Shading

Steve Canves

yqykrhf@163.com

1 Definitation

In graphics, **shading** means the process of applying a material to an object.

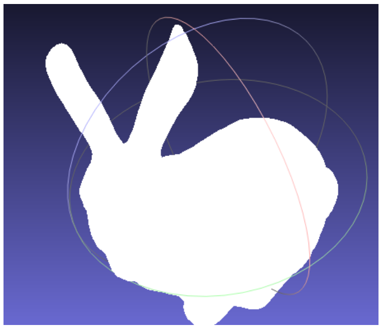


Figure 1: Bunny without shading

2 Bilnn-Phong reflectance model

Shading is local. Billnn-Phong contains three kinds of reflectance that Specular highlights, diffuse reflection and ambient lighting as shown in Figure **??**

Figure 2: Three kinds of reflection in Blinn-Phong reflectance

2.1 Specular highlights

Intensity depends on view direction. From mathematics view, It's depends on the angle between **R** and **I**.

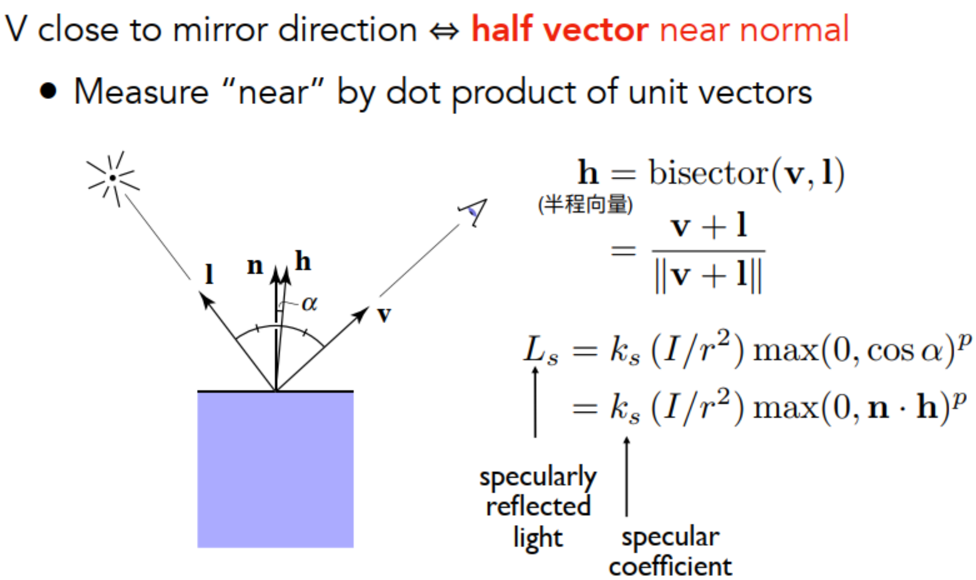
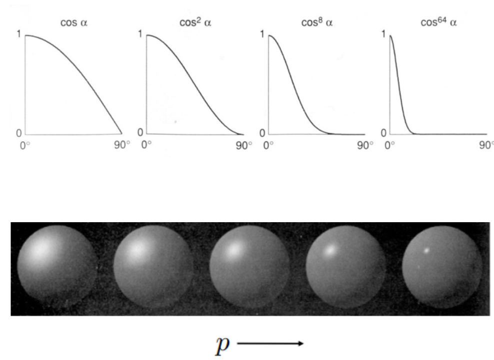


Figure 3: specular reflection

Increasing p narrows the reflection lobe. Experimentally, p is assignment about from 100 to 200.



2.2 Diffuse reflection

Light is scattered uniformly in all directions. That means surface color is the same for all viewing directions. Shown in Figure **??**

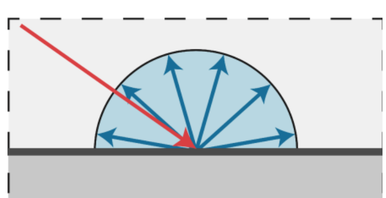


Figure 4: Diffuse reflection

we think light as energy. And the light intensity of surface reflection is calculated by the **Lambert's cosine law**. Shown in Figure **??**

