16-720 Assignment 3 Solutions

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Q1 Something like "'plot the data points and find the specular portion, which is the same color as the inpute light, via the specular-diffuse model for dielectrics."'

Q2 Even though the diffuse and specular are not orthogonal, they are seperable as long as there is a large enough angle between them.

Q3 It represents Lambert's cosine law, which says that a light will be brightest if you shine it perpendicular to the surface normal and zero when it is parellel to the surface normal. This is due to the surface taking up a larger solid angle if it is not perpendicular to the light.

Q4 Anything reasonable was fine for this question.

Q5 One way to solve this is: We know that the dot product between a point and a line is zero, or $l^T p = 0$. A homography between two points is $p_2 = Hp_1$. For the two lines, we have $l_1^T p_1 = 0$ and $l_2^T p_2 = 0$. Substitute the homography transformation for one of the points, or $l_1^t p_2 = l_1^t H p_1 = l_2^t H p_1 = 0$. Setting the two equations equal gives $l_1^T p_1 = l_2^T H p_1$. Looking just at the part without the p_1, we have $l_q^T = l_2^T H$. Transposing these yields $(l_1^T)^T = (l_2^T H)^T$, $l_1 = H^T l_2$, and $H^{-T} l_1 = l_2$.

Q6 At any point in time, the energy at all points of equal distance from the point source was emitted at the same time. This is the simplest case, and you basically that since energy is conserved, the total energy on the surface of a sphere should be the same, regardless of it's radius. Therefore, as the radius increases, the energy is spread more thin, and at any point, it decreases by the inverse square of the radius (distance).

Q7 This is a more tricky case, because you cannot assume that the energy at all points of equal distance from a point on the source was emitted at the same time, unless the light source is emitting a plane wave (i.e. $exp(\pm ik(cos(\theta_x)x + cos(\theta_y)y))$. In other words, each point on the source emits light in all directions, rather than just perpendicular to the source. The answer does turn out to be similar to that of an expanding cylinder, but you would have to explain how each point on the cylinder receives light from the entire source, but with different temporal offsets. The easiest way is probably to consider a single point at some perpendicular distance d from the source. Integrate over the entire source for this point $\int_{-\infty}^{\infty} \frac{1}{d^2+y^2} dy$, which gives an equation proportional to the inverse of d.

ComputeRotation

```
ia = [1 0 0];
ja = [0 1 0];
ka = [0 0 1];

N = zeros(3,3);
N(:,1) = lightColor;
[u,w,v]=svd(N);

ib = S;
jb = u(:,2);
kb = u(:,3);

R = [dot(ia,ib) dot(ja,ib) dot(ka,ib);
     dot(ia,jb) dot(ja,jb) dot(ka,jb);
     dot(ia,kb) dot(ja,kb) dot(ka,kb);];
```

RGB2DS

```
pixels = reshape(im,size(im,1)*size(im,2),size(im,3))';
SUV = R*pixels;
diffuse = sqrt(sum(SUV(2:3,:).^2));
specular = SUV(1,:);
```