GLSL - Texturierung

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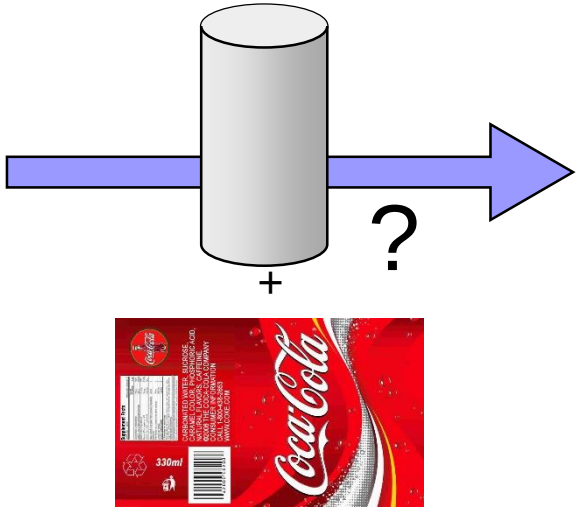
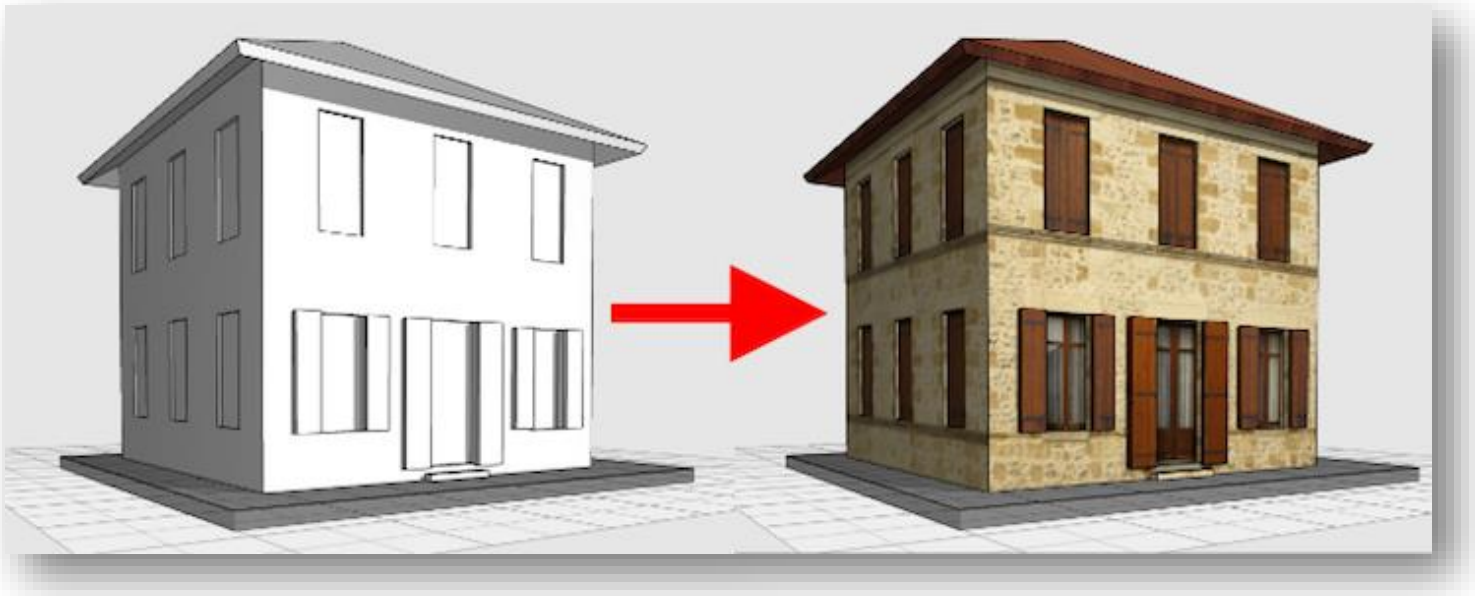
Texturierung, *Texture Mapping*

- Realismus durch Aufkleben von Bildern
  Ed Catmull, Pixar 1974



Parameter in Texturen

- Im Shader kommen Oberflächenparameter (z.B. Farbe, Diffuser Koeffizient k_d) aus Texturen!

