

# *Contents*

Preface.....	ix
Author.....	xi
<b>1. Introduction.....</b>	<b>1</b>
<b>2. Underwater Signal Parameter Detection and Estimation.....</b>	<b>3</b>
2.1    Acoustic Sensor Unit .....	4
2.2    Direct-Integration Method.....	6
2.3    Normalization and Optimization.....	10
2.3.1    System Optimization.....	13
2.4    Reversed Configuration .....	16
2.5    Active Modality.....	21
<b>3. System Analysis.....</b>	<b>23</b>
3.1    Linear Coherent Systems .....	23
3.1.1    Impulse Functions .....	23
3.1.2    Plane Waves .....	25
3.1.3    Impulse Responses of Wave Propagation .....	27
3.1.4    Transfer Functions .....	28
3.1.5    Correspondences.....	29
3.2    Backward Propagation .....	31
3.2.1    Image Reconstruction by Inverse Filtering .....	32
3.2.2    Plane-to-Plane Backward Propagation .....	33
3.2.3    Power Spectrum and the Point-Spread Function.....	34
3.2.4    Wavefield Signal Processing.....	35
3.2.5    Backward Propagation in Space Domain.....	36
3.2.6    Phase-Only Technique .....	39
3.3    Fresnel and Fraunhofer Approximations .....	40
3.3.1    Fresnel Approximation .....	41
3.3.2    Fraunhofer Approximation .....	44
3.4    Holographic Imaging .....	44
3.5    Diffraction Tomography.....	47
3.5.1    Active Illumination.....	48
3.5.2    Tomographic Reconstruction .....	50
3.5.3    Finite-Size Aperture .....	51
3.6    Resolution Analysis of Discrete Arrays.....	53
3.6.1    Classical Formulation.....	54
3.6.2    Fourier Analysis.....	55
3.6.3    Active Systems.....	57

3.6.4	Range Resolution .....	59
3.6.5	Wideband Case .....	62
<b>4.</b>	<b>Acoustical Imaging Applications.....</b>	<b>65</b>
4.1	Multi-Frequency Imaging .....	65
4.1.1	Scanning Tomographic Acoustic Microscopy .....	66
4.1.2	Multi-Frequency Backward Propagation .....	68
4.2	Pulse-Echo Imaging .....	70
4.2.1	Synthetic-Aperture Sonar Imaging .....	71
4.3	Linear-Chirp Signaling .....	72
4.4	Step-Frequency FMCW Ultrasound Imaging.....	75
4.4.1	Superposition of the Range Profiles.....	79
4.4.2	FMCW Medical Ultrasound Imaging.....	80
4.5	Chirp Signal and Fresnel Phase Pattern .....	82
4.5.1	Implementation by FFT.....	84
<b>5.</b>	<b>Resolution Enhancement and Motion Estimation.....</b>	<b>87</b>
5.1	Quadrature-Receiver Phase Errors and Correction.....	87
5.1.1	Data Acquisition of the Step-Frequency FMCW Systems.....	87
5.1.2	Quadrature-Receiver Phase Errors.....	89
5.1.3	Estimation of the Phase Errors .....	90
5.1.4	Correction Procedure .....	92
5.2	Resolution Enhancement by Wavefield Statistics.....	98
5.2.1	Image Reconstruction by Coherent Backward Propagation.....	98
5.2.2	Wavefield Statistics .....	100
5.2.3	Wideband Modality .....	101
5.2.4	Cascade Form .....	102
5.2.5	Calculation of Wavefield Statistics .....	102
5.3	Parameter-Based Motion Estimation .....	103
5.3.1	Point Features and Matching Correspondences .....	103
5.3.2	Without Matching Correspondences .....	105
5.3.3	Complex-Image Statistics.....	107
5.4	Image-Based Motion Estimation and Imaging.....	110
5.4.1	Image-Domain Methods.....	110
5.4.2	Data-Domain Methods.....	110
5.4.3	Hybrid Version .....	111
5.4.4	Frequency-Domain Analysis.....	112
<b>Index.....</b>		<b>117</b>