

Lesson 9 – Geometry Shaders

PV227 – GPU Rendering

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Geometry Shader

- new programmable stage (optional),
- between vertex shader and fragment shader,
- before the rasterizer.

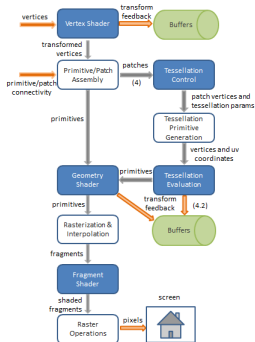


Figure: Taken from lighthouse3d.com

Geometry Shader (cont.)

- needs input and output format,
- receives the assembled primitives (no strip, fan or loop),
- full knowledge of the primitive.

Input Types

primitive	#vertices
points	1
lines	2
lines_adjacency	4
triangles	3
triangles_adjacency	6

- primitive type must match the draw command,
- `layout` (triangles) `in`;

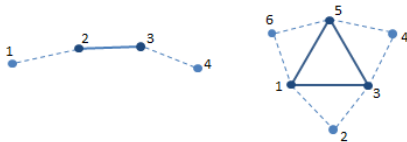


Figure: Taken from lighthouse3d.com

Input Data

- build-in:

- ▶ array `gl_in` of input vertices,
- ▶ default vertex attributes.

```
1 in gl_PerVertex
2 {
3     vec4   gl_Position;
4     float  gl_PointSize;
5     float  gl_ClipDistance [];
6 } gl_in []; // # of vertices: gl_in.length()
7
8 in int gl_PrimitiveIDIn;
```

- user-defined:

- ▶ same way as usual,
- ▶ array, data for each vertex.

```
1 in Data
2 {
3     vec3 normal;
4 } vertexData [];
```

Output Types

primitive

points

line_strip

triangle_strip

- output type need not match the input type,
- `GL_MAX_GEOMETRY_OUTPUT_VERTICES` (1024),
- can output [0, max] primitives,
- input primitive is discarded,
- `layout (line_strip , max_vertices = 4) out;`

Output Data

- outputs vertices,
- attributes passed the same way as in the vertex shader,
- vertex definition ended with `EmitVertex()`;
- need enough vertices to form primitives,
- primitive definition ended with `EndPrimitive()`;

Examples

- culling,
- explosion,
- tessellation,
- normal visualization.

Culling

- render only triangles visible from a point,
- do not emit triangles for the others.

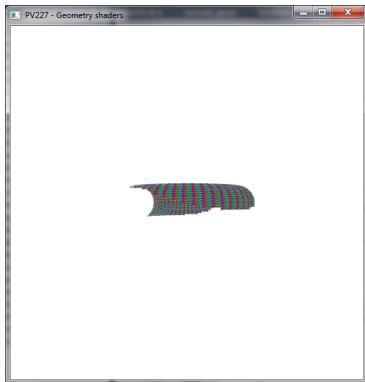


Figure: Point view culling

Explosion

- move vertices along the common triangle normal,
- color the vertices with R, G, B.

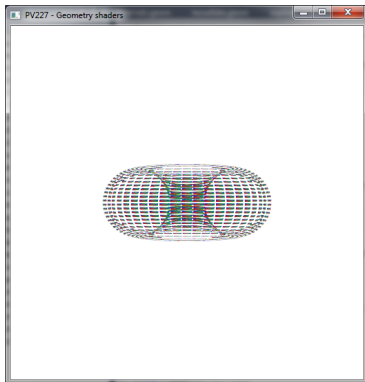


Figure: Explosion in $t = 0.5f$

Tessellation

- only minor amplification,
- create new point in the barycenter.

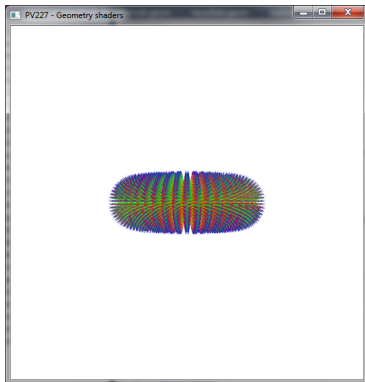


Figure: Extruded tessellation in $t = 0.5f$

Tessellation (triangle)

- one new point and three triangles.

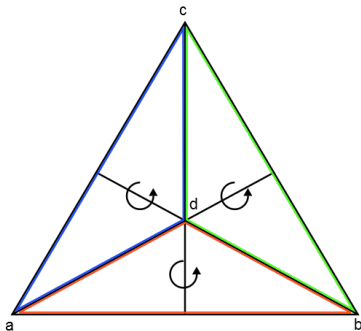


Figure: Tessellated triangle.

Triangle Strips

- mind the emit order of primitives,
- must follow the winding order of triangle strips.

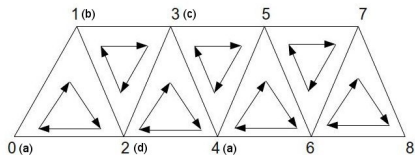


Figure: Taken from atspace.co.uk

Normal Visualization

- draw lines for normals,
- visualize both kinds of normals.

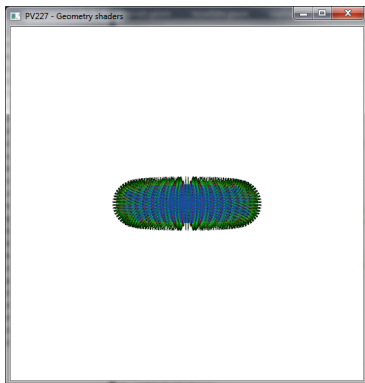


Figure: Visualized vertex and face normals.

Geometry Shaders Today

- not for tessellation, surpassed by tessellation shaders
- probably not for culling (not necessary)
- expanding a point to a quad (particle systems), compete with instancing
- expanding a line to a quad (grass, hair), in combination with tessellation shaders
- transform feedback
- layered rendering: render to cube map, render to stereo buffers
- instanced geometry shaders