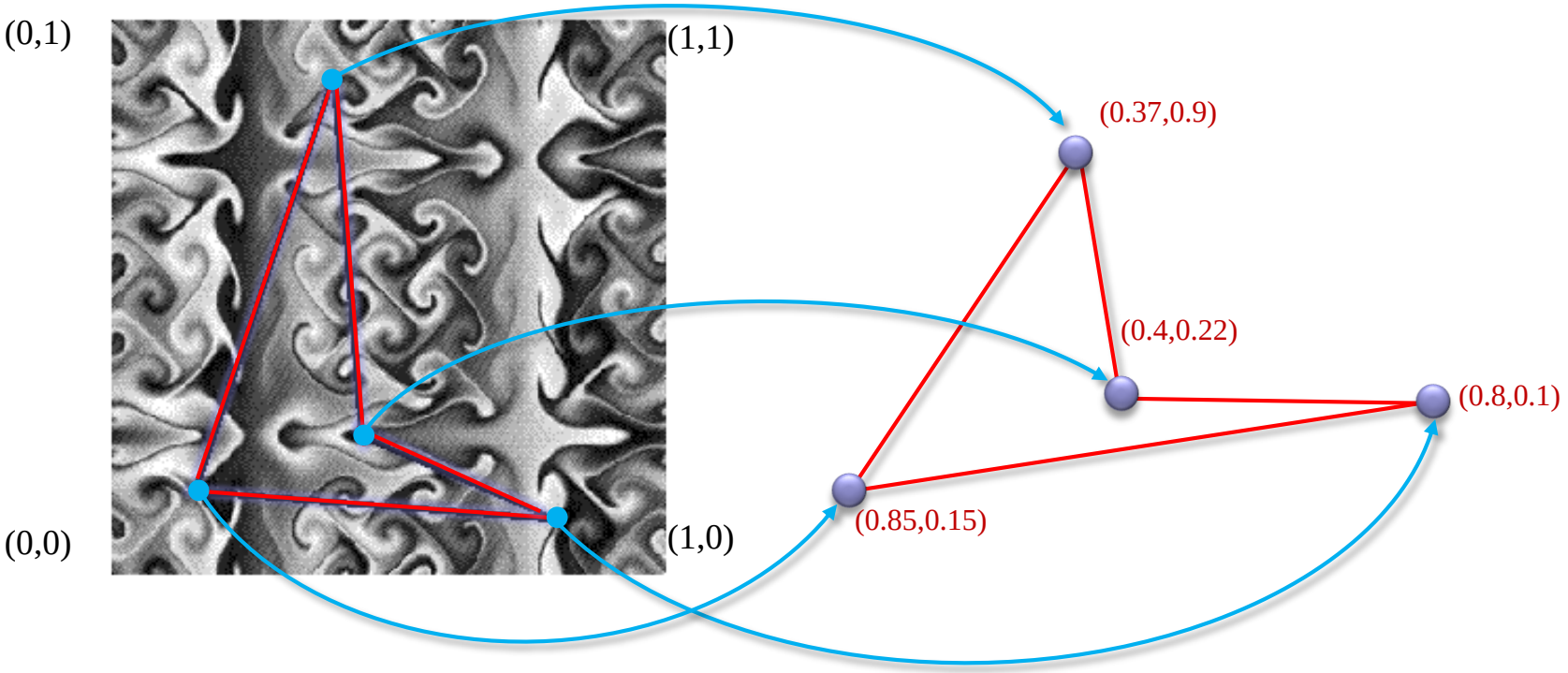


Texturierung

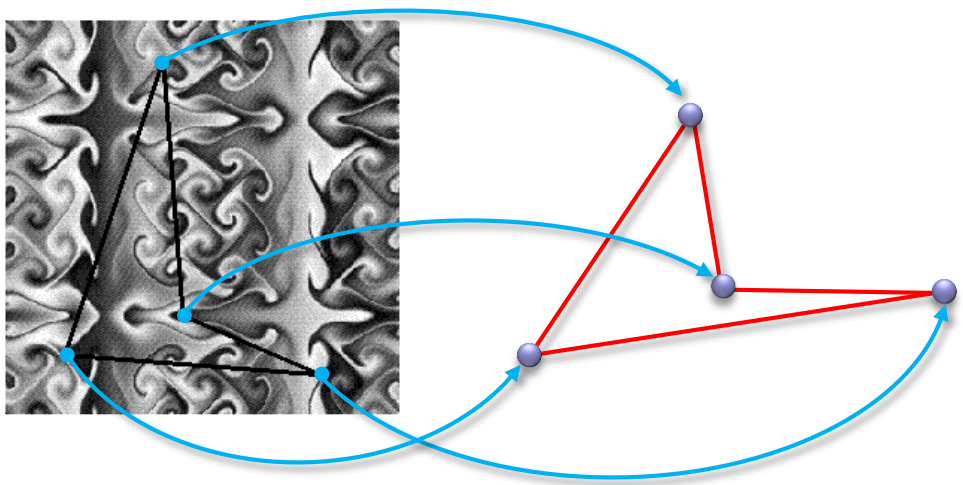
- OpenGL: siehe Blatt07.zip
  TextureObject.h/.cpp
- GLSL:
  shader/textured.vert/.frag

Texture Mapping

Texturkoordinaten pro Vertex (als Attribut).

