

Bibliography

- [1] S. Acton and D. Mukherjee. Scale space classification using area morphology. *IEEE Transactions on Image Processing*, 9(4):623–635, 2000.
- [2] C. R. Adams and J. A. Clarkson. Properties of functions $f(x, y)$ of bounded variation. *Transactions of American Mathematical Society*, 36(4), 1934.
- [3] A. Almansa and T. Lindeberg. Fingerprint enhancement by shape adaptation of scale-space operators with automatic scale selection. *IEEE Transactions on Image Processing*, 9(12):2027–2042, 2000.
- [4] L. Alvarez, F. Guichard, P.-L. Lions, and J.-M. Morel. Axioms and fundamental equations in image processing. *Archive for Rational Mechanics and Analysis*, 123:199–257, 1993.
- [5] R. Anguelov. *Constructive Theory of Functions*, chapter LULU Operators and Locally δ -Monotone Approximations, pages 22–34. Marin Drinov Academic Publishing House, Sofia, 2006.
- [6] R. Anguelov and I. Fabris-Rotelli. Locally monotone approximations of real functions on graphs. In G. Nikolov and R. Uluchev, editors, *Constructive Theory of Functions*, pages 21–29, Sozopol 2010, 2012. Prof. Marin Drinov Academic Publishing House, Sofia. In memory of Borislav Bojanov.
- [7] R. Anguelov and I. Fabris-Rotelli. On the axiomatization of scale-space theory. In M. Todorov, editor, *Application of Mathematics in Technical and Natural Sciences, 4th International Conference, AMiTaNS '12*, volume 1487, pages 159–167, St. Constantine and Helena, Bulgaria, 11-16 June 2012 2012. American Institute of Physics.
- [8] R. Anguelov and I. N. Fabris-Rotelli. LULU operators and discrete pulse transform for multi-dimensional arrays. *IEEE Transactions on Image Processing*, 19(11):3012–3023, 2010.

- [9] R. Anguelov and C. H. Rohwer. LULU operators for functions of continuous argument. *Quaestiones Mathematicae*, 32(2), 2009.
- [10] G. Arfken and H. Weber. *Mathematical Methods for Physicists*. Elsivier Academic Press, 6th edition, 2005.
- [11] A. Arias-Castro, E. Candés, and A. Durand. Detection of an anomalous cluster in a network. *The Annals of Statistics*, 39(1):278–304, 2011.
- [12] J. Babaud, A. Witkin, M. Baudin, and R. Duda. Uniqueness of the gaussian kernel for scale-space filtering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, PAMI-8(1):26–33, 1986.
- [13] H. Barlow. The efficiency of detecting changes of density in random dot patterns. *Vision Research*, 18:637–650, 1978.
- [14] R. Barrett, M. Berry, T. Chan, J. Demmel, J. Donato, J. Dongarra, V. Eijkhout, R. Pozo, C. Romine, and H. van der Vorst. *Templates for the solution of linear systems: building blocks for iterative methods*. SIAM, 2nd edition, 1994.
- [15] H. Barrow and Tenenbaum. Recovering intrinsic scene characteristics from images. Techincal Report 157, SRI International, April 1978.
- [16] N. Berline, E. Getzler, and M. Vergne. *Heat Kernels and Dirac Operators*. Springer-Verlag, Berlin, New York, 2004.
- [17] H. Biermann, I. Martin, F. Bernardini, and D. Zorin. Cut-and-paste editing of multiresolution surfaces. In *Proceedings of the 29th Annual Conference on Computer Graphics and Interactive Techniques*, pages 312–321, San Antonio, Texas, USA, 2002.
- [18] R. N. Bracewell. *The Fourier Transform and its Application*. McGraw-Hill, Kogakusha, 1978.
- [19] J. Bradley and C. Brislawn. Image compression by vector quantization of multiresolution decompositions. *Physica D*, 60:245–258, 1992.
- [20] U. Braga-Neto. Multiscale connected operators. *Journal of Mathematical Imaging and Vision*, 22:199–216, 2005.
- [21] U. Braga-Neto. Object-based image analysis using multiscale connectivity. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 27(6):892–907, 2005.

- [22] U. Braga-Neto and J. Goutsias. An axiomatic approach to multiscale connectivity in image analysis. Technical report, The Johns Hopkins University, Baltimore, April 2001.
- [23] U. Braga-Neto and J. Goutsias. Connectivity on complete lattices: New results. *Computer Vision and Images Understanding*, 85:22–53, 2002.
- [24] U. Braga-Neto and J. Goutsias. A multiscale approach to connectivity. *Computer Vision and Image Understanding*, 89:70–107, 2003.
- [25] U. Braga-Neto and J. Goutsias. A theoretical tour of connectivity in image processing and analysis. *Journal of Mathematical Imaging and Vision*, 19:5–31, 2003.
- [26] U. Braga-Neto and J. Goutsias. Grayscale level connectivity: Theory and applications. *IEEE Transactions on Image Processing*, 13(12):1567–1580, 2004.
- [27] U. Braga-Neto and J. Goutsias. Constructing multiscale connectivities. *Computer Vision and Image Understanding*, 99:126–150, 2005.
- [28] R. W. Brockett and P. Maragos. Evolution equations for continuous-scale morphological filtering. *IEEE Transactions on Image Processing*, 42(12):3377–3386, 1994.
- [29] M. Bulmer. Music from fractal noise. In *Proceedings of the Mathematics 2000 Festival*, Melbourne, 10-13 January 2000 2000.
- [30] R. Burden and J. Faires. *Numerical Analysis*. Brooks/Cole, CA, USA, 2001.
- [31] P. Burt. Fast filter transfroms for images processing. *Computer Graphics and Image Processing*, 16(1):20–51, 1981.
- [32] P. Burt and T.-H. H. A. Rosenfeld. Segmentation and estimation of image region propertires through cooperative hierarchical computation. *IEEE Transactions*, SMC-II:802–825, 1981.
- [33] P. Butler. The transfer of distributions of LULU smoothers. Masters thesis, University of Stellenbosch, 2008.
- [34] A. Chambolle and P.-L. Lions. Image recovery via total variation minimization and related problems. *Numerische Mathematik*, 76:167–188, 1997.

