

1. Record Nr.	UNINA9910139024003321
Autore	Kim Yang-Hann
Titolo	Sound visualization and manipulation / / Yang-Hann Kim and Jung-Woo Choi, Korea Advanced Institute of Science and Technology (KAIST), Republic of Korea
Pubbl/distr/stampa	Singapore : , : Wiley, , 2013 [Piscataway, New Jersey] : , : IEEE Xplore, , [2013]
ISBN	1-118-36850-9 1-118-36848-7 1-118-36849-5
Descrizione fisica	1 online resource (438 p.)
Altri autori (Persone)	ChoiJung-Woo
Disciplina	534.01/5153533
Soggetti	Sound-waves - Mathematical models Helmholtz equation
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Note generali	Description based upon print version of record.
Nota di bibliografia	Includes bibliographical references and index.
Nota di contenuto	About the Author xi -- Preface xiii -- Acknowledgments xvii -- Part I ESSENCE OF ACOUSTICS -- 1 Acoustic Wave Equation and Its Basic Physical Measures 3 -- 1.1 Introduction 3 -- 1.2 One-Dimensional Acoustic Wave Equation 3 -- 1.2.1 Impedance 9 -- 1.3 Three-Dimensional Wave Equation 10 -- 1.4 Acoustic Intensity and Energy 11 -- 1.4.1 Complex-Valued Pressure and Intensity 16 -- 1.5 The Units of Sound 18 -- 1.6 Analysis Methods of Linear Acoustic Wave Equation 27 -- 1.6.1 Acoustic Wave Equation and Boundary Condition 28 -- 1.6.2 Eigenfunctions and Modal Expansion Theory 31 -- 1.6.3 Integral Approach Using Green's Function 35 -- 1.7 Solutions of the Wave Equation 39 -- 1.7.1 Plane Wave 40 -- 1.7.2 Spherical Wave 41 -- 1.8 Chapter Summary 46 -- References 46 -- 2 Radiation, Scattering, and Diffraction 49 -- 2.1 Introduction/Study Objectives 49 -- 2.2 Radiation of a Breathing Sphere and a Trembling Sphere 50 -- 2.3 Radiation from a Baffled Piston 58 -- 2.4 Radiation from a Finite Vibrating Plate 65 -- 2.5 Diffraction and Scattering 70 -- 2.6 Chapter Summary 79 -- 2.7 Essentials of Radiation, Scattering, and Diffraction 80 -- 2.7.1 Radiated Sound Field from an Infinitely Baffled Circular Piston 80 -- 2.7.2 Sound

Field at an Arbitrary Position Radiated by an Infinitely Baffled Circular Piston	81
2.7.3 Understanding Radiation, Scattering, and Diffraction Using the Kirchhoff / Helmholtz Integral Equation	82
2.7.4 Scattered Sound Field Using the Rayleigh Integral Equation	96
References	97
Part II SOUND VISUALIZATION	103
3 Acoustic Holography	103
3.1 Introduction	103
3.2 The Methodology of Acoustic Source Identification	103
3.3 Acoustic Holography: Measurement, Prediction, and Analysis	106
3.3.1 Introduction and Problem Definitions	106
3.3.2 Prediction Process	107
3.3.3 Mathematical Derivations of Three Acoustic Holography Methods and Their Discrete Forms	113
3.3.4 Measurement	119
3.3.5 Analysis of Acoustic Holography	124
3.4 Summary	129
References	130
4 Beamforming	137
4.1 Introduction	137
4.2 Problem Statement	138
4.3 Model-Based Beamforming	140
4.3.1 Plane and Spherical Wave Beamforming	140
4.3.2 The Array Configuration	142
4.4 Signal-Based Beamforming	145
4.4.1 Construction of Correlation Matrix in Time Domain	146
4.4.2 Construction of Correlation Matrix in Frequency Domain	151
4.4.3 Correlation Matrix of Multiple Sound Sources	152
4.5 Correlation-Based Scan Vector Design	160
4.5.1 Minimum Variance Beamformer	160
4.5.2 Linear Prediction	164
4.6 Subspace-Based Approaches	170
4.6.1 Basic Principles	170
4.6.2 MUSIC Beamformer	173
4.6.3 ESPRIT	180
4.7 Wideband Processing Technique	182
4.7.1 Frequency-Domain Approach: Mapping to the Beam Space	182
4.7.2 Coherent Subspace Method (CSM)	184
4.7.3 Partial Field Decomposition in Beam Space	185
4.7.4 Time-Domain Technique	190
4.7.5 Moving-Source Localization	198
4.8 Post-Processing Techniques	204
4.8.1 Deconvolution and Beamforming	204
4.8.2 Nonnegativity Constraint	207
4.8.3 Nonnegative Least-Squares Algorithm	209
4.8.4 DAMAS	210
References	212
Part III SOUND MANIPULATION	219
5 Sound Focusing	219
5.1 Introduction	219
5.2 Descriptions of the Problem of Sound Focusing	221
5.2.1 Free-Field Radiation from Loudspeaker Arrays	221
5.2.2 Descriptions of a Sound Field Depending on the Distance from the Array	221
5.2.3 Fresnel Approximation	223
5.2.4 Farfield Description of the Rayleigh Integral (Fraunhofer Approximation)	225
5.2.5 Descriptors of Directivity	227
5.3 Summing Operator (+)	230
5.3.1 Delay-and-Sum Technique	230
5.3.2 Beam Shaping and Steering	231
5.3.3 Wavenumber Cone and Diffraction Limit	233
5.3.4 Frequency Invariant Radiation Pattern	236
5.3.5 Discrete Array and Grating Lobes	237
5.4 Product Theorem (x)	240
5.4.1 Convolution and Multiplication of Sound Beams	240
5.4.2 On-Axis Pressure Response	243
5.5 Differential Operator and Super-Directivity (-)	245
5.5.1 Endfire Differential Patterns	245
5.5.2 Combination of Delay-and-Sum and Endfire Differential Patterns	252
5.5.3 Broadside Differential Pattern	252
5.5.4 Combination of the Delay-and-Sum and Broadside Differential Patterns	258
5.6 Optimization with Energy Ratios ($\frac{E}{E_0}$)	259
5.6.1 Problem Statement	259
5.6.2 Capon's Minimum Variance Estimator (Minimum Variance Beamformer)	261
5.6.3 Acoustic Brightness and Contrast Control	262
5.6.4 Further Analysis of Acoustic Brightness and Contrast Control	273
5.6.5 Application Examples	276
References	280
6 Sound Field Reproduction	283
6.1 Introduction	283
6.2 Problem Statement	284
6.2.1 Concept of Sound Field Reproduction	284
6.2.2 Objective of Sound Field Reproduction	284
6.3 Reproduction of One-Dimensional Sound Field	286
6.3.1 Field-Matching Approach	286
6.3.2 Mode-Matching Approach	288
6.3.3 Integral Approach	

