CSE-170 Computer Graphics

Lecture 26

Radiosity

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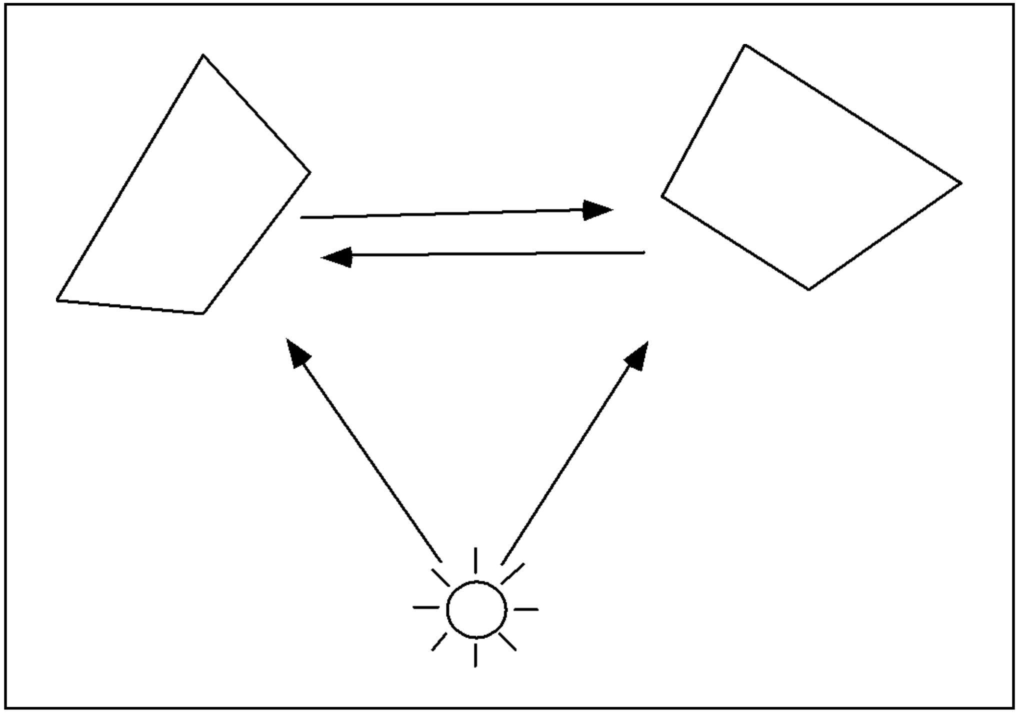
Global Illumination Methods

- Ray tracing
  – Reflection from other objects
  – Shadows
  – Transparency
  – Transmission (refraction)

- Is anything missing?

