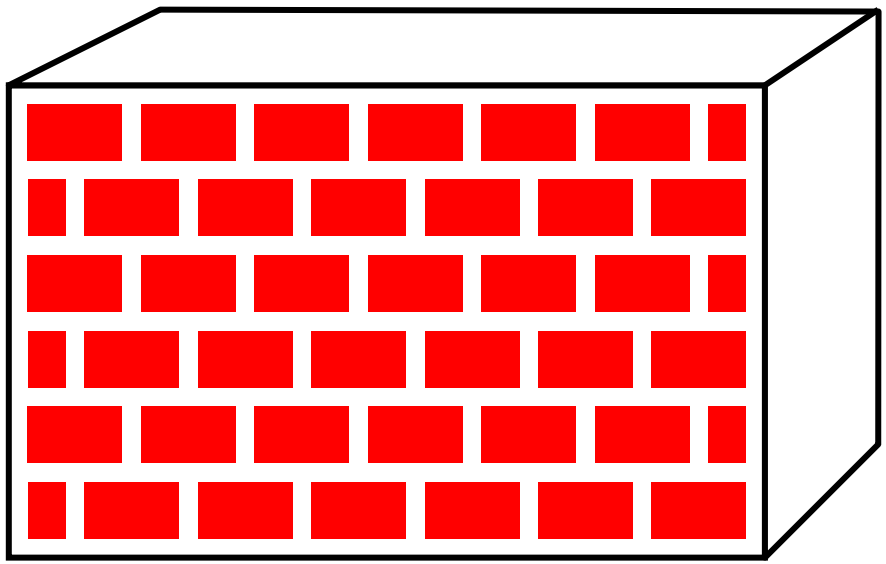
Kapitel 19:
Texturing

Strukturierte Fläche

Beispiel: Steinmauer

lege viele rote Rechtecke
auf eine großes weißes Rechteck:



Nachteil: aufwändige Geometrie

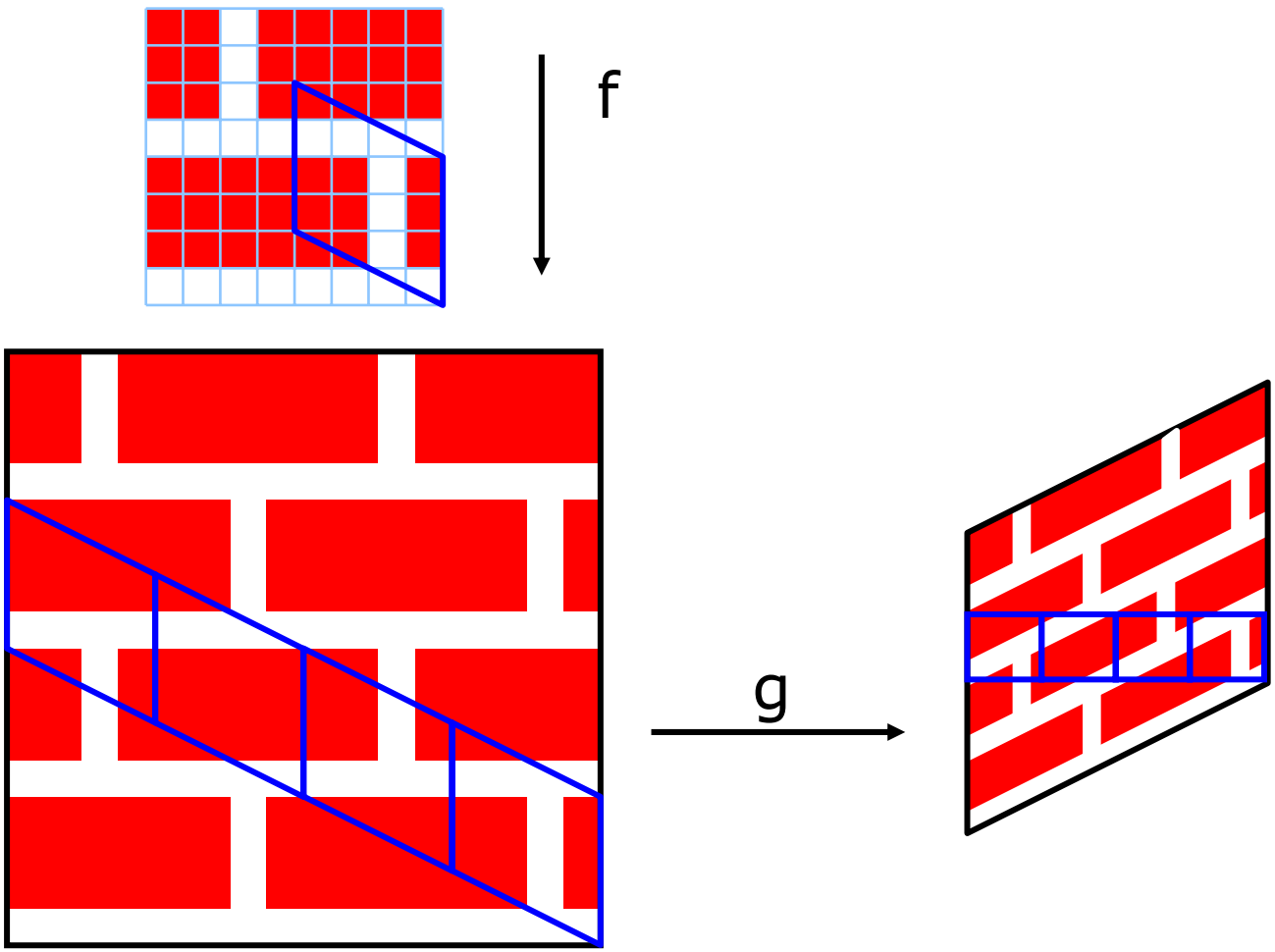
Texel statt Geometrie

Lösung: Bild auf Objekt legen

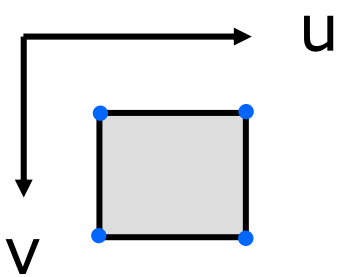
genauer: beim Rastern einer Scanline wird 2-dimensionale Pixelmatrix eingearbeitet.

