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# CMPS 160
# Intro to Graphics
# Fall 2005

## Midterm Exam #2

Total = 60
Mean = 42 A/Mean 70%
Std = 9 Std

1. You change the normal vectors of an OpenGL triangle, but don't change the position of the vertices. Which components of the color seen by the viewer (ambient, diffuse, and specular) might change? Why?

Ambient lighting will not change but diffuse and specular lighting might. Diffuse and specular lighting both use N in their computation. There is a chance they will not change if the lights were on the triangle hence they might change.

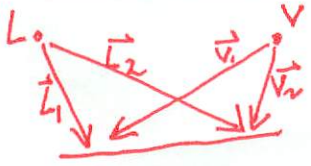
2. You are in an empty room (just 4 walls, floor and ceiling), with a single light bulb. You carefully measure the dimensions of the room, the color of the paint on each wall, and the radiant intensity of the light bulb. You use these measurements to construct an OpenGL model of the room, and render the scene. Nevertheless, the rendering will not look like a photograph of the room. Why not?

In the real world the walls also act as light sources because the reflect rays from the primary light and on another. The OpenGL model does not capture this behavior.

OpenGL has a local illumination model so does not capture global illumination effects. -5

3. In the table below, write "YES" or "NO" and an explanation in each of the four squares, to indicate whether a viewer might see a finite-sized specular highlight (shiny spot) on a large flat plane. You may assume the plane is made up of many tiny triangles, so that it is effectively computing a normal for each pixel.

| | Directional Light (w=0) | Point Light (w=1) |
|---|---|---|
| Orthographic Projection (viewer w=0) | a) NO the dot product is the same everywhere on the plane | b) YES L changes across the plane |
| Perspective Projection (viewer w=1) | c) YES H changes across the plane | d) YES L changes across the plane, |




when either L or V is not distant, then ($\vec{L}_1$ and $\vec{L}_2$ or $\vec{V}_1$ and $\vec{V}_2$) are not the same so lighting computation would produce different results at different places on the plane, and thus a "spot". -5

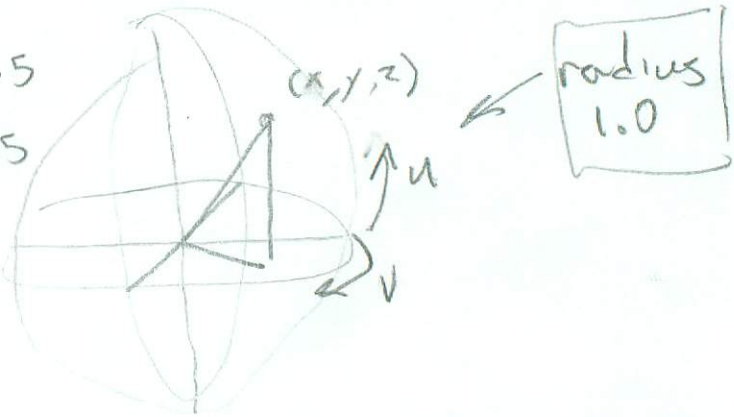
4. What does the value at each pixel in a bump map correspond to? How is this data used in rendering? Address what feature of the surface is affected.

Pixel values correspond to the heights of micro geometry details. The gradient of this heightmap is used to perturb the normal of the surface while rendering.

5. A satellite has photographed the surface of the homeworld of a terribly evil alien race with a camera and probed the geometry of the surface with radar. You are given a mesh of the surface geometry, a roughly spherical thing centered at (0,0,0) with the z axis pointing towards the north pole and the x and y axes point toward the equator. Additionally, you are given an image of the combined photographs projected such that the u and v coordinates of the image correspond to the latitude (lines parallel to the equator) and longitude (lines through the poles) of the surface patch imaged by that pixel. To save humanity, you must define a mapping of (x,y,z) to (u,v) that will properly texture the mesh.