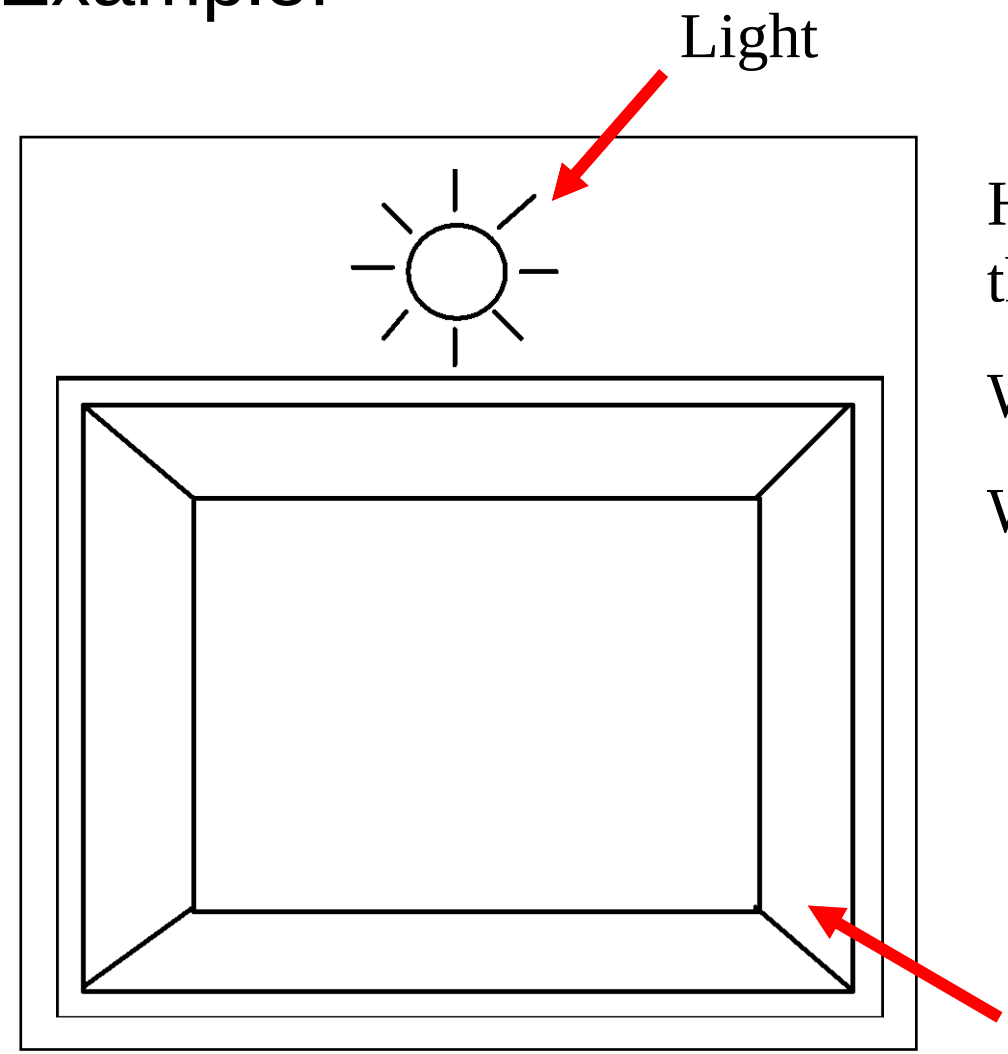
Ambient Light

- What is really ambient light?
  – Ambient light does not really exist!
  – It should be light reflecting from other surfaces



Ambient Light

- Example:

