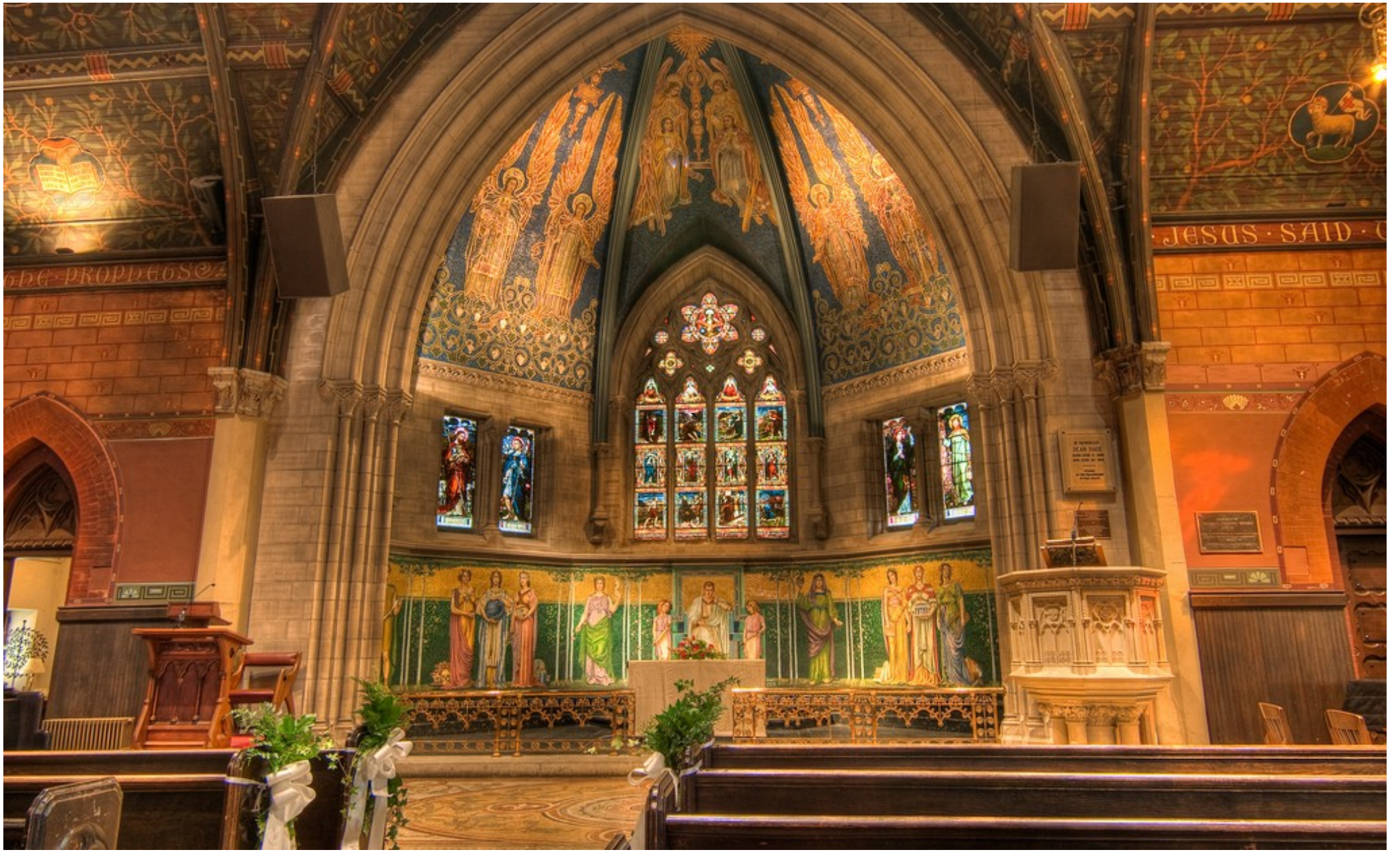


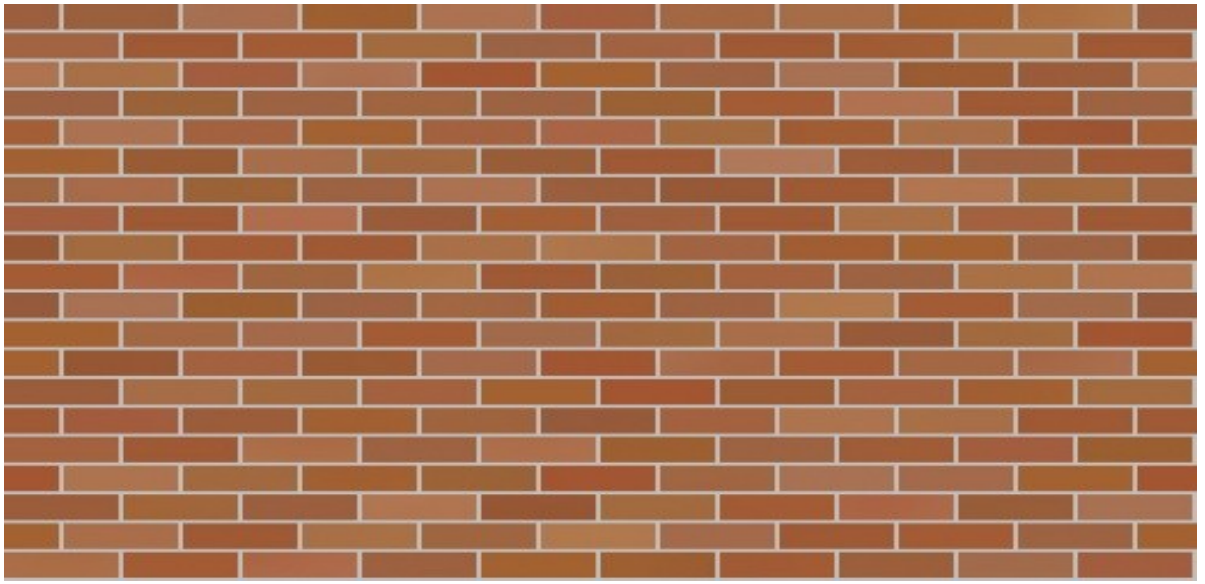
TEXTURE MAPPING

Texture Mapping

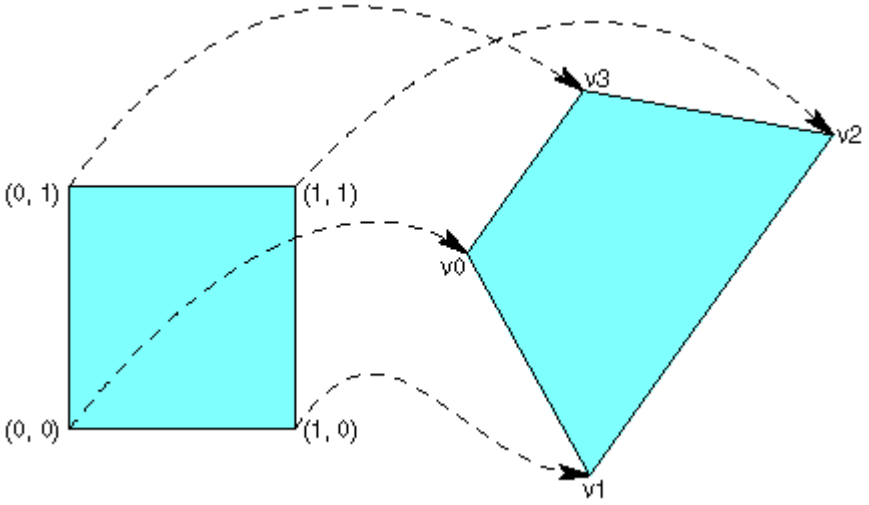
- A way of adding surface details

- Two ways can achieve that goal:
  - 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
- **glTexParameteri**
  - set texture configuration: how does the texture wrap? How are nearest-pixel values interpolated?
- **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.

Textures in CS 4621 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.

