

## **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](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.