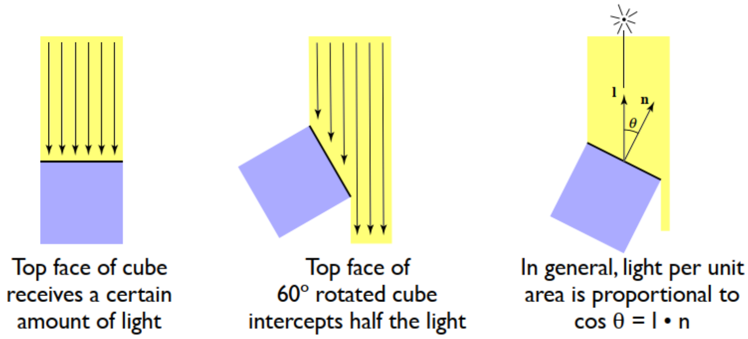


Figure 5: Lambert's cosine law

we consider light falloff. The light will generate the sphere whose surface area is the energy.$4\pi I = 4\pi r^2 I'$

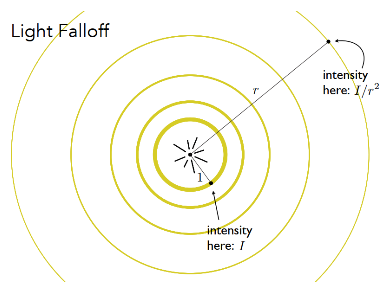
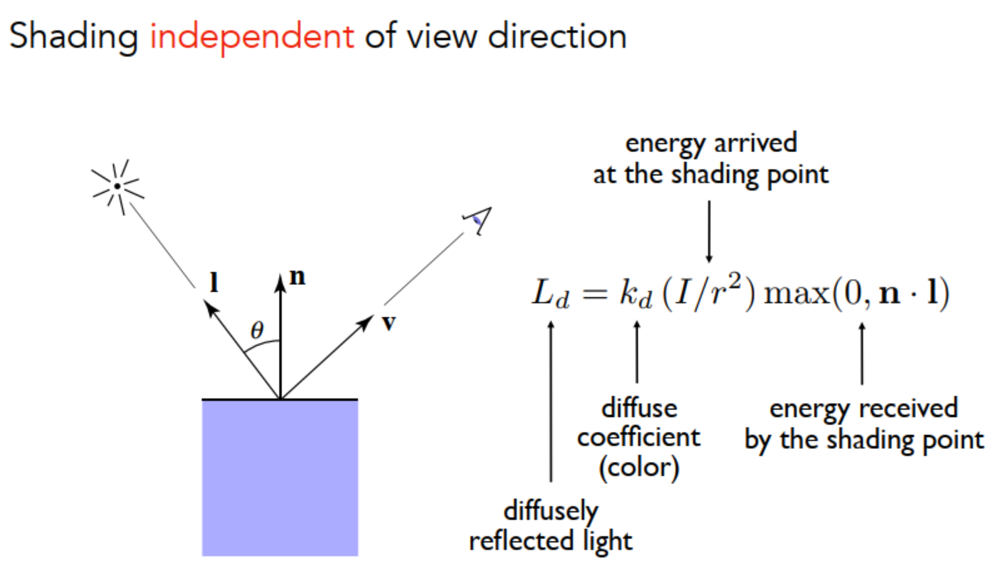
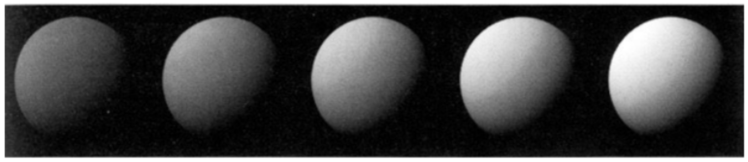


Figure 6: Light Falloff

Then we can get the formulation:



max term is added because of physical meaning. K_d is light absorption rate which equals to 0 means object absorp all light and which equals to 1 means object reflect all light.

