

Computer Graphics

Midterm Exam

May. 5th, 2019

1.(10 marks)

Compute the dot product and cross product between two vectors $\vec{v}_1 = \{1, 1, 1\}$ and $\vec{v}_2 = \{0, 1, 0\}$. Compute the angle θ between the two vectors. Also draw all the vectors, \vec{v}_1 , \vec{v}_2 and $\vec{v}_1 \times \vec{v}_2$ in a coordinate system.

2.(10 marks)

Derive the rotation transformation of θ degrees about the point $(a, b)^T$ in 2D plane. Write the transformation in the form of $X' = MX + B$.

3.(10 marks)

In a world coordinate system xyz , there is a local coordinate system uvw , where $\vec{u} = \{x_u, y_u, z_u\}$, $\vec{v} = \{x_v, y_v, z_v\}$, $\vec{w} = \{x_w, y_w, z_w\}$ and origin $\vec{e} = \{x_e, y_e, z_e\}$.

- (a) If point p 's local coordinates are $\{u_p, v_p, w_p\}$, what are p 's world coordinates?
- (b) If point p 's world coordinates are $\{x_p, y_p, z_p\}$, what are p 's local coordinates?

4.(10 marks)

Let $P : A^T X = 0$ be a plane in 3D, where $A = (a, b, c, 1)^T$ and $X = (x, y, z, 1)$. Suppose that P is transformed to a plane \tilde{P} under an affine transformation M , represented as a 4×4 matrix. Find the equation of \tilde{P} .

5.(20 marks) A camera sits at $(0, -2, 0)$ and aims along positive y axis; the viewing plane passes through point $(0, 1, 0)$.

- (a) Write the coordinates of point $(2, 2, 2)$ after perspective projection.
- (b) Write the projected vector of vector $(2, 2, 2)$ when starting from $(0, 0, 0)$ or $(2, 2, 2)$.
- (c) Write the projection matrix.

6.(10 marks)

Suppose we have a sphere centered at the origin, $x^2 + y^2 + z^2 = r^2$. There is a light source at (a, b, c) . Generate a formula for finding the color at any point (x, y, z) on the surface of the sphere, assuming that there is diffuse reflection. Define any additional terms you introduce.

7.(10 marks)

- (a) Explain why highlights can be missed by the Gouraud shading method.
- (b) Compare the strengths and weaknesses of the Phong shading method and Gouraud shading method for shading polyhedral models.

8.(20 marks)

Please raise your comments, suggestions or feedback on this course so far.