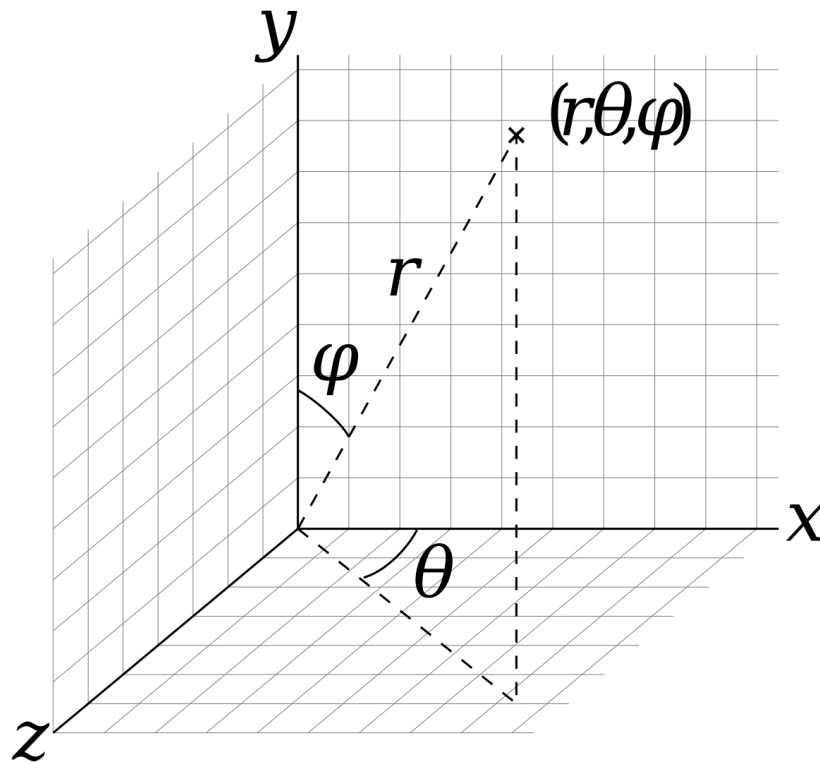


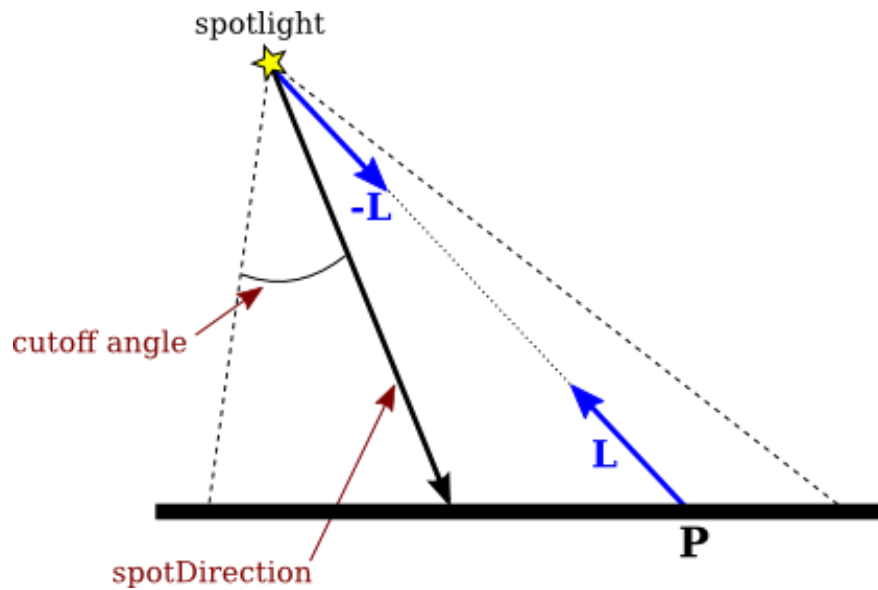
CS3388B Problem Set 9

Exercise 1.

Let a camera have position $(8,4,-3)$ in world coordinates. Describe this position in spherical coordinates as a radius r from the world's origin, and two angles ϑ and ϕ , where ϑ is measured from the positive x axis toward the positive z axis, and ϕ is measured from the positive y axis toward the x - z plane.



Exercise 2.



Consider a spotlight, as shown in the above diagram. Therein, L is the direction of the light source from the point P . Spot direction refers to the direction the spotlight is pointing, while cutoff angle refers to the **half-angle** of the cone of light produced by the spotlight.

Let a spotlight have position $(5,10,2)$, be pointed at $(3,2,1)$, and have a cutoff angle of 30° . For a point in space $P = (x_p, y_p, z_p)$ determine a function $f(x, y, z)$ such that $f(x_p, y_p, z_p) > 0$ if P is inside the spotlight's cone of light, and $f(x_p, y_p, z_p) < 0$ if P is outside the spotlight's cone of light.

Exercise 3.

Write a vertex/fragment shader pair which implements the Phong lighting model for two simultaneous directional lights. You can use the `DiffuseShader.vertexshader` and `DiffuseShader.fragmentshader` on OWL as starting points.

Exercise 4.

Write a vertex/fragment shader pair which implements the Phong lighting model with parameterized material colors. Let the vertex shader have two input vertex attributes: position and normal. Let the vertex shader have four uniforms:

- The MVP matrix
- The View matrix
- The Model matrix
- The position of the light source in world coordinates

In the fragment shader let there be four uniform variables:

- Light color
- Material ambient color
- Material diffuse color
- Material specular color

and three input variables:

- Normal
- Eye direction (camera direction)
- Light direction

Submission.

Submit to OWL:

- Your answers and workings for Exercises 1 and 2.
- Your vertex shader and fragment shader for Exercise 3.
- Your vertex shader and fragment shader for Exercise 4.