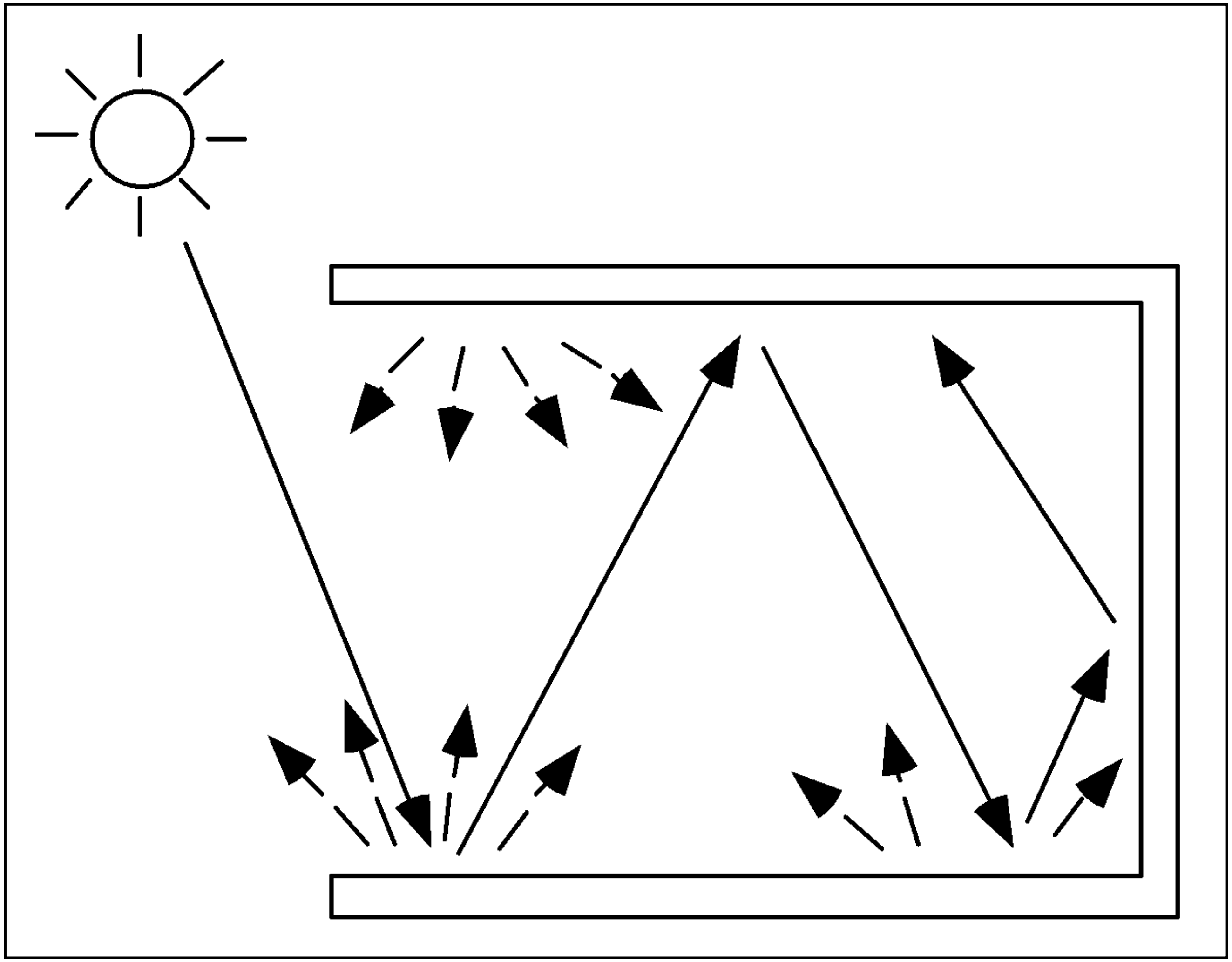


How will OpenGL draw this box?

What about ray tracing?

What about nature?

Ambient Light



Radiosity

- There are diffuse and specular interactions everywhere!

- Radiosity Principle
  - Conservation of energy
  - Light is either absorbed or reflected
    - Every piece of surface is a diffuse reflector and an emitter!
    - No more need to have "special" light element

Radiosity

- Based on radiative heat transfer
  - Cornell, Goral et al. 1984
    - Hemicube algorithm $O(n^2)$

- Summary
  - Every surface in the scene is divided in patches
  - Each patch reflects light received from all others, until energy equilibrium
  - Light intensity is constant along each patch
    - Chosen subdivision is therefore very important

