1. Gooch, Bruce, Peter-Pike J. Sloan, Amy Gooch, Peter Shirley, and Richard Riesenfeld, “In- teractive Technical Illustration,” in *Proceedings of the 1999 Symposium on Interactive 3D Graphics*, ACM, pp. 31–38, 1999. Cited on p. 656, 667
2. Gooch, Bruce or Amy, and Amy or Bruce Gooch, *Non-Photorealistic Rendering*, A K Peters,

Ltd., 2001. Cited on p. 652, 678

1. Good, Otavio, and Zachary Taylor, “Optimized Photon Tracing Using Spherical Harmonic Light Maps,” in *ACM SIGGRAPH 2005 Sketches*, article no. 53, Aug. 2005. Cited on p. 475
2. Goodwin, Todd, Ian Vollick, and Aaron Hertzmann, “Isophote Distance: A Shading Ap- proach to Artistic Stroke Thickness,” *Proceedings of the 5th International Symposium on Non-Photorealistic Animation and Rendering*, ACM, pp. 53–62, Aug. 2007. Cited on p. 657, 667
3. Goral, Cindy M., Kenneth E. Torrance, Donald P. Greenberg, and Bennett Battaile, “Mod- elling the Interaction of Light Between Diﬀuse Surfaces,” *Computer Graphics (SIGGRAPH ’84 Proceedings)*, vol. 18, no. 3, pp. 212–222, July 1984. Cited on p. 442
4. Gortler, Steven J., Radek Grzeszczuk, Richard Szeliski, and Michael F. Cohen, “The Lu- migraph,” in *SIGGRAPH ’96: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 43–54, Aug. 1996. Cited on p. 549
5. Gosselin, David R., Pedro V. Sander, and Jason L. Mitchell, “Real-Time Texture-Space Skin Rendering,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 171–183, 2004. Cited on p. 635
6. Gosselin, David R., “Real Time Skin Rendering,” *Game Developers Conference*, Mar. 2004.

Cited on p. 634, 635

1. Goswami, Prashant, Yanci Zhang, Renato Pajarola, and Enrico Gobbetti, “High Quality Interactive Rendering of Massive Point Models Using Multi-way kd-Trees,” *Pacific Graphics 2010*, Sept. 2010. Cited on p. 574
2. Gotanda, Yoshiharu, “*Star Ocean 4*: Flexible Shader Management and Post-Processing,”

*Game Developers Conference*, Mar. 2009. Cited on p. 286

1. Gotanda, Yoshiharu, “Film Simulation for Videogames,” *SIGGRAPH Color Enhancement and Rendering in Film and Game Production course*, July 2010. Cited on p. 286
2. Gotanda, Yoshiharu, “Beyond a Simple Physically Based Blinn-Phong Model in Real-Time,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2012. Cited on p. 354, 364, 421
3. Gotanda, Yoshiharu, “Designing Reﬂectance Models for New Consoles,” *SIGGRAPH Physi- cally Based Shading in Theory and Practice course*, Aug. 2014. Cited on p. 331, 354, 355
4. Gotanda, Yoshiharu, Masaki Kawase, and Masanori Kakimoto, *SIGGRAPH Real-Time Ren- dering of Physically Based Optical Effect in Theory and Practice course*, Aug. 2015. Cited on p. 543
5. Gottschalk, S., M. C. Lin, and D. Manocha, “OBBTree: A Hierarchical Structure for Rapid Interference Detection,” in *SIGGRAPH ’96: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 171–180, Aug. 1996. Cited on p. 946, 980
6. Gottschalk, Stefan, *Collision Queries Using Oriented Bounding Boxes*, PhD thesis, Depart- ment of Computer Science, University of North Carolina at Chapel Hill, 2000. Cited on p. 947, 951, 980
7. Gouraud, H., “Continuous Shading of Curved Surfaces,” *IEEE Transactions on Computers*, vol. C-20, pp. 623–629, June 1971. Cited on p. 118
8. Green, Chris, “Eﬃcient Self-Shadowed Radiosity Normal Mapping,” *SIGGRAPH Advanced Real-Time Rendering in 3D Graphics and Games course*, Aug. 2007. Cited on p. 403
9. Green, Chris, “Improved Alpha-Tested Magniﬁcation for Vector Textures and Special Eﬀects,”

*SIGGRAPH Advanced Real-Time Rendering in 3D Graphics and Games course*, Aug. 2007.

Cited on p. 206, 677, 678, 890

1. Green, D., and D. Hatch, “Fast Polygon-Cube Intersection Testing,” in Alan Paeth, ed.,

*Graphics Gems V*, Academic Press, pp. 375–379, 1995. Cited on p. 974

1. Green, Paul, Jan Kautz, and Fr´edo Durand, “Eﬃcient Reﬂectance and Visibility Approxima- tions for Environment Map Rendering,” *Computer Graphics Forum*, vol. 26, no. 3, pp. 495– 502, 2007. Cited on p. 398, 417, 424, 466, 471
2. Green, Robin, “Spherical Harmonic Lighting: The Gritty Details,” *Game Developers Confer- ence*, Mar. 2003. Cited on p. 401, 430
3. Green, Simon, “Stupid OpenGL Shader Tricks,” *Game Developers Conference*, Mar. 2003.

Cited on p. 537, 539, 540

1. Green, Simon, “Summed Area Tables Using Graphics Hardware,” *Game Developers Confer- ence*, Mar. 2003. Cited on p. 188
2. Green, Simon, “Real-Time Approximations to Subsurface Scattering,” in Randima Fernando, ed., *GPU Gems*, Addison-Wesley, pp. 263–278, 2004. Cited on p. 633, 635, 638, 639
3. Green, Simon, “Implementing Improved Perlin Noise,” in Matt Pharr, ed., *GPU Gems 2*,

Addison-Wesley, pp. 409–416, 2005. Cited on p. 199

1. Green, Simon, “DirectX 10/11 Visual Eﬀects,” *Game Developers Conference*, Mar. 2009.

Cited on p. 518

1. Green, Simon, “Screen Space Fluid Rendering for Games,” *Game Developers Conference*,

Mar. 2010. Cited on p. 520, 569

1. Greene, Ned, “Environment Mapping and Other Applications of World Projections,” *IEEE Computer Graphics and Applications*, vol. 6, no. 11, pp. 21–29, Nov. 1986. Cited on p. 410, 414, 424
2. Greene, Ned, Michael Kass, and Gavin Miller, “Hierarchical Z-Buﬀer Visibility,” in *SIG- GRAPH ’93: Proceedings of the 20th Annual Conference on Computer Graphics and Inter- active Techniques*, ACM, pp. 231–238, Aug. 1993. Cited on p. 846, 847, 1015
3. Greene, Ned, “Detecting Intersection of a Rectangular Solid and a Convex Polyhedron,” in Paul S. Heckbert, ed., *Graphics Gems IV*, Academic Press, pp. 74–82, 1994. Cited on p. 946
4. Greene, Ned, *Hierarchical Rendering of Complex Environments*, PhD thesis, Technical Report UCSC-CRL-95-27, University of California at Santa Cruz, June 1995. Cited on p. 846, 847
5. Greger, Gene, Peter Shirley, Philip M. Hubbard, and Donald P. Greenberg, “The Irradiance Volume,” *IEEE Computer Graphics and Applications*, vol. 18, no. 2, pp. 32–43, Mar./Apr. 1998. Cited on p. 487
6. Gregorius, Dirk, “The Separating Axis Test between Convex Polyhedra,” *Game Developers Conference*, Mar. 2013. Cited on p. 987
7. Gregorius, Dirk, “Implementing QuickHull,” *Game Developers Conference*, Mar. 2014. Cited on p. 950, 951
8. Gregorius, Dirk, “Robust Contact Creation for Physics Simulations,” *Game Developers Con- ference*, Mar. 2015. Cited on p. 947
9. Grenier, Jean-Philippe, “Physically Based Lens Flare,” *Autodesk Stingray* blog, July 3, 2017.

Cited on p. 524, 526

1. Grenier, Jean-Philippe, “Notes on Screen Space HIZ Tracing,” *Autodesk Stingray* blog, Aug. 14, 2017. Cited on p. 508
2. Gribb, Gil, and Klaus Hartmann, “Fast Extraction of Viewing Frustum Planes from the World-View-Projection Matrix,” *gamedevs.org*, June 2001. Cited on p. 984
3. Griﬃn, Wesley, and Marc Olano, “Objective Image Quality Assessment of Texture Compres- sion,” in *Proceedings of the 18th Meeting of the ACM SIGGRAPH Symposium on Interactive* [*3*](#_bookmark0)*D Graphics and Games*, ACM, pp. 119–126, Mar. 1999. Cited on p. 198
4. Griﬃths, Andrew, “Real-Time Cellular Texturing,” in Wolfgang Engel, ed., *ShaderX*5, Charles River Media, pp. 519–532, 2006. Cited on p. 199
5. Grimes, Bronwen, “Shading a Bigger, Better Sequel: Techniques in *Left 4 Dead 2*,” *Game Developers Conference*, Mar. 2010. Cited on p. 366
6. Grimes, Bronwen, “Building the Content that Drives the *Counter-Strike: Global Offensive*

Economy,” *Game Developers Conference*, Mar. 2014. Cited on p. 366

1. Gritz, Larry, “Shader Antialiasing,” in *Advanced RenderMan: Creating CGI for Motion Pic- tures*, Morgan Kaufmann, [Chapter 11](#_bookmark0), 1999. Also (as “Basic Antialiasing in Shading Lan- guage”) in *SIGGRAPH Advanced RenderMan: Beyond the Companion course*, Aug. 1999.

Cited on p. 200

1. Gritz, Larry, “The Secret Life of Lights and Surfaces,” *SIGGRAPH Advanced RenderMan 2: To RI INFINITY and Beyond course*, July 2000. Also in “Illumination Models and Light,” in *Advanced RenderMan: Creating CGI for Motion Pictures*, Morgan Kaufmann, 1999. Cited on p. 382
2. Gritz, Larry, and Eugene d’Eon, “The Importance of Being Linear,” in Hubert Nguyen, ed.,

*GPU Gems 3*, Addison-Wesley, pp. 529–542, 2007. Cited on p. 161, 166, 184

1. Gritz, Larry, ed., “Open Shading Language 1.9: Language Speciﬁcation,” Sony Pictures Im- ageworks Inc., 2017. Cited on p. 37
2. Gronsky, Stefan, “Lighting Food,” *SIGGRAPH Anyone Can Cook—Inside Ratatouille’s Kitchen course*, Aug. 2007. Cited on p. 638
3. Gruen, Holger, “Hybrid Min/Max Plane-Based Shadow Maps,” in Wolfgang Engel, ed., *GPU Pro*, A K Peters, Ltd., pp. 447–454, 2010. Cited on p. 252
4. Gruen, Holger, and Nicolas Thibieroz, “OIT and Indirect Illumination Using Dx11 Linked Lists,” *Game Developers Conference*, Mar. 2010. Cited on p. 155
5. Gruen, Holger, “An Optimized Diﬀusion Depth Of Field Solver (DDOF),” *Game Developers Conference*, Mar. 2011. Cited on p. 535
6. Gruen, Holger, “Constant Buﬀers without Constant Pain,” *NVIDIA GameWorks* blog, Jan.

14, 2015. Cited on p. 795

1. Gru¨n, Holger, “Smoothed N-Patches,” in Wolfgang Engel, ed., *ShaderX*5, Charles River Me- dia, pp. 5–22, 2006. Cited on p. 747
2. Gru¨n, Holger, “Implementing a Fast DDOF Solver,” Eric Lengyel, ed., *Game Engine Gems 2*, A K Peters, Ltd., pp. 119–133, 2011. Cited on p. 535
3. Gu, Xianfeng, Steven J. Gortler, and Hugues Hoppe, “Geometry Images,” *ACM Transactions on Graphics (SIGGRAPH 2002)*, vol. 21, no. 3, pp. 355–361, 2002. Cited on p. 566
4. Guennebaud, Ga¨el, Lo¨ıc Barthe, and Mathias Paulin, “High-Quality Adaptive Soft Shadow Mapping,” *Computer Graphics Forum*, vol. 26, no. 3, pp. 525–533, 2007. Cited on p. 252
5. Guenter, B., J. Rapp, and M. Finch, “Symbolic Diﬀerentiation in GPU Shaders,” Technical Report MSR-TR-2011-31, Microsoft, Mar. 2011. Cited on p. 1017
6. Guenter, Brian, Mark Finch, Steven Drucker, Desney Tan, and John Snyder, “Foveated 3D Graphics,” *ACM Transactions on Graphics*, vol. 31, no. 6, article no. 164, 2012. Cited on p. 924, 931
7. Guerrette, Keith, “Moving The Heavens,” *Game Developers Conference*, Mar. 2014. Cited on p. 617
8. Guertin, Jean-Philippe, Morgan McGuire, and Derek Nowrouzezahrai, “A Fast and Stable Feature-Aware Motion Blur Filter,” Technical Report, NVIDIA, Nov. 2013. Cited on p. 537, 542, 543
9. Guigue, Philippe, and Olivier Devillers, “Fast and Robust Triangle-Triangle Overlap Test Using Orientation Predicates,” *journals of graphics tools*, vol. 8, no. 1, pp. 25–42, 2003. Cited on p. 972, 974
10. Gulbrandsen, Ole, “Artist Friendly Metallic Fresnel,” *Journal of Computer Graphics Tech- niques*, vol. 3, no. 4, pp. 64–72, 2014. Cited on p. 320
11. Guymon, Mel, “Pyro-Techniques: Playing with Fire,” *Game Developer*, vol. 7, no. 2, pp. 23– 27, Feb. 2000. Cited on p. 554
12. Haar, Ulrich, and Sebastian Aaltonen, “GPU-Driven Rendering Pipelines,” *SIGGRAPH Ad- vances in Real-Time Rendering in Games course*, Aug. 2015. Cited on p. 246, 247, 263, 833,

848, 849, 850, 851, 905

1. Habel, Ralf, Bogdan Mustata, and Michael Wimmer, “Eﬃcient Spherical Harmonics Light- ing with the Preetham Skylight Model,” in *Eurographics 2008—Short Papers*, Eurographics Association, pp. 119–122, 2008. Cited on p. 430
2. Habel, Ralf, and Michael Wimmer, “Eﬃcient Irradiance Normal Mapping,” in *Proceedings of the 2010 ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 189–195, Feb. 2010. Cited on p. 404, 475
3. Hable, John, “*Uncharted 2*: HDR Lighting,” *Game Developers Conference*, Mar. 2010. Cited on p. 286, 288
4. Hable, John, “Why Reinhard Desaturates Your Blacks,” *Filmic Worlds Blog*, May 17, 2010.

Cited on p. 288

1. Hable, John, “Why a Filmic Curve Saturates Your Blacks,” *Filmic Worlds Blog*, May 24, 2010. Cited on p. 288
2. Hable, John, “*Uncharted 2*: Character Lighting and Shading,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, July 2010. Cited on p. 357, 635
3. Hable, John, “Next-Gen Characters: From Facial Scans to Facial Animation,” *Game Devel- opers Conference*, Mar. 2014. Cited on p. 466
4. Hable, John, “Simple and Fast Spherical Harmonic Rotation,” *Filmic Worlds Blog*, July 2, 2014. Cited on p. 401
5. Hable, John, “Filmic Tonemapping with Piecewise Power Curves,” *Filmic Worlds Blog*, Mar.

26, 2017. Cited on p. 286

1. Hable, John, “Minimal Color Grading Tools,” *Filmic Worlds Blog*, Mar. 28, 2017. Cited on p. 290
2. Hadwiger, Markus, Christian Sigg, Henning Scharsach, Khatja Bu¨hler, and Markus Gross, “Real-Time Ray-Casting and Advanced Shading of Discrete Isosurfaces,” *Computer Graphics Forum*, vol. 20, no. 3, pp. 303–312, 2005. Cited on p. 583
3. Haeberli, P., and K. Akeley, “The Accumulation Buﬀer: Hardware Support for High-Quality Rendering,” *Computer Graphics (SIGGRAPH ’90 Proceedings)*, vol. 24, no. 4, pp. 309–318,

Aug. 1990. Cited on p. 139, 529, 537, 547

1. Haeberli, Paul, and Mark Segal, “Texture Mapping as a Fundamental Drawing Primitive,” in *4th Eurographics Workshop on Rendering*, Eurographics Association, pp. 259–266, June 1993. Cited on p. 200
2. Hagen, Margaret A., “How to Make a Visually Realistic 3D Display,” *Computer Graphics*, vol. 25, no. 2, pp. 76–81, Apr. 1991. Cited on p. 554
3. Haines, Eric, “Essential Ray Tracing Algorithms,” in Andrew Glassner, ed., *An Introduction to Ray Tracing*, Academic Press Inc., [Chapter 2](#_bookmark0), 1989. Cited on p. 955, 959, 961, 969
4. Haines, Eric, “Fast Ray-Convex Polyhedron Intersection,” in James Arvo, ed., *Graphics Gems II*, Academic Press, pp. 247–250, 1991. Cited on p. 961
5. Haines, Eric, “Point in Polygon Strategies,” in Paul S. Heckbert, ed., *Graphics Gems IV*,

Academic Press, pp. 24–46, 1994. Cited on p. 962, 966, 968, 969, 970

1. Haines, Eric, and Steven Worley, “Fast, Low-Memory Z-Buﬀering when Performing Medium-

Quality Rendering,” *journal of graphics tools*, vol. 1, no. 3, pp. 1–6, 1996. Cited on p. 803

1. Haines, Eric, “Soft Planar Shadows Using Plateaus,” *journal of graphics tools*, vol. 6, no. 1, pp. 19–27, 2001. Also collected in [[112](#_bookmark0)]. Cited on p. 229
2. Haines, Eric, “Interactive 3D Graphics,” *Udacity Course 291*, launched May 2013. Cited on p. 1048
3. Haines, Eric, “60 Hz, 120 Hz, 240 Hz...,” *Real-Time Rendering Blog*, Nov. 5, 2014. Cited on

p. 1011

1. Haines, Eric, “Limits of Triangles,” *Real-Time Rendering Blog*, Nov. 10, 2014. Cited on p. 688, 695
2. Haines, Eric, “GPUs Prefer Premultiplication,” *Real-Time Rendering Blog*, Jan. 10, 2016.

Cited on p. 160, 208

1. Haines, Eric, “A PNG Puzzle,” *Real-Time Rendering Blog*, Feb. 19, 2016. Cited on p. 160
2. Haines, Eric, “Minecon 2016 Report,” *Real-Time Rendering Blog*, Sept. 30, 2016. Cited on p. 920
3. Hakura, Ziyad S., and Anoop Gupta, “The Design and Analysis of a Cache Architecture for Texture Mapping,” in *Proceedings of the 24th Annual International Symposium on Computer Architecture*, ACM, pp. 108–120, June 1997. Cited on p. 997, 1007, 1017
4. Hall, Chris, Rob Hall, and Dave Edwards, “Rendering in *Cars 2*,” *SIGGRAPH Advances in Real-Time Rendering in 3D Graphics and Games course*, Aug. 2011. Cited on p. 245, 246, 937
5. Hall, Roy, *Illumination and Color in Computer Generated Imagery*, Springer-Verlag, 1989.

Cited on p. 1010

1. Hall, Tim, “A How To for Using OpenGL to Render Mirrors,” *comp.graphics.api.opengl* news- group, Aug. 1996. Cited on p. 505
2. Halstead, Mark, Michal Kass, and Tony DeRose, “Eﬃcient, Fair Interpolation Using Catmull- Clark Surfaces,” in *SIGGRAPH ’93: Proceedings of the 20th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 35–44, Aug. 1993. Cited on p. 762, 763, 778
3. Hamilton, Andrew, and Kenneth Brown, “Photogrammetry and *Star Wars Battlefront*,”

*Game Developers Conference*, Mar. 2016. Cited on p. 366

1. Hammon, Earl, Jr., “PBR Diﬀuse Lighting for GGX+Smith Microsurfaces,” *Game Developers Conference*, Feb.–Mar. 2017. Cited on p. 331, 334, 337, 342, 355
2. Han, Charles, Bo Sun, Ravi Ramamoorthi, and Eitan Grinspun, “Frequency Domain Normal Map Filtering,” *ACM Transactions on Graphics (SIGGRAPH 2007)*, vol. 26, no. 3, pp. 28:1– 28::11, July 2007. Cited on p. 369, 370
3. Han, S., and P. Sander, “Triangle Reordering for Reduced Overdraw in Animated Scenes,” in *Proceedings of the 20th ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 23–27, 2016. Cited on p. 831
4. Hanika, Johannes, “Manuka: Weta Digital’s Spectral Renderer,” *SIGGRAPH Path Tracing in Production course*, Aug. 2017. Cited on p. 278, 280, 311, 591
5. Hanrahan, P., and P. Haeberli, “Direct WYSIWYG Painting and Texturing on 3D Shapes,”

*Computer Graphics (SIGGRAPH ’90 Proceedings)*, vol. 24, no. 4, pp. 215–223, Aug. 1990.

Cited on p. 942

1. Hanrahan, Pat, and Wolfgang Krueger, “Reﬂection from Layered Surfaces due to Subsurface Scattering,” in *SIGGRAPH ’93: Proceedings of the 20th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 165–174, Aug. 1993. Cited on p. 353, 354
2. Hanson, Andrew J., *Visualizing Quaternions*, Morgan Kaufmann, 2006. Cited on p. 102
3. Hapke, B., “A Theoretical Photometric Function for the Lunar Surface,” *Journal of Geophys- ical Research*, vol. 68, no. 15, pp. 4571–4586, Aug. 1, 1963. Cited on p. 314
4. Harada, T., J. McKee, and J. Yang, “Forward+: Bringing Deferred Lighting to the Next Level,” in *Eurographics 2012—Short Papers*, Eurographics Association, pp. 5–8, May 2012.

Cited on p. 895

1. Harada, T., “A 2.5D culling for Forward+,” in *SIGGRAPH Asia 2012 Technical Briefs*, ACM, pp. 18:1–18:4, Dec. 2012. Cited on p. 897
2. Harada, Takahiro, Jay McKee, and Jason C. Yang, “Forward+: A Step Toward Film-Style Shading in Real Time,” in Wolfgang Engel, ed., *GPU Pro*4, CRC Press, pp. 115–135, 2013.

Cited on p. 887, 895, 896, 897, 904

1. Hargreaves, Shawn, “Deferred Shading,” *Game Developers Conference*, Mar. 2004. Cited on p. 882, 884, 886
2. Hargreaves, Shawn, and Mark Harris, “Deferred Shading,” *NVIDIA Developers Conference*,

June 29, 2004. Cited on p. 882, 884

1. Harris, Mark J., and Anselmo Lastra, “Real-Time Cloud Rendering,” *Computer Graphics Forum*, vol. 20, no. 3, pp. 76–84, 2001. Cited on p. 556, 617
2. Hart, Evan, Dave Gosselin, and John Isidoro, “Vertex Shading with Direct3D and OpenGL,”

*Game Developers Conference*, Mar. 2001. Cited on p. 659

1. Hart, Evan, “UHD Color for Games,” NVIDIA White Paper, June 2016. Cited on p. 161, 165, 278, 281, 283, 287, 290
2. Hart, J. C., D. J. Sandin, and L. H. Kauﬀman, “Ray Tracing Deterministic 3-D Fractals,”

*Computer Graphics (SIGGRAPH ’89 Proceedings)*, vol. 23, no. 3, pp. 289–296, 1989. Cited

on p. 752

1. Hart, John C., George K. Francis, and Louis H. Kauﬀman, “Visualizing Quaternion Rotation,”

*ACM Transactions on Graphics*, vol. 13, no. 3, pp. 256–276, 1994. Cited on p. 102

1. Hasenfratz, Jean-Marc, Marc Lapierre, Nicolas Holzschuch, and Franc¸ois Sillion, “A Survey of Real-Time Soft Shadows Algorithms,” *Computer Graphics Forum*, vol. 22, no. 4, pp. 753–774, 2003. Cited on p. 265
2. Hasselgren, J., T. Akenine-M¨oller, and L. Ohlsson, “Conservative Rasterization,” in Matt Pharr, ed., *GPU Gems 2*, Addison-Wesley, pp. 677–690, 2005. Cited on p. 1001
3. Hasselgren, J., T. Akenine-M¨oller, and S. Laine, “A Family of Inexpensive Sampling Schemes,”

*Computer Graphics Forum*, vol. 24, no. 4, pp. 843–848, 2005. Cited on p. 146

1. Hasselgren, J., and T. Akenine-M¨oller, “An Eﬃcient Multi-View Rasterization Architecture,” in *Proceedings of the 17th Eurographics Conference on Rendering Techniques*, Eurographics Association, pp. 61–72, June 2006. Cited on p. 928
2. Hasselgren, J., and T. Akenine-M¨oller, “Eﬃcient Depth Buﬀer Compression,” in *Graphics Hardware 2006*, Eurographics Association, pp. 103–110, Sept. 2006. Cited on p. 997, 1009,

1016

1. Hasselgren, J., and T. Akenine-M¨oller, “PCU: The Programmable Culling Unit,” *ACM Trans- actions on Graphics*, vol. 26, no. 3, pp. 92.1–91.20, 2007. Cited on p. 252
2. Hasselgren, J., M. Andersson, J. Nilsson, and T. Akenine-M¨oller, “A Compressed Depth Cache,” *Journal of Computer Graphics Techniques*, vol. 1, no. 1, pp. 101–118, 2012. Cited on p. 1009
3. Hasselgren, Jon, Jacob Munkberg, and Karthik Vaidyanathan, “Practical Layered Recon- struction for Defocus and Motion Blur,” *Journal of Computer Graphics Techniques*, vol. 4, no. 2, pp. 45–58, 2012. Cited on p. 542
4. Hasselgren, J., M. Andersson, and T. Akenine-M¨oller, “Masked Software Occlusion Culling,”

*High-Performance Graphics*, June 2016. Cited on p. 849, 850

1. Hast, Anders, “3D Stereoscopic Rendering: An Overview of Implementation Issues,” in Eric Lengyel, ed., *Game Engine Gems*, Jones & Bartlett, pp. 123–138, 2010. Cited on p. 927, 932, 934
2. Hathaway, Benjamin, “Alpha Blending as a Post-Process,” in Wolfgang Engel, ed., *GPU Pro*,

A K Peters, Ltd., pp. 167–184, 2010. Cited on p. 208

1. He, Xiao D., Kenneth E. Torrance, Fran¸cois X. Sillion, and Donald P. Greenberg, “A Com- prehensive Physical Model for Light Reﬂection,” *Computer Graphics (SIGGRAPH ’91 Pro- ceedings)*, vol. 25, no. 4, pp. 175–186, July 1991. Cited on p. 361, 424
2. He, Y., Y. Gu, and K. Fatahalian, “Extending the Graphics Pipeline with Adaptive, Multi- rate Shading,” *ACM Transactions on Graphics*, vol. 33, no. 4, pp. 142:1–142:12, 2014. Cited on p. 1013
3. He, Y., T. Foley, N. Tatarchuk, and K. Fatahalian, “A System for Rapid, Automatic Shader Level-of-Detail,” *ACM Transactions on Graphics*, vol. 34, no. 6, pp. 187:1–187:12, 2015. Cited

on p. 853

1. Hearn, Donald, and M. Pauline Baker, *Computer Graphics with OpenGL*, Fourth Edition,

Prentice-Hall, Inc., 2010. Cited on p. 102

1. Heckbert, Paul, “Survey of Texture Mapping,” *IEEE Computer Graphics and Applications*, vol. 6, no. 11, pp. 56–67, Nov. 1986. Cited on p. 222
2. Heckbert, Paul S., “Fundamentals of Texture Mapping and Image Warping,” Technical Report 516, Computer Science Division, University of California, Berkeley, June 1989. Cited on p. 187, 189, 222, 688
3. Heckbert, Paul S., “What Are the Coordinates of a Pixel?” in Andrew S. Glassner, ed.,

*Graphics Gems*, Academic Press, pp. 246–248, 1990. Cited on p. 176

1. Heckbert, Paul S., “Adaptive Radiosity Textures for Bidirectional Ray Tracing,” *Computer Graphics (SIGGRAPH ’90 Proceedings)*, vol. 24, no. 4, pp. 145–154, Aug. 1990. Cited on

p. 439

1. Heckbert, Paul S., and Henry P. Moreton, “Interpolation for Polygon Texture Mapping and Shading,” *State of the Art in Computer Graphics: Visualization and Modeling*, Springer-

Verlag, pp. 101–111, 1991. Cited on p. 22, 999

1. Heckbert, Paul S., ed., *Graphics Gems IV*, Academic Press, 1994. Cited on p. 102, 991
2. Heckbert, Paul S., “A Minimal Ray Tracer,” in Paul S. Heckbert, ed., *Graphics Gems IV*,

Academic Press, pp. 375–381, 1994. Cited on p. 444

1. Heckbert, Paul S., and Michael Herf, “Simulating Soft Shadows with Graphics Hardware,”

Technical Report CMU-CS-97-104, Carnegie Mellon University, Jan. 1997. Cited on p. 228

1. Hecker, Chris, “More Compiler Results, and What To Do About It,” *Game Developer*, pp. 14– 21, Aug./Sept. 1996. Cited on p. 793
2. Hector, Tobias, “Vulkan: High Eﬃciency on Mobile,” *Imagination Blog*, Nov. 5, 2015. Cited on p. 40, 794, 814
3. Hegeman, Kyle, Nathan A. Carr, and Gavin S. P. Miller, “Particle-Based Fluid Simulation on the GPU,” in *Computational Science—ICCS 2006*, Springer, pp. 228–235, 2006. Cited on p. 571
4. Heidmann, Tim, “Real Shadows, Real Time,” *Iris Universe*, no. 18, pp. 23–31, Nov. 1991.