- [35] Y. Chi and M. Leung. A general shape context framework for object identification. *Computer Vision and Image Understanding*, 112:324–336, 2008.
- [36] J. A. Clarkson and C. R. Adams. On definitions of bounded variation for functions of two variables. *Transactions of American Mathematical Society*, 35(4), 1933.
- [37] M. Cohen and S. Grossberg. Neural dynamics of brightness perception: features, boundaries, diffusion, and resonance. *Attention, Perception, & Psychophysics*, 36(5):428–456, 1984.
- [38] W. Conradie, T. de Wet, and M. Jankowitz. An overview of LULU smoothers with application to financial data. *Journal for Studies in Economics and Econometrics*, 29(1):97–121, 2005.
- [39] R. Courant and D. Hilbert. *Methoden der mathematischen en physik*. Springer-Verlag, Berlin, 4th edition, 1993.
- [40] R. Coutinho, D. Selviah, and H. Griffiths. Theoretical modeling of a detection system based on optical coherence contrast. In W. Watkins, D. Clement, and W. Reynolds, editors, *Targets and Backgrounds X: Characterization and Representation*, volume 5431 of *Proceedings of SPIE*, pages 24–35, 2004.
- [41] J. Crespo and R. Schafer. Locality and adjacency stability constraints for morphological connected operators. *Journal of Mathematical Imaging and Vision*, 7:85–102, 1997.
- [42] J. Crespo, J. Serra, and R. Schafer. Theoretical aspects of morphological filters by reconstruction. *Signal Processing*, 47:201–225, 1995.
- [43] J. Crowley. *A representation for visual information*. Phd thesis, Robotics Institute, Carnegie-Mellon University, Pittsburgh, Pennsylvania, 1981.
- [44] J. L. Crowley. *A representation for visual information*. Technical report number cmu-ri-tr-82-7, Robotics Institute, Carnegie-Mellon Unievrsity, Pittsburgh, Pa., 1982.
- [45] I. Daubechies. Orthonormal bases of compactly supported wavelets. *Communications on Pure and Applied Mathematics*, XLI:909–996, 1988.

- [46] P. Debba, A. Stein, F. van der Merwe, E. Carranza, and A. Lucieer. Field sampling from a segmented image. In *Proceedings of the International Conference on Computational Science and its Applications, Part I*, pages 756–768, Perugia, Italy, 30 June - 3 July 2008. Springer-Verlag.
- [47] D. Donoho and I. Johnstone. Ideal spatial adaptation by wavelet shrinkage. *Biometrika*, 81(3):425–455, 1994.
- [48] T. Duda and M. Canty. Unsupervised classification of satellite imagery: choosing a good algorithm. *International Journal of Remote Sensing*, 23(11):2193–2212, 2002.
- [49] I. Duff, R. Grimes, and J. Lewis. Sparse matrix test problems. *ACM Transactions on Mathematical Software*, 15:1–14, 1989.
- [50] Editorial. Special issue: Shape representation and similarity for image databases. *Pattern Recognition*, 35:1–2, 2002.
- [51] J. Elder and S. Zucker. Scale space localization, blur, and contour-based image coding. In *IEEE Conference on Computer Vision and Pattern Recognition CVPR '96*, pages 27–34, San Fransico, CA, USA, 18-20 June 1996.
- [52] I. Fabris-Rotelli. LULU operators on multidimensional arrays and applications. Masters dissertation, University of Pretoria, November 2009.
- [53] I. Fabris-Rotelli. The discrete pulse transform for images with entropy-based feature detection. In P. Robinson and A. Nel, editors, *Proceedings of the 22nd Annual Symposium of the Pattern Recognition Association of South Africa*, pages 43–48. PRASA, 22-25 November 2011.
- [54] I. Fabris-Rotelli. Characterization of the Discrete Pulse Transform of images. *International Journal on Mathematical Methods and Models in Biosciences*, 1(2), 2012.
- [55] I. Fabris-Rotelli and S. van der Walt. Applications and memory efficient implementation of the two-dimensional Discrete Pulse Transform. Under review, December 2010.
- [56] I. Fabris-Rotelli, K. van Oldenmark, and P. van Staden. Evaluation of noise removal in signals by LULU operators. In P. Debba, F. Lombard, V. Yadavalli, and L. Fatti, editors, *Peer-reviewed Proceedings of the 52nd Annual Conference of the South African Statistical Association*

