POINT NORMAL TRIANGLES

Rick van Veen Laura Baakman

December 14, 2015

Advanced Computer Graphics

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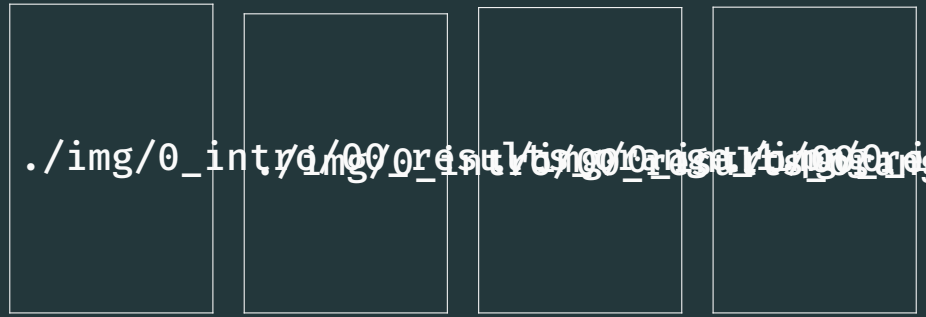
2015-12-09



INPUT MESH GOURAUD PN GEOMETRY PN TRIANGLES

SINGLE PN TRIANGLE

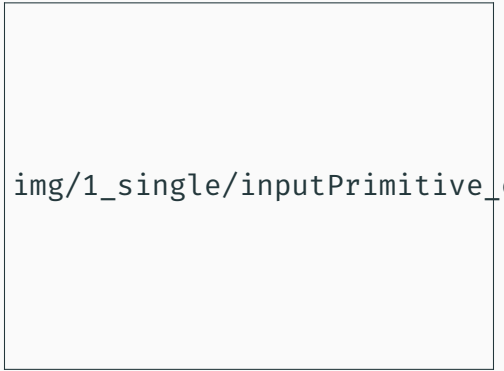
OVERVIEW

./img/1_single/recap_inputToGeom.png

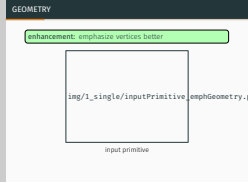
OVERVIEW
./img/1_single/recap_inputToGeom.png

GEOMETRY

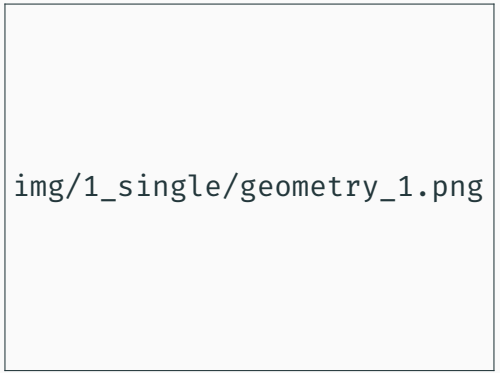
enhancement: emphasize vertices better



input primitive



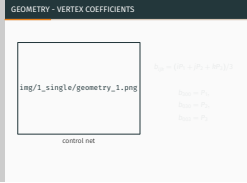
GEOMETRY - VERTEX COEFFICIENTS



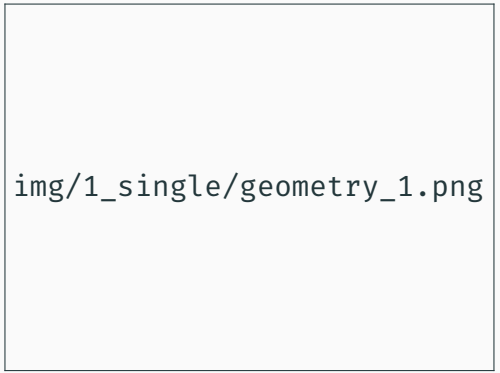
control net

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

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



GEOMETRY - VERTEX COEFFICIENTS



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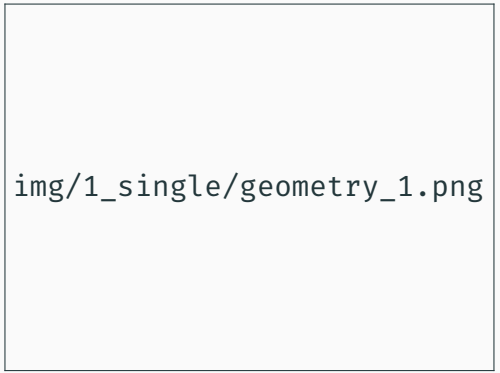
GEOMETRY - VERTEX COEFFICIENTS
img/1_single/geometry_1.png
control net
$b_{ijk} = (iP_1 + jP_2 + kP_3)/3$