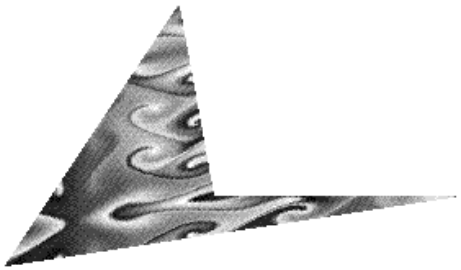


Texture Mapping



Textur
+

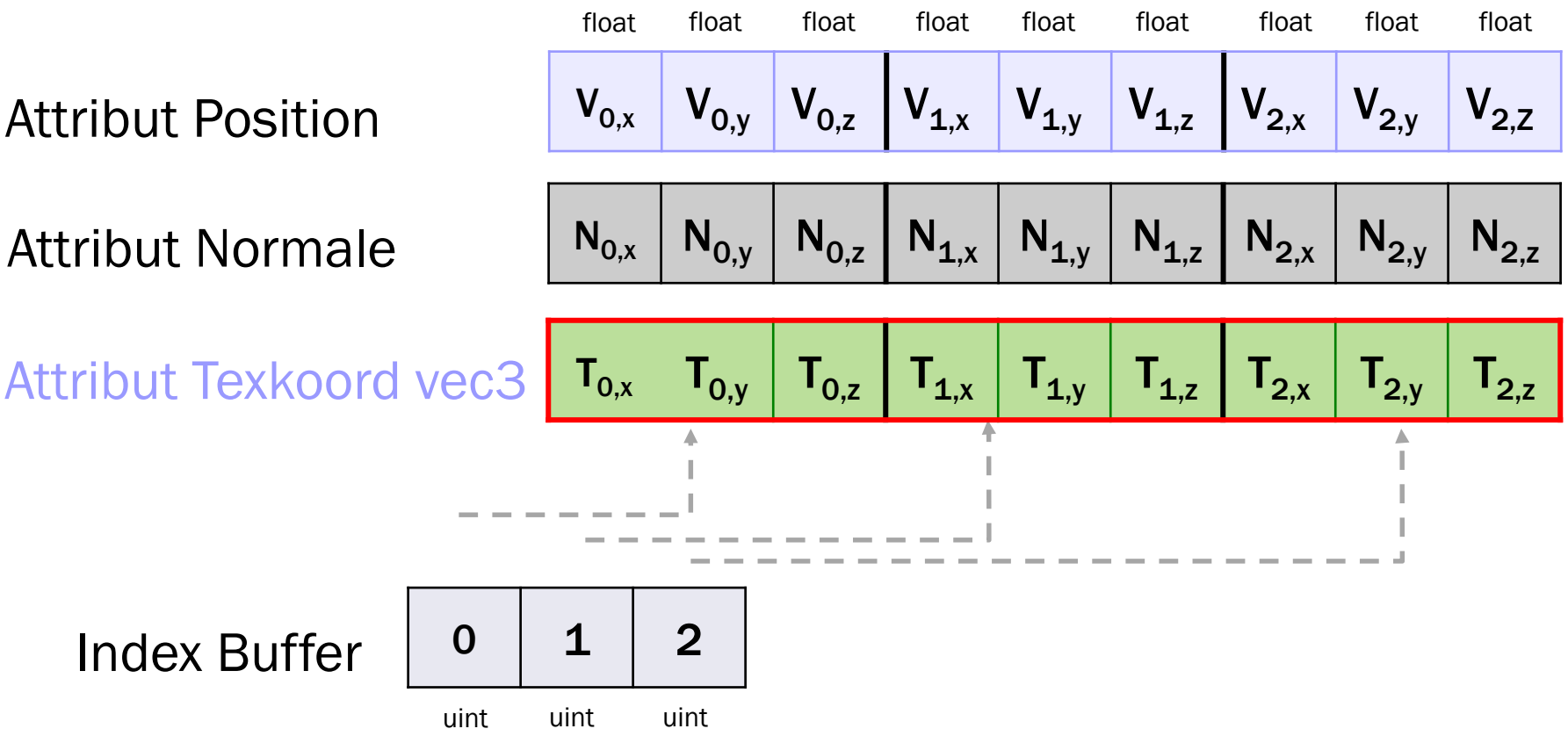
Vertices mit
Texturkoordinaten



= Texturiertes
Polygon

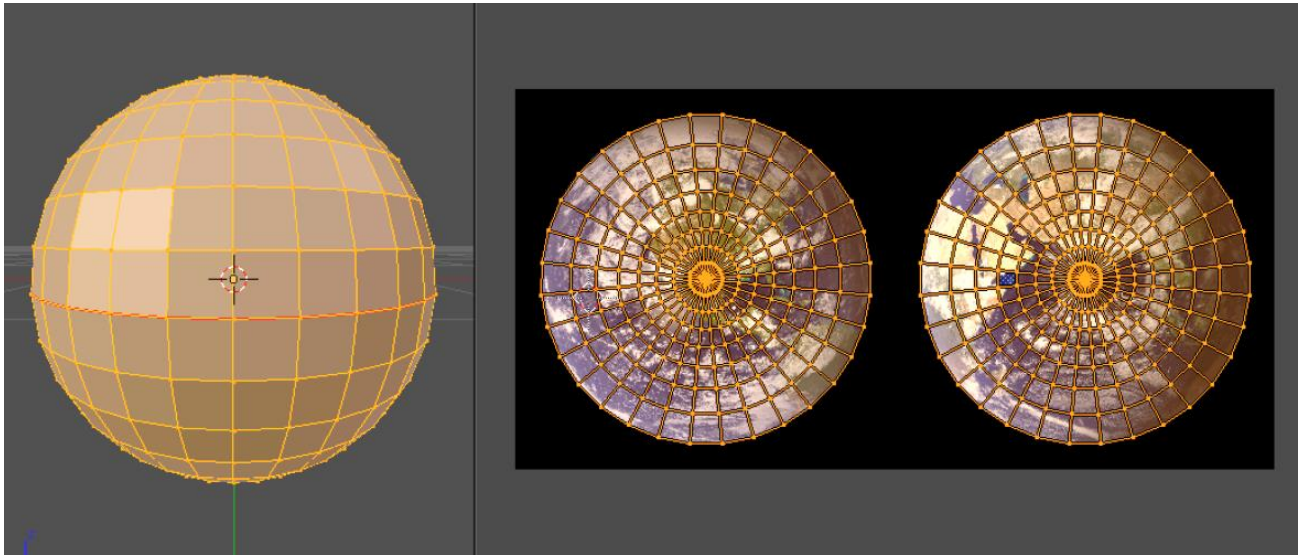
Per Attribut

- Per-Vertex Texturkoord (OBJ, Maya, Blender)



