega_x} f_r \ L_i \ \cos \theta' \ d\omega' \]
\[ = \int_{\Omega_x} f_r \ L_l \ \cos \theta' \ d\omega' + \text{direct} \]
\[ \int_{\Omega_x} f_{r,s} (L_{i,c} + L_d) \ \cos \theta' \ d\omega' + \text{specular} \]
The Rendering Equation

\[ L_r = \int_{\Omega_x} f_r L_i \cos \theta' \, d\omega' \]
\[ = \int_{\Omega_x} f_r L_l \cos \theta' \, d\omega' + \text{direct} \]
\[ + \int_{\Omega_x} f_{r,s} \left( L_{i,c} + L_d \right) \cos \theta' \, d\omega' + \text{specular} \]
\[ + \int_{\Omega_x} f_{r,d} L_c \cos \theta' \, d\omega' + \text{caustics} \]
The Rendering Equation

\[ L_r = \int_{\Omega_x} f_r L_i \cos \theta' d\omega' \]

\[ = \int_{\Omega_x} f_r L_l \cos \theta' d\omega' + \text{direct} \]

\[ + \int_{\Omega_x} f_{r,s} (L_{i,c} + L_d) \cos \theta' d\omega' + \text{specular} \]

\[ + \int_{\Omega_x} f_{r,d} L_c \cos \theta' d\omega' + \text{caustics} \]

\[ + \int_{\Omega_x} f_{r,d} L_d \cos \theta' d\omega' + \text{soft indirect} \]
Practical Global Illumination With Irradiance Caching
(SIGGRAPH 2008 Class) August 2008

H. Wann Jensen
Rendering: direct illumination
Rendering: specular reflection
Rendering: caustics
Rendering: indirect illumination
No Importance Sampling
Importance Sampling

(Using the 50 nearest photons)
Photon mapping + irradiance caching
Fractal box
Mies house (2pm)
Participating Media

H. Wann Jensen
Radiance Caching

- cache point
- valid radius
Gradient Evaluation

\[ L_\omega(x, \omega) = \int_A p(\omega, x' \rightarrow x) L_r(x' \rightarrow x) V(x' \rightarrow x) H(x' \rightarrow x) \, dx' \]

\[ \nabla L_\omega(x, \omega) = \int_A (\nabla p) L_r V H + p(\nabla L_r) VH + pL_r V(\nabla H) \, dx' \]
Radiance Caching Results

H. Wann Jensen
JMore Details

Wojciech Jarosz, Craig Donner, and Henrik Wann Jensen

"Advanced Global Illumination Using Photon Mapping"

Course this afternoon... in this room...