Texture Mapping in Practice

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Textbook Appendix A4, Chapter 15

Some slides courtesy of M. Kim, KAIST

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Today

- Announcements
  - Assignment 3: signup at http://doodle.com/9g5hndwk2denfx74
  - Don't forget to sign up for face-to-face grading in time! This is necessary to get a mark for the assignment. Sign up will close on Sunday night.
  - Assignment part 2 discussion
  - Last call for unclaimed umbrella, left during office hour
- Texture mapping, continued

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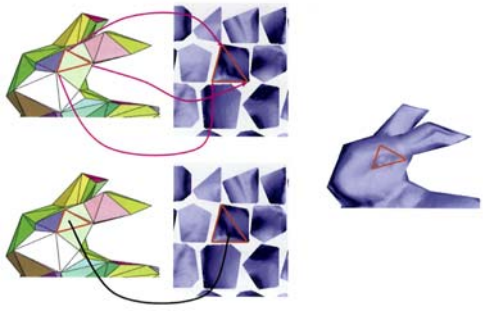
Texture mapping

- In basic texturing, we simply ‘glue’ part of an image onto a triangle by specifying texture coordinates at the three vertices.



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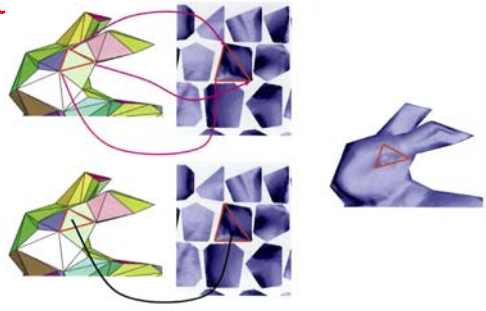
Texture mapping

- Bunch of OpenGL/WebGL functions to load a texture and set various parameters (lin/const, mipmap, wrapping rules).
- A uniform variable is used to point to the desired texture unit



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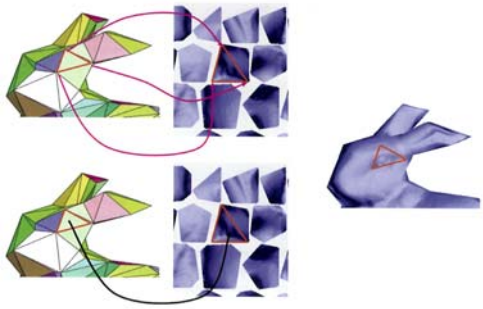
Texture mapping

- Varying variables are used to store texture coordinates.
- In this simplest incarnation, we just fetch r,g,b values from the texture and send them directly to the frame buffer.



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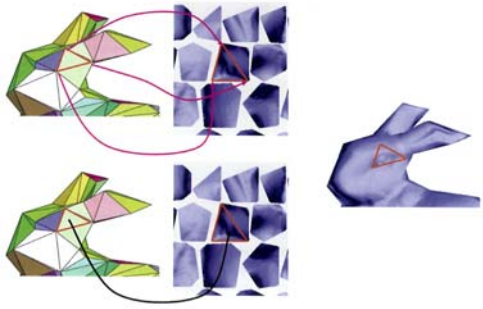
Texture mapping

- Alternatively, the texture data could be interpreted as, say, the diffuse material color of the surface point, which would then be followed by the diffuse material computation described earlier.



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Steps for Texture Mapping

1. Create a *texture object* and load texels into it
2. Include *texture coordinates* with your vertices
3. Associate a *texture sampler* with each texture map used in shader
4. Retrieve texel values

(Reference: Red Book)