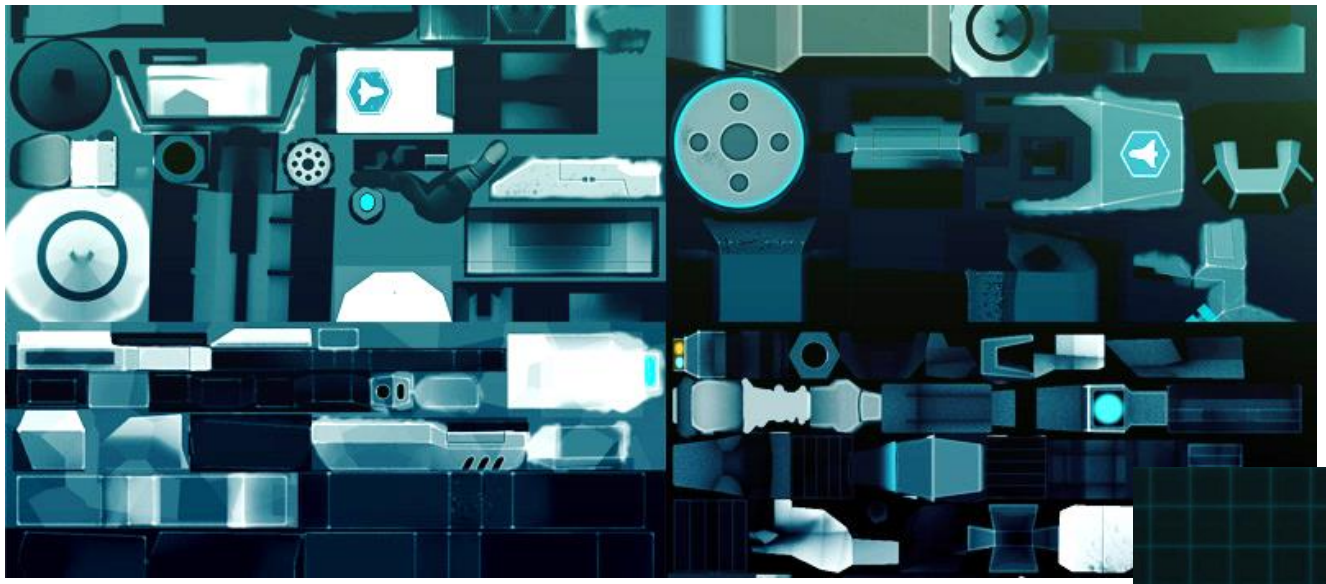
Per Texturatlas

- Alle Polygone eines Objekts in einer Textur
- Keine Verzerrungen
  Stückweise Parametrisierung



Per Texturatlas

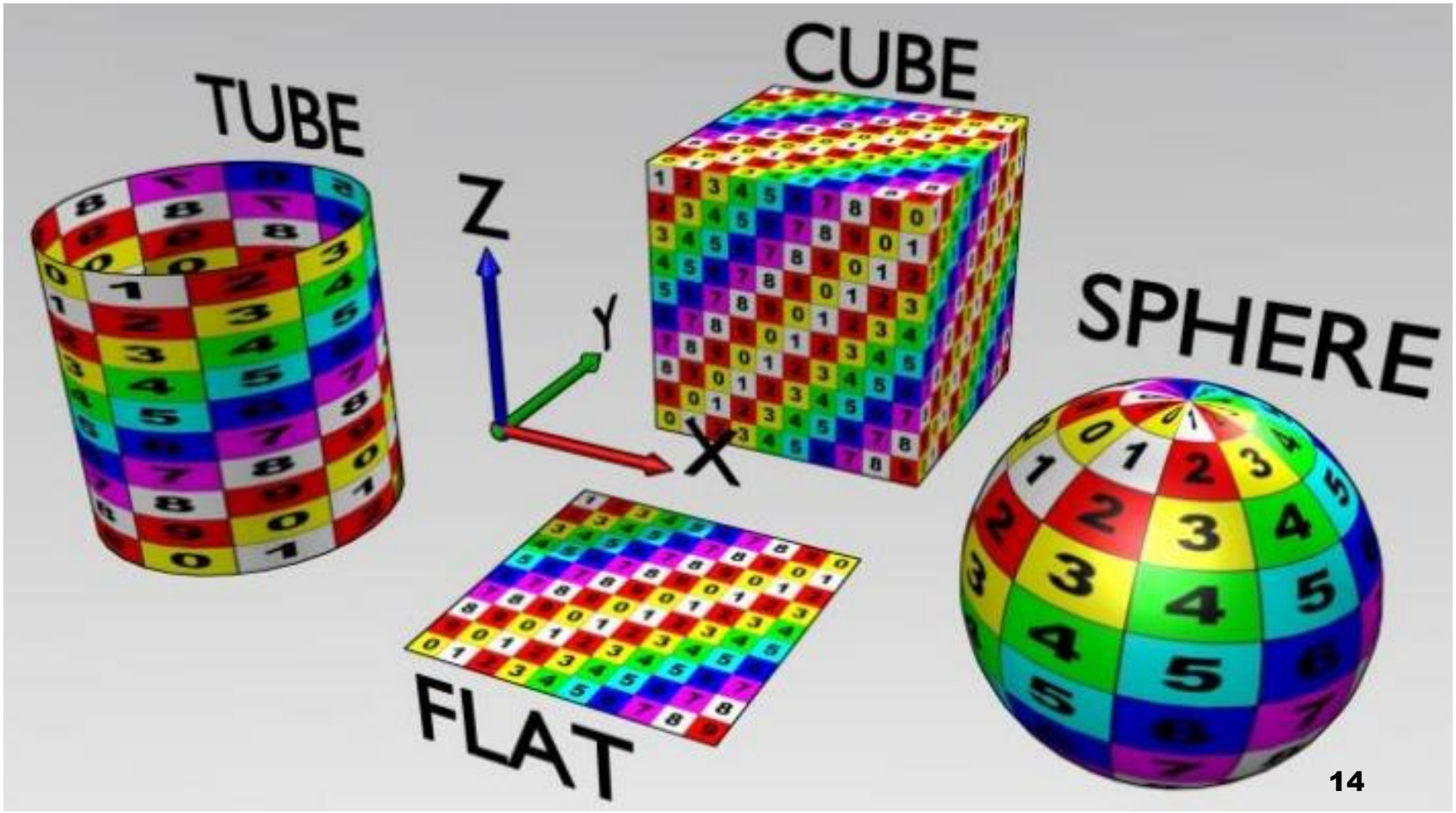
Atlas mit Texturstücken für verschiedene Objektteile, gespeichert in einer einzigen Textur



