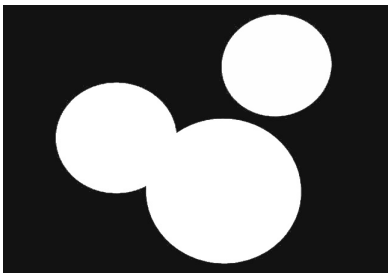
Local Illumination

The Image without Lighting



Introduction

- Local illumination
  - Valid for ray-tracing and for Z-Buffer (projection)
  - Notation
    - I_r Intensity radiating from the object (What we're looking for)
    - I_l Normalized intensity of the light (Characteristic of the light)
    - K proportion of the light reflected rather than absorbed by the material (Characteristic of the surface; varies with light wavelength)
  - 3 wavelengths: Red, Green & Blue
  - Illumination: Ambient + Diffuse + Specular

Ambient Light

- Approximation to global illumination
  - Each object is illuminated to a certain extent by "stray" light
  - Constant across a whole object
- Often used simply to make sure everything is lit, just in case it isn't struck by light direct from a light source

Ambient Light

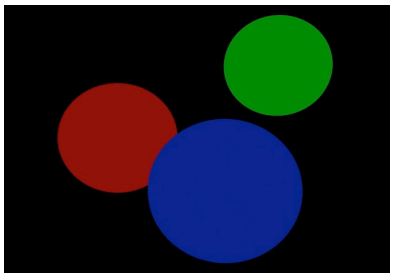
- Ambient light usually set for whole scene (I_a)
- Each object reflects only a proportion of that (k_a)
- So far then $I_r = k_a I_a$

Lighting Equation #1

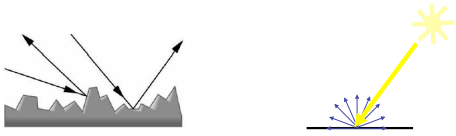
But we use RGB so

$$I_{r,\,red} = k_{a,red}\ I_{a,red}$$
$$I_{r,green} = k_{a,green}\ I_{a,green}$$
$$I_{r,blue} = k_{a,blue}\ I_{a,blue}$$

The Image - Ambient

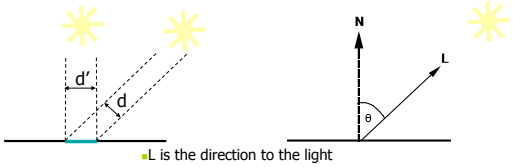


Lambert's Law



- Diffuse reflector scatters light
- Assume equality in all directions
- Called Lambertian surface
- Angle of incoming light is still critical

Lambert's Law



- L is the direction to the light
- N is the surface normal

- Incoming intensity of light is proportional to d
- d is proportional to cos Θ = N.L

⇨ Reflected intensity is proportional to cos Θ

Diffuse Light

- The normalised intensity of the light incident on the surface due to a ray from a light source
- The light reflected due to Lambert's law
- The proportion of light reflected rather than absorbed (k_d)

Lighting Equation #2

$$I_r = k_a I_a + k_d I_i (n.l)$$

- Ambient and diffuse components
- Again k_d is wavelength dependent and we work with $k_{d,red}$ $k_{d,green}$ and $k_{d,\ blue}$

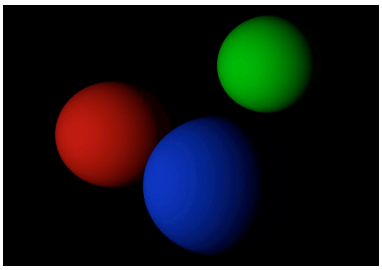
Multiple Lights?

- Add the diffuse terms

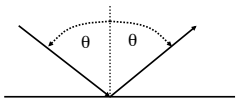
$$I_r = k_a I_a + \sum_{j=1}^{m} k_d I_{i,j} (n.l_j)$$

- $I_{i,j}$ is the incoming intensity of light j
- l_j is the vector to light j

The Image - Diffuse

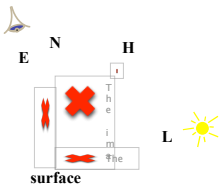


Perfect Specularity



- Would almost never see the specular highlight

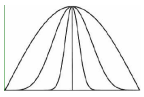
Imperfect Specularity (Phong)

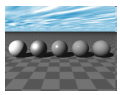


- E is the direction to the eye
- N is the normal
- L is the direction to the light
- H bisects E and L

Specular Component

$k_s I_i (h.n)^m$





- m is the power of the light (shininess)
  - High m implies smaller specular highlight
  - Low m makes the highlight more blurred

Lighting Equation #3

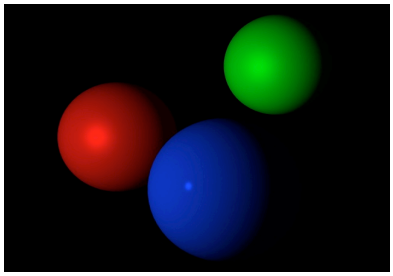
$$I_r = k_a I_a + I_i (k_d (n.l) + k_s (h.n)^m)$$

- Ambient, diffuse & specular components
- Again if there are multiple lights there is a sum of the specular and diffuse components for each light

(This is the time to worry about clamping values to 0,1 required for monitor display)

The Image - Specular

Small and big specular highlight



Conclusions

- We can now colour the pixels by combining
  - Ambient light
  - Diffuse reflections
  - Specular reflections

  Summed over several light sources
- We need
  - Shadows
  - Better model for light reflection of the object: BRDF
  - Global illumination