Texture Mapping

Sintel
Blender Open Movie

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Blender Open Movie

Bump Mapping

Instead of encoding colors in a texture, you encode normals!

By Bump-map-demo-smooth.png, Orange-bumpmap.png and Bump-map-demo-bumpy.png: Original uploader was Brion VIBBER at en.wikipediaLater version(s) were uploaded by McLoaf at en.wikipedia.derivwork: GDallimore (talk) - Bump-map-demo-smooth.png, Orange-bumpmap.png and Bump-map-demo-bumpy.png, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=11747953

Normal/Bump Mapping

original mesh
4M triangles

simplified mesh
500 triangles

simplified mesh
and normal mapping
500 triangles

Displacement Mapping

Instead of normals, you encode a displacement.

Original

Bump Mapping

Displacement Mapping

Image courtesy of: http://www.chromesphere.com/Tutorials/Vue6/Optics-Basic.html

Texture Mapping

- The idea is the same. Instead of encoding values at vertices of triangles, you encode them in images.
- You gain all the advantages of images (easy to store, compress, interpolate, sample)
- You can encode any property that you want, the most common are:
  - Colors (Texture Mapping)
  - Normals (Bump Mapping)
  - Displacements (Displacement Mapping)

What do you need?

- One additional per-vertex property, the UV coordinates
- An image uploaded to the GPU memory (2D texture)
- The UV coordinates are interpolated inside each triangle, and used to find the corresponding value in the texture
- The texture value is interpolated before it is used in the shader

World Coordinates

UV Space

Checkerboards are great to visualize a UV map

“Seams” are needed for complex objects

Image from Vallet and Levy, techreport INRIA

How are UV maps encoded?

- 2 versions of the mesh are stored, one for the triangles in 3D and one for those in 2D
- The faces of the 2 meshes are in one-to-one correspondence
- OpenGL *does not support this* you need to duplicate all the vertices on the seams and pass one single mesh. An easy (and inefficient) way to do this is by duplicating all vertices and not using an element buffer.

A minimal example

World Coordinates

UV Space

Faces

v_1	v_2	v_3
v_1	v_3	v_4

UV Faces

v_1	v_2	v_3
v_4	v_5	v_6

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Texture Filtering

Nearest Point

Bilinear Interpolation

Bilinear Interpolation

$$E = (1-u)\,A + u\,B$$
$$F = (1-u)\,D + u\,C$$

$$G = (1-v)\,E + u\,F$$

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Moire Pattern

http://photo.net/digital-darkroom-forum/00W8gC

Mipmapping

Mipmapping

- Moire pattern can appear if the resolution of the texture is much higher than the sampling rate

- A good solution for this problem is mipmapping

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