POINT NORMAL TRIANGLES

Rick van Veen Laura Baakman

December 14, 2015

Advanced Computer Graphics

INPUT MESH

GOURAUD

PN GEOMETRY

PN TRIANGLES

SINGLE PN TRIANGLE

OVERVIEW

./img/1_single/recap_geometry.png

GEOMETRY

From input to geometry control net

img/1_single/inputPrimitive_emphGeometry.p

Input primitive

GEOMETRY - VERTEX COEFFICIENTS

img/1_single/geometry_1.png

Control net

$$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$$

$$b_{300} = P_1,$$
$$b_{030} = P_2,$$
$$b_{003} = P_3$$

GEOMETRY - VERTEX COEFFICIENTS

img/1_single/geometry_1.png

Control net

$$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$$

$$b_{300} = P_1,$$
$$b_{030} = P_2,$$
$$b_{003} = P_3$$

GEOMETRY - VERTEX COEFFICIENTS

img/1_single/geometry_1.png

Control net

$$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$$

$$\begin{aligned} b_{300} &= P_1, \\ b_{030} &= P_2, \\ b_{003} &= P_3 \end{aligned}$$

GEOMETRY - TANGENT COEFFICIENTS

img/1_single/geometry_2.png

Normal projection

$$
\begin{aligned}
w_{ij} &= (P_j - P_i) \cdot N_i \in \mathbb{R} \\
b_{210} &= \frac{2P_1 + P_2 - w_{12}N1}{3}, \\
&\vdots \\
b_{201} &= \frac{2P_1 + P_3 - w_{13}N1}{3}
\end{aligned}
$$

GEOMETRY - TANGENT COEFFICIENTS

img/1_single/geometry_2.png

Normal projection

$$w_{ij} = (P_j - P_i) \cdot N_i \in \mathbb{R}$$

$$b_{210} = \frac{2P_1 + P_2 - w_{12}N1}{3},$$

$$\vdots$$

$$b_{201} = \frac{2P_1 + P_3 - w_{13}N1}{3}$$

GEOMETRY - CENTER COEFFICIENT

img/1_single/geometry_3.png

Center control point

$$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$$

$$V = (P_1 + P_2 + P_3)/3,$$

$$b_{111} = E + (E - V)/2$$

GEOMETRY - CENTER COEFFICIENT

img/1_single/geometry_3.png

Center control point

$$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$$

$$V = (P_1 + P_2 + P_3)/3,$$

$$b_{111} = E + (E - V)/2$$

GEOMETRY

with control net point to curve (shading)

img/1_single/geometry_4.png

OVERVIEW

./img/1_single/recap_result.png

CUBIC PATCH

$$b : \mathbb{R}^2 \to \mathbb{R}^3, \text{ for } w = 1 - u - v, u, v, w \geq 0$$

$$\begin{aligned}
b(u, v) &= \sum_{i+j+k=3} b_{ijk} \frac{3!}{i!j!k!} u^i v^j w^k \\
&= b_{300} w^3 + b_{030} u^3 + b_{003} v^3 \\
&+ b_{210} 3w^2 u + b_{120} 3wu^2 + b_{201} 3w^2 v \\
&+ b_{021} 3u^2 v + b_{102} 3wv^2 + b_{012} 3uv^2 \\
&+ b_{111} 6wuv.
\end{aligned}$$

OVERVIEW

./img/1_single/recap_normals.png

NORMALS

from input to more normals

img/1_single/inputPrimitive_emphNormal.png

Input primitive

NORMALS - THEORY

Why do we want to compute these normals?

img/1_single/linearVsQuadraticNormals_line

Linear

Quadratic

Why do we want to compute these normals?

img/1_single/linearVsQuadraticNormals_line

Linear

img/1_single/linearVsQuadraticNormals_quad

Quadratic

NORMALS - EXAMPLE

img/1_single/linearlyVaryingNormals.png

Linear

img/1_single/quadriticall

Quadratic

How to compute them

img/1_single/computingNormals.png

$$v_{ij} = 2\frac{(P_j - P_i)\cdot(N_i + N_j)}{\text{[illegible]}} \in \mathbb{R}$$

How to compute them

img/1_single/computingNormals.png

$$v_{ij} = 2\frac{(P_j - P_i) \cdot (N_i + N_j)}{(P - P) \cdot (P - P)} \in \mathbb{R}$$

NORMALS - RESULT

img/1_single/normals.png

OVERVIEW

./img/1_single/recap_result.png

QUADRATIC PATCH

$$n : \mathbb{R}^2 \to \mathbb{R}^3, \text{ for } w = 1 - u - v,\ u, v, w \geq 0$$

$$\begin{aligned} n(u,v) &= \sum_{i+j+k=2} n_{ijk} u^i v^j w^k \\ &= n_{200} w^2 + n_{020} u^2 + n_{002} v^2 \\ &\quad + n_{110} wu + n_{011} uv + n_{101} wv \end{aligned}$$

LEVEL OF DETAIL

LOD verhaal

./img/1_single/lod_lod0.png ./img/1_single/lod_lod1.png ./img/1_single/lod_lod2.png ./img/1_singl

0 1 2 3

OVERVIEW

./img/1_single/recap_quadraticVsCubicPatch.png

A TRIANGLE MESH

PROPERTIES

Shared normals + [Thales of Milet, 500 BC]?

CONTINUITY

SHARP EDGES

Sharp edges

GRAPHICS PIPELINE

HARDWARE - PIPELINE

Waarom waren PN triangles hip in 2001? Plus pipeline

HARDWARE - PIPELINES

Hoe zou je het nu kunnen implementeren? Plus pipeline

CONCLUSION

FIN.

Questions?

REFERENCES

REFERENCES

beamericonarticle.pdf Alex Vlachos et al. "Curved PN triangles". In: *Proceedings of the 2001 symposium on Interactive 3D graphics*. ACM. 2001, pp. 159–166.