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資訊網路與多媒體研究所

資格考試科目：計算機圖形

Computer Graphics Ph.D. Qualifying Exam, March 2011

1. (20%) Write down the matrix M that takes the orthonormal 3D vectors $\mathbf{u} = (x_u, y_u, z_u)$, $\mathbf{v} = (x_v, y_v, z_v)$ and $\mathbf{w} = (x_w, y_w, z_w)$, to orthonormal 3D vectors $\mathbf{a} = (x_a, y_a, z_a)$, $\mathbf{b} = (x_b, y_b, z_b)$ and $\mathbf{c} = (x_c, y_c, z_c)$, so that $\mathbf{Mu} = \mathbf{a}$, $\mathbf{Mv} = \mathbf{b}$, and $\mathbf{Mw} = \mathbf{c}$. You do not need to write down the explicit matrix if it involves matrix inverse or transpose.

2. (20%) (a) The Phong illumination model can be summarized by the following equation:

$$I = k_e + k_a I_a + \sum_i \left[I_{l_i} \left(k_d (\mathbf{N} \cdot \mathbf{L}_i)_+ + k_s (\mathbf{V} \cdot \mathbf{R}_i)_+^{n_s} \right) \min \left(1, \frac{1}{a_0 + a_1 d_i + a_2 d_i^2} \right) \right]$$

   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. (20%) What is the average value of the function xyz in the unit cube $(x, y, z) \in [0, 1]^3$?

4. (20%) Given a sphere with the origin as its center and r as its radius, describe algebraically how to determine its intersections with a ray whose origin is $\mathbf{o} = \{o_x, o_y, o_z\}$ and direction is $\mathbf{d} = \{d_x, d_y, d_z\}$.

5. (20%) Assume a very simple scene, the inside of a uniformly emitting Lambertian sphere with emittance E and reflectance ρ. What is the radiance for each point inside the sphere when the scene reaches equilibrium.