Modell mit Texturen

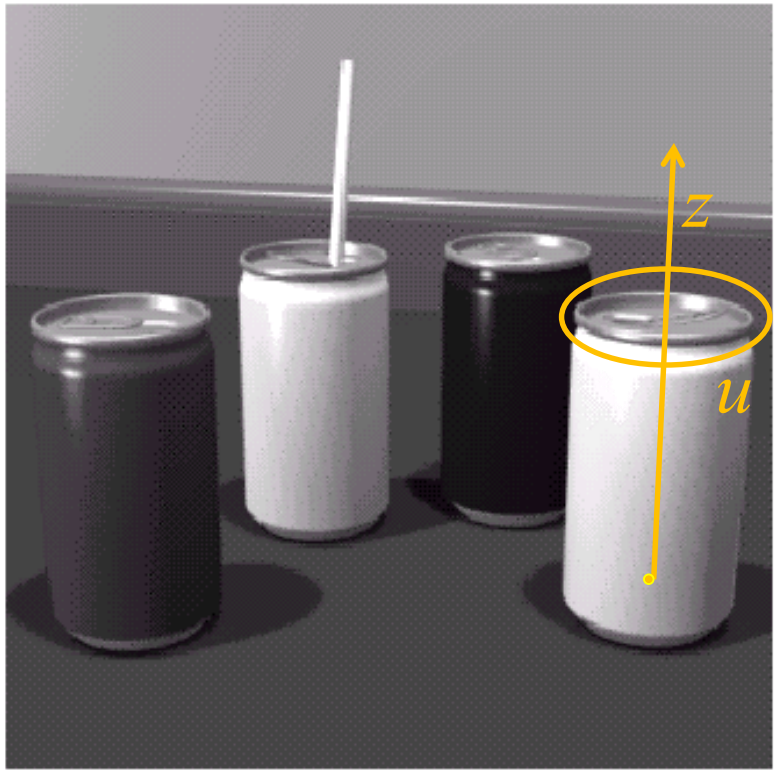
Per Projektion

- Modellpunkt auf Zylinder, Kugel, Ebene/Rechtec



Projektion auf Zylinder

- Punktkoord (x, y, z) auf Zylinderkoord (u, z)



Vergleich: Projektionen

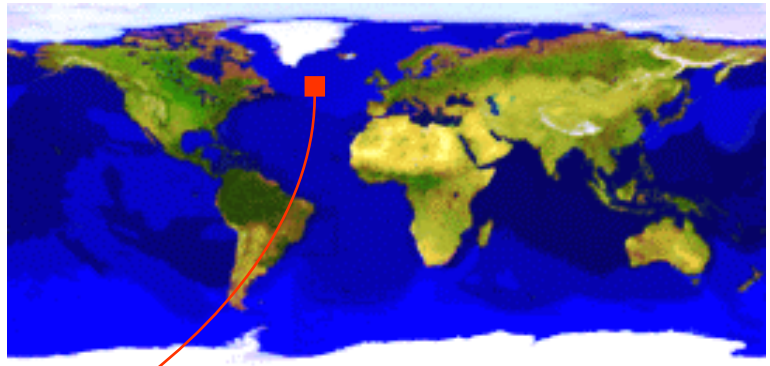
Ebene

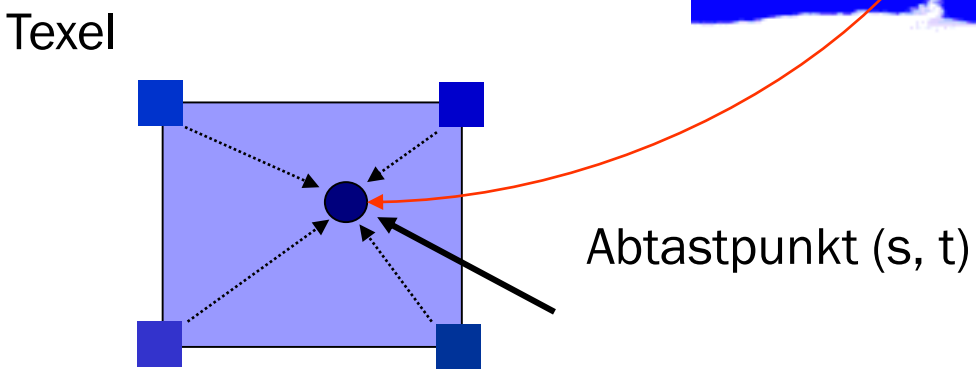
Zylinder

Kugel

Internas: Texturierung

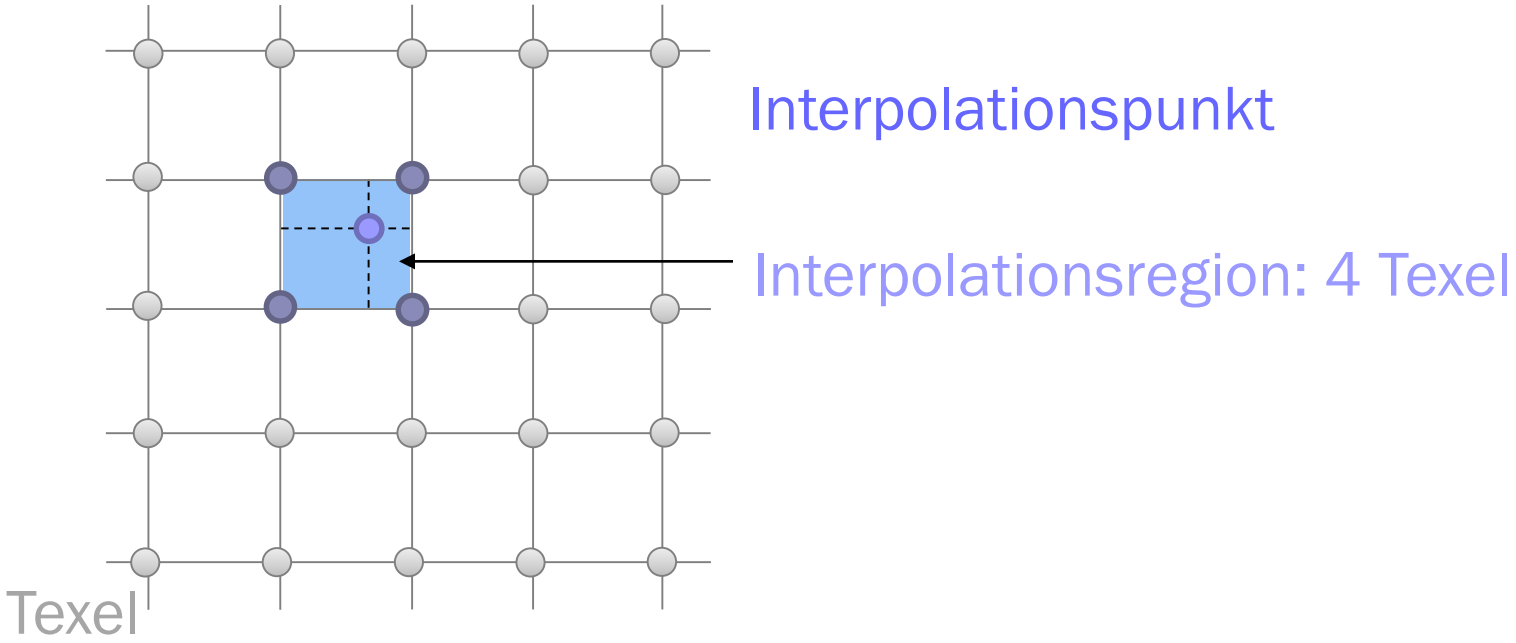
- Textur ausgewertet an Texturkoordinaten $(s, t) \in \mathbb{R}^2$
- Ausserhalb von [0, 1]²
  GL_TEXTURE_WRAP_S, GL_TEXTURE_WRAP_T
- Zwischen 4 Texeln
  GL_TEXTURE_MIN_FILTER,
  GL_TEXTURE_MAX_FILTER





