Contents

Acknowledgments ix

Preface xi

1 Fundamentals of blind signal separation 1

1.1 Introduction 1
1.2 Applications 2
1.3 Instantaneous mixing model 3
1.4 Assumptions 4
1.5 Independent & principal component analysis 7
1.6 Illustration of PCA and ICA 8
1.7 Acoustics 9
1.8 Convolutive mixing model 13
1.9 Summary 19

2 Modern blind signal separation algorithms 23

2.1 Introduction 23
2.2 Information-theoretic criteria 23
2.2.1 Kullback-Leibler divergence 23
2.2.2 Entropy maximization 24
2.3 Adaptive algorithms for BSS 27
2.3.1 Stochastic gradient 27
2.3.2 Natural (or relative) gradient 28
2.4 Parametric source density models for BSS 30
2.4.1 Generalized Gaussian density 30
2.4.2 Moment matching estimators 31
2.4.3 Parametric score functions 32

2.5 Blind signal separation strategies for convolutive mixtures 35
2.5.1 Convolutive BSS based on second-order statistics 36
2.5.2 Convolutive BSS based on higher-order statistics 38
2.5.3 Scaling and permutation 41
2.6 Performance measures 42
2.7 Summary 45

3 Application of blind signal processing strategies to noise reduction for the hearing-impaired 47
3.1 Introduction 47
3.1.1 Hearing loss 47
3.1.2 Hearing aids 48
3.1.3 Cochlear implants 49
3.2 Speech intelligibility in noise 50
3.3 Noise reduction strategies for hearing-impaired listeners 53
3.3.1 2M-SESS strategy 53
3.3.2 2M2-BEAM strategy 54
3.3.3 4M-SESS strategy 54
3.4 Speech intelligibility studies with hearing-impaired listeners 56
3.4.1 Subjects 56
3.4.2 Procedure 57
3.4.3 Stimuli 58
3.4.4 Anechoic conditions 58
3.4.5 Reverberant conditions 59
3.5 Results & Discussion 61
3.5.1 Anechoic conditions 61
3.5.2 Effects of training on speech intelligibility 62
3.5.3 Reverberant conditions 67

4 Conclusions and future challenges 71

Bibliography 75

Authors' Biographies 87