Using Noise to Automatically Generate Generic Terrain

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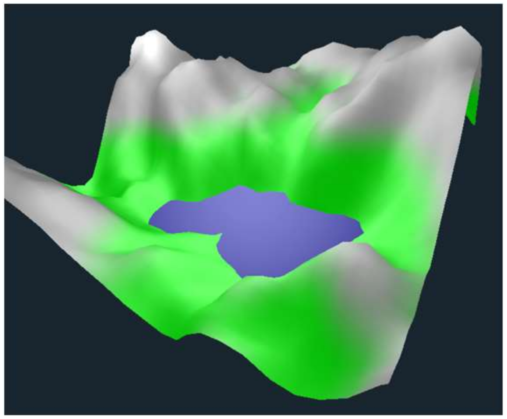
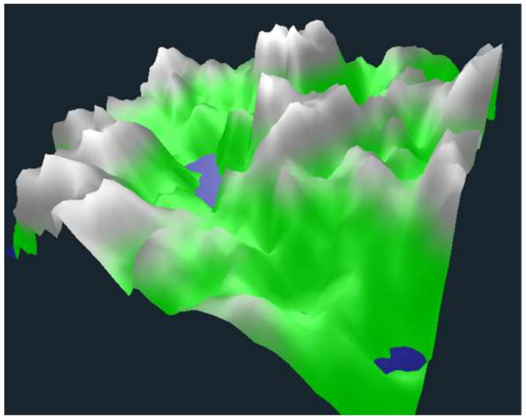
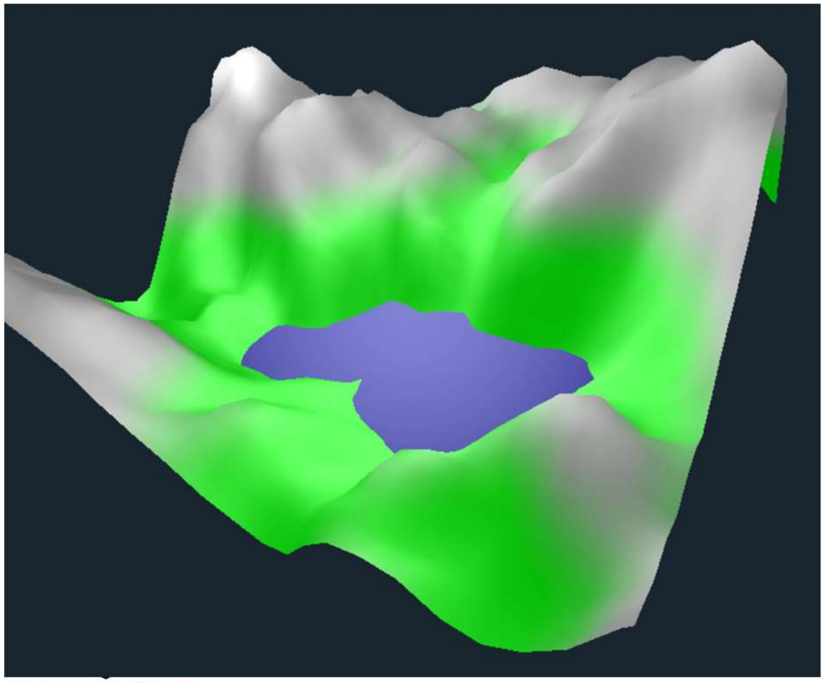
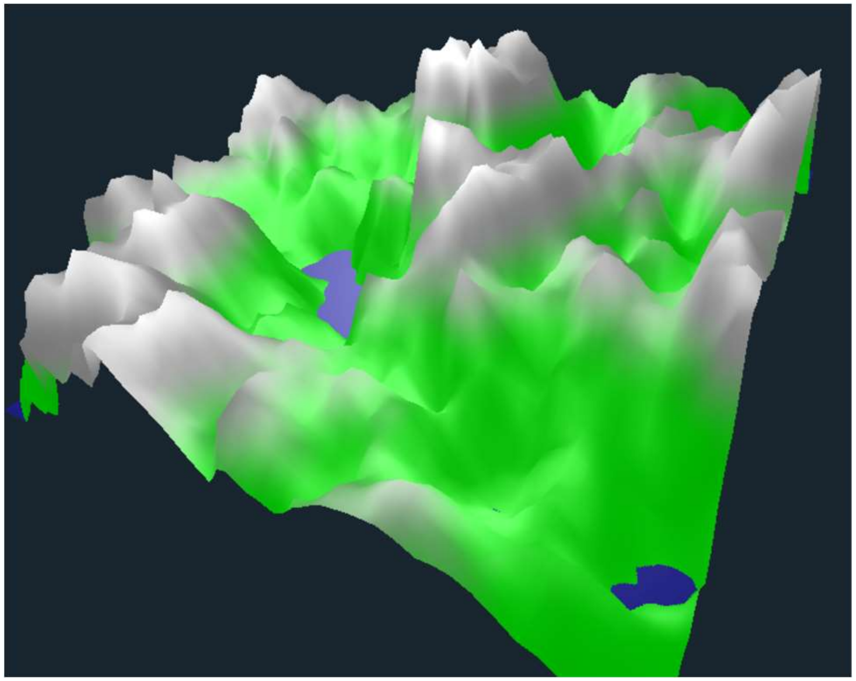