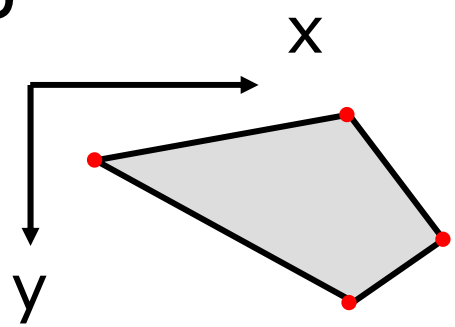
Materialfarbe wird ersetzt und/oder kombiniert mit Texturpixel = Texel

Texture Mapping



Bildverzerrung





$$\begin{pmatrix} u \\ v \\ w \end{pmatrix} := \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & 1 \end{pmatrix} \cdot \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$$

$$u = \frac{ax+by+c}{gx+hy+1} \qquad v = \frac{dx+ey+f}{gx+hy+1}$$

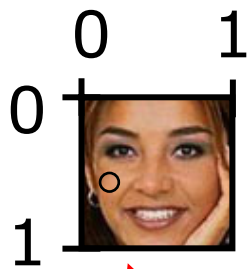
$\Rightarrow$ 8 Gleichungen, 8 Unbekannte

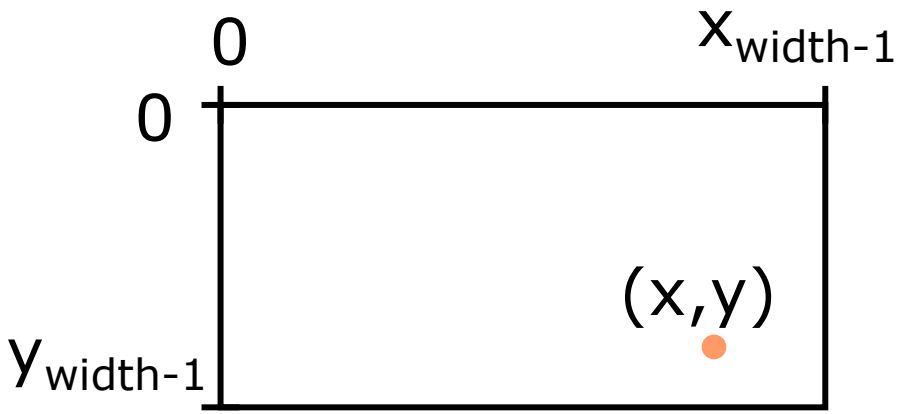
Ergebnis liefert Transformationsmatrix M

Zugriff auf Texture Map

Inverse Projektion ergibt (x,y) := $g^{-1}(x',y',z')$

Faktoren f_x, f_y





$$u = \frac{x}{x_{width}} \cdot f_x \qquad \frac{320}{400} \cdot 4 = 3.2$$

$$v = \frac{y}{y_{width}} \cdot f_y \qquad \frac{160}{200} \cdot 2 = 1.6$$

bei 16×16 Textur T:

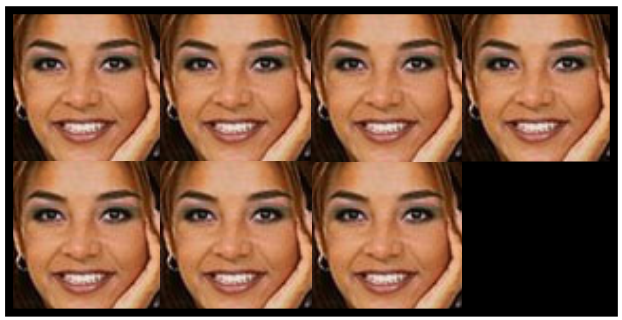
T[16*0.2][16*0.6]

Phasen des Texture Mapping

- Raumkoordinaten des Flächenpunktes berechnen $\Rightarrow$ (x',y',z')
- zugehörige Flächenkoordinaten berechnen $\Rightarrow$ (x,y)
- Abbildung in den Parameterraum durchführen $\Rightarrow$ (u,v)
- Texturkoordinaten berechnen (Korrespondenzfunktion berücksichtigen)
- Texturwerte ermitteln
- Erscheinungsbild mit dem Texturwert modifizieren

