Texture mapping

Texture slides are based on E. Angel’s slides

geometry

screen

image
Texture mapping triangles

- Each vertex gets \((s,t)\) coordinates in the texture plane
- Image dimensions are always 1x1 in texture coordinates
- \(s,t\) are typically in \(0..1\) range but do not have to be

triangle in 3d  triangle in texture domain
Texture mapping triangles

- Barycenteric coordinates: write each point inside the triangle as an affine combination of vertices

\[ p = \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3, \quad \alpha_1 + \alpha_2 + \alpha_3 = 1 \]

- assign to \( p \) texture coordinate \( q = \alpha_1 q_1 + \alpha_2 q_2 + \alpha_3 q_3 \)
Computing $\alpha_i$

$p = \alpha_1 (p_1 - p_3) + \alpha_2 (p_2 - p_3) + p_3$, i.e.,

$p - p_3 = \alpha_1 (p_1 - p_3) + \alpha_2 (p_2 - p_3)$; taking dot product with $(p_2 - p_3)^\perp$

we get $\alpha_1 = (p - p_3) \cdot (p_2 - p_3)^\perp / (p_2 - p_3) \cdot (p_2 - p_3)^\perp$

similarly we can get the rest
Sampling texture maps

Texture map

Polygon far from the viewer in perspective projection

Rasterized and textured

the back row is a very poor representation of the true image
How computer images work?

Continuous real image

Digitization
(e.g. scanning)

square array of numbers
(abstract pixels)

each physical pixel
covers an area

display (physical pixels)

The eye blurs pixels into
continuous image

perceived image

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What can go wrong?

Pipeline: sample - process - reconstruct

All kinds of artifacts can appear

- jaggies
- alias patterns
- moire patterns
- temporal aliasing (wheels going wrong way)

Question: how do we avoid all this?
Aliasing

Slightly different frequency

What can go wrong?
Aliasing

Slightly different frequency

Lower frequency appears
Shrinking

Naïve 1.5x shrinking : drop 2 out of 3

What do we get?
Shrinking

Naïve 1.5x shrinking: drop 1 out of 3

But we want (impossible, not enough samples)
Shrinking

original

resized, nearest neighbor

resized, 11-point filter
Shrinking

original

resized, nearest neighbor

resized, 11-point filter

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Frequency analysis

The key to fighting aliasing is to avoid frequencies we cannot represent.

Big question:

When can we reconstruct a continuous signal from samples?
Frequency analysis

Need enough samples, to be more precise, sampling frequency should be more than twice the frequency of the wave.