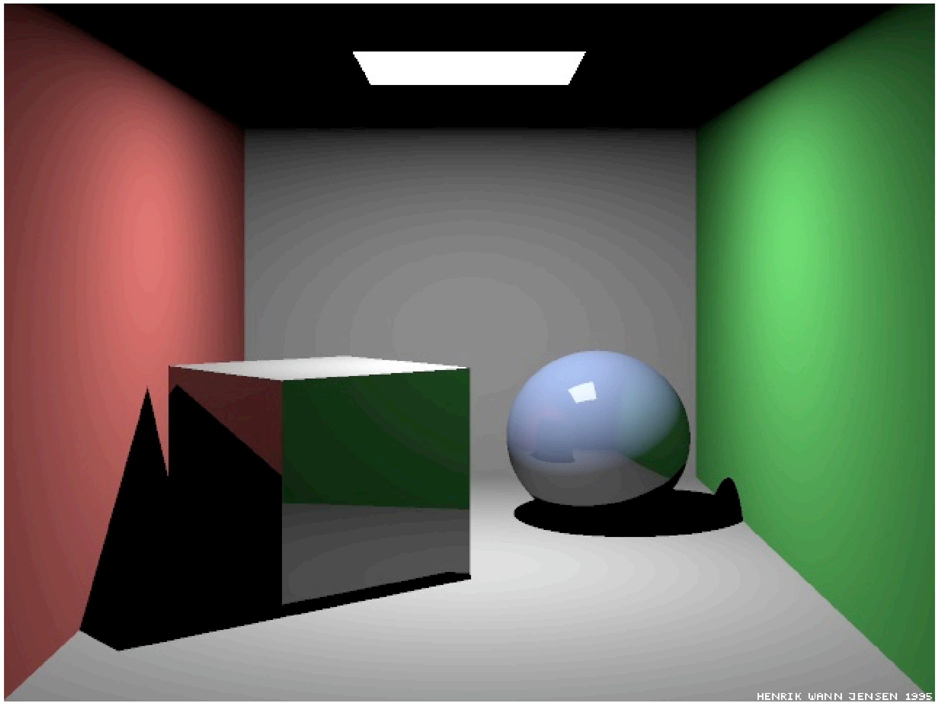
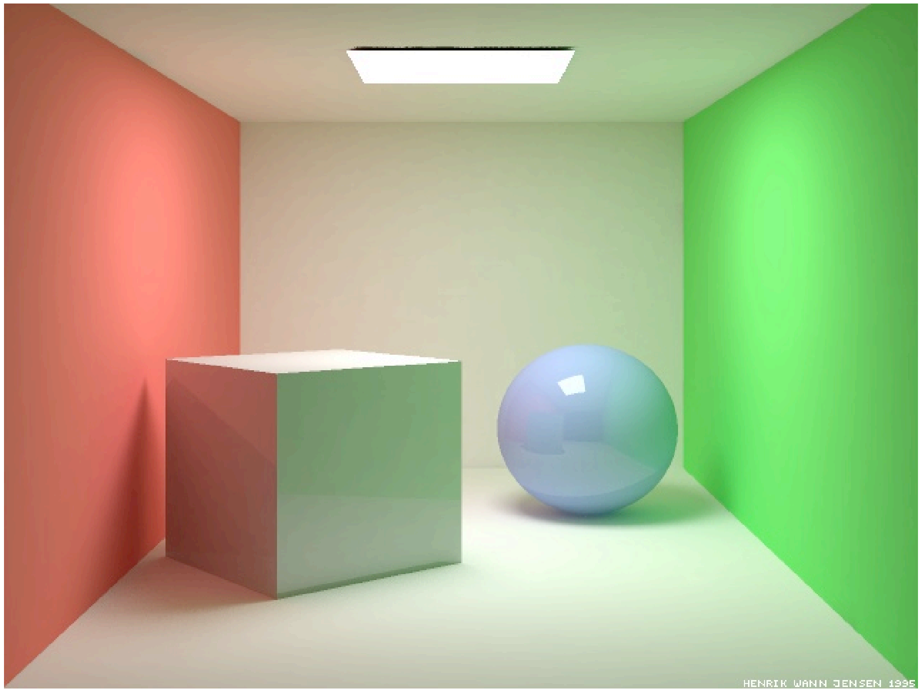
Radiosity





Ray-traced Cornell box, due to Henrik Jensen,
http://www.gk.dtu.dk/~hwj

Radiosity Cornell box, due to Henrik Jensen,
http://www.gk.dtu.dk/~hwj, rendered with ray tracer

Radiosity

Want to capture the basic effect that surfaces illuminate each other

Again, following every piece of light from a diffuse reflector is impractical--but combinations of brute force and clever hacks can be done

Another approach: Radiosity methods

Radiosity

Think of the "world" as a bunch of patches. Some are sources, (and reflect), some just reflect. Each sends light towards all the others.