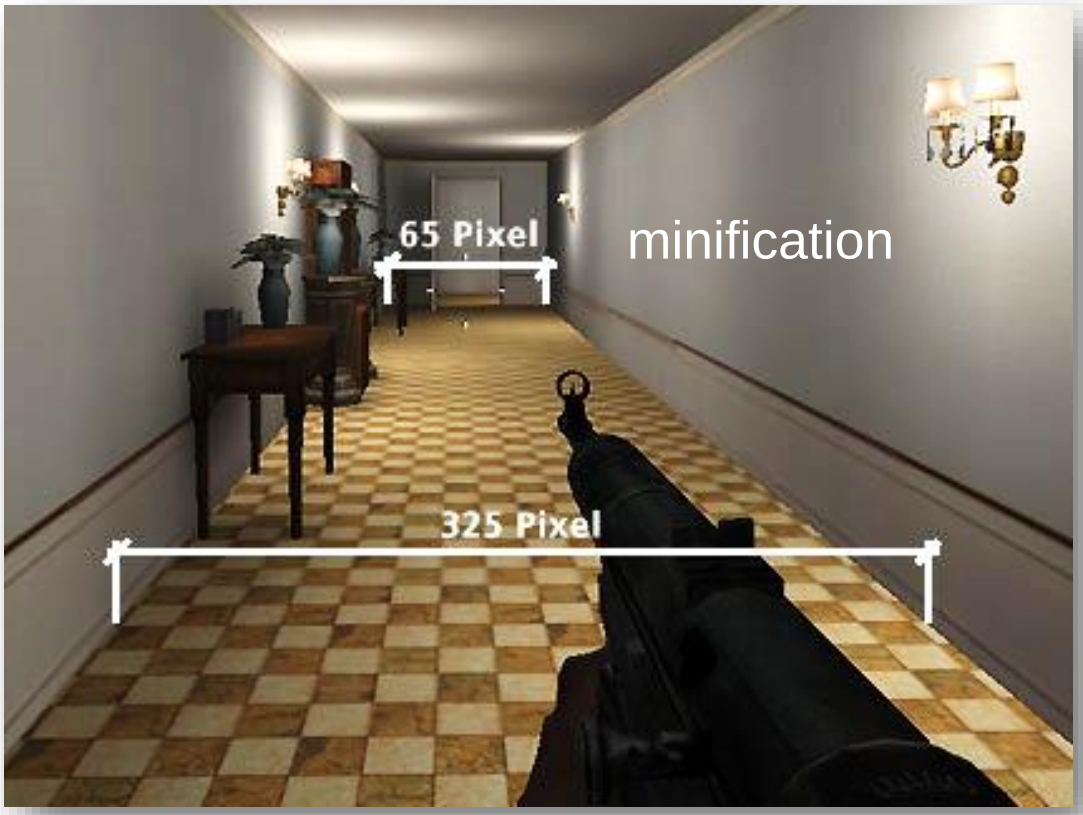
Internas:Magnification (der Textur)

- Nächster Punkt GL_NEAREST
  (Stückweise) Bi-Linear GL_LINEAR



Internas:Minification (der Textur)