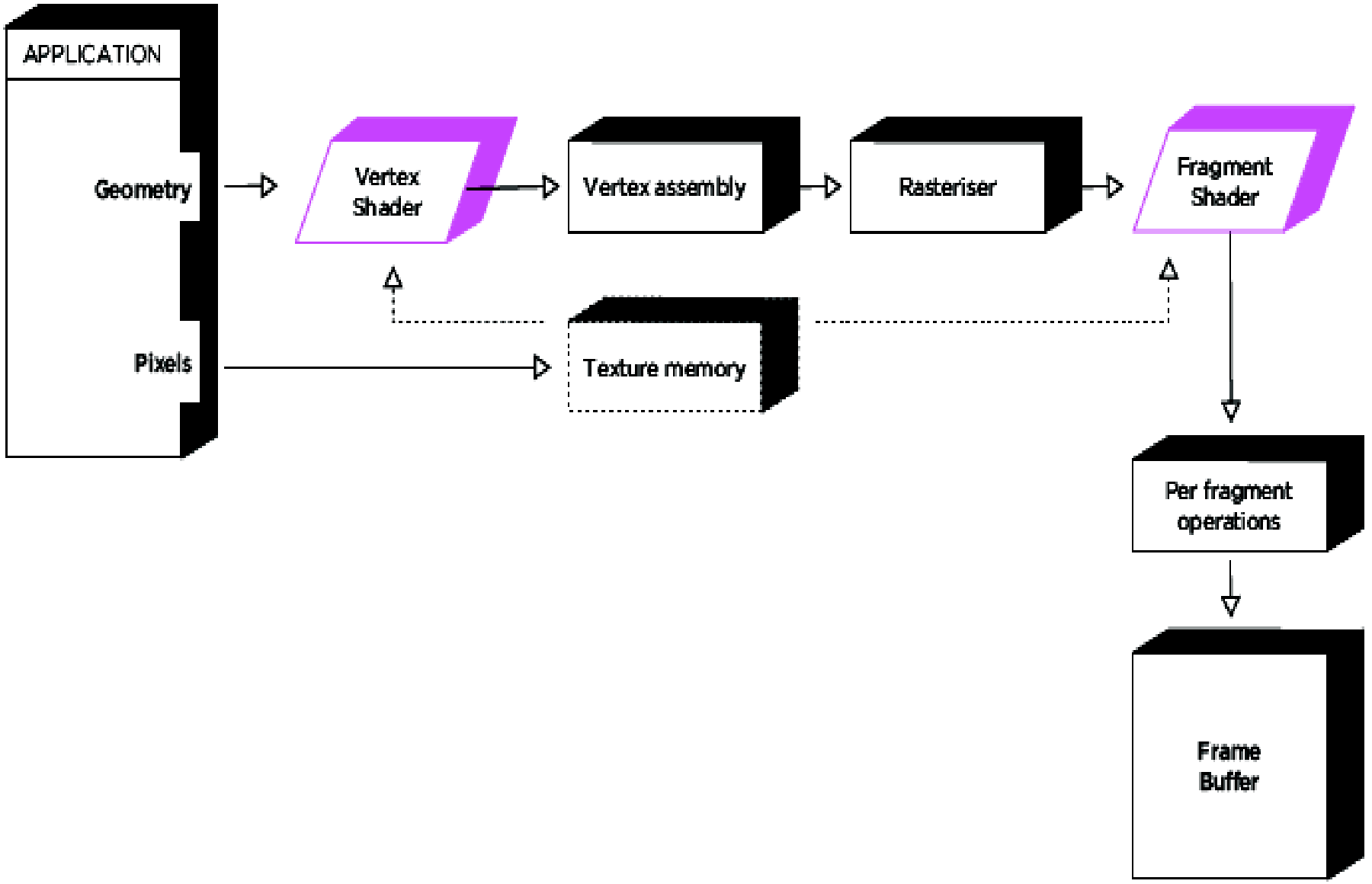
Textures in CS 4621 Framework ...

```
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 4621 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



Texturing in GLSL

- New elements:
  - sampler2D (type)
  - texture2D (function)
  - gl_MultiTexCoord0 (uniform variable)

Texturing in GLSL – Vertex Shader

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

```
varying vec2 coord;

void main() {
   gl_Position =
      gl_ModelViewProjectionMatrix * gl_Vertex;

   coord = vec2(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);
}
```

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).bin
dToUniform(samplerUniform);

draw(gl); // Render your scene

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

Examples ...

- Simple texturing example using the fixed pipeline
- The same example, but using GLSL
- Toon shader with 1D texture map