

Contents

Acknowledgments	vi
Abstract	viii
Kurzfassung	xi
List of Acronyms	xx
List of Figures	xxiv
List of Tables	xxv
1 Introduction	1
1.1 Thesis Outline	3
1.2 Contributions	5
I Priors/Regularizers and Algorithms	7
2 Related Work and Results Preview	9
2.1 Related Work	9
2.2 A Preview of Results	13

3	The Smoothed-NUV Priors	21
3.1	General Form	21
3.2	Variations of SNUV Priors	23
3.2.1	The Plain SNUV Cost Function	23
3.2.2	The Huber Function	25
3.2.3	Smoothed L_p Norms	26
3.3	Discussions and Extensions	27
3.3.1	Analytical 1D Interpolation	28
3.3.2	Sparsity and Edge Detection	30
3.3.3	Color	30
4	Image Estimation by Iterative Reweighted Descent	33
4.1	Iterative Reweighted Coordinate Descent (IRCD)	35
4.2	Iterative Reweighted Gradient Descent (IRGD)	39
4.3	IRCD versus IRGD	39
4.4	Orthogonal Columns and IRCD with Parallel Updates . . .	40
4.5	Notes on Convergence	40
5	Image Estimation by Approximate Expectation Maximiza- tion	43
5.1	Statistical Model and Outline of Method	44
5.2	Iterative Scalar Gaussian Message Passing (ISGMP)	47
5.2.1	Background and Remarks	47
5.2.2	Message Passing Rules	47
5.3	Modifications of ISGMP for Stability	51
5.4	Comparison with IRCD	51
5.4.1	Analytical 1D Interpolation for EM	51

II Imaging Applications of SNUV **53****6 Computed Tomography** **55**

6.1	2D Tomography	56
6.1.1	2D Modified Shepp–Logan Phantom (Fig. 2.1) . . .	56
6.1.2	Squares (Fig. 6.3)	57
6.2	3D Tomography	59
6.3	Notes on the Algorithms	59
6.4	Multi-resolution Estimation	62
6.4.1	An Example	63
6.4.2	The Successive Cancellation Algorithm	64
6.4.3	Multi-resolution Reconstruction Results	64
6.5	Correcting the Rotation Center Misalignment	67
6.5.1	A Measure of Sharpness	68
6.5.2	Experimental Results	69

7 Image Segmentation **71**

7.1	Iterative Edge Cutting	72
7.1.1	Toy Example 1	73
7.1.2	Toy Example 2	73
7.1.3	Example 3	73
7.2	2D Segmentation	74
7.3	3D Segmentation	75
7.3.1	3D Object segmentation	78
7.3.2	Video Segmentation	78

8	Blind Image Deblurring	83
8.1	The Estimation Problem	84
8.2	Minimizing the Cost Function	85
8.2.1	Extended IRCD	85
8.2.2	Rescaling the Estimates	86
8.2.3	Finding σ_0	87
8.2.4	Extension to Multiple Color Measurements	88
8.3	Viability of MAP Methods for Blind Deblurring	88
8.4	Experimental Results	89
III	Beyond Edges	95
9	Extracting Edge Rates in 1D	97
9.1	Edge Count in 1D	98
9.2	Model Choice	98
9.3	The Recursions	100
9.4	1D Experimental Results	102
10	Extracting Edge Rates in 2D	107
10.1	Edge Count in 2D	107
10.2	Model Choice	108
10.3	The Recursions	112
10.4	2D Experimental Results	115
11	Conclusions	121
	Bibliography	123
	About the Author	137
	Appendix A Derivation of (3.17) and (3.18): SNUV Induced	
	L_p Norm	139

Appendix B Derivation of (3.20) to (3.22): Analytical 1D Interpolation	143
B.1 Derivation of (3.20)	144
B.2 Derivation of (3.21) and (3.22)	145
B.3 Visualization and Discussion	149