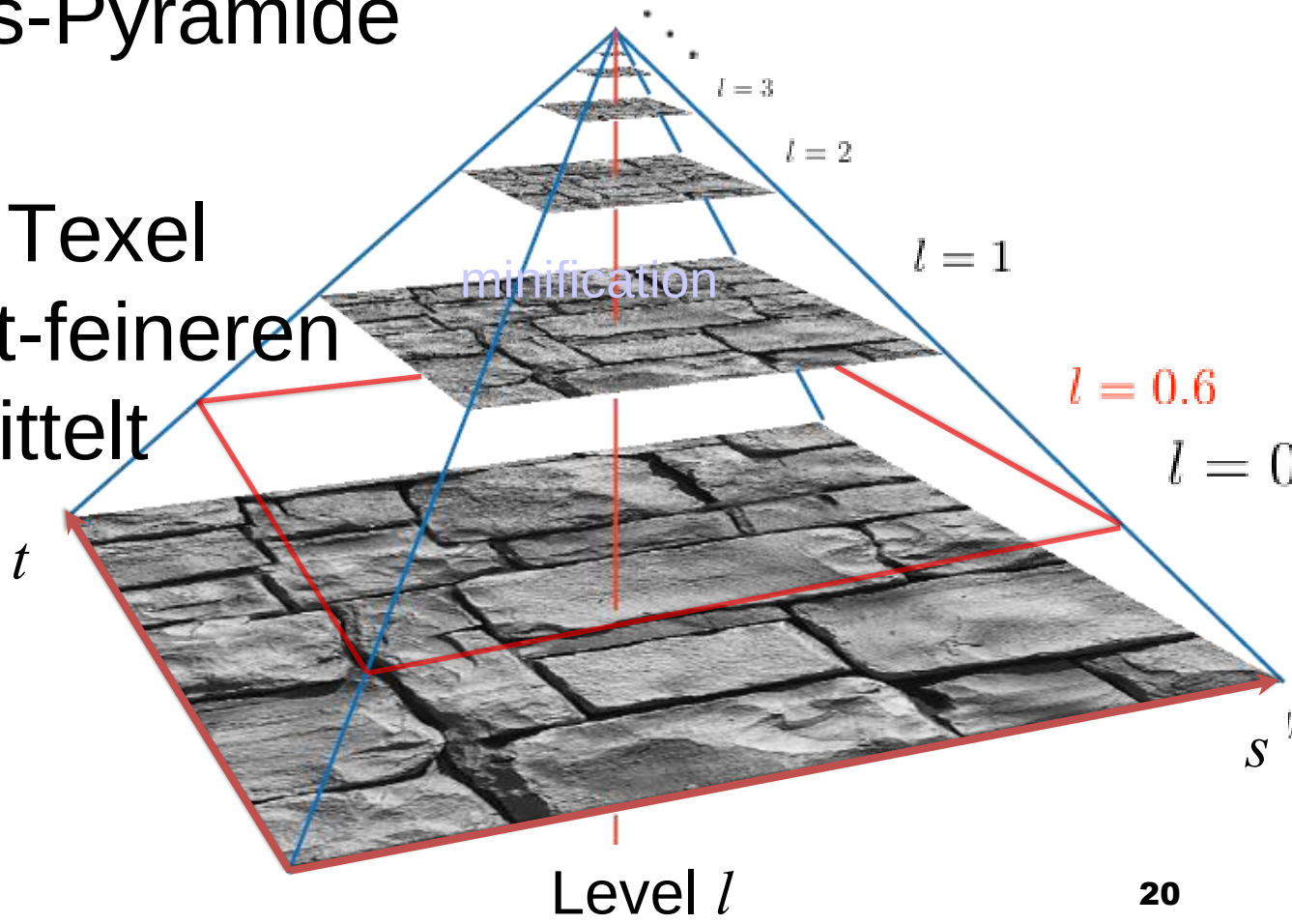
- Viele Texel fallen in ein Pixel!



minification

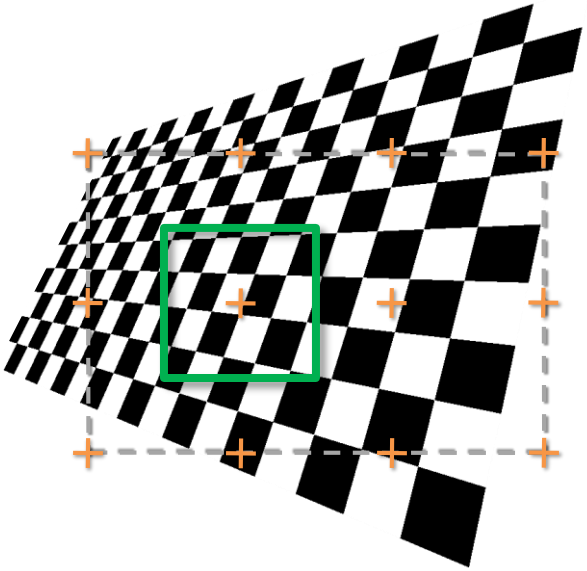
Mipmapping

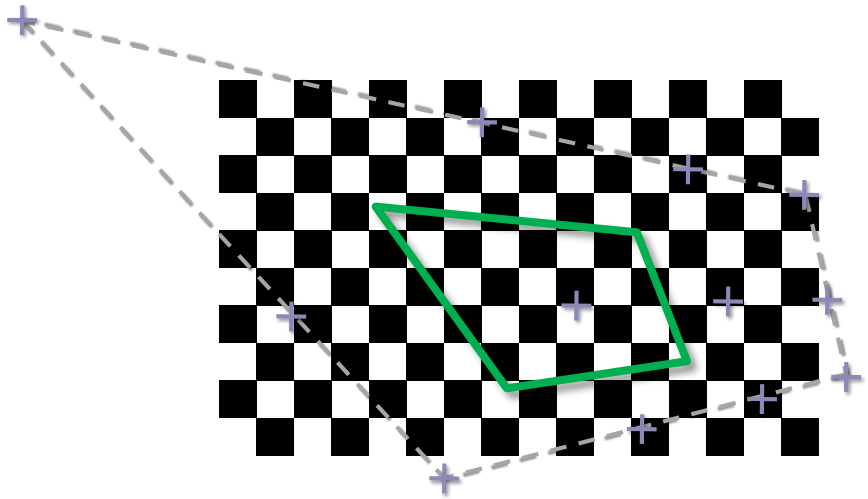
- Vorgefilterte Texturen (LOD) Auflösungs-Pyramide
- Level: 2*2 Texel des nächst-feineren Level gemittelt



Mipmapping

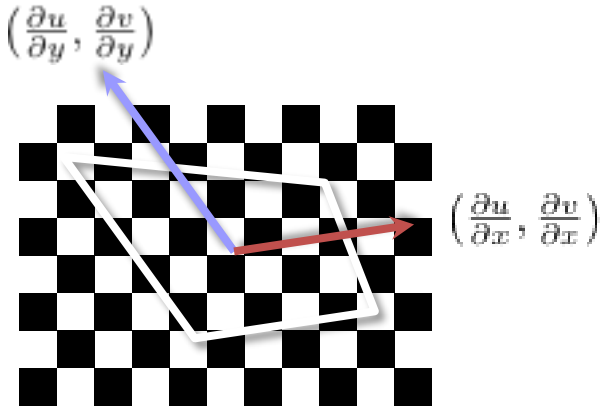
- Wie berechnet sich die Größe eines Texels relativ zur Pixelgröße? Skalierungsfaktor?