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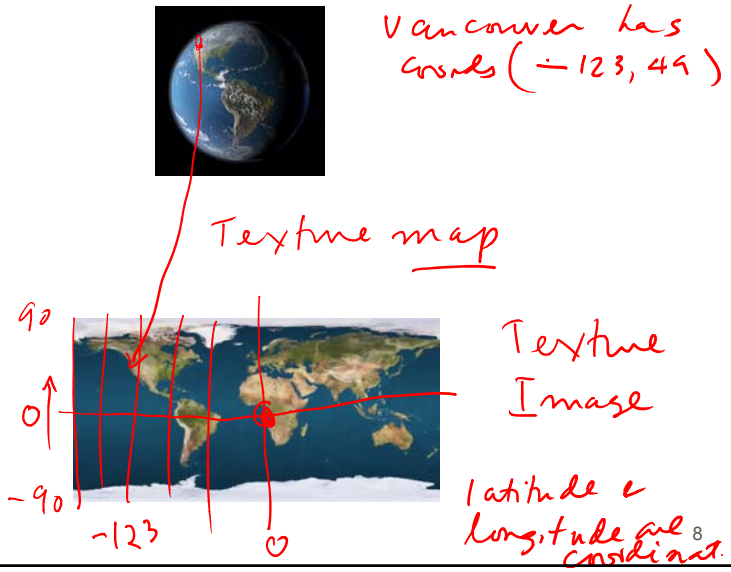
Texture coordinates from last class



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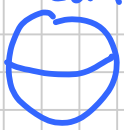
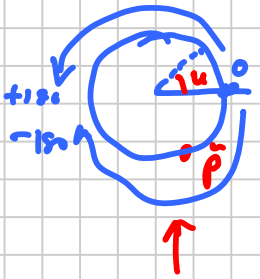
Texture coordinates

Note Title 2015-03-11

3D Earth



2D Earth (longitudes)



Object.

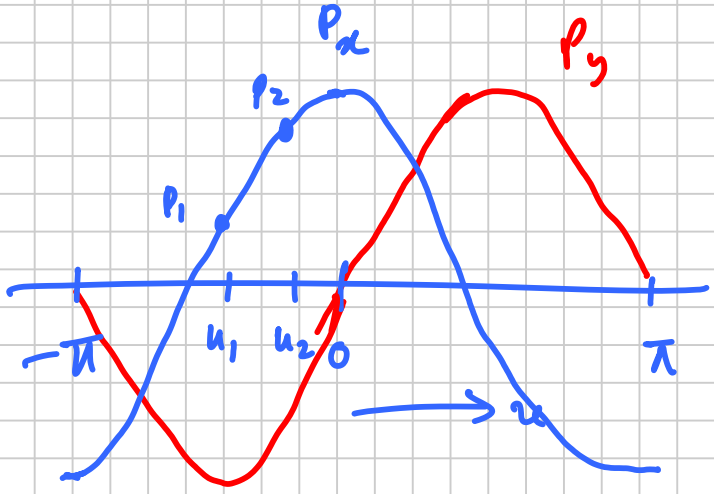
Aside: texture coordinates are named or sit by convention
OpenGL
U,V
Others like Maya

Texture

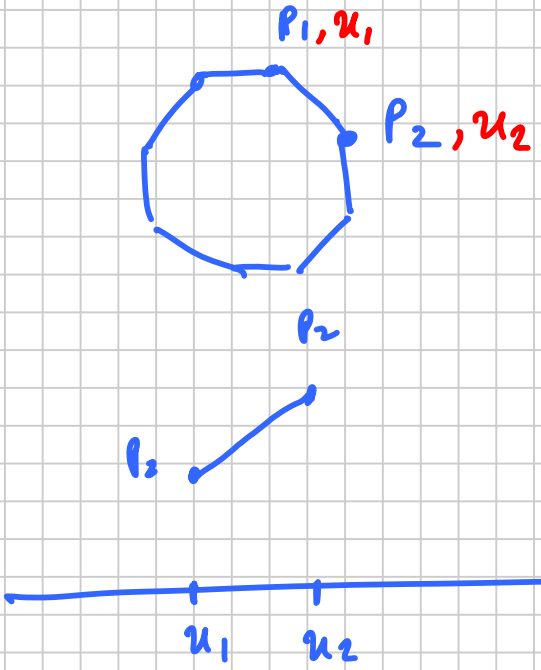
(1) Smooth parameterization

$$p = \begin{pmatrix} r\cos u \\ r \sin u \\ 1 \end{pmatrix} \qquad u = \tan^{-1}\left(\frac{p_y}{p_x}\right)$$

Can't do this for most real objects



(2) Piecewise linear mapping



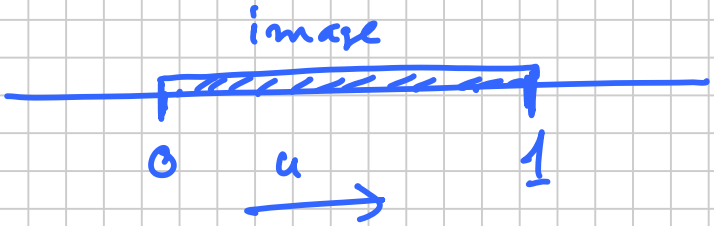
A new per-vertex attribute

linear interpolation between vertex values approximates the mapping.