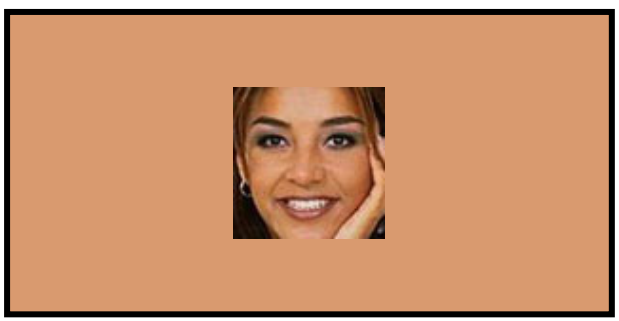
Korrespondenzfunktion

repeat

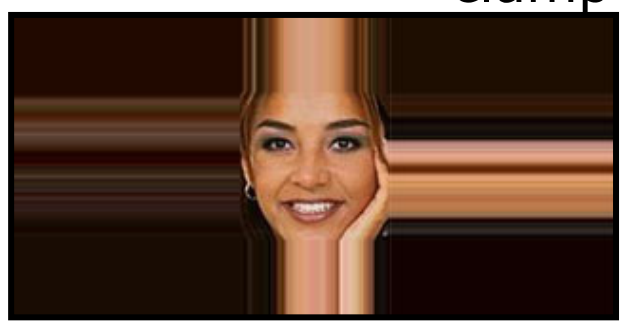


mirror

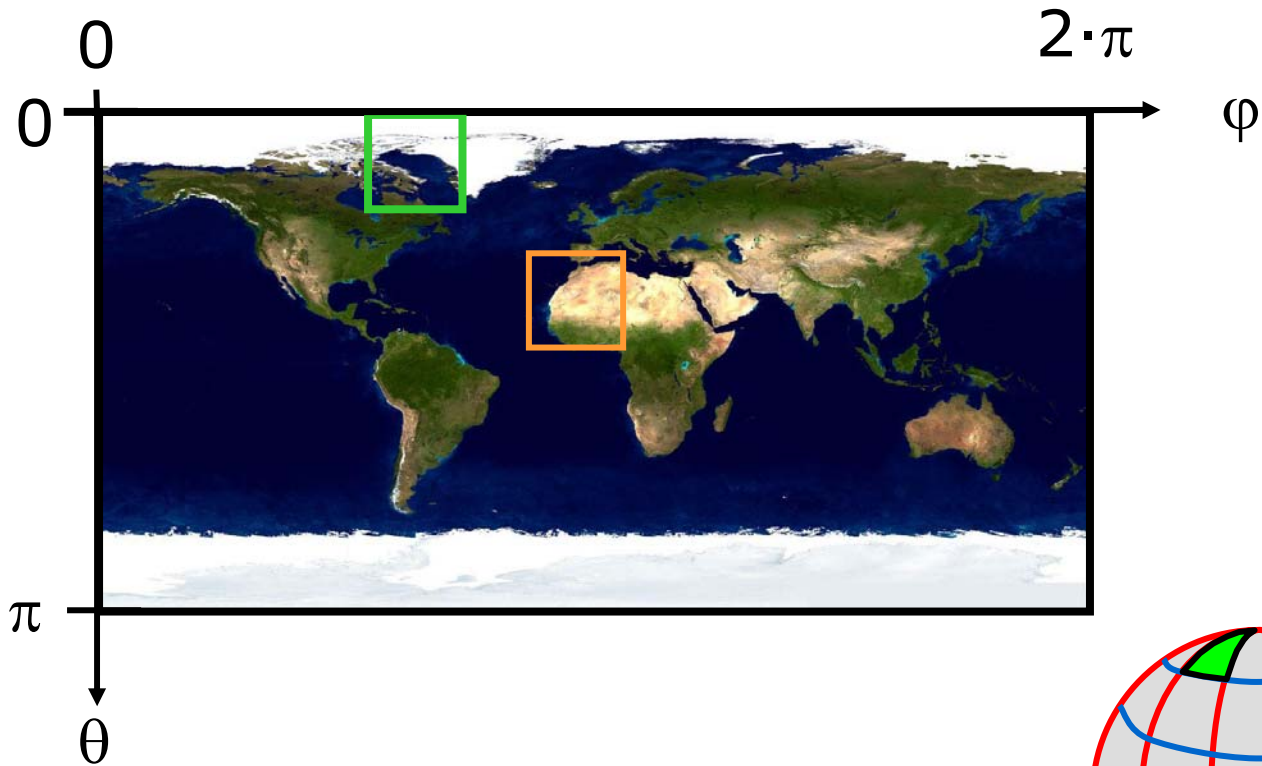
border



clamp



Sphärische Projektion

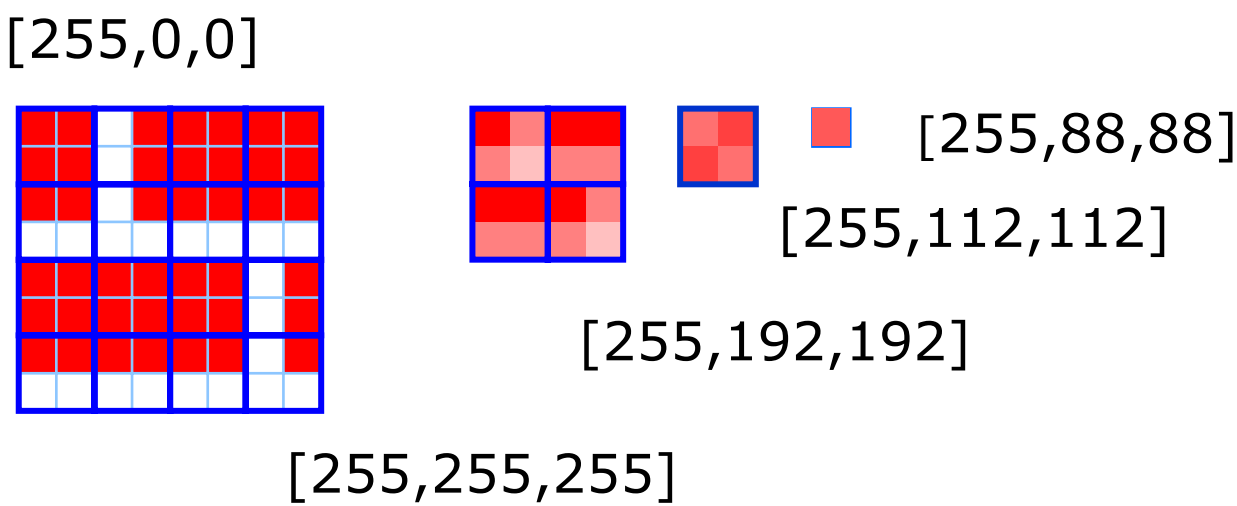


$[\sin(\theta)\cdot \cos(\varphi), \sin(\theta)\cdot \sin(\varphi), \cos(\theta), 1]$