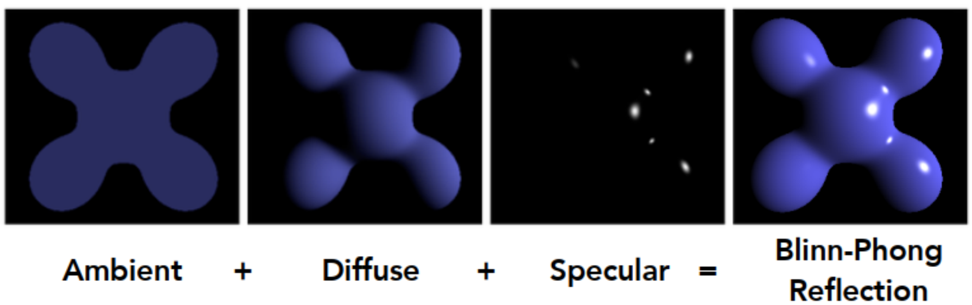


2.3 Ambient reflection

we assume that a point's light received from environment is always the same. A light is from the different reflection from other objects rather than the source light.

$$L_a = k_a I_a$$

2.4 Concluson



$$\begin{aligned} L &= L_a + L_d + L_s \\ &= k_a\, I_a + k_d\,(I/r^2)\max(0, \mathbf{n}\cdot\mathbf{l}) + k_s\,(I/r^2)\max(0, \mathbf{n}\cdot\mathbf{h})^p \end{aligned}$$

3 Shading Frequencies

Shading frequencies means we apply shading method to what element, point or triangle. Loot at the Figure **??**.

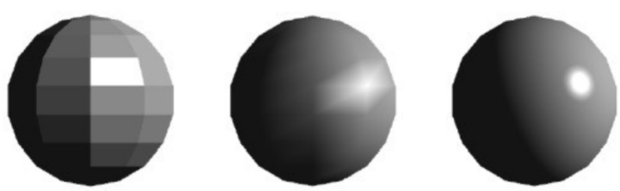


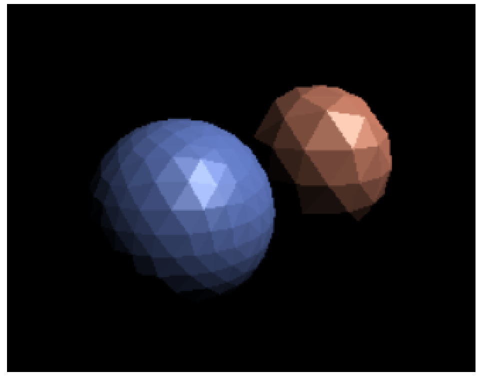
Figure 7: Different shading frequency

The first one shades face only. The second shades the every vertex, and the point in the face whose shading is obtained by interpolation of vertexs. The last one shades every vertex. And the points's normal in the face the is acquired by interpolation, then calculating the shading according to normal.

3.1 Shade each triangle (flat shading)

Flat shading

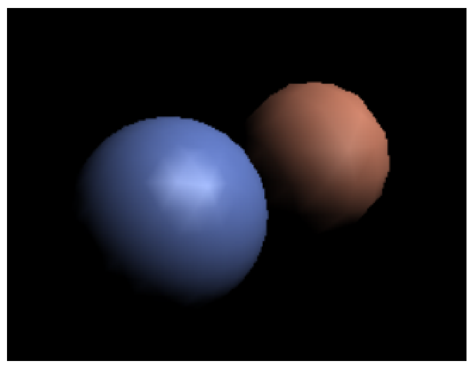
- Triangle face is flat — one normal vector
- Not good for smooth surfaces



3.2 Shade each vertex (Gouraud shading)

Gouraud shading

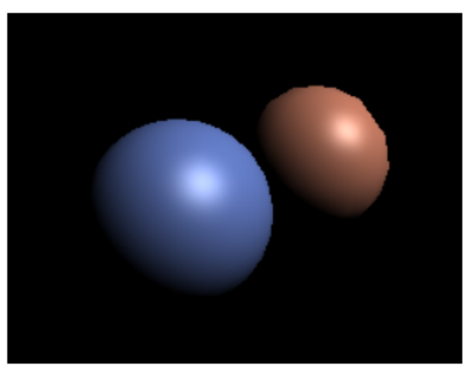
- Interpolate colors from vertices across triangle
- Each vertex has a normal vector (how?)



3.3 Shade each pixel (Phong shading)

Phong shading

- Interpolate normal vectors across each triangle
- Compute full shading model at each pixel
- Not the **Blinn-Phong Reflectance Model**



Compare with differenct approach.