Radiosity

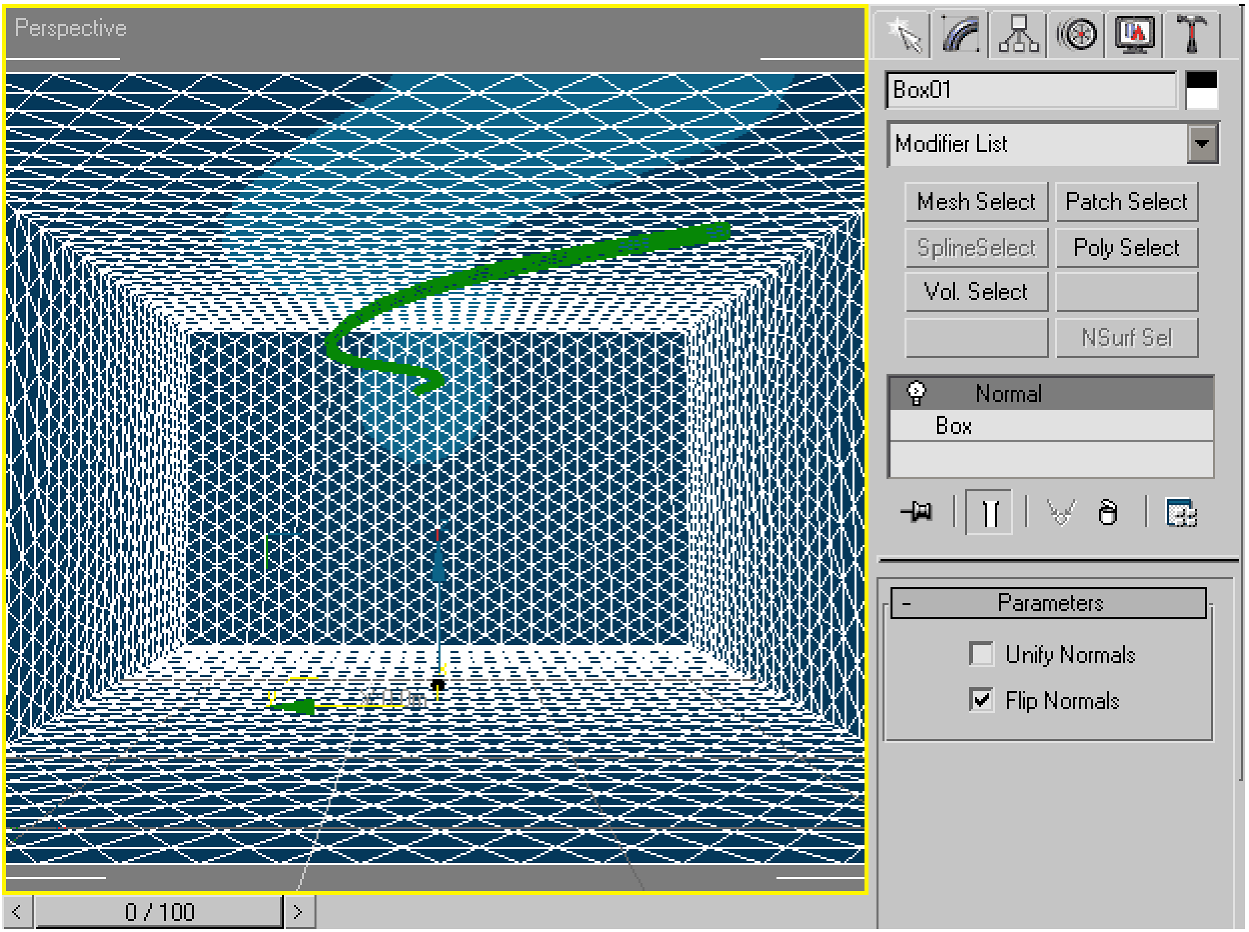
- Radiosity is very realistic!

- It is viewer independent
  - After computation, a renderer computes a camera projection and hidden surface removal

