

Exam – Computer Graphics

16 december 2006, 8-13

Electronic calculator allowed

- 1 Let $T=R*S$ where R is the matrix representation for a rotation of the angle $alpha$ around the positive x-axis och S is a scaling with factors (2,3,1).
 - (a) Give the matrix representation for T . (0.6)
 - (b) Give the matrixrepresentation for its inverse, T^{-1} (0.4)

- 2
 - (a) What is *backface culling*? (0.2)
 - (b) Describe how it is implemented? (0.4)
 - (c) What is the relationship between the normal, the tangent and the binormal of a surface? (0.4)

- 3
 - (a) Explain how bilinear interpolation is done. (0.6)
 - (b) In Catmull-Rom-interpolation the tangents at the control points are computed automatically. Explain how. (0.4)

- 4
 - (a) What is a mip-map and which problem does it solve? (0.5)
 - (b) What is ray-tracing and how does it work? (0.5)

5. (a) What is drawn on the screen after a call to the function *draw()* below? (0.8)

```
def draw():
    glColor(1, 0, 0)
    glPushMatrix()
    glScale(1, 2, 1)
    glTranslate(2, -2, 0)
    drawSquare()

    glColor(0, 1, 0)
    glTranslate(2, 3, 0)
    glPushMatrix()
    glRotate(180, 0,0,-1)
    glPushMatrix()
    glRotate(90, 0,0,1)
    glTranslate(-2, -1, 0)
    glPopMatrix()
    glPushMatrix()
    glScale(2, 2, 1)
    drawSquare()

    glColor(0, 0, 1)
    glPopMatrix()
    glPushMatrix()
    glRotate(180, 0,0,1)
    glTranslate(-1, 0, 0)
    drawSquare()
```

```
def drawSquare():
    glBegin(GL_QUADS)
    glVertex(0,0,0)
    glVertex(0,1,0)
    glVertex(1,1,0)
    glVertex(1,0,0)
    glEnd()
```

(b) What is GLUT? (0.2)

- 6 A triangle with vertices P_0, P_1, P_2 is lit by a directional lightsource with emittance L and radiating in the direction of V_L and the viewer is placed in the point P_V . The ambient light is negligible and the material properties of the surface are given below.

Material constants	Vertices	Directional light	Viewer
$k_a = (0.1, 0.1, 0.1)$ $k_d = (0.3, 0.3, 0.8)$ $k_s = (0.8, 0.8, 0.8)$ $\alpha = 12$	$P_0 = \begin{bmatrix} -1 \\ 1 \\ 3 \end{bmatrix}$ $P_1 = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}$ $P_2 = \begin{bmatrix} 0 \\ 0 \\ -2 \end{bmatrix}$	$L = (1.0, 1.0, 1.0)$ $V_L = \begin{bmatrix} 1 \\ -2 \\ 9 \end{bmatrix}$	$P_V = \begin{bmatrix} 3 \\ 2 \\ 7 \end{bmatrix}$

- (a) Describe in words the general appearance according to Phong's reflection model, of a surface with the given material parameters and other circumstances given above. (0.1)
- (b) Let P be the point which has the barycentric coordinates $[0.5, 0.2, 0.3]$ with respect to the vertices of the triangle. Use Phong's reflection model to determine the reflection from P . (0.4)
- (c) Determine the reflection from the same point according to Blinn-Phong's reflection model. (0.2)
- (d) Describe in words how the appearance with this reflection model is different from the one described in (a). (0.3)

THE END!