Practice Questions

CS475/CS675 - Computer Graphics
August 26, 2019

1 Rasterization

1. Give an algorithm to rasterize a circle of radius $r$ that is centered at the origin. Give an analysis of the error your rasterization algorithm incurs while choosing which pixels to color. Also show whether your algorithm produces a rasterization with least deviation (or error) from the true circle given by $x^2 + y^2 = r^2$.

2 Clipping

1. A rectangular clipping window is defined by the following window coordinates: (0, 0) for the left, bottom corner and (5, 4) for the right, top corner. We are also given two line segments: Line $AB$ (from $A(-1, -1)$ to $B(6, 6)$) and Line $CD$ (from $C(-1, 1)$ to $D(4, -3)$) that we want to clip against the window using the Cohen-Sutherland Clipping algorithm. What is the sequence of bitcodes generated by the algorithm when it is run on the lines $AB$ and $CD$. Also, mention what is the final result of the clipping.

The 4 bit bitcode PQRS are defined as per the following convention:

\[
\begin{align*}
P & \text{ is 1 if } x < 0 \\
Q & \text{ is 1 if } x > 5 \\
R & \text{ is 1 if } y < 0 \\
S & \text{ is 1 if } y > 4
\end{align*}
\]

2. Does the Cyrus-Beck clipping algorithm have any advantage over the Cohen-Sutherland algorithm? Explain with an example.
3 Transformations

1. Two lines, \( AB \equiv -(2/3)x + y = -(1/3) \) and \( EF \equiv x + y = 1 \) are transformed using the following transformation matrix,

\[
T = \begin{bmatrix}
1 & 1 & 0 \\
2 & -3 & 0 \\
0 & 0 & 1 \\
\end{bmatrix}
\]

(1)

What is the point of intersection of the transformed lines?

2. A triangle \( ABC \) formed by the vertices \( A(4,1), B(5,2), C(4,3) \). What are the final coordinates of the vertices if the triangle it is first reflected about the \( x-axis \) and then reflected about the line \( y = -x \). Show that this transformed configuration of vertices is also obtainable by rotating the original triangle about the origin by 270 degrees.

3. A cuboid has sides of length 4 units, 6 units and 10 units respectively. Write an anisotropic 3D scaling transformation, \( T \), to transform this cuboid to a cube of side 2 units. What does the transformation do to the volume of the cuboid?

4. If \( T(P) = MP + t \) where \( M \) is a general \( 2 \times 2 \) matrix and \( t \) and \( P \) are 2-dimensional vectors, is \( T \) a linear map or not? Prove your claim.

4 Viewing

1. Given a set of arbitrarily oriented line segments in 3D space, which of the line segments will retain their original lengths under a perspective projection on the \( z = 0 \) plane through a camera center lying on the positive \( z-axis \)?

2. Given two line segments \( AB \) and \( CD \) in 3D space, prove that their point of intersection maps to the point of intersection of \( A'B' \) and \( C'D' \) where the points \( A', B', C', D' \) are the perspective projections of points \( A, B, C, D \) respectively.

3. How can we get the following in OpenGL (answer in terms of a general sequence of operations, exact syntax of commands in not necessary):

   (a) Axonometric Projections
   (b) Oblique Projections
   (c) 2 and 3 point perspective projections