Cited on p. 230, 231

1. Heidrich, Wolfgang, and Hans-Peter Seidel, “View-Independent Environment Maps,” in *Pro- ceedings of the ACM SIGGRAPH/EUROGRAPHICS Workshop on Graphics Hardware*,

ACM, pp. 39–45, Aug. 1998. Cited on p. 413

1. Heidrich, Wolfgang, Ru¨difer Westermann, Hans-Peter Seidel, and Thomas Ertl, “Applications of Pixel Textures in Visualization and Realistic Image Synthesis,” in *Proceedings of the 1999 Symposium on Interactive 3D Graphics*, ACM, pp. 127–134, Apr. 1999. Cited on p. 538
2. Heidrich, Wolfgang, and Hans-Peter Seidel, “Realistic, Hardware-Accelerated Shading and Lighting,” in *SIGGRAPH ’99: Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 171– 178, Aug. 1999. Cited on p. 413, 417, 426
3. Heidrich, Wolfgang, Katja Daubert, Jan Kautz, and Hans-Peter Seidel, “Illuminating Micro Geometry Based on Precomputed Visibility,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-

Wesley Publishing Co., pp. 455–464, July 2000. Cited on p. 466

1. Heitz, Eric, and Fabrice Neyret, “Representing Appearance and Pre-ﬁltering Subpixel Data in Sparse Voxel Octrees,” in *Proceedings of the Fourth ACM SIGGRAPH / Eurographics Con- ference on High-Performance Graphics*, Eurographics Association, pp. 125–134, June 2012.

Cited on p. 579, 585, 586

1. Heitz, Eric, Christophe Bourlier, and Nicolas Pinel, “Correlation Eﬀect between Transmitter and Receiver Azimuthal Directions on the Illumination Function from a Random Rough Sur- face,” *Waves in Random and Complex Media*, vol. 23, no. 3, pp. 318–335, 2013. Cited on p. 336
2. Heitz, Eric, “Understanding the Masking-Shadowing Function in Microfacet-Based BRDFs,”

*Journal of Computer Graphics Techniques*, vol. 3, no. 4, pp. 48–107, 2014. Cited on p. 332,

333, 334, 335, 336, 337, 339, 344

1. Heitz, Eric, and Jonathan Dupuy, “Implementing a Simple Anisotropic Rough Diﬀuse Material with Stochastic Evaluation,” Technical Report, 2015. Cited on p. 331
2. Heitz, Eric, Jonathan Dupuy, Cyril Crassin, and Carsten Dachsbacher, “The SGGX Microﬂake Distribution,” *ACM Transactions on Graphics (SIGGRAPH 2015)*, vol. 34, no. 4, pp. 48:1–

48:11, Aug. 2015. Cited on p. 648, 649

1. Heitz, Eric, Jonathan Dupuy, Stephen Hill, and David Neubelt, “Real-Time Polygonal-Light Shading with Linearly Transformed Cosines,” *ACM Transactions on Graphics (SIGGRAPH 2016)*, vol. 35, no. 4, pp. 41:1–41:8, July 2016. Cited on p. 390
2. Heitz, Eric, Johannes Hanika, Eugene d’Eon, and Carsten Dachsbacher, “Multiple-Scattering Microfacet BSDFs with the Smith Model,” *ACM Transactions on Graphics (SIGGRAPH 2016)*, vol. 35, no. 4, pp. 58:1–58:8, July 2016. Cited on p. 346
3. Held, Martin, “ERIT—A Collection of Eﬃcient and Reliable Intersection Tests,” *journal of graphics tools*, vol. 2, no. 4, pp. 25–44, 1997. Cited on p. 959, 974
4. Held, Martin, “FIST: Fast Industrial-Strength Triangulation of Polygons,” *Algorithmica*, vol. 30, no. 4, pp. 563–596, 2001. Cited on p. 685
5. Hennessy, John L., and David A. Patterson, *Computer Architecture: A Quantitative Ap- proach*, Fifth Edition, Morgan Kaufmann, 2011. Cited on p. 12, 30, 783, 789, 867, 1007,

1040

1. Hennessy, Padraic, “Implementation Notes: Physically Based Lens Flares,” *Placeholder Art*

blog, Jan. 19, 2015. Cited on p. 526

1. Hennessy, Padraic, “Mixed Resolution Rendering in *Skylanders: SuperChargers*,” *Game De- velopers Conference*, Mar. 2016. Cited on p. 520
2. Hensley, Justin, and Thorsten Scheuermann, “Dynamic Glossy Environment Reﬂections Using Summed-Area Tables,” in Wolfgang Engel, ed., *ShaderX*4, Charles River Media, pp. 187–200, 2005. Cited on p. 188, 419
3. Hensley, Justin, Thorsten Scheuermann, Greg Coombe, Montek Singh, and Anselmo Lastra, “Fast Summed-Area Table Generation and Its Applications,” *Computer Graphics Forum*, vol. 24, no. 3, pp. 547–555, 2005. Cited on p. 188, 419
4. Hensley, Justin, “Shiny, Blurry Things,” *SIGGRAPH Beyond Programmable Shading course*,

Aug. 2009. Cited on p. 419

1. Henyey, L. G., and J. L. Greenstein, “Diﬀuse Radiation in the Galaxy,” in *Astrophysical Journal*, vol. 93, pp. 70–83, 1941. Cited on p. 598
2. Herf, M., and P. S. Heckbert, “Fast Soft Shadows,” in *ACM SIGGRAPH ’96 Visual Proceed- ings*, ACM, p. 145, Aug. 1996. Cited on p. 228
3. Hermosilla, Pedro, and Pere-Pau V´azquez, “NPR Eﬀects Using the Geometry Shader,” in Wolfgang Engel, ed., *GPU Pro*, A K Peters, Ltd., pp. 149–165, 2010. Cited on p. 668
4. Herrell, Russ, Joe Baldwin, and Chris Wilcox, “High-Quality Polygon Edging,” *IEEE Com- puter Graphics and Applications*, vol. 15, no. 4, pp. 68–74, July 1995. Cited on p. 673
5. Hertzmann, Aaron, “Introduction to 3D Non-Photorealistic Rendering: Silhouettes and Out- lines,” *SIGGRAPH Non-Photorealistic Rendering course*, Aug. 1999. Cited on p. 663, 667
6. Hertzmann, Aaron, and Denis Zorin, “Illustrating Smooth Surfaces,” in *SIGGRAPH ’00: Pro- ceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*,

ACM Press/Addison-Wesley Publishing Co., pp. 517–526, July 2000. Cited on p. 667, 672

1. Hertzmann, Aaron, “A Survey of Stroke-Based Rendering,” *IEEE Computer Graphics and Applications*, vol. 23, no. 4, pp. 70–81, July/Aug. 2003. Cited on p. 678
2. Hertzmann, Aaron, “Non-Photorealistic Rendering and the Science of Art,” in *Proceedings of the 8th International Symposium on Non-Photorealistic Animation and Rendering*, ACM, pp. 147–157, 2010. Cited on p. 678
3. Hery, Christophe, “On Shadow Buﬀers,” *Stupid RenderMan/RAT Tricks*, SIGGRAPH 2002 RenderMan Users Group meeting, July 2002. Cited on p. 638
4. Hery, Christophe, “Implementing a Skin BSSRDF (or Several),” *SIGGRAPH RenderMan,*

*Theory and Practice course*, July 2003. Cited on p. 638

1. Hery, Christophe, Michael Kass, and Junyi Ling, “Geometry into Shading,” Technical memo,

Pixar Animation Studios, 2014. Cited on p. 370

1. Hery, Christophe, and Junyi Ling, “Pixar’s Foundation for Materials: PxrSurface and Pxr- MarschnerHair,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2017. Cited on p. 321, 343, 359, 363, 364, 370
2. Herzog, Robert, Elmar Eisemann, Karol Myszkowski, and H.-P. Seidel, “Spatio-Temporal Upsampling on the GPU,” in *Proceedings of the 2010 ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 91–98, 2010. Cited on p. 520
3. Hicks, Odell, “A Simulation of Thermal Imaging,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 169–170, 2004. Cited on p. 521
4. Hill, F. S., Jr., “The Pleasures of ‘Perp Dot’ Products,” in Paul S. Heckbert, ed., *Graphics Gems IV*, Academic Press, pp. 138–148, 1994. Cited on p. 6, 987
5. Hill, Steve, “A Simple Fast Memory Allocator,” in David Kirk, ed., *Graphics Gems III*,

Academic Press, pp. 49–50, 1992. Cited on p. 793

1. Hill, Stephen, “Rendering with Conviction,” *Game Developers Conference*, Mar. 2010. Cited on p. 452, 457
2. Hill, Stephen, and Daniel Collin, “Practical, Dynamic Visibility for Games,” in Wolfgang Engel, ed., *GPU Pro*2, A K Peters/CRC Press, pp. 329–348, 2011. Cited on p. 848
3. Hill, Stephen, “Specular Showdown in the Wild West,” *Self-Shadow* blog, July 22, 2011. Cited on p. 370
4. Hill, Stephen, and Dan Baker, “Rock-Solid Shading: Image Stability Without Sacriﬁcing Detail,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2012. Cited on p. 371
5. Hillaire, S´ebastien, “Improving Performance by Reducing Calls to the Driver,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 353–363, 2012. Cited on p. 795, 796, 797
6. Hillaire, S´ebastien, “Physically-Based and Uniﬁed Volumetric Rendering in Frostbite,” *SIG- GRAPH Advances in Real-Time Rendering course*, Aug. 2015. Cited on p. 570, 610, 611, 612, 613
7. Hillaire, S´ebastien, “Physically Based Sky, Atmosphere and Cloud Rendering in Frostbite,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, July 2016. Cited on p. 589, 596, 599, 602, 610, 614, 615, 616, 617, 620, 621, 622, 623, 649
8. Hillaire, S´ebastien, “Volumetric Stanford Bunny,” *Shadertoy*, Mar. 25, 2017. Cited on p. 594
9. Hillaire, S´ebastien, “Real-Time Raytracing for Interactive Global Illumination Workﬂows in Frostbite,” *Game Developers Conference*, Mar. 2018. Cited on p. 1044
10. Hillesland, Karl, “Real-Time Ptex and Vector Displacement,” in Wolfgang Engel, ed., *GPU Pro*4, CRC Press, pp. 69–80, 2013. Cited on p. 191
11. Hillesland, K. E., and J. C. Yang, “Texel Shading,” in *Eurographics 2016—Short Papers*,

Eurographics Association, pp. 73–76, May 2016. Cited on p. 911

1. Hillesland, Karl, “Texel Shading,” *GPUOpen* website, July 21, 2016. Cited on p. 911
2. Hinsinger, D., F. Neyret, and M.-P. Cani, “Interactive Animation of Ocean Waves,” in *Pro- ceedings of the 2002 ACM SIGGRAPH/Eurographics Symposium on Computer Animation*,

ACM, pp. 161–166, 2002. Cited on p. 878

1. Hirche, Johannes, Alexander Ehlert, Stefan Guthe, and Michael Doggett, “Hardware Ac- celerated Per-Pixel Displacement Mapping,” in *Graphics Interface 2004*, Canadian Human-

Computer Communications Society, pp. 153–158, 2004. Cited on p. 220

1. Hoberock, Jared, and Yuntao Jia, “High-Quality Ambient Occlusion,” in Hubert Nguyen, ed.,

*GPU Gems 3*, Addison-Wesley, pp. 257–274, 2007. Cited on p. 454

1. Hoetzlein, Rama, “GVDB: Raytracing Sparse Voxel Database Structures on the GPU,” *High Performance Graphics*, June 2016. Cited on p. 578, 582, 586
2. Hoetzlein, Rama, “NVIDIA R GVDB Voxels: Programming Guide,” NVIDIA website, May 2017. Cited on p. 578, 580, 582

Ⓧ

1. Hoﬀman, Donald D., *Visual Intelligence*, W. W. Norton & Company, 2000. Cited on p. 150
2. Hoﬀman, Naty, and Kenny Mitchell, “Photorealistic Terrain Lighting in Real Time,” *Game Developer*, vol. 8, no. 7, pp. 32–41, July 2001. More detailed version in “Real-Time Photore- alistic Terrain Lighting,” *Game Developers Conference*, Mar. 2001. Also collected in [1786]. Cited on p. 451
3. Hoﬀman, Naty, “Color Enhancement for Videogames,” *SIGGRAPH Color Enhancement and Rendering in Film and Game Production course*, July 2010. Cited on p. 289, 290
4. Hoﬀman, Naty, “Outside the Echo Chamber: Learning from Other Disciplines, Industries, and Art Forms,” Opening keynote of *Symposium on Interactive 3D Graphics and Games*,

Mar. 2013. Cited on p. 284, 289

1. Hoﬀman, Naty, “Background: Physics and Math of Shading,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, July 2013. Cited on p. 315
2. Holbert, Daniel, “Normal Oﬀset Shadows,” *Dissident Logic* blog, Aug. 27, 2010. Cited on p. 238
3. Holbert, Daniel, “Saying ‘Goodbye’ to Shadow Acne,” *Game Developers Conference poster*,

Mar. 2011. Cited on p. 238

1. Hollemeersch, C.-F., B. Pieters, P. Lambert, and R. Van de Walle, “Accelerating Virtual Texturing Using CUDA,” in Wolfgang Engel, ed., *GPU Pro*, A K Peters, Ltd., pp. 623–642, 2010. Cited on p. 868
2. Holzschuch, Nicolas, and Romain Pacanowski, “Identifying Diﬀraction Eﬀects in Measured Reﬂectances,” *Eurographics Workshop on Material Appearance Modeling*, June 2015. Cited on p. 361
3. Holzschuch, Nicolas, and Romain Pacanowski, “A Two-Scale Microfacet Reﬂectance Model Combining Reﬂection and Diﬀraction,” *ACM Transactions on Graphics (SIGGRAPH 2017)*, vol. 36, no. 4, pp. 66:1–66:12, July 2017. Cited on p. 331, 343, 361
4. Hoobler, Nathan, “High Performance Post-Processing,” *Game Developers Conference*, Mar.

2011. Cited on p. 54, 536

1. Hoobler, Nathan, “Fast, Flexible, Physically-Based Volumetric Light Scattering,” *Game De- velopers Conference*, Mar. 2016. Cited on p. 608
2. Hooker, JT, “Volumetric Global Illumination at Treyarch,” *SIGGRAPH Advances in Real-*

*Time Rendering in Games course*, July 2016. Cited on p. 395, 478, 488, 489

1. Hoppe, H., T. DeRose, T. Duchamp, M. Halstead, H. Jin, J. McDonald, J. Schweitzer, and

W. Stuetzle, “Piecewise Smooth Surface Reconstruction,” in *SIGGRAPH ’94: Proceedings of the 21st Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 295–302, July 1994. Cited on p. 758, 760, 763

1. Hoppe, Hugues, “Progressive Meshes,” in *SIGGRAPH ’96: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 99–108, Aug. 1996.

Cited on p. 706, 707, 710, 859

1. Hoppe, Hugues, “View-Dependent Reﬁnement of Progressive Meshes,” in *SIGGRAPH ’97: Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Tech- niques*, ACM Press/Addison-Wesley Publishing Co., pp. 189–198, Aug. 1997. Cited on p. 772
2. Hoppe, Hugues, “Eﬃcient Implementation of Progressive Meshes,” *Computers and Graphics*, vol. 22, no. 1, pp. 27–36, 1998. Cited on p. 707, 710
3. Hoppe, Hugues, “Optimization of Mesh Locality for Transparent Vertex Caching,” in *SIG- GRAPH ’99: Proceedings of the 26th Annual Conference on Computer Graphics and Interac- tive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 269–276, Aug. 1999. Cited on p. 700
4. Hoppe, Hugues, “New Quadric Metric for Simplifying Meshes with Appearance Attributes,” in *Proceedings of Visualization ’99*, IEEE Computer Society, pp. 59–66, Oct. 1999. Cited on p. 709
5. Hormann, K., and M. Floater, ‘Mean Value Coordinates for Arbitrary Planar Polygons,” *ACM Transactions on Graphics*, vol. 25, no. 4, pp. 1424–1441, Oct. 2006. Cited on p. 970
6. Hormann, Kai, Bruno L´evy, and Alla Sheﬀer, *SIGGRAPH Mesh Parameterization: Theory and Practice course*, Aug. 2007. Cited on p. 173
7. Hornus, Samuel, Jared Hoberock, Sylvain Lefebvre, and John Hart, “*ZP+*: Correct *Z-Pass* Stencil Shadows,” in *Proceedings of the 2005 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 195–202, Apr. 2005. Cited on p. 232
8. Horvath, Helmuth, “Gustav Mie and the Scattering and Absorption of Light by Particles: His- toric Developments and Basics,” *Journal of Quantitative Spectroscopy and Radiative Transfer*, vol. 110, no. 11, pp. 787–799, 2009. Cited on p. 597
9. Hoschek, Josef, and Dieter Lasser, *Fundamentals of Computer Aided Geometric Design*, A K Peters, Ltd., 1993. Cited on p. 718, 721, 725, 732, 734, 738, 742, 749, 754, 781
10. Hosek, Lukas, and Alexander Wilkie, “An Analytic Model for Full Spectral Sky-Dome Radi- ance,” *ACM Transaction on Graphics*, vol. 31, no. 4, pp. 1–9, July 2012. Cited on p. 614
11. Hu, Jinhui, Suya You, and Ulrich Neumann, “Approaches to Large-Scale Urban Modeling,” *IEEE Computer Graphics and Applications*, vol. 23, no. 6, pp. 62–69, Nov./Dec. 2003. Cited on p. 573
12. Hu, L., P. Sander, and H. Hoppe, “Parallel View-Dependent Level-of-Detail Control,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 16, no. 5, pp. 718–728, 2010.

Cited on p. 475, 859

1. Hu, Liwen, Chongyang Ma, Linjie Luo, and Hao Li, “Single-View Hair Modeling Using a Hairstyle Database,” *ACM Transaction on Graphics*, vol. 34, no. 4, pp. 1–9, July 2015. Cited on p. 645
2. Hubbard, Philip M., “Approximating Polyhedra with Spheres for Time-Critical Collision De- tection,” *ACM Transactions on Graphics*, vol. 15, no. 3, pp. 179–210, 1996. Cited on p. 976
3. Hughes, James, Reza Nourai, and Ed Hutchins, “Understanding, Measuring, and Analyzing VR Graphics Performance,” in Wolfgang Engel, ed., *GPU Zen*, Black Cat Publishing, pp. 253– 274, 2017. Cited on p. 785, 815, 937, 938, 940
4. Hughes, John F., and Tomas M¨oller, “Building an Orthonormal Basis from a Unit Vector,”

*journal of graphics tools*, vol. 4, no. 4, pp. 33–35, 1999. Also collected in [112]. Cited on p. 75,

552

1. Hughes, John F., Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven

K. Feiner, and Kurt Akeley, *Computer Graphics: Principles and Practice*, Third Edition,

Addison-Wesley, 2013. Cited on p. 102, 278

1. Hullin, Matthias, Elmar Eisemann, Hans-Peter Seidel, and Sungkil Lee, “Physically-Based Real-Time Lens Flare Rendering,” *ACM Transactions on Graphics (SIGGRAPH 2011)*, vol. 30, no. 4, pp. 108:1–108:10, July 2011. Cited on p. 524, 526
2. Humphreys, Greg, Mike Houston, Ren Ng, Randall Frank, Sean Ahern, Peter D. Kirchner, and James t. Klosowski, “Chromium: A Stream-Processing Framework for Interactive Rendering on Clusters,” *ACM Transactions on Graphics*, vol. 21, no. 3, pp. 693–702, July 2002. Cited on p. 1020
3. Hunt, R. W. G., *The Reproduction of Colour*, Sixth Edition, John Wiley & Sons, Inc., 2004.

Cited on p. 291

1. Hunt, R. W. G., and M. R. Pointer, *Measuring Colour*, Fourth Edition, John Wiley & Sons,

Inc., 2011. Cited on p. 276, 291

1. Hunt, Warren, “Real-Time Ray-Casting for Virtual Reality,” Hot 3D Session, *High-*

*Performance Graphics*, July 2017. Cited on p. 939

1. Hunter, Biver, and Paul Fuqua, *Light Science and Magic: An Introduction to Photographic Lighting*, Fourth Edition, Focal Press, 2011. Cited on p. 435
2. Hurlburt, Stephanie, “Improving Texture Compression in Games,” *Game Developers Confer- ence AMD Capsaicin & Cream Developer Sessions*, Feb. 2017. Cited on p. 870
3. Hwu, Wen-Mei, and David Kirk, “Programming Massively Parallel Processors,” Course ECE 498 AL1 Notes, Department of Electrical and Computer Engineering, University of Illinois,

Fall 2007. Cited on p. 1040

1. Igehy, Homan, Matthew Eldridge, and Kekoa Proudfoot, “Prefetching in a Texture Cache Ar- chitecture,” in *Proceedings of the ACM SIGGRAPH/EUROGRAPHICS Workshop on Graph- ics Hardware*, ACM, pp. 133–142, Aug. 1998. Cited on p. 1017
2. Igehy, Homan, Matthew Eldridge, and Pat Hanrahan, “Parallel Texture Caching,” in *Proceed- ings of the ACM SIGGRAPH/EUROGRAPHICS Workshop on Graphics Hardware*, ACM, pp. 95–106, Aug. 1999. Cited on p. 1017
3. Iglesias-Guitian, Jose A., Bochang Moon, Charalampos Koniaris, Eric Smolikowski, and Kenny Mitchell, “Pixel History Linear Models for Real-Time Temporal Filtering,” *Computer Graphics Forum (Pacific Graphics 2016)*, vol. 35, no. 7, pp. 363–372, 2016. Cited on p. 143
4. Ikits, Milan, Joe Kniss, Aaron Lefohn, and Charles Hansen, “Volume Rendering Techniques,” in Randima Fernando, ed., *GPU Gems*, Addison-Wesley, pp. 667–692, 2004. Cited on p. 605, 607
5. Iourcha, Konstantine, and Jason C. Yang, “A Directionally Adaptive Edge Anti-Aliasing Filter,” in *Proceedings of the Conference on High-Performance Graphics 2009*, ACM, pp. 127– 133, Aug. 2009. Cited on p. 147
6. Isenberg, Tobias, Bert Freudenberg, Nick Halper, Stefan Schlechtweg, and Thomas Strothotte, “A Developer’s Guide to Silhouette Algorithms for Polygonal Models,” *IEEE Computer Graphics and Applications*, vol. 23, no. 4, pp. 28–37, July/Aug. 2003. Cited on p. 678
7. Isenberg, M., and P. Alliez, “Compressing Polygon Mesh Geometry with Parallelogram Pre- diction,” in *Proceedings of the Conference on Visualization ’02*, IEEE Computer Society, pp. 141–146, 2002. Cited on p. 92
8. Isensee, Pete, “C++ Optimization Strategies and Techniques,” *Pete Isensee* website, 2007.

Cited on p. 815

1. Isidoro, John, Alex Vlachos, and Chris Brennan, “Rendering Ocean Water,” in Wolfgang En- gel, ed., *Direct3D ShaderX: Vertex & Pixel Shader Tips and Techniques*, Wordware, pp. 347– 356, May 2002. Cited on p. 43
2. Isidoro, John, “Next Generation Skin Rendering,” *Game Tech Conference*, 2004. Cited on p. 635
3. Isidoro, John, “Shadow Mapping: GPU-Based Tips and Techniques,” *Game Developers Con- ference*, Mar. 2006. Cited on p. 250
4. Iwanicki, Micha-l, “Normal Mapping with Low-Frequency Precomputed Visibility,” in *SIG-*

*GRAPH 2009 Talks*, ACM, article no. 52, Aug. 2009. Cited on p. 466, 471

1. Iwanicki, Micha-l, “Lighting Technology of *The Last of Us*,” in *ACM SIGGRAPH 2013 Talks*,

ACM, article no. 20, July 2013. Cited on p. 229, 289, 467, 476, 486, 498

1. Iwanicki, Micha-l, and Angelo Pesce, “Approximate Models for Physically Based Rendering,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2015. Cited on p. 386, 387, 422, 424, 502
2. Iwanicki, Michal-, and Peter-Pike Sloan, “Ambient Dice,” *Eurographics Symposium on Rendering—Experimental Ideas & Implementations*, June 2017. Cited on p. 395, 478, 488
3. Iwanicki, Micha-l, and Peter-Pike Sloan, “Precomputed Lighting in *Call of Duty: Infinite Warfare*,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2017. Cited on p. 402, 471, 476, 490, 491
4. Jakob, Wenzel, Miloˇs Haˇsan, Ling-Qi Yan, Jason Lawrence, Ravi Ramamoorthi, and Steve Marschner, “Discrete Stochastic Microfacet Models,” *ACM Transactions on Graphics (SIG-*

*GRAPH 2014)*, vol. 33, no. 4, pp. 115:1–115:9, July 2014. Cited on p. 372

1. Jakob, Wenzel, Eugene d’Eon, Otto Jakob, and Steve Marschner, “A Comprehensive Frame- work for Rendering Layered Materials,” *ACM Transactions on Graphics (SIGGRAPH 2014)*, vol. 33, no. 4, pp. 118:1–118:14, July 2014. Cited on p. 346, 364
2. Jakob, Wenzel, “layerlab: A Computational Toolbox for Layered Materials,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2015. Cited on p. 364
3. James, Doug L., and Christopher D. Twigg, “Skinning Mesh Animations,” *ACM Transactions on Graphics*, vol. 23, no. 3, pp. 399–407, Aug. 2004. Cited on p. 85
4. James, Greg, “Operations for Hardware Accelerated Procedural Texture Animation,” in Mark DeLoura, ed., *Game Programming Gems 2*, Charles River Media, pp. 497–509, 2001. Cited on p. 521
5. James, Greg, and John O’Rorke, “Real-Time Glow,” in Randima Fernando, ed., *GPU Gems*,

Addison-Wesley, pp. 343–362, 2004. Cited on p. 517, 518, 527

1. Jansen, Jon, and Louis Bavoil, “Fast Rendering of Opacity-Mapped Particles Using DirectX 11 Tessellation and Mixed Resolutions,” NVIDIA White Paper, Feb. 2011. Cited on p. 520, 569, 570, 571, 609, 612
2. Jarosz, Wojciech, “Fast Image Convolutions,” SIGGRAPH Workshop at University of Illinois at Urbana-Champaign, 2001. Cited on p. 518
3. Jarosz, Wojciech, *Efficient Monte Carlo Methods for Light Transport in Scattering Media*,

PhD Thesis, University of California, San Diego, Sept. 2008. Cited on p. 589

1. Jarosz, Wojciech, Nathan A. Carr, and Henrik Wann Jensen, “Importance Sampling Spherical Harmonics,” *Computer Graphics Forum*, vol. 28, no. 2, pp. 577–586, 2009. Cited on p. 419
2. Jendersie, Johannes, David Kuri, and Thorsten Grosch, “Precomputed Illuminance Com- position for Real-Time Global Illumination,” in *Proceedings of the 20th ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 129–137, 2016. Cited on p. 483
3. Jensen, Henrik Wann, Justin Legakis, and Julie Dorsey, “Rendering of Wet Materials,” in

*Rendering Techniques ’99*, Springer, pp. 273–282, June 1999. Cited on p. 349

1. Jensen, Henrik Wann, *Realistic Image Synthesis Using Photon Mapping*, A K Peters, Ltd., 2001. Cited on p. 630
2. Jensen, Henrik Wann, Stephen R. Marschner, Marc Levoy, and Pat Hanrahan, “A Practical Model for Subsurface Light Transport,” in *SIGGRAPH ’01 Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 511–518, Aug. 2001.