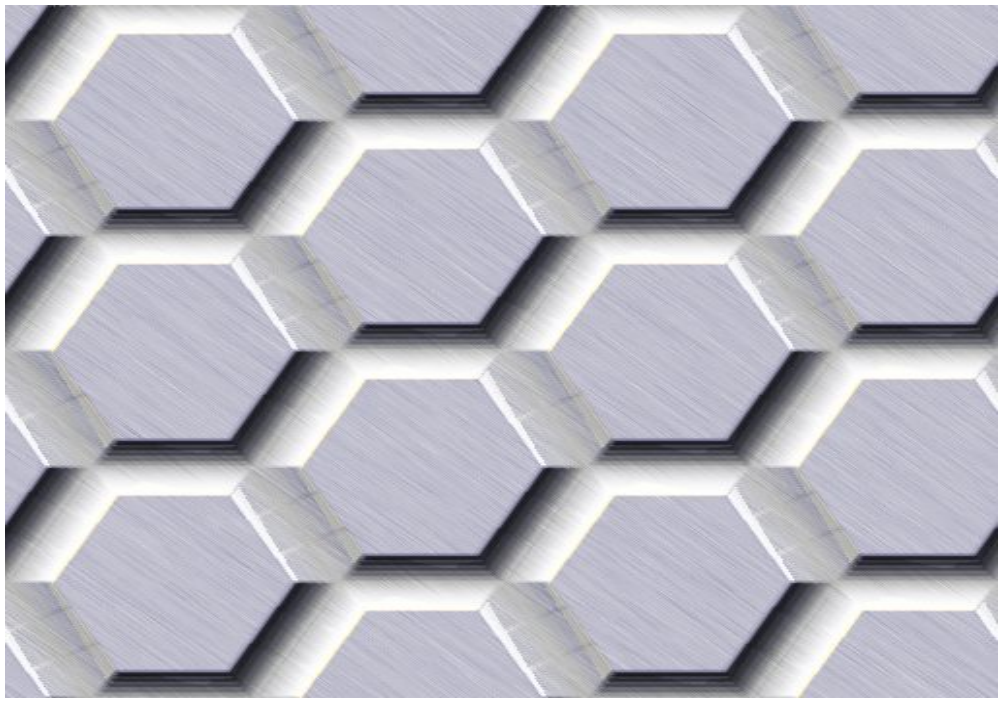
Mip mapping

(multum in parvo mapping)

halte verschiedene Textur-Auflösungen vor
für verschiedene level of detail (LOD)



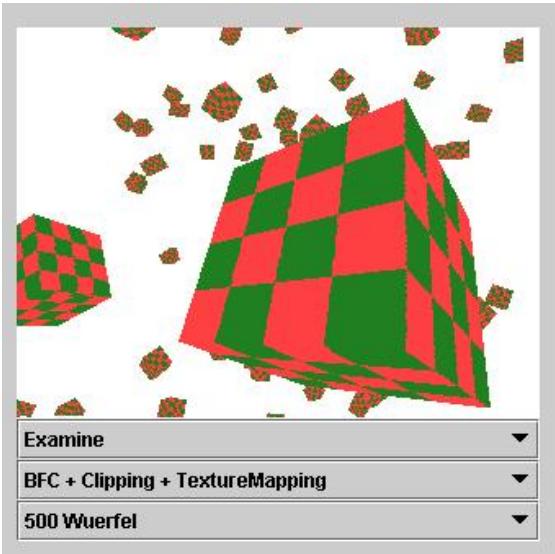
Texture Maker

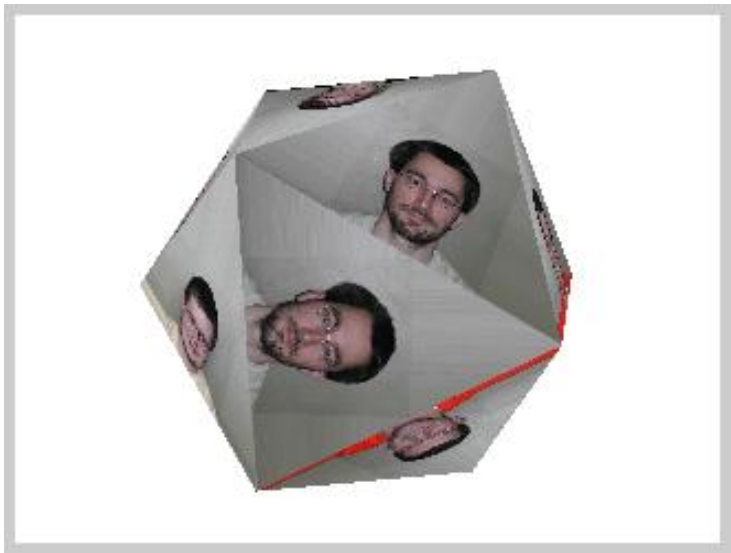


http://www.texturemaker.com/gallery.php

Java-Applet zu Texturen

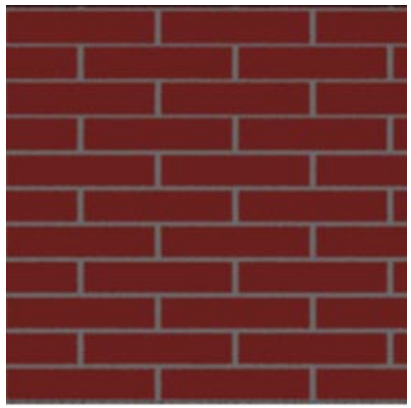
~cg/2006/skript/Applets/Texturemap/app-1.html



