

ICCV 2007 Short Course Proposal

Gradient Domain Manipulation Techniques in Vision and Graphics

Ramesh Raskar and Amit Agrawal

Mitsubishi Electric Research Labs
201 Broadway
Cambridge, MA 02139

<http://www.merl.com/people/raskar/raskar.html>
<http://www.cfar.umd.edu/~aagrawal/{raskar,agrawal}@merl.com>

Published Research on Gradient Domain Manipulation Techniques

Decomposing Images and Scene Parameters

- Y. Weiss. Deriving intrinsic images from image sequences. In *Proceedings of ICCV*, volume 2, pages 68–75, 2001.
- Y. Matsushita, S. Lin, S.B. Kang, and H.Y. Shum. Estimating intrinsic images from image sequences with biased illumination. In *Proc. European Conf. Computer Vision*, pages 274–286, 2004.
- Y. Matsushita, K. Nishino, K. Ikeuchi, and M. Sakauchi. Illumination normalization with time-dependent intrinsic images for video surveillance. *IEEE Trans. Pattern Anal. Machine Intell.*, 26(10):1336–1347, 2004.
- B.K.P. Horn. Determining lightness from an image. *Comput. Graphics, Image Processing*, 3:277–299, 1974.
- J. Sun, J. Jia, C.K. Tang, and H.Y. Shum. Poisson matting. *ACM Trans. Graph.*, 23(3):315–321, 2004.
- A. Agrawal, R. Raskar, and R. Chellappa. Edge suppression by gradient field transformation using cross-projection tensors. In *Proc. Conf. Computer Vision and Pattern Recognition*, June 2006.
- A. Agrawal, R. Raskar, S.K. Nayar, and Y. Li. Removing photography artifacts using gradient projection and flash-exposure sampling. *ACM Trans. Graph.*, 24(3):828–835, 2005.
- B.V. Funt, M.S. Drew, and M. Brockington. Recovering shading from color images. In *ECCV*, pages 124–132, May 1992.

Image Editing

- C. Ballester, M. Bertalmio, V. Caselles, G. Sapiro, and J. Verdera. Filling-in by joint interpolation of vector fields and gray levels. *IEEE Trans. Image Processing*, 10(8):1200–1211, August 2001.

- G. D. Finlayson, S. D. Hordley, and M. S. Drew. Removing shadows from images. In *Proc. European Conf. Computer Vision*, pages 823–836, 2002.
- P. Pérez, M. Gangnet, and A. Blake. Poisson image editing. In *Proceedings of SIGGRAPH 2003*, pages 313–318, 2003.
- Jiaya Jia, Jian Sun, Chi-Keung Tang, and Heung-Yeung Shum. Drag-and-drop pasting. *ACM Transactions on Graphics*, 25(3):631–637, July 2006.
- Todor Georgiev. Aesthetics in covariant image reconstruction. In *Eurographics Symposium on Computational Aesthetics*, pages 75–81, June 2005.
- Todor Georgiev. Photoshop healing brush: a tool for seamless cloning. Workshop on Applications of Computer Vision, ECCV 2006.
- James H. Elder and Richard M. Goldberg. Image editing in the contour domain. *IEEE Trans. Pattern Anal. Mach. Intell.*, 23(3):291–296, 2001.
- T. Georgiev. Covariant derivatives and vision. In *ECCV*, pages IV: 56–69, 2006.
- Z. Du, X. Qin, H. Lin, and H. Bao. Shadow removal in gradient domain. In *ICIAR*, 2005.

