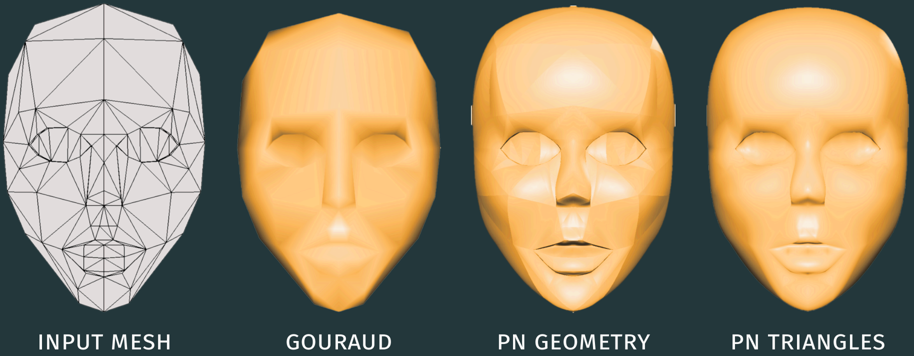
POINT NORMAL TRIANGLES

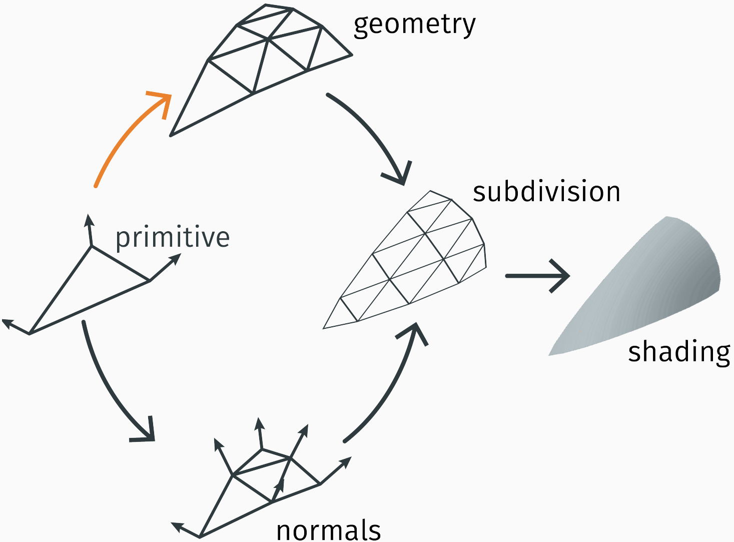
Rick van Veen Laura Baakman

December 14, 2015

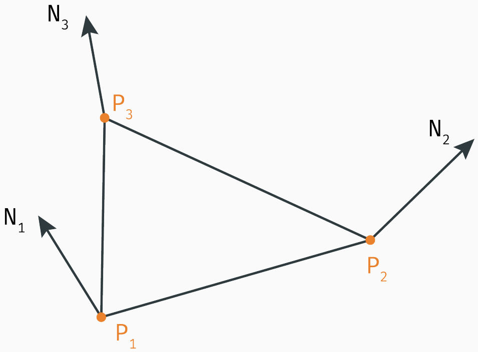
Advanced Computer Graphics


INPUT MESH
GOURAUD
PN GEOMETRY
PN TRIANGLES

SINGLE PN TRIANGLE

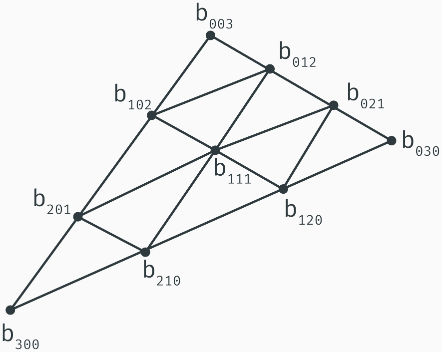

geometry
primitive
subdivision
shading
normals

GEOMETRY



input primitive

GEOMETRY - VERTEX COEFFICIENTS

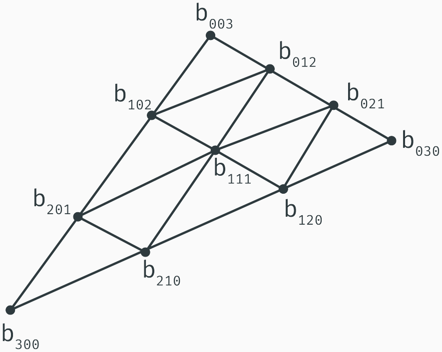


control net

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

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