289 --	6.3.4 Single-Layer Potential	295 --	6.4 Reproduction of a 3D Sound Field
296 --	6.4.1 Problem Statement and Associated Variables	296 --	6.5 Field-Matching Approach
298 --	6.5.1 Inverse Problem	298 --	6.5.2 Regularization of an Inverse Problem
305 --	6.5.3 Selection of the Regularization Parameter	309 --	6.6 Mode-Matching Approach
311 --	6.6.1 Encoding and Decoding of Sound Field	311 --	6.6.2 Mode-Matching with Plane Waves
313 --	6.6.3 Mode-Matching with Spherical Harmonics	320 --	6.7 Surface Integral Equations
337 --	6.7.1 Source Inside, Listener Inside (V_0, r, V)	337 --	6.7.2 Source Inside, Listener Outside (V_0, r, V)
340 --	6.7.3 Source Outside, Listener Outside (V_0, r, V)	341 --	6.7.4 Source Outside, Listener Inside (V_0, r, V)
342 --	6.7.5 Listener on the Control Surface	342 --	6.7.6 Summary of Integral Equations
344 --	6.7.7 Nonradiating Sound Field and Nonuniqueness Problem	344 --	6.8 Single-layer Formula
346 --	6.8.1 Single-layer Formula for Exterior Virtual Source	346 --	6.8.2 Integral Formulas for Interior Virtual Source
355 --	References	369.	Appendix A Useful Formulas
371 --	A.1 Fourier Transform	371 --	A.1.1 Fourier Transform Table
371 --	A.2 Dirac Delta Function	374 --	A.3 Derivative of Matrices
374 --	A.3.1 Derivative of Real-Valued Matrix	374 --	A.3.2 Derivative of Complex-Valued Function
375 --	A.3.3 Derivative of Complex Matrix	376 --	A.4 Inverse Problem
376 --	A.4.1 Overdetermined Linear Equations and Least Squares (LS) Solution	377 --	A.4.2 Underdetermined Linear Equations and Minimum-Norm Problem
378 --	A.4.3 Method of Lagrange Multiplier	379 --	A.4.4 Regularized Least Squares
380 --	A.4.5 Singular Value Decomposition	380 --	A.4.6 Total Least Squares (TLS)
382 --	Appendix B Description of Sound Field	385 --	B.1 Three-Dimensional Acoustic Wave Equation
385 --	B.1.1 Conservation of Mass	385 --	B.1.2 Conservation of Momentum
385 --	B.1.3 Equation of State	388 --	B.1.4 Velocity Potential Function
390 --	B.1.5 Complex Intensity	391 --	B.1.6 Singular Sources
392 --	B.2 Wavenumber Domain Representation of the Rayleigh Integral	398 --	B.2.1 Fourier Transform of Free-Field Green's Function (Weyl's Identity)
398 --	B.2.2 High Frequency Approximation (Stationary Phase Approximation)	399 --	B.3 Separation of Variables in Spherical Coordinates
400 --	B.3.1 Angle Functions: Associated Legendre Functions	400 --	B.3.2 Angle Functions: Spherical Harmonics
402 --	B.3.3 Radial Functions	404 --	B.3.4 Radial Functions: Spherical Bessel and Hankel Functions
404 --	B.3.5 Description of Sound Fields by Spherical Basis Function	408 --	B.3.6 Representation of the Green's Function
409 --	References	411 --	Index
413.			

Sommario/riassunto

Unique in addressing two different problems - sound visualization and manipulation - in a unified way Advances in signal processing technology are enabling ever more accurate visualization of existing sound fields and precisely defined sound field production. The idea of explaining both the problem of sound visualization and the problem of the manipulation of sound within one book supports this inter-related area of study. With rapid development of array technologies, it is possible to do much in terms of visualization and manipulation, among other technologies involved