Same machinery as previous classes L21, L22

u, v are called texture coordinates.

One more refinement: want to abstract out the fact that texture images have finite extent

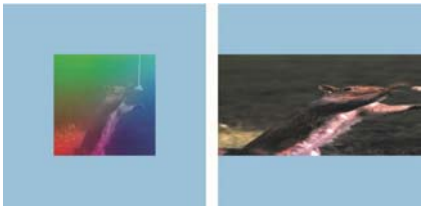


u between 0 & 1 within image,

outside this, coordinates can repeat, or be clamped.

Second basic example: Texture mapping a square

- See Appendix A.4



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- See Nehe texture tutor

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Texture mapping in OpenGL (WebGL is very similar)

- initGLState()

```
…
glActiveTexture(GL_TEXTURE0);
glGenTextures(1, &h_texture);
glBindTexture(GL_TEXTURE_2D, h_texture);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_S, GL_CLAMP);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_WRAP_T, GL_CLAMP);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);
int twidth, theight;
packed_pixel_t * pixdata = ppmread("reachup.ppm", &twidth, &theight);
assert(pixdata);
glTexImage2D(GL_TEXTURE_2D, 0, GL_SRGB, twidth, theight, 0, GL_RGB,
GL_UNSIGNED_BYTE, pixdata);
free(pixdata);
...
```

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Texture mapping

- initShaders()

```
h_texUnit0 = safe_glGetUniformLocation(h_program, "texUnit0");
h_aTexCoord = safe_glGetAttribLocation(h_program, "aTexCoord");
```

- display()

```
safe_glUniform1i(h_texUnit0, 0);
```

- Texture location (0,0) → lower left, (1,1) → upper right

```
GlfloatsqTex[12] =
{
  0, 0,
  1, 1,
  1, 0,

  0, 0,
  0, 1,
  1, 1
};
```

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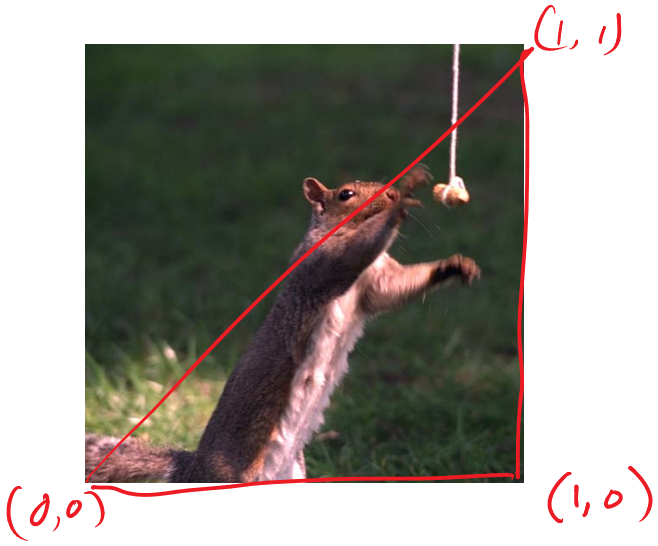

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Texture mapping

- Vertex shader, just “pass through”

```
#version 330
uniform float uVertexScale;
uniform mat4 uProjMatrix;
uniform mat4 uModelViewMatrix;
in vec2 aVertex;
in vec2 aTexCoord;
in vec3 aColor;
out vec3 vColor;
out vec2 vTexCoord;

void main()
{
  gl_Position = vec4(uProjMatrix * uModelViewMatrix * aVertex);
  vColor = aColor;
  vTexCoord = aTexCoord;
}
```

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Texture mapping

- Fragment shader changes

```
#version 330

uniform sampler2D texUnit0;
in vec2 vTexCoord;
out vec4 fragColor;

void main() {
   vec4 texColor0 = texture2D(texUnit0, vTexCoord);
   fragColor = texColor0;
}
```

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Texture Mapping in Three.js

- Demo

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