

Question 1:

Given what you know about mapping a 3D point on a unit sphere to a 2D UV point in texture space, propose a method for mapping a 3D point on a cylindrical tube (i.e. no endcaps) to a 2D texture coordinate. The cylinder is assumed to be centered at the origin, aligned with the Y axis, and has a radius of 1 and a total height of 2 (spanning 1 unit of distance away from the origin along the Y axis). Don't worry about getting the mathematics 100% right; try explaining your method conceptually if you can't do it mathematically.

Unwrap the tube into a square shape by choosing an arbitrary seam . Use the angle between the point in the XZ plane and the seam to compute U, and linearly map Y to V.

$\Phi = \text{atan2}(p.z, p.x)$, if $\Phi < 0$ add 2π

$U = 1 - \Phi/2\pi$, and $V = p.y/2 + 0.5$

Question 2:

Why are the shadows and focused light patches (known as caustics) cast by refractive objects not able to be properly represented in a simple ray tracer? Answer in no more than two sentences.

You have no way of knowing if the ray from a point to a light source will still reach the light source in question after being refracted through an object; you'd have to iteratively cast rays through the obscuring object to properly determine which rays hit the light source and contribute to the shadow/caustic color.

Question 3

What issue do we encounter when trying to sample textures on a purely per-pixel basis? How can we mitigate this problem? Answer in no more than two sentences.

The image becomes aliased due to a lower-than-resolution sampling rate. We can interpolate texture pixels based on our point of intersection to try and anti-alias the image.

Question 4:

What is the visual difference in the shadow cast by a spherical light source with an infinitely small radius (i.e. a point light) and a spherical light source with a large radius (e.g. ten feet)? Why does this difference occur? Explain in at most two sentences.

Point light shadows have hard edges while area light shadows have edges that gradually transition from complete darkness to no shadow at all. A point light is either visible or not visible to any given point in space, but an area light can be partially visible, causing a shadow to be cast that is not completely dark at points which can see part, but not all, of the light.

Bonus Question

As you're traveling along Locust Walk to get to your CIS 560 lecture, one of the multitude of club event promoters hands you a flyer. You unthinkingly accept the paper and continue on your way. Moments later, you feel a sharp pain in your hand, and look down to discover that the flyer has sunk its teeth into you, giving you a row of tiny papercuts! You realize that it's no flyer at all, but a GRAPHICS QUIZ equipped with rows and rows of pixel-sharp teeth! You wave your hand

frantically in an attempt to shake it off, but it is determined to stay affixed to your fingers. How do you extricate your hand from this quiz?