Cited on p. 634, 638

1. Jeschke, Stefan, Stephan Mantler, and Michael Wimmer, “Interactive Smooth and Curved Shell Mapping,” in *Rendering Techniques*, Eurographics Association, pp. 351–360, June 2007.

Cited on p. 220

1. Jiang, Yibing, “The Process of Creating Volumetric-Based Materials in *Uncharted 4*,” *SIG- GRAPH Advances in Real-Time Rendering in Games course*, July 2016. Cited on p. 356, 357, 358, 359
2. Jim´enez, J. J., F. R. Feito, and R. J. Segura, “Robust and Optimized Algorithms for the Point-in-Polygon Inclusion Test without Pre-processing,” *Computer Graphics Forum*, vol. 28, no. 8, pp. 2264–2274, 2009. Cited on p. 970
3. Jim´enez, J. J., David Whelan, Veronica Sundstedt, and Diego Gutierrez, “Real-Time Realistic Skin Translucency,” *Computer Graphics and Applications*, vol. 30, no. 4, pp. 32–41, 2010. Cited on p. 637
4. Jimenez, Jorge, Belen Masia, Jose I. Echevarria, Fernando Navarro, and Diego Gutierrez, “Practical Morphological Antialiasing,” in Wolfgang Engel, ed., *GPU Pro*2, A K Peters/CRC Press, pp. 95–113, 2011. Cited on p. 148
5. Jimenez, Jorge, Diego Gutierrez, et al., *SIGGRAPH Filtering Approaches for Real-Time Anti-Aliasing course*, Aug. 2011. Cited on p. 147, 165
6. Jimenez, Jorge, Jose I. Echevarria, Tiago Sousa, and Diego Gutierrez, “SMAA: Enhanced Subpixel Morphological Antialiasing,” *Computer Graphics Forum*, vol. 31, no. 2, pp. 355– 364, 2012. Cited on p. 146, 148
7. Jimenez, Jorge, “Next Generation Character Rendering,” *Game Developers Conference*, Mar.

2013. Cited on p. 636, 637

1. Jimenez, Jorge, “Next Generation Post Processing in *Call of Duty Advanced Warfare*,” *SIG- GRAPH Advances in Real-Time Rendering in Games course*, Aug. 2014. Cited on p. 251, 527, 534, 535, 537, 540, 542, 543
2. Jimenez, Jorge, Karoly Zsolnai, Adrian Jarabo, Christian Freude, Thomas Auzinger, Xian- Chun Wu, Javier von der Pahlen, Michael Wimmer, and Diego Gutierrez, “Separable Sub- surface Scattering,” *Computer Graphics Forum*, vol. 34, no. 6, pp. 188–197, 2015. Cited on p. 637
3. Jimenez, Jorge, “Filmic SMAA: Sharp Morphological and Temporal Antialiasing,” *SIG-*

*GRAPH Advances in Real-Time Rendering in Games course*, July 2016. Cited on p. 148

1. Jimenez, Jorge, Xianchun Wu, Angelo Pesce, and Adrian Jarabo, “Practical Real-Time Strate- gies for Accurate Indirect Occlusion,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, July 2016. Cited on p. 451, 461, 462, 468, 472
2. Jimenez, Jorge, “Dynamic Temporal Antialiasing in *Call of Duty: Infinite Warfare*,” *SIG- GRAPH Advances in Real-Time Rendering in Games course*, Aug. 2017. Cited on p. 142, 143, 145, 146, 148, 166, 805
3. Jin, Shuangshuang, Robert R. Lewis, and David West, “A Comparison of Algorithms for Vertex Normal Computation,” *The Visual Computer*, vol. 21, pp. 71–82, 2005. Cited on p. 695
4. Johansson, Mikael, “Eﬃcient Stereoscopic Rendering of Building Information Models (BIM),”

*Journal of Computer Graphics Techniques*, vol. 5, no. 3, pp. 1–17, 2016. Cited on p. 927

1. Johnson, G. S., J. Lee, C. A. Burns, and W. R. Mark, “The Irregular Z-Buﬀer: Hardware Acceleration for Irregular Data Structures,” *ACM Transactions on Graphics*, vol. 24, no. 4, pp. 1462–1482, Oct. 2005. Cited on p. 260
2. Johnsson, Bj¨orn, Per Ganestam, Michael Doggett, and Tomas Akenine-M¨oller, “Power Eﬃ- ciency for Software Algorithms Running on Graphics Processors,” in *Proceedings of the Fourth ACM SIGGRAPH / Eurographics Conference on High-Performance Graphics*, Eurographics Association, pp. 67–75, June 2012. Cited on p. 790
3. Jones, James L., “Eﬃcient Morph Target Animation Using OpenGL ES 3.0,” in Wolfgang Engel, ed., *GPU Pro*5, CRC Press, pp. 289–295, 2014. Cited on p. 90
4. J¨onsson, Daniel, Erik Sund´en, Anders Ynnerman, and Timo Ropinski, “A Survey of Volumet- ric Illumination Techniques for Interactive Volume Rendering,” *Computer Graphics Forum*, vol. 33, no. 1, pp. 27–51, 2014. Cited on p. 605
5. Joy, Kenneth I., *On-Line Geometric Modeling Notes*, [http://graphics.idav.ucdavis.edu/](http://graphics.idav.ucdavis.edu/education/CAGDNotes/homepage.html%2C%201996) [education/CAGDNotes/homepage.html,](http://graphics.idav.ucdavis.edu/education/CAGDNotes/homepage.html%2C%201996) [1](#_bookmark0)[996](http://graphics.idav.ucdavis.edu/education/CAGDNotes/homepage.html%2C%201996)[.](#_bookmark0) Cited on p. 756
6. Junkins, S., “The Compute Architecture of Intel Processor Graphics Gen9,” Intel White Paper v1.0, Aug. 2015. Cited on p. 1006, 1007
7. Kajiya, James T., “Anisotropic Reﬂection Models,” *Computer Graphics (SIGGRAPH ’85 Proceedings)*, vol. 19, no. 3, pp. 15–21, July 1985. Cited on p. 853
8. Kajiya, James T., “The Rendering Equation,” *Computer Graphics (SIGGRAPH ’86 Proceed- ings)*, vol. 20, no. 4, pp. 143–150, Aug. 1986. Cited on p. 315, 437, 444
9. Kajiya, James T., and Timothy L. Kay, “Rendering Fur with Three Dimensional Textures,”

*Computer Graphics (SIGGRAPH ’89 Proceedings)*, vol. 17, no. 3, pp. 271–280, July 1989.

Cited on p. 359, 642

1. Kalnins, Robert D., Philip L. Davidson, Lee Markosian, and Adam Finkelstein, “Coherent Stylized Silhouettes,” *ACM Transactions on Graphics (SIGGRAPH 2003)*, vol. 22, no. 3, pp. 856–861, 2003. Cited on p. 667
2. K¨ampe, Viktor, *Fast, Memory-Efficient Construction of Voxelized Shadows*, PhD Thesis,

Chalmers University of Technology, 2016. Cited on p. 586

1. K¨ampe, Viktor, Erik Sintorn, Ola Olsson, and Ulf Assarsson, “Fast, Memory-Eﬃcient Con- struction of Voxelized Shadows,” *IEEE Transactions on Visualization and Computer Graph- ics*, vol. 22, no. 10, pp. 2239–2248, Oct. 2016. Cited on p. 264, 586
2. Kaneko, Tomomichi, Toshiyuki Takahei, Masahiko Inami, Naoki Kawakami, Yasuyuki Yanagida, Taro Maeda, and Susumu Tachi, “Detailed Shape Representation with Parallax Mapping,” *International Conference on Artificial Reality and Telexistence 2001*, Dec. 2001.

Cited on p. 215

1. Kang, H., H. Jang, C.-S. Cho, and J. Han, “Multi-Resolution Terrain Rendering with GPU Tessellation,” *The Visual Computer*, vol. 31, no. 4, pp. 455–469, 2015. Cited on p. 567, 876
2. Kaplan, Matthew, Bruce Gooch, and Elaine Cohen, “Interactive Artistic Rendering,” in *Pro- ceedings of the 1st International Symposium on Non-photorealistic Animation and Rendering*,

ACM, pp. 67–74, June 2000. Cited on p. 670, 672

1. Kaplanyan, Anton, “Light Propagation Volumes in CryEngine 3,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2009. Cited on p. 493
2. Kaplanyan, Anton, and Carsten Dachsbacher, “Cascaded Light Propagation Volumes for Real- Time Indirect Illumination,” in *Proceedings of the 2010 ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 99–107, Feb. 2010. Cited on p. 494, 496
3. Kaplanyan, Anton, “CryENGINE 3: Reaching the Speed of Light,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, July 2010. Cited on p. 196, 289, 290, 848, 849, 887,

892

1. Kaplanyan, Anton, Stephen Hill, Anjul Patney, and Aaron Lefohn, “Filtering Distributions of Normals for Shading Antialiasing,” in *Proceedings of High-Performance Graphics*, Euro- graphics Association, pp. 151–162, June 2016. Cited on p. 371
2. Kapoulkine, Arseny, “Optimal Grid Rendering Is Not Optimal,” *Bits, pixels, cycles and more*

blog, July 31, 2017. Cited on p. 700, 701

1. Karabassi, Evaggelia-Aggeliki, Georgios Papaioannou, and Theoharis Theoharis, “A Fast Depth-Buﬀer-Based Voxelization Algorithm,” *journal of graphics tools*, vol. 4, no. 4, pp. 5–10, 1999. Cited on p. 580
2. Karis, Brian, “Tiled Light Culling,” *Graphic Rants* blog, Apr. 9, 2012. Cited on p. 113, 882
3. Karis, Brian, “Real Shading in Unreal Engine 4,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, July 2013. Cited on p. 111, 113, 116, 325, 336, 340, 342, 352,

355, 383, 385, 388, 421, 423

1. Karis, Brian, “High Quality Temporal Supersampling,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2014. Cited on p. 142, 143, 144, 620
2. Karis, Brian, “Physically Based Hair Shading in Unreal,” *SIGGRAPH Physically Based Shad- ing in Theory and Practice course*, July 2016. Cited on p. 641, 644, 646
3. Kass, Michael, Aaron Lefohn, and John Owens, “Interactive Depth of Field Using Simulated Diﬀusion on a GPU,” Technical memo, Pixar Animation Studios, 2006. Cited on p. 535
4. Kasyan, Nikolas, “Playing with Real-Time Shadows,” *SIGGRAPH Efficient Real-Time Shad- ows course*, July 2013. Cited on p. 54, 234, 245, 251, 264, 585
5. Kautz, Jan, Wolfgang Heidrich, and Katja Daubert, “Bump Map Shadows for OpenGL Rendering,” Technical Report MPI-I-2000–4-001, Max-Planck-Institut fu¨r Informatik,

Saarbru¨cken, Germany, Feb. 2000. Cited on p. 466

1. Kautz, Jan, and M. D. McCool, “Approximation of Glossy Reﬂection with Preﬁltered En- vironment Maps,” in *Graphics Interface 2000*, Canadian Human-Computer Communications Society, pp. 119–126, May 2000. Cited on p. 423
2. Kautz, Jan, P.-P. V´azquez, W. Heidrich, and H.-P. Seidel, “A Uniﬁed Approach to Preﬁltered Environment Maps,” in *Rendering Techniques 2000*, Springer, pp. 185–196, June 2000. Cited on p. 420
3. Kautz, Jan, Peter-Pike Sloan, and John Snyder, “Fast, Arbitrary BRDF Shading for Low- Frequency Lighting Using Spherical Harmonics,” in *Proceedings of the 13th Eurographics Workshop on Rendering*, Eurographics Association, pp. 291–296, June 2002. Cited on p. 401, 431
4. Kautz, Jan, Jaakko Lehtinen, and Peter-Pike Sloan, *SIGGRAPH Precomputed Radiance Transfer: Theory and Practice course*, Aug. 2005. Cited on p. 481
5. Kautz, Jan, “SH Light Representations,” *SIGGRAPH Precomputed Radiance Transfer: The- ory and Practice course*, Aug. 2005. Cited on p. 430
6. Kavan, Ladislav, Steven Collins, Jiˇr´ı Zˇ´ara, and Carol O’Sullivan, “Skinning with Dual Quater- nions,” in *Proceedings of the 2007 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 39–46, Apr.–May 2007. Cited on p. 87
7. Kavan, Ladislav, Steven Collins, Jiˇr´ı Zˇ´ara, and Carol O’Sullivan, “Geometric Skinning with Approximate Dual Quaternion Blending,” *ACM Transactions on Graphics*, vol. 27, no. 4, pp. 105:1–105:23, 2008. Cited on p. 87
8. Kavan, Ladislav, Simon Dobbyn, Steven Collins, Jiˇr´ı Zˇ´ara, and Carol O’Sullivan, “Polypostors: 2D Polygonal Impostors for 3D Crowds,” in *Proceedings of the 2008 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 149–156, 2008. Cited on p. 562
9. Kavan, Ladislav, Adam W. Bargteil, and Peter-Pike Sloan, “Least Squares Vertex Baking,”

*Computer Graphics Forum*, vol. 30, no. 4, pp. 1319–1326, 2011. Cited on p. 452

1. Kay, L., “SceneJS: A WebGL-Based Scene Graph Engine,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 571–582, 2012. Cited on p. 829
2. Kay, T. L., and J. T. Kajiya, “Ray Tracing Complex Scenes,” *Computer Graphics (SIG-*

*GRAPH ’86 Proceedings)*, vol. 20, no. 4, pp. 269–278, Aug. 1986. Cited on p. 959, 961

1. Kelemen, Csaba, and L´azlo´ Szirmay-Kalos, “A Microfacet Based Coupled Specular-Matte BRDF Model with Importance Sampling,” in *Eurographics 2001—Short Presentations*, Eu- rographics Association, pp. 25–34, Sept. 2001. Cited on p. 346, 352, 419
2. Keller, Alexander, “Instant Radiosity,” in *SIGGRAPH ’97: Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 49–56, Aug. 1997. Cited on p. 491
3. Keller, Alexander, and Wolfgang Heidrich, “Interleaved Sampling,” in *Rendering Techniques 2001*, Springer, pp. 266–273, June 2001. Cited on p. 145
4. Kemen, B., “Logarithmic Depth Buﬀer Optimizations & Fixes,” *Outerra* blog, July 18, 2013.

Cited on p. 101

1. Kensler, Andrew, and Peter Shirley, “Optimizing Ray-Triangle Intersection via Automated Search,” in *2006 IEEE Symposium on Interactive Ray Tracing*, IEEE Computer Society, pp. 33–38, 2006. Cited on p. 962
2. Kent, James R., Wayne E. Carlson, and Richard E. Parent, “Shape Transformation for Poly- hedral Objects,” *Computer Graphics (SIGGRAPH ’92 Proceedings)*, vol. 26, no. 2, pp. 47–54,

1992. Cited on p. 87

1. Kershaw, Kathleen, *A Generalized Texture-Mapping Pipeline*, MSc thesis, Program of Com- puter Graphics, Cornell University, Ithaca, New York, 1992. Cited on p. 169, 170
2. Kessenich, John, Graham Sellers, and Dave Shreiner, *OpenGL Programming Guide: The Of- ficial Guide to Learning OpenGL, Version 4.5 with SPIR-V*, Ninth Edition, Addison-Wesley, 2016. Cited on p. 27, 39, 41, 55, 96, 173, 174
3. Kettlewell, Richard, “Rendering in Codemasters’ GRID2 and beyond,” *Game Developers Conference*, Mar. 2014. Cited on p. 258
4. Kharlamov, Alexander, Iain Cantlay, and Yury Stepanenko, “Next-Generation SpeedTree Rendering,” in Hubert Nguyen, ed., *GPU Gems 3*, Addison-Wesley, pp. 69–92, 2007. Cited on p. 207, 560, 564, 646, 856
5. Kihl, Robert, “Destruction Masking in Frostbite 2 Using Volume Distance Fields,” *SIG- GRAPH Advances in Real-Time Rendering in Games course*, July 2010. Cited on p. 889, 890
6. Kilgard, Mark J., “Realizing OpenGL: Two Implementations of One Architecture,” in *Proceed- ings of the ACM SIGGRAPH/EUROGRAPHICS Workshop on Graphics Hardware*, ACM, pp. 45–55, Aug. 1997. Cited on p. 1007
7. Kilgard, Mark J., “Creating Reﬂections and Shadows Using Stencil Buﬀers,” *Game Developers Conference*, Mar. 1999. Cited on p. 805
8. Kilgard, Mark J., “A Practical and Robust Bump-Mapping Technique for Today’s GPUs,”

*Game Developers Conference*, Mar. 2000. Cited on p. 212, 214

1. Kim, Pope, and Daniel Barrero, “Rendering Tech of Space Marine,” *Korea Game Conference*,

Nov. 2011. Cited on p. 892, 900, 905

1. Kim, Pope, “Screen Space Decals in *Warhammer 40,000: Space Marine*,” in *ACM SIG-*

*GRAPH 2012 Talks*, article no. 6, Aug. 2012. Cited on p. 889

1. Kim, Tae-Yong, and Ulrich Neumann, “Opacity Shadow Maps,” in *Rendering Techniques 2001*, Springer, pp. 177–182, 2001. Cited on p. 257, 570, 571, 612
2. King, Gary, and William Newhall, “Eﬃcient Omnidirectional Shadow Maps,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 435–448, 2004. Cited on p. 234
3. King, Gary, “Shadow Mapping Algorithms,” GPU Jackpot presentation, Oct. 2004. Cited on p. 235, 240
4. King, Gary, “Real-Time Computation of Dynamic Irradiance Environment Maps,” in Matt Pharr, ed., *GPU Gems 2*, Addison-Wesley, pp. 167–176, 2005. Cited on p. 426, 428, 430
5. King, Yossarian, “Never Let ’Em See You Pop—Issues in Geometric Level of Detail Selection,” in Mark DeLoura, ed., *Game Programming Gems*, Charles River Media, pp. 432–438, 2000.

Cited on p. 861, 864

1. King, Yossarian, “2D Lens Flare,” in Mark DeLoura, ed., *Game Programming Gems*, Charles River Media, pp. 515–518, 2000. Cited on p. 524
2. Kircher, Scott, “Lighting & Simplifying *Saints Row: The Third*,” *Game Developers Confer- ence*, Mar. 2012. Cited on p. 889, 892
3. Kirk, David B., and Douglas Voorhies, “The Rendering Architecture of the DN-10000VS,”

*Computer Graphics (SIGGRAPH ’90 Proceedings)*, vol. 24, no. 4, pp. 299–307, Aug. 1990.

Cited on p. 185

1. Kirk, David, ed., *Graphics Gems III*, Academic Press, 1992. Cited on p. 102, 991
2. Kirk, David B., and Wen-mei W. Hwu, *Programming Massively Parallel Processors: A Hands- on Approach*, Third Edition, Morgan Kaufmann, 2016. Cited on p. 55, 1040
3. Klehm, Oliver, Tobias Ritschel, Elmar Eisemann, and Hans-Peter Seidel, “Bent Normals and Cones in Screen Space,” in *Vision, Modeling, and Visualization*, Eurographics Association, pp. 177–182, 2011. Cited on p. 467, 471
4. Klein, Allison W., Wilmot Li, Michael M. Kazhdan, Wagner T. Corrˆea, Adam Finkelstein, and Thomas A. Funkhouser, “Non-Photorealistic Virtual Environments,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Tech- niques*, ACM Press/Addison-Wesley Publishing Co., pp. 527–534, July 2000. Cited on p. 670, 671
5. Klein, R., G. Liebich, and W. Strasser, “Mesh Reduction with Error Control,” in *Proceedings of the 7th Conference on Visualization ’96*, IEEE Computer Society, pp. 311–318, 1996. Cited on p. 875
6. Kleinhuis, Christian, “Morph Target Animation Using DirectX,” in Wolfgang Engel, ed.,

*ShaderX*4, Charles River Media, pp. 39–45, 2005. Cited on p. 89

1. Klint, Josh, “Vegetation Management in Leadwerks Game Engine 4,” in Eric Lengyel, ed.,

*Game Engine Gems 3*, CRC Press, pp. 53–71, 2016. Cited on p. 560

1. Kloetzli, J., “D3D11 Software Tessellation,” *Game Developers Conference*, Mar. 2013. Cited on p. 879
2. Klosowski, J. T., M. Held, J. S. B. Mitchell, H. Sowizral, and K. Zikan, “Eﬃcient Collision De- tection Using Bounding Volume Hierarchies of k-DOPs,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 4, no. 1, pp. 21–36, 1998. Cited on p. 979

*IEEE Transactions on Visualization and Computer Graphics*, vol. 6, no. 2, pp. 108–123, Apr./June 2000.

1. Knight, Balor, Matthew Ritchie, and George Parrish, “Screen-Space Classiﬁcation for Eﬃcient Deferred Shading,” Eric Lengyel, ed., *Game Engine Gems 2*, A K Peters, Ltd., pp. 55–73, 2011. Cited on p. 898
2. Kniss, Joe, G. Kindlmann, and C. Hansen, “Multi-Dimensional Transfer Functions for In- teractive Volume Rendering,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 8, no. 3, pp. 270–285, 2002. Cited on p. 606
3. Kniss, Joe, S. Premoze, C.Hansen, P. Shirley, and A. McPherson, “A Model for Volume Lighting and Modeling,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 9, no. 2, pp. 150–162, 2003. Cited on p. 607
4. Knowles, Pyarelal, Geoﬀ Leach, and Fabio Zambetta, “Eﬃcient Layered Fragment Buﬀer Techniques,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 279–292, 2012. Cited on p. 155
5. Kobbelt, Leif, “√3-Subdivision,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Con-*

*ference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Pub- lishing Co., pp. 103–112, July 2000. Cited on p. 756, 761

1. Kobbelt, Leif, and Mario Botsch, “A Survey of Point-Based Techniques in Computer Graph- ics,” *Computers & Graphics*, vol. 28, no. 6, pp. 801–814, Dec. 2004. Cited on p. 578
2. Kochanek, Doris H. U., and Richard H. Bartels, “Interpolating Splines with Local Tension, Continuity, and Bias Control,” *Computer Graphics (SIGGRAPH ’84 Proceedings)*, vol. 18, no. 3, pp. 33–41, July 1984. Cited on p. 730, 731
3. Koenderink, Jan J., Andrea J. van Doorn, and Marigo Stavridi, “Bidirectional Reﬂection Distribution Function Expressed in Terms of Surface Scattering Modes,” *Proceedings of ECCV 2001*, vol. 2, pp. 28–39, 1996. Cited on p. 404
4. Koenderink, Jan J., and Sylvia Pont, “The Secret of Velvety Skin,” *Journal of Machine Vision and Applications*, vol. 14, no. 4, pp. 260–268, 2002. Cited on p. 356
5. K¨ohler, Johan, “Practical Order Independent Transparency,” Technical Report ATVI-TR-16- 02, Activision Research, 2016. Cited on p. 569
6. Kojima, Hideo, Hideki Sasaki, Masayuki Suzuki, and Junji Tago, “Photorealism Through the Eyes of a FOX: The Core of *Metal Gear Solid Ground Zeroes*,” *Game Developers Conference*,

Mar. 2013. Cited on p. 289

1. Kolchin, Konstantin, “Curvature-Based Shading of Translucent Materials, such as Human Skin,” in *Proceedings of the 5th International Conference on Computer Graphics and Inter- active Techniques in Australia and Southeast Asia*, ACM, pp. 239–242, Dec. 2007. Cited on p. 634
2. Koltun, Vladlen, Yiorgos Chrysanthou, and Daniel Cohen-Or, “Hardware-Accelerated From- Region Visibility Using a Dual Ray Space,” in *Rendering Techniques 2001*, Springer, pp. 204– 214, June 2001. Cited on p. 843
3. Kontkanen, Janne, and Samuli Laine, “Ambient Occlusion Fields,” in Wolfgang Engel, ed.,

*ShaderX*4, Charles River Media, pp. 101–108, 2005. Cited on p. 452

1. Kontkanen, Janne, and Samuli Laine, “Ambient Occlusion Fields,” in *Proceedings of the 2005 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 41–48, Apr. 2005. Cited on p. 452
2. Kontkanen, Janne, and Samuli Laine, “Sampling Precomputed Volumetric Lighting,” *journal of graphics tools*, vol. 11, no. 3, pp. 1–16, 2006. Cited on p. 489, 491
3. Koonce, Rusty, “Deferred Shading in *Tabula Rasa*,” in Hubert Nguyen, ed., *GPU Gems 3*,

Addison-Wesley, pp. 429–457, 2007. Cited on p. 239, 886, 887

1. Kopta, D., T. Ize, J. Spjut, E. Brunvand, A. Davis, and A. Kensler, “Fast, Eﬀective BVH Updates for Animated Scenes,” in *Proceedings of the ACM SIGGRAPH Symposium on In- teractive 3D Graphics and Games*, ACM, pp. 197–204, 2012. Cited on p. 821
2. Kopta, D., K. Shkurko, J. Spjut, E. Brunvand, and A. Davis, “An Energy and Bandwidth Eﬃcient Ray Tracing Architecture,” *Proceedings of the 5th High-Performance Graphics Con- ference*, ACM, pp. 121–128, July 2013. Cited on p. 1039
3. Kotﬁs, Dave, and Patrick Cozzi, “Octree Mapping from a Depth Camera,” in Wolfgang Engel, ed., *GPU Pro*7, CRC Press, pp. 257–273, 2016. Cited on p. 573, 580, 919
4. Kovacs, D., J. Mitchell, S. Drone, and D. Zorin, “Real-Time Creased Approximate Subdivision Surfaces with Displacements,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 16, no. 5, pp. 742–751, 2010. Cited on p. 777
5. Koval`e´ık, V´ıt, and Jiˇr´ı Sochor, “Occlusion Culling with Statistically Optimized Occlusion Queries,” *International Conference in Central Europe on Computer Graphics, Visualization and Computer Vision (WSCG)*, Jan.–Feb. 2005. Cited on p. 845
6. Krajcevski, P., Adam Lake, and D. Manocha, “FasTC: Accelerated Fixed-Rate Texture En- coding,” in *Proceedings of the ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 137–144, Mar. 2013. Cited on p. 870
7. Krajcevski, P., and D. Manocha, “Fast PVRTC Compression Using Intensity Dilation,” *Jour- nal of Computer Graphics Techniques*, vol. 3, no. 4, pp. 132–145, 2014. Cited on p. 870
8. Krajcevski, P., and D. Manocha, “SegTC: Fast Texture Compression Using Image Segmen- tation,” in *Proceedings of High-Performance Graphics*, Eurographics Association, pp. 71–77, June 2014. Cited on p. 870
9. Krassnigg, Jan, “A Deferred Decal Rendering Technique,” in Eric Lengyel, ed., *Game Engine Gems*, Jones and Bartlett, pp. 271–280, 2010. Cited on p. 889
10. Kraus, Martin, and Magnus Strengert, “Pyramid Filters based on Bilinear Interpolation,” in *GRAPP 2007, Proceedings of the Second International Conference on Computer Graphics Theory and Applications*, INSTICC, pp. 21–28, 2007. Cited on p. 518
11. Krishnamurthy, V., and M. Levoy, “Fitting Smooth Surfaces to Dense Polygon Meshes,” in *SIGGRAPH ’96: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 313–324, Aug. 1996. Cited on p. 765
12. Krishnan, S., M. Gopi, M. Lin, D. Manocha, and A. Pattekar, “Rapid and Accurate Contact Determination between Spline Models Using ShellTrees,” *Computer Graphics Forum*, vol. 17, no. 3, pp. 315–326, 1998. Cited on p. 718
13. Krishnan, S., A. Pattekar, M. C. Lin, and D. Manocha, “Spherical Shell: A Higher Order Bounding Volume for Fast Proximity Queries,” in *Proceedings of Third International Work- shop on the Algorithmic Foundations of Robotics*, A K Peters, Ltd, pp. 122–136, 1998. Cited on p. 718
14. Kristensen, Anders Wang, Tomas Akenine-Mller, and Henrik Wann Jensen, “Precomputed Local Radiance Transfer for Real-Time Lighting Design,” *ACM Transactions on Graphics (SIGGRAPH 2005)*, vol. 24, no. 3, pp. 1208–1215, Aug. 2005. Cited on p. 481
15. Kronander, Joel, Francesco Banterle, Andrew Gardner, Ehsan Miandji, and Jonas Unger, “Photorealistic Rendering of Mixed Reality Scenes,” *Computer Graphics Forum*, vol. 34, no. 2, pp. 643–665, 2015. Cited on p. 935
16. Kryachko, Yuri, “Using Vertex Texture Displacement for Realistic Water Rendering,” in Matt Pharr, ed., *GPU Gems 2*, Addison-Wesley, pp. 283–294, 2005. Cited on p. 43
17. Kubisch, Christoph, and Markus Tavenrath, “OpenGL 4.4 Scene Rendering Techniques,”

*NVIDIA GPU Technology Conference*, Mar. 2014. Cited on p. 795, 849, 851

1. Kubisch, Christoph, “Life of a Triangle—NVIDIA’s Logical Pipeline,” *NVIDIA GameWorks*

blog, Mar. 16, 2015. Cited on p. 32

1. Kubisch, Christoph, “Transitioning from OpenGL to Vulkan,” *NVIDIA GameWorks* blog,

Feb. 11, 2016. Cited on p. 40, 41, 796, 814

1. Kulla, Christopher, and Alejandro Conty, “Revisiting Physically Based Shading at Image- works,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2017.