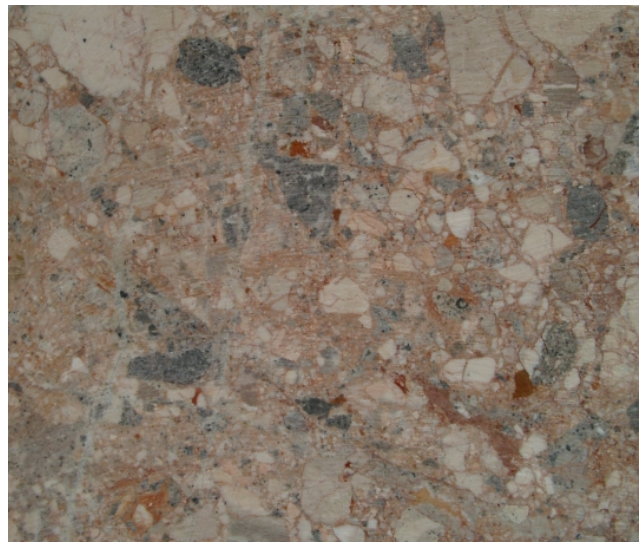


~cg/2006/skript/Applets/Texturemap/app-2.html

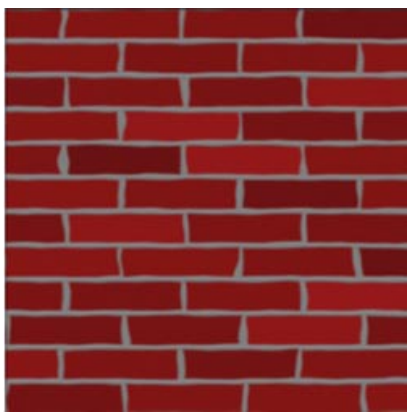
Algorithmen für Texturen



statisch

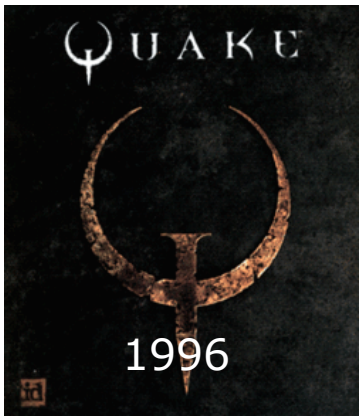


prozedural



mit Störungen

Light Map



Schatten vorberechnen
(z-Buffer von Lichtquelle)
in Textur ablegen

$$C_{gesamt,diffus}[x,y] = C_{lighting,diffus}[x,y]$$

$$* \; LightMap[u(x,y), v(x,y)]$$

LighterDemo by DHRUVA Interactive

Alpha Mapping

Textur enthält Alphawerte

0	völlig durchsichtig
0 < x <255	teilweise durchsichtig
255	undurchsichtig

Baum als Kreisfläche
mit Löchern

Alpha Mapping Implementation

$$C_{gesamt,alpha}[x,y] =$$

$$C_{Baum,lighting}[x,y]$$

$$* \; AlphaMap[u(x,y), v(x,y)]$$

$$+ \; C_{Hintergrund,lighting}$$

$$* \; (1 - AlphaMap[u(x,y), v(x,y)])$$

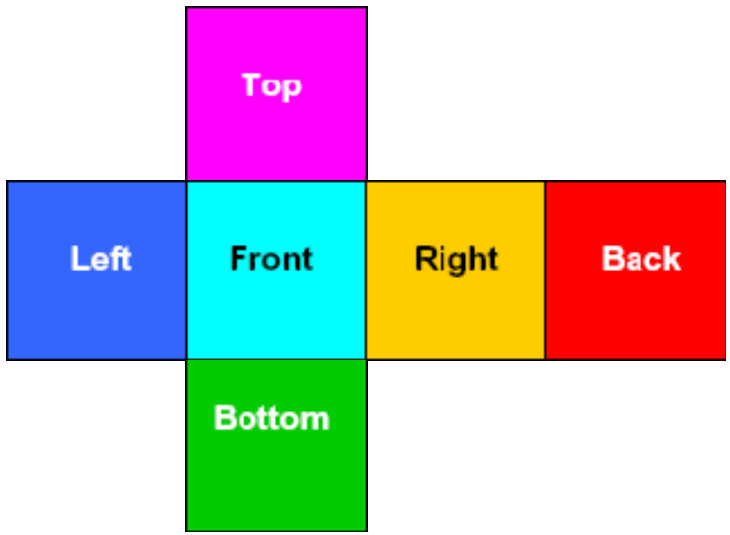
Environment Mapping

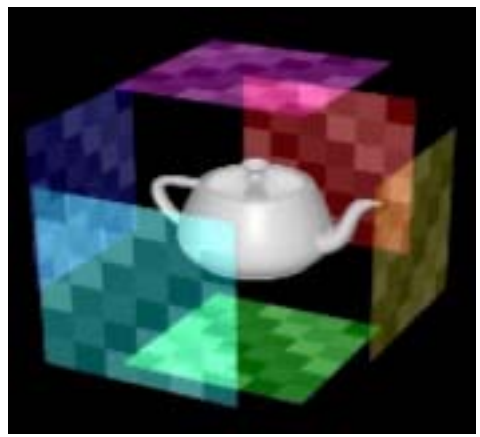
Textur enthält Projektion der Umgebung

Zugriff abhängig vom Augenpunkt

Implementation Environment Mapping

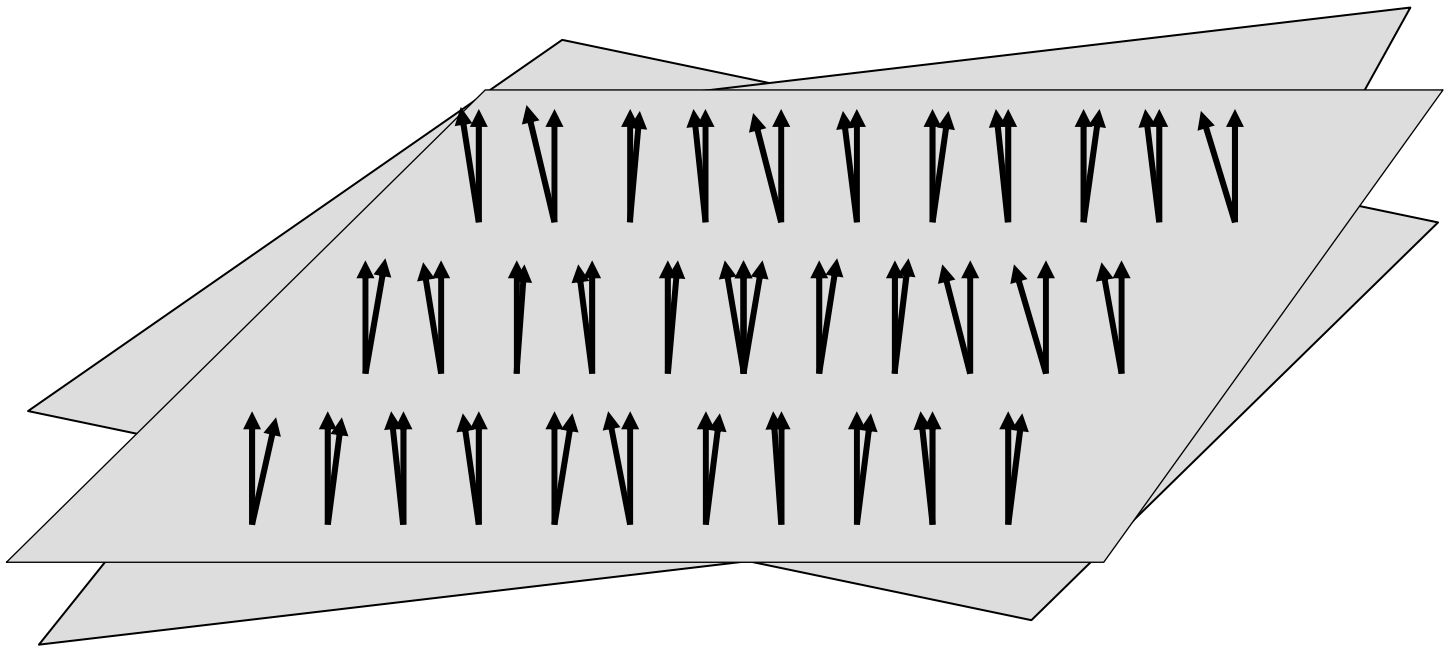
Speichere pro Objekt sechs Projektionen:



