

Contents

1 Introduction	1
1.1 Problem Statement.	1
1.2 State of the Art in High-Resolution Spatial Sound Reproduction.	4
1.3 State of the Art in High-Resolution Spatial Sound Analysis	5
1.4 State of the Art in Adaptive Filtering.	6
1.4.1 Frequency-Domain Adaptive Filtering	7
1.4.2 Proportionate Adaptive Filtering Algorithms	8
1.4.3 Model-Based Adaptive Filtering and Post-Processing	8
1.4.4 Convergence Enhancement for Stereo Acoustic Echo Cancellation by a Preprocessing Stage.	9
1.5 Overview of This Book	10
References	11

Part I Theoretical Multichannel System Identification

2 Fundamentals of Adaptive Filter Theory	17
2.1 Signal and System Model.	17
2.1.1 Standard Representation.	17
2.1.2 Compact Representation	18
2.2 Optimal System Identification in Least-Squares Sense	19
2.2.1 The Wiener–Hopf Equation	19
2.2.2 Derivation of Iterative Estimation Approaches	20
References	22
3 Spatio-Temporal Regularized Recursive Least Squares Algorithm	23
3.1 Regularization from a Probabilistic Point of View.	23
3.2 Structured Regularization	25
3.3 $\ell_{p,q}$ -norm Constrained Adaptive Filtering	25

3.4	Discussion of Special Cases	27
3.4.1	Multichannel Sparse Adaptive Filtering	27
3.4.2	Efficient Computation of the Regularized Inverse	29
3.5	Ill-Conditioning in Multichannel Adaptive Filtering and Sparseness Constraint.	30
3.6	Experiments	31
	References	33
4	Sparse Representation of Multichannel Acoustic Systems	35
4.1	System Sparsity.	35
4.1.1	Prior Knowledge from Physics	35
4.1.2	Incorporating the Prior Knowledge on Spatially Discrete Acoustic Systems	43
4.1.3	Eigenspace Adaptive Filtering	46
4.2	Signal Sparsity	48
4.3	Source-Domain Estimation	48
4.3.1	Permutation Problem	50
4.4	Efficient System Identification in the Source Domain	51
4.4.1	Algorithm	51
4.4.2	Adaptation Control	52
4.5	Experiments	52
	References	54
5	Unique System Identification from Projections	55
5.1	Generic Spatially Transformed Adaptive Filtering for Ill-Conditioned Problems.	55
5.2	System Eigenspace Estimation	58
5.2.1	Validity of the Estimated Eigenspace	60
5.2.2	Adaptation Control	61
5.3	Experimental Results	61
5.3.1	Performance Measures.	61
5.3.2	Simulation	62
	References	62
 Part II Practical Aspects		
6	Geometrical Constraints.	67
6.1	Synthesis of Sound Fields.	69
6.2	Analytical Solution to the Synthesis of Sound Figures	71
6.2.1	Mathematical Problem Formulation.	71
6.2.2	Conditions for the Synthesis of Sound Figures	72

6.3	Synthesis of Closed Zones of Quiet	77
6.3.1	Approximation of the Driving Functions Based on the Kirchhoff–Helmholtz Integral	79
6.3.2	Analytical Derivation of the Driving Functions.	79
6.4	Linear Distribution of Secondary Sources as Limiting Case of a Closed Distribution	81
6.4.1	Linear Secondary Source Distributions	81
6.4.2	Arrays with Convex Geometries as Linear Arrays.	83
6.4.3	Example of the Synthesis of Sound Figures on a Line Using Linear Arrays	84
6.4.4	Sound Figures as Functions on Two-Dimensional Manifolds.	87
6.5	Simulations and Discussion of Practical Aspects	89
6.5.1	Limitations of the Synthesis of Sound Figures	91
6.5.2	Robustness Due to Practical Aspects	91
	References	93
7	Acoustic Echo Suppression	97
7.1	Problem Formulation and the Proposed Approach	98
7.1.1	Signal Model	98
7.1.2	Initial Guess of the Near-End Signal	99
7.1.3	Complexity Reduction for the Massive Multichannel Case.	101
7.2	MVDR Processing Stage	102
7.2.1	Minimum Variance	103
7.2.2	Distortionless Response	104
7.3	Experimental Results	104
7.3.1	Performance Measures	104
7.3.2	Simulations	105
	References	107
8	Conclusion and Outlook	109
	Appendix A: Definitions and Useful Identities	111
	Appendix B: Derivation of the Hessian Matrix for a Least-Squares Problem with Structured Regularization	113



<http://www.springer.com/978-3-319-08953-9>

Adaptive Identification of Acoustic Multichannel
Systems Using Sparse Representations

Helwani, K.

2015, XIV, 113 p. 39 illus., 10 illus. in color., Hardcover

ISBN: 978-3-319-08953-9