GEOMETRY - VERTEX COEFFICIENTS



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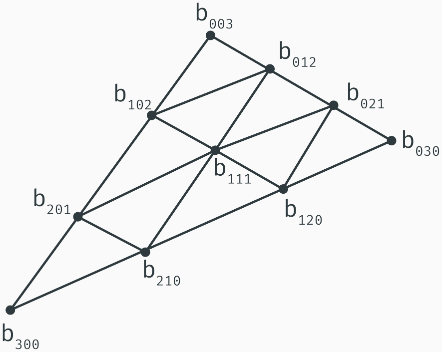

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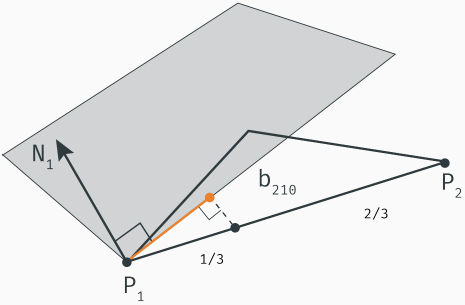
GEOMETRY - TANGENT COEFFICIENTS



normal projection

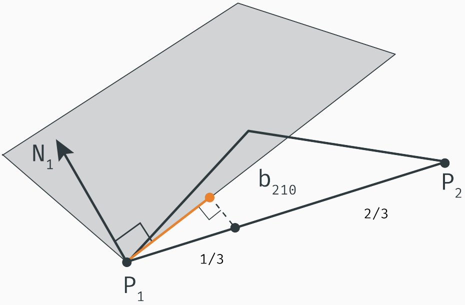
$$w_{ij} = (P_j - P_i) \cdot N_i \in \mathbb{R}$$

$$b_{210} = \frac{2P_1 + P_2 - w_{12}N_1}{3},$$

$$\vdots$$

$$b_{201} = \frac{2P_1 + P_3 - w_{13}N_1}{3}$$

GEOMETRY - TANGENT COEFFICIENTS



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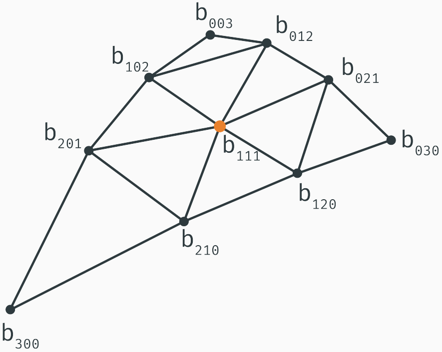
GEOMETRY - CENTER COEFFICIENT



