11/03/2020

I am extending the deadline for E1 to 11/5/2020
You must include a detailed explanation of your solutions.
I am instructing the graders to give only up to 60% of the grade to questions answered without sufficient explanation.
This applies to all future assignments.

Shading – adding light sources and light effects (light interaction with material vertices → geometry objects) to the
Scene (instead of glColor())

Shadowing (not supported in OGL) – the way the light sources generate shadows upon interaction with the objects.

OGL model (local model - Phong Model) is not carefully following the
physical model of lighting/light interaction
Contains many degrees of freedom that enable realistic rendering.

9 degrees of freedom on lights (regardless of the type).
10 degrees of freedom om material (vertices)

Physical model requires ray tracing
Phong model requires trial and error

The local model ➔ apply the Phong Model (or the Blinn Model) to vertices.
Finds the RGB components of the light intensity at each vertex. Using one a few methods to determine the intensity of the points of geometric objects defined by the vertices.

Local: Slide 18-11 types of light sources

Point source finite position. Light is dispersed from the source evenly to every directions

infinite (e.g., the sun) light is dispersed from the source in parallel rays.

To define a Point light Source in a finite point specify point (x, y, z, 1)
For infinite (very far) e.g., the sun, (x, y, z, 0) specifies the direction.

Spotlight – limits the point source dispersion. GL-20 9.

Ambient light uniform (almost like glColor()) throughout the scene.
Many sources, objects, reflections
The end effect is “average/uniform” intensity throughout the scene.

Surface

Smooth (like mirror) - one direction of reflection is preferred
Rough (like paper or carton) scatters light in all direction

Given a vertex V is it on a rough or
smooth surface → intensity of V in different directions

A vertex may be on more than one plan ➔ shares more than one normal

Phong

Each light can have 3 (RGB) components
Diffusive
Specular
Ambient

Each material (vertex) can have 3 (RGB) components
Diffusive
Specular
Ambient

4 vectors to:
I The light source
n The normal to the plan where V "resides"
V to the viewer / camera
R Perfect reflector

How do we figure V?
Using camera location e.g., gluLookAt()

How to figure I and N?
Given by OGL programmer

To figure R?

Assume angle between I and N is θ (implies dot-product $\theta = cos^{-1}(I.N)$).
Then angle between R and N θ (R is assuming ideal reflector based on Snell's law).
We can find R from $\theta = cos^{-1}(R.N)$

18-14 Snell law $\theta_i = \theta_r$
$\theta_i = I.N = \theta_r = R.N$ is used to find R
The parameters of the Phong model are used to find the RGB components of the intensity at point P (13)

Rough surface is also referred as Lambertian or **Diffusive**
Smooth is called **Specular** or Reflective

According to Phong (17)
Lambertian surface (18-15)

If the surface is rough the light is dispersed uniformly in all directions.

Assume pure Lambertian.
Given light sources and position.
Given the Normal
Material properties.

What is the intensity of vertex P
Intensity is proportional to $\cos(\theta_i)$

Effect of the distance between the light source and the material?
The "circle" area grows.

R the radius of the circle get larger
Proportional to R^2

The angle and coefficients Kr, Kg, Kb determine the proportion.
Kr is the amount of red light absorbed by the material.

K r, g, b for the red, black and white parts 0-1 meaning percent of light
Reflected??? Assume correct
Red 1, 0, 0
White
1, 1, 1

Black 0, 0, 0

Slide 17

Ir – Reflective component of the light source

Ks S – for specular – are RGB absorption coefficients of the material
θ_i – angle between i-n or r-n
Alpha shininess

19-3 Ambient light → Ka, Ia
19-10, a different model (BLINN) can be used referred to as the Blinn model

The programmer is responsible for setting the Norma

One way is using the cross product (2 vectors on 3 points on the plane)

Can be determined for the plane equation.

19-14 19-18 normal to a sphere skipped.

Question given the [different] gray level intensities
on a triangle vertices A, B, C (Ia, Ib, Ic) calculated by OGL using Phong..
What is the intensity at an arbitrary point inside the triangle.

Let us consider an arbitrary pixel on the screen

Flat – The Intensity at A is rendered as the intensity of every point
(including vertices) on the triangle.

OGL default Smooth – interpolation (holds for texture mapping where image pixels intensities at
Vertices are interpolated

Gouraud interpolation based on Normal values.

Consider slides 11-2 to 16 as user manual taking slides 18 19 into OGL functions.

Fix alpha
Assume S(alpha) is a point on PQ find its equation as a function of alpha.

Now find the equation of a point on the line RS T(a,b)

$S(a) = P*a + (1-a)*Q$

$T(a, b) = R*b + (1-b)*S(a)$

$T(a, b) = R*b + (1-b)*(P*a + (1-a)*Q)$

The reflective component of the intensity at P is proportional
To the absorption coefficient (RGB) at P and The intensity of the light source (RGB)
And the angle between V (viewer) and R the direction of light reflected from P if P
Is on an ideal reflector

One more parameter a determines how the intensity behave s in the vicinity of the vertex P.

Slide 18 shows the effect of alpha