GEOMETRY - VERTEX COEFFICIENTS



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$b_{300} = P_1,$
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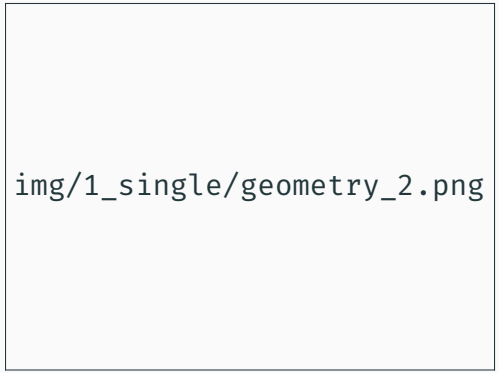
GEOMETRY - TANGENT COEFFICIENTS



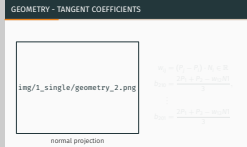
normal projection

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

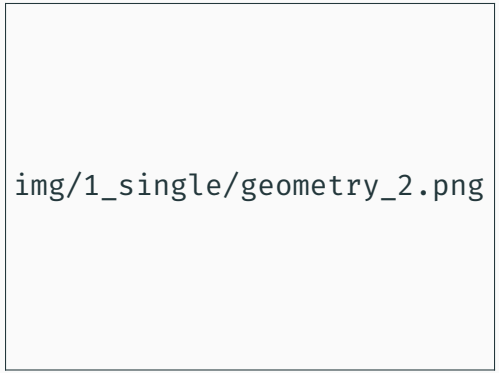
$$b_{210} = \frac{2P_1 + P_2 - w_{12}N1}{3},$$

$$\vdots$$

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



GEOMETRY - TANGENT COEFFICIENTS



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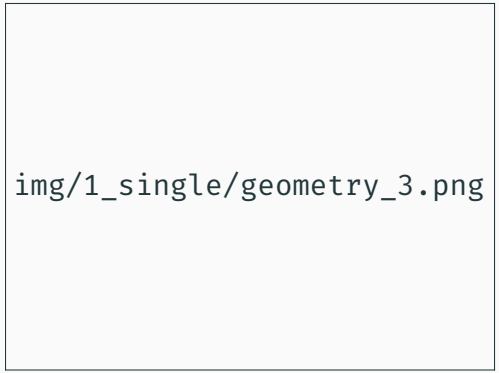
GEOMETRY - TANGENT COEFFICIENTS
img/1_single/geometry_2.png
normal projection
$w_{ij} = (P_j - P_i) \cdot N_i \in \mathbb{R}$
$b_{210} = \frac{2P_1 + P_2 - w_{12}N1}{3},$
$\vdots$
$b_{201} = \frac{2P_1 + P_3 - w_{13}N1}{3}$

GEOMETRY - CENTER COEFFICIENT



center control point

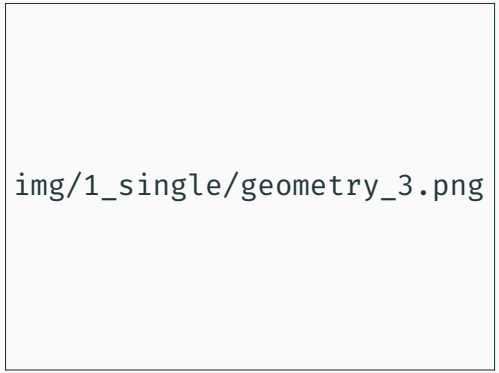
$$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$$

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

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

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

GEOMETRY - CENTER COEFFICIENT



center control point

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GEOMETRY - CENTER COEFFICIENT
img/1_single/geometry_3.png
center control point
$E = (b_{210} + b_{120} + b_{021} + b_{012} + b_{102} + b_{201})/6,$
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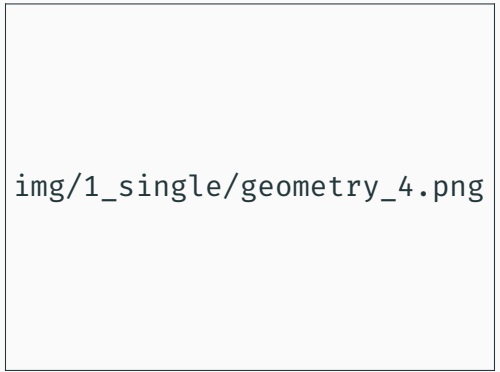
GEOMETRY - RESULT

