

Contents

Abstract	III
Kurzfassung	V
Acknowledgements	VII
List of Figures	XI
List of Tables	XVII
List of Symbols and Operators	XIX
List of Acronyms and Abbreviations	XXIII
1 Introduction	1
1.1 Motivation	1
1.2 State-of-the-Art	2
1.3 Objectives and Organization of the Thesis	4
2 SAR Remote Sensing	7
2.1 Synthetic Aperture Radar Imaging	7
2.1.1 Principles of Radar Imaging	7
2.1.2 Interpretation of SAR Images	10
2.2 SAR Interferometry (InSAR)	13
2.2.1 InSAR Geometry	13
2.2.2 Interferometric Coherence	14
2.3 Polarimetric SAR (PolSAR)	16
2.3.1 Polarimetric Target Descriptors	16
2.3.2 Polarimetric Observables	18
2.3.3 Eigenvector-based Decomposition	19
2.3.4 Polarimetric Interferometric SAR (Pol-InSAR)	22
3 Detection of Coherent Scatterers	25
3.1 Introduction	25
3.2 SAR Response of a Coherent Scatterer	26
3.2.1 Response of a Coherent Scatterer in the Range Dimension	26
3.2.2 Response of a Coherent Scatterer in the Azimuth Dimension	28
3.2.3 Response of a Coherent Scatterer in Range and Azimuth Dimensions	30
	IX

3.3	Observed Signal Model and Problem Statement for Coherent Scatterer Detection . . .	35
3.3.1	The Sublooking Process	35
3.3.2	SAR Response of a Coherent Scatterer in Sublook Images	36
3.3.3	Clutter Model	38
3.3.4	Detection Problem Statement	41
3.4	Coherent Scatterer Detection Methods	42
3.4.1	Sublook Coherence Approach (SCA)	43
3.4.2	Sublook Entropy Approach (SEA)	45
3.4.3	Phase Variance Approach (PVA)	45
3.4.4	Generalized Likelihood Ratio Test Approach (GLRTA)	47
4	Theoretical Performance Analysis	51
4.1	Introduction	51
4.2	GLRTA Performance	51
4.2.1	Independent Sublooks	52
4.2.2	Overlapping Sublooks	54
4.2.3	Sublook Bandwidth Size	57
4.2.4	Compound-Gaussian Clutter	58
4.2.5	Position Estimation	61
4.2.6	Range and Azimuth Directions	63
4.3	Performance Comparisons	68
4.3.1	SCA Performance	68
4.3.2	SEA Performance	69
4.3.3	PVA Performance	70
5	Experiments with Real Data	73
5.1	Introduction	73
5.2	CS Detection: Performance Analysis with Real Data	73
5.2.1	Helheim Glacier Test Site	73
5.2.2	Remningstorp Forest Test Site	81
5.3	Detection of Coherent Scatterers in Different Scenarios	89
5.3.1	Paris City Test Site	90
5.3.2	Etna Volcano Test Site	95
5.3.3	Glacier Environments	99
5.4	Coherent Scatterers Detection in Time Series	109
5.4.1	Temporal Stability of Coherent Scatterers	109
5.4.2	Coherent Scatterers for Monitoring Subsidences	115
6	Summary and Conclusions	123
6.1	Introduction	123
6.2	Summary	123
6.3	Contributions	128
6.4	Outlook	129
	References	131
	Curriculum Vitae	139