

Homework 2

CSCI-4967: Three-Dimensional Computer Graphics

Fall 2004

Due: Thursday, September 30, 2004

Homeworks are due at the **beginning** of lecture on Thursday, September 30. **Late homeworks will receive no credit.** Homeworks are to be done individually and will be graded on the basis of correctness, clarity, and legibility. Show the steps in your work where appropriate. Each question is worth **10 points**, for a total of **50 points**.

Be sure to write your **name** and **RPI email address** on your homework submission.

- Compare the Digital Differential Analyzer (DDA) and Bresenham line drawing algorithms. What are the advantages of the Bresenham algorithm?
 - Consider a transformation that maps a square into a trapezoid. Is this an affine transformation? Justify your answer.
 - Suppose that a triangle is clipped to a rectangular window. After being clipped against the window, what is the maximum number of sides that the resulting clipped polygon might have? Draw an example to illustrate.
- Suppose you are given an orthonormal frame F located at (f_x, f_y, f_z) and whose unit vectors are (u_x, u_y, u_z) , (v_x, v_y, v_z) , (n_x, n_y, n_z) , expressed in the world coordinate frame W .
 - Write the 4×4 matrix that transforms points from the world coordinate frame W to the coordinate frame F .
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 - What are the coordinates of the origin of the world coordinate frame W in the frame F ?
- Compare the relative advantages of orthographic and perspective projections.
 - What are the advantages of using perspective projection matrices of the form used by `glFrustum()` and `gluPerspective()` rather than the simple perspective projection matrix?
 - Consider a point located at $(0, b, -\text{far})$ in the view volume specified by the perspective transformation `glFrustum(-a, a, -b, b, near, far)`. Compute the corresponding coordinates of this point in the canonical view volume, which is the unit cube centered at the origin with sides of length 2 units. (Note: The perspective transformation matrix corresponding to `glFrustum()` is discussed in the class lecture notes and the OpenGL Blue book.)

4. (a) What is the relationship between the quaternion representing a rotation of θ about the unit vector \hat{u} and the quaternion representing a rotation of $-\theta$ about the unit vector $-\hat{u}$? Do they represent the same rotation or not? Justify your answer.
- (b) Using quaternions, compute the resulting point p' when the point $p = (1, 0, 3)$ is rotated by 90 degrees about the $(1, 1, 1)$ axis passing through the origin. Note that $\sin(45) = \cos(45) = 1/\sqrt{2}$.
5. Consider the use of quaternions for composition of rotations.
- (a) Compute the quaternion corresponding to a composite rotation consisting of a rotation of 90 degrees about the X axis followed by a rotation of 90 degrees about the Z axis. Show the quaternions corresponding to the individual rotations as well the quaternion corresponding to the composite rotation.
- (b) Identify a rotation angle and axis of rotation that describe the above composite rotation.