Cited on p. 321, 336, 343, 346, 347, 352, 353, 358, 363, 364

1. Kyprianidis, Jan Eric, Henry Kang, and Ju¨rgen Do¨llner, “Anisotropic Kuwahara Filtering on the GPU,” in Wolfgang Engel, ed., *GPU Pro*, A K Peters, Ltd., pp. 247–264, 2010. Cited on p. 665
2. Kyprianidis, Jan Eric, John Collomosse, Tinghuai Wang, and Tobias Isenberg, “State of the ‘Art’: A Taxonomy of Artistic Stylization Techniques for Images and Video,” *IEEE Transac- tions on Visualization and Computer Graphics*, vol. 19, no. 5, pp. 866–885, May 2013. Cited on p. 665, 678
3. Lacewell, Dylan, Dave Edwards, Peter Shirley, and William B. Thompson, “Stochastic Bill- board Clouds for Interactive Foliage Rendering,” *journal of graphics tools*, vol. 11, no. 1, pp. 1–12, 2006. Cited on p. 563, 564
4. Lacewell, Dylan, “Baking With OptiX,” *NVIDIA GameWorks* blog, June 7, 2016. Cited on p. 452
5. Lachambre, S´ebastian, S´ebastian Lagarde, and Cyril Jover, *Unity Photogrammetry Workflow*,

Unity Technologies, 2017. Cited on p. 349

1. Lacroix, Jason, “Casting a New Light on a Familiar Face: Light-Based Rendering in *Tomb Raider*,” *Game Developers Conference*, Mar. 2013. Cited on p. 114, 116
2. Lafortune, Eric P. F., Sing-Choong Foo, Kenneth E. Torrance, and Donald P. Greenberg, “Non-Linear Approximation of Reﬂectance Functions,” in *SIGGRAPH ’97: Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 117–126, Aug. 1997. Cited on p. 424
3. Lagae, Ares, and Philip Dutr´e, “An Eﬃcient Ray-Quadrilateral Intersection Test,” *journal of graphics tools*, vol. 10, no. 4, pp. 23–32, 2005. Cited on p. 967
4. Lagae, A., S. Lefebvre, R. Cook, T. DeRose, G. Drettakis, D. S. Ebert, J. P. Lewis, K. Perlin, and M. Zwicker, “State of the Art in Procedural Noise Functions,” in *Eurographics 2010—State of the Art Reports*, Eurographics Association, pp. 1–19, 2010. Cited on p. 199
5. Lagarde, S´ebastian, “Relationship Between Phong and Blinn Lighting Models,” *S´ebastian Lagarde* blog, Mar. 29, 2012. Cited on p. 421
6. Lagarde, S´ebastian, and Antoine Zanuttini, “Local Image-Based Lighting with Parallax- Corrected Cubemap,” in *ACM SIGGRAPH 2012 Talks*, ACM, article no. 36, Aug. 2012.

Cited on p. 500

1. Lagarde, S´ebastian, “Memo on Fresnel Equations,” *S´ebastian Lagarde* blog, Apr. 29, 2013.

Cited on p. 321

1. Lagarde, S´ebastian, and Charles de Rousiers, “Moving Frostbite to Physically Based Render- ing,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2014. Cited on p. 111, 113, 115, 116, 312, 325, 336, 340, 341, 354, 371, 422, 426, 435, 503, 890
2. Lagarde, S´ebastian, “IES Light Format: Speciﬁcation and Reader,” *S´ebastian Lagarde* blog,

Nov. 5, 2014. Cited on p. 116, 435

1. Laine, Samuli, Hannu Saransaari, Janne Kontkanen, Jaakko Lehtinen, and Timo Aila, “In- cremental Instant Radiosity for Real-Time Indirect Illumination,” in *Proceedings of the 18th Eurographics Symposium on Rendering Techniques*, Eurographics Association, pp. 277–286,

June 2007. Cited on p. 492

1. Laine, Samuli, and Tero Karras, “‘Eﬃcient Sparse Voxel Octrees—Analysis, Extensions, and Implementation,” Technical Report, NVIDIA, 2010. Cited on p. 579, 580, 586
2. Laine, Samuli, “A Topological Approach to Voxelization,” *Computer Graphics Forum*, vol. 32, no. 4, pp. 77–86, 2013. Cited on p. 581
3. Laine, Samuli, and Tero Karras, “Apex Point Map for Constant-Time Bounding Plane Ap- proximation,” in *Eurographics Symposium on Rendering—Experimental Ideas & Implemen- tations*, Eurographics Association, pp. 51–55, 2015. Cited on p. 980
4. Lake, Adam, Carl Marshall, Mark Harris, and Marc Blackstein, “Stylized Rendering Tech- niques for Scalable Real-Time Animation,” in *International Symposium on Non-Photorealistic Animation and Rendering*, ACM, pp. 13–20, June 2000. Cited on p. 670
5. Lambert, J. H., *Photometria*, 1760. English translation by D. L. DiLaura, Illuminating Engi- neering Society of North America, 2001. Cited on p. 109, 389, 390, 469
6. Lander, Jeﬀ, “Skin Them Bones: Game Programming for the Web Generation,” *Game De- veloper*, vol. 5, no. 5, pp. 11–16, May 1998. Cited on p. 86
7. Lander, Jeﬀ, “Under the Shade of the Rendering Tree,” *Game Developer*, vol. 7, no. 2, pp. 17– 21, Feb. 2000. Cited on p. 657, 670
8. Lander, Jeﬀ, “That’s a Wrap: Texture Mapping Methods,” *Game Developer*, vol. 7, no. 10, pp. 21–26, Oct. 2000. Cited on p. 170, 173
9. Lander, Jeﬀ, “Haunted Trees for Halloween,” *Game Developer*, vol. 7, no. 11, pp. 17–21, Nov.

2000. Cited on p. 942

1. Lander, Jeﬀ, “Images from Deep in the Programmer’s Cave,” *Game Developer*, vol. 8, no. 5, pp. 23–28, May 2001. Cited on p. 654, 666, 672
2. Lander, Jeﬀ, “The Era of Post-Photorealism,” *Game Developer*, vol. 8, no. 6, pp. 18–22, June 2001. Cited on p. 670
3. Landis, Hayden, “Production-Ready Global Illumination,” *SIGGRAPH RenderMan in Pro- duction course*, July 2002. Cited on p. 446, 448, 465
4. Langlands, Anders, “Render Color Spaces,” *alShaders blog*, June 23, 2016. Cited on p. 278
5. Lanman, Douglas, and David Luebke, “Near-Eye Light Field Displays,” *ACM Transactions on Graphics*, vol. 32, no. 6, pp. 220:1–220:10, Nov. 2013. Cited on p. 549, 923
6. Lanza, Stefano, “Animation and Rendering of Underwater God Rays,” in Wolfgang Engel, ed., *ShaderX*5, Charles River Media, pp. 315–327, 2006. Cited on p. 626, 631
7. Lapidous, Eugene, and Guofang Jiao, “Optimal Depth Buﬀer for Low-Cost Graphics Hard- ware,” in *Proceedings of the ACM SIGGRAPH/EUROGRAPHICS Workshop on Graphics Hardware*, ACM, pp. 67–73, Aug. 1999. Cited on p. 100
8. Larsen, E., S. Gottschalk, M. Lin, and D. Manocha, “Fast Proximity Queries with Swept Sphere Volumes,” Technical Report TR99-018, Department of Computer Science, University of North Carolina, 1999. Cited on p. 976
9. Larsson, Thomas, and Tomas Akenine-Mo¨ller, “Collision Detection for Continuously Deform- ing Bodies,” in *Eurographics 2001—Short Presentations*, Eurographics Association, pp. 325– 333, Sept. 2001. Cited on p. 821
10. Larsson, Thomas, and Tomas Akenine-Mo¨ller, “A Dynamic Bounding Volume Hierarchy for Generalized Collision Detection,” *Computers & Graphics*, vol. 30, no. 3, pp. 451–460, 2006.

Cited on p. 821

1. Larsson, Thomas, Tomas Akenine-Mo¨ller, and Eric Lengyel, “On Faster Sphere-Box Overlap Testing,” *journal of graphics tools*, vol. 12, no. 1, pp. 3–8, 2007. Cited on p. 977
2. Larsson, Thomas, “An Eﬃcient Ellipsoid-OBB Intersection Test,” *journal of graphics tools*, vol. 13, no. 1, pp. 31–43, 2008. Cited on p. 978
3. Larsson, Thomas, and Linus Ka¨llberg, “Fast Computation of Tight-Fitting Oriented Bounding Boxes,” Eric Lengyel, ed., *Game Engine Gems 2*, A K Peters, Ltd., pp. 3–19, 2011. Cited on p. 951, 952
4. Lathrop, Olin, David Kirk, and Doug Voorhies, “Accurate Rendering by Subpixel Addressing,” *IEEE Computer Graphics and Applications*, vol. 10, no. 5, pp. 45–53, Sept. 1990. Cited on p. 689
5. Latta, Lutz, “Massively Parallel Particle Systems on the GPU,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 119–133, 2004. Also presented at GDC 2004 and published as “Building a Million-Particle System,” *Gamasutra*, July 28, 2004. Cited on p. 568, 571
6. Latta, Lutz, “Everything about Particle Eﬀects,” *Game Developers Conference*, Mar. 2007.

Cited on p. 568, 569, 571

1. Lauritzen, Andrew, “Summed-Area Variance Shadow Maps,” in Hubert Nguyen, ed., *GPU Gems 3*, Addison-Wesley, pp. 157–182, 2007. Cited on p. 188, 252, 253, 255
2. Lauritzen, Andrew, and Michael McCool, “Layered Variance Shadow Maps,” in *Graphics Interface 2008*, Canadian Human-Computer Communications Society, pp. 139–146, May 2008.

Cited on p. 257

1. Lauritzen, Andrew, “Deferred Rendering for Current and Future Rendering Pipelines,” *SIG- GRAPH Beyond Programmable Shading course*, July 2010. Cited on p. 888, 893, 895, 896,

914

1. Lauritzen, Andrew, Marco Salvi, and Aaron Lefohn, “Sample Distribution Shadow Maps,” in *Symposium on Interactive 3D Graphics and Games*, ACM, pp. 97–102, Feb. 2011. Cited on p. 54, 101, 244, 245
2. Lauritzen, Andrew, “Intersecting Lights with Pixels: Reasoning about Forward and Deferred Rendering,” *SIGGRAPH Beyond Programmable Shading course*, Aug. 2012. Cited on p. 882, 887, 896
3. Lauritzen, Andrew, “Future Directions for Compute-for-Graphics,” *SIGGRAPH Open Prob- lems in Real-Time Rendering course*, Aug. 2017. Cited on p. 32, 812, 908
4. LaValle, Steve, “The Latent Power of Prediction,” *Oculus Developer Blog*, July 12, 2013.

Cited on p. 915, 920, 936, 939

1. LaValle, Steven M., Anna Yershova, Max Katsev, and Michael Antonov, “Head Tracking for the Oculus Rift,” in *IEEE International Conference Robotics and Automation (ICRA)*, IEEE Computer Society, pp. 187–194, May–June 2014. Cited on p. 915, 916, 936
2. Laven, Philip, *MiePlot* website and software, 2015. Cited on p. 597, 599
3. Lax, Peter D., *Linear Algebra and Its Applications*, Second Edition, John Wiley & Sons, Inc., 2007. Cited on p. 61
4. Lazarov, Dimitar, “Physically-Based lighting in *Call of Duty: Black Ops*,” *SIGGRAPH Ad- vances in Real-Time Rendering in Games course*, Aug. 2011. Cited on p. 340, 370, 371, 421,

476

1. Lazarov, Dimitar, “Getting More Physical in *Call of Duty: Black Ops II*,” *SIGGRAPH Phys- ically Based Shading in Theory and Practice course*, July 2013. Cited on p. 352, 421, 502

[[1000](#_bookmark0)] Lazarus, F., and A. Verroust, “Three-Dimensional Metamorphosis: A Survey,” *The Visual Computer*, vol. 14, no. 8, pp. 373–389, 1998. Cited on p. 87, 102

[[1001](#_bookmark0)] Le, Binh Huy, and Jessica K. Hodgins, “Real-Time Skeletal Skinning with Optimized Centers of Rotation,” *ACM Transactions on Graphics*, vol. 35, no. 4, pp. 37:1–37:10, 2016. Cited on

p. 87

[[1002](#_bookmark0)] Leadbetter, Richard, “The Making of *Forza Horizon 2*,” *Eurogamer.net*, Oct. 11, 2014. Cited on p. 141, 900

[[1003](#_bookmark0)] Lecocq, Pascal, Pascal Gautron, Jean-Eudes Marvie, and Gael Sourimant, “Sub-Pixel Shadow Mapping,” in *Proceedings of the 18th Meeting of the ACM SIGGRAPH Symposium on In- teractive 3D Graphics and Games*, ACM, pp. 103–110, 2014. Cited on p. 259

[[1004](#_bookmark0)] Lecocq, Pascal, Arthur Dufay, Gael Sourimant, and Jean-Eude Marvie, “Analytic Approxima- tions for Real-Time Area Light Shading,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 23, no. 5, pp. 1428–1441, 2017. Cited on p. 389

[[1005](#_bookmark0)] Lee, Aaron W. F., David Dobkin, Wim Sweldens, and Peter Schr¨oder, “Multiresolution mesh morphing,” in *SIGGRAPH ’99: Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 343– 350, 1999. Cited on p. 87

[[1006](#_bookmark0)] Lee, Aaron, Henry Moreton, and Hugues Hoppe, “Displaced Subdivision Surfaces,” in *SIG- GRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Inter- active Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 85–94, July 2000. Cited on p. 706, 765, 766

[[1007](#_bookmark0)] Lee, Aaron, “Building Your Own Subdivision Surfaces,” *Gamasutra*, Sept. 8, 2000. Cited on p. 706

[[1008](#_bookmark0)] Lee, Hyunho, and Min-Ho Kyung, “Parallel Mesh Simpliﬁcation Using Embedded Tree Col- lapsing,” *The Visual Computer*, vol. 32, no. 6, pp. 967–976, 2016. Cited on p. 709

[[1009](#_bookmark0)] Lee, Hyunjun, Sungtae Kwon, and Seungyong Lee, “Real-Time Pencil Rendering,” in *Proceed- ings of the 4th International Symposium on Non-Photorealistic Animation and Rendering*, ACM, pp. 37–45, 2006. Cited on p. 672

[[1010](#_bookmark0)] Lee, Jongseok, Sungyul Choe, and Seungyong Lee, “Mesh Geometry Compression for Mobile Graphics,” in *2010 7th IEEE Consumer Communications and Networking Conference*, IEEE Computer Society, pp. 1–5, 2010. Cited on p. 714

[[1011](#_bookmark0)] Lee, Mark, “Pre-lighting in *Resistance 2*,” *Game Developers Conference*, Mar. 2009. Cited on p. 892

[[1012](#_bookmark0)] Lee, Sungkil, and Elmar Eisemann, “Practical Real-Time Lens-Flare Rendering,” *Computer Graphics Forum*, vol. 32, no. 4, pp. 1–6, 2013. Cited on p. 526

[[1013](#_bookmark0)] Lee, W.-J., Y. Youngsam, J. Lee, J.-W. Kim, J.-H. Nah, S. Jung, S. Lee, H.-S. Park, and T.-D. Han, “SGRT: A Mobile GPU Architecture for Real-Time Ray Tracing,” in *Proceedings of the 5th High-Performance Graphics Conference*, ACM, pp. 109–119, July 2013. Cited on p. 1039

[[1014](#_bookmark0)] Lee, Yunjin, Lee Markosian, Seungyong Lee, and John F. Hughes, “Line Drawings via Abstracted Shading,” *ACM Transactions on Graphics (SIGGRAPH 2007)*, vol. 26, no. 3, pp. 18:1–18:6, July 2007. Cited on p. 656

[[1015](#_bookmark0)] Lee-Steere, J., and J. Harmon, “Football at 60 FPS: The Challenges of Rendering Madden NFL 10,” *Game Developers Conference*, Mar. 2010. Cited on p. 198

[[1016](#_bookmark0)] Lefebvre, Sylvain, and Fabrice Neyret, “Pattern Based Procedural Textures,” *Proceedings of the 2003 Symposium on Interactive 3D Graphics*, ACM, pp. 203–212, 2003. Cited on p. 175

[[1017](#_bookmark0)] Lefebvre, Sylvain, Samuel Hornus, and Fabrice Neyret, “Octree Textures on the GPU,” in Matt Pharr, ed., *GPU Gems 2*, Addison-Wesley, pp. 595–613, 2005. Cited on p. 190

[[1018](#_bookmark0)] Lefebvre, Sylvain, and Hugues Hoppe, “Perfect Spatial Hashing,” *ACM Transactions on Graphics*, vol. 25, no. 3, pp. 579–588, July 2006. Cited on p. 190

[[1019](#_bookmark0)] Lehtinen, Jaakko, “A Framework for Precomputed and Captured Light Transport,” *ACM Transactions on Graphics*, vol. 26, no. 4, pp. 13:1–13:22, 2007. Cited on p. 481

[[1020](#_bookmark0)] Lehtinen, Jaakko, *Theory and Algorithms for Efficient Physically-Based Illumination*, PhD thesis, Helsinki University of Technology, Espoo, Finland, 2007. Cited on p. 481

[[1021](#_bookmark0)] Lehtinen, Jaakko, Matthias Zwicker, Emmanuel Turquin, Janne Kontkanen, Fr´edo Durand, Fran¸cois Sillion, and Timo Aila, “A Meshless Hierarchical Representation for Light Transport,”

*ACM Transactions on Graphics*, vol. 27, no. 3, pp. 37:1–37:9, 2008. Cited on p. 484

[[1022](#_bookmark0)] Lengyel, Eric, “Tweaking a Vertex’s Projected Depth Value,” in Mark DeLoura, ed., *Game Programming Gems*, Charles River Media, pp. 361–365, 2000. Cited on p. 236, 657

[[1023](#_bookmark0)] Lengyel, Eric, “T-Junction Elimination and Retriangulation,” in Dante Treglia, ed., *Game Programming Gems 3*, Charles River Media, pp. 338–343, 2002. Cited on p. 690

[[1024](#_bookmark0)] Lengyel, Eric, ed., *Game Engine Gems 2*, A K Peters, Ltd., 2011. Cited on p. 815

[[1025](#_bookmark0)] Lengyel, Eric, *Mathematics for 3D Game Programming and Computer Graphics*, Third Edi- tion, Charles River Media, 2011. Cited on p. 102, 209, 210

[[1026](#_bookmark0)] Lengyel, Eric, “Game Math Case Studies,” *Game Developers Conference*, Mar. 2015. Cited on p. 863

[[1027](#_bookmark0)] Lengyel, Eric, “Smooth Horizon Mapping,” in Eric Lengyel, ed., *Game Engine Gems 3*, CRC Press, pp. 73–83, 2016. Cited on p. 214

[[1028](#_bookmark0)] Lengyel, Eric, “GPU-Friendly Font Rendering Directly from Glyph Outlines,” *Journal of Computer Graphics Techniques*, vol. 6, no. 2, pp. 31–47, 2017. Cited on p. 677, 970

[[1029](#_bookmark0)] Lengyel, Jerome, “The Convergence of Graphics and Vision,” *Computer*, vol. 31, no. 7, pp. 46– 53, July 1998. Cited on p. 546

[[1030](#_bookmark0)] Lengyel, Jerome, “Real-Time Fur,” in *Rendering Techniques 2000*, Springer, pp. 243–256, June 2000. Cited on p. 853

[[1031](#_bookmark0)] Lengyel, Jerome, Emil Praun, Adam Finkelstein, and Hugues Hoppe, “Real-Time Fur over Arbitrary Surfaces,” in *Proceedings of the 2001 Symposium on Interactive 3D Graphics*, ACM, pp. 227–232, Mar. 2001. Cited on p. 646, 853

[[1032](#_bookmark0)] Lensch, Hendrik P. A., Michael Goesele, Philippe Bekaert, Jan Kautz, Marcus A. Magnor, Jochen Lang, and Hans-Peter Seidel, “Interactive Rendering of Translucent Objects,” in *Pa- cific Conference on Computer Graphics and Applications 2002*, IEEE Computer Society, pp. 214–224, Oct. 2002. Cited on p. 635

[[1033](#_bookmark0)] Levoy, Marc, and Turner Whitted, “The Use of Points as a Display Primitive,” Technical Report 85-022, Computer Science Department, University of North Carolina at Chapel Hill,

Jan. 1985. Cited on p. 572

[[1034](#_bookmark0)] Levoy, Marc, and Pat Hanrahan, “Light Field Rendering,” in *SIGGRAPH ’96: Proceedings of the 23rd Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 31–42, Aug. 1996. Cited on p. 549

[[1035](#_bookmark0)] Levoy, Marc, Kari Pulli, Brian Curless, Szymon Rusinkiewicz, David Koller, Lucas Pereira, Matt Ginzton, Sean Anderson, James Davis, Jeremy Ginsberg, and Jonathan Shade, “The Digital Michelangelo Project: 3D Scanning of Large Statues,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 131–144, July 2000. Cited on p. 573

[[1036](#_bookmark0)] L´evy, Bruno, Sylvain Petitjean, Nicolas Ray, and J´erome Maillot, “Least Squares Conformal Maps for Automatic Texture Atlas Generation,” *ACM Transaction on Graphics*, vol. 21, no. 3, pp. 362–371, July 2002. Cited on p. 485, 486

[[1037](#_bookmark0)] Lewis, J. P., Matt Cordner, and Nickson Fong, “Pose Space Deformation: A Uniﬁed Approach to Shape Interpolation and Skeleton-Driven Deformation,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 165–172, July 2000. Cited on p. 84, 87, 90, 102

[[1038](#_bookmark0)] Leyendecker, Felix, “Crafting the World of *Crysis 3*,” *Game Developers Conference Europe*,

Aug. 2013. Cited on p. 366

[[1039](#_bookmark0)] Li, Xin, “To Slerp, or Not to Slerp,” *Game Developer*, vol. 13, no. 7, pp. 17–23, Aug. 2006.

Cited on p. 82

[[1040](#_bookmark0)] Li, Xin, “iSlerp: An Incremental Approach of Slerp,” *journal of graphics tools*, vol. 12, no. 1, pp. 1–6, 2007. Cited on p. 82

[[1041](#_bookmark0)] Licea-Kane, Bill, “GLSL: Center or Centroid? (Or When Shaders Attack!)” *The OpenGL Pipeline Newsletter*, vol. 3, 2007. Cited on p. 141

[[1042](#_bookmark0)] Liktor, Ga´bor, and Carsten Dachsbacher, “Decoupled Deferred Shading for Hardware Ras- terization,” in *Proceedings of the ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 143–150, 2012. Cited on p. 910

[[1043](#_bookmark0)] Liktor, G´abor, and Carsten Dachsbacher, “Decoupled Deferred Shading on the GPU,” in Wolfgang Engel, ed., *GPU Pro*4, CRC Press, pp. 81–98, 2013. Cited on p. 910

[[1044](#_bookmark0)] Liktor, G., M. Pan, and C. Dachsbacher, “Fractional Reyes-Style Adaptive Tessellation for Continuous Level of Detail,” *Computer Graphics Forum*, vol. 33, no. 7, pp. 191–198, 2014.

Cited on p. 774, 775

[[1045](#_bookmark0)] Liktor, G., and K. Vaidyanathan, “Bandwidth-Eﬃcient BVH Layout for Incremental Hard- ware Traversal,” in *Proceedings of High-Performance Graphics*, Eurographics Association, pp. 51–61, June 2016. Cited on p. 1039

[[1046](#_bookmark0)] Lilley, Sean, “Shadows and Cesium Implementation,” *Cesium* website, Nov. 2016. Cited on p. 265

[[1047](#_bookmark0)] Lin, Gang, and Thomas P.-Y. Yu, “An Improved Vertex Caching Scheme for 3D Mesh Ren- dering,” *IEEE Trans. on Visualization and Computer Graphics*, vol. 12, no. 4, pp. 640–648, 2006. Cited on p. 701

[[1048](#_bookmark0)] Lindbloom, Bruce, “RGB/XYZ Matrices,” *Bruce Lindbloom* website, Apr. 7, 2017. Cited on p. 278

[[1049](#_bookmark0)] Lindholm, Erik, Mark Kilgard, and Henry Moreton, “A User-Programmable Vertex Engine,” in *SIGGRAPH ’01 Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 149–158, Aug. 2001. Cited on p. 15, 38

[[1050](#_bookmark0)] Lindholm, E., J. Nickolls, S. Oberman, and J. Montrym, “NVIDIA Tesla: A Uniﬁed Graphics and Computing Architecture,” *IEEE Micro*, vol. 28, no. 2, pp. 39–55, 2008. Cited on p. 1004,

1029, 1031

[[1051](#_bookmark0)] Lindstrom, P., and J. D. Cohen, “On-the-Fly Decompression and Rendering of Multiresolu- tion Terrain,” in *Proceedings of the 2010 ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 65–73, 2010. Cited on p. 879

[[1052](#_bookmark0)] Ling-Qi, Yan, Chi-Wei Tseng, Henrik Wann Jensen, and Ravi Ramamoorthi, “Physically- Accurate Fur Reﬂectance: Modeling, Measurement and Rendering,” *ACM Transactions on Graphics (SIGGRAPH Asia 2015)*, vol. 34, no. 6, article no. 185, 2015. Cited on p. 640, 641,

647

[[1053](#_bookmark0)] Lira, Felipe, Felipe Chaves, Fl´avio Villalva, Jesus Sosa, Kl´everson Pai˜ao, and Teo´ﬁlo Dutra, “Mobile Toon Shading,” in Wolfgang Engel, ed., *GPU Zen*, Black Cat Publishing, pp. 115–122, 2017. Cited on p. 659

[[1054](#_bookmark0)] Liu, Albert Julius, Zhao Dong, Miloˇs Haˇsan, and Steve Marschner, “Simulating the Structure and Texture of Solid Wood,” *ACM Transactions on Graphics*, vol. 35, no. 6, article no. 170, 2016. Cited on p. 199

[[1055](#_bookmark0)] Liu, Edward, “Lens Matched Shading and Unreal Engine 4 Integration Part 3,” *NVIDIA GameWorks* blog, Jan. 18, 2017. Cited on p. 930, 940

[[1056](#_bookmark0)] Liu, Fang, Meng-Cheng Huang, Xue-Hui Liu, and En-Hua Wu, “Eﬃcient Depth Peeling via Bucket Sort,” in *Proceedings of the Conference on High-Performance Graphics*, ACM, pp. 51– 57, Aug. 2009. Cited on p. 155

[[1057](#_bookmark0)] Liu, Ligang, Lei Zhang, Yin Xu, Craig Gotsman, and Steven J. Gortler, “A Local/Global Ap- proach to Mesh Parameterization,” in *Proceedings of the Symposium on Geometry Processing*,

Eurographics Association, pp. 1495–1504, 2008. Cited on p. 485

[[1058](#_bookmark0)] Liu, Songrun, Zachary Ferguson, Alec Jacobson, and Yotam Gingold, “Seamless: Seam Era- sure and Seam-Aware Decoupling of Shape from Mesh Resolution,” *ACM Transactions on Graphics*, vol. 36, no. 6, pp. 216:1–216:15, 2017. Cited on p. 486

[[1059](#_bookmark0)] Liu, Xinguo, Peter-Pike Sloan, Heung-Yeung Shum, and John Snyder, “All-Frequency Pre- computed Radiance Transfer for Glossy Objects,” in *Proceedings of the Fifteenth Eurograph- ics Conference on Rendering Techniques*, Eurographics Association, pp. 337–344, June 2004.

