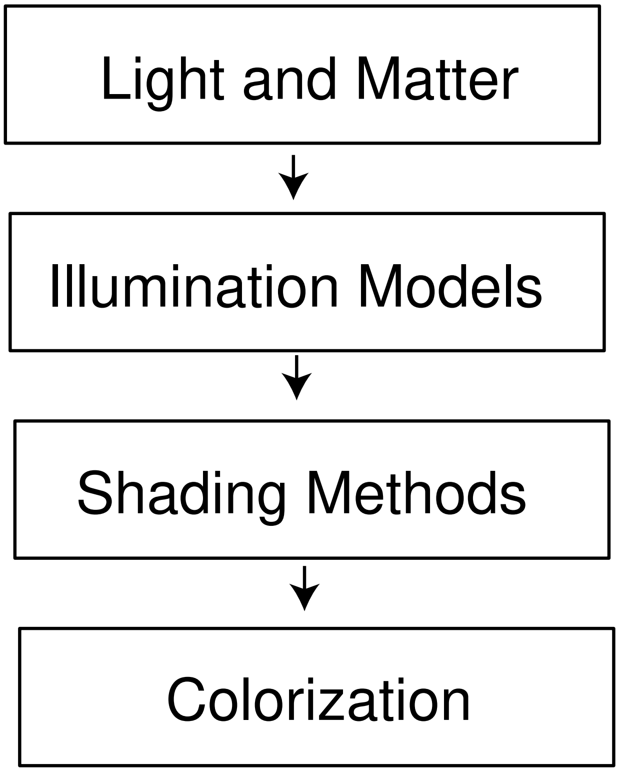
Conceptual Framework



Illumination

"Study of Light Emission
and Propagation"

- Light
- Materials
- Transport

Light

- Dual Model
  - Particle (Photon)
    (Radiant Energy)
  - Wave
    (Electromagnetic Wave)
- Attributes
  - Energy
  - Wavelenght

Transmission

- Geometric Optics
  - Direction
- Interface 2 Medium
  - Reflection

    $\theta_i = \theta_r$
  - Refraction (Snell's law)

    $\frac{\sin\theta_i}{\sin\theta_r} = n_{21}$
- Assumptions
  - No Participating Media

Surface Material

- Boundary Interaction
  - Fresnell Equation

    (function of angle and wavelenght)

- Types
  - Dielectric (Insulating)
    - Translucent (ex: glass)
  - Metal (Conductors)
    - Opaque (ex: copper)
  - Composite (Pigment + Substrate)
    - (ex: plastic, paint)

Surface Geometry

- Attenuation and Scattering
  - Microfacet Model
- Types
  - Smooth
    - Total Transmission
    - No Absorption
  - Rough
    - Partial Transmission
    - Partial Absorption

Illumination Mechanisms

- Light Transport
  - Coherent
  - Incoherent
- Bidirectional Transport Function

  R_{bd} and T_{bd}

Illumination Models

- Principle
  - Conservation of Energy
- Electromagnetic Model

  (Local)

  $\Phi_i = F_r \Phi_i + F_t \Phi_i$

  $F_r + F_t = 1$
- Thermodynamic Model

  (Global)

  $\Phi_{tot} = \mathcal{E}_{tot}$

  $\Phi_{out} = \mathcal{E} + \Phi_{in}$

Local Illumination

I = Dif + Spec + Trans

- Pure Diffuse

  (Lambert's law)

  $k_d < N, L >$

- Specular

  (Phong Approximation)

  $k_s < R, L >^n$

- Transmitted

  $k_t < T, L >^m$

Global Illumination

$$\phi(s,\omega) = \mathcal{E}(s,\omega) \int_S k(s,\omega',\omega)\phi(s,\omega')d\omega'$$

- Kernel of Integral
  - Geometry
  - Visibility
  - Reflectivity
- Diffuse

$$k(s,\omega',\omega) = \rho(s)\frac{\cos\theta_a \cos\theta_b}{\pi r_{ab}^2}V_{ab}$$

Approximating the Illumination Integral

$$I = g\mathcal{E} + gMI$$

- Newman Series

$$(1 + gM)I = g\mathcal{E}$$

$$I = g\mathcal{E} + gMg\mathcal{E} + g(Mg)^2\mathcal{E} + \ldots$$

Utah Solution

$I = g\mathcal{E} + gM\mathcal{E}_0$

- Local Illumination

(only for light sources)

- No Shadows
- Direct Computation
- No Integration

Ray Tracing

$$I = g\mathcal{E} + gM_0g\mathcal{E}_0 + g(M_0g)^2\mathcal{E}_0 + \ldots$$

- Global Illumination

(specular)

- View Dependent
- Recursive Computation
- Monte Carlo Integration

Radiosity

$$I = (1 - gM_0)^{-1} g\mathcal{E}$$

- Global Illumination

(diffuse)

- View Independent
- Relaxation Computation
- Finite Element Solution