Image Fusion and Enhancement

- L.B. Socolinsky, D.A. Wolff. Multispectral image visualization through first-order fusion. *IEEE Trans. Image Processing*, 11:923–931, 2002.
- Yuri Rzhannov Fan Gu. Optimal image blending for underwater mosaics. In *IEEE Ocean*, 2006.
- R. Raskar, A. Ilie, and J. Yu. Image Fusion for Context Enhancement and Video Surrealism. In *Proc. of NPAR*, 2004.
- A. Levin, A. Zomet, S. Peleg, and Y. Weiss. Seamless image stitching in the gradient domain. In *Proc. European Conf. Computer Vision*, volume 4, pages 377–389, 2004.
- Aseem Agarwala, Mira Dontcheva, Maneesh Agrawala, Steven Drucker, Alex Colburn, Brian Curless, David Salesin, and Michael Cohen. Interactive digital photomontage. *ACM Trans. Graph.*, 23(3):294–302, 2004.
- Carsten Rother, Lucas Bordeaux, Youssef Hamadi, and Andrew Blake. Autocollage. *ACM Transactions on Graphics*, 25(3):847–852, July 2006.
- Soonmin Bae, Sylvain Paris, and Frédo Durand. Two-scale tone management for photographic look. *ACM Transactions on Graphics*, 25(3):637–645, July 2006.
- A. Agrawal, R. Raskar, and R. Chellappa. Edge suppression by gradient field transformation using cross-projection tensors. In *Proc. Conf. Computer Vision and Pattern Recognition*, June 2006.
- A. Agrawal, R. Raskar, S.K. Nayar, and Y. Li. Removing photography artifacts using gradient projection and flash-exposure sampling. *ACM Trans. Graph.*, 24(3):828–835, 2005.
- Richard Szeliski. Image alignment and stitching: A tutorial. Technical report, MSR-TR-2004-92, 2005.
- Thomas Luft, Carsten Colditz, and Oliver Deussen. Image enhancement by unsharp masking the depth buffer. *ACM Transactions on Graphics*, 25(3):1206–1213, July 2006.

- Jiaya Jia and Chi-Keung Tang. Eliminating structure and intensity misalignment in image stitching. In *Proc. Int'l Conf. Computer Vision*, 2005.
- James W. Davis and Vinay Sharma. Fusion-based background-subtraction using contour saliency. In *CVPR '05: Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05) - Workshops*, page 11, Washington, DC, USA, 2005. IEEE Computer Society.

Video Synthesis

- Shachar Fleishman Daniel Cohen-Or Iddo Drori, Tommer Leyvand and Hezy Yeshurun. Video operations in the gradient domain. Technical report, Tel-Aviv Univ, 2004.
- Hongcheng Wang, Ramesh Raskar, and Narendra Ahuja. High dynamic range video using split aperture camera. In *IEEE 6th Workshop on Omnidirectional Vision, Camera Networks and Non-classical Cameras*, Washington, DC, USA, 2005. IEEE Computer Society.
- Aseem Agarwala, Ke Colin Zheng, Chris Pal, Maneesh Agrawala, Michael Cohen, Brian Curless, David H. Salesin, and Richard Szeliski. Panoramic video textures. *ACM Transactions on Graphics*, 24(3):821–827, August 2005.
- Hongcheng Wang, Ramesh Raskar, and Narendra Ahuja. Seamless video editing. In *ICPR '04: Proceedings of the Pattern Recognition, 17th International Conference on (ICPR'04) Volume 3*, pages 858–861, Washington, DC, USA, 2004. IEEE Computer Society.
- Hongcheng Wang, Ning Xu, Ramesh Raskar, and Narendra Ahuja. Videoshop: A new framework for spatio-temporal video editing. In *Proc. Conf. Computer Vision and Pattern Recognition*, volume 2, page 1201, 2005.

High Dynamic Range Imaging

- R. Fattal, D. Lischinski, and M. Werman. Gradient Domain High Dynamic Range Compression. In *Proceedings of SIGGRAPH 2002*, pages 249–256. ACM SIGGRAPH, 2002.
- S.B. Kang, M. Uyttendaele, S. Winder, and R. Szeliski. High dynamic range video. *ACM Trans. Graph.*, 22(3):319–325, 2003.
- Hongcheng Wang, Ramesh Raskar, and Narendra Ahuja. High dynamic range video using split aperture camera. In *IEEE 6th Workshop on Omnidirectional Vision, Camera Networks and Non-classical Cameras*, Washington, DC, USA, 2005. IEEE Computer Society.
- J. Tumblin, A. Agrawal, and R. Raskar. Why I want a gradient camera. In *Proc. Conf. Computer Vision and Pattern Recognition*, volume 1, pages 103–110, June 2005.

Reconstruction from Gradients/Interpolation

- Taucs, a library of sparse linear solvers, tel-aviv university. <http://www.tau.ac.il/stoledo/taucs/>, 2003.