Cited on p. 432

[[1060](#_bookmark0)] Llopis, Noel, “High-Performance Programming with Data-Oriented Design,” in Eric Lengyel, ed., *Game Engine Gems 2*, A K Peters, Ltd., pp. 251–261, 2011. Cited on p. 791, 812

[[1061](#_bookmark0)] Lloyd, Brandon, Jeremy Wendt, Naga Govindaraju, and Dinesh Manocha, “CC Shadow Vol- umes,” in *Proceedings of the 15th Eurographics Workshop on Rendering Techniques*, Euro- graphics Association, pp. 197–206, June 2004. Cited on p. 233

[[1062](#_bookmark0)] Lloyd, Brandon, David Tuft, Sung-Eui Yoon, and Dinesh Manocha, “Warping and Partition- ing for Low Error Shadow Maps,” in *Eurographics Symposium on Rendering*, Eurographics Association, pp. 215–226, June 2006. Cited on p. 241, 242, 244

[[1063](#_bookmark0)] Lloyd, Brandon, *Logarithmic Perspective Shadow Maps*, PhD thesis, Dept. of Computer Sci- ence, University of North Carolina at Chapel Hill, Aug. 2007. Cited on p. 101, 241, 242

[[1064](#_bookmark0)] Lobanchikov, Igor A., and Holger Gruen, “GSC Game World’s S.T.A.L.K.E.R: Clear Sky—A Showcase for Direct3D 10.0/1,” *Game Developers Conference*, Mar. 2009. Cited on p. 252, 887, 888

[[1065](#_bookmark0)] L¨ofstedt, Marta, and Tomas Akenine-M¨oller, “An Evaluation Framework for Ray-Triangle Intersection Algorithms,” *journal of graphics tools*, vol. 10, no. 2, pp. 13–26, 2005. Cited on p. 962

[[1066](#_bookmark0)] Lokovic, Tom, and Eric Veach, “Deep Shadow Maps,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 385–392, July 2000. Cited on p. 257, 258, 570, 638

[[1067](#_bookmark0)] Loop, C., *Smooth Subdivision Based on Triangles*, MSc thesis, Department of Mathematics,

University of Utah, Aug. 1987. Cited on p. 758, 759, 760, 761

[[1068](#_bookmark0)] Loop, Charles, and Jim Blinn, “Resolution Independent Curve Rendering Using Pro- grammable Graphics Hardware,” *ACM Transactions on Graphics*, vol. 24, no. 3, pp. 1000– 1009, 2005. Cited on p. 677, 725

[[1069](#_bookmark0)] Loop, Charles, and Jim Blinn, “Rendering Vector Art on the GPU,” in Hubert Nguyen, ed.,

*GPU Gems 3*, Addison-Wesley, pp. 543–561, 2007. Cited on p. 677, 725

[[1070](#_bookmark0)] Loop, Charles, and Scott Schaefer, “Approximating Catmull-Clark Subdivision Surfaces with Bicubic Patches,” *ACM Transactions on Graphics*, vol. 27, no. 1, pp. 8:1–8:11, 2008. Cited on p. 767, 775, 776, 777, 779

[[1071](#_bookmark0)] Loop, Charles, Cha Zhang, and Zhengyou Zhang, “Real-Time High-Resolution Sparse Vox- elization with Application to Image-Based Modeling,” in *Proceedings of the 5th High-*

*Performance Graphics Conference*, ACM, pp. 73–79, July 2013. Cited on p. 580

[[1072](#_bookmark0)] Loos, Bradford, and Peter-Pike Sloan, “Volumetric Obscurance,” in *Proceedings of the 2010 ACM SIGGRAPH Symposium on Interactive 3D Graphics*, ACM, pp. 151–156, Feb. 2010.

Cited on p. 459

[[1073](#_bookmark0)] Loos, Bradford J., Lakulish Antani, Kenny Mitchell, Derek Nowrouzezahrai, Wojciech Jarosz, and Peter-Pike Sloan, “Modular Radiance Transfer,” *ACM Transactions on Graphics*, vol. 30, no. 6, pp. 178:1–178:10, 2011. Cited on p. 484

[[1074](#_bookmark0)] Lorach, Tristan, “DirectX 10 Blend Shapes: Breaking the Limits,” in Hubert Nguyen, ed.,

*GPU Gems 3*, Addison-Wesley, pp. 53–67, 2007. Cited on p. 90

[[1075](#_bookmark0)] Lorach, Tristan, “Soft Particles,” NVIDIA White Paper, Jan. 2007. Cited on p. 558

[[1076](#_bookmark0)] Lord, Kieren, and Ross Brown, “Using Genetic Algorithms to Optimise Triangle Strips,” in *Proceedings of the 3rd International Conference on Computer Graphics and Interactive Techniques in Australasia and South East Asia (GRAPHITE 2005)*, ACM, pp. 169–176, 2005. Cited on p. 699

[[1077](#_bookmark0)] Lorensen, William E., and Harvey E. Cline, “Marching Cubes: A High Resolution 3D Surface Construction Algorithm,” *Computer Graphics (SIGGRAPH ’87 Proceedings)*, vol. 21, no. 4, pp. 163–169, July 1987. Cited on p. 583

[[1078](#_bookmark0)] Losasso, F., and H. Hoppe, “Geometry Clipmaps: Terrain Rendering Using Nested Regular Grids,” *ACM Transactions on Graphics*, vol. 23, no. 3, pp. 769–776, 2004. Cited on p. 872,

873

[[1079](#_bookmark0)] Lottes, Timothy, “FXAA,” NVIDIA White Paper, Feb. 2009. Cited on p. 148

[[1080](#_bookmark0)] Lottes, Timothy, “FXAA 3.11 in 15 Slides,” *SIGGRAPH Filtering Approaches for Real-Time Anti-Aliasing course*, Aug. 2011. Cited on p. 148

[[1081](#_bookmark0)] Lottes, Timothy, “Advanced Techniques and Optimization of -HDR- VDR Color Pipelines,”

*Game Developers Conference*, Mar. 2016. Cited on p. 281, 286, 1010

[[1082](#_bookmark0)] Lottes, Timothy, “VDR Follow Up—Tonemapping for HDR Signals,” *GPUOpen* website, Oct.

5, 2016. Cited on p. 281

[[1083](#_bookmark0)] Lottes, Timothy, “Technical Evaluation of Traditional vs New ‘HDR’ Encoding Crossed with Display Capability,” *Timothy Lottes* blog, Oct. 12, 2016. Cited on p. 283

[[1084](#_bookmark0)] Lottes, Timothy, “FXAA Pixel Width Contrast Reduction,” *Timothy Lottes* blog, Oct. 27, 2016. Cited on p. 148

[[1085](#_bookmark0)] Loviscach, J¨orn, “Silhouette Geometry Shaders,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 49–56, 2004. Cited on p. 853

[[1086](#_bookmark0)] Loviscach, J¨orn, “Care and Feeding of Normal Vectors,” in Wolfgang Engel, ed., *ShaderX*6,

Charles River Media, pp. 45–56, 2008. Cited on p. 366

[[1087](#_bookmark0)] Loviscach, J¨orn, “Care and Feeding of Normal Vectors,” *Game Developers Conference*, Mar.

2008. Cited on p. 366

[[1088](#_bookmark0)] Low, Kok-Lim, and Tiow-Seng Tan, “Model Simpliﬁcation Using Vertex-Clustering,” in *Pro- ceedings of the 1997 Symposium on Interactive 3D Graphics*, ACM, pp. 75–81, Apr. 1997.

Cited on p. 709

[[1089](#_bookmark0)] Ludwig, Joe, “Lessons Learned Porting *Team Fortress 2* to Virtual Reality,” *Game Developers Conference*, Mar. 2013. Cited on p. 920, 932, 940

[[1090](#_bookmark0)] Luebke, David P., and Chris Georges, “Portals and Mirrors: Simple, Fast Evaluation of Potentially Visible Sets,” in *Proceedings of the 1995 Symposium on Interactive 3D Graphics*,

ACM, pp. 105–106, Apr. 1995. Cited on p. 838

[[1091](#_bookmark0)] Luebke, David P., “A Developer’s Survey of Polygonal Simpliﬁcation Algorithms,” *IEEE Computer Graphics & Applications*, vol. 21, no. 3, pp. 24–35, May–June 2001. Cited on p. 706, 716

[[1092](#_bookmark0)] Luebke, David, *Level of Detail for 3D Graphics*, Morgan Kaufmann, 2003. Cited on p. 706, 708, 709, 716, 854, 879

[[1093](#_bookmark0)] Luksch, C., R. F. Tobler, T. Mu¨hlbacher, M. Schwa¨rzler, and M. Wimmer, “Real-Time Ren- dering of Glossy Materials with Regular Sampling,” *The Visual Computer*, vol. 30, no. 6-8, pp. 717–727, 2014. Cited on p. 423

[[1094](#_bookmark0)] Lysenko, Mikola, “Meshing in a Minecraft Game,” *0 FPS* blog, June 30, 2012. Cited on p. 582, 583

[[1095](#_bookmark0)] Ma, Wan-Chun, Tim Hawkins, Pieter Peers, Charles-F´elix Chabert, Malte Weiss, and Paul Debevec, “Rapid Acquisition of Specular and Diﬀuse Normal Maps from Polarized Spherical Gradient Illumination,” in *Proceedings of the 18th Eurographics Symposium on Rendering Techniques*, Eurographics Association, pp. 183–194, June 2007. Cited on p. 634, 635

[[1096](#_bookmark0)] MacDonald, J. D., and K. S. Booth, “Heuristics for Ray Tracing Using Space Subdivision,”

*Visual Computer*, vol. 6, no. 6, pp. 153–165, 1990. Cited on p. 953

[[1097](#_bookmark0)] Maciel, P., and P. Shirley, “Visual Navigation of Large Environments Using Textured Clus- ters,” in *Proceedings of the 1995 Symposium on Interactive 3D Graphics*, ACM, pp. 96–102, 1995. Cited on p. 561, 853, 866

[[1098](#_bookmark0)] Macklin, Miles, “Faster Fog,” *Miles Macklin* blog, June 10, 2010. Cited on p. 603

[[1099](#_bookmark0)] Maglo, Adrien, Guillaume Lavou´e, Florent Dupont, and C´eline Hudelot, “3D Mesh Compres- sion: Survey, Comparisons, and Emerging Trends,” *ACM Computing Surveys*, vol. 47, no. 3, pp. 44:1–44:41, Apr. 2015. Cited on p. 712, 714

[[1100](#_bookmark0)] Magnenat-Thalmann, Nadia, Richard Laperri`ere, and Daniel Thalmann, “Joint-Dependent Local Deformations for Hand Animation and Object Grasping,” in *Graphics Interface ’88*,

Canadian Human-Computer Communications Society, pp. 26–33, June 1988. Cited on p. 85

[[1101](#_bookmark0)] Magnusson, Kenny, “Lighting You Up with *Battlefield 3*,” *Game Developers Conference*, Mar.

2011. Cited on p. 482

[[1102](#_bookmark0)] Mah, Layla, and Stephan Hodes, “DirectCompute for Gaming: Supercharge Your Engine with Compute Shaders,” *Game Developers Conference*, Mar. 2013. Cited on p. 54, 518, 535

[[1103](#_bookmark0)] Mah, Layla, “Powering the Next Generation Graphics: AMD GCN Architecture,” *Game Developers Conference*, Mar. 2013. Cited on p. 1035

[[1104](#_bookmark0)] Mah, Layla, “Low Latency and Stutter-Free Rendering in VR and Graphics Applications,”

*Game Developers Conference*, Mar. 2015. Cited on p. 922, 928, 938, 939

[[1105](#_bookmark0)] Maillot, Patrick-Giles, “Using Quaternions for Coding 3D Transformations,” in Andrew S.

Glassner, ed., *Graphics Gems*, Academic Press, pp. 498–515, 1990. Cited on p. 77

[[1106](#_bookmark0)] Maillot, J´erˆome, and Jos Stam, “A Uniﬁed Subdivision Scheme for Polygonal Modeling,”

*Computer Graphics Forum*, vol. 20, no. 3, pp. 471–479, 2001. Cited on p. 761

[[1107](#_bookmark0)] Ma¨ım, Jonathan, and Daniel Thalmann, “Improved Appearance Variety for Geometry In- stancing,” in Wolfgang Engel, ed., *ShaderX*6, Charles River Media, pp. 17–28, 2008. Cited on p. 798, 800

[[1108](#_bookmark0)] Ma¨ım, Jonathan, Barbara Yersin, and Daniel Thalmann, “Unique Instances for Crowds,”

*IEEE Computer Graphics & Applications*, vol. 29, no. 6, pp. 82–90, 2009. Cited on p. 798,

800

[[1109](#_bookmark0)] Malan, Hugh, “Graphics Techniques in *Crackdown*,” in Wolfgang Engel, ed., *ShaderX*7,

Charles River Media, pp. 189–215, 2009. Cited on p. 561

[[1110](#_bookmark0)] Malan, Hugh, “Real-Time Global Illumination and Reﬂections in *Dust 514*,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2012. Cited on p. 142, 143, 493

[[1111](#_bookmark0)] Malmer, Mattias, Fredrik Malmer, Ulf Assarsson, and Nicolas Holzschuch, “Fast Precomputed Ambient Occlusion for Proximity Shadows,” *journal of graphics tools*, vol. 12, no. 2, pp. 59–71, 2007. Cited on p. 452

[[1112](#_bookmark0)] Malvar, Henrique S., Gary J. Sullivan, and Sridhar Srinivasan, “Lifting-Based Reversible Color Transformations for Image Compression,” in *Applications of Digital Image Processing XXXI*,

SPIE, 2008. Cited on p. 197

[[1113](#_bookmark0)] Malvar, R., “Fast Progressive Image Coding Without Wavelets,” *Data Compression Confer- ence*, Mar. 2000. Cited on p. 870

[[1114](#_bookmark0)] Malyshau, Dzmitry, “A Quaternion-Based Rendering Pipeline,” in Wolfgang Engel, ed., *GPU Pro*3, CRC Press, pp. 265–273, 2012. Cited on p. 82, 210, 715

[[1115](#_bookmark0)] Mammen, Abraham, “Transparency and Antialiasing Algorithms Implemented with the Vir- tual Pixel Maps Technique,” *IEEE Computer Graphics & Applications*, vol. 9, no. 4, pp. 43–55,

July 1989. Cited on p. 139, 154

[[1116](#_bookmark0)] Mamou, Khaled, Titus Zaharia, and Fran¸coise Prˆeteux, “TFAN: A Low Complexity 3D Mesh Compression Algorithm,” *Computer Animation and Virtual Worlds*, vol. 20, pp. 1–12, 2009.

Cited on p. 712

[[1117](#_bookmark0)] Mansencal, Thomas, “About Rendering Engines Colourspaces Agnosticism,” *Colour Science*

blog, Sept. 17, 2014. Cited on p. 278

[[1118](#_bookmark0)] Mansencal, Thomas, “About RGB Colourspace Models Performance,” *Colour Science* blog,

Oct. 9, 2014. Cited on p. 278

[[1119](#_bookmark0)] Manson, Josiah, and Scott Schaefer, “Parameterization-Aware MIP-Mapping,” *Computer Graphics Forum*, vol. 31, no. 4, pp. 1455–1463, 2012. Cited on p. 191

[[1120](#_bookmark0)] Manson, Josiah, and Peter-Pike Sloan, “Fast Filtering of Reﬂection Probes,” *Computer Graph- ics Forum*, vol. 35, no. 4, pp. 119–127, 2016. Cited on p. 420, 503, 518

[[1121](#_bookmark0)] Mantor, M., and M. Houston, “AMD Graphic Core Next—Low Power High Performance Graphics & Parallel Compute,” *AMD Fusion Developer Summit*, June 2011. Cited on p. 1036

[[1122](#_bookmark0)] Mara, M., and M. McGuire, “2D Polyhedral Bounds of a Clipped, Perspective-Projected 3D Sphere,” *Journal of Computer Graphics Techniques*, vol. 2, no. 2, pp. 70–83, 2013. Cited on p. 863, 886, 894

[[1123](#_bookmark0)] Mara, M., M. McGuire, D. Nowrouzezahrai, and D. Luebke, “Deep G-Buﬀers for Stable Global Illumination Approximation,” in *Proceedings of High Performance Graphics*, Eurographics Association, pp. 87–98, June 2016. Cited on p. 509

[[1124](#_bookmark0)] Mara, Michael, Morgan McGuire, Benedikt Bitterli, and Wojciech Jarosz, “An Eﬃcient De- noising Algorithm for Global Illumination,” *High Performance Graphics*, June 2017. Cited on p. 511

[[1125](#_bookmark0)] Markosian, Lee, Michael A. Kowalski, Samuel J. Trychin, Lubomir D. Bourdev, Daniel Gold- stein, and John F. Hughes, “Real-Time Nonphotorealistic Rendering,” in *SIGGRAPH ’97: Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Tech- niques*, ACM Press/Addison-Wesley Publishing Co., pp. 415–420, Aug. 1997. Cited on p. 667

[[1126](#_bookmark0)] Markosian, Lee, Barbara J. Meier, Michael A. Kowalski, Loring S. Holden, J. D. Northrup, and John F. Hughes, “Art-Based Rendering with Continuous Levels of Detail,” in *Proceedings of the 1st International Symposium on Non-Photorealistic Animation and Rendering*, ACM, pp. 59–66, June 2000. Cited on p. 670, 672

[[1127](#_bookmark0)] Marques, R., C. Bouville, M. Ribardi`ere, L. P. Santos, and K. Bouatouch, “Spherical Fibonacci Point Sets for Illumination Integrals,” *Computer Graphics Forum*, vol. 32, no. 8, pp. 134–143, 2013. Cited on p. 397

[[1128](#_bookmark0)] Marschner, Stephen R., Henrik Wann Jensen, Mike Cammarano, Steve Worley, and Pat Han- rahan, “Light Scattering from Human Hair Fibers,” *ACM Transactions on Graphics (SIG-*

*GRAPH 2003)*, vol. 22, no. 3, pp. 780–791, 2000. Cited on p. 359, 640, 641, 642, 643, 644

[[1129](#_bookmark0)] Marschner, Steve, and Peter Shirley, *Fundamentals of Computer Graphics*, Fourth Edition,

CRC Press, 2015. Cited on p. 102

[[1130](#_bookmark0)] Marshall, Carl S., “Cartoon Rendering: Real-Time Silhouette Edge Detection and Rendering,” in Mark DeLoura, ed., *Game Programming Gems 2*, Charles River Media, pp. 436–443, 2001.

Cited on p. 666

[[1131](#_bookmark0)] Martin, Sam, and Per Einarsson, “A Real-Time Radiosity Architecture for Video Game,” *SIGGRAPH Advances in Real-Time Rendering in 3D Graphics and Games course*, July 2010. Cited on p. 482

[[1132](#_bookmark0)] Martin, Tobias, and Tiow-Seng Tan, “Anti-aliasing and Continuity with Trapezoidal Shadow Maps,” in *15th Eurographics Symposium on Rendering*, Eurographics Association, pp. 153– 160, June 2004. Cited on p. 241

[[1133](#_bookmark0)] Martinez, Adam, “Faster Photorealism in Wonderland: Physically-Based Shading and Light- ing at Sony Pictures Imageworks,” *SIGGRAPH Physically-Based Shading Models in Film and Game Production course*, July 2010. Cited on p. 340

[[1134](#_bookmark0)] Mason, Ashton E. W., and Edwin H. Blake, “Automatic Hierarchical Level of Detail Opti- mization in Computer Animation,” *Computer Graphics Forum*, vol. 16, no. 3, pp. 191–199, 1997. Cited on p. 866

[[1135](#_bookmark0)] Masserann, Arnaud, “Indexing Multiple Vertex Arrays,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 365–374, 2012. Cited on p. 691, 699, 703

[[1136](#_bookmark0)] Mattausch, Oliver, Jiˇr´ı Bittner, and Michael Wimmer, “CHC++: Coherent Hierarchical Culling Revisited,” *Computer Graphics Forum*, vol. 27, no. 2, pp. 221–230, 2008. Cited

on p. 845

[[1137](#_bookmark0)] Mattausch, Oliver, Jiˇr´ı Bittner, Ari Silvennoinen, Daniel Scherzer, and Michael Wimmer, “Eﬃcient Online Visibility for Shadow Maps,” in Wolfgang Engel, ed., *GPU Pro*3, CRC Press, pp. 233–242, 2012. Cited on p. 247

[[1138](#_bookmark0)] Mattes, Ben, and Jean-Francois St-Amour, “Illustrative Rendering of *Prince of Persia*,” *Game Developers Conference*, Mar. 2009. Cited on p. 658, 662

[[1139](#_bookmark0)] Matusik, W., C. Buehler, R. Raskar, S. J. Gortler, and L. McMillan, “Image-Based Visual Hulls,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 369–374, 2000.

Cited on p. 580

[[1140](#_bookmark0)] Maughan, Chris, “Texture Masking for Faster Lens Flare,” in Mark DeLoura, ed., *Game Programming Gems 2*, Charles River Media, pp. 474–480, 2001. Cited on p. 524

[[1141](#_bookmark0)] Maule, Marilena, Jo˜ao L. D. Comba, Rafael Torchelsen, and Rui Bastos, “A Survey of Raster- Based Transparency Techniques,” *Computer and Graphics*, vol. 35, no. 6, pp. 1023–1034, 2011. Cited on p. 159

[[1142](#_bookmark0)] Maule, Marilena, Jo˜ao Comba, Rafael Torchelsen, and Rui Bastos, “Hybrid Transparency,” in *Proceedings of the ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*,

ACM, pp. 103–118, 2013. Cited on p. 156

[[1143](#_bookmark0)] Mavridis, Pavlos, and Georgios Papaioannou, “High Quality Elliptical Texture Filtering on GPU,” in *Symposium on Interactive 3D Graphics and Games*, ACM, pp. 23–30, Feb. 2011.

Cited on p. 189

[[1144](#_bookmark0)] Mavridis, P., and G. Papaioannou, “The Compact YCoCg Frame Buﬀer,” *Journal of Com- puter Graphics Techniques*, vol. 1, no. 1, pp. 19–35, 2012. Cited on p. 804, 805

[[1145](#_bookmark0)] Max, Nelson L., “Horizon Mapping: Shadows for Bump-Mapped Surfaces,” *The Visual Com- puter*, vol. 4, no. 2, pp. 109–117, 1988. Cited on p. 460, 466

[[1146](#_bookmark0)] Max, Nelson L., “Weights for Computing Vertex Normals from Facet Normals,” *journal of graphics tools*, vol. 4, no. 2, pp. 1–6, 1999. Also collected in [112]. Cited on p. 695

[[1147](#_bookmark0)] Max, Nelson, “Improved Accuracy When Building an Orthonormal Basis,” *Journal of Com- puter Graphics Techniques*, vol. 6, no. 1, pp. 9–16, 2017. Cited on p. 75

[[1148](#_bookmark0)] *Maxima, a Computer Algebra System*, [http://maxima.sourceforge.net/, 2017](http://maxima.sourceforge.net/%2C2017). Cited on p. 991

[[1149](#_bookmark0)] Mayaux, Benoit, “Real-Time Volumetric Rendering,” *Revision Demo Party*, Mar.–Apr. 2013.

Cited on p. 620

[[1150](#_bookmark0)] McAllister, David K., Anselmo A. Lastra, and Wolfgang Heidrich, “Eﬃcient Rendering of Spatial Bi-directional Reﬂectance Distribution Functions,” in *Graphics Hardware 2002*, Eu- rographics Association, pp. 79–88, Sept. 2002. Cited on p. 417, 424

[[1151](#_bookmark0)] McAllister, David, “Spatial BRDFs,” in Randima Fernando, ed., *GPU Gems*, Addison-Wesley, pp. 293–306, 2004. Cited on p. 417, 424

[[1152](#_bookmark0)] McAnlis, Colt, “A Multithreaded 3D Renderer,” in Eric Lengyel, ed., *Game Engine Gems*,

Jones and Bartlett, pp. 149–165, 2010. Cited on p. 814

[[1153](#_bookmark0)] McAuley, Stephen, “Calibrating Lighting and Materials in *Far Cry 3*,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, Aug. 2012. Cited on p. 349

[[1154](#_bookmark0)] McAuley, Stephen, “Rendering the World of Far Cry 4,” *Game Developers Conference*, Mar.

2015. Cited on p. 143, 146, 210, 420, 424, 453, 481, 503, 715, 864

[[1155](#_bookmark0)] McCabe, Dan, and John Brothers, “DirectX 6 Texture Map Compression,” *Game Developer*, vol. 5, no. 8, pp. 42–46, Aug. 1998. Cited on p. 1013

[[1156](#_bookmark0)] McCaﬀrey, Jon, “Exploring Mobile vs. Desktop OpenGL Performance,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 337–352, 2012. Cited on p. 814

[[1157](#_bookmark0)] McCloud, Scott, *Understanding Comics: The Invisible Art*, Harper Perennial, 1994. Cited on p. 652, 678

[[1158](#_bookmark0)] McCombe, J. A., “PowerVR Graphics—Latest Developments and Future Plans,” *Game De- velopers Conference*, Mar. 2015. Cited on p. 511, 1039, 1044

[[1159](#_bookmark0)] McCool, Michael D., Chris Wales, and Kevin Moule, “Incremental and Hierarchical Hilbert Order Edge Equation Polygon Rasterization,” in *Graphics Hardware 2001*, Eurographics As- sociation, pp. 65–72, Aug. 2001. Cited on p. 996, 1001

[[1160](#_bookmark0)] McCormack, J., R. McNamara, C. Gianos, L. Seiler, N. P. Jouppi, and Ken Corell, “Neon: A Single-Chip 3D Workstation Graphics Accelerator,” in *Proceedings of the ACM SIG- GRAPH/EUROGRAPHICS Workshop on Graphics Hardware*, ACM, pp. 123–123, Aug. 1998. Cited on p. 185, 1010, 1034

[[1161](#_bookmark0)] McCormack, Joel, Ronald Perry, Keith I. Farkas, and Norman P. Jouppi, “Feline: Fast El- liptical Lines for Anisotropic Texture Mapping,” in *SIGGRAPH ’99: Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-

Wesley Publishing Co., pp. 243–250, Aug. 1999. Cited on p. 189

[[1162](#_bookmark0)] McCormack, Joel, and Robert McNamara, “Tiled Polygon Traversal Using Half-Plane Edge Functions,” in *Graphics Hardware 2000*, Eurographics Association, pp. 15–22, Aug. 2000.

Cited on p. 22, 996, 997

[[1163](#_bookmark0)] McDermott, Wes, *The Comprehensive PBR Guide by Allegorithmic*, vol. 2, Allegorithmic, 2016. Cited on p. 325, 349

[[1164](#_bookmark0)] McDonald, J., and M. Kilgard, “Crack-Free Point-Normal Triangles Using Adjacent Edge Normals,” Technical Report, NVIDIA, Dec. 2010. Cited on p. 747

[[1165](#_bookmark0)] McDonald, J., “Don’t Throw It All Away: Eﬃcient Buﬀer Management,” *Game Developers Conference*, Mar. 2012. Cited on p. 117

[[1166](#_bookmark0)] McDonald, John, “Alpha Blending: To Pre or Not To Pre,” *NVIDIA GameWorks* blog, Jan.

31, 2013. Cited on p. 208

[[1167](#_bookmark0)] McDonald, John, “Avoiding Catastrophic Performance Loss: Detecting CPU-GPU Sync Points,” *Game Developers Conference*, Mar. 2014. Cited on p. 790, 794, 805

[[1168](#_bookmark0)] McEwan, Ian, David Sheets, Mark Richardson, and Stefan Gustavson, “Eﬃcient Computa- tional Noise in GLSL,” *journal of graphics tools*, vol. 16, no. 2, pp. 85–94, 2012. Cited on p. 199

[[1169](#_bookmark0)] McGuire, Morgan, and John F. Hughes, “Hardware-Determined Feature Edges,” in *Proceed- ings of the 3rd International Symposium on Non-Photorealistic Animation and Rendering*,

ACM, pp. 35–47, June 2004. Cited on p. 668

[[1170](#_bookmark0)] McGuire, Morgan, “The SuperShader,” in Wolfgang Engel, ed., *ShaderX*4, Charles River Media, pp. 485–498, 2005. Cited on p. 128

[[1171](#_bookmark0)] McGuire, Morgan, and Max McGuire, “Steep Parallax Mapping,” *Symposium on Interactive 3D Graphics and Games poster*, Apr. 2005. Cited on p. 215, 216, 217, 218, 933

[[1172](#_bookmark0)] McGuire, Morgan, *Computer Graphics Archive*, [http://graphics.cs.williams.edu/data, Aug.](http://graphics.cs.williams.edu/data%2CAug.2011)

[2](#_bookmark0)[011](http://graphics.cs.williams.edu/data%2CAug.2011)[.](#_bookmark0) Cited on p. 105, 118

[[1173](#_bookmark0)] McGuire, Morgan, Padraic Hennessy, Michael Bukowski, and Brian Osman, “A Reconstruc- tion Filter for Plausible Motion Blur,” *Symposium on Interactive 3D Graphics and Games*,

Feb. 2012. Cited on p. 537, 540, 541, 542, 543

[[1174](#_bookmark0)] McGuire, Morgan, Michael Mara, and David Luebke, “Scalable Ambient Obscurance,” *High Performance Graphics*, June 2012. Cited on p. 459

[[1175](#_bookmark0)] McGuire, M., D. Evangelakos, J. Wilcox, S. Donow, and M. Mara, “Plausible Blinn-Phong Reﬂection of Standard Cube MIP-Maps,” Technical Report CSTR201301, Department of Computer Science, Williams College, 2013. Cited on p. 419

[[1176](#_bookmark0)] McGuire, Morgan, and Louis Bavoil, “Weighted Blended Order-Independent Transparency,”

*Journal of Computer Graphics Techniques*, vol. 2, no. 2, pp. 122–141, 2013. Cited on p. 158

[[1177](#_bookmark0)] McGuire, Morgan, “Z-Prepass Considered Irrelevant,” *Casual Effects* blog, Aug. 14, 2013.

Cited on p. 803, 882

[[1178](#_bookmark0)] McGuire, Morgan, “The *Skylanders SWAP Force* Depth-of-Field Shader,” *Casual Effects* blog,

Sept. 13, 2013. Cited on p. 529, 530, 532, 533, 536

[[1179](#_bookmark0)] McGuire, Morgan, and Michael Mara, “Eﬃcient GPU Screen-Space Ray Tracing,” *Journal of Computer Graphics Techniques*, vol. 3, no. 4, pp. 73–85, 2014. Cited on p. 506

[[1180](#_bookmark0)] McGuire, Morgan, “Implementing Weighted, Blended Order-Independent Transparency,” *Ca- sual Effects* blog, Mar. 26, 2015. Cited on p. 158, 569

[[1181](#_bookmark0)] McGuire, Morgan, “Fast Colored Transparency,” *Casual Effects* blog, Mar. 27, 2015. Cited on p. 158

[[1182](#_bookmark0)] McGuire, Morgan, “Peering Through a Glass, Darkly at the Future of Real-Time Trans- parency,” *SIGGRAPH Open Problems in Real-Time Rendering course*, July 2016. Cited on p. 159, 165, 623, 649

[[1183](#_bookmark0)] McGuire, Morgan, “Strategies for Avoiding Motion Sickness in VR Development,” *Casual Effects* blog, Aug. 12, 2016. Cited on p. 920

[[1184](#_bookmark0)] McGuire, Morgan, Mike Mara, Derek Nowrouzezahrai, and David Luebke, “Real-Time Global Illumination Using Precomputed Light Field Probes,” in *Proceedings of the 21st ACM SIG- GRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 2:1–2:11, Feb. 2017.

Cited on p. 490, 502

[[1185](#_bookmark0)] McGuire, Morgan, and Michael Mara, “Phenomenological Transparency,” *IEEE Transactions of Visualization and Computer Graphics*, vol. 23, no.5, pp. 1465–1478, May 2017. Cited on p. 158, 623, 624, 629, 632, 649

[[1186](#_bookmark0)] McGuire, Morgan, “The Virtual Frontier: Computer Graphics Challenges in Virtual Reality & Augmented Reality,” *SIGGRAPH NVIDIA talks*, July 31, 2017. Cited on p. 923, 939, 940

[[1187](#_bookmark0)] McGuire, Morgan, “How NVIDIA Research is Reinventing the Display Pipeline for the Future of VR, Part 2,” *Road to VR* website, Nov. 30, 2017. Cited on p. 919, 940, 1046

[[1188](#_bookmark0)] McGuire, Morgan, *The Graphics Codex*, Edition 2.14, Casual Eﬀects Publishing, 2018. Cited on p. 372, 512, 1047

[[1189](#_bookmark0)] McGuire, Morgan, “Ray Marching,” in *The Graphics Codex*, Edition 2.14, Casual Eﬀects Publishing, 2018. Cited on p. 752

[[1190](#_bookmark0)] McLaren, James, “The Technology of The Tomorrow Children,” *Game Developers Conference*,

Mar. 2015. Cited on p. 496, 504, 569

[[1191](#_bookmark0)] McNabb, Doug, “Sparse Procedural Volume Rendering,” in Wolfgang Engel, ed., *GPU Pro*6,

CRC Press, pp. 167–180, 2015. Cited on p. 611, 934

[[1192](#_bookmark0)] McReynolds, Tom, and David Blythe, *Advanced Graphics Programming Using OpenGL*, Mor- gan Kaufmann, 2005. Cited on p. 152, 153, 199, 200, 221, 222, 229, 538, 551, 674, 675, 678

[[1193](#_bookmark0)] McTaggart, Gary, “*Half-Life 2*/Valve Source Shading,” *Game Developers Conference*, Mar.

2004. Cited on p. 127, 394, 402, 478, 488, 499

[[1194](#_bookmark0)] McVoy, Larry, and Carl Staelin, “lmbench: Portable Tools for Performance Analysis,” in

*Proceedings of the USENIX Annual Technical Conference*, USENIX, pp. 120–133, Jan. 1996.

Cited on p. 792

[[1195](#_bookmark0)] Mehra, Ravish, and Subodh Kumar, “Accurate and Eﬃcient Rendering of Detail Using Direc- tional Distance Maps,” in *Proceedings of the Eighth Indian Conference on Vision, Graphics and Image Processing*, ACM, pp. 34:1–34:8, Dec. 2012. Cited on p. 219

[[1196](#_bookmark0)] Melax, Stan, “A Simple, Fast, and Eﬀective Polygon Reduction Algorithm,” *Game Developer*, vol. 5, no. 11, pp. 44–49, Nov. 1998. Cited on p. 707, 860

[[1197](#_bookmark0)] Melax, Stan, “The Shortest Arc Quaternion,” in Mark DeLoura, ed., *Game Programming Gems*, Charles River Media, pp. 214–218, 2000. Cited on p. 83

[[1198](#_bookmark0)] Meneveaux, Daniel, Benjamin Bringier, Emmanuelle Tauzia, Micka¨el Ribardi`ere, and Li- onel Simonot, “Rendering Rough Opaque Materials with Interfaced Lambertian Microfacets,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 24, no. 3, pp. 1368–1380, 2018. Cited on p. 331

[[1199](#_bookmark0)] Meng, Johannes, Florian Simon, Johannes Hanika, and Carsten Dachsbacher, “Physically Meaningful Rendering Using Tristimulus Colours,” *Computer Graphics Forum*, vol. 34, no. 4, pp. 31–40, 2015. Cited on p. 349

[[1200](#_bookmark0)] Merry, Bruce, “Performance Tuning for Tile-Based Architectures,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 323–335, 2012. Cited on p. 790, 814

[[1201](#_bookmark0)] Mertens, Tom, Jan Kautz, Philippe Bekaert, Hans-Peter Seidel, and Frank Van Reeth, “Eﬃ- cient Rendering of Local Subsurface Scattering,” in *Proceedings of the 11th Pacific Conference on Computer Graphics and Applications*, IEEE Computer Society, pp. 51–58, Oct. 2003. Cited on p. 639

[[1202](#_bookmark0)] Meshkin, Houman, “Sort-Independent Alpha Blending,” *Game Developers Conference*, Mar.

2007. Cited on p. 156

[[1203](#_bookmark0)] Meyer, Alexandre, and Fabrice Neyret, “Interactive Volumetric Textures,” in *Rendering Tech- niques ’98*, Springer, pp. 157–168, July 1998. Cited on p. 565, 646

[[1204](#_bookmark0)] Meyer, Alexandre, Fabrice Neyret, and Pierre Poulin, “Interactive Rendering of Trees with Shading and Shadows,” in *Rendering Techniques 2001*, Springer, pp. 183–196, June 2001.

Cited on p. 202

[[1205](#_bookmark0)] Meyer, Quirin, Jochen Su¨ßner, Gerd Sußner, Marc Stamminger, and Gu¨nther Greiner, “On Floating-Point Normal Vectors,” *Computer Graphics Forum*, vol. 29, no. 4, pp. 1405–1409, 2010. Cited on p. 222

[[1206](#_bookmark0)] Meyers, Scott, “CPU Caches and Why You Care,” *code::dive* conference, Nov. 5, 2014. Cited on p. 791, 792

[[1207](#_bookmark0)] Microsoft, “Coordinate Systems,” *Windows Mixed Reality* website, 2017. Cited on p. 918, 932

[[1208](#_bookmark0)] Microsoft, “Direct3D 11 Graphics,” *Windows Dev Center*. Cited on p. 42, 233, 525

[[1209](#_bookmark0)] Mikkelsen, Morten S., “Bump Mapping Unparametrized Surfaces on the GPU,” Technical Report, Naughty Dog, 2010. Cited on p. 210

[[1210](#_bookmark0)] Mikkelsen, Morten S., “Fine Pruned Tiled Light Lists,” in Wolfgang Engel, ed., *GPU Pro*7,

CRC Press, pp. 69–81, 2016. Cited on p. 897, 914

[[1211](#_bookmark0)] Miller, Gavin, “Eﬃcient Algorithms for Local and Global Accessibility Shading,” in *SIG- GRAPH ’94: Proceedings of the 21st Annual Conference on Computer Graphics and Inter- active Techniques*, ACM, pp. 319–326, July 1994. Cited on p. 449

[[1212](#_bookmark0)] Miller, Gene S., and C. Robert Hoﬀman, “Illumination and Reﬂection Maps: Simulated Ob- jects in Simulated and Real Environments,” *SIGGRAPH Advanced Computer Graphics Ani- mation course*, July 1984. Cited on p. 408, 424

[[1213](#_bookmark0)] Miller, Scott, “A Perceptual EOTF for Extended Dynamic Range Imagery,” *SMPTE Stan- dards Update presentation*, May 6, 2014. Cited on p. 281

[[1214](#_bookmark0)] Mitchell, D., and A. Netravali, “Reconstruction Filters in Computer Graphics,” *Computer Graphics (SIGGRAPH ’88 Proceedings)*, vol. 22, no. 4, pp. 239–246, Aug. 1988. Cited on

p. 136

[[1215](#_bookmark0)] Mitchell, Jason L., Michael Tatro, and Ian Bullard, “Multitexturing in DirectX 6,” *Game Developer*, vol. 5, no. 9, pp. 33–37, Sept. 1998. Cited on p. 200

[[1216](#_bookmark0)] Mitchell, Jason L., “Advanced Vertex and Pixel Shader Techniques,” *European Game Devel- opers Conference*, Sept. 2001. Cited on p. 521

[[1217](#_bookmark0)] Mitchell, Jason L., “Image Processing with 1.4 Pixel Shaders in Direct3D,” in Wolfgang Engel, ed., *Direct3D ShaderX: Vertex & Pixel Shader Tips and Techniques*, Wordware, pp. 258–269, 2002. Cited on p. 521, 662

[[1218](#_bookmark0)] Mitchell, Jason L., Marwan Y. Ansari, and Evan Hart, “Advanced Image Processing with DirectX 9 Pixel Shaders,” in Wolfgang Engel, ed., *ShaderX*2*: Shader Programming Tips and Tricks with DirectX 9*, Wordware, pp. 439–468, 2004. Cited on p. 515, 517, 521

[[1219](#_bookmark0)] Mitchell, Jason L., “Light Shaft Rendering,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 573–588, 2004. Cited on p. 604

[[1220](#_bookmark0)] Mitchell, Jason L., and Pedro V. Sander, “Applications of Explicit Early-Z Culling,” *SIG-*

*GRAPH Real-Time Shading course*, Aug. 2004. Cited on p. 53, 1016

[[1221](#_bookmark0)] Mitchell, Jason, “Motion Blurring Environment Maps,” in Wolfgang Engel, ed., *ShaderX*4,

Charles River Media, pp. 263–268, 2005. Cited on p. 538

[[1222](#_bookmark0)] Mitchell, Jason, Gary McTaggart, and Chris Green, “Shading in Valve’s Source Engine,”

*SIGGRAPH Advanced Real-Time Rendering in 3D Graphics and Games course*, Aug. 2006.

Cited on p. 289, 382, 402, 499

[[1223](#_bookmark0)] Mitchell, Jason L., Moby Francke, and Dhabih Eng, “Illustrative Rendering in *Team Fortress 2*,” *Proceedings of the 5th International Symposium on Non-Photorealistic Animation and Rendering*, ACM, pp. 71–76, Aug. 2007. Collected in [1746]. Cited on p. 678

[[1224](#_bookmark0)] Mitchell, Jason, “ Stylization with a Purpose: The Illustrative World of *Team Fortress 2*,”

*Game Developers Conference*, Mar. 2008. Cited on p. 652, 654

[[1225](#_bookmark0)] Mitchell, Kenny, “Volumetric Light Scattering as a Post-Process,” in Hubert Nguyen, ed.,

*GPU Gems 3*, Addison-Wesley, pp. 275–285, 2007. Cited on p. 604

[[1226](#_bookmark0)] Mittring, Martin, “Triangle Mesh Tangent Space Calculation,” in Wolfgang Engel, ed.,

*ShaderX*4, Charles River Media, pp. 77–89, 2005. Cited on p. 210

[[1227](#_bookmark0)] Mittring, Martin, “Finding Next Gen—CryEngine 2,” *SIGGRAPH Advanced Real-Time Ren- dering in 3D Graphics and Games course*, Aug. 2007. Cited on p. 43, 195, 239, 242, 255, 457,

476, 559, 856, 860, 861

[[1228](#_bookmark0)] Mittring, Martin, and Byran Dudash, “The Technology Behind the DirectX 11 Unreal Engine ‘Samaritan’ Demo,” *Game Developers Conference*, Mar. 2011. Cited on p. 389, 502, 531, 641,

642

[[1229](#_bookmark0)] Mittring, Martin, “The Technology Behind the ‘Unreal Engine 4 Elemental Demo’,” *Game Developers Conference*, Mar. 2012. Cited on p. 288, 371, 383, 495, 526, 536, 571

[[1230](#_bookmark0)] Mohr, Alex, and Michael Gleicher, “Building Eﬃcient, Accurate Character Skins from Exam- ples,” *ACM Transactions on Graphics (SIGGRAPH 2003)*, vol. 22, no. 3, pp. 562–568, 2003.

Cited on p. 85

[[1231](#_bookmark0)] M¨oller, Tomas, and Ben Trumbore, “Fast, Minimum Storage Ray-Triangle Intersection,” *jour- nal of graphics tools*, vol. 2, no. 1, pp. 21–28, 1997. Also collected in [112]. Cited on p. 962,

965

[[1232](#_bookmark0)] M¨oller, Tomas, “A Fast Triangle-Triangle Intersection Test,” *journal of graphics tools*, vol. 2, no. 2, pp. 25–30, 1997. Cited on p. 972

[[1233](#_bookmark0)] M¨oller, Tomas, and John F. Hughes, “Eﬃciently Building a Matrix to Rotate One Vector to Another,” *journal of graphics tools*, vol. 4, no. 4, pp. 1–4, 1999. Also collected in [112]. Cited on p. 83, 84

[[1234](#_bookmark0)] Molnar, Steven, “Eﬃcient Supersampling Antialiasing for High-Performance Architectures,” Technical Report TR91-023, Department of Computer Science, University of North Carolina at Chapel Hill, 1991. Cited on p. 145, 547

[[1235](#_bookmark0)] Molnar, S., J. Eyles, and J. Poulton, “PixelFlow: High-Speed Rendering Using Image Compo- sition,” *Computer Graphics (SIGGRAPH ’92 Proceedings)*, vol. 26, no. 2, pp. 231–240, July

1992. Cited on p. 883, 1022

[[1236](#_bookmark0)] Molnar, S., M. Cox, D. Ellsworth, and H. Fuchs, “A Sorting Classiﬁcation of Parallel Render- ing,” *IEEE Computer Graphics and Applications*, vol. 14, no. 4, pp. 23–32, July 1994. Cited on p. 1020, 1023

[[1237](#_bookmark0)] Montesdeoca, S. E., H. S. Seah, and H.-M. Rall, “Art-Directed Watercolor Rendered Anima- tion,” in *Expressive 2016*, Eurographics Association, pp. 51–58, May 2016. Cited on p. 665

[[1238](#_bookmark0)] Morein, Steve, “ATI Radeon HyperZ Technology,” *Graphics Hardware Hot3D session*, Aug.

2000. Cited on p. 1009, 1015, 1016, 1038

[[1239](#_bookmark0)] Moreton, Henry P., and Carlo H. S´equin, “Functional Optimization for Fair Surface Design,”

*Computer Graphics (SIGGRAPH ’92 Proceedings)*, vol. 26, no. 2, pp. 167–176, July 1992.

Cited on p. 761

[[1240](#_bookmark0)] Moreton, Henry, “Watertight Tessellation Using Forward Diﬀerencing,” in *Graphics Hardware 2001*, Eurographics Association, pp. 25–132, Aug. 2001. Cited on p. 768, 769

[[1241](#_bookmark0)] Moroviˇc, J´an, *Color Gamut Mapping*, John Wiley & Sons, 2008. Cited on p. 278

[[1242](#_bookmark0)] Mortenson, Michael E., *Geometric Modeling*, Third Edition, John Wiley & Sons, 2006. Cited on p. 718, 781

[[1243](#_bookmark0)] Morton, G. M., “A Computer Oriented Geodetic Data Base and a New Technique in File Sequencing,” Technical Report, IBM, Ottawa, Ontario, Mar. 1, 1966. Cited on p. 1018

[[1244](#_bookmark0)] Mueller, Carl, “Architectures of Image Generators for Flight Simulators,” Technical Report TR95-015, Department of Computer Science, University of North Carolina at Chapel Hill, 1995. Cited on p. 149

[[1245](#_bookmark0)] Mulde, Jurriaan D., Frans C. A. Groen, and Jarke J. van Wijk, “Pixel Masks for Screen-Door Transparency,” in *Visualization ’98*, IEEE Computer Society, pp. 351–358, Oct. 1998. Cited on p. 149

[[1246](#_bookmark0)] Munkberg, Jacob, and Tomas Akenine-M¨oller, “Backface Culling for Motion Blur and Depth of Field,” *Journal of Graphics, GPU, and Game Tools*, vol. 15, no. 2, pp. 123–139, 2011.

Cited on p. 835

[[1247](#_bookmark0)] Munkberg, Jacob, Karthik Vaidyanathan, Jon Hasselgren, Petrik Clarberg, and Tomas Akenine-Mo¨ller, “Layered Reconstruction for Defocus and Motion Blur,” *Computer Graphics Forum*, vol. 33, no. 4, pp. 81–92, 2014. Cited on p. 542

[[1248](#_bookmark0)] Munkberg, J., J. Hasselgren, P. Clarberg, M. Andersson, and T. Akenine-M¨oller, “Texture Space Caching and Reconstruction for Ray Tracing,” *ACM Transactions on Graphics*, vol. 35, no. 6, pp. 249:1–249:13, 2016. Cited on p. 934

[[1249](#_bookmark0)] Museth, Ken, “VDB: High-Resolution Sparse Volumes with Dynamic Topology,” *ACM Trans- actions on Graphics*, vol. 32, no. 2, article no. 27, June 2013. Cited on p. 578, 584

[[1250](#_bookmark0)] Myers, Kevin, “Alpha-to-Coverage in Depth,” in Wolfgang Engel, ed., *ShaderX*5, Charles River Media, pp. 69–74, 2006. Cited on p. 207

[[1251](#_bookmark0)] Myers, Kevin, “Variance Shadow Mapping,” NVIDIA White Paper, 2007. Cited on p. 253

[[1252](#_bookmark0)] Myers, Kevin, Randima (Randy) Fernando, and Louis Bavoil, “Integrating Realistic Soft Shadows into Your Game Engine,” NVIDIA White Paper, Feb. 2008. Cited on p. 250

[[1253](#_bookmark0)] Myers, Kevin, “Sparse Shadow Trees,” in *ACM SIGGRAPH 2016 Talks*, ACM, article no. 14,

July 2016. Cited on p. 239, 246, 263

[[1254](#_bookmark0)] Nagy, Gabor, “Real-Time Shadows on Complex Objects,” in Mark DeLoura, ed., *Game Pro- gramming Gems*, Charles River Media, pp. 567–580, 2000. Cited on p. 229

[[1255](#_bookmark0)] Nagy, Gabor, “Convincing-Looking Glass for Games,” in Mark DeLoura, ed., *Game Program- ming Gems*, Charles River Media, pp. 586–593, 2000. Cited on p. 153

[[1256](#_bookmark0)] Nah, J.-H., H.-J. Kwon, D.-S. Kim, C.-H. Jeong, J. Park, T.-D. Han, D. Manocha, and W.-C. Park, “RayCore: A Ray-Tracing Hardware Architecture for Mobile Devices,” *ACM Transactions on Graphics*, vol. 33, no. 5, pp. 162:1–162:15, 2014. Cited on p. 1039

[[1257](#_bookmark0)] Naiman, Avi C., “Jagged Edges: When Is Filtering Needed?,” *ACM Transactions on Graph- ics*, vol. 14, no. 4, pp. 238–258, 1998. Cited on p. 143

[[1258](#_bookmark0)] Narasimhan, Srinivasa G., Mohit Gupta, Craig Donner, Ravi Ramamoorthi, Shree K. Nayar, and Henrik Wann Jensen, “Acquiring Scattering Properties of Participating Media by Dilu- tion,” *ACM Transactions on Graphics (SIGGRAPH 2006)*, vol. 25, no. 3, pp. 1003–1012,

Aug. 2006. Cited on p. 591, 592

[[1259](#_bookmark0)] Narkowicz, Krzysztof, *Real-Time BC6H Compression on GPU*, in Wolfgang Engel, ed., *GPU Pro*5, CRC Press, pp. 219–230, 2014. Cited on p. 503, 870

[[1260](#_bookmark0)] Narkowicz, Krzysztof, “ACES Filmic Tone Mapping Curve,” *Krzysztof Narkowicz* blog, Jan.

6, 2016. Cited on p. 287

[[1261](#_bookmark0)] Narkowicz, Krzysztof, “HDR Display—First Steps,” *Krzysztof Narkowicz* blog, Aug. 31, 2016.

Cited on p. 287

[[1262](#_bookmark0)] Nassau, Kurt, *The Physics and Chemistry of Color: The Fifteen Causes of Color*, Second Edition, John Wiley & Sons, Inc., 2001. Cited on p. 373

[[1263](#_bookmark0)] Navarro, Fernando, Francisco J. Ser´on, and Diego Gutierrez, “Motion Blur Rendering: State of the Art,” *Computer Graphics Forum*, vol. 30, no. 1, pp. 3–26, 2011. Cited on p. 543

[[1264](#_bookmark0)] Nehab, D., P. Sander, J. Lawrence, N. Tatarchuk, and J. Isidoro, “Accelerating Real-Time Shading with Reverse Reprojection Caching,” in *Graphics Hardware 2007*, Eurographics As- sociation, pp. 25–35, Aug. 2007. Cited on p. 522, 523

[[1265](#_bookmark0)] Nelson, Scott R., “Twelve Characteristics of Correct Antialiased Lines,” *journal of graphics tools*, vol. 1, no. 4, pp. 1–20, 1996. Cited on p. 165

[[1266](#_bookmark0)] Neubelt, D., and M. Pettineo, “Crafting a Next-Gen Material Pipeline for *The Order: 1886*,” *SIGGRAPH Physically Based Shading in Theory and Practice course*, July 2013. Cited on p. 357, 365, 370

[[1267](#_bookmark0)] Neubelt, D., and M. Pettineo, “Crafting a Next-Gen Material Pipeline for *The Order: 1886*,”

*Game Developers Conference*, Mar. 2014. Cited on p. 365, 370, 466, 896

[[1268](#_bookmark0)] Neubelt, D., and M. Pettineo, “Advanced Lighting R&D at Ready At Dawn Studios,” *SIG- GRAPH Physically Based Shading in Theory and Practice course*, Aug. 2015. Cited on p. 398, 477, 488, 498

[[1269](#_bookmark0)] Ng, Ren, Ravi Ramamoorthi, and Pat Hanrahan, “All-Frequency Shadows Using Non-linear Wavelet Lighting Approximation,” *ACM Transactions on Graphics (SIGGRAPH 2003)*, vol. 22, no. 3, pp. 376–281, 2003. Cited on p. 433

[[1270](#_bookmark0)] Ng, Ren, Ravi Ramamoorthi, and Pat Hanrahan, “Triple Product Wavelet Integrals for All- Frequency Relighting,” *ACM Transactions on Graphics (SIGGRAPH 2004)*, vol. 23, no. 3, pp. 477–487, Aug. 2004. Cited on p. 402, 433, 470

[[1271](#_bookmark0)] Ngan, Addy, Fr´edo Durand, and Wojciech Matusik, “Experimental Analysis of BRDF Mod- els,” in *16th Eurographics Symposium on Rendering*, Eurographics Association, pp. 117–126,

June–July 2005. Cited on p. 338, 343

[[1272](#_bookmark0)] Nguyen, Hubert, “Casting Shadows on Volumes,” *Game Developer*, vol. 6, no. 3, pp. 44–53,

Mar. 1999. Cited on p. 229

[[1273](#_bookmark0)] Nguyen, Hubert, “Fire in the ‘Vulcan’ Demo,” in Randima Fernando, ed., *GPU Gems*, Addison-Wesley, pp. 87–105, 2004. Cited on p. 152, 521, 554

[[1274](#_bookmark0)] Nguyen, Hubert, and William Donnelly, “Hair Animation and Rendering in the ‘Nalu’ Demo,” in Matt Pharr, ed., *GPU Gems 2*, Addison-Wesley, pp. 361–380, 2005. Cited on p. 257, 644,

719, 730

[[1275](#_bookmark0)] Ni, T., I. Castan˜o, J. Peters, J. Mitchell, P. Schneider, and V. Verma, *SIGGRAPH Efficient Substitutes for Subdivision Surfaces course*, Aug. 2009. Cited on p. 767, 781

[[1276](#_bookmark0)] Nichols, Christopher, “The Truth about Unbiased Rendering,” *Chaosgroup Labs* blog, Sept.

29, 2016. Cited on p. 1043

[[1277](#_bookmark0)] Nicodemus, F. E., J. C. Richmond, J. J. Hsia, I. W. Ginsberg, and T. Limperis, “Geometric Considerations and Nomenclature for Reﬂectance,” National Bureau of Standards (US), Oct. 1977. Cited on p. 310, 634

[[1278](#_bookmark0)] Nienhuys, Han-Wen, Jim Arvo, and Eric Haines, “Results of Sphere in Box Ratio Contest,”

*Ray Tracing News*, vol. 10, no. 1, Jan. 1997. Cited on p. 953

[[1279](#_bookmark0)] Nießner, M., C. Loop, M. Meyer, and T. DeRose, “Feature-Adaptive GPU Rendering of Catmull-Clark Subdivision Surfaces,” *ACM Transactions on Graphics*, vol. 31, no. 1, pp. 6:1– 6:11, Jan. 2012. Cited on p. 771, 774, 777, 778, 779

[[1280](#_bookmark0)] Nießner, M., C. Loop, and G. Greiner, “Eﬃcient Evaluation of Semi-Smooth Creases in Catmull-Clark Subdivision Surfaces,” in *Eurographics 2012—Short Papers*, Eurographics As- sociation, pp. 41–44, May 2012. Cited on p. 777

[[1281](#_bookmark0)] Nießner, M., and C. Loop, “Analytic Displacement Mapping Using Hardware Tessellation,”

*ACM Transactions on Graphics*, vol. 32, no. 3, pp. 26:1–26:9, 2013. Cited on p. 766, 773

[[1282](#_bookmark0)] Nießner, M., *Rendering Subdivision Surfaces Using Hardware Tessellation*, PhD thesis,

Friedrich-Alexander-Universit¨at Erlangen-Nu¨rnberg, 2013. Cited on p. 777, 779, 781

[[1283](#_bookmark0)] Nießner, M., B. Keinert, M. Fisher, M. Stamminger, C. Loop, and H. Sch¨afer, “Real-Time Rendering Techniques with Hardware Tessellation,” *Computer Graphics Forum*, vol. 35, no. 1, pp. 113–137, 2016. Cited on p. 773, 781, 879

[[1284](#_bookmark0)] Nishita, Tomoyuki, Thomas W. Sederberg, and Masanori Kakimoto, “Ray Tracing Trimmed Rational Surface Patches,” *Computer Graphics (SIGGRAPH ’90 Proceedings)*, vol. 24, no. 4, pp. 337–345, Aug. 1990. Cited on p. 967

[[1285](#_bookmark0)] Nishita, Tomoyuki, Takao Sirai, Katsumi Tadamura, and Eihachiro Nakamae, “Display of the Earth Taking into Account Atmospheric Scattering,” in *SIGGRAPH ’93: Proceedings of the 20th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 175–182, Aug. 1993. Cited on p. 614

[[1286](#_bookmark0)] N¨oll, Tobias, and Didier Stricker, “Eﬃcient Packing of Arbitrarily Shaped Charts for Auto- matic Texture Atlas Generation,” in *Proceedings of the Twenty-Second Eurographics Confer- ence on Rendering*, Eurographics Association, pp. 1309–1317, 2011. Cited on p. 191

[[1287](#_bookmark0)] Northrup, J. D., and Lee Markosian, “Artistic Silhouettes: A Hybrid Approach,” in *Proceed- ings of the 1st International Symposium on Non-photorealistic Animation and Rendering*,

ACM, pp. 31–37, June 2000. Cited on p. 668

[[1288](#_bookmark0)] Nov´ak, J., and C. Dachsbacher, “Rasterized Bounding Volume Hierarchies,” *Computer Graph- ics Forum*, vol. 31, no. 2, pp. 403–412, 2012. Cited on p. 565

[[1289](#_bookmark0)] Novosad, Justin, “Advanced High-Quality Filtering,” in Matt Pharr, ed., *GPU Gems 2*,

Addison-Wesley, pp. 417–435, 2005. Cited on p. 136, 517, 521

[[1290](#_bookmark0)] Nowrouzezahrai, Derek, Patricio Simari, and Eugene Fiume, “Sparse Zonal Harmonic Fac- torization for Eﬃcient SH Rotation,” *ACM Transactions on Graphics*, vol. 31, no. 3, article no. 23, 2012. Cited on p. 401

[[1291](#_bookmark0)] Nuebel, Markus, “Hardware-Accelerated Charcoal Rendering,” in Wolfgang Engel, ed.,

*ShaderX*3, Charles River Media, pp. 195–204, 2004. Cited on p. 671

[[1292](#_bookmark0)] Nummelin, Niklas, “Frostbite on Mobile,” *SIGGRAPH Moving Mobile Graphics course*, Aug.

2015. Cited on p. 903

[[1293](#_bookmark0)] NVIDIA Corporation, “Improve Batching Using Texture Atlases,” SDK White Paper, 2004.

Cited on p. 191

[[1294](#_bookmark0)] NVIDIA Corporation, “GPU Programming Exposed: The Naked Truth Behind NVIDIA’s Demos,” *SIGGRAPH Exhibitor Tech Talk*, Aug. 2005. Cited on p. 531

[[1295](#_bookmark0)] NVIDIA Corporation, “Solid Wireframe,” White Paper, WP-03014-001 v01, Feb. 2007. Cited on p. 673, 675

[[1296](#_bookmark0)] NVIDIA Corporation, “NVIDIA GF100—World’s Fastest GPU Delivering Great Gaming Per- formance with True Geometric Realism,” White Paper, 2010. Cited on p. 1031

[[1297](#_bookmark0)] NVIDIA Corporation, “NVIDIA GeForce GTX 1080—Gaming Perfected,” White Paper, 2016.

Cited on p. 929, 1029, 1030, 1032, 1033

[[1298](#_bookmark0)] NVIDIA Corporation, “NVIDIA Tesla P100—The Most Advanced Datacenter Accelerator Ever Built,” White Paper, 2016. Cited on p. 1029, 1030, 1034

[[1299](#_bookmark0)] *NVIDIA GameWorks DirectX Samples*, [https://developer.nvidia.com/gameworks-directx](https://developer.nvidia.com/gameworks-directx-samples)

[-samples](https://developer.nvidia.com/gameworks-directx-samples). Cited on p. 888, 914

[[1300](#_bookmark0)] *NVIDIA SDK 10*, [http://developer.download.nvidia.com/SDK/10/direct3d/samples.html](http://developer.download.nvidia.com/SDK/10/direct3d/samples.html%2C2008),

[2](#_bookmark0)[008](http://developer.download.nvidia.com/SDK/10/direct3d/samples.html%2C2008)[.](#_bookmark0) Cited on p. 48, 255, 558, 647

[[1301](#_bookmark0)] *NVIDIA SDK 11*, <https://developer.nvidia.com/dx11-samples>. Cited on p. 46, 55, 150

[[1302](#_bookmark0)] Nystad, J., A. Lassen, A. Pomianowski, S. Ellis, and T. Olson, “Adaptive Scalable Texture Compression,” in *Proceedings of the Fourth ACM SIGGRAPH / Eurographics Conference on High-Performance Graphics*, Eurographics Association, pp. 105–114, June 2012. Cited on p. 196

[[1303](#_bookmark0)] Oat, Chris, “A Steerable Streak Filter,” in Wolfgang Engel, ed., *ShaderX*3, Charles River Media, pp. 341–348, 2004. Cited on p. 520, 524, 525

[[1304](#_bookmark0)] Oat, Chris, “Irradiance Volumes for Games,” *Game Developers Conference*, Mar. 2005. Cited on p. 487

[[1305](#_bookmark0)] Oat, Chris, “Irradiance Volumes for Real-Time Rendering,” in Wolfgang Engel, ed., *ShaderX*5,

Charles River Media, pp. 333–344, 2006. Cited on p. 487

[[1306](#_bookmark0)] Oat, Christopher, and Pedro V. Sander, “Ambient Aperture Lighting,” *SIGGRAPH Advanced Real-Time Rendering in 3D Graphics and Games course*, Aug. 2006. Cited on p. 466

[[1307](#_bookmark0)] Oat, Christopher, and Pedro V. Sander, “Ambient Aperture Lighting,” in *Proceedings of the 2007 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 61–64, Apr.–May 2007.

Cited on p. 466, 467, 470

[[1308](#_bookmark0)] Oat, Christopher, and Thorsten Scheuermann, “Computing Per-Pixel Object Thickness in a Single Render Pass,” in Wolfgang Engel, ed., *ShaderX*6, Charles River Media, pp. 57–62, 2008. Cited on p. 602

[[1309](#_bookmark0)] Obert, Juraj, J. M. P. van Waveren, and Graham Sellers, *SIGGRAPH Virtual Texturing in Software and Hardware course*, Aug. 2012. Cited on p. 867

[[1310](#_bookmark0)] Ochiai, H., K. Anjyo, and A. Kimura, *SIGGRAPH An Elementary Introduction to Matrix Exponential for CG course*, July 2016. Cited on p. 102

[[1311](#_bookmark0)] *Oculus Best Practices*, Oculus VR, LLC, 2017. Cited on p. 920, 923, 924, 925, 928, 932, 933,

935, 936, 937, 939

[[1312](#_bookmark0)] O’Donnell, Yuriy, and Matth¨aus G. Chajdas, “Tiled Light Trees,” *Symposium on Interactive 3D Graphics and Games*, Feb. 2017. Cited on p. 903

[[1313](#_bookmark0)] O’Donnell, Yuriy, “FrameGraph: Extensible Rendering Architecture in Frostbite,” *Game De- velopers Conference*, Feb.–Mar. 2017. Cited on p. 514, 520, 812, 814

[[1314](#_bookmark0)] Ofek, E., and A. Rappoport, “Interactive Reﬂections on Curved Objects,” in *SIGGRAPH ’98: Proceedings of the 25th Annual Conference on Computer Graphics and Interactive Tech- niques*, ACM, pp. 333–342, July 1998. Cited on p. 505

[[1315](#_bookmark0)] Ohlarik, Deron, “Bounding Sphere,” *AGI* blog, Feb. 4, 2008. Cited on p. 950

[[1316](#_bookmark0)] Ohlarik, Deron, “Precisions, Precisions,” *AGI* blog, Sept. 3, 2008. Cited on p. 715

[[1317](#_bookmark0)] Olano, M., and T. Greer, “Triangle Scan Conversion Using 2D Homogeneous Coordinates,” in

*Proceedings of the ACM SIGGRAPH/EUROGRAPHICS Workshop on Graphics Hardware*,

ACM, pp. 89–95, Aug. 1997. Cited on p. 832, 999

[[1318](#_bookmark0)] Olano, Marc, Bob Kuehne, and Maryann Simmons, “Automatic Shader Level of Detail,” in

*Graphics Hardware 2003*, Eurographics Association, pp. 7–14, July 2003. Cited on p. 853

[[1319](#_bookmark0)] Olano, Marc, “Modiﬁed Noise for Evaluation on Graphics Hardware,” in *Graphics Hardware 2005*, Eurographics Association, pp. 105–110, July 2005. Cited on p. 199

[[1320](#_bookmark0)] Olano, Marc, and Dan Baker, “LEAN Mapping,” in *Proceedings of the 2010 ACM SIG- GRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 181–188, 2010. Cited on p. 370

[[1321](#_bookmark0)] Olano, Marc, Dan Baker, Wesley Griﬃn, and Joshua Barczak, “Variable Bit Rate GPU Tex- ture Decompression,” in *Proceedings of the Twenty-Second Eurographics Symposium on Ren- dering Techniques*, Eurographics Association, pp. 1299–1308, June 2011. Cited on p. 871

[[1322](#_bookmark0)] Olick, Jon, “Segment Buﬀering,” in Matt Pharr, ed., *GPU Gems 2*, Addison-Wesley, pp. 69– 73, 2005. Cited on p. 797

[[1323](#_bookmark0)] Olick, Jon, “Current Generation Parallelism in Games,” *SIGGRAPH Beyond Programmable Shading course*, Aug. 2008. Cited on p. 584

[[1324](#_bookmark0)] Oliveira, Manuel M., Gary Bishop, and David McAllister, “Relief Texture Mapping,” in *SIG- GRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interac- tive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 359–368, July 2000. Cited on p. 565

[[1325](#_bookmark0)] Oliveira, Manuel M., and Fabio Policarpo, “An Eﬃcient Representation for Surface Details,” Technical Report RP-351, Universidade Federal do Rio Grande do Sul, Jan. 26, 2005. Cited on p. 220

[[1326](#_bookmark0)] Oliveira, Manuel M., and Maicon Brauwers, “Real-Time Refraction Through Deformable Ob- jects,” in *Proceedings of the 2007 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 89–96, Apr.–May 2007. Cited on p. 630

[[1327](#_bookmark0)] Olsson, O., and U. Assarsson, “Tiled Shading,” *Journal of Graphics, GPU, and Game Tools*, vol. 15, no. 4, pp. 235–251, 2011. Cited on p. 882, 894, 895

[[1328](#_bookmark0)] Olsson, O., M. Billeter, and U. Assarsson, “Clustered Deferred and Forward Shading,” in *High-Performance Graphics 2012*, Eurographics Association, pp. 87–96, June 2012. Cited on p. 899, 900, 901, 903

[[1329](#_bookmark0)] Olsson, O., M. Billeter, and U. Assarsson, “Tiled and Clustered Forward Shading: Supporting Transparency and MSAA,” in *ACM SIGGRAPH 2012 Talks*, ACM, article no. 37, Aug. 2012.

Cited on p. 899, 900

[[1330](#_bookmark0)] Olsson, Ola, Markus Billeter, and Erik Sintorn, “More Eﬃcient Virtual Shadow Maps for Many Lights,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 21, no. 6, pp. 701–713, June 2015. Cited on p. 247, 882, 904

[[1331](#_bookmark0)] Olsson, Ola, “Eﬃcient Shadows from Many Lights,” *SIGGRAPH Real-Time Many-Light Management and Shadows with Clustered Shading course*, Aug. 2015. Cited on p. 904, 914

[[1332](#_bookmark0)] Olsson, Ola, “Introduction to Real-Time Shading with Many Lights,” *SIGGRAPH Real-Time Many-Light Management and Shadows with Clustered Shading course*, Aug. 2015. Cited on p. 886, 892, 893, 900, 904, 905, 914, 1042

[[1333](#_bookmark0)] O’Neil, Sean, “Accurate Atmospheric Scattering,” in Matt Pharr, ed., *GPU Gems 2*, Addison-

Wesley, pp. 253–268, 2005. Cited on p. 614

[[1334](#_bookmark0)] van Oosten, Jeremiah, “Volume Tiled Forward Shading,” *3D Game Engine Programming*

website, July 18, 2017. Cited on p. 900, 914

[[1335](#_bookmark0)] *Open 3D Graphics Compression*, Khronos Group, 2013. Cited on p. 712

[[1336](#_bookmark0)] *OpenVDB*, [http://openvdb.org,](http://openvdb.org/) 2017. Cited on p. 578

[[1337](#_bookmark0)] Oren, Michael, and Shree K. Nayar, “Generalization of Lambert’s Reﬂectance Model,” in *SIGGRAPH ’94: Proceedings of the 21st Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 239–246, July 1994. Cited on p. 331, 354

[[1338](#_bookmark0)] O’Rourke, Joseph, “Finding Minimal Enclosing Boxes,” *International Journal of Computer & Information Sciences*, vol. 14, no. 3, pp. 183–199, 1985. Cited on p. 951

[[1339](#_bookmark0)] O’Rourke, Joseph, *Computational Geometry in C*, Second Edition, Cambridge University Press, 1998. Cited on p. 685, 686, 967

[[1340](#_bookmark0)] O¨ rtegren, Kevin, and Emil Persson, “Clustered Shading: Assigning Lights Using Conservative Rasterization in DirectX 12,” in Wolfgang Engel, ed., *GPU Pro*7, CRC Press, pp. 43–68, 2016.

Cited on p. 901, 914

[[1341](#_bookmark0)] van Overveld, C. V. A. M., and B. Wyvill, “An Algorithm for Polygon Subdivision Based on Vertex Normals,” in *Computer Graphics International ’97*, IEEE Computer Society, pp. 3–12,

June 1997. Cited on p. 744

[[1342](#_bookmark0)] van Overveld, C. V. A. M., and B. Wyvill, “Phong Normal Interpolation Revisited,” *ACM Transactions on Graphics*, vol. 16, no. 4, pp. 397–419, Oct. 1997. Cited on p. 746

[[1343](#_bookmark0)] Ownby, John-Paul, Chris Hall, and Rob Hall, “*Toy Story 3: The Video Game*—Rendering Techniques,” *SIGGRAPH Advances in Real-Time Rendering in 3D Graphics and Games course*, July 2010. Cited on p. 230, 249, 519

[[1344](#_bookmark0)] Paeth, Alan W., ed., *Graphics Gems V*, Academic Press, 1995. Cited on p. 102, 991

[[1345](#_bookmark0)] Pag´an, Tito, “Eﬃcient UV Mapping of Complex Models,” *Game Developer*, vol. 8, no. 8, pp. 28–34, Aug. 2001. Cited on p. 171, 173

[[1346](#_bookmark0)] Palandri, R´emi, and Simon Green, “Hybrid Mono Rendering in UE4 and Unity,” *Oculus Developer Blog*, Sept. 30, 2016. Cited on p. 928

[[1347](#_bookmark0)] Pallister, Kim, “Generating Procedural Clouds Using 3D Hardware,” in Mark DeLoura, ed.,

*Game Programming Gems 2*, Charles River Media, pp. 463–473, 2001. Cited on p. 556

[[1348](#_bookmark0)] Pangerl, David, “Quantized Ring Clipping,” in Wolfgang Engel, ed., *ShaderX*6, Charles River Media, pp. 133–140, 2008. Cited on p. 873

[[1349](#_bookmark0)] Pangerl, David, “Practical Thread Rendering for DirectX 9,” in Wolfgang Engel, ed., *GPU Pro*, A K Peters, Ltd., pp. 541–546, 2010. Cited on p. 814

[[1350](#_bookmark0)] Pantaleoni, Jacopo, “VoxelPipe: A Programmable Pipeline for 3D Voxelization,” in *High- Performance Graphics 2011*, Eurographics Association, pp. 99–106, Aug. 2011. Cited on p. 581

[[1351](#_bookmark0)] Papathanasis, Andreas, “Dragon Age II DX11 Technology,” *Game Developers Conference*,

Mar. 2011. Cited on p. 252, 892

[[1352](#_bookmark0)] Papavasiliou, D., “Real-Time Grass (and Other Procedural Objects) on Terrain,” *Journal of Computer Graphics Techniques*, vol. 4, no. 1, pp. 26–49, 2015. Cited on p. 864

[[1353](#_bookmark0)] Parberry, Ian, “Amortized Noise,” *Journal of Computer Graphics Techniques*, vol. 3, no. 2, pp. 31–47, 2014. Cited on p. 199

[[1354](#_bookmark0)] Parent, R., *Computer Animation: Algorithms & Techniques*, Third Edition, Morgan Kauf- mann, 2012. Cited on p. 102

[[1355](#_bookmark0)] Paris, Sylvain, Pierre Kornprobst, Jack Tumblin, and Fr´edo Durand, *SIGGRAPH A Gentle Introduction to Bilateral Filtering and Its Applications course*, Aug. 2007. Cited on p. 518, 520, 543

[[1356](#_bookmark0)] Parker, Steven, William Martin, Peter-Pike J. Sloan, Peter Shirley, Brian Smits, and Charles Hansen, “Interactive Ray Tracing,” in *Proceedings of the 1999 Symposium on Interactive 3D Graphics*, ACM, pp. 119–134, 1999. Cited on p. 431

[[1357](#_bookmark0)] Patney, Anjul, Marco Salvi, Joohwan Kim, Anton Kaplanyan, Chris Wyman, Nir Benty, David Luebke, and Aaron Lefohn, “Towards Foveated Rendering for Gaze-Tracked Virtual Reality,” *ACM Transactions on Graphics*, vol. 35, no. 6, article no. 179, 2016. Cited on p. 143, 924,

931, 932

[[1358](#_bookmark0)] Patney, Anuj, *SIGGRAPH Applications of Visual Perception to Virtual Reality course*, Aug.

2017. Cited on p. 931, 940

[[1359](#_bookmark0)] Patry, Jasmin, “HDR Display Support in *Infamous Second Son* and *Infamous First Light*

(Part 1),” *glowybits* blog, Dec. 21, 2016. Cited on p. 287

[[1360](#_bookmark0)] Patry, Jasmin, “HDR Display Support in *Infamous Second Son* and *Infamous First Light*

(Part 2),” *glowybits* blog, Jan. 4, 2017. Cited on p. 283

[[1361](#_bookmark0)] Patterson, J. W., S. G. Hoggar, and J. R. Logie, “Inverse Displacement Mapping,” *Computer Graphics Forum*, vol. 10 no. 2, pp. 129–139, 1991. Cited on p. 217

[[1362](#_bookmark0)] Paul, Richard P. C., *Robot Manipulators: Mathematics, Programming, and Control*, MIT Press, 1981. Cited on p. 73

[[1363](#_bookmark0)] Peercy, Mark S., Marc Olano, John Airey, and P. Jeﬀrey Ungar, “Interactive Multi-Pass Programmable Shading,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 425–432, July 2000. Cited on p. 38

[[1364](#_bookmark0)] Pegoraro, Vincent, Mathias Schott, and Steven G. Parker, “An Analytical Approach to Sin- gle Scattering for Anisotropic Media and Light Distributions,” in *Graphics Interface 2009*,

Canadian Information Processing Society, pp. 71–77, 2009. Cited on p. 604

[[1365](#_bookmark0)] Pellacini, Fabio, “User-Conﬁgurable Automatic Shader Simpliﬁcation,” *ACM Transactions on Graphics (SIGGRAPH 2005)*, vol. 24, no. 3, pp. 445–452, Aug. 2005. Cited on p. 853

[[1366](#_bookmark0)] Pellacini, Fabio, Miloˇs Haˇsan, and Kavita Bala, “Interactive Cinematic Relighting with Global Illumination,” in Hubert Nguyen, ed., *GPU Gems 3*, Addison-Wesley, pp. 183–202, 2007.

Cited on p. 547

[[1367](#_bookmark0)] Pelzer, Kurt, “Rendering Countless Blades of Waving Grass,” in Randima Fernando, ed.,

*GPU Gems*, Addison-Wesley, pp. 107–121, 2004. Cited on p. 202

[[1368](#_bookmark0)] Penner, E., “Shader Amortization Using Pixel Quad Message Passing,” in Wolfgang Engel, ed., *GPU Pro*2, A K Peters/CRC Press, pp. 349–367, 2011. Cited on p. 1017, 1018

[[1369](#_bookmark0)] Penner, E., “Pre-Integrated Skin Shading,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2011. Cited on p. 634

[[1370](#_bookmark0)] Perlin, Ken, “An Image Synthesizer,” *Computer Graphics (SIGGRAPH ’85 Proceedings)*, vol. 19, no. 3, pp. 287–296, July 1985. Cited on p. 198, 199

[[1371](#_bookmark0)] Perlin, Ken, and Eric M. Hoﬀert, “Hypertexture,” *Computer Graphics (SIGGRAPH ’89 Proceedings)*, vol. 23, no. 3, pp. 253–262, July 1989. Cited on p. 198, 199, 618

|  |  |
| --- | --- |
| [[1372](#_bookmark0)] | Perlin, Ken, “Improving Noise,” *ACM Transactions on Graphics (SIGGRAPH 2002)*, vol. 21, |
|  | no. 3, pp. 681–682, 2002. Cited on p. 181, 198, 199 |
| [[1373](#_bookmark0)] | Perlin, Ken, “Implementing Improved Perlin Noise,” in Randima Fernando, ed., *GPU Gems*, |
|  | Addison-Wesley, pp. 73–85, 2004. Cited on p. 199, 620 |
| [[1374](#_bookmark0)] | Persson, Emil, “Alpha to Coverage,” *Humus* blog, June 23, 2005. Cited on p. 204 |
| [[1375](#_bookmark0)] | Persson, Emil, “Post-Tonemapping Resolve for High-Quality HDR Anti-aliasing in D3D10,” in Wolfgang Engel, ed., *ShaderX*6, Charles River Media, pp. 161–164, 2008. Cited on p. 142 |
| [[1376](#_bookmark0)] | Persson, Emil, “GPU Texture Compression,” *Humus* blog, Apr. 12, 2008. Cited on p. 870 |
| [[1377](#_bookmark0)] | Persson, Emil, “Linearize Depth,” *Humus* blog, Aug. 2, 2008. Cited on p. 601 |
| [[1378](#_bookmark0)] | Persson, Emil, “Performance,” *Humus* blog, July 22, 2009. Cited on p. 790 |
| [[1379](#_bookmark0)] | Persson, Emil, “Making It Large, Beautiful, Fast, and Consistent: Lessons Learned Developing |
|  | *Just Cause 2*,” in Wolfgang Engel, ed., *GPU Pro*, A K Peters, Ltd., pp. 571–596, 2010. Cited |
|  | on p. 114, 556, 558, 715, 882 |
| [[1380](#_bookmark0)] | Persson, Emil, “Volume Decals,” in Wolfgang Engel, ed., *GPU Pro*2, A K Peters/CRC Press, |
|  | pp. 115–120, 2011. Cited on p. 889, 890 |
| [[1381](#_bookmark0)] | Persson, Emil, “Creating Vast Game Worlds: Experiences from Avalanche Studios,” in *ACM* |
|  | *SIGGRAPH 2012 Talks*, ACM, article no. 32, Aug. 2012. Cited on p. 69, 210, 245, 714, 715, |
|  | 796, 797 |
| [[1382](#_bookmark0)] | Persson, Emil, “Graphics Gems for Games: Findings from Avalanche Studios,” *SIGGRAPH* |
|  | *Advances in Real-Time Rendering in Games course*, Aug. 2012. Cited on p. 556, 797, 798 |
| [[1383](#_bookmark0)] | Persson, Emil, “Low-Level Thinking in High-Level Shading Languages,” *Game Developers* |
|  | *Conference*, Mar. 2013. Cited on p. 788 |
| [[1384](#_bookmark0)] | Persson, Emil, “Wire Antialiasing,” in Wolfgang Engel, ed., *GPU Pro*5, CRC Press, pp. 211– |
|  | 218, 2014. Cited on p. 139 |
| [[1385](#_bookmark0)] | Persson, Emil, “Low-Level Shader Optimization for Next-Gen and DX11,” *Game Developers* |
|  | *Conference*, Mar. 2014. Cited on p. 788 |
| [[1386](#_bookmark0)] | Persson, Emil, “Clustered Shading,” *Humus* blog, Mar. 24, 2015. Cited on p. 905, 914 |
| [[1387](#_bookmark0)] | Persson, Emil, “Practical Clustered Shading,” *SIGGRAPH Real-Time Many-Light Manage-* |
|  | *ment and Shadows with Clustered Shading course*, Aug. 2015. Cited on p. 883, 886, 888, 896, |
|  | 897, 899, 900, 901, 914 |
| [[1388](#_bookmark0)] | Persson, Tobias, “Practical Particle Lighting,” *Game Developers Conference*, Mar. 2012. Cited |
|  | on p. 569 |
| [[1389](#_bookmark0)] | Pesce, Angelo, “Stable Cascaded Shadow Maps—Ideas,” *C0DE517E* blog, Mar. 27, 2011. |
|  | Cited on p. 245 |
| [[1390](#_bookmark0)] | Pesce, Angelo, “Current-Gen DOF and MB,” *C0DE517E* blog, Jan. 4, 2012. Cited on p. 532, |
|  | 534, 542 |
| [[1391](#_bookmark0)] | Pesce, Angelo, “33 Milliseconds in the Life of a Space Marine...,” *SCRIBD* presentation, Oct. |
|  | 8, 2012. Cited on p. 238, 245, 250, 518, 527, 542, 889 |
| [[1392](#_bookmark0)] | Pesce, Angelo, “Smoothen Your Functions,” *C0DE517E* blog, Apr. 26, 2014. Cited on p. 200 |
| [[1393](#_bookmark0)] | Pesce, Angelo, “Notes on Real-Time Renderers,” *C0DE517E* blog, Sept. 3, 2014. Cited on |
|  | p. 882, 884, 889, 913 |
| [[1394](#_bookmark0)] | Pesce, Angelo, “Notes on G-Buﬀer Normal Encodings,” *C0DE517E* blog, Jan. 24, 2015. Cited |
|  | on p. 715, 887 |
| [[1395](#_bookmark0)] | Pesce, Angelo, “Being More Wrong: Parallax Corrected Environment Maps,” *C0DE517E* |
|  | blog, Mar. 28, 2015. Cited on p. 502 |

[[1396](#_bookmark0)] Pesce, Angelo, “Low-Resolution Eﬀects with Depth-Aware Upsampling,” *C0DE517E* blog,

Feb. 6, 2016. Cited on p. 520

[[1397](#_bookmark0)] Pesce, Angelo, “The Real-Time Rendering Continuum: A Taxonomy,” *C0DE517E* blog, Aug.

6, 2016. Cited on p. 913

[[1398](#_bookmark0)] Peters, Christoph, and Reinhard Klein, “Moment Shadow Mapping,” in *Proceedings of the 19th Symposium on Interactive 3D Graphics and Games*, ACM, pp. 7–14, Feb.–Mar. 2015.