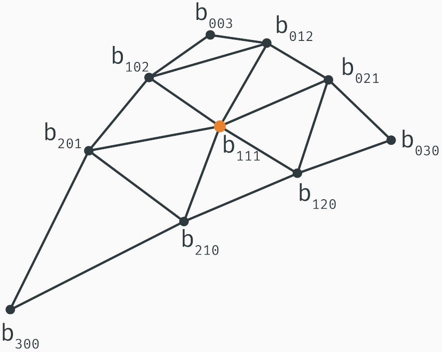
center control point

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

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

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

GEOMETRY - CENTER COEFFICIENT



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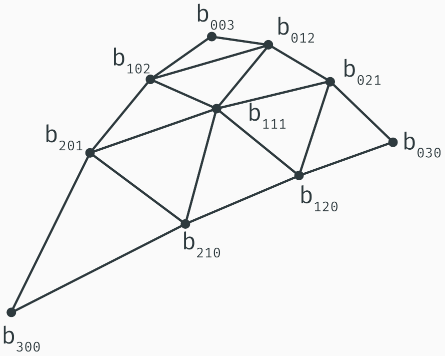
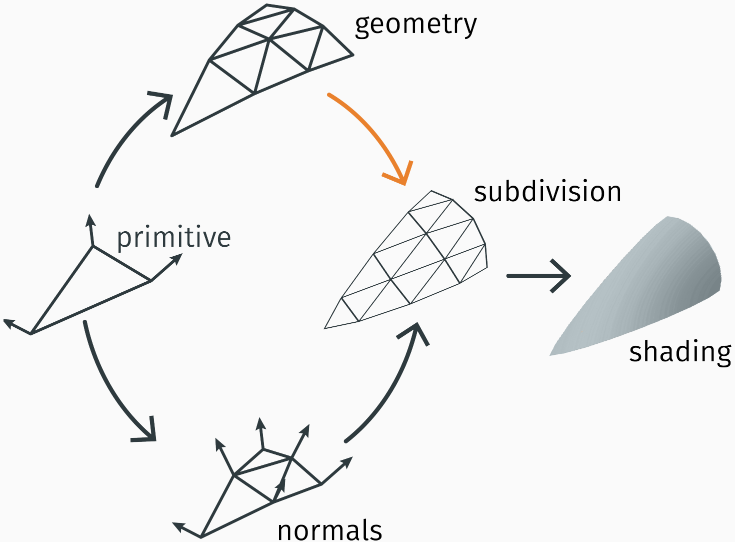
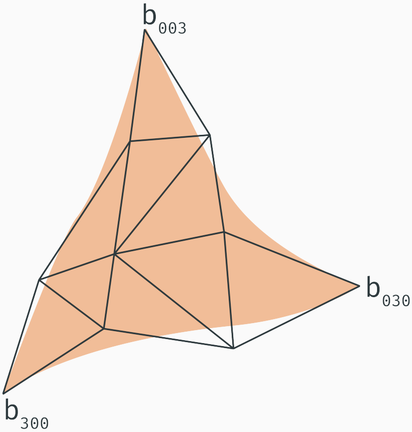
GEOMETRY - RESULT



