DEPARTEMENT INFORMATICA EN INFORMATIEKUNDE, FACULTEIT BÈTAWETENSCHAPPEN, UU.
IN ELEKTRONISCHE VORM BESCHIKBAAR GEMAAKT DOOR DE $\mathcal{TBC}$ VAN A−Eskwadraat.
HET COLLEGE INFODDM WERD IN 2006/2007 GEGEVEN DOOR TWAN MAINTZ EN ROLAND GERAERTS.

Drie-dimensionaal Modelleren (INFODDM)
16 april 2007

Acquisition

Opgave 1

a) A triangulation scanner shines a laser on an object to capture its 3D coordinates. To speed up the scanning process, multiple lines can be swept across the object. Because of holes and occlusions, lines may disappear and even change order. Describe how structured light is used to decide the order.

b) A triangulation technique is of an example of an active optical shape acquisition. Give two other examples of *active optical shape acquisition* techniques, and describe each technique in one sentence.

Reconstruction

Opgave 2

Hoppe's paper on *Surface reconstruction from Unorganized Points* describes a general method for surface reconstruction.

a) Give three difficulties (except the one mentioned in b)) that have to be tackled when dealing with surface reconstruction.

b) One of those difficulties is how to determine whether or not there is a hole in the model. Describe how Hoppe detects such a hole in the case that there is no noise in the data.

Simplification

Opgave 3

Describe how a progressive mesh representation can be exploited to achieve mesh compression. Also mention and describe the two basic operations involved in mesh compression.

Terrains, Fractals and Procedural modeling

Opgave 4

Describe how statistical self-similar fractals can be used to generate a terrain with trees.

Representations

Opgave 5

a) What is an *oriented 2-manifold* polygonal mesh?

b) Why is it important for a Finite Element Method that a polygonal mesh is an oriented 2-manifold?

Curves and Surfaces

Opgave 6

Compute the tangent line equation at $t = \frac{\pi}{3}$ of the curve

$$\mathbf{Q}(t) = (\cos^2(t), \sin^2(\tfrac{t}{2}), \cos(t)\sin(t)).$$

Opgave 7

Compute $\mathbf{Q}_{uv}$ for $u = v = 1$ for a cubic Bézier patch if $\mathbf{P}$ is a control point matrix,

$$\mathbf{Q}(u, v) = \begin{bmatrix} u^3 & u^2 & u & 1 \end{bmatrix} \mathbf{B}_z \mathbf{P} \mathbf{B}_z^T \begin{bmatrix} v^3 \\ v^2 \\ v \\ 1 \end{bmatrix}$$

and

$$\mathbf{B}_z = \begin{bmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{bmatrix}.$$

Opgave 8

Many curves $\mathbf{Q}$ are formulated as weighted combinations of a control points set, i.e.,

$$\mathbf{Q}(u) = \sum_i \mathbf{P}_i B_i(u),$$

with control points $\mathbf{P}_i$, curve parameter u and weight functions B_i.

a) Give a formula for the rational variant of this $\mathbf{Q}$, and

b) explain why the rational form is more flexible, i.e., can represent more curve shape variation than the non-rational form.

Animation

Opgave 9

a) Compute the rotation angle θ and unit rotation axis $\mathbf{n}$ corresponding to the quaternion $q = (0.7071, (0.3536, 0.5, 0.3536))$.

b) Compute the quaternion w corresponding to the rotation axis $\mathbf{n}$ and rotation angle $-\theta$.

c) Try to compute the quaternion 'midway' ($u = 0.5$) the quaternions q and w, as given by *slerp* interpolation. (Reminder: $slerp(s, t, u) = s\frac{\sin((1-u)\Omega)}{\sin\Omega} + t\frac{\sin(u\Omega)}{\sin\Omega}$.) Why does the standard *slerp* formula not work in this case?

Opgave 10

When using kinematics for producing an animation, we may use forward (FK) or inverse kinematics (IK).

a) Give an advantage of using FK over IK.

b) Give an advantage of using IK over FK.