$u = \arctan\left(\frac{z}{\sqrt{x^2+y^2}}\right)/2\pi + 0.5$

$v = \arctan(x/y)/2\pi + 0.5$

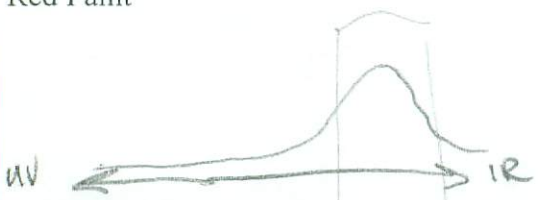
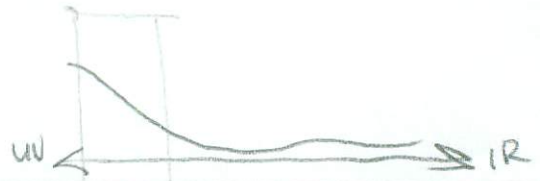
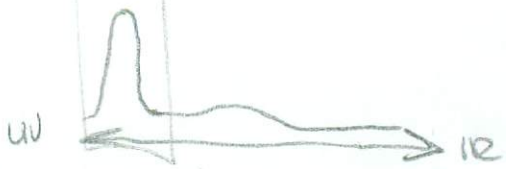



Oops! Not enough information to figure out what range to map to.

6. You have a 3D comic book that uses special glasses. The left eye has a blue filter and the right eye has a red filter. Without the glasses the pictures are red-blue double images, but with the glasses you see in 3D.


Captain 3D promises to make good use of your texture projection above to fight evil where it lives.

6a) Draw a possible spectral reflectivity curve for each of the red and blue paints used in the comic book, as well as the spectral transmission curves for each of the red and blue filters in the glasses. Peaks are in the same bands!

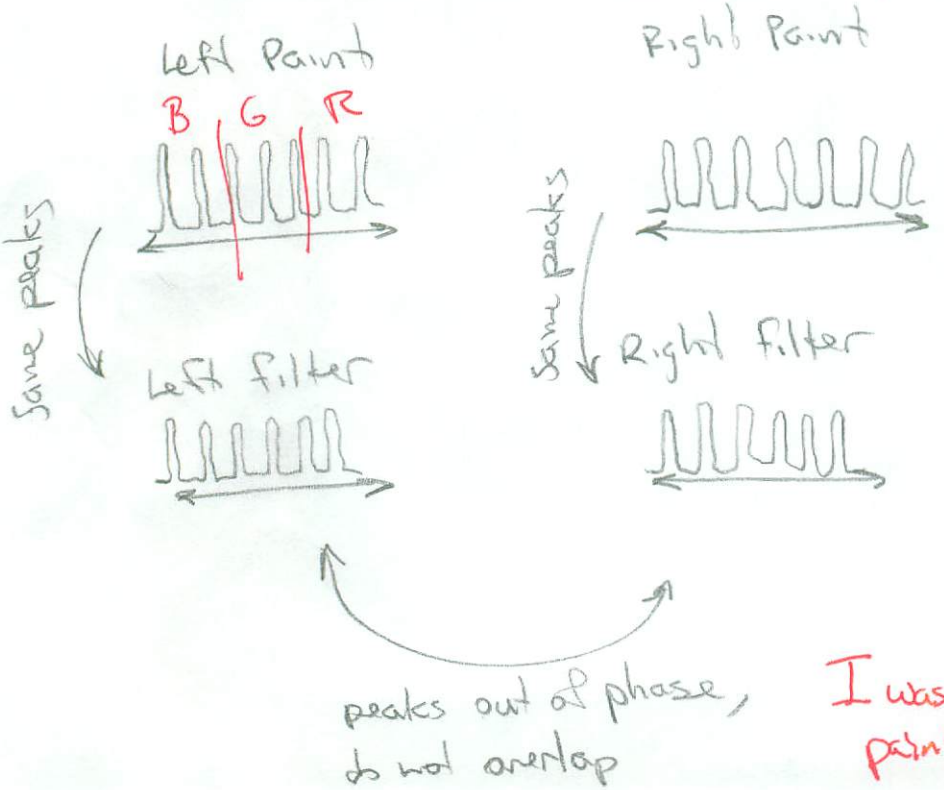
| Red Paint | Blue Paint |
|---|---|
|   |   |
| **Red Plastic (Right Eye)** | **Blue Plastic (Left eye)** |
|   |   |