OVERVIEW



CUBIC BÉZIER PATCH

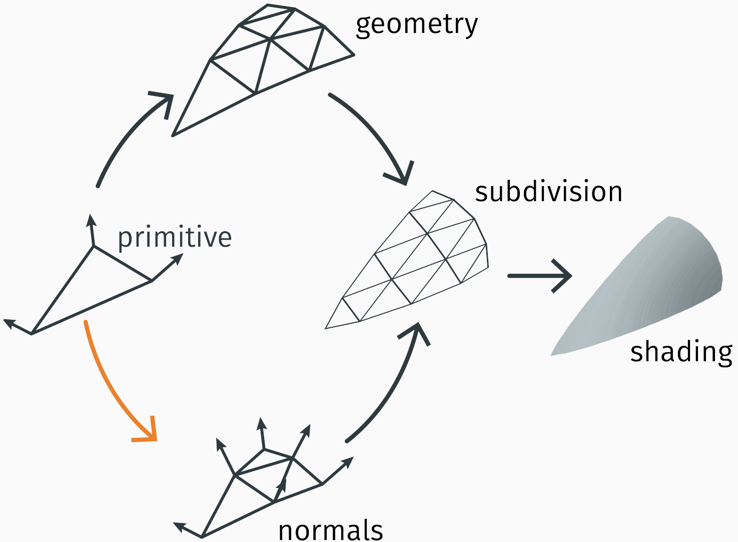


$$w = 1 - u - v$$

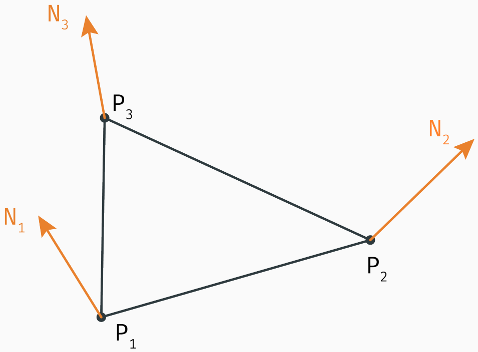
$$u,\ v,\ w \geq 0$$

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

OVERVIEW

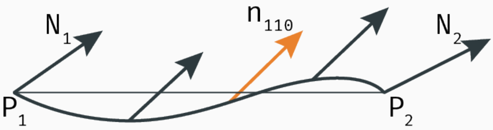


NORMALS



input primitive

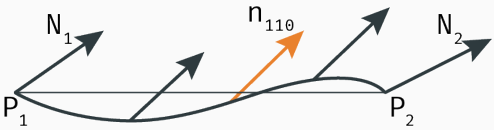
NORMALS - THEORY



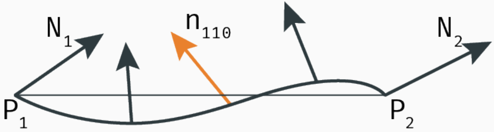
linear

quadratic

NORMALS - THEORY

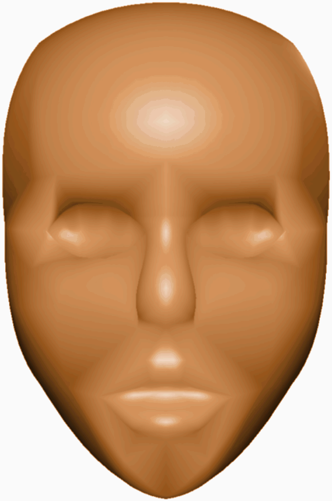


linear



quadratic

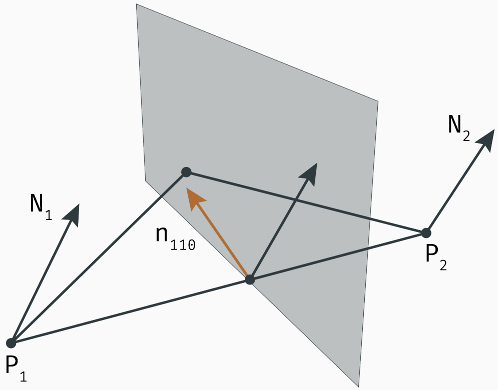
NORMALS - EXAMPLE



linear

quadratic

NORMALS - THEORY

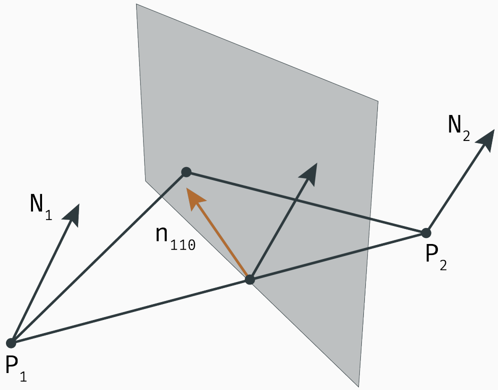


$$v_{ij} = 2\frac{(P_j - P_i) \cdot (N_i + N_j)}{(P_j - P_i) \cdot (P_j - P_i)} \in \mathbb{R}$$

