

# Contents

Contributors	ix
Preface	xi
Arab School on Science and Technology	xiv
<b>1. FUNDAMENTALS OF DIGITAL SIGNAL PROCESSING</b>	<b>1</b>
<b>J. S. Lim</b>	
Signals and Systems	2
Fourier Transform	7
z-Transform	11
Difference Equation	16
Discrete Fourier Series	19
Discrete Fourier Transform	21
Fast Fourier Transform	25
Digital Processing of Analog Signals	32
Finite Impulse Response Digital Filter	39
Infinite Impulse Response Filters	50
References	56
Acknowledgments	57
<b>2. LINEAR ESTIMATIONS FOR STATIONARY AND NEAR-STATIONARY PROCESSES</b>	<b>59</b>
<b>T. Kailath</b>	
Introduction	60
Innovations for Scalar Stationary Processing	61
More on Scalar Stationary Processing	72
Multichannel Stationary Processes	96
Adaptive Filtering and Nonstationary Processes	111
References	122

<b>3. SPECTRAL ESTIMATION WITH APPLICATIONS</b>	<b>129</b>
<b>S. L. Marple, Jr.</b>	
Introduction	130
Spectral Density Basics	131
Classical Methods	132
Parametric Methods	134
Nonparametric Methods	144
Multidimensional MEM	148
Summary of Methods	148
Applications	149
Current Problems in Spectral Estimation	154
References	155
<b>4. ADVANCED DIGITAL FILTERS</b>	<b>169</b>
<b>P. Dewilde</b>	
Introduction	169
Basic Notations and Usage	174
Orthogonal Filters and Embeddings	177
Wave Digital Filters: An Introduction	193
Implementation and Discussion	203
Appendix: Lyapunov Equations and Hamiltonians	206
References	208
<b>5. SPEECH CODING AND PROCESSING</b>	<b>211</b>
<b>J. Makhoul</b>	
Introduction	212
The Speech Signal	212
General Coding Systems	213
Waveform Coding	214
Baseband Coding	234
Narrowband Coders	236
Speech Synthesis	241
Speech Recognition	242
Speech Hardware	243
Glossary	244
References	244
<b>6. SIGNAL PROCESSING IN THE ARAB WORLD</b>	<b>249</b>
<b>M. Mrayati</b>	
Introduction	250
Applications of One-dimensional Signal Processing	250
Applications of Two-dimensional Signal Processing	257
Teaching and Research on Signal Processing in the Arab World	259
References	259

<b>7. SIGNAL PROCESSING IN COMMUNICATIONS</b>	<b>261</b>
<b>J. G. Proakis</b>	
Introduction	262
Digital Communications over Telephone Channels	268
Digital Communications over Fading Multipath Channels	285
Excision of Narrowband Interference in PN Spread	
Spectrum Systems	296
Concluding Remarks	304
References	305
<b>8. RADAR/SONAR SIGNAL PROCESSING</b>	<b>309</b>
<b>H. J. Whitehouse</b>	
Introduction	310
Fundamental Concepts	311
Waveform Selection	312
Waveform Processing	314
Sensor Processing	317
Imaging Radars	322
Conclusions	330
References	331
Bibliography	331
<b>9. DIGITAL IMAGE PROCESSING: PROBLEMS AND METHODS</b>	<b>335</b>
<b>A. K. Jain</b>	
Introduction	336
Image Representation	336
Image Enhancement	346
Image Restoration	346
Image Data Compression and Coding	351
Image Reconstruction from Projections	358
Other Areas	364
Bibliography	366
<b>10. SIGNAL PROCESSING TECHNOLOGY</b>	<b>369</b>
<b>H. J. Whitehouse</b>	
Introduction	370
Signal Processing	370
Analog Signal Processing	374
Fourