POINT NORMAL TRIANGLES

Rick van Veen Laura Baakman

December 14, 2015

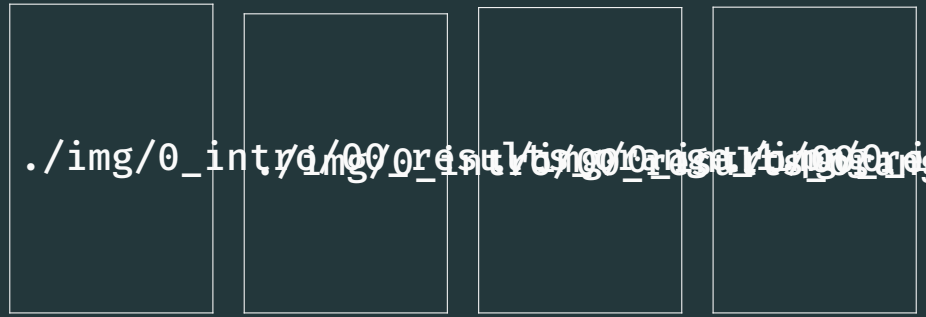
Advanced Computer Graphics

POINT NORMAL TRIANGLES

Rick van Veen Laura Baakman
December 14, 2015
Advanced Computer Graphics

Point Normal triangles

2015-12-09



INPUT MESH GOURAUD PN GEOMETRY PN TRIANGLES

SINGLE PN TRIANGLE

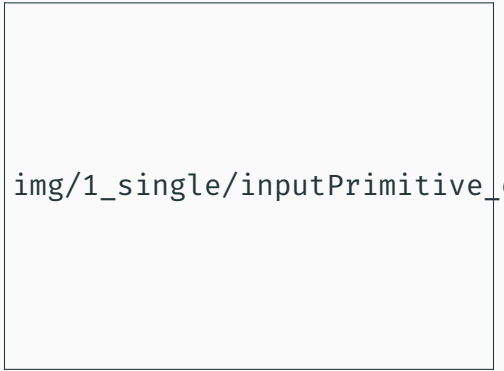
OVERVIEW

./img/1_single/recap_inputToGeom.png

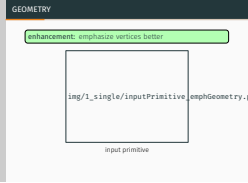
OVERVIEW
./img/1_single/recap_inputToGeom.png

GEOMETRY

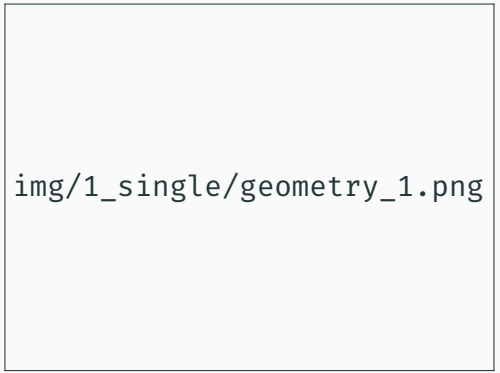
enhancement: emphasize vertices better



input primitive



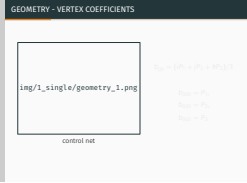
GEOMETRY - VERTEX COEFFICIENTS



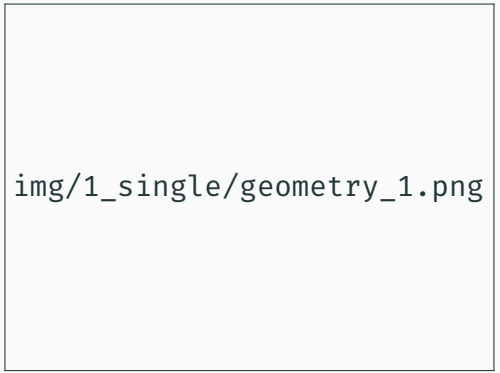
control net

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

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



GEOMETRY - VERTEX COEFFICIENTS



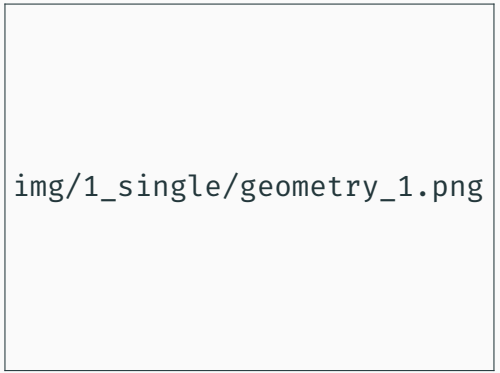
control net

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

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

GEOMETRY - VERTEX COEFFICIENTS
img/1_single/geometry_1.png
control net
$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$

GEOMETRY - VERTEX COEFFICIENTS



control net

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

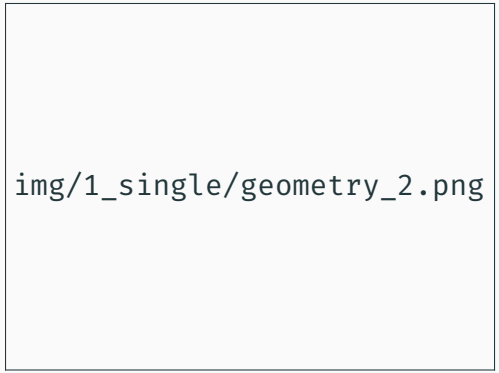
$$b_{300} = P_1,$$

$$b_{030} = P_2,$$

$$b_{003} = P_3$$

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 - TANGENT COEFFICIENTS



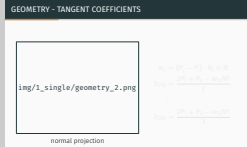
normal projection

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

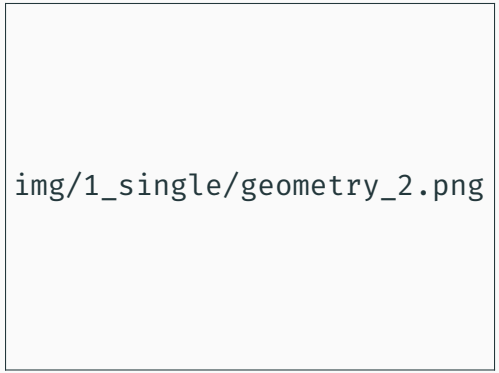
$$b_{210} = \frac{2P_1 + P_2 - w_{12}N1}{3},$$

$$\vdots$$

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



GEOMETRY - TANGENT COEFFICIENTS



normal projection

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

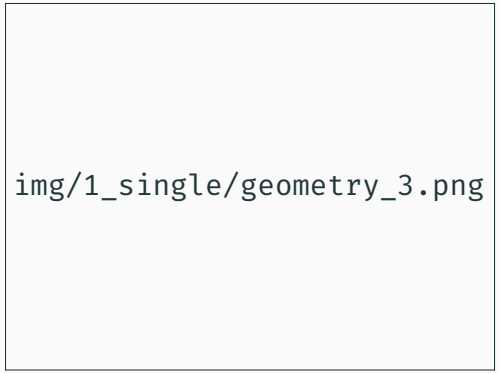
$$b_{210} = \frac{2P_1 + P_2 - w_{12}N1}{3},$$

$$\vdots$$

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

GEOMETRY - 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



center control point

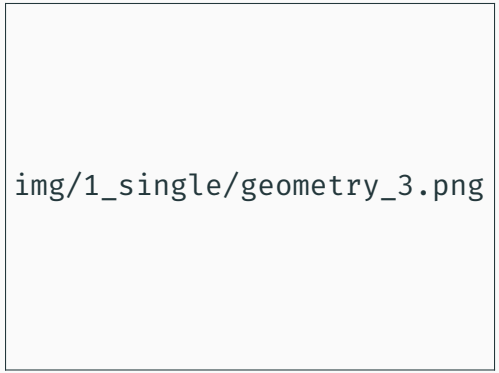
$$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$$

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

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

GEOMETRY - CENTER COEFFICIENT
img/1_single/geometry_3.png
center control point

GEOMETRY - CENTER COEFFICIENT



center control point

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

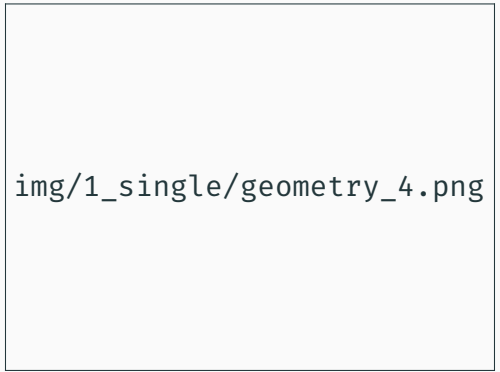
$$V = (P_1 + P_2 + P_3)/3,$$

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

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 - RESULT

enhancement: Set result slide to plain



GEOMETRY - RESULT
enhancement: Set result slide to plain
img/1_single/geometry_4.png

OVERVIEW

./img/1_single/recap_geomToShading.png

OVERVIEW
./img/1_single/recap_geomToShading.png

CUBIC PATCH

Spacing van de for all

Plaatje?

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

$$b(u,v) = \sum_{i+j+k=3} b_{ijk} \frac{3!}{i!j!k!} u^i v^j w^k$$

$$= b_{300} w^3 + b_{030} u^3 + b_{003} v^3$$
$$+ b_{210} 3w^2 u + b_{120} 3wu^2 + b_{201} 3w^2 v$$
$$+ b_{021} 3u^2 v + b_{102} 3wv^2 + b_{012} 3uv^2$$
$$+ b_{111} 6wuv.$$

CUBIC PATCH
Spacing van de for all
Plaatje?
$b : \mathbb{R}^2 \to \mathbb{R}^3$, for $w = 1 - u - v, u, v, w \geq 0$
$b(u,v) = \sum_{i+j+k=3} b_{ijk} \frac{3!}{i!j!k!} u^i v^j w^k$
$= b_{300} w^3 + b_{030} u^3 + b_{003} v^3$
$+ b_{210} 3w^2 u + b_{120} 3wu^2 + b_{201} 3w^2 v$
$+ b_{021} 3u^2 v + b_{102} 3wv^2 + b_{012} 3uv^2$
$+ b_{111} 6wuv.$

OVERVIEW

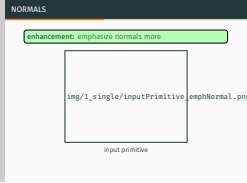
./img/1_single/recap_inputToNormals.png

OVERVIEW
./img/1_single/recap_inputToNormals.png

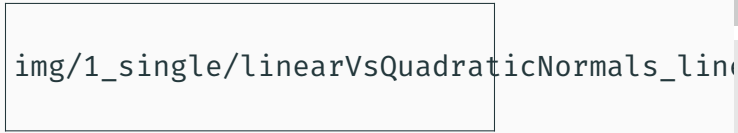
NORMALS

enhancement: emphasize normals more

input primitive



NORMALS - THEORY



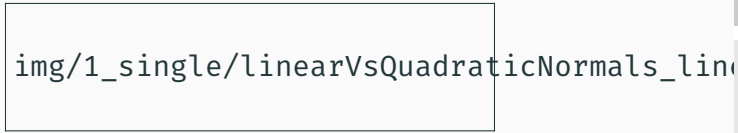
linear

quadratic

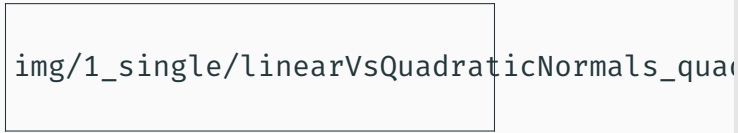
NORMALS - THEORY

linear

NORMALS - THEORY



linear



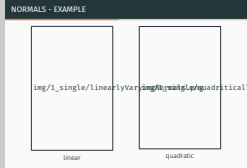
quadratic

NORMALS - THEORY
img/1_single/linearVsQuadraticNormals_lin
linear
img/1_single/linearVsQuadraticNormals_quad
quadratic