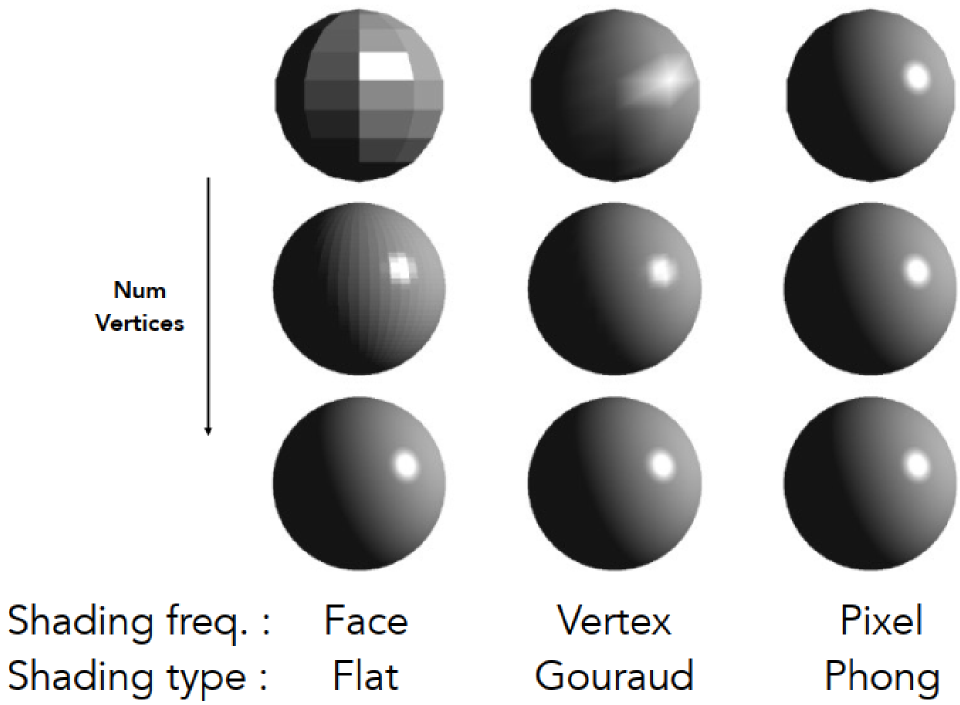


Figure 8: Comparing with differencce

3.4 Vertex Normal Vector

Best to get vertex normals from the underlying geometry. As shown in Figure **??**

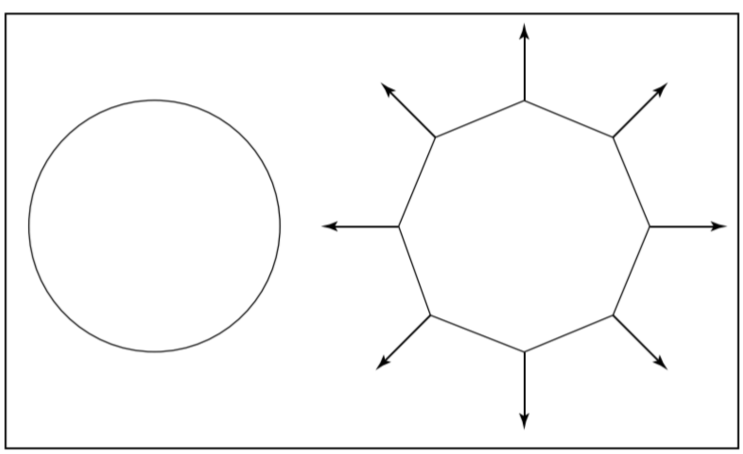


Figure 9: Sphere

Otherewise have to infer vertex normals from triangle faces. Simple scheme is average surrounding face normals and weighted average surrounding face normals whose weight is propotional to the triangle area

$$N_v = \frac{\sum_i N_i}{\|\sum_i N_i\|}$$

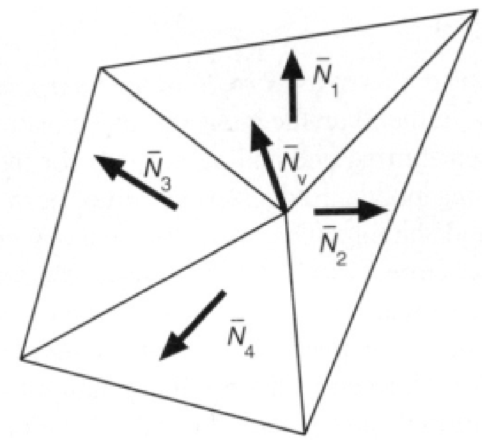


Figure 10: Vertex Normal