

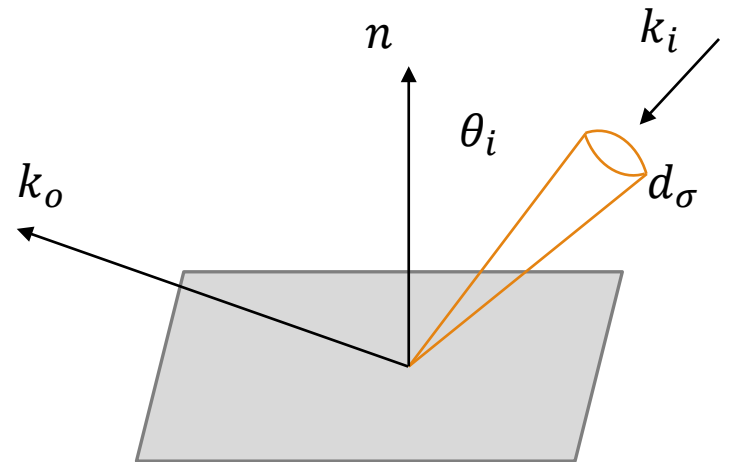
AI5505: Photorealistic Rendering

Light Transport Equation

Lecturer: Bochang Moon

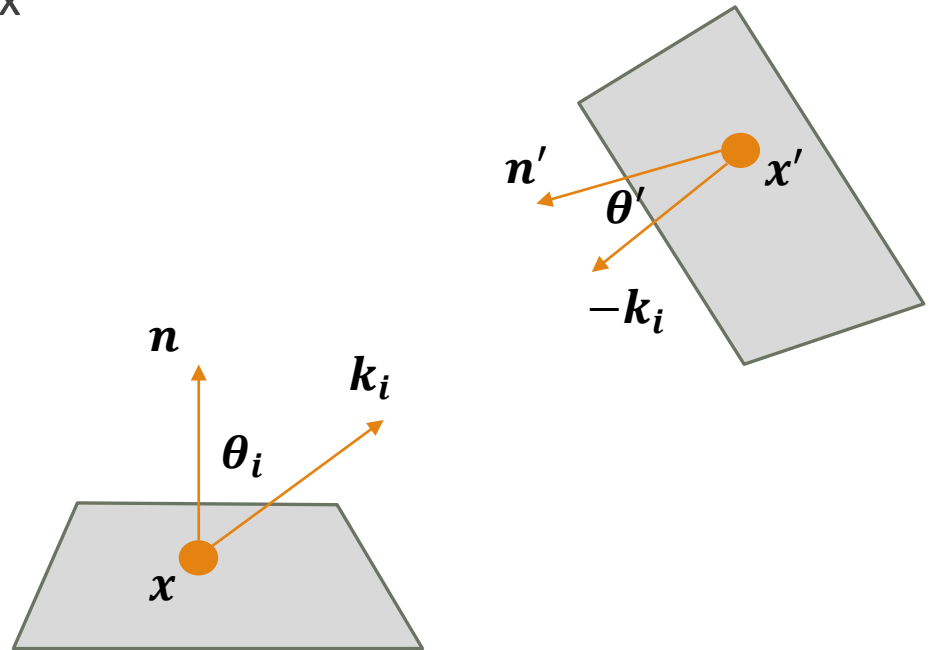
Transport Equation

- $L_s(k_o) = \int_{all\ k_i} \rho(k_i, k_o) L_f(k_i) \cos\theta_i d\sigma_i$
 - $L_f(k_i)$: field radiance from k_i direction
 - $L_s(k_o)$: surface radiance measured in k_o direction
 - *Rendering equation* [Immel, Cohen & Greenberg, 1986]
 - We can also write the equation with surface radiances only [Kajiya, 1986]