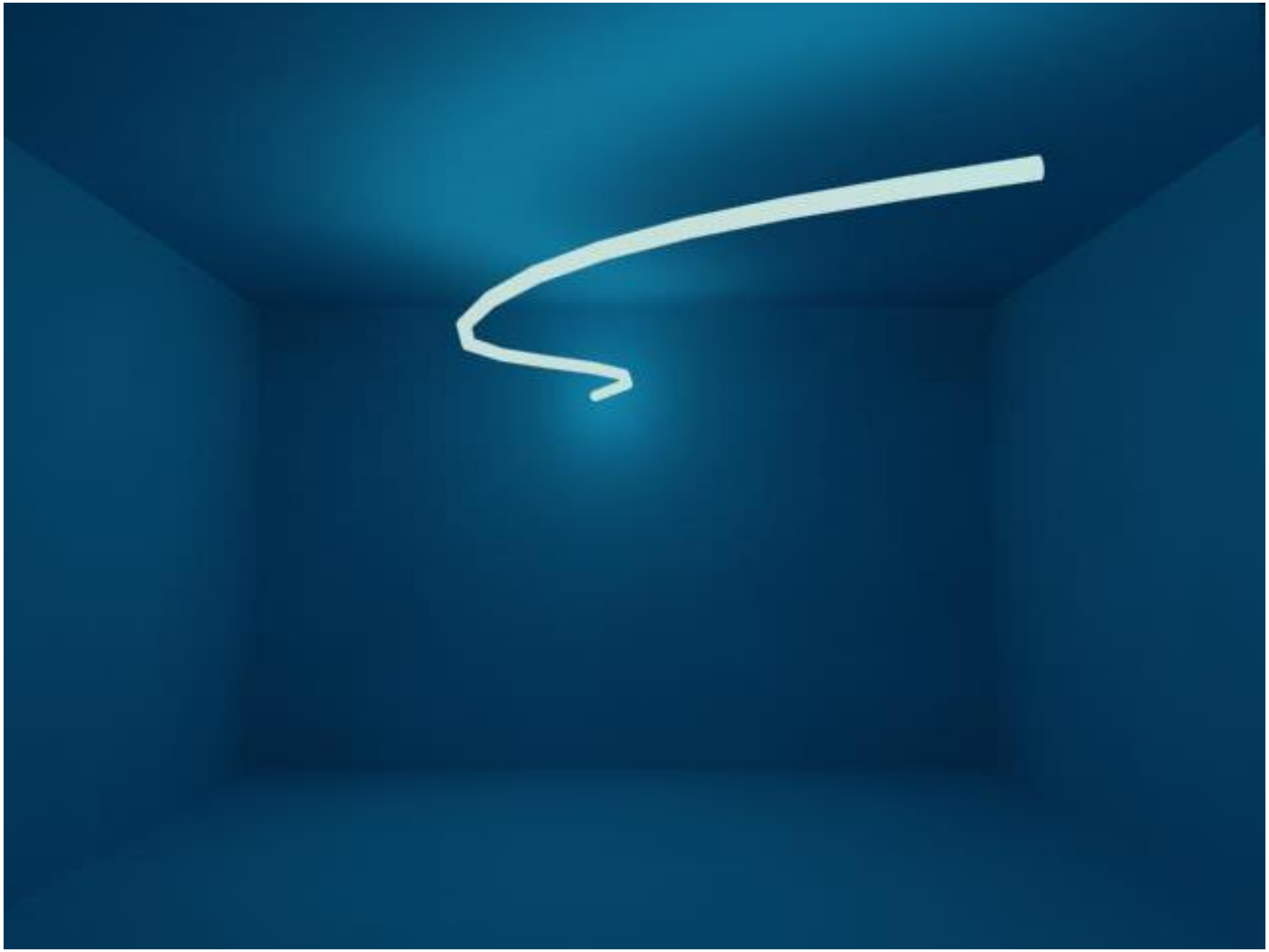
- Comparison with Ray Tracing:
  - Radiosity alone does not incorporate specular interaction
  - Ray tracing cannot compute diffuse interaction

