

CZ2003 Tutorial 12 (2022/2023, Semester 1)

Surface mapping

1. Figure 1 (left) shows a surface patch that is defined parametrically by

$$\begin{cases} x = (v + 1)\sin(0.6\pi u) \\ y = 2v + 0.5 \\ z = (v + 1)\cos(0.6\pi u) \end{cases} \quad u, v \in [0, 1]$$

Design parametric functions $r(u, v)$, $g(u, v)$ and $b(u, v)$ to define diffuse color for the surface patch such that the diffuse color varies continuously across the patch, as shown in Figure 1 (right), and the color at the four corners P_1 , P_2 , P_3 and P_4 is red, green, blue and white, respectively.

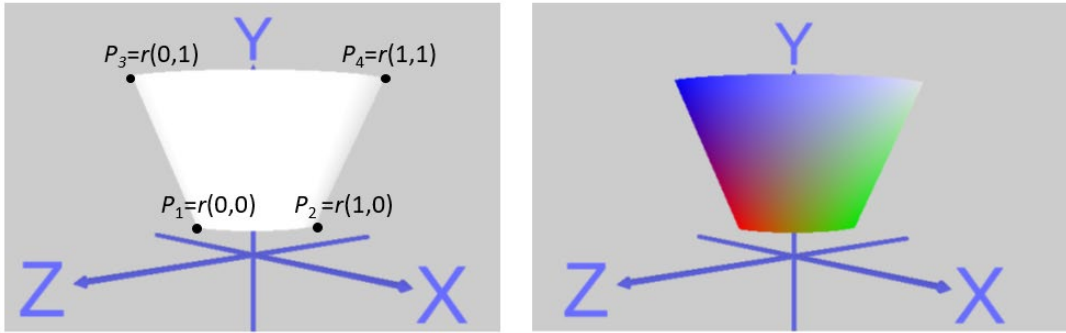


Figure Q1

2. A bilinear surface is defined by $P(s, t) = P_1 + (P_2 - P_1)s + (P_3 - P_1)t + (P_1 - P_2 - P_3 + P_4)st$ with $P_1 = (10, 30, 0)$, $P_2 = (4, 20, 0)$, $P_3 = (16, 10, 2)$ and $P_4 = (12, 5, 2)$. With reference to Figure Q2(left), an image of pixels 101×161 is defined by $\text{Pixel}(i, j) = (r(i, j), g(i, j), b(i, j))$, $i=0, 1, \dots, 100$, $j=0, 1, \dots, 160$, where

$$\begin{cases} r(i, j) = 0.9 \sin^2\left(\frac{\pi}{2} \left\lfloor \frac{j}{30} \right\rfloor\right) \\ g(i, j) = \frac{1}{8} \left\lfloor \frac{j}{20} \right\rfloor \\ b(i, j) = 0.5 \end{cases}$$

- The image is mapped to the bilinear surface as shown in Figure Q2(right). Which pixel on the image is mapped to the point with coordinates (9.8, 18, 0.8) on the surface? Compute the color values at that pixel.
- If the image is used for displacement mapping, derive the parametric equations of the displaced surface.

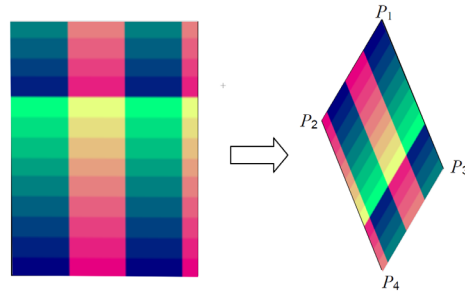


Figure Q2

3. With reference to Figure Q3, a displacement mapping is applied to a sphere, which creates a 3D solid object defined implicitly by:

$$f(x, y, z) =$$

$$(9 - x^2 - y^2 - z^2) + 0.1 \cdot [\sin(20\pi x)\sin(20\pi y) + \sin(20\pi x)\sin(20\pi z) + \sin(20\pi y)\sin(20\pi z)] \geq 0$$

Find a tight sphere containing this object. What are the center and radius of the bounding sphere?

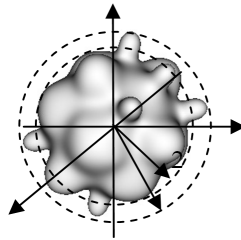


Figure Q3