Texturing in GLSL

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2D Texturing

Vertex shader:

```
#version 330 compatibility
out  vec2  vST;

void
main( )
{
        vST = gl_MultiTexCoord0.st;
        gl_Position = gl_ModelViewProjectionMatrix * gl_Vertex;
}
```

Fragment shader:

```
#version 330 compatibility
in  vec2  vST;
uniform sampler2D  uTexUnit;

void
main( )
{
        vec3 newcolor = texture( uTexUnit, vST ).rgb;
        gl_FragColor = vec4( newcolor, 1. );
}
```

On Macs, this function should be called **texture2D**

Both-named functions return a vec4: rgba

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2D Texturing in the OpenGL API

Fragment shader:

```
#version 330 compatibility
in  vec2  vST;
uniform sampler2D  uTexUnit;

void
main( )
{
        vec3 newcolor = texture( uTexUnit, vST ).rgb;
        gl_FragColor = vec4( newcolor, 1. );
}
```

```
GLuint  TexName;                        // a global
. . .
glGenTextures( 1, &TexName );           // in InitGraphics( )
int nums, numt;
unsigned char *texture = BmpToTexture( "filename.bmp", &nums, &numt );
glBindTexture( GL_TEXTURE_2D, TexName );
glTexParameterf( GL_TEXTURE_2D, GL_TEXTURE_WRAP_S, GL_REPEAT );
glTexParameterf( GL_TEXTURE_2D, GL_TEXTURE_WRAP_T, GL_REPEAT );
glTexParameterf( GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR );
glTexParameterf( GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR );
glTexImage2D( GL_TEXTURE_2D, 0, 3, nums, numt, 0, GL_RGB, GL_UNSIGNED_BYTE, texture );
. . .
Pattern.Use( );                         // in Display( ):
glActiveTexture( GL_TEXTURE6 );         // use texture unit 6
glBindTexture( GL_TEXTURE_2D, TexName );
Pattern.SetUniformVariable( “uTexUnit”, 6 );
```


2D Texturing in glman

Fragment shader:

```
#version 330 compatibility
in  vec2  vST;
uniform sampler2D  uTexUnit;

void
main( )
{
        vec3 newcolor = texture( uTexUnit, vST ).rgb;
        gl_FragColor = vec4( newcolor, 1. );
}
```

```
Texture2D 6 worldtex.bmp
. . .
Vertex      pattern.vert
Fragment pattern.frag
Program  World      uTexUnit  6
```

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The OsuSphere Has Sensible s,t Coordinates Assigned

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The GLUT Teapot Doesn't

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What if You Want to Use Two Textures in One Shader?

C++ Program:

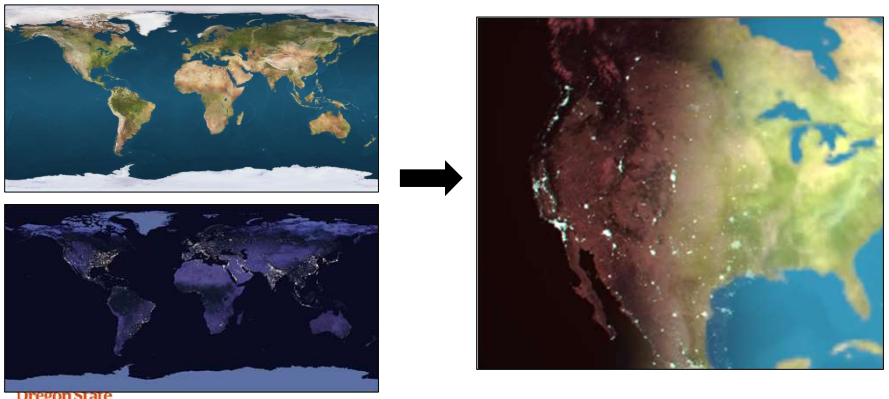
```
// In Display( ):
Pattern.Use( );
glActiveTexture( GL_TEXTURE5 );
glBindTexture( GL_TEXTURE_2D, TexName0 );

glActiveTexture( GL_TEXTURE6 );
glBindTexture( GL_TEXTURE_2D, TexName1 );

Pattern.SetUniformVariable( "uTexUnit0", 5 );
Pattern.SetUniformVariable( "uTexUnit1", 6 );

<< draw something >>
Pattern.UnUse( );
```

Fragment shader:

```
#version 330 compatibility
in  vec2  vST;
uniform sampler2D  uTexUnit0;
uniform sampler2D  uTexUnit1;

void
main( )
{
        vec3 newColor0 = texture( uTexUnit0, vST );
        vec3 newColor1 = texture( uTexUnit1, vST );
        gl_FragColor = ...
}
```

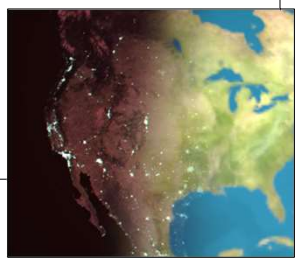

Why Might You Want to Use Two Textures in One Shader?

