

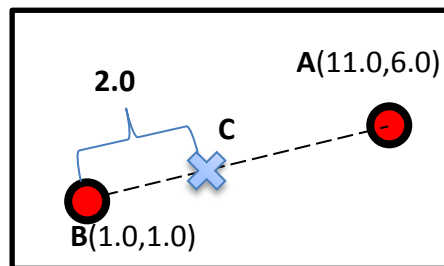
CMSC5716 Web-based Graphics and Virtual Reality

Written Assignment

Deadline: 27 February 2017

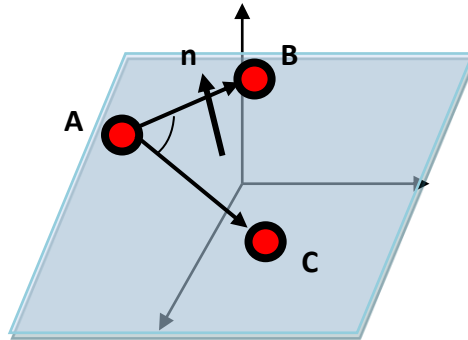
Please answer all 5 questions below and submit your answers before the deadline

1. Please refers to the following illustration about 2D points A, B and C to answer the following sub-questions (22)



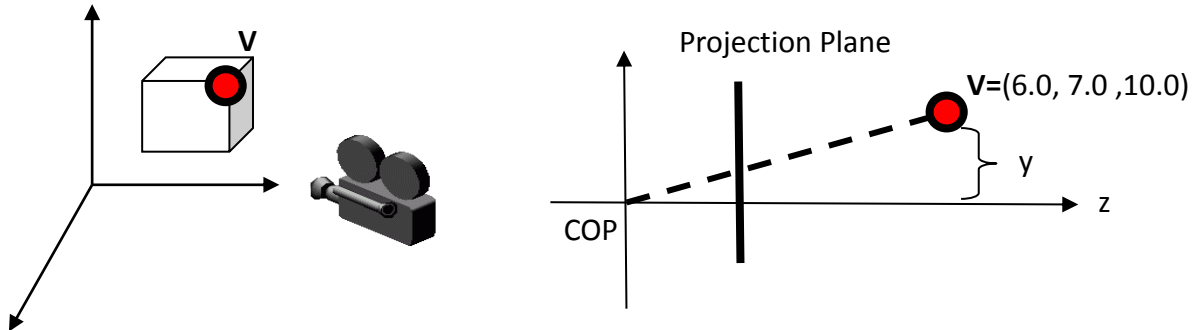
- 1.1 Calculate the vector BA (2)
- 1.2 Calculate the length of vector BA, please show your steps. (3)
- 1.3 Calculate the point C on the vector formed by BA and is 2.0 far from point B, please show your steps. (4)
- 1.4 Write down the 2D rotation matrix for rotating in clockwise for 45 degrees. Then, compute the coordinate of point B after rotating about the origin for 45 degrees in clockwise, please show your steps. (6)
- 1.5 Compose the 2D rotation matrix (in homogenous coordinates) for rotating about the point B, please show your steps. (7)

2. Following shows a three 3D vertices A(-1.0, 4.0, 4.0), B(2.5, 6.0, 2.0) and C (4.5, 0.0, 3.0), please answer the following sub-questions (a-c) (15)



- 2.1 Compute the vectors AB and AC (2)
- 2.2 Compute the angle between AB and AC, please show your steps (8)
- 2.3 Given the normal of the plane formed by the three vertices A, B and C is $\mathbf{n} = \langle 0.36, 0.27, 0.89 \rangle$, explain how to determine a point $\mathbf{D}(1.9, 4.4, 2.71)$ is on the plane or not. (5)

3. Following shows a regular cube formed by 8 corner vertices in 3D space. The cube is 2.0 in size and has the center at (4.0,3.0,3.0). One of its vertices $V = (5.0,4.0,4.0)$ is also indicated below. (27)