- A. Robles-Kelly and R.E. Hancock. A graph-spectral method for surface height recovery. In *Proc. Math. Surfaces*, pages 163–181, 2003.
- A. J. Roberts. Simple and fast multigrid solution of Poisson’s equation using diagonally oriented grids. *ANZIAM J.*, 43(E):E1–E36, July 2001.
- Henson, V. E. and Briggs, W. L. and S. F. McCormick, editors. *A Multigrid Tutorial, second ed.* Society for Industrial and Applied Mathematics, Philadelphia., 2000.
- Y. Saad. *Iterative Methods for Sparse Linear Systems*. SIAM, 2nd edition, 2003.
- A. P. Pentland. Interpolation using wavelet bases. *IEEE Trans. Pattern Anal. Machine Intell.*, 16:410–414, 1994.
- D. Terzopoulos. Multilevel computational processes for visual surface reconstruction. *Computer Vision, Graphics, and Image Processing*, 24:5296, 1983.
- M.-H. Yaou and W.-T. Chang. Fast surface interpolation using multiresolution wavelets. *IEEE Trans. Pattern Anal. Machine Intell.*, 16:673–689, 1994.
- R. T. Frankot and R. Chellappa. A method for enforcing integrability in shape from shading algorithms. *IEEE Trans. Pattern Anal. Machine Intell.*, 10(4):439–451, July 1988.
- T. Simchony, R. Chellappa, and M. Shao. Direct analytical methods for solving poisson equations in computer vision problems. *IEEE Trans. Pattern Anal. Machine Intell.*, 12(5):435–446, May 1990.
- A. Agrawal, R. Raskar, and R. Chellappa. What is the range of surface reconstructions from a gradient field? In *Proc. European Conf. Computer Vision*, May 2006.
- A. Agrawal, R. Chellappa, and R. Raskar. An algebraic approach to surface reconstruction from gradient fields. In *Proc. Int’l Conf. Computer Vision*, volume 1, pages 174–181, October 2005.
- P. Kovesi. Shapelets correlated with surface normals produce surfaces. In *Proc. Int’l Conf. Computer Vision*, pages 994–1001, 2005.
- R. Szeliski. Fast surface interpolation using hierarchical basis functions. *IEEE Trans. Pattern Anal. Mach. Intell.*, 12(6):513–528, 1990.
- Richard Szeliski. Locally adapted hierarchical basis preconditioning. *ACM Transactions on Graphics*, 25(3):1135–1143, July 2006.
- M.J. Brooks and B.K.P. Horn. Shape and source from shading. In *Proc. Intl. Joint Conf. Artif. Intelli.*, pages 932–936, 1985.
- *Numerical Recipes in C*. Cambridge University Press.
- B. Karacali and W. Snyder. Noise reduction in surface reconstruction from a given gradient field. *Int’l J. Computer Vision*, 60(1):25–44, 2004.
- T. Wei and R. Klette. Regularization method for depth recovery from noisy gradient vector fields. In *Proc. Image and Vision Computing New Zealand (IVCNZ)*, pages 53–58, 2002.

Photometric Stereo, Shape from Shading & Phase Unwrapping

- M.J. Brooks and B.K.P. Horn. Shape and source from shading. In *Proc. Intl. Joint Conf. Artif. Intelli.*, pages 932–936, 1985.
- B.K.P. Horn. Height and gradient from shading. *Int’l J. Computer Vision*, 5(1):37–75, 1990.

- R.J. Woodham B.K.P. Horn and Silver W. Determining Shape and Reflectance Using Multiple Images . In *AI-Memo 'r90*, 1978.
- I. Horovitz and N. Kiryati. Depth from gradient fields and control points: bias correction in photometric stereo. *Image Vision Computing*, 22(9):681–694, 2004.
- K. Ikeuchi and B.K.P. Horn. Numerical shape from shading and occluding boundaries. *Artificial Intelligence*, 17:141–184, 1981.
- B.K.P. Horn and M. Brooks, editors. *Shape from Shading*. The MIT Press, July 1989.
- I. Horovitz and N. Kiryati. Depth from gradient fields and control points: Bias correction in photometric stereo. *Image and Vision Computing*, 22:681–694, 2004.
- R.J. Woodham. Photometric method for determining surface orientation from multiple images. *OptEng*, 19(1):139–144, 1980.
- G. Fornaro, G. Franceschetti, and R. Lanari. Interferometric SAR phase unwrapping using greens formulation. *IEEE Trans. Geosci. Remote Sens.*, 34:720–727, 1996.
- R. M. Goldstein, H. A. Zebker, and C. L. Werner. Satellite radar interferometry: Two-dimensional phase unwrapping. *Radio Science*, 23:713–720, 1988.
- M.A. Herraiez, M.A. Gdeisat, D.R. Burton, and M.J. Lalor. Robust, fast, and effective two-dimensional automatic phase unwrapping algorithm based on image decomposition. *Applied Optics*, 41(35):7445–7455, December 2002.
- H.A. Zebker and Y. Lu. Phase unwrapping algorithms for radar interferometry: residue-cut, least-squares, and synthesis algorithms. *J. Opt. Soc. of America*, 15(3):586–598, 1998.