NORMALS - EXAMPLE

linear

quadratic



NORMALS - THEORY

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

$$h_{110} = N_1 + N2 - v_{12}(P_2 - P_1)$$

NORMALS - THEORY
img/1_single/computingNormals.png

NORMALS - THEORY

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

$$h_{110} = N_1 + N2 - v_0(P_2 - P_1)$$

NORMALS - THEORY
img/1_single/computingNormals.png
$v_i = 2\frac{(P_j - P_i)\cdot(N_i + N_j)}{(P_j - P_i)\cdot(P_j - P_i)} \in \mathbb{R}$
$h_{110} = N_1 + N2 - v_0(P_2 - P_1)$
$n_{110} = h_{110}/\|h_{110}\|$

NORMALS - RESULT

enhancement: Set result slide to plain

img/1_single/normals.png

NORMALS - RESULT
enhancement: Set result slide to plain
img/1_single/normals.png

OVERVIEW

./img/1_single/recap_normalsToShading.png

OVERVIEW
./img/1_single/recap_normalsToShading.png

QUADRATIC PATCH

Plaatje

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

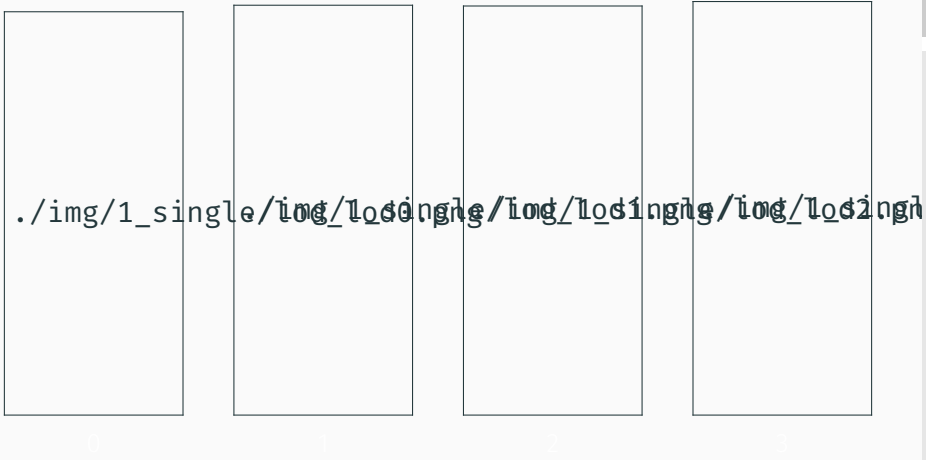
$$n(u,v) = \sum_{i+j+k=2} n_{ijk} u^i v^j w^k$$

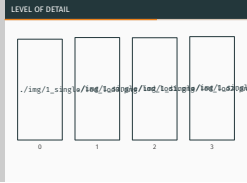
$$= n_{200} w^2 + n_{020} u^2 + n_{002} v^2$$

$$+ n_{110} wu + n_{011} uv + n_{101} wv$$

QUADRATIC PATCH
Plaatje
$n : \mathbb{R}^2 \to \mathbb{R}^3$, for $w = 1 - u - v, u, v, w \geq 0$
$n(u,v) = \sum_{i+j+k=2} n_{ijk} u^i v^j w^k$
$= n_{200} w^2 + n_{020} u^2 + n_{002} v^2$
$+ n_{110} wu + n_{011} uv + n_{101} wv$

LEVEL OF DETAIL





OVERVIEW

./img/1_single/recap_overview.png

OVERVIEW
./img/1_single/recap_overview.png

A TRIANGLE MESH

PROPERTIES

"PN triangles should not deviate too much from the original triangle to preserve the shape and avoid interference with other curved triangles." [1]

[1] Vlachos et al.