Radiosity

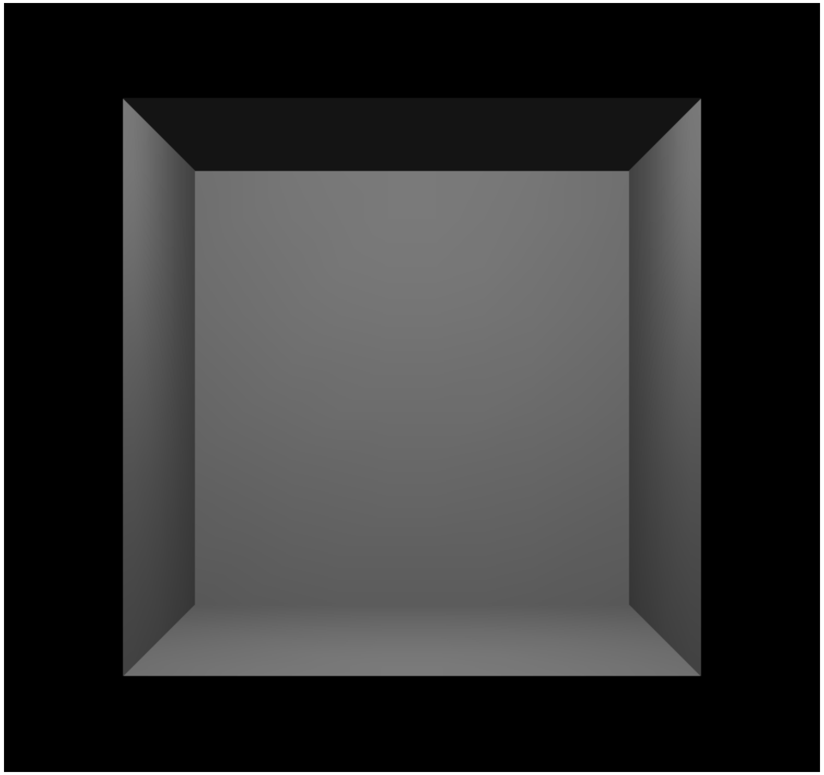
– Regular Scene Subdivision Example (adaptive subdivision is always better)