- for 2010 (SASA 2010)*, pages 44–51, North-West University: Potchefstroom Campus, 10-12 November 2010. SASA.
- [57] P. Felzenszwalb and D. Huttenlocher. Image segmentation using local variation. In *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition*, pages 98–104, 1998.
 - [58] M. Felsberg. *Low-level image processing with the structures multivector*. Phd thesis, Institut für Informatik und Praktische Mathematik der Christian-Albrechts-Universität zu Kiel Olshausenstr. 40 D 24098 Kiel, March 2002.
 - [59] M. Ferraro, G. Boccignone, and T. Caelli. On the representation of image structures via scale space. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 21(10):1–5, 1999.
 - [60] C. Fiorio and J. Gustedt. Two linear time union-find strategies for image processing. *Theoretical Computer Science*, 154(2):165–181, 1996.
 - [61] L. Florack. Data, models, and images. volume I, pages 469–472, Lausanne, 16-19 September 1996. 1996 IEEE International Conference on Image Processing, ICIP '96.
 - [62] L. Florack and A. Kuijper. The topological structure of scale-space images. *Journal of Mathematical Imaging and Vision*, 12:65–79, 2000.
 - [63] L. Florack, R. Maas, and W. Niessen. Pseudo-linear scale-space theory. *International Journal of Computer Vision*, 31(2/3):247–259, 1999.
 - [64] L. Florack, B. Romeny, J. Koenderink, and M. Viergever. Scale and the differential structure of images. *Image and Vision Computing*, 10(6):376 – 388, 1992.
 - [65] L. Florack, A. Salden, B. ter Haar Romeny, and J. K. andMA Viergever. Nonlinear scale-space. *Image and Vision Computing*, 13(4):279–294, 1995.
 - [66] P. A. Foerster. *Precalculus with Trigonometry: Concepts and Connections*. Birkhäuser, 2002.
 - [67] J. Fourier. *Théorie analytique de la chaleur*. Translated to English by A Freeman in 1878, reissue by Cambridge University Press in 2009, 1822.

- [68] D. Gabor. Theory of communication. *Journal of the Institute of Electrical Engineers Part III*, 93:429–457, 1946.
- [69] G. Gagaudakis and P. Rosin. Incorporating shape into histograms for CBIR. *Pattern Recognition*, 35:81–91, 2002.
- [70] I. Gath and A. Geva. Unsupervised optimal fuzzy clustering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 11(7):773–781, 1989.
- [71] J. Gilles. Image decomposition: Theory, numerical schemes, and performance evaluation. *Advances in Imaging and Electron Physics, Chapter 8*, 158:89–137, 2009.
- [72] G. Granlund. In search of a general picture processing operator. *Computer Vision, Graphics, and Image Processing*, 8:155–173, 1978.
- [73] M. Greated. The nature of sound and vision in relation to colour. *Optics & Laser Technology*, 2011(43):337–347, 2011.
- [74] J. Hadamard. *Lectures on the Cauchy Problem in Linear Partial Differential Equations*. Yale University Press, New Haven, 1923.
- [75] R. Hammah and J. Currah. On distance measures for the fuzzy k -means algorithm for joint data. *Rock Mechanics and Rock Engineering*, 32(1):1–27, 1999.
- [76] A. R. Hansen and E. M. Riseman. Processing cones: A parallel computational structure for scene analysis. Technical report, University of Massachusetts, Amherst, Massachusetts, 1974.
- [77] G. Hay and M. Chesters. A model of visual threshold detection. *Journal of Theoretical Biology*, 67:221–240, 1977.
- [78] H. Heijmans and A. Goutsias. Nonlinear multiresolution signal decomposition schemes - part ii: Morphological wavelets. *IEEE Transactions on Image Processing*, 9(11):1897–1913, 2000.
- [79] I. Herstein. *Topics in Algebra*. Wiley, second edition, 1975.
- [80] D. Hilbert. Grundzüge einer allgemeinen theorie der linearen integralgleichungen. Nachrichten der Göttinger Akademie der Wissenschaften, Mathematisch-Physikalische Klasses, 1904.

- [81] R. Hobson. Properties preserved by some smoothing functions. *Journal of the American Statistical Association*, 71(355):763–766, 1976.
- [82] A. Hoover, G. Jean-Baptiste, D. Goldgof, and K. Bowyer. A methodology for evaluating range image segmentation techniques. In *Proceedings of the Second IEEE Workshop on Applications of Computer Vision*, pages 264–271, Sarasota, FL, USA, 5-7 December 1994.
- [83] C.-T. Hsu and J.-L. Wu. Multiresolution watermarking for digital images. *IEEE Transactions on Circuits and Systems-II: Analog and Digital Signal Processing*, 45(8):1097–1101, 1998.
- [84] D. H. Hubel. *Eye, Brain, and Vision*. Scientific American Library, 1988.
- [85] R. Hummel. *The Scale-Space Formulation of Pyramid Data Structures*, pages 187–223. Parallel Computer Vision. Academic Press, New York, 1987.
- [86] T. Iijima. Basic theory on normalization of pattern (in case of typical one-dimensional pattern). *Bulletin of the Electrotechnical Laboratory*, 26:368–388, 1962. in Japanese.
- [87] T. Iijima. Basic theory on normalization of two-dimensional visual pattern. *Studies on Information and Control, Pattern Recognition Issue, IECE, Japan*,, 1:15–22, 1963. in Japanese.
- [88] T. Iijima. Theory of pattern recognition. *Electronics and Communications in Japan*, pages 123–134, November 1963. in English.
- [89] T. Iijima. Basic equation of figure and observational transformation. *Systems, Computers, Controls*, 2(4):70–77, 1971. in English.
- [90] T. Iijima. Basic theory on normalization of figures. *Electronics and Communications in Japan*, 54-C(12):106–112, 1971. in English.
- [91] T. Iijima. Basic theory on the construction of figure space. *Systems, Computers, Controls*, 2(5):51–57, 1971. in English.
- [92] T. Iijima. A suppression kernel of a figure and its mathematical characteristics. *Systems, Computers, Controls*, 2(6):16–23, 1971. in English.
- [93] T. Iijima. A system of fundamental functions in an abstract figure space. *Systems, Computers, Controls*, 2(6):96–103, 1971. in English.

