

Written Assignment #2

15-462 Computer Graphics, Fall 2007

DUE: Tuesday, December 4, just before class
(4 problems, 100 points total)

The work must be your own. Please use any resources available to you (the book, the web, etc.), but write up the answers in your own words. **Please show your work**, explaining all of the steps. Also please cite any external references you use (other than the textbook) to come up with your answers.

1. [30 points] Rendering and Light

Consider the following rendering algorithms studied in class:

1. OpenGL graphics pipeline
2. Ray Casting
- 3.. Ray Tracing
- 4.. Particle Tracing
5. Path Tracing
- 6.. Lightfields/Lumigraph

- a) Which of the above cannot handle mirror surfaces? Why?
- b) Which of the above have the largest memory requirements for a typical scene? Why?
- c) Given the following expressions for particular light paths (see Lecture 19), which of the above algorithms can handle them:
 - i. LDSE
 - ii. LSDE
 - iii. LD
 - iv. LDSSSE
 - v. LDSDSDE
- d) What is the light path expression for “color bleeding”? Which of the algorithms can handle it?

2. [20 points] Direct vs. Global Illumination

Consider Nayar et al examples of separating direct illumination from global illumination http://www1.cs.columbia.edu/CAVE/projects/separation/separation_gallery.php to answer the following questions:

- a) If the skin of a yellow pepper blocked all light arriving at its surface, what color would the yellow pepper appear to us?
- b) If you pluck a petal from a red flower and examine it in isolation it would appear to be not as red as when observed as part of the flower. Why?
- c) The differences in skin color are due to the albedo of the skin surface, or due to the subsurface scattering within the skin layer?

3. [20 points] Hierarchical Data Structures

- a) Describe, in 1 sentence, the main difference between the following two approaches: (1) constructing a bounding volume hierarchy (e.g. bounding boxes or bounding spheres), (2) constructing a hierarchy of splitting planes (e.g. KD trees or BSP trees).
- b) Propose a top-down technique for constructing a bounding box hierarchy:
- c) Propose a bottom-up technique for constructing a bounding box hierarchy:

4. [30 points] Visual Perception

- a) Why is tone mapping possible? That is, why can we ever hope that a sunset and a picture of a sunset could be made to look the same to a human observer?
- b) What does the Campbell-Robson contrast sensitivity curve tell us about human vision?
- c) How is that being used for lossy image compression, e.g. JPEG?
- d) Which step of the JPEG compression is lossy? That is, at which stage is information being lost when compressing an image.