Computer Graphics Ph.D. Qualifying Exam, October 2009

1. (10%) (a) Explain what normals are. (b) What relationship do normals and tangents have?

2. (25%) (a) The Phong illumination model can be summarized by the following equation:

\[ I = k_c + k_a I_a + \sum_i \left[ I_i \left( k_d (N \cdot L_i)_+ + k_s (V \cdot R_i)^n \right) \min \left( 1, \frac{1}{a_0 + a_1 d_i + a_2 d_i^2} \right) \right] \]

Draw a diagram to explain the main variables in the above formulation. What effects do the terms of the above formulation intend to model? (b) Describe how to shade a triangle using flat shading, Gouraud shading and Phong shading. Discuss their visual differences.

3. (25%) (a) Describe the rendering equation proposed by Kajiya in his classic SIGGRAPH 1986 paper. (10%) (b) Explain how to derive Whitted’s model from the rendering equation. (10%) (c) Could you suggest a way to find the solution to the rendering equation without making assumptions. You can ignore the efficiency issue. (5%)

4. (40%) Ray tracing and radiosity are two popular approaches for global illumination. (a) Briefly describe both methods. (20%) (b) Describe their strengths and weaknesses. (10%) (c) Give one example for each that you will prefer one over the other and explain why. (10%)