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

$$n_{110} = h_{110}/||h_{110}||$$

NORMALS - THEORY



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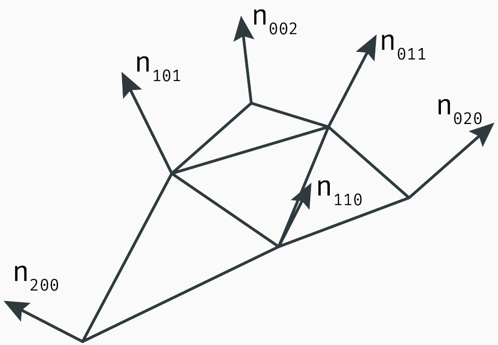
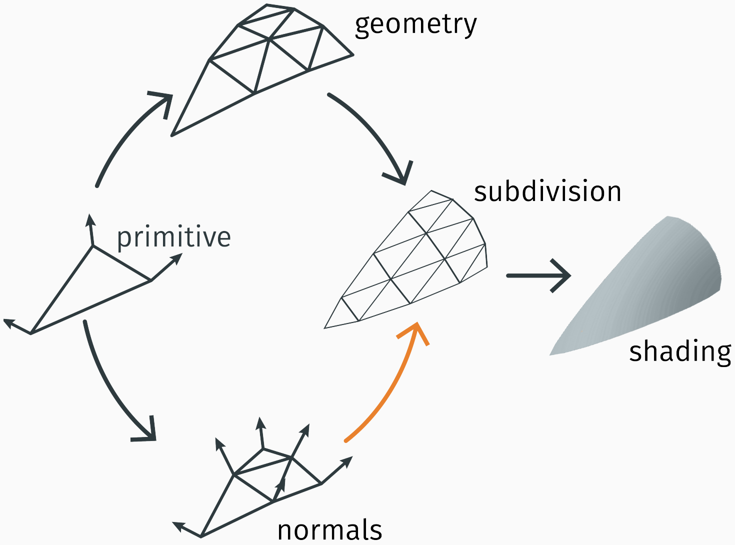
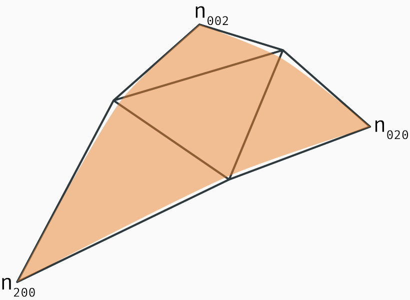
NORMALS - RESULT



OVERVIEW



QUADRATIC PATCH



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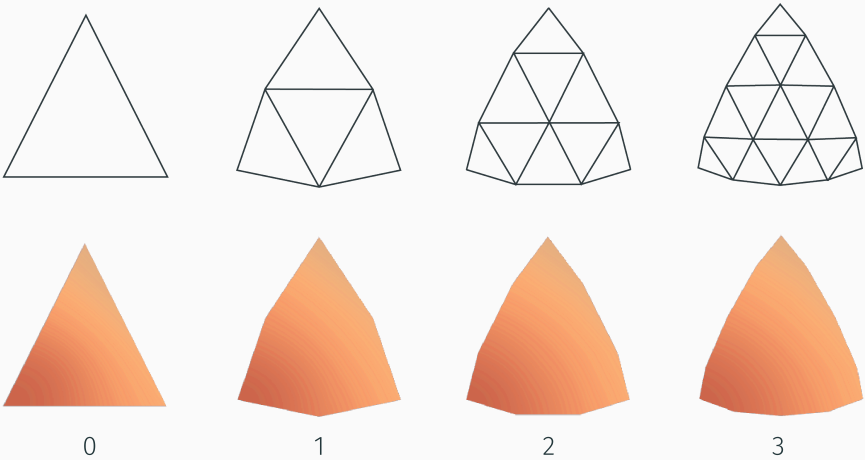
LEVEL OF DETAIL