6b) Your little brother complains that he doesn't like red and blue and wants a 3D comic with yellow and green! Why aren't the comic companies giving him any satisfaction? Why are they all red-blue?

Green and yellow are close on the spectrum and would be hard to separate without expensive filters.

Red-blue is the maximum seperation on the visible spectrum.

6c) Your little sister wants full color! Supposing that we have access to ideal engineering and can design any paint and lens spectral reflectance and transmittance curves we like, can we provide color 3D comics? [Why yes, we can!] What might those curves look like?




Using a tight comb pattern for the paint and filter we can show each eye a nearly complete spectrum without crosstalk between the eyes.

Really, only 3 appropriately selected spikes of the comb are necessary. They should yield metamers.

I was looking for seperate R,G,B paints. One paint won't give color! -J

7. HSV is not a perceptually linear color space. Assume that values for each channels are specified in the range 0 to 1. Give a numerical example of changing some value by 0.2 yields little or no visible difference in the perceived color. Give another example where changing some value by 0.2 yields a significant visible difference in the perceived color.

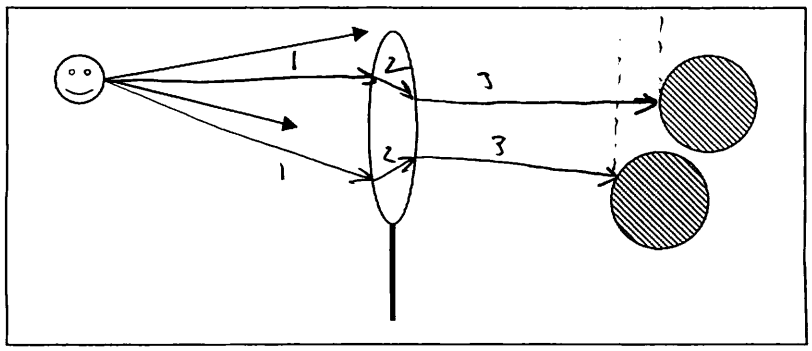
(0.0, 0.0, 1.0) → (0.2, 0.0, 1.0), H has no effect when S is 0 !!

(0.0, 1.0, 0.5) → (0.2, 1.0, 0.5) The color moved a noticable distance around the color wheel.
Red → Yellow?

8. In nature, light flies out of emissive objects, bounces around the world, then lands in our eye where we begin to perceive it. In ray tracing, why do we shoot rays out of the eye instead?

Many rays leaving the lights never hit the eye. Working backwards we can be much more efficient in our computation by assuming <u>every</u> ray includes the eye in its path.

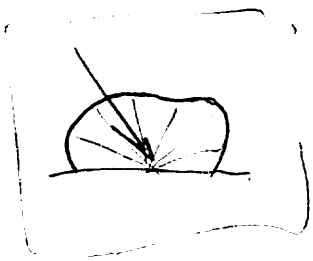
9. You are modeling the effects of a magnifying glass using a ray tracer. Your scene consists of two solid *<u>shiny</u>* spheres next to each other and a large *<u>transparent</u>*, *<u>thick</u>*, refractive lens between the spheres and the eye point of the scene. They are lit from a directional light from the top. If we limit the depth of the ray tree to 3 levels of branching to speed up rendering what might not look right in the output image? How come? Do not count the ray that is shot out to check the light at each node.