Cited on p. 256

[[1399](#_bookmark0)] Peters, Christoph, Cedrick Mu¨nstermann, Nico Wetzstein, and Reinhard Klein, “Improved Moment Shadow Maps for Translucent Occluders, Soft Shadows and Single Scattering,” *Jour- nal of Computer Graphics Techniques*, vol. 6, no. 1, pp. 17–67, 2017. Cited on p. 257

[[1400](#_bookmark0)] Pettineo, Matt, “How to Fake Bokeh (and Make It Look Pretty Good),” *The Danger Zone*

blog, Feb. 28, 2011. Cited on p. 536

[[1401](#_bookmark0)] Pettineo, Matt, “Light-Indexed Deferred Rendering,” *The Danger Zone* blog, Mar. 31, 2012.

Cited on p. 896, 905, 914

[[1402](#_bookmark0)] Pettineo, Matt, “Experimenting with Reconstruction Filters for MSAA Resolve,” *The Danger Zone* blog, Oct. 28, 2012. Cited on p. 136, 142

[[1403](#_bookmark0)] Pettineo, Matt, “A Sampling of Shadow Techniques,” *The Danger Zone* blog, Sept. 10, 2013.

Cited on p. 54, 238, 245, 250, 265

[[1404](#_bookmark0)] Pettineo, Matt, “Shadow Sample Update,” *The Danger Zone* blog, Feb. 18, 2015. Cited on p. 256, 265

[[1405](#_bookmark0)] Pettineo, Matt, “Rendering the Alternate History of *The Order: 1886*,” *SIGGRAPH Advances in Real-Time Rendering in Games course*, Aug. 2015. Cited on p. 141, 142, 143, 245, 256,

257, 803, 896

[[1406](#_bookmark0)] Pettineo, Matt, “Stairway to (Programmable Sample Point) Heaven,” *The Danger Zone* blog,

Sept. 13, 2015. Cited on p. 142, 906

[[1407](#_bookmark0)] Pettineo, Matt, “Bindless Texturing for Deferred Rendering and Decals,” *The Danger Zone*

blog, Mar. 25, 2016. Cited on p. 192, 888, 900, 901, 907

[[1408](#_bookmark0)] Pettineo, Matt, “SG Series Part 6: Step into the Baking Lab,” *The Danger Zone* blog, Oct.

9, 2016. Cited on p. 398, 477, 536, 540

[[1409](#_bookmark0)] Pﬁster, Hans-Peter, Matthias Zwicker, Jeroen van Barr, and Markus Gross, “Surfels: Surface Elements as Rendering Primitives,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 335–342, July 2000. Cited on p. 573

[[1410](#_bookmark0)] Phail-Liﬀ, Nathan, Scot Andreason, and Anthony Vitale, “Crafting Victorian London: The Environment Art and Material Pipelines of *The Order: 1886*,” in *ACM SIGGRAPH 2015 Talks*, ACM, article no. 59, Aug. 2015. Cited on p. 365

[[1411](#_bookmark0)] Pharr, Matt, “Fast Filter Width Estimates with Texture Maps,” in Randima Fernando, ed.,

*GPU Gems*, Addison-Wesley, pp. 417–424, 2004. Cited on p. 185

[[1412](#_bookmark0)] Pharr, Matt, and Simon Green, “Ambient Occlusion,” in Randima Fernando, ed., *GPU Gems*,

Addison-Wesley, pp. 279–292, 2004. Cited on p. 452, 465

[[1413](#_bookmark0)] Pharr, Matt, Wenzel Jakob, and Greg Humphreys, *Physically Based Rendering: From Theory to Implementation*, Third Edition, Morgan Kaufmann, 2016. Cited on p. 136, 144, 145, 165,

271, 442, 445, 512, 589, 623, 630

[[1414](#_bookmark0)] Phong, Bui Tuong, “Illumination for Computer Generated Pictures,” *Communications of the ACM*, vol. 18, no. 6, pp. 311–317, June 1975. Cited on p. 118, 340, 416

[[1415](#_bookmark0)] Picott, Kevin P., “Extensions of the Linear and Area Lighting Models,” *Computer Graphics*, vol. 18, no. 2, pp. 31–38, Mar. 1992. Cited on p. 385, 387

[[1416](#_bookmark0)] Piegl, Les A., and Wayne Tiller, *The NURBS Book*, Second Edition, Springer-Verlag, 1997.

Cited on p. 781

[[1417](#_bookmark0)] Pineda, Juan, “A Parallel Algorithm for Polygon Rasterization,” *Computer Graphics (SIG-*

*GRAPH ’88 Proceedings)*, vol. 22, no. 4, pp. 17–20, Aug. 1988. Cited on p. 994

[[1418](#_bookmark0)] Pines, Josh, “From Scene to Screen,” *SIGGRAPH Color Enhancement and Rendering in Film and Game Production course*, July 2010. Cited on p. 285, 289

[[1419](#_bookmark0)] Piponi, Dan, and George Borshukov, “Seamless Texture Mapping of Subdivision Surfaces by Model Pelting and Texture Blending,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 471–478, July 2000. Cited on p. 767

[[1420](#_bookmark0)] Placeres, Frank Puig, “Overcoming Deferred Shading Drawbacks,” in Wolfgang Engel, ed.,

*ShaderX*5, Charles River Media, pp. 115–130, 2006. Cited on p. 886, 887

[[1421](#_bookmark0)] Pletinckx, Daniel, “Quaternion Calculus as a Basic Tool in Computer Graphics,” *The Visual Computer*, vol. 5, no. 1, pp. 2–13, 1989. Cited on p. 102

[[1422](#_bookmark0)] Pochanayon, Adisak, “Capturing and Visualizing RealTime GPU Performance in *Mortal Kombat X*,” *Game Developers Conference*, Mar. 2016. Cited on p. 790

[[1423](#_bookmark0)] Pohl, Daniel, Gregory S. Johnson, and Timo Bolkart, “Improved Pre-Warping for Wide Angle, Head Mounted Displays,” in *Proceedings of the 19th ACM Symposium on Virtual Reality Software and Technology*, ACM, pp. 259–262, Oct. 2013. Cited on p. 628, 925, 926

[[1424](#_bookmark0)] Policarpo, Fabio, Manuel M. Oliveira, and Joa˜o L. D. Comba, “Real-Time Relief Mapping on Arbitrary Polygonal Surfaces,” in *Proceedings of the 2005 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 155–162, Apr. 2005. Cited on p. 217, 218

[[1425](#_bookmark0)] Policarpo, Fabio, and Manuel M. Oliveira, “Relief Mapping of Non-Height-Field Surface De- tails,” in *Proceedings of the 2006 Symposium on Interactive 3D Graphics and Games*, ACM, pp. 55–62, Mar. 2006. Cited on p. 566

[[1426](#_bookmark0)] Policarpo, Fabio, and Manuel M. Oliveira, “Relaxed Cone Stepping for Relief Mapping,” in Hubert Nguyen, ed., *GPU Gems 3*, Addison-Wesley, pp. 409–428, 2007. Cited on p. 219

[[1427](#_bookmark0)] Pool, J., A. Lastra, and M. Singh, “Lossless Compression of Variable-Precision Floating-Point Buﬀers on GPUs,” in *Proceedings of the ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games*, ACM, pp. 47–54, Mar. 2012. Cited on p. 1009, 1016

[[1428](#_bookmark0)] Porcino, Nick, “Lost Planet Parallel Rendering,” *Meshula.net* website, Oct. 2007. Cited on p. 538, 647

[[1429](#_bookmark0)] Porter, Thomas, and Tom Duﬀ, “Compositing Digital Images,” *Computer Graphics (SIG- GRAPH ’84 Proceedings)*, vol. 18, no. 3, pp. 253–259, July 1984. Cited on p. 149, 151,

153

[[1430](#_bookmark0)] P¨otzsch, Christian, “Speeding up GPU Barrel Distortion Correction in Mobile VR,” *Imagi- nation Blog*, June 15, 2016. Cited on p. 926

[[1431](#_bookmark0)] Poynton, Charles, *Digital Video and HD: Algorithms and Interfaces*, Second Edition, Morgan Kaufmann, 2012. Cited on p. 161, 163, 166

[[1432](#_bookmark0)] Pranckeviˇcius, Aras, “Compact Normal Storage for Small G-Buﬀers,” *Aras’ blog*, Mar. 25, 2010. Cited on p. 715

[[1433](#_bookmark0)] Pranckeviˇcius, Aras, and Renaldas Zioma, “Fast Mobile Shaders,” *SIGGRAPH Studio Talk*,

Aug. 2011. Cited on p. 549, 803, 814

[[1434](#_bookmark0)] Pranckeviˇcius, Aras, “Rough Sorting by Depth,” *Aras’ blog*, Jan. 16, 2014. Cited on p. 803

[[1435](#_bookmark0)] Pranckeviˇcius, Aras, Jens Fursund, and Sam Martin, “Advanced Lighting Techniques in Unity,” *Unity DevDay, Game Developers Conference*, Mar. 2014. Cited on p. 482

[[1436](#_bookmark0)] Pranckeviˇcius, Aras, “Cross Platform Shaders in 2014,” *Aras’ blog*, Mar. 28, 2014. Cited on p. 129

[[1437](#_bookmark0)] Pranckeviˇcius, Aras, “Shader Compilation in Unity 4.5,” *Aras’ blog*, May 5, 2014. Cited on p. 129

[[1438](#_bookmark0)] Pranckeviˇcius, Aras, “Porting Unity to New APIs,” *SIGGRAPH An Overview of Next Gen- eration APIs course*, Aug. 2015. Cited on p. 40, 806, 814

[[1439](#_bookmark0)] Pranckeviˇcius, Aras, “Every Possible Scalability Limit Will Be Reached,” *Aras’ blog*, Feb. 5, 2017. Cited on p. 128

[[1440](#_bookmark0)] Pranckeviˇcius, Aras, “Font Rendering Is Getting Interesting,” *Aras’ blog*, Feb. 15, 2017. Cited on p. 677, 679

[[1441](#_bookmark0)] Praun, Emil, Adam Finkelstein, and Hugues Hoppe, “Lapped Textures,” in *SIGGRAPH ’00: Proceedings of the 27th Annual Conference on Computer Graphics and Interactive Tech- niques*, ACM Press/Addison-Wesley Publishing Co., pp. 465–470, July 2000. Cited on p. 671

[[1442](#_bookmark0)] Praun, Emil, Hugues Hoppe, Matthew Webb, and Adam Finkelstein, “Real-Time Hatching,” in *SIGGRAPH ’01 Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 581–586, Aug. 2001. Cited on p. 670

[[1443](#_bookmark0)] Preetham, Arcot J., Peter Shirley, and Brian Smitsc, “A Practical Analytic Model for Day- light,” in *SIGGRAPH ’99: Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques*, ACM Press/Addison-Wesley Publishing Co., pp. 91–100, Aug. 1999. Cited on p. 614

[[1444](#_bookmark0)] Preparata, F. P., and M. I. Shamos, *Computational Geometry: An Introduction*, Springer-

Verlag, 1985. Cited on p. 686, 967

[[1445](#_bookmark0)] Preshing, Jeﬀ, “How Ubisoft Montreal Develops Games for Multicore—Before and After C++11,” *CppCon 2014*, Sept. 2014. Cited on p. 812, 815

[[1446](#_bookmark0)] Press, William H., Saul A. Teukolsky, William T. Vetterling, and Brian P. Flannery, *Numerical Recipes in C*, Cambridge University Press, 1992. Cited on p. 948, 951, 957

[[1447](#_bookmark0)] Proakis, John G., and Dimitris G. Manolakis, *Digital Signal Processing: Principles, Algo- rithms, and Applications*, Fourth Edition, Pearson, 2006. Cited on p. 130, 133, 135, 136

[[1448](#_bookmark0)] Purnomo, Budirijanto, Jonathan Bilodeau, Jonathan D. Cohen, and Subodh Kumar, “Hardware-Compatible Vertex Compression Using Quantization and Simpliﬁcation,” in *Graphics Hardware 2005*, Eurographics Association, pp. 53–61, July 2005. Cited on p. 713

[[1449](#_bookmark0)] Quidam, *Jade2 model*, published by wismo, [http://www.3dvia.com/wismo, 2017](http://www.3dvia.com/wismo%2C2017). Cited on p. 653

[[1450](#_bookmark0)] Qu´ılez, ´In˜igo, “Rendering Worlds with Two Triangles with Ray Tracing on the GPU in 4096 bytes,” *NVScene*, Aug. 2008. Cited on p. 454, 594, 752

[[1451](#_bookmark0)] Qu´ılez, ´In˜igo, “Improved Texture Interpolation,” *iquilezles.org*, 2010. Cited on p. 180

[[1452](#_bookmark0)] Qu´ılez, ´In˜igo, “Correct Frustum Culling,” *iquilezles.org*, 2013. Cited on p. 986

[[1453](#_bookmark0)] Qu´ılez, ´In˜igo, “Eﬃcient Stereo and VR Rendering,” in Wolfgang Engel, ed., *GPU Zen*, Black Cat Publishing, pp. 241–251, 2017. Cited on p. 927, 928

[[1454](#_bookmark0)] Ragan-Kelley, Jonathan, Charlie Kilpatrick, Brian W. Smith, and Doug Epps, “The Light- speed Automatic Interactive Lighting Preview System,” *ACM Transactions on Graphics (SIGGRAPH 2007)*, vol. 26, no. 3, 25:1–25:11, July 2007. Cited on p. 547

[[1455](#_bookmark0)] Ragan-Kelley, Jonathan, Jaakko Lehtinen, Jiawen Chen, Michael Doggett, and Fr´edo Durand, “Decoupled Sampling for Graphics Pipelines,” *ACM Transactions on Graphics*, vol. 30, no. 3, pp. 17:1–17:17, May 2011. Cited on p. 910

[[1456](#_bookmark0)] R´akos, Daniel, “Massive Number of Shadow-Casting Lights with Layered Rendering,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 259–278, 2012.

Cited on p. 246

[[1457](#_bookmark0)] R´akos, Daniel, “Programmable Vertex Pulling,” in Patrick Cozzi & Christophe Riccio, eds.,

*OpenGL Insights*, CRC Press, pp. 293–301, 2012. Cited on p. 703

[[1458](#_bookmark0)] Ramamoorthi, Ravi, and Pat Hanrahan, “An Eﬃcient Representation for Irradiance Environ- ment Maps,” in *SIGGRAPH ’01 Proceedings of the 28th Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 497–500, Aug. 2001. Cited on p. 425, 427, 428, 429, 430

[[1459](#_bookmark0)] Ramamoorthi, Ravi, and Pat Hanrahan, “Frequency Space Environment Map Rendering,”

*ACM Transactions on Graphics*, vol. 21, no. 3, pp. 517–526, 2002. Cited on p. 431

[[1460](#_bookmark0)] Raskar, Ramesh, and Michael Cohen, “Image Precision Silhouette Edges,” in *Proceedings of the 1999 Symposium on Interactive 3D Graphics*, ACM, pp. 135–140, 1999. Cited on p. 657, 658

[[1461](#_bookmark0)] Raskar, Ramesh, “Hardware Support for Non-photorealistic Rendering,” in *Graphics Hard- ware 2001*, Eurographics Association, pp. 41–46, Aug. 2001. Cited on p. 658, 660

[[1462](#_bookmark0)] Raskar, Ramesh, and Jack Tumblin, *Computational Photography: Mastering New Techniques for Lenses, Lighting, and Sensors*, A K Peters, Ltd., 2007. Cited on p. 549

[[1463](#_bookmark0)] Rasmusson, J., J. Hasselgren, and T. Akenine-M¨oller, “Exact and Error-Bounded Approxi- mate Color Buﬀer Compression and Decompression,” in *Graphics Hardware 2007*, Eurograph- ics Association, pp. 41–48, Aug. 2007. Cited on p. 997, 1009

[[1464](#_bookmark0)] Rasmusson, J., J. Stro¨m, and T. Akenine-M¨oller, “Error-Bounded Lossy Compression of Floating-Point Color Buﬀers Using Quadtree Decomposition,” *The Visual Computer*, vol. 26, no. 1, pp. 17–30, 2009. Cited on p. 1009

[[1465](#_bookmark0)] Ratcliﬀ, John W., “Sphere Trees for Fast Visibility Culling, Ray Tracing, and Range Search- ing,” in Mark DeLoura, ed., *Game Programming Gems 2*, Charles River Media, pp. 384–387, 2001. Cited on p. 821

[[1466](#_bookmark0)] Rauwendaal, Randall, and Mike Bailey, “Hybrid Computational Voxelization Using the Graphics Pipeline,” *Journal of Computer Graphics Techniques*, vol. 2, no. 1, pp. 15–37, 2013.

Cited on p. 582

[[1467](#_bookmark0)] Ray, Nicolas, Vincent Nivoliers, Sylvain Lefebvre, and Bruno L´evy, “Invisible Seams,” in *Proceedings of the 21st Eurographics Conference on Rendering*, Eurographics Association, pp. 1489–1496, June 2010. Cited on p. 486

[[1468](#_bookmark0)] Reddy, Martin, *Perceptually Modulated Level of Detail for Virtual Environments*, PhD thesis,

University of Edinburgh, 1997. Cited on p. 864

[[1469](#_bookmark0)] Reed, Nathan, “Ambient Occlusion Fields and Decals in *inFAMOUS 2*,” *Game Developers Conference*, Mar. 2012. Cited on p. 452

[[1470](#_bookmark0)] Reed, Nathan, “Quadrilateral Interpolation, Part 1,” *Nathan Reed* blog, May 26, 2012. Cited on p. 688

[[1471](#_bookmark0)] Reed, Nathan, and Dean Beeler, “VR Direct: How NVIDIA Technology Is Improving the VR Experience,” *Game Developers Conference*, Mar. 2015. Cited on p. 928, 936, 937, 938

[[1472](#_bookmark0)] Reed, Nathan, “Depth Precision Visualized,” *Nathan Reed* blog, July 3, 2015. Cited on p. 100, 1014

[[1473](#_bookmark0)] Reed, Nathan, “GameWorks VR,” *SIGGRAPH*, Aug. 2015. Cited on p. 927, 928, 929

[[1474](#_bookmark0)] Reeves, William T., “Particle Systems—A Technique for Modeling a Class of Fuzzy Objects,”

*ACM Transactions on Graphics*, vol. 2, no. 2, pp. 91–108, Apr. 1983. Cited on p. 567

[[1475](#_bookmark0)] Reeves, William T., David H. Salesin, and Robert L. Cook, “Rendering Antialiased Shadows with Depth Maps,” *Computer Graphics (SIGGRAPH ’87 Proceedings)*, vol. 21, no. 4, pp. 283– 291, July 1987. Cited on p. 247

[[1476](#_bookmark0)] Rege, Ashu, “DX11 Eﬀects in *Metro 2033: The Last Refuge*,” *Game Developers Conference*,

Mar. 2010. Cited on p. 535

[[1477](#_bookmark0)] Reimer, Jeremy, “Valve Goes Multicore,” *ars technica* website, Nov. 5, 2006. Cited on p. 812

[[1478](#_bookmark0)] Reinhard, Erik, Mike Stark, Peter Shirley, and James Ferwerda, “Photographic Tone Repro- duction for Digital Images,” *ACM Transactions on Graphics (SIGGRAPH 2002)*, vol. 21, no. 3, pp. 267–276, July 2002. Cited on p. 286, 288

[[1479](#_bookmark0)] Reinhard, Erik, Greg Ward, Sumanta Pattanaik, and Paul Debevec, *High Dynamic Range Imaging: Acquisition, Display, and Image-Based Lighting*, Morgan Kaufmann, 2006. Cited on p. 406, 435

[[1480](#_bookmark0)] Reinhard, Erik, Erum Arif Khan, Ahmet Oguz Akyu¨z, and Garrett Johnson, *Color Imaging:*

*Fundamentals and Applications*, A K Peters, Ltd., 2008. Cited on p. 291

[[1481](#_bookmark0)] Reis, Aurelio, “Per-Pixel Lit, Light Scattering Smoke,” in Wolfgang Engel, ed., *ShaderX*5,

Charles River Media, pp. 287–294, 2006. Cited on p. 569

[[1482](#_bookmark0)] Ren, Zhong Ren, Rui Wang, John Snyder, Kun Zhou, Xinguo Liu, Bo Sun, Peter-Pike Sloan, Hujun Bao, Qunsheng Peng, and Baining Guo, “Real-Time Soft Shadows in Dynamic Scenes Using Spherical Harmonic Exponentiation,” *ACM Transactions on Graphics (SIGGRAPH 2006)*, vol. 25, no. 3, pp. 977–986, July 2006. Cited on p. 456, 458, 467

[[1483](#_bookmark0)] Reshetov, Alexander, “Morphological Antialiasing,” in *High-Performance Graphics 2009*, Eu- rographics Association, pp. 109–116, Aug. 2009. Cited on p. 146

[[1484](#_bookmark0)] Reshetov, Alexander, “Reducing Aliasing Artifacts through Resampling,” in *High-Per- formance Graphics 2012*, Eurographics Association, pp. 77–86, June 2012. Cited on p. 148

[[1485](#_bookmark0)] Reshetov, Alexander, and David Luebke, “Inﬁnite Resolution Textures,” in *High-Performance Graphics 2016*, Eurographics Association, pp. 139–150, June 2016. Cited on p. 677

[[1486](#_bookmark0)] Reshetov, Alexander, and Jorge Jimenez, “MLAA from 2009 to 2017,” *High-Performance Graphics* research impact retrospective, July 2017. Cited on p. 143, 146, 148, 165

[[1487](#_bookmark0)] Reuter, Patrick, Johannes Behr, and Marc Alexa, “An Improved Adjacency Data Structure for Fast Triangle Stripping,” *journal of graphics tools*, vol. 10, no. 2, pp. 41–50, 2016. Cited on p. 692

[[1488](#_bookmark0)] Revet, Burke, and Jon Riva, “Immense Zombie Horde Variety and Slicing,” *Game Developers Conference*, Mar. 2014. Cited on p. 366

[[1489](#_bookmark0)] Revie, Donald, “Implementing Fur Using Deferred Shading,” in Wolfgang Engel, ed., *GPU Pro*2, A K Peters/CRC Press, pp. 57–75, 2011. Cited on p. 424

[[1490](#_bookmark0)] Rhodes, Graham, “Fast, Robust Intersection of 3D Line Segments,” in Mark DeLoura, ed.,

*Game Programming Gems 2*, Charles River Media, pp. 191–204, 2001. Cited on p. 990

[[1491](#_bookmark0)] Ribardi`ere, Micka¨el, Benjamin Bringier, Daniel Meneveaux, and Lionel Simonot, “STD: Stu- dent’s t-Distribution of Slopes for Microfacet Based BSDFs,” *Computer Graphics Forum*, vol. 36, no. 2, pp. 421–429, 2017. Cited on p. 343

[[1492](#_bookmark0)] Rideout, Philip, “Silhouette Extraction,” *The Little Grasshopper* blog, Oct. 24, 2010. Cited on p. 47, 668

[[1493](#_bookmark0)] Rideout, Philip, and Dirk Van Gelder, “An Introduction to Tessellation Shaders,” in Patrick Cozzi & Christophe Riccio, eds., *OpenGL Insights*, CRC Press, pp. 87–104, 2012. Cited on p. 44, 46

[[1494](#_bookmark0)] Riguer, Guennadi, “Performance Optimization Techniques for ATI Graphics Hardware with DirectX 9.0,” ATI White Paper, 2002. Cited on p. 702

[[1495](#_bookmark0)] Riguer, Guennadi, “LiquidVRTM Today and Tomorrow,” *Game Developers Conference*, Mar.

2016. Cited on p. 928

[[1496](#_bookmark0)] Ring, Kevin, “Rendering the Whole Wide World on the World Wide Web,” Lecture at Ana- lytical Graphics, Inc., Dec. 2013. Cited on p. 708

[[1497](#_bookmark0)] Risser, Eric, Musawir Shah, and Sumanta Pattanaik, “Faster Relief Mapping Using the Secant Method,” *journal of graphics tools*, vol. 12, no. 3, pp. 17–24, 2007. Cited on p. 218

[[1498](#_bookmark0)] Ritschel, T., T. Grosch, M. H. Kim, H.-P. Seidel, C. Dachsbacher, and J. Kautz, “Imperfect Shadow Maps for Eﬃcient Computation of Indirect Illumination,” *ACM Transactions on Graphics*, vol. 27, no. 5, pp. 129:1–129:8, 2008. Cited on p. 492, 578

[[1499](#_bookmark0)] Ritschel, Tobias, Thorsten Grosch, and Hans-Peter Seidel, “Approximating Dynamic Global Illumination in Image Space,” in *Proceedings of the 2009 Symposium on Interactive 3D Graph- ics and Games*, ACM, pp. 75–82, 2009. Cited on p. 496

[[1500](#_bookmark0)] Ritter, Jack, “An Eﬃcient Bounding Sphere,” in Andrew S. Glassner, ed., *Graphics Gems*,

Academic Press, pp. 301–303, 1990. Cited on p. 950

[[1501](#_bookmark0)] Robbins, Steven, and Sue Whitesides, “On the Reliability of Triangle Intersection in 3D,” in *International Conference on Computational Science and Its Applications*, Springer, pp. 923– 930, 2003. Cited on p. 974

[[1502](#_bookmark0)] Robinson, Alfred C., “On the Use of Quaternions in Simulation of Rigid-Body Motion,”

Technical Report 58-17, Wright Air Development Center, Dec. 1958. Cited on p. 76

[[1503](#_bookmark0)] Rockenbeck, Bill, “The *inFAMOUS: Second Son* Particle System Architecture,” *Game De- velopers Conference*, Mar. 2014. Cited on p. 568, 569, 571

[[1504](#_bookmark0)] Rockwood, Alyn, and Peter Chambers, *Interactive Curves and Surfaces: A Multimedia Tu- torial on CAGD*, Morgan Kaufmann, 1996. Cited on p. 718

[[1505](#_bookmark0)] Rogers, David F., *Procedural Elements for Computer Graphics*, Second Edition, McGraw-Hill, 1998. Cited on p. 685

[[1506](#_bookmark0)] Rogers, David F., *An Introduction to NURBS: With Historical Perspective*, Morgan Kauf- mann, 2000. Cited on p. 781

[[1507](#_bookmark0)] Rohleder, Pawel, and Maciej Jamrozik, “Sunlight with Volumetric Light Rays,” in Wolfgang Engel, ed., *ShaderX*6, Charles River Media, pp. 325–330, 2008. Cited on p. 604

[[1508](#_bookmark0)] Rohlf, J., and J. Helman, “IRIS Performer: A High Performance Multiprocessing Toolkit for Real-Time 3D Graphics,” in *SIGGRAPH ’94: Proceedings of the 21st Annual Conference on Computer Graphics and Interactive Techniques*, ACM, pp. 381–394, July 1994. Cited on p. 807, 809, 861

[[1509](#_bookmark0)] Rosado, Gilberto, “Motion Blur as a Post-Processing Eﬀect,” in Hubert Nguyen, ed., *GPU Gems 3*, Addison-Wesley, pp. 575–581, 2007. Cited on p. 538

[[1510](#_bookmark0)] Rossignac, J., and M. van Emmerik, M., “Hidden Contours on a Frame-Buﬀer,” in *Proceedings of the Seventh Eurographics Conference on Graphics Hardware*, Eurographics Association, pp. 188–204, Sept. 1992. Cited on p. 657

[[1511](#_bookmark0)] Rossignac, Jarek, and Paul Borrel, “Multi-resolution 3D Approximations for Rendering Com- plex Scenes,” in Bianca Falcidieno & Tosiyasu L. Kunii, eds. *Modeling in Computer Graphics:*

*Methods and Applications*, Springer-Verlag, pp. 455–465, 1993. Cited on p. 709

[[1512](#_bookmark0)] Rost, Randi J., Bill Licea-Kane, Dan Ginsburg, John Kessenich, Barthold Lichtenbelt, Hugh Malan, and Mike Weiblen, *OpenGL Shading Language*, Third Edition, Addison-Wesley, 2009.

Cited on p. 55, 200

[[1513](#_bookmark0)] Roth, Marcus, and Dirk Reiners, “Sorted Pipeline Image Composition,” in *Eurographics Sym- posium on Parallel Graphics and Visualization*, Eurographics Association, pp. 119–126, 2006. Cited on p. 1020, 1022