

HOMWORK ASSIGNMENT 1 (THEORY)

CO19-320322: COMPUTER GRAPHICS
320322: GRAPHICS AND VISUALIZATION

Fall 2016

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Due: Friday, September 23, 2016, at 8pm.

Problem 1: Geometric Background

(5+6+4=15 points)

Assuming 3D Cartesian coordinates, we are given a triangle Δ with vertices $\mathbf{p}_1 = (3, 0, 2)$, $\mathbf{p}_2 = (2, 0, 2)$, and $\mathbf{p}_3 = (1, 1, 2)$. Let $\mathbf{v} = (0, 0, 0)$ be the viewpoint. Moreover, let the screen be given by the quadrilateral $\mathbf{v}_1 = (-1, -1, 1)$, $\mathbf{v}_2 = (1, -1, 1)$, $\mathbf{v}_3 = (1, 1, 1)$, and $\mathbf{v}_4 = (-1, 1, 1)$.

- (a) The triangle Δ is scaled with factors 3 and -1 in the x - and y -coordinate, respectively, rotated (counter-clockwise) by 90° around the z -coordinate, and translated by distance 3 in the direction of the x -coordinate. The transformations are executed in the given order.
- Derive the transformation matrix of each transformation step in homogeneous coordinates.
 - Compute the combined transformation matrix in homogeneous coordinates.
 - Apply the combined transformation matrix to triangle Δ .
- (b) The triangle Δ is projected into the given image plane using perspective projection.
- A perspective projection can be described as a matrix in homogeneous coordinates. Derive the general version of the matrix assuming any viewpoint \mathbf{v} and any screen space ($\mathbf{o}; \mathbf{e}_1, \mathbf{e}_2$).
 - Compute the projection matrix A in homogeneous coordinates for the given example.
 - Apply the projection matrix A to the triangle Δ and map the results to 2D Cartesian coordinates.
- (c) Given point $\mathbf{q}_1 = (\frac{1}{2}, \frac{1}{4}, \frac{1}{4})$ in barycentric coordinates with respect to triangle Δ and point $\mathbf{q}_2 = (6, 1, 6, 3)$ in homogeneous coordinates.
- Compute \mathbf{q}_1 in homogeneous coordinates.
 - Compute \mathbf{q}_2 in barycentric coordinates with respect to triangle Δ .

Remarks: The theoretical assignments have to be submitted in paper form into the box labeled “Linsen” in the Research I entrance hall. In case the theoretical part is typed (e.g., using \LaTeX), the generated PDF-file can also be uploaded to jGrader.