The spheres will not appear to reflect one another or the lens. There is no ray path of length 3 or less that hits both spheres and the eye.
If you counted off by one less, you would be missing a sphere reflecting another sphere's reflection. Basically, you can see the recursion stop somewhere.

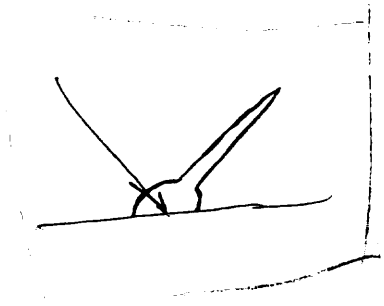
10. Consider the material properties of the light gray cement on a sidewalk or parking lot. The look of this cement changes when it is wet. Sketch a goniometric diagram for dry cement and another for wet cement. In terms of the OpenGL lighting model, what is changing between the dry and wet conditions.


Dry



High diffuse amount
Low specular amount
Low specular exponent

Wet



Low diffuse amount
High specular amount
High specular exponent

11. You are an astronomer (or work for one), and you are writing software to locate and catalog stars. Ideally, your software works by recording the location of all pixels brighter than a certain threshold value in pictures from a telescope but many of the pictures have blurry splotches in them (from clouds in the sky or birds nesting in the telescope). These interference sources are bright enough that you cannot set a threshold value low enough to find all the stars without including parts of the splotches. Noticing that the sharp stars and blurry splotches have significantly different spatial frequency characteristics, you think to employ a filter to remove just the interference leaving only the stars so you can use a much lower threshold and record more stars.

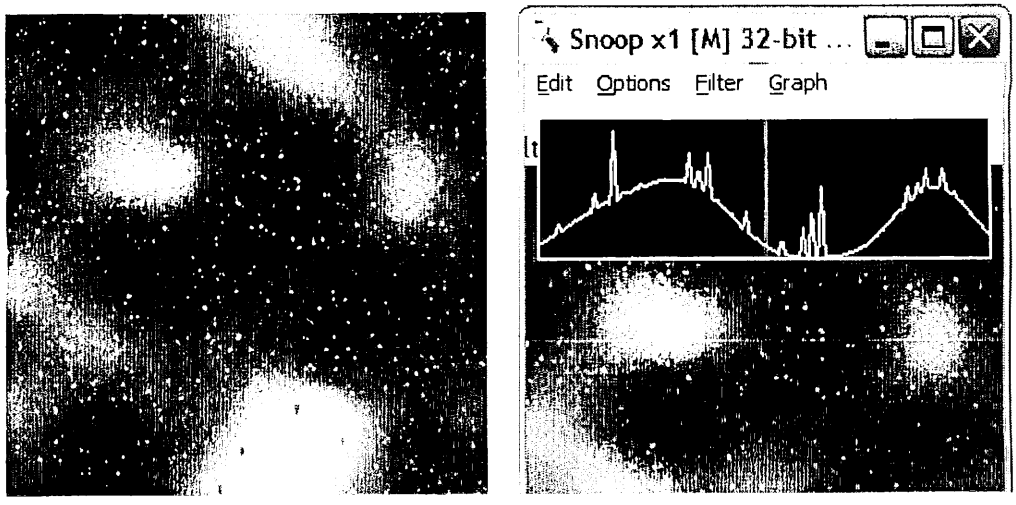
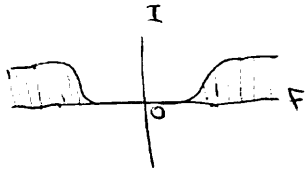



**Figure 1: Example image from telescope. On the right is a plot of the intensity along a single row of the image.**

Describe the filter you should apply in terms of what happens to high and low spatial frequencies.




Use a high-pass filter to discard low frequency junk while preserving sharp, high frequency star detail.

Sketch the intensity along a single row of the image after applying your filter.