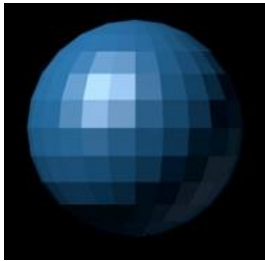
- 3.1 If now the cube is to be scale uniformly about center of the cube by a factor of **1.5**, use **matrices** to compute the coordinate of vertex V after the scaling. Please show your steps. (6)
- 3.2 Name the matrices involved when converting from object space to camera space. What is the advantage of transforming the vertex coordinates into the camera space before projection occurs? (3)
- 3.3 Assume the coordinate of vertex V in camera space is **(6.0, 7.0, 10.0)**, and the projection plane is at **Z= 2.0**. If perspective projection is used, compute the 2D coordinates after projection onto the screen. Please show your steps. (8)
- 3.4 A student needs to perform a camera zoom-in effect to cube, while he implements this by scaling to the cube. Is there any problem? Do you have another solution to him? Explain why your suggested method works. (You can draw to illustrate in case of necessary) (10)

4 Answer the following sub-questions related to lighting and texture mapping (20)

3.1 Please tell the differences of a point light source and a spot light source (3)

3.2 Given the light direction $\mathbf{l} = \langle 0.577, 0.577, 0.577 \rangle$, light intensity in RGBA channels are $(0.5, 1.0, 0.4, 1.0)$, normal vector $\mathbf{n} = \langle 0.707, 0.707, 0.0 \rangle$ of the surface, and the material properties in RGBA channels are $(1.0, 0.3, 0.3, 1.0)$. Compute the **diffuse** component of RGB channels using Phong lighting model (5)

3.3 A student is rendering a sphere in 3D with a directional light source. He would like to model the highlight reflection similar to the one as shown below:



The current rendered sphere looks blocky, why there is such a problem? How can we solve this? Briefly explain how your suggested method works. (5)

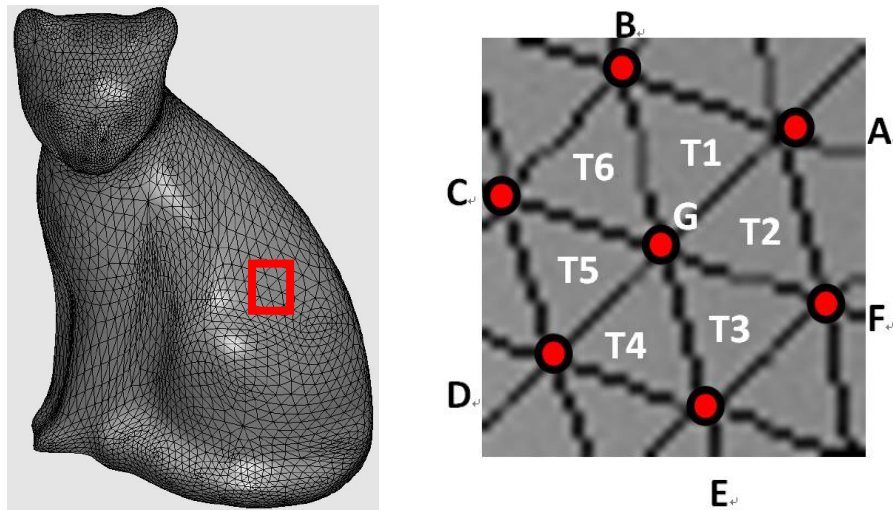
3.4 Based on your answer in 3.3, what is the drawback of using your suggested method? (2)

3.5 When will aliasing happen in texture mapped object? Please draw a figure to illustrate the situation. (5)

- 5 A student is modeling a cat statue in 3D software. He found that parametric surfaces are suggested to be used instead of triangular mesh in modeling 3D objects on many internet forums. (16)

(a) What is the advantage of modeling surface using parametric surface? What are involved in defining a parametric surface? What is the operation to convert parametric surface to triangle mesh. (4)

(b) The student exports the cat statue to triangle mesh as shown above. The blow-up region shows 7 vertices (A-G) and 6 triangles (T1-T6). Explain how to store them using Indexed triangular mesh? Also count the number of integer and floating point needed. 2 (8)



(c) The student would like to create a dancing cat statue animation by key-frame animation. Do you suggest him to do so? Why? Please suggest another technique available to help creating the dancing animation and briefly describe the technique works. (4)

Guideline to assignment submission

You are recommended to submit your completed assignment in soft copy (pdf or docx), a scanned hand written answer is welcomed. Then, submit your file to CUHK elearning system

Hard copy is also acceptable; please submit in person to your lecturer.