Meshes and Shape Descriptors

- Olga Sorkine, Daniel Cohen-Or, Yaron Lipman, Marc Alexa, Christian Rössl, and Hans-Peter Seidel. Laplacian surface editing. In *Eurographics / ACM SIGGRAPH Symposium on Geometry Processing*, pages 175–184, July 2004.
- Sang-Mook Lee, A. L. Abbott, N. A. Clark, and P. A. Araman. A shape representation for planar curves by shape signature harmonic embedding. In *2006 Conference on Computer Vision and Pattern Recognition (CVPR 2006)*, pages 1940–1947, June 2006.
- Seyoun Park, Xiaohu Guo, Hayong Shin, and Hong Qin. Surface completion for shape and appearance. *The Visual Computer*, 22(3):168–180, 2006.
- Y. Yu, K. Zhou, D. Xu, X. Shi, H. Bao, B. Guo, and H.Y. Shum. Mesh editing with poisson-based gradient field manipulation. *ACM Trans. Graph.*, 23(3):644–651, 2004.
- Michael Kazhdan, Matthew Bolitho, and Hugues Hoppe. Poisson surface reconstruction. In *Fourth Eurographics Symposium on Geometry Processing*, pages 61–70, June 2006.
- Jin Huang, Xiaohan Shi, Xinguo Liu, Kun Zhou, Li-Yi Wei, Shang-Hua Teng, Hujun Bao, Baining Guo, and Heung-Yeung Shum. Subspace gradient domain mesh deformation. *ACM Transactions on Graphics*, 25(3):1126–1134, July 2006.
- Dong Xu, Hongxin Zhang, Qing Wang, and Hujun Bao. Poisson shape interpolation. In *SPM '05: Proceedings of the 2005 ACM symposium on Solid and physical modeling*, pages 267–274, New York, NY, USA, 2005. ACM Press.

- Lena Gorelick, Meirav Galun, Eitan Sharon, Ronen Basri, and Achi Brandt. Shape representation and classification using the poisson equation. In *2004 Conference on Computer Vision and Pattern Recognition (CVPR 2004)*, pages 61–67, June 2004.

Texture

- Hui Fang and John C. Hart. Textureshop: texture synthesis as a photograph editing tool. *ACM Transactions on Graphics*, 23(3):354–359, August 2004.
- Minh X. Nguyen, Xiaoru Yuan, and Baoquan Chen. Geometry completion and detail generation by texture synthesis. *The Visual Computer*, 21(8-10):669–678, 2005.
- Yanwen Guo, Jin Wang, Xiang Zeng, Zhongyi Xie, Hanqiu Sun, and Qunsheng Peng. Image and video retexturing. *Computer Animation and Virtual Worlds*, 16(3-4):451–461, 2005.
- Ramesh Raskar, Kar-Han Tan, Rogerio Feris, Jingyi Yu, and Matthew Turk. Non-photorealistic camera: depth edge detection and stylized rendering using multi-flash imaging. *ACM Trans. Graph.*, 23(3):679–688, 2004.
- Aseem Agarwala, Ke Colin Zheng, Chris Pal, Maneesh Agrawala, Michael Cohen, Brian Curless, David H. Salesin, and Richard Szeliski. Panoramic video textures. *ACM Transactions on Graphics*, 24(3):821–827, August 2005.

Others

- Amy A. Gooch, Sven C. Olsen, Jack Tumblin, and Bruce Gooch. Color2gray: salience-preserving color removal. *ACM Transactions on Graphics*, 24(3):634–639, August 2005.
- Jack Tumblin and Prason Choudhury. Bixels: Picture samples with sharp embedded boundaries. In *Rendering Techniques 2004: 15th Eurographics Workshop on Rendering*, pages 255–264, June 2004.
- R. Raskar R. Feris, M. Turk and K. Tan. Specular reflection reduction with multi-flash photography. *International Journal of the Brazilian Computer Society*, 2005.

We will continue to update this bibliography.