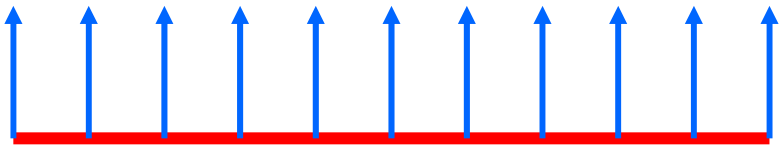


[Courtesy of NVIDIA Corporation]

Modifikation der Normalen

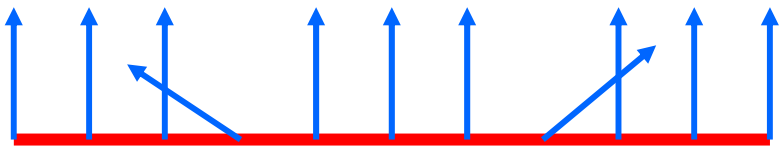


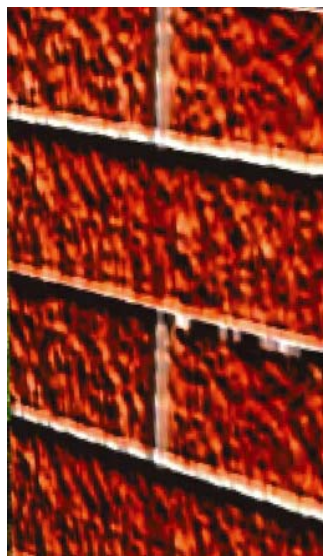
Bump Mapping



kombinierbar
mit Textur:

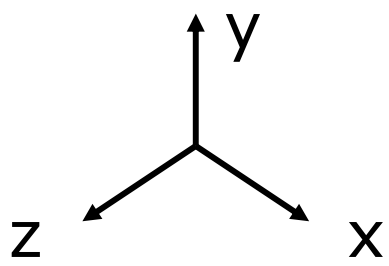
modifiziere Normalenvektor

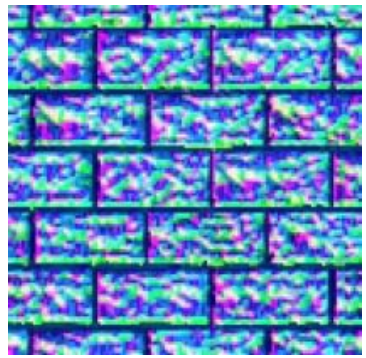




Simulation von Unebenheit:

Bump Mapping Implementation





Height Mapping:
Grauwertmatrix enthält Höhenänderungen

Normal Mapping:
Farbmatrix enthält Normalenänderung

Obacht:
die suggerierten Höhendifferenzen
sind von der Seite nicht sichtbar !

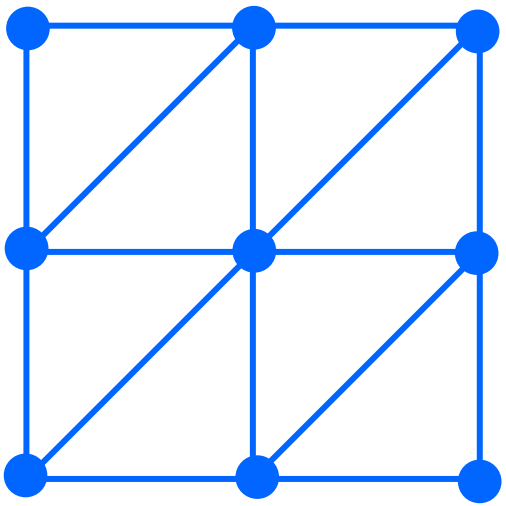
Displacement Mapping

Textur enthält Angaben zur Veränderung der Geometrie

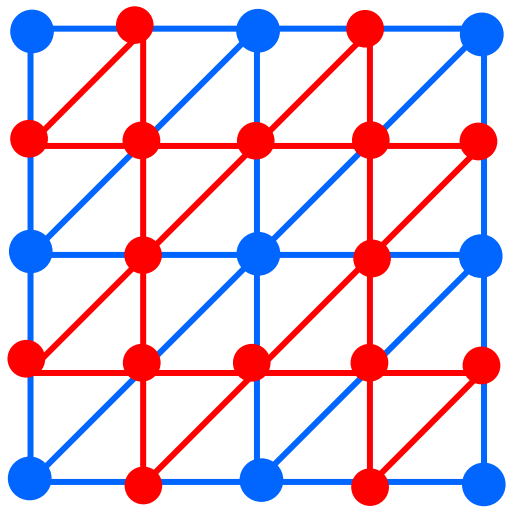
Vorteile:

