

Textures

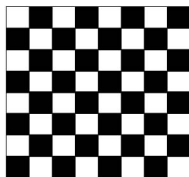
Textures

Texture = 1/2/3D data table.

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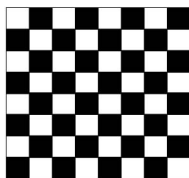
Often: (color values of) 2D picture.



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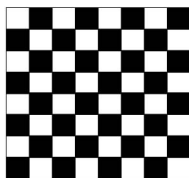


External file, generated online inside program (animated textures), or generated (offline or online) via rendering in OpenGL.

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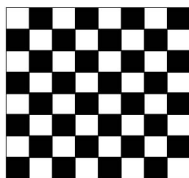
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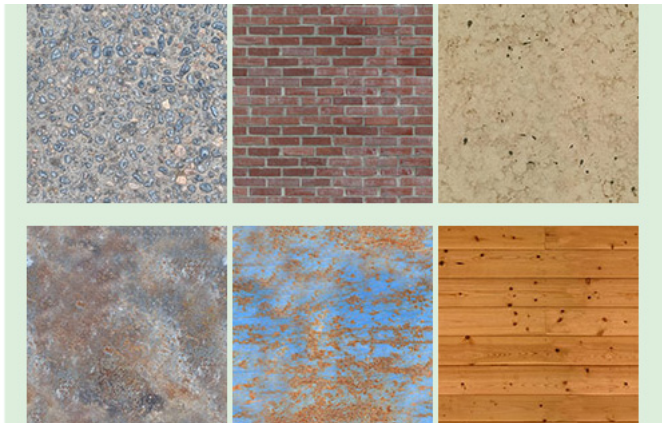
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A data entry in a texture table is called a **texel**.

Use of Textures

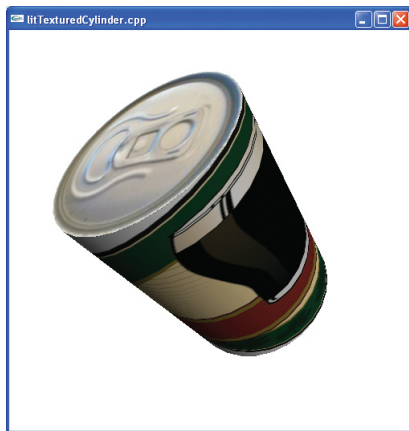
- ▶ Generate detailed graphical content hardly possible with triangles (such clouds, skyboxes, plain pictures (posters, decals) on surfaces).
- ▶ Create illusion of structure, saving lots of triangles. Can be (low level) part of a level-of-detail scheme.
- ▶ Most of a game's graphical expression is via artwork using textures.
- ▶ Hold special-purpose data for use in rendering process.

Examples



(From All Things Designed)

Examples



Examples

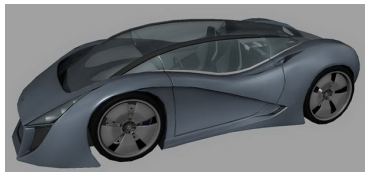
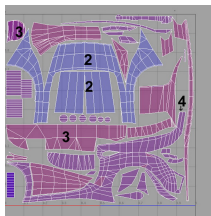
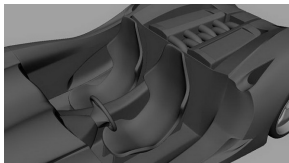
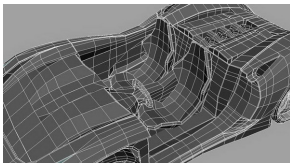


Examples



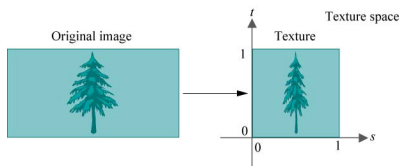
(From Sly Cooper)

Examples



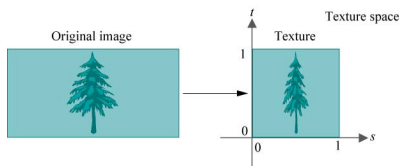
(By Valentin Nadolu)

Texture Coordinates



Texture data get mapped to $[0; 1]^{1,2,3}$ in *texture space*.

Texture Coordinates

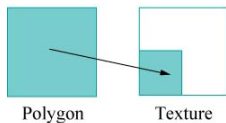


Texture data get mapped to $[0; 1]^{1,2,3}$ in **texture space**.

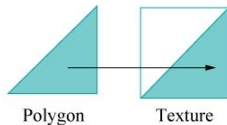
When using textures, vertices are associated with texture coordinates.

