Math 143 Reading Week 1

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1 Section 2.2: Photometric Image Formation

1.1 2.2.1: Lighting

Images need light to exist — sources for which are denoted as either **point** light sources or **area** light sources. Point light sources originate at a single point and have intensity and a color spectrum denoted by $L(\lambda)$ (wavelength). Light sources may also have directional falloff. Area light sources, on the other hand, can be modeled either by a simple 3D shape or sometimes, in the case of strongly directional lights, a 4-D lightfield is more useful. An **environment map** is a light distribution that maps incident light directions $\hat{v}$ to color values (or wavelengths λ: $L(\hat{v}; \lambda)$.

1.2 2.2.2: Reflectance and Shading

When light hits a surface, it is either scattered or reflected. The **Bidirectional Reflectance Distribution Function (BRDF)** is the most general form of a model to describe this. Relative to a local coordinate of the surface, it is a 4-D function that describes how much of each wavelength arriving at an *incident direction* $\hat{v}_i$ is emitted in a *reflected* direction $\hat{v}_r$. It is *reciprocal* in that we can flip the role of $\hat{v}_i$ and $\hat{v}_r$ and receive the same answer due to the physics of light transport.

Most surfaces are isotropic (no preferred orientation). We represent the BRDF as a function

$$f_r(\theta_i, \phi_i, \theta_r, \phi_r; \lambda),$$

where ϕ represents azimuthal (planar on the surface) angles and θ represents angles from the surface's normal vector.

To calculate the amount of light leaving a surface at a point p in a direction $\hat{v}$, we can integrate the product of the BRDF with the incoming light $L(\hat{v}; \lambda)$:

$$L_r(\hat{v}_i; \lambda) = \int L_i(\hat{v}_i; \lambda) f_r(\hat{v}_i, \hat{v}_r, \hat{n}; \lambda) \ \cos^+ \theta_i \ d\hat{v}_i$$

Where $\cos^+ \theta_i = \max(0, \theta_i)$ is the **foreshortening factor**.

If the light sources are discrete (finite number of point light sources), we can use a summation instead:

$$L_r(\hat{v}_i; \lambda) = \sum_i L_i(\hat{v}_i; \lambda) f_r(\hat{v}_i, \hat{v}_r, \hat{n}; \lambda) \ \cos^+ \theta_i \ d\hat{v}_i$$

BRDFs can be obtained through physical modeling of a surface, heuristic modeling and empirical observation. They can typically be slit into *diffuse* and *specular* components.