- [94] T. Iijima. Basic theory of feature extraction for figures. *Systems, Computers, Control*, 3(1):32–39, 1972. in English.
- [95] T. Iijima. Basic theory on the structural recognition of figures. *Systems, Computers, Control*, 3(4):30–36, 1972. in English.
- [96] T. Iijima. Theoretical studies on the figure identification by pattern matching. *Systems, Computers, Control*, 3(4):37–44, 1972. in English.
- [97] T. Iijima. Basic theory of pattern observation. *Papers of Technical Group on Automata and Automatic Control, IECE, Japan*, December 1959. in Japanese.
- [98] T. Iijima. Observation theory of two-dimensional visual patterns. *Papers of Technical Group on Automata and Automatic Control, IECE, Japan*, October 1962. in Japanese.
- [99] P. T. Jackway. Morphological scale-space. In *Proceedings of 11th IAPR International Conference on Image, Speech and Signal Analysis, Pattern Recognition*, volume III, 1992.
- [100] M. Jankowitz. *Some Statistical Aspects of LULU Smoothers*. PhD thesis, Department of Statistics and Actuarial Science, Stellenbosch University, South Africa, 2007.
- [101] R. Johnson and D. Wichern. *Applied Multivariate Statistical Analysis*. Prentice-Hall, Inc., Upper Saddle River, NJ, 2002.
- [102] R. Jones. Connected filtering and segmentation using component trees. *Computer Vision and Image Understanding*, 75(3):215–228, 1999.
- [103] B. Julesz. Textons, the elements of texture perception, and their interaction. *Nature*, 290:91–97, 1981.
- [104] B. Julesz. *Dialogues on Perception*. MIT Press, Cambridge, MA, 1995.
- [105] A. Kadir and M. Brady. Saliency, scale and image description. *International Journal of Computer Vision*, 45(2):83–105, 2001.
- [106] O. Kao. Modification of the LULU operators for preservation of critical image details. In *Proceedings of CISST'02: International Conference on Imaging Science, Systems and Technology*, Las Vegas, Nevada, USA, 24-27 June 2002 2002.

- [107] R. Kessel. Estimating the limitations that image resolution and contrast place on target recognition. In F. Sadjadi, editor, *Automatic Target Recognition XII, Proceedings of SPIE*, volume 4726, pages 316–327, 2002.
- [108] A. Klinger. *Pattern and Search Statistics*. Optimizing Methods in Statistics. Academic Press, New York, 1971.
- [109] K. Koenderink. The structure of images. *Biological Cybernetics*, 50:363–370, 1984.
- [110] R. Krishnapuram and J. Keller. A possibilistic approach to clustering. *IEEE Transactions on Fuzzy Systems*, 1(2):98–110, 1993.
- [111] A. Kuijper, L. Florack, and M. Viergever. Scale space hierarchy. *Journal of Mathematical Imaging and Vision*, 18:169–189, 2003.
- [112] D. Laurie. The roadmaker’s algorithm for the Discrete Pulse Transform. *IEEE Transactions on Image Processing*, 20(2):361–371, 2011.
- [113] D. Laurie and C. Rohwer. The Discrete Pulse Transform. *SIAM Journal of Mathematical Analysis*, 38(3), 2007.
- [114] D. P. Laurie and C. H. Rohwer. Fast implementation of the Discrete Pulse Transform. In *Extended Abstracts of ICAAM 2006: International Conference of Numerical Analysis and Applied Mathematics*, pages 484–487, Crete, Greece, 15-19 September 2006.
- [115] Y. Leung, J.-S. Zhang, and Z.-B. Xu. Clustering by scale-space filtering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 22(12):1396–1410, 2000.
- [116] Q. Li and J. S. Racine. *Nonparametric Econometrics: Theory and Practice*. Princeton University Press, New Jersey 08540, Oxfordshire OX20 1SY, 2007.
- [117] Z. Li and M. J. Crocker. *Handbook of Noise and Vibration Control*, chapter 41: Equipment for Data Aquisition, pages 486–492. John Wiley & Sons, Inc., 2007.
- [118] L. Lifshitz and S. Pizer. A multiresolution hierarchical approach to image segmentation based on intensity extrema. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 12(6):529–540, 1990.

- [119] C.-L. Lin, T. Chuang, and K.-C. Fan. Palmprint verification using hierarchical decomposition. *Pattern Recognition*, 38:2639–2652, 2005.
- [120] T. Lindeberg. Scale-space for discrete signals. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 12(3):234–254, 1990.
- [121] T. Lindeberg. *Discrete Scale Space Theory and the Scale Space Primal Sketch*. Phd thesis, Department of Numerica Analysis and Computing Science, Royal Institute of Technology, Stockholm, May 1991.
- [122] T. Lindeberg. On scale selection for differential operators. In *Proceedings of the 8th Scandinavian Conference on Image Analysis*, pages 857–866, Tromsø, Norway, 1993.
- [123] T. Lindeberg. *Scale-Space Theory in Computer Vision*. Kluwer Academic Publishers, Dordrecht, The Netherlands, 1994.
- [124] T. Lindeberg. Scale-space: A framework for handling image structures at multiple scales. In *Proceedings of CERN School of Computing*, number 8, pages 27–38, Egmond aan Zee, The Netherlands, 8-21 September 1996.
- [125] T. Lindeberg. *Gaussian Scale-Space Theory*, chapter On the Axiomatic Formulations of Linear Scale-Space, pages 75–97. Kluwer, Dordrecht, 1997.
- [126] T. Lindeberg. Edge detection and ridge detection with automatic scale selection. *International Journal of Computer Vision*, 30(2), 1998.
- [127] T. Lindeberg. Feature detection with automatic scale selection. *International Journal of Computer Vision*, 30(2), 1998.
- [128] T. Lindeberg. *Scale-Space*, volume IV of *Encyclopedia of Computer Science*, pages 2495–2504. John Wiley and Sons, Hoboken, New Jersey, 2009.
- [129] T. Lindeberg and K. V. Mardia. Scale-space theory: A basic tool for analyzing structures at different scales. *Journal of Applied Statistics*, 21(1/2):225–271, 1994.
- [130] S. Loncaric. A survey of shape analysis techniques. *Pattern Recognition*, 31(8):983–1001, 1998.
- [131] A. K. Louis and P. Maass. A mollifier method for linear operator equation of the first kind. *Inverse Problems*, 6:427–440, 1990.

- [132] S. Mallat. Multifrequency channel decompositions of images and wavelet models. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, 37(12):2091–2110, 1989.
- [133] S. Mallat. A theory for multiresolution signal decomposition: The wavelet representation. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 11(7):674–693, 1989.
- [134] S. Mallat and Z. Zhang. Matching pursuits with time-frequency dictionaries. *IEEE Transactions on Signal Processing*, 41(12):3397–3415, 1993.
- [135] P. Maragos. Pattern spectrum and multiscale shape representation. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 11(7):701–716, 1989.
- [136] D. Marr. Early processing of visual information. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences*, 275(942):483–519, October 1976.
- [137] D. Marr. Artificial intelligence - a personal review. *Artificial Intelligence*, 9:37–48, 1977.
- [138] D. Marr. *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. W H Freeman and Company, 1982.
- [139] D. Marr and E. Hildreth. Theory of edge detection. *Proceedings of the Royal Society of London B*, 207:187–217, 1980.
- [140] D. Marr and T. Poggio. A computational theory of human stereo vision. *Proceedings of the Royal Society of London, Series B, Biological Sciences*, 204(1156):301–328, 1979.
- [141] H. Mayer and C. Steger. Scale-spcae events and their link to abstraction for road extraction. *Journal of Photogrammetry and Remote Sensing*, 53:67–75, 1998.
- [142] N. McLachlan. *Bessel Functions for Engineers*. Oxford University Press, London, 1955.
- [143] P. Meer, E. S. Baugher, and A. Rosenfeld. Frequency domain analysis and synthesis of image pyramid generating kernels. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 9:512–522, 1987.

- [144] J. Mercer. Functions of positive and negative type and their connection with the theory of integral equations. *Philosophical Transactions of the Royal Society, London*, A290:415–446, 1909.
- [145] F. Meyer, A. Averbuch, and R. Coifman. Multilayered image representation: Application to image compression. *IEEE Transaction on Image Processing*, 11(9):1072–1080, 2002.
- [146] F. Meyer and P. Maragos. Nonlinear scale-space representation with morphological levelings. *Journal of Visual Communication and Image Representation*, 11:245–265, 2000.
- [147] Y. Meyer. *Wavelets and Operators*. Cambridge University Press, 1993.
- [148] M. Mignotte, C. Collet, P. Pérez, and P. Bouthemy. Sonar image segmentation using an unsupervised hierarchical mrf model. *IEEE Transactions on Image Processing*, 9(7):1216–1231, 2000.
- [149] P. Mishra and B. Jenkins. Hierarchical feature extraction and object recognition based on biologically inspired filters. In *Proceedings of SPIE, IS&T/SPIE Electronic Imaging Conference*, volume 753805-5, California, USA, 17-21 January 2010.
- [150] F. Mokhtarian and S. Abbasi. Shape similarity retrieval under affine transforms. *Pattern Recognition*, 35:31–41, 2002.
- [151] F. Mokhtarian, S. Abbasi, and J. Kittler. Robust and efficient shape indexing through curvature scale space. In *Proceedings of the British Machine Vision Conference*, pages 53–62, 1996.
- [152] F. Mokhtarian, S. Abbasi, and J. Kittler. *Efficient and Robust Retrieval by Shape Content through Curvature Scale Space*, pages 51–58. Series on Software Engineering and Knowledge Engineering. World Scientific Publishing, 1997.
- [153] F. Mokhtarian and A. Mackworth. A theory of multiscale, curvature-based shape representation for planar curves. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 14(8):789–805, 1992.
- [154] F. Murtagh and J.-L. Starck. Image processing through multiscale analysis and measurement noise modeling. *Statistics and Computing*, 10:95–103, 2000.