The General Idea

Use noise to determine terrain heights. Utilize as many different parameters as we can to give a variety of terrain.





terrainnoise.glib

```
##OpenGL GLIB
Perspective 70
LookAt 0 0 3  0 0 0  0 1 0

Vertex       noiseterrain.vert
Fragment     noiseterrain.frag
Program      NoiseTerrain                                   \
             uNoiseAmp <0. 0. 5.>                           \
             uNoiseFreq <0.1 0.2 0.5>                       \
                          uDelta 0.1                        \
                          uBiasx <-2. 0. 2.>                \
                          uBiasy <-2. 0. 2.>                \
                          uBiasz <0. 0.1 1.>                \
                          uLevel1 <0.1 0.2 0.8>             \
                          uLevel2 <0.4 0.6 1.0>             \
                          uTol <0. 0.2 01.0>                \
                          uKa <0. 0.1 1.0>                  \
                          uKd <0. 0.6 1.0>                  \
                          uKs <0. 0.3 1.0>                  \
                          uShininess <3. 10. 200.>          \
                          uLightX <-20. 0. 20.>             \
                          uLightY <-20. 0. 20.>             \
                          uLightZ <5. 10. 20.>              \
                          uSpecularColor {1. 1. 1. 1.}


QuadXY  -0.2  1.  1000 1000
```

terrainnoise.vert, I

```
#version 330 compatibility

uniform sampler3D Noise3;
uniform float uNoiseAmp;
uniform float uNoiseFreq;
uniform float uBiasx, uBiasy, uBiasz;
uniform float uLightX, uLightY, uLightZ;

out vec3 vNs;
out vec3 vLs;
out vec3 vEs;
out vec3 vMC;
uniform float uDelta;


vec3 DELTAX = vec3( uDelta, 0., 0. );
vec3 DELTAY = vec3( 0., uDelta, 0. );


float
Height( vec3 mc )
{
                vec3 newmc = vec3( mc.x+uBiasx, mc.y+uBiasy, mc.z );
                vec4 nv = texture( Noise3, uNoiseFreq * newmc );
                float n = nv.r + nv.g + nv.b + nv.a;
                n = n - 2.;
                n = n + uBiasz;
                n *= uNoiseAmp;
                return n;
}
```

