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Further Graphics supervision 1

Lecture 1-3

1. Parametric surfaces are surfaces parametrised by two real parameters using some mapping function. Implicit surfaces are the zero set of some function of $\mathbb{R}^3$. Point set surfaces are not defined by an equation, but just a set of points, usually gathered from a real-life source object.

- Parametric surfaces can be mapped to textures more easily.
- It is easier to detect if a point is inside or outside an implicit surface, as well as proximity.
- Implicit surfaces can be easily combined.

2. An exponential spiral, centred on the origin.

3. The surface normal for a parametric surface with a mapping function $s(u, v)$ is given by

$$\hat{\mathbf{n}} = \frac{\mathbf{s}_u \times \mathbf{s}_v}{||\mathbf{s}_u \times \mathbf{s}_v||}$$

where

$$\mathbf{s}_u = \frac{\partial s(u,v)}{\partial u}, \mathbf{s}_v = \frac{\partial s(u,v)}{\partial v}$$

For the torus equation given, we have

$$\mathbf{s}_u = \begin{bmatrix} -(3+\sqrt{2}\cos v)\sin u \\ (3+\sqrt{2}\cos v)\cos u \\ 0 \end{bmatrix} = \begin{bmatrix} -2\sqrt{3} \\ 2 \\ 0 \end{bmatrix}$$

$$\mathbf{s}_v = \begin{bmatrix} -\sqrt{2}\sin v\cos u \\ -\sqrt{2}\sin v\sin u \\ \sqrt{2}\cos v \end{bmatrix} = \begin{bmatrix} -1/2 \\ -\sqrt{3}/2 \\ 1 \end{bmatrix}$$

$$\therefore \hat{\mathbf{n}} = \frac{1}{4\sqrt{2}} \begin{bmatrix} 2 \\ 2\sqrt{3} \\ 4 \end{bmatrix}$$

4. Parametric equation:

$$s(\theta, \phi) = \begin{bmatrix} 2\cos\theta\sin\phi \\ 3\sin\theta\cos\phi \\ 2\cos\phi \end{bmatrix}$$

$P = (2, 3, -2)$ does not lie on the surface, since

$$\frac{2^2}{4} + \frac{3^2}{9} + \frac{(-2)^2}{4} - 1 \neq 0$$

There is therefore no surface normal at P.

5. Since $f(x, y) = 0$ has 2 lines of solutions that intersect at $(0, 0)$, we may encounter unexpected behaviour if we don't take this into account.

6. A closed 2-manifold is a surface that is homeomorphic to a disk at all points. A manifold with boundaries is a manifold where each boundary point is homeomorphic to a half-disk.

7. I don't understand this question.

8.
$$\Delta(e^{-(x-c)^2/s^2}) = \frac{4(x-c)^2 e^{-(x-c)^2/s^2}}{s^4} - \frac{2e^{-(x-c)^2/s^2}}{s^2}$$
$$\Delta(\sin(x^T d)) = dT(T-1)x^{T-2}\cos(dx^T) - d^2T^2x^{2T-2}\sin(x^T d)$$

Lecture 4-5

1.

a. Motion capture, key-framing, video based, etc.
b. Rigging is where a model is given a skeleton, which is stored as the joint vertices. The model is then moved according to the movements of the skeleton.
c. If the initial positions of the points are p_{-1}, p_0, p_1, then their new positions will be $p_{-1}, \frac{1}{2}Tp_0, Tp_1$

2.

a. Matrix transformations blend translations, but do not blend rotations correctly. Dual quaternions blend both translations and rotations well.
b. I don't know.

3. I cannot do either of these questions.