- [155] E. Nakamura and N. Kehtarnavaz. Determining number of clusters and prototype locations via multi-scale clustering. *Pattern Recognition Letters*, 19:1265–1283, 1998.
- [156] U. Neisser. Visual search. *Scientific American*, 210(6):94–102, 1964.
- [157] M. Nielson, L. Florack, and R. Deriche. Regularization, scale-space, and edge detection filters. In B. Baxton and R. Cipolla, editors, *Computer Vision - ECCV '96*, volume 1065, pages 70–81. Lecture Notes in Computer Science, Kluwer, Berlin, 1996.
- [158] L. Nirenberg. A strong maximum principle for parabolic equations. *Communications on Pure and Applied Mathematics*, 6(2):167–177, 1953.
- [159] F. Olver, D. Lozier, R. Boisvert, and C. Clark, editors. *NIST Handbook of Mathematical Functions*. Cambridge University Press, New York, first edition, 2010.
- [160] S. Oscher, A. Solé, and L. Vese. Image decomposition and restoration using total variation minimization and the h^{-1} norm. *Multiscale Modeling and Simulation*, 1(3):349–370, 2003.
- [161] N. Otsu. *Mathematical Studies on Feature Extraction in Pattern Recognition*. Report number 818, phd, Electrotechnical Laboratory, 1-1-4, Umezono, Sakura-mura, Niihari-gun, Ibaraki, Japan, 1981. in Japanese.
- [162] G. Ouzounis. *Generalized connected morphological operators for robust shape extraction*. Phd thesis, University of Groningen, 2009.
- [163] G. Ouzounis and M. Wilkinson. Countering oversegmentation in partitioning-based connectivities. In *Proceedings of the IEEE International Conference on Image Processing*, volume III, pages 844–847, 2005.
- [164] A. B. Owen. *Multidimensional Variation for Quasi-Monte Carlo*, chapter Contemporary Multivariate Analysis and Design of Experiments. 2005.
- [165] N. Pal, K. Pal, J. Keller, and J. Bezdek. A possibilistic fuzzy c -means clustering algorithm. *IEEE Transactions on fuzzy systems*, 13(4):517–530, 2005.

- [166] A. Papoulis. *The Fourier Integral and its Applications*. McGraw-Hill Book Company, reissue edition, 1987.
- [167] T. Parrish, D. Gitelman, K. LaBar, and M.-M. Mesulam. Impact of signal-to-noise on functional MRI. *Magnetic Resonance in Medicine*, 44:925–932, 2000.
- [168] E. J. Pauwels, L. van Gool, P. Fiddelaers, and T. Moons. An extended class of scale-invariant and recursive scale-space filters. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 17:691–701, 1995.
- [169] A. Pentland. Shape information from shading: A theory about human perception. *Spatial Vision*, 4(2-3):165–182, 1989.
- [170] P. Perona and J. Malik. Scale-space and edge detection using anisotropic diffusion. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 12:629–639, 1990.
- [171] A. Petrovic, O. Escoda, and P. Vandergheynst. Multiresolution segmentation of natural images: from linear to nonlinear scale-space representations. *IEEE Transactions on Image Processing*, 13(8):1104–1114, 2004.
- [172] I. Pitas and A. N. Venetsanopoulos. Order statistics in digital image processing. *Proceedings of the IEEE*, 80(12):1893–1921, 1992.
- [173] C. Podilchuk and W. Zeng. Image-adaptive watermarking using visual models. *IEEE Journal on Selected Areas in Communications*, 16(4):525–539, 1998.
- [174] T. Poggio and V. Torre. Ill-posed problems and regularization analysis in early vision. Technical Report A.I. Memo 773, C.B.I.P. Paper 001, Massachusetts Institute of Technology, AI Laboratory and Center for Biological Information Processing, Whitaker College, 1984.
- [175] L. Qi and D. Sun. Smoothing functions and a smoothing newton method for complementarity and variational inequality problems. *Journal of Optimization and Variational Inequality Problems*, 113(1):121–147, 2002.
- [176] M. Ramos, S. Hemami, and M. Tamburro. Psychovisually-based multiresolution image segmentation. In *International Conference on Image Processing*, volume 3, pages 60–69, Santa Barbara, CA, USA, 26-29 October 1997.

- [177] A. Rattarangsi and R. Chin. Scale-based detection of corners of planar curves. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 14(4):430–449, 1992.
- [178] F. Relton. *Applied Bessel Functions*. Blackie & Son Limited, London and Glasgow, 1946.
- [179] A. Restrepo and A. Bovik. Locally monotone regression. *IEEE Transactions on Signal Processing*, 41(9):2796–2810, 1993.
- [180] O. Rioul. A discrete-time multiresolution theory. *IEEE Transactions on Signal Processing*, 41(8):2591–2606, 1993.
- [181] C. Rohwer. Fast approximation with locally monotone sequences. *Rend. Circ. Mat. Palermo*, 2 Suppl.(68), 2002.
- [182] C. Rohwer. Fully trend preserving operators. *Quaestiones Mathematicae*, 27:217–230, 2004.
- [183] C. Rohwer. *Nonlinear Smoothers and Multiresolution Analysis*. Birkhäuser, 2005.
- [184] C. Rohwer and M. Wild. LULU theory, idempotent stack filters, and the mathematics of vision of marr. *Advances in Imaging and Electron Physics*, 146:57–162, 2007.
- [185] C. H. Rohwer. Variation reduction and LULU-smoothing. 25:163–176, 2002.
- [186] C. Ronse. Partial partitions, partial connections and connective segmentation. *Journal of Mathematical Imaging and Vision*, 32:97–125, 2008.
- [187] C. Ronse and J. Serra. Geodesy and connectivity in lattices. *Fundamenta Informaticae*, 46:349–395, 2001.
- [188] A. Rosenfeld. Fuzzy digital topology. *Information and Control*, 40:76–87, 1979.
- [189] A. Rosenfeld. On connectivity properties of grayscale pictures. *Pattern Recognition*, 16:47–50, 1983.
- [190] A. Rosenfeld. The fuzzy geometry of image subsets. *Pattern Recognition Letters*, 2:311–317, 1984.