Consider one color band at a time (some of the computation is shared among bands).

Each surface, i, *radiates* reflected light, B_i

Each surface, *emits* light E_i (if it is not a source, this is 0).

Denote the albedo of surface i as ρ_i

Radiosity equation

$$B_i = E_i + \rho_i \sum_j F_{j \to i} B_j \frac{A_j}{A_i}$$

The form factor $F_{j \to i}$

is the fraction of light leaving dA_j arriving at dA_i
taking into account orientation and obstructions

Useful relation

$$A_i F_{i \rightarrow j} = A_j F_{j \rightarrow i}$$

The equation now becomes

$$B_i = E_i + \rho_i \sum F_{i \rightarrow j} B_i$$

Rearrange to get

$$B_i - \rho_i \sum F_{i \rightarrow j} B_i = E_i$$

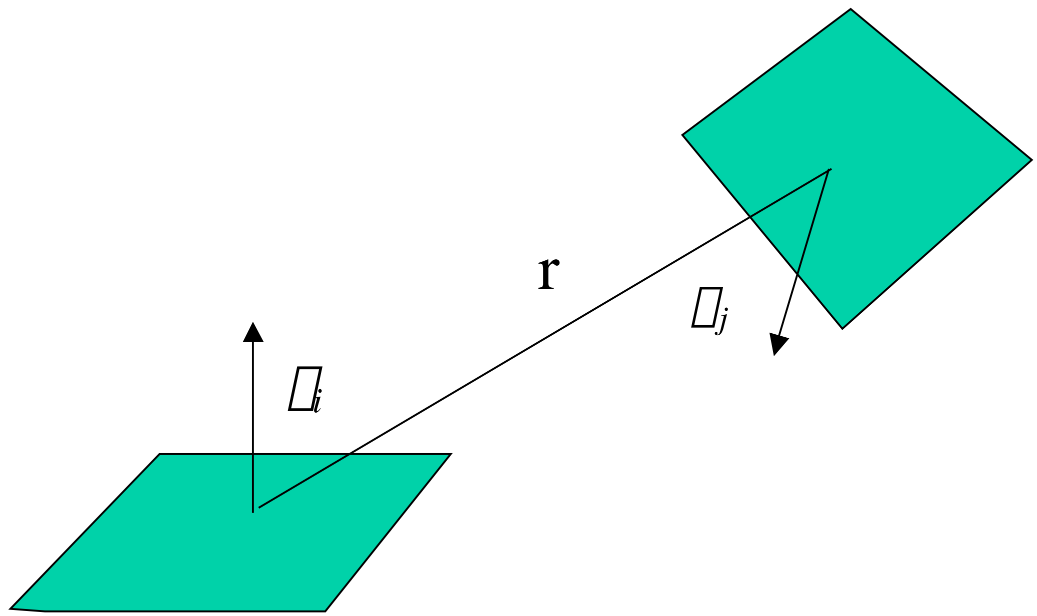
In matrix form

$$\begin{bmatrix} 1-\rho_1 F_{1\to 1} & -\rho_1 F_{1\to 2} & \cdots & -\rho_1 F_{1\to n} \\ -\rho_2 F_{2\to 1} & 1-\rho_2 F_{2\to 2} & & -\rho_2 F_{2\to n} \\ & & & \\ -\rho_n F_{n\to 1} & -\rho_n F_{n\to 2} & & 1-\rho_n F_{n\to n} \end{bmatrix} \begin{bmatrix} B_1 \\ B_2 \\ \\ B_n \end{bmatrix} = \begin{bmatrix} E_1 \\ E_2 \\ \\ E_n \end{bmatrix}$$

So, in theory, we just compute the Bi's by solving this (large!) matrix equation. (Gauss-Sidel method is applicable) Optional

The fun part: Computing the $F_{i \rightarrow j}$

Without obstruction $dF_{dj \rightarrow di} = \frac{\cos\theta_i \cos\theta_j}{r^2} dA_j$



Optional

Fancy methods exist for of computing and/or approximating storing form factors (e.g. hemisphere and hemi-cube methods)

Can combine with visibility computations

See book §11.2 for more details

Previous equation is in terms of energy received

Can also do energy emitted

$$B_j \quad due \ to \ \ B_i \ \ is \ \ p_j B_i F_{j \to i}$$

Rewrite as

$$B_j \quad due \ to \ \ B_i \ \ is \ \ p_j B_i F_{i \to j} \frac{A_i}{A_j}$$

Now *cast* energy. Advantage: Can do successive approximation