Once the RGBs have been read from a texture, they are just numbers. You can do any arithmetic you want with the texture RGBs, other colors, lighting, etc. Here is an example of blending two textures at once:



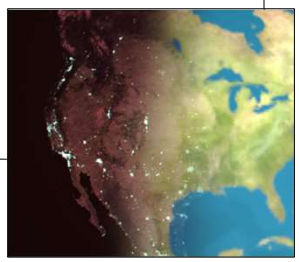
Using Two Textures in One Shader, I


```
#version 330 compatibility

uniform float uBlend;
uniform float uSunLng;
uniform sampler2D  uTexUnitDay, uTexUnitNight;

in float vLightIntensity;
in vec2  vST;

const float OFFSETS =  0.0;                    // how much the images are off horizontally

void
main( )
{
      float sunlng = uSunLng; // -180. to +180.
      float sunlngp = sunlng - 180.;
      if( sunlngp < -180. )   sunlngp += 360.;     // -180. to +180.

      vec2 nightST = vST;
      vec2 dayST    = vST;
      dayST.s += OFFSETS;
      if( dayST.s < 0. )      dayST.s += 1.;
```

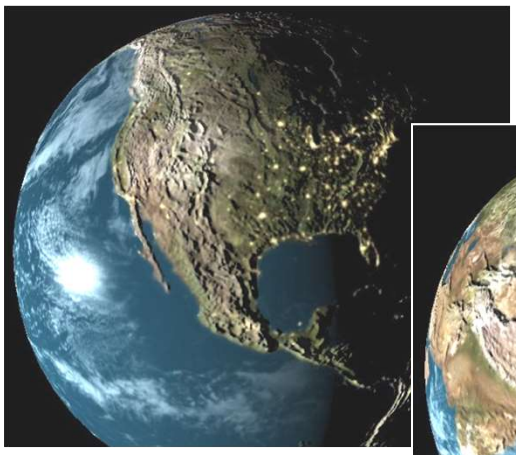


Using Two Textures in One Shader, II

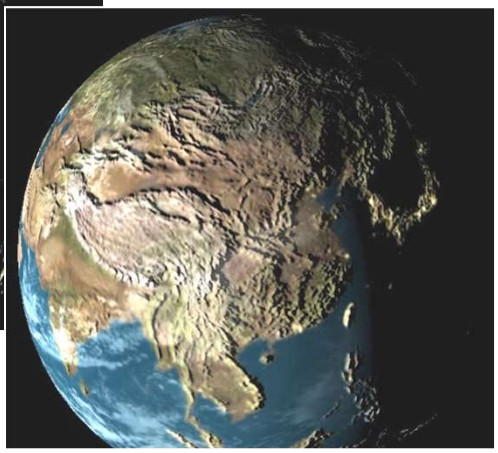

```
      float earthlng = 360. * ( dayST.s - 0.5 );                    // -180. to +180.

      float delta0 = earthlng - sunlng;
      if( delta0 < -180. ) delta0 += 360.;
      if( delta0 >  180. ) delta0 -= 360.;

      float delta1 = earthlng - sunlngp;
      if( delta1 < -180. ) delta1 += 360.;
      if( delta1 >  180. ) delta1 -= 360.;
      float delta = delta0;
      if( abs(delta1) < abs(delta0) )
            delta = -delta1;

      vec3 rgbday   = texture( uTexUnitDay,   dayST).rgb;
      vec3 rgbnight = texture( uTexUnitNight, nightST).rgb;

      float t = smoothstep( -uBlend, uBlend, delta  );
      vec3 newcolor = mix( rgbday, rgbnight, t );
      gl_FragColor = vec4( vLightIntensity*newcolor, 1. );
}
```



Shaders Can Combine More than Two Textures



Just assign each texture a different texture unit



Textures used here:
- Day
- Night
- Heights (bump-mapping)
- Clouds
- Specular highlights

Visualization by Nick Gebbie