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

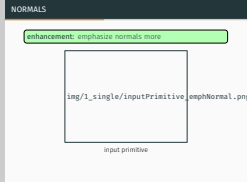
./img/1_single/recap_inputToNormals.png

OVERVIEW
./img/1_single/recap_inputToNormals.png

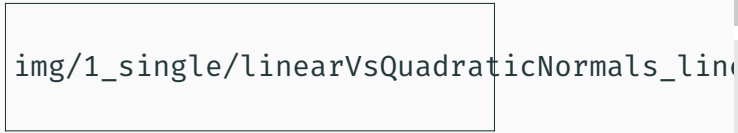
NORMALS

enhancement: emphasize normals more

input primitive



NORMALS - THEORY



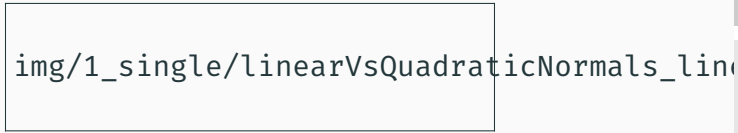
linear

quadratic

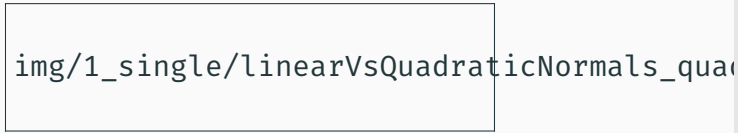
NORMALS - THEORY

linear

NORMALS - THEORY



linear



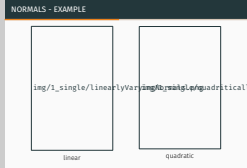
quadratic

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

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

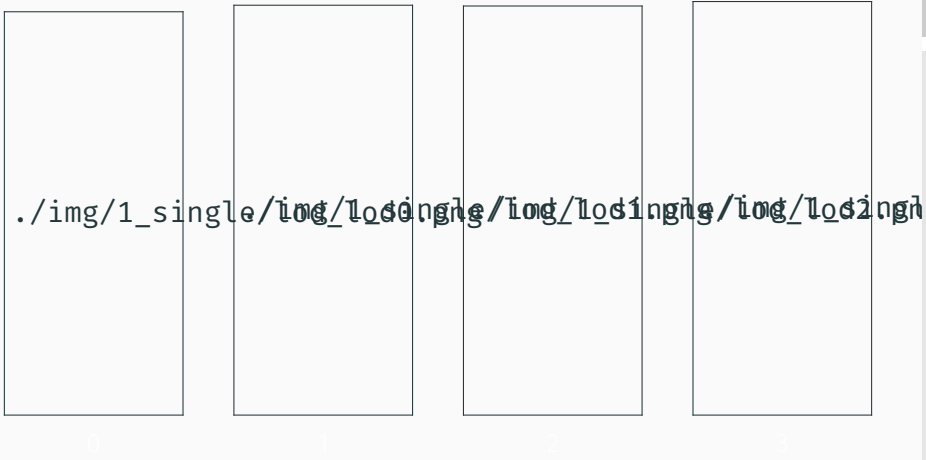
$$n(u,v) = \sum_{i+j+k=2} n_{ijk} u^i v^j w^k$$

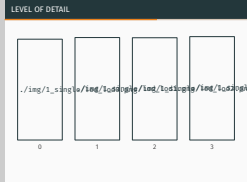
$$= n_{200} w^2 + n_{020} u^2 + n_{002} v^2$$

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

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

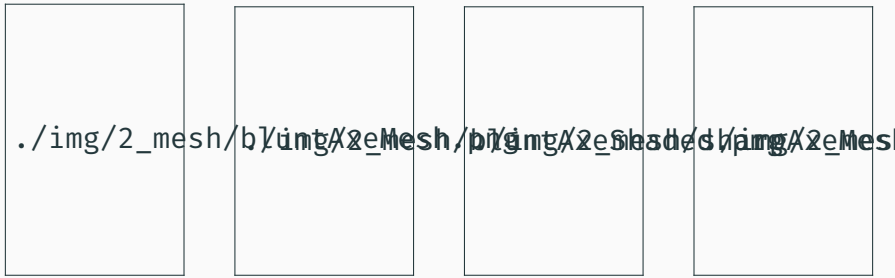
PN triangles have:[2]

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

[2] Jiao and Alexander

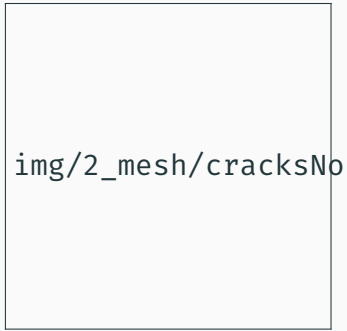
CONTINUITY
PN triangles have:[2]
- C^1 continuity in the vertex points
- C^0 continuity everywhere else
[2] Jiao and Alexander

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 Philip J Alexander. “Parallel feature-preserving mesh smoothing”. In: *Computational Science and Its Applications–ICCSA 2005*. Springer, 2005, pp. 1180–1189.

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