Part 2 of Study guide for Graduate Computer Vision

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Abstract

1. Understand the difference between a point source of light (emits a finite amount of light from an infinitessimally small location) and extended source (emits a differentially small amount of light from each position, but, integrated over an area, emits a finite amount of light).

2. Be able to do the "solar panel" calculation showing what percentage of the power of the sun a solar panel absorbs given the relevant parameters (angle of the solar panel to the direction of the sun, size of the solar panel, distance of the solar panel from the sun). To do this you will need to konw the formula for the surface area of a sphere ($4\pi r^2$).

3. Understand pinhole cameras and their pros and cons.

4. Understand the meaning of the (BRDF) bidirectional reflectance distribution function (answer: it is a 4 parameter function (2 parameters for angle of incoming ray, 2 parameters for outgoing ray) that gives the percentage of light in each outgoing direction for each incoming direction).

5. What are two simplest and most commonly discussed BRDFs? Answer: matte surface (also called Lambertian) and perfectly reflective (mirror) surfaces. Lambertian surfaces appear to have the same brightness from every angle. Mirror surfaces reflect all incoming light in a single direction.

6. How does a corner reflector work? Describe its BRDF in relation to a mirror.

7. Describe how one can build a classifier for the material from which a surface is made. Come up with some reasonable features that might help you classify materials.

8. The light-detecting cells in the retina are rods and cones. Cones come in 3 varieties, "red", "green" and "blue". They all have different, but broad spectrum responses. They are primarily useful in bright light scenarios (photopic vision). In dim light, we use rods to detect brightness fluctuations, but not color (scotopic vision). Why does watching "black and white" TV seem fairly natural to us?

9. What is the fovea? (Answer: the central part of the retina with the highest density of receptors.) What does it mean to foveate to an object? (Answer: change your direction of gaze so that the object falls on the fovea of the eye.) What is a saccade? (Answer: A rapid, jerky movement of the eye.) Where is the blind spot and what causes it (it's where the optic nerve attaches to the retina. There are no rods or cones there.)

10. What is the basic idea behind stereo vision? (Triangulation to judge distance.) Over what range is stereo vision most useful in humans? (Answer: within about an arm's length). Why is stereo vision not useful at large distances? (The difference in the angle between the two eyes is too small to be measured accurately.) Why can a person with one eye do most of

the things we can do with 2 eyes? (Because moving back and forth gives us just as much (if not more) information about depth as stereo vision. When moving left and right, objects apparent motion is proportional to the depth.

11. Understand the meaning of radians and steradians. Steradians are units of solid angle, which can be thought of as a measure of what percentage of the sphere is covered by a solid angle. The number of steradians in a sphere is 4π, which is the surface area of a unit sphere. For example, the northern hemisphere of the earth contains 2π steradians. Note that the number of steradians in a patch of a sphere is equal to the area of the patch divided by the radius of the sphere squared:

$$steradians = \frac{area}{radius^2}.$$

12. Let ϕ be the power output (in watts) of a point light source. Let R be the *radiant intensity*, defined to be the watts per steradian. Consider the irradiance E of a patch at a distance r from a point light source. The irradiance is the power per unit area falling on a patch. Then we have:

$$R = \frac{watts}{steradian} = \frac{radius^2 \times watts}{area} = radius^2 \times E.$$

Hence

$$E = \frac{radiantintensity}{radius^2}.$$

13. What would happen if a matte (Lambertian) surface really emitted light equally in all directions? Answer: when viewing a surface from a shallow angle, an unlimited amount of energy would enter the eye, due to forshortening, and instantly blind you.