- Displacement Map + grobe Geometrie braucht weniger Platz als feine Geometrie
- eine Geometrie mit mehreren Displacements (Skins) nutzbar

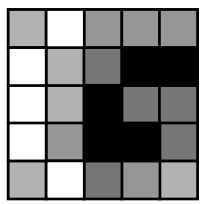
Verfeinerung der Geometrie



Ausgangsnetz

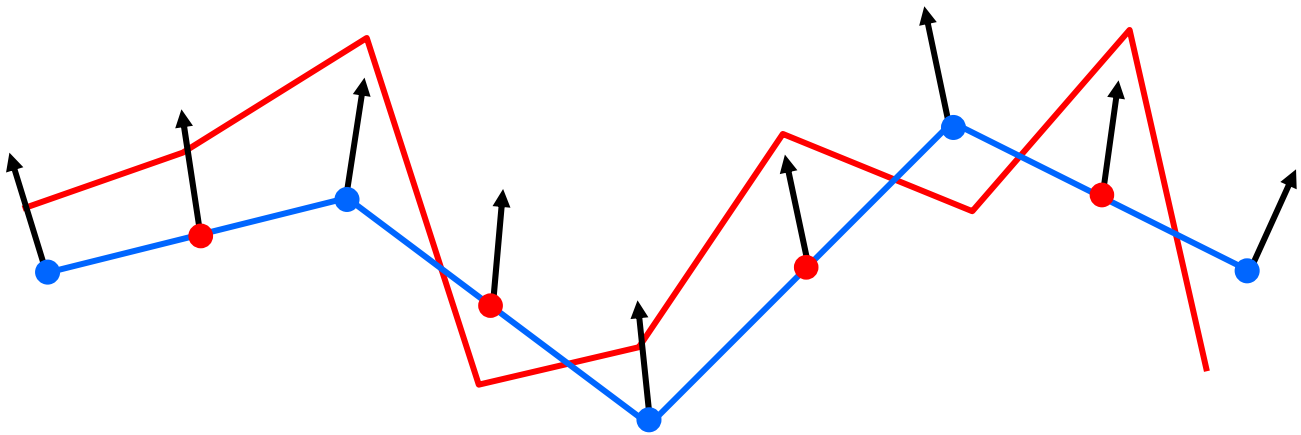


verfeinertes Netz

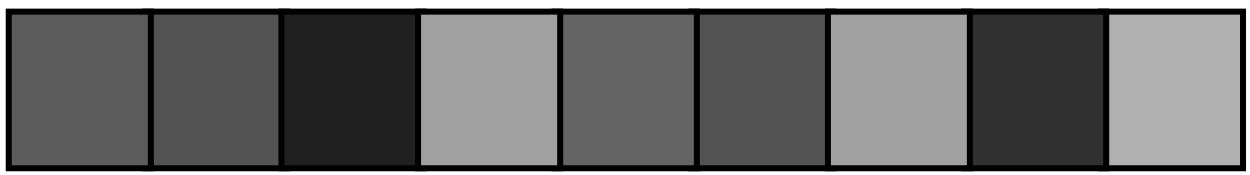


Displacement Map

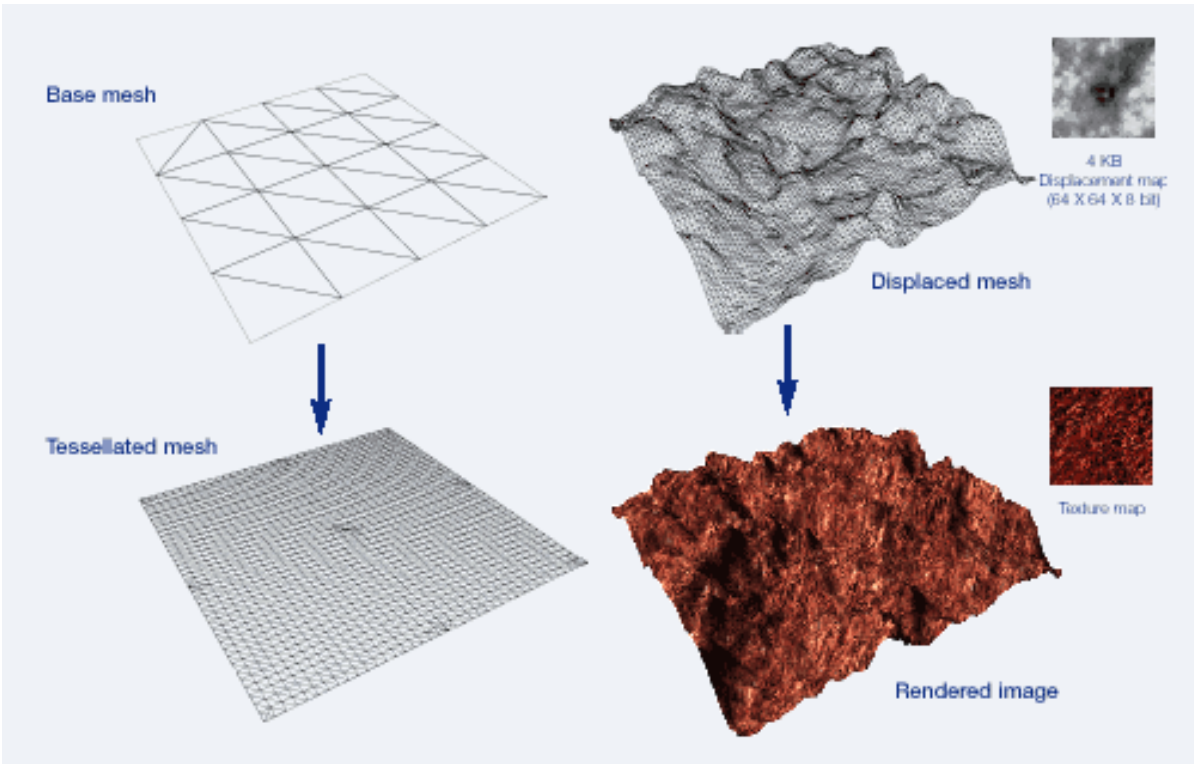
Verformung der Geometrie



37	46	97	-32	29	54	-34	81	-48
164	173	224	95	156	187	93	208	79



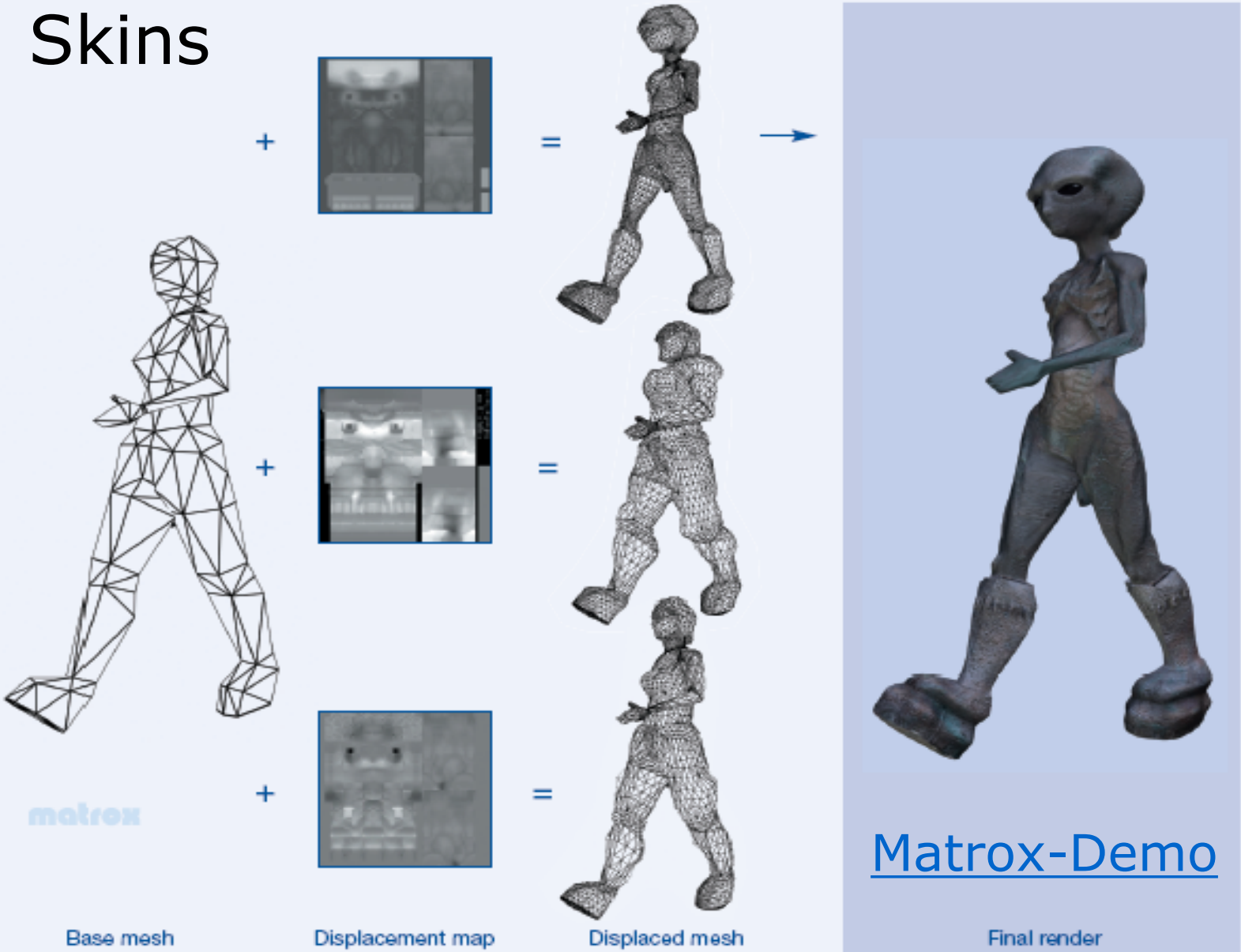
Landschaft & Displacement



Kopf & Displacement

modelliert von Sami Sorjonen, gerendert von Mathias Wein

Skins

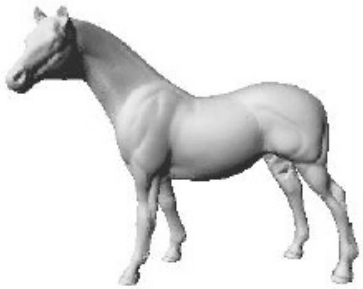


Matrox-Demo