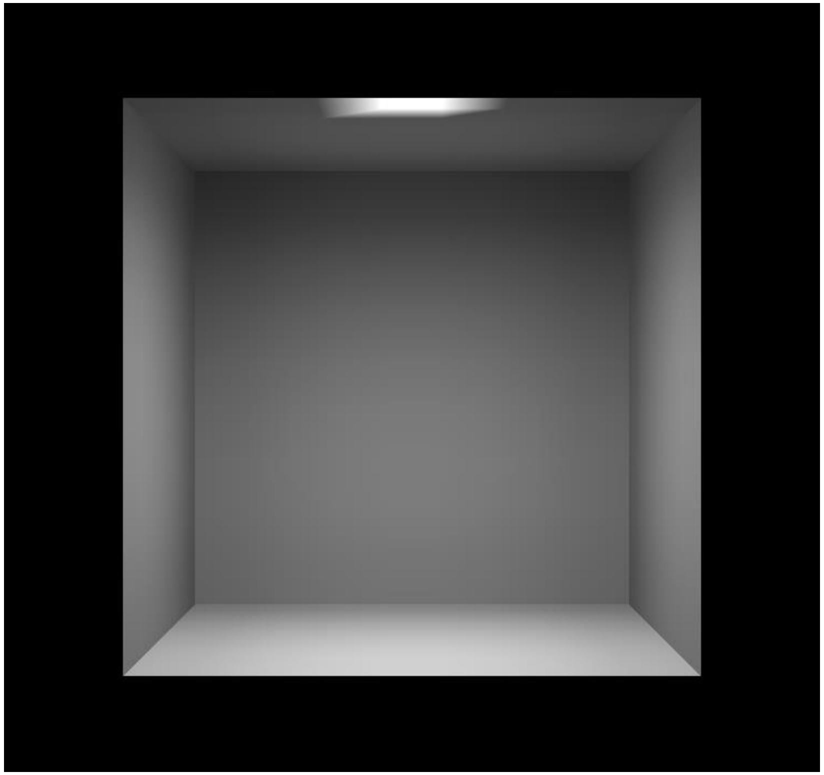
Radiosity



Radiosity

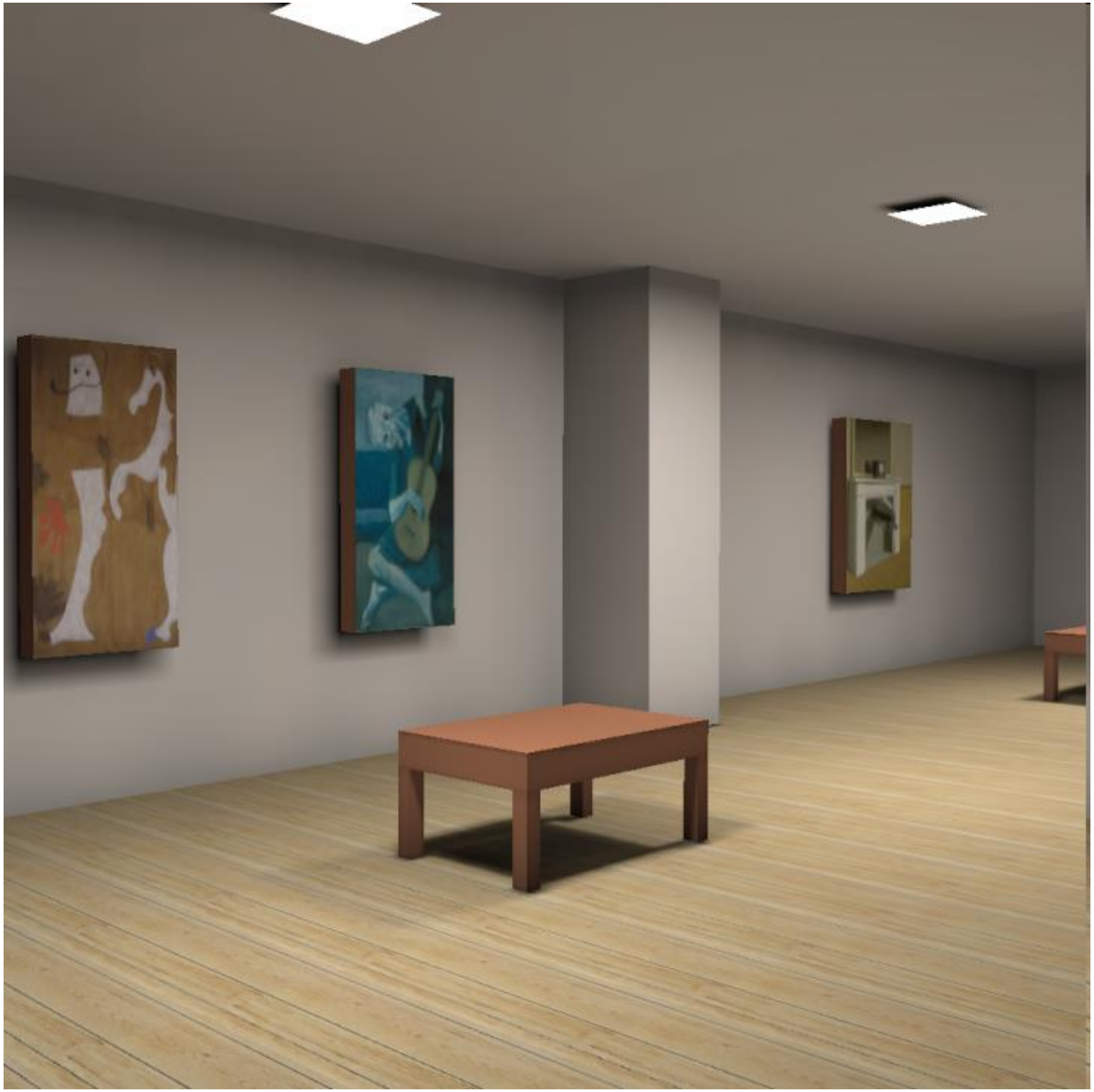


OpenGL Rendering



Radiosity Rendering

Radiosity



Radiosity

- Basic Method: (https://en.wikipedia.org/wiki/Radiosity_(computer_graphics))