CONTINUITY

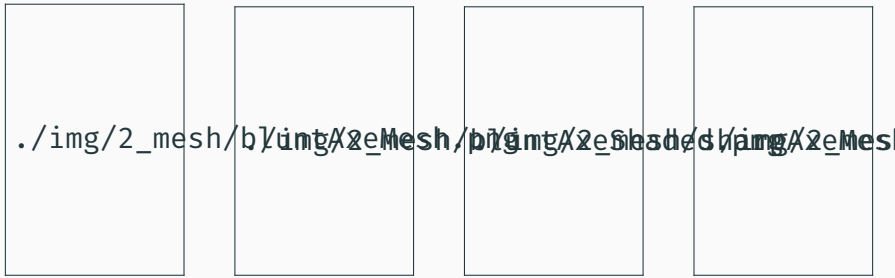
PN triangles have:[2]

- C^1 continuity in the vertex points
- C^0 continuity everywhere else

[2] Jiao and Alexander

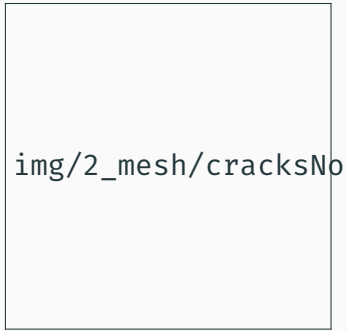
CONTINUITY
PN triangles have:[2]
- C^1 continuity in the vertex points
- C^0 continuity everywhere else
[2] Jiao and Alexander

SHARP EDGES


./img/2_mesh/blunt/Mesh/
./img/2_mesh/mesh/Mesh/
./img/2_mesh/sharp/Mesh/
mesh
blunt
mesh
sharp


SHARP EDGES
mesh
blunt
mesh
sharp

SEPARATE NORMALS



normals

cracks

SEPARATE NORMALS
img/2_mesh/cracksNormals.png
normals
img/2_mesh/cracks.png
cracks

GRAPHICS PIPELINE

HARDWARE - PIPELINES

img/3_pipeline/pipelineDifferences_oldOpenGL.png

2001

2015

HARDWARE - PIPELINES
img/3_pipeline/pipelineDifferences_oldOpenGL.png
2001

HARDWARE - PIPELINES

img/3_pipeline/pipelineDifferences_oldOpenGL.png

2001

img/3_pipeline/pipelineDifferences_newOpenGL.png

2015

HARDWARE - PIPELINES
img/3_pipeline/pipelineDifferences_oldOpenGL.png
2001
img/3_pipeline/pipelineDifferences_newOpenGL.png
2015

CONCLUSION

CONCLUSION

Some conclusion?

CONCLUSION
Some conclusion?

Figuur 13 uit paper

questions?

Figuur 13 uit paper

REFERENCES

- beamericonarticle.pdf Xiangmin Jiao and Phillip J Alexander. "Parallel feature-preserving mesh smoothing". In: *Computational Science and Its Applications–ICCSA 2005*. Springer, 2005, pp. 1180–1189.
- beamericonarticle.pdf J McDonald and M Kilgard. *Crack-free point-normal triangles using adjacent edge normals*. 2010.
- beamericonarticle.pdf Alex Vlachos et al. "Curved PN triangles". In: *Proceedings of the 2001 symposium on Interactive 3D graphics*. ACM. 2001, pp. 159–166.

REFERENCES

beamericonarticle.pdf Xiangmin Jiao and Phillip J Alexander. "Parallel feature-preserving mesh smoothing". In: *Computational Science and Its Applications–ICCSA 2005*. Springer, 2005, pp. 1180–1189.

beamericonarticle.pdf J McDonald and M Kilgard. *Crack-free point-normal triangles using adjacent edge normals*. 2010.

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