Splines and surfaces in OpenGL

Pre-generated shapes on CPU

Generate by multi-pass GPU processing

Old OpenGL: glMap

3.2: Geometry shaders

4: Tesselation shaders


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3.2: Geometry shaders

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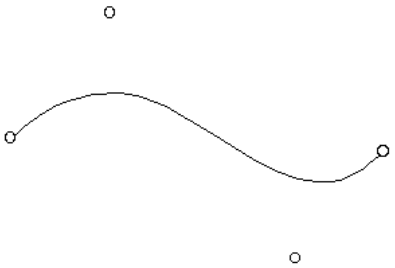
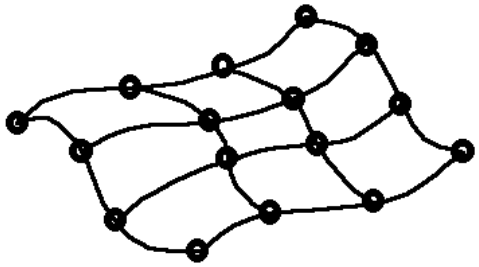
Evaluators

Old built-in Bezier evaluator. Easy to use but no longer recommended.

Supported both curves and surfaces





Evaluators

Very straight-forward but not very flexible.

```
glMap1f(GL_MAP1_VERTEX_3, u0, u1, 3, 4, &data2[0][0]);
glEnable(GL_MAP1_VERTEX_3);
glBegin(GL_LINE_STRIP);
for (int i = 0; i <= 20; i++)
  glEvalCoord1f(u0 + i*(u1-u0)/20);
glEnd();
```

Control points

Evaluation, specifies vertices

Geometry shaders

OpenGL 3 (extension in GL 2)

Shader between vertex and fragment, converts geometry, can add new vertices

Modest hardware demand: G80 or better (2007+)

Core functionality since GL3 - but will it last? Some irritating limitations. Criticised for low performance.

GL4 adds tesselation shaders, more like Evaluators.

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Applications:

- Splines/surfaces
- Edge extraction, silhouettes
- Polygon-level effects (shrinking triangles)
- Adaptive subdivision
- Visualizing normal vectors etc

Geometry shader examples

Input:Single triangle (as our first example)

Load geometry shader together with vertex and fragment.

Input to shader: triangle, lines or point

Output: triangle strip, line strip


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Pass-through geometry shader

```
#version 150

layout(triangles) in;
layout(triangle_strip, max_vertices = 3)
out;

void main()
{
  for(int i = 0; i < gl_in.length(); i++)
  {
    gl_Position = gl_in[i].gl_Position;
    EmitVertex();
  }
}
```

Just pass on the same vertices

EmitVertex tells that we have a finished vertex ready

Bezier curve geometry shader

```
// Simple 3-point spline geometry shader

#version 150

layout(triangles) in;
layout(line_strip, max_vertices = 50) out;

// quadratic bezier 0..1
vec4 bez3(vec3 a, vec3 b, vec3 c, float u)
{
    float aw = (1-u)*(1-u);
    float bw = 2*(1-u)*u;
    float cw = u*u;
    return vec4(a*aw+b*bw+c*cw, 1.0);
}
```

```
void main()
{
    for (int i = 0; i <= 20; i++)
    {
        gl_Position = bez3(
            vec3(gl_in[0].gl_Position),
            vec3(gl_in[1].gl_Position),
            vec3(gl_in[2].gl_Position),
            float(i)/20.0);
        EmitVertex();
    }
}
```

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Pre-generating splines

Evaluation of polynomials many times

Optimizations will pay!

Evaluating polynomials

Important problem for efficient spline calculations.

1) Horner's Rule

2) Forward-difference calculations

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Next time

More about curves and surfaces

Animation and collision detection