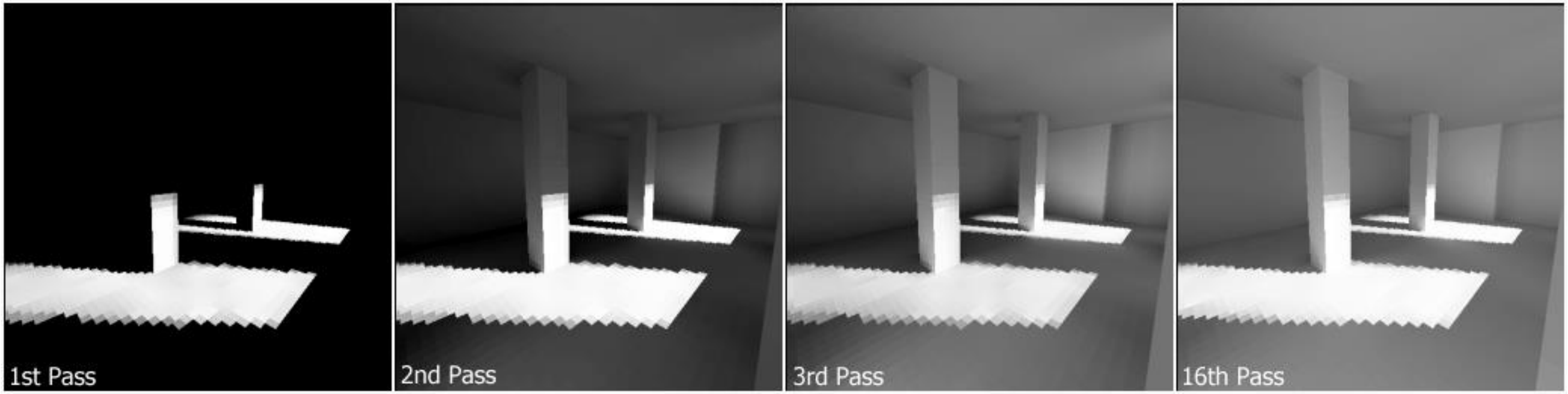
radiosity B is the energy per unit area leaving the patch surface per discrete time interval and is the combination of emitted and reflected energy:

$$B(x)\,dA = E(x)\,dA + \rho(x)\,dA \int_S B(x')\frac{1}{\pi r^2}\cos\theta_x \cos\theta_{x'} \cdot \mathrm{Vis}(x,x')\,\mathrm{d}A'$$

where:

- $B(x)_i$ dA_i is the total energy leaving a small area dA_i around a point x.
- $E(x)_i$ dA_i is the emitted energy.
- $\rho(x)$ is the reflectivity of the point, giving reflected energy per unit area by multiplying by the incident energy per unit area (the total energy which arrives from other patches).
- S denotes that the integration variable x' runs over all the surfaces in the scene
- r is the distance between x and x'
- θ_x and $\theta_{x'}$ are the angles between the line joining x and x' and vectors normal to the surface at x and x' respectively.
- Vis(x,x') is a visibility function, defined to be 1 if the two points x and x' are visible from each other, and 0 if they are not.

Radiosity



Review

Part II – Modeling

- Geometric Modeling
  - Lagrange Interpolation
  - Hermite Formulation
  - Bézier
    - Geometric construction (De Casteljau method), Properties, Subdivision, Degree Elevation, Cubic Patches, Rational and Non-Rational
  - B-Splines, Rational B-Splines, NURBS
  - Interpolating Splines
    - Catmull-Rom, Bessel-Overhauser
  - Subdivision Surfaces

Part II – Modeling

- Solid Modeling
  - Implicit Curves and Marching Cubes
  - Primitive Instancing
  - CSG Representation and operations
  - Spatial Enumeration and Decomposition
    - Quad trees, Octrees, BSP trees
  - Boundary Representation
    - Euler Formula, Topological Classes, Plane Models, Data Structures
  - Global Illumination: Raytracing

Final Exam: Monday 8:00 AM

- From Part I:
  - Composition of transformations
- Main topics from Part II:
  - Parametric curves
  - Hermite, Bézier and B-Splines
  - Quadtrees
  - CSG
  - Marching Cubes
  - Representation of curves
  - Euler formula
  - etc.