Reading a texture from within the vertex shader

terrainnoise.vert, II

```
void
main( )
{
		float h00 = Height( gl_Vertex.xyz );
		float hp0 = Height( gl_Vertex.xyz + DELTAX );
		float hm0 = Height( gl_Vertex.xyz - DELTAX );
		float h0p = Height( gl_Vertex.xyz + DELTAY );
		float h0m = Height( gl_Vertex.xyz - DELTAY );

		float dzdx = hp0 - hm0;
		vec3 xtangent = vec3( 1., 0., dzdx );
		float dzdy = h0p - h0m;
		vec3 ytangent = vec3( 0., 1., dzdy );
		//vNs = normalize(  gl_NormalMatrix * cross( xtangent, ytangent )  );
		vNs = normalize( cross( xtangent, ytangent )  );

		vec3 new = gl_Vertex.xyz;
		new.z += h00;			// displace the point
		if( new.z < 0. )
			new.z = 0.;
		vMC = new;

		vec4 ECposition = gl_ModelViewMatrix * vec4( new, 1. );
		vec3 eyeLightPosition = vec3( uLightX, uLightY, uLightZ );

		vLs = normalize( eyeLightPosition - ECposition.xyz );
		vEs = normalize( vec3( 0., 0., 0. ) - ECposition.xyz );

		gl_Position = gl_ModelViewProjectionMatrix * vec4( new, 1. );
}
```

Cross product to get a normal vector

It’s always a heated discussion about how much quality lighting to put on terrain. We usually don’t multiply by the normal matrix because you generally don’t turn a landform around in your hands.

terrainnoise.frag, I

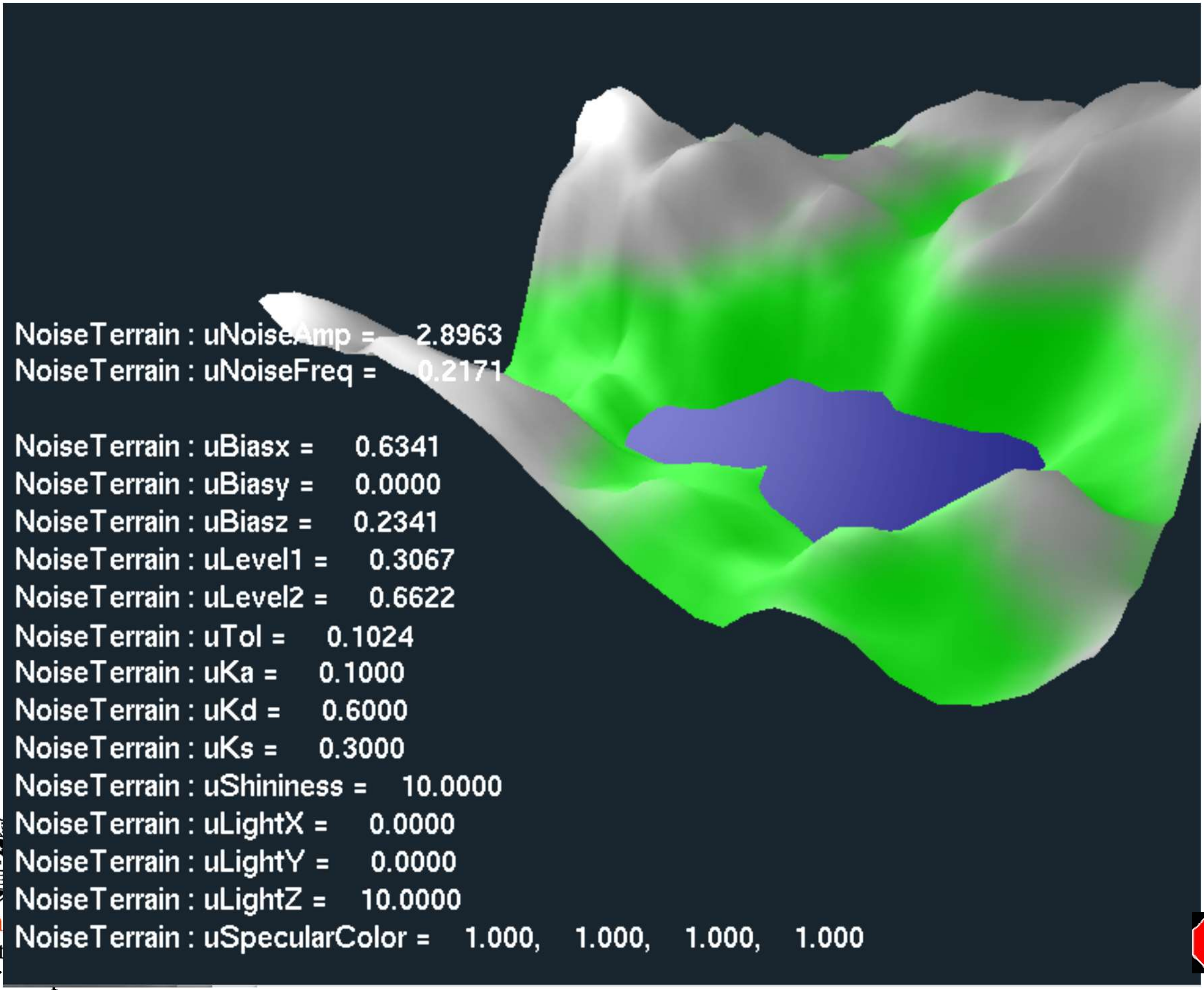
```
#version 330 compatibility

uniform float           uLevel1, uLevel2, uTol;
uniform float           uKa, uKd, uKs;
uniform vec4            uSpecularColor;
uniform float           uShininess;

in vec3 vNs;
in vec3 vLs;
in vec3 vEs;
in vec3 vMC;

const vec3 BLUE     =   vec3( 0.1, 0.1, 0.5 );
const vec3 GREEN  =   vec3( 0.0, 0.8, 0.0 );
const vec3 BROWN =   vec3( 0.6, 0.3, 0.1 );
const vec3 WHITE   =   vec3( 1.0, 1.0, 1.0 );
const vec3 GRAY    =   vec3( 0.5,  0.5, 0.5 );
```