- [191] A. Rosenfeld and M. Thurston. Edge and curve detection for visual scene analysis. *IEEE Transactions on Computers*, C-20(5):562–569, May 1971.
- [192] L. Rudin and V. Caselles. Image recovery via multiscale total variation. In *Proceedings of the Second European Conference on Image Processings*, Palma, Spain, 1995.
- [193] L. I. Rudin, S. Osher, and E. Fatemi. Nonlinear total variation based noise removal algorithms. *Physica D*, 60:259–268, 1992.
- [194] T. Sakai and A. Imiya. Gradient structure of image in scale space. *Journal f Mathematical Imaging and Vision*, 28:243–257, 2007.
- [195] T. Sakai and A. Imiya. Unsupervised cluster discovery using statistics in scale space. *Engineering Applications of Artificial Intelligence*, 22:92–100, 2009.
- [196] E. Salari and Z. Ling. Texture segmentation using hierarchical wavelet decomposition. *Pattern Recognition*, 28(12):1819–1824, 1995.
- [197] P. Salembier and A. Oliveras. *Mathematical Morphology and its Applications to Image and Signal Processing*, volume 5 of *Computational Imaging and Vision*, chapter Practical Extensions of Connected Operators. Springer, 1996.
- [198] P. Salembier and A. Oliveras. *Practical extensions of connected operators*, pages 97–110. Mathematical Morphology and its Applications to Image and Signal Processing. Kluwer Academic, Dordrecht, 1996.
- [199] P. Salembier, A. Oliveras, and L. Garrido. Antiextensive connected operators for image and sequence processing. *IEEE Transactions on Image Processing*, 7(4):555–570, 1998.
- [200] P. Salembier and J. Serra. Flat zones filtering, connected operators, and filers by reconstruction. *IEEE Transactions on Image Processing*, 4(8):1153–1160, August 1995.
- [201] P. Salembier and M. H. F. Wilkinson. Connected operators: A review of region-based morphological image processing techniques. *IEEE Signal Processing Magazine*, 136:136–157, November 2009.
- [202] H. Samet. The quadtree and related hierarchical data structures. *Computing Surveys*, 16(2):187–260, 1984.

- [203] I. Santillán, A. M. Herrera-Navarro, J. D. Mendiola-Sahtibánez, and I. R. Terol-Villalobos. Morphological connected filtering on viscous lattices. *Journal of Mathematical Imaging and Vision*, 36:254 – 269, 2010.
- [204] J. Schavemaker, M. Reinders, J. Gerbrands, and E. Backer. Image sharpening by morphological filtering. *Pattern Recognition*, 33:997–1012, 2000.
- [205] B. Schölkopf and A. Smola. *Learning with kernels: support vector machines, regularization, optimization, and beyond*. The MIT Press, Cambridge, Massachusetts, London, England, 2002.
- [206] B. Sendov and V. Popov. On some properties of the hausdorff metric. *Mathematica*, 7(1):145–154, 1965.
- [207] J. Serra. *Image Analysis and Mathematical Morphology, Volume II: Theoretical Advances*, chapter Mathematical Morphology for Boolean Lattices, pages 37–58. Academic Press, London, 1988.
- [208] J. Serra. Connectivity on complete lattices. *Journal of Mathematical Imaging and Vision*, 9(3):231–251, 1998.
- [209] J. Serra. Set connections and discrete filters. *Lecture Notes in Computer Science: Discrete Geometry and Computer Imagery*, 1568:191–206, 1999.
- [210] J. Serra. Connections for sets and functions. *Fundamenta Informaticae*, 41:147–186, 2000.
- [211] J. Serra. Connection, image segmentation and filtering. In *Proceedings of the XI International Computing Conference*, Mexico, November 2002.
- [212] J. Serra. Viscous lattices. *Journal of Mathematical Imaging and Vision*, 22:269–282, 2005.
- [213] J. Serra. A lattice approach to image sementation. *Journal of Mathematical Imaging and Vision*, 24:83–130, 2006.
- [214] J. Serra and G. Matheron. *Image Analysis and Mathematical Morphology, Volume II: Theoretical Advances*, chapter Strong Filters and Connectivity, pages 141–157. Academic Press, London, 1988.

- [215] J. Serra and P. Salembier. Connected operators and pyramids. In *Proceedings of SPIE: Nonlinear Algebra and Morphological Image Analysis*, volume 2030, pages 65–76, 1993.
- [216] J. Shah. Segmentation by nonlinear diffusion. In *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, pages 202–207, 1991.
- [217] P. Soille. Constrained connectivity for hierarchical image partitioning and simplification. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 30(7):1132–1145, 2008.
- [218] X. Song and G. Fan. A study of supervised, semi-supervised and unsupervised multiscale bayesian image segmentation. In *The 2002 45th Midwest Symposium on Circuits and Systems*, volume 2, 2002.
- [219] J. Sporring. The entropy of scale-space. In *Proceedings of the 13th International Conference on Pattern Recognition*, volume 1, pages 900–904, Vienna, Austria, 25–29 August 1996.
- [220] J. L. Stansfield. Conclusions from the commodity expert project. Technical Report A.I. memo 671, Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA, USA, 1980.
- [221] G. Strang. *Introduction to Applied Mathematics*. Wellesley-Cambridge Press, Massachusetts, 1986.
- [222] E. Tadmor, S. Nezzar, and L. Vese. A multiscale image representation using hierarchical (bv, l^2) decompositions. *Multiscale Modeling and Simulation*, 2(4):554–579, 2004.
- [223] E. Tadmor, S. Nezzar, and L. Vese. Multiscale hierarchical decomposition of images with applications to deblurring, denoising and segmentation. *Communications in Mathematical Sciences*, 6(2):281–307, 2008.
- [224] S. Tanimoto and T. Pavlidis. A hierarchical structure for image processing. *Computer Vision, Graphics, and Image Processing*, 4:104–119, 1975.
- [225] A. Toet. Hierarchical image fusion. *Machine Vision and Applications*, 3:1–11, 1990.
- [226] L. Uhr. Layered ‘recognition cone’ networks the preprocess, classify, and describe. *IEEE Transactions on Computers*, 21(7):758–768, 1972.

