CS 348B - Computer Graphics:
Image Synthesis Techniques
Stanford University

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Handout #26

Written assignment #2 - texture and local illumination

Due Thursday, May 21, in class

(1) Paul Heckbert's chapter on texture resampling (course reader, paper #7) discusses prefiltering using 3D and 4D image pyramids. Neither perfectly matches the quadrilaterals that result from perspective projections of square texture areas. How many dimensions are needed for a perfect match? Ignore errors introduced by discretization of the pyramid. Defend your answer.

(2) Problem 16.1 in Foley, van Dam, Feiner, Hughes. An equivalent restatement follows:

(a) Describe the difference in appearance you would expect between a Phong illumination model that uses $(\mathbf{N}\cdot\mathbf{H})^n$ and one that uses $(\mathbf{R}\cdot\mathbf{V})^n$.

(b) Show that $arccos(\mathbf{R}\cdot\mathbf{V}) = 2\,arccos(\mathbf{N}\cdot\mathbf{H})$ when all vectors are coplanar.

(c) Show that this relationship is *not* true in general.

(3) What effect does failure to gamma correct have on the chromaticity of colors in a graphics display? Sketch your answer on a chromaticity diagram and defend it.

(4) As every boy (and girl) scout knows, you can start a fire on a sunny day by holding a magnifying glass between the sun and a piece of paper placed on the ground. Assume a magnifying glass 20 cm in diameter with a focal length of 10 cm, the sun subtends 1/2 degree of arc in the sky, and we perform this experiment on a perfectly clear day with the sun directly overhead.

(a) What is the ratio of the radiance of the sun as seen from the focal point of the lens to the radiance as seen from another point on the paper?

(b) What is the ratio of the irradiance due to the sun at the focal point to the irradiance at another point on the paper?

Warning: Never look at the sun directly, never hold a magnifying glass between your eye and the sun, and never look directly at its focused spot on a reflective surface.

(5) Consider a hemispherical sky above a surface patch on the ground. In class, we approximated the radiance of a cloudy sky as uniform. That may be true in San Francisco where cloudy means foggy, but the radiance of an overcast sky in dry weather is non-uniform and may be approximated by a Cardioid distribution, that is, $L(\theta) = L\cos\theta$. Here θ is zero in the direction of the zenith. Thus, this radiance distribution is maximal straight up and zero at the horizon. Compute the irradiance on the ground from a cloudy sky.

(6) **For extra credit:** Suppose the moon is rising over a pond where all the waves are moving from left to right (i.e. think of the surface as being made of cylinders whose axis is in the direction from you to the moon). What does the reflection of the moon on the surface look like? How is it different if the waves are moving from you toward the moon?