Netzvereinfachung

Ziel: Zahl der Polygone dezimieren

Beispiel von Collins & Hilton, University of Surrey

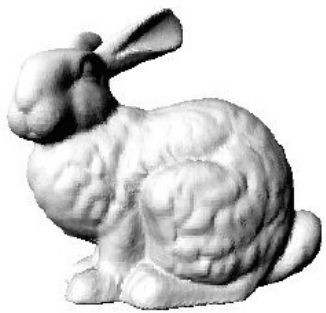


96.000

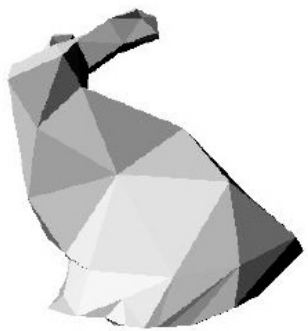
502

Reduktion < 1%

Fehler < 0.1 %



69.000



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Platzersparnis

n Polygone à 3 Knoten vom Grad 6 $\Rightarrow$ n/2 Knoten

Feinstruktur:

pro Polygon:	1 Farbwert:	4 Bytes
	3 Verweise auf Knoten:	12 Bytes
pro Knoten:	homogene Koordinate:	16 Bytes
	homogene Normale:	16 Bytes
		16n + 16n = 32n Bytes

Grobstruktur:

n/100 Polygone:	32/100n Bytes
n/2 Displacementwerte:	n/2 Bytes

$\Rightarrow$ Reduktionfaktor = 32/(32/100+1/2) ≈ 39