terrainnoise.frag, II

```
void
main( )
{
        vec3 Normal = vec3( 0., 0., 1. );
        vec3 color = BLUE;
        if( vMC.z > 0. )
        {
                float t = smoothstep( uLevel1-uTol, uLevel1+uTol, vMC.z);
                color = mix( GREEN, GRAY, t );
                Normal = normalize( vNs );
        }
        if( vMC.z > uLevel1+uTol )
        {
                float t = smoothstep( uLevel2-uTol, uLevel2+uTol, vMC.z);
                color = mix( GRAY, WHITE, t );
                Normal = normalize( vNs );
        }

        vec3 Light = normalize( vLs );
        vec3 Eye = normalize( vEs );
        vec3 ambient = uKa * color;
        float d = dot(Normal,Light);
        vec3 diffuse = uKd * d * color;

        float s = 0.;
        if( d > 0. )                    // only do specular if the light can see the point
        {
                vec3 ref = normalize( 2. * Normal * dot(Normal,Light) - Light );
                s = pow( max( dot(Eye,ref),0. ), uShininess );
        }
        vec3 specular = uKs * s * uSpecularColor.rgb;

        gl_FragColor = vec4( ambient.rgb + diffuse.rgb + specular.rgb, 1. );
}
```

What does it mean to do specular lighting on *terrain*? No, I don't know either, but here it is if you want it.

Lots of Parameters Can Be Changed



NoiseTerrain : uNoiseAmp = 2.8963
NoiseTerrain : uNoiseFreq = 0.2171

NoiseTerrain : uBiasx = 0.6341
NoiseTerrain : uBiasy = 0.0000
NoiseTerrain : uBiasz = 0.2341
NoiseTerrain : uLevel1 = 0.3067
NoiseTerrain : uLevel2 = 0.6622
NoiseTerrain : uTol = 0.1024
NoiseTerrain : uKa = 0.1000
NoiseTerrain : uKd = 0.6000
NoiseTerrain : uKs = 0.3000
NoiseTerrain : uShininess = 10.0000
NoiseTerrain : uLightX = 0.0000
NoiseTerrain : uLightY = 0.0000
NoiseTerrain : uLightZ = 10.0000
NoiseTerrain : uSpecularColor = 1.000, 1.000, 1.000, 1.000