TEXTURE MAPPING

Texture Mapping

A way of adding surface details

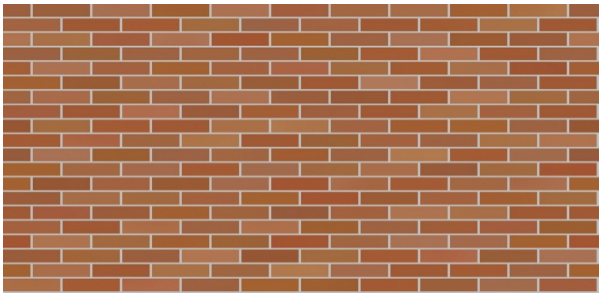
Two ways we can achieve this:

Model the surface with more polygons

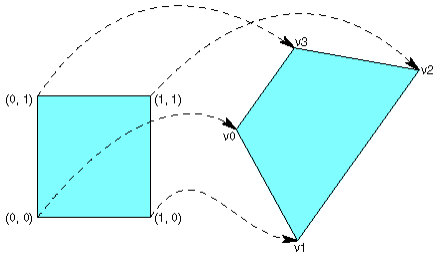
- Slow downs rendering
- Hard to model fine features

Map a texture to the surface

- Image complexity does not affect complexity of processing



Map textures to surfaces



The polygon can have an arbitrary size and shape

Use glTexCoord2f(s, t) to specify texture coordinates for each vertex in object space

State machine: texture coordinates remain valid until you change them or exit texture mode via glDisable(GL2.GL_TEXTURE_2D)

Example:

```
gl.glBegin(GL2.GL_QUADS);
gl.glTexCoord2f(1, 1);
gl.glVertex3f( 1.0f, 1.0f, 0.0f);
gl.glTexCoord2f(0, 1);
gl.glVertex3f(-1.0f, 1.0f, 0.0f);
gl.glTexCoord2f(0, 0);
gl.glVertex3f(-1.0f,-1.0f, 0.0f);
gl.glTexCoord2f(1, 0);
gl.glVertex3f( 1.0f,-1.0f, 0.0f);
gl.glEnd();
```

Textures in OpenGL ...

- **glEnable(GL_TEXTURE_2D)**

  turn on the 2D texture store

- **glTexImage2D**

  declares a texture's size, color components (RGBA, etc), data type (byte, float...), pixel data

- **glBindTexture**

  "bind" the given texture to the active store. Only one texture can be bound at a time. All future configuration and co-ordinates correspond to this texture. For the fixed pipeline, you can only use one texture for rendering. For shaders, you bind textures to uniforms.

Textures in OpenGL Continued...

.glTexParameteri

Used to set texture configuration:

How are the texture values interpolated?
GL_NEAREST vs GL_LINEAR

- GL_NEAREST rounds to nearest texel
- GL_LINEAR linearly interpolates the texels

Does the texture repeat itself?
GL_REPEAT vs GL_CLAMP

Say we have a texture coordinate of (-0.1,1.1)

- GL_CLAMP changes it to (0.0,1.0)
- GL_REPEAT changes it to (0.9,0.1)

More options for Texture Parameters can be found here:
http://www.opengl.org/sdk/docs/man2/xhtml/glTexParameter.xml
Examples of use can be found in the Texture class in the framework

Textures in CS 4620 Framework ...

Takes the burden of:

Loading texture files as texture maps (~ glTexImage2D)
Setting up the texture parameters (~ glTexParameteri)

Managing the texture units (~ glBindTexture)

Wrapper classes for working with 1D, 2D and 2D Mip-Mapped textures.

Simple interface for using textures with GLSL.