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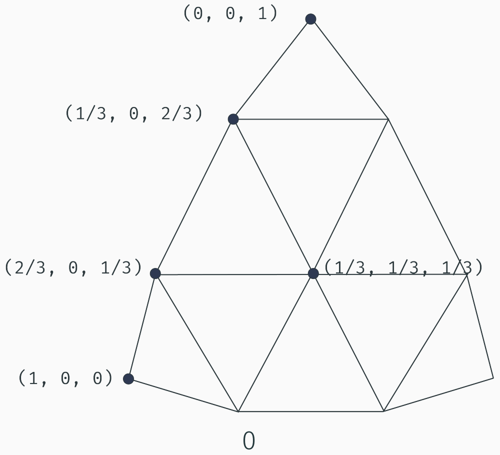
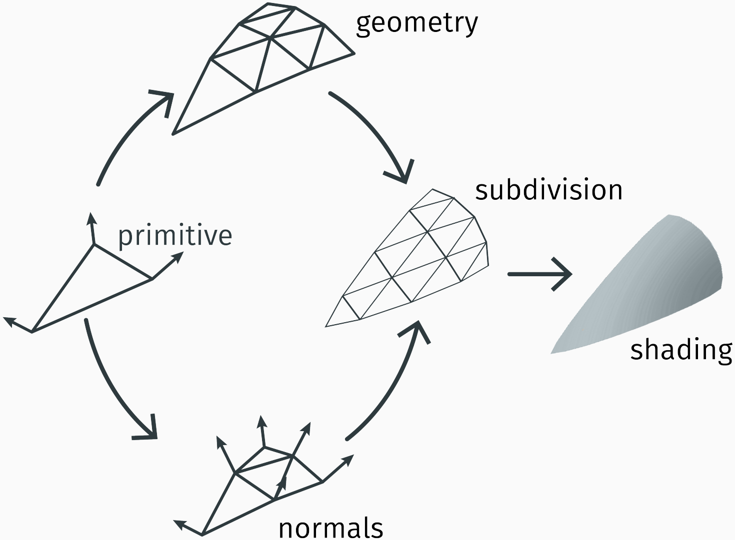


OVERVIEW



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.

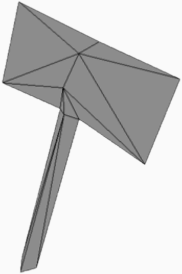
CONTINUITY

PN triangles have:[2]

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

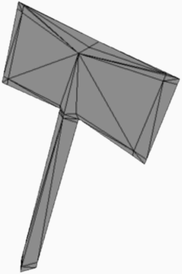
[2] Jiao and Alexander

SHARP EDGES



mesh

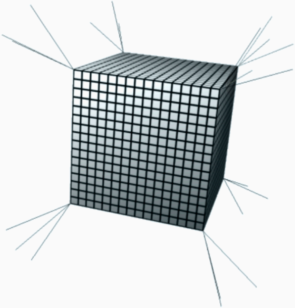
blunt



mesh

sharp

SEPARATE NORMALS



normals

cracks

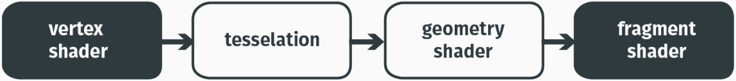
GRAPHICS PIPELINE

2001

2015

HARDWARE - PIPELINES

2001

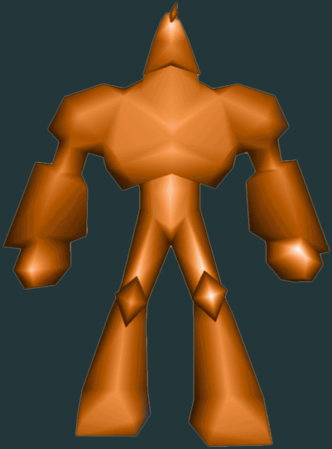


2015

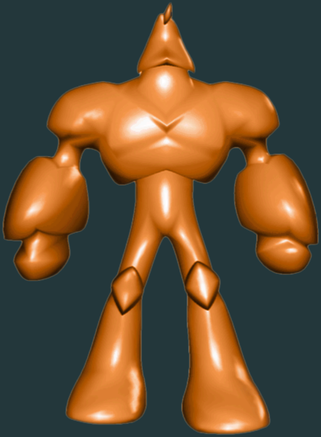
CONCLUSION

CONCLUSION

QUESTIONS?



TRIANGLES



PN TRIANGLES

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

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

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