Computer Graphics

CSE 167 [Win 22], Lecture 12: Review of
Transformations and OpenGL

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To Do

- Finish HW 2. How are people doing on that?

- Start on HW 3

- Prepare for midterm
  - In perspective, important but only equal 1 HW

Review Lectures

- Chance to cover some topics in depth

- Go over some questions (see review notes)
  - More detailed mathematical questions
  - Preparation for midterm

- Please feel free to also ask questions

- More informal, done mostly on board

Questions?

Question 1

Write the homogeneous 4x4 matrices for the
following transforms:

- Translate by +5 units in the X direction

- Rotate by 30 degrees about the X axis

- The rotation, followed by the translation above,
  followed by scaling by a factor of 2.

Question 2

- In 3D, consider applying a rotation R followed by
  a translation T. Write the form of the combined
  transformation in homogeneous coordinates (i.e.
  supply a 4x4 matrix) in terms of the elements of
  R and T. Now, construct the inverse
  transformation, giving the corresponding 4x4
  matrix in terms of R and T. Verify by matrix
  multiplication that the inverse times the original
  transform does in fact give the identity.

Question 3

Consider flatland (without homogeneous coordinates) 2x2 transformation matrices. Let's say we want to scale by 1.5 (increase length 50%) not about the coordinate axes, but about an axis at -45 degrees to the horizontal. What is the resulting transformation matrix?

Question 4

How can any 2D or 3D transformation (without homogeneous coordinates) be written (decomposed) as a combination of rotations and scales?

Question 7

Assume that in OpenGL, your near and far clipping planes are set at a distance of 1m and 100m respectively. Further, assume your z-buffer has 9 bits of depth resolution. This means that after the gluPerspective transformation, the remapped z values [ranging from -1 to +1] are quantized into 512 discrete depths.

- How far apart are these discrete depth levels close to the near clipping plane?

- More concretely, what is the z range (i.e. 1m to ?) of the first discrete depth?

- Now, consider the case where all the interesting geometry lies further than 10m. How far apart are the discrete depth levels at 10m? Compare your answer to the first part and explain the cause for this difference.

- How many discrete depth levels describe the region between 10m and 100m?

- What is the number of bits required for this number of depth levels? How many bits of precision have been lost?

- What would you recommend doing to increase precision?

Question 8

Consider the following operations in the standard OpenGL pipeline: Scan conversion or Rasterization, Texture Mapping, Projection Matrix, Transformation of Points and Normals by the ModelView Matrix, Dehomogenization (perspective division), clipping. Briefly explain what each of these operations are, and in what order they are usually performed and why. Which of these operations are conventionally performed in the vertex shader, fragment shader, or the OpenGL fixed pipeline?