- [227] C. Urdiales, A. Bandera, and F. Sandoval. Non-parametric planar shape representation based on adaptive curvature functions. *Pattern Recognition*, 35:43–53, 2002.
- [228] C. Vachier. Morphological scale-space analysis and feature extraction. In *Proceedings of the 2001 International Conference on Image Processing*, volume 3, pages 676–679, Thessaloniki, Greece, 7-10 October 2001.
- [229] C. Valens. A really friendly guide to wavelets. Technical report, 1999.
- [230] R. van den Boomgaard and A. Smeulders. The morphological structure of images: The differential equations of morphological scale-space. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 16(11):1101–1113, 1994.
- [231] S. J. van der Walt. *Super-Resolution Imaging*. Phd thesis, Stellenbosch University, December 2010.
- [232] P. van Staden and M. Loots. Method of L -moment estimation for the generalized lambda distribution. In *Proceedings of the Third Annual ASEARC Conference*, Newcastle, Australia, 7-8 December 2009.
- [233] P. Velleman. Robust nonlinear data smoothers: Definitions and recommendations. *Proceedings of the National Academy of Sciences*, 74(2):434–436, 1977.
- [234] P. F. Velleman. Definition and comparison of robust nonlinear data smoothing algorithms. *Journal of the American Statistical Association*, 75(371):609–615, 1980.
- [235] Z. Wang, A. Bovik, H. Sheik, and E. Somincelli. Image quality assessment: from error visibility to structural similarity. *IEEE Transactions on Image Processing*, 13(4):600–612, 2004.
- [236] M. Watanabe, D. Williams, and Y. Tomokyo. Comparison of detection limits for elemental mapping by EF-TEM and STEMXEDS. *Microscopy and Microanalysis*, 8:1588–1589, 2002.
- [237] G. Watson. *A Treatise on the Theory of Bessel Functions*. Cambridge University Press, London, 2nd edition, 1944.
- [238] J. Weickert, S. Ishikawa, and A. Imiya. On the history of gaussian scale-space axiomatics. *Computational Imaging and Vision*, 8:45–49, 1994.

- [239] J. Weickert, S. Ishikawa, and A. Imiya. Linear scale-space has first been proposed in japan. *Journal of Mathematical Imaging and Vision*, 10:237–252, 1999.
- [240] E. Weisstein. Convolution. From MathWorld—A Wolfram Web Resource <http://mathworld.wolfram.com/Convolution.html>.
- [241] R. Whitaker and S. Pizer. A multi-scale approach to nonuniform diffusion. *Computer Vision, Graphics, and Image Processing*, 57(1), 1993.
- [242] D. Widder. *The Heat Equation*. Academic Press, New York, 1975.
- [243] M. Wild. Idempotent and co-idempotent stack filters and min-max operators. *Theoretical Computer Science*, 299:603–631, 2003.
- [244] M. H. F. Wilkinson and G. K. Ouzounis. *Advances in Imaging and Electron Physics*, volume 161, chapter 5: Advances in Connectivity and Connected Attribute Filters, pages 211–275. 2010.
- [245] A. Witkin. Scale-space filtering: A new approach to multi-scale description. In *IEEE International Conference on Acoustics, Speech, and Signal Processing, ICASSP'84*, pages 150–153, March 1984.
- [246] A. P. Witkin. Scale-space filtering. In *Proceedings of the Eighth International Joint Conference on Artificial Intelligence IJCAI '83*, pages 1019–1022, Karlsruhe, 8-12 August 1983.
- [247] A. Wong and A. Mishra. Generalized probabilistic scale space for image restoration. *IEEE Transactions on Image Processing*, 19(10):2774–2780, 2010.
- [248] K. Wu, E. Otoo, and A. Shoshani. Optimizing connected component labeling algorithms. <http://repositories.cdlib.org/lbnl/LBNL-56864>, 2005.
- [249] X. Xie and G. Beni. A validity measure for fuzzy clustering. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 13(8):841–847, 1991.
- [250] A. Yuille and T. Poggio. Scaling theorems for zero-crossings. A.i. memo 722, Massachusetts Institute of Technology Artificial Intelligence Laboratory, June 1983.

- [251] C. Zahn. Graph-theoretical methods for detecting and describing gestalt clusters. *IEEE Transactions on Computers*, C-20(1):68–86, 1971.
- [252] S. Zeki. *A Vision of the Brain*. Blackwell Scientific Publications, 1993.
- [253] Y. Zhang. A survey on evaluation methods for image segmentation. *Pattern Recognition*, 29(8):1335–1346, 1996.
- [254] L. Zusne. *Contemporary Theory of Visual Form Perception: III. Global Properties*, chapter Chapter 4, pages 108–174. Academic Press, 1970.