Texture Coordinates

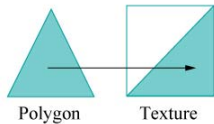
Texture space points can be arbitrary:



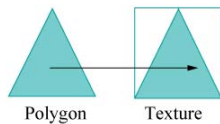
(a)



(b)



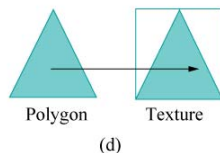
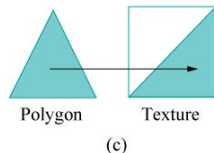
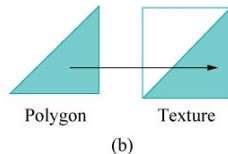
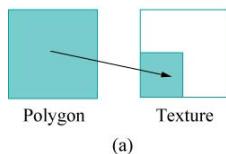
(c)



(d)

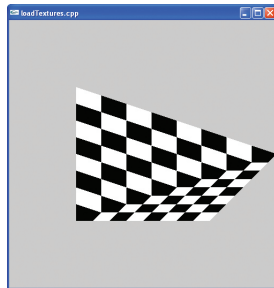
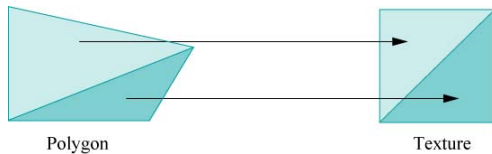
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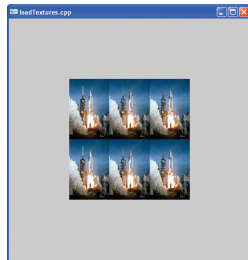
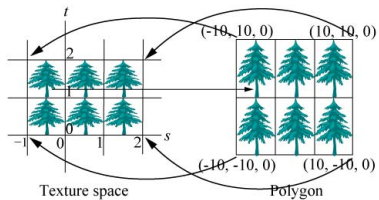


Points internally in triangle are associated with points in texture space using [interpolation](#) (via barycentric coordinates).

Interpolation Example



Coordinates Outside the Texture



Above is repetition

Below is **clamping** (on s-axis in texture space).

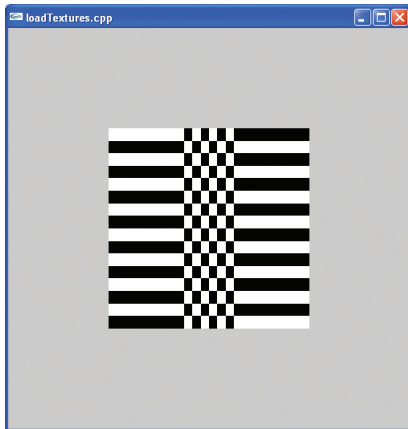
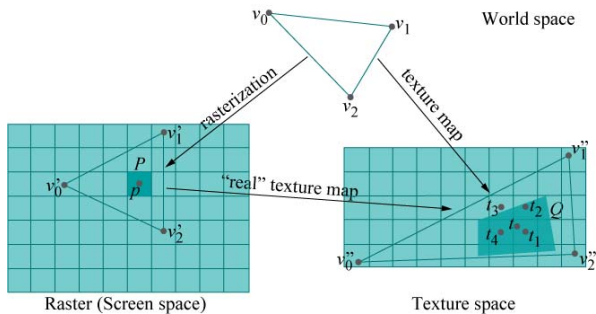


Table Lookup in Texture

Points on triangle do not correspond exactly to (middle of) texture cells.



- ▶ Nearest neighbor
- ▶ Linear interpolation (bilinear: linear interpolation on both s - and t -axes).

Minification/Magnification

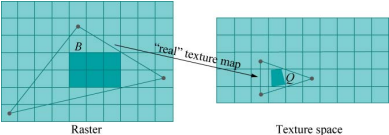
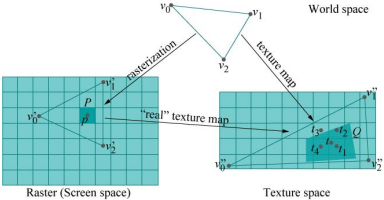
Associated pixels and texels may not be similar in size.

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Remedies::

- ▶ Magnification: Use interpolation.
- ▶ Minification: use [mipmaps](#).

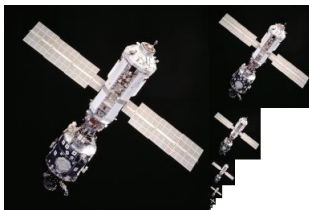
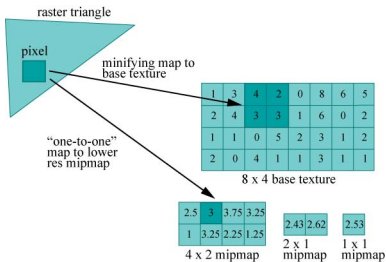
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Mipmap: Pre-made series of resolutions of a texture.

OpenGL has method for finding (during lookup) which one is closest to matching pixels and texels in size, and makes lookup in that. Or can use linear interpolation on lookups from two neighboring candidate resolutions. (Trilinear interpolation: also do bilinear interpolation in lookups).

Start with high-resolution texture. Create lower-resolution versions by averaging over sets of neighboring texels. (See GLU library.)



(By Mike Hick)

Example

No mipmap, nearest neighbor:



Example

Using mipmap:



Parametrised Surfaces and Textures

Usually parameters can map simply to texture space