Mipmapping

Berechnung der Pixelgröße in Texturkoord.



u,v: Texel-Koordinaten des Fragments

x,y: Pixel-Koordinaten

$$d \approx \max\left(\left\|\left(\frac{\partial u}{\partial x}, \frac{\partial v}{\partial x}\right)\right\|, \left\|\left(\frac{\partial u}{\partial y}, \frac{\partial v}{\partial y}\right)\right\|\right)$$

$$l = \log_2 d$$

$$\frac{\partial u}{\partial x} \approx u_{x+1,y} - u_{x,y}$$

$$\frac{\partial u}{\partial y} \approx u_{x,y+1} - u_{x,y}$$

$l < 0 \Rightarrow$ weniger als ein Texel pro Pixel
magnification

$l > 0 \Rightarrow$ mehr als ein Texel pro Pixel
minification

Interpolation

MIN_FILTER = GL_NEAREST, MAG_FILTER = GL_NEAREST

minification

magnification

Undersampling / aliasing

Treppeneffekte

Interpolation

MIN_FILTER = GL_LINEAR, MAG_FILTER = GL_LINEAR

Interpolation: Mipmapping

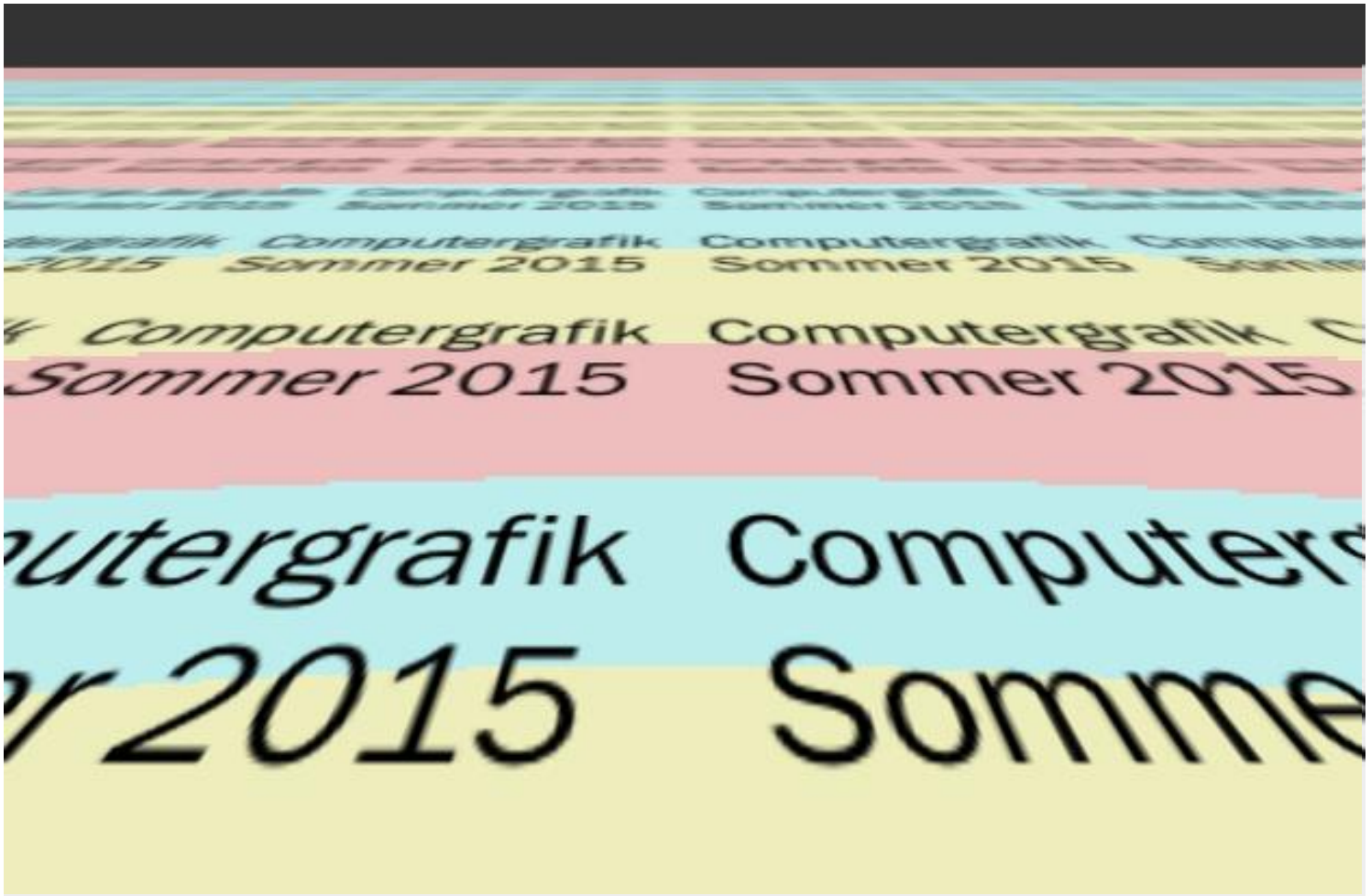
MIN_FILTER = **GL_LINEAR_MIPMAP_LINEAR**, MAG_FILTER = GL_LINEAR

Undersampling / aliasing

Treppeneffekte

Interpolation: Mipmapping

Mipmap-Levels: gelb (*Level* gross) bis rot-violett (*Level* klein)



Ausblick

- Bump/Normal Mapping

- Environment Mapping