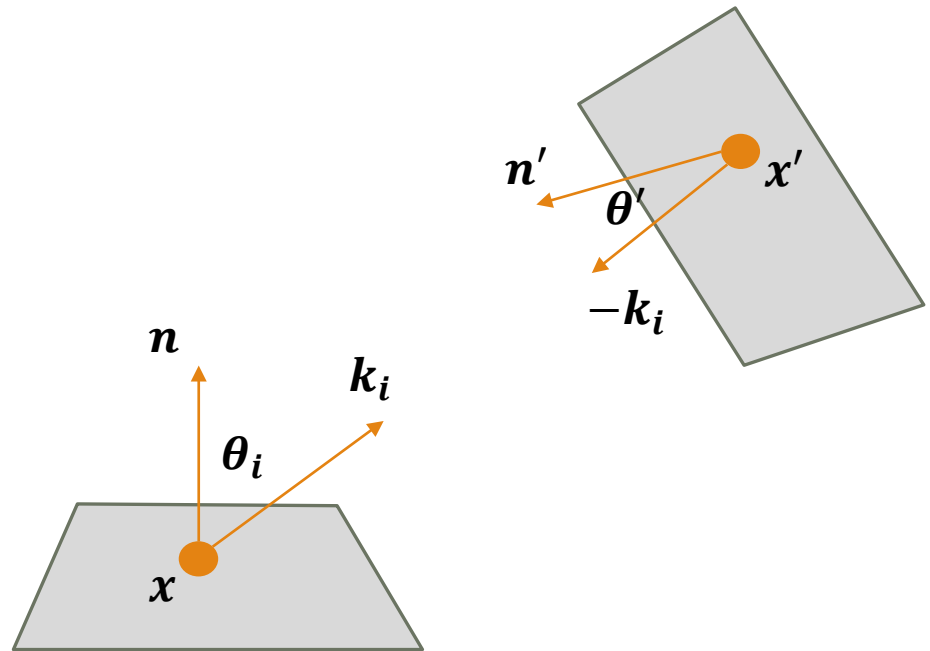
Transport Equation

- $L_s(k_o) = \int_{all\ k_i} \rho(k_i, k_o) L_f(k_i) \cos\theta_i d\sigma_i$
- $L_s(-k_i) = L_f(k_i)$
- Solid angle subtended by the point x'
 - Area on a unit sphere
 - $\Delta\sigma_i = \frac{\Delta A' \cos\theta'}{||x-x'||^2}$
 - $\Delta A'$ is the area associated with x'
- Differential solid angle
 - $d\sigma_i = \frac{dA' \cos\theta'}{||x-x'||^2}$



Transport Equation

- $$L_s(k_o) = \int_{\text{all } x' \text{ visible to } x} \frac{\rho(k_i, k_o) L_s(x', x-x') \cos \theta_i \cos \theta'}{|x-x'|^2} dA'$$



Transport Equation

- $$L_s(k_o) = \int_{all\ x'} \frac{\rho(k_i, k_o) L_s(x', x - x') v(x, x') \cos \theta_i \cos \theta'}{||x - x'||^2} dA'$$
 - Rendering equation [Kajiya, 1986]
 - $v(x, x')$: visibility function
 - 1 if x and x' are mutually visible
 - 0 otherwise

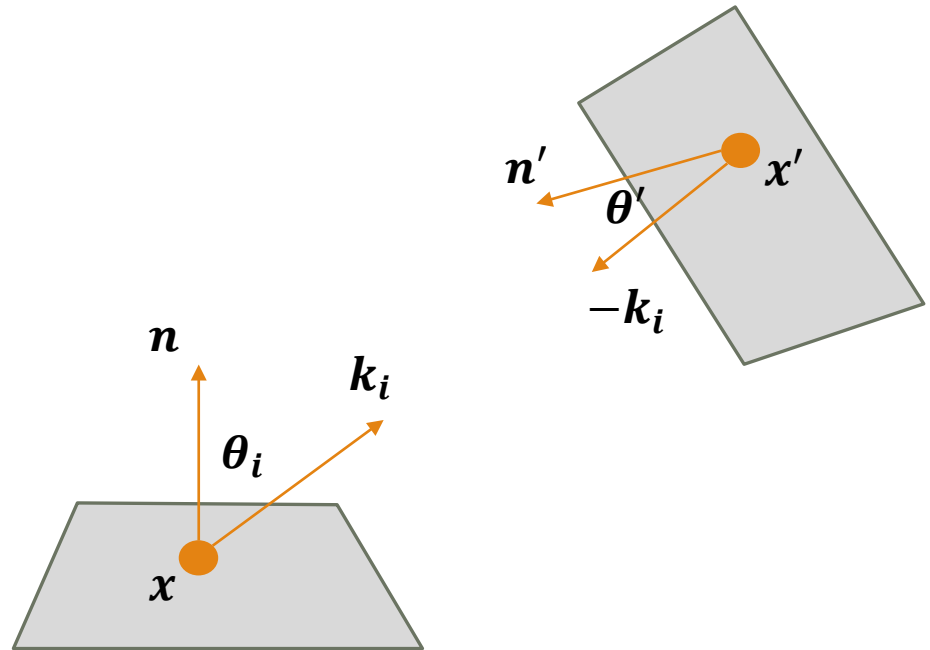


Image Contribution Function

- The value of pixel j :
- $I_j = \int_{\Omega} h_j(x)L(x)d\Omega$
 - Note that we aim to reconstruct a discretized 2D function (i.e., a raster image)
 - $L(x)$: radiance from x
 - h_j : a pixel reconstruction filter of pixel j
 - Typically it depends on the samples' image positions
 - What are the examples?
 - Box filter
 - Gaussian filter
 - Polynomial filters

Image Contribution Function

- The value of pixel j :
- $I_j = \int_{\Omega} h_j(x)L(x)d\Omega$
- Primary sample space formulation:
 - The integration domain Ω can be considered $[0,1)^d$
- e.g.,
 - A typical implementation of path tracing relies on a random number generation that draws uniform samples x
 - Light path vertices are determined by the random samples
 - It always returns a radiance value $L(x)$

Path Space Formulation

- The value of pixel j :
- $I_j = \int_{\mathcal{P}} h_j(\bar{x}) L(\bar{x}) d\mu(\bar{x})$
 - $\bar{x} = \{x_0, \dots, x_n\}$
 - $\bar{x}$ is the path vertices that define a light path from the image plane to light sources
 - x_0 : the position on the image plane
 - This is called path integral formulation [Veach and Guibas 1995, 1997]

Conclusion

- The integral of light transport equation can be represented in multiple ways
- Which ones should be used?
 - It depends on the light transport algorithm that you actually relies on.

Paper Presentation & Project

- Each student should select an interesting problem, which is related to this course
- Procedure
 - Choose two papers and send the titles of the papers to me via email (due date: 16 (Fri.) Oct.
 - I will prepare the schedule of each student (after mid-term period)
 - Each student present two papers (15 min. presentation + 5 min. Q&A)