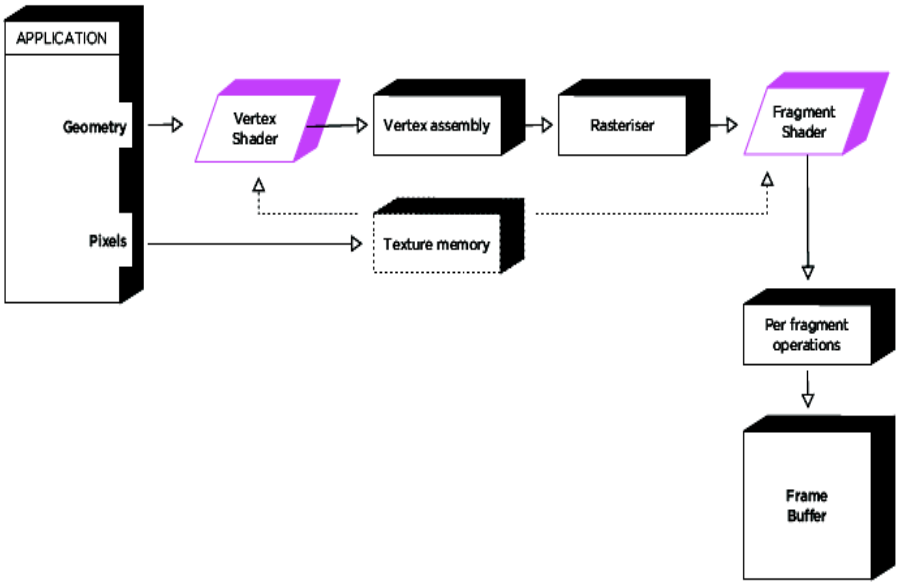
Textures in CS 4620 Framework ...

```
private Texture2D texture;

public void init(GLAutoDrawable drawable) {
        super.init(drawable);

        final GL2 gl = drawable.getGL().getGL2();

        try {
                texture = new Texture2D(gl,
                "data/textures/sample.jpg");}
        catch (IOException e) {
                System.out.print("Can't load texture: ");
                System.out.println(e.getMessage());
                Terminate();
        }
}
```

Textures in CS 4620 Framework ...

```
protected void drawTexturedQuad(GL2 gl) {
        texture.use();
        gl.glBegin(GL2.GL_QUADS);
        {
                gl.glTexCoord2f(1, 1);
                gl.glVertex3f( 1.0f, 1.0f, 0.0f);
                gl.glTexCoord2f(0, 1);
                gl.glVertex3f(-1.0f, 1.0f, 0.0f);
                gl.glTexCoord2f(0, 0);
                gl.glVertex3f(-1.0f,-1.0f, 0.0f);
                gl.glTexCoord2f(1, 0);
                gl.glVertex3f( 1.0f,-1.0f, 0.0f);
        }
        gl.glEnd();
        texture.unuse();
}
```

Texturing in GLSL/Pipeline



Texturing in GLSL

New elements:

sampler2D (type)

vec4 texture2D(sampler2D,vec2) (function)

gl_MultiTexCoord0 (uniform)

Texturing in GLSL – OpenGL App

In the OpenGL app, we have to bind the desired texture to the sampler uniform

Inside Init()

```
// Load the 2D texture
texture = new Texture2D(gl,
      "data/textures/sample.jpg");

// Get the sampler uniform
samplerUniform =
  textureShaderProgram.GetUniforms().
  get("sampler");

// Load, compile and link the shaders
textureShaderProgram = new
  Program(gl, vertexFileName,
          fragmentFileName);
```

Inside Render()

```
texture.use(); // Make it the active texture unit
textureShaderProgram.use(); // Activate the shader

// Bind the active texture unit to the sampler uniform
TextureUnit.getActiveTextureUnit(gl).bindToUniform(sa
mplerUniform);

draw(gl); // Render your scene

// Revert the changes
textureShaderProgram.unuse();
texture.unuse();
```

Texturing in GLSL – Vertex Shader

Figure out the coordinate that we want to sample from using gl_MultiTexCoord0

```
varying vec2 coord;

void main() {
        gl_Position = gl_ModelViewProjectionMatrix * gl_Vertex;

        coord = vec2(gl_MultiTexCoord0);
        or
        gl_TexCoord[0] = gl_MultiTexCoord0);
}
```

Texturing in GLSL – Fragment Shader

Take the coordinate data from the vertex shader and sample the appropriate pixel from the desired texture

```
varying vec2 coord;
uniform sampler2D sampler;

void main() {
        gl_FragColor = texture2D(sampler, coord);
        or
        gl_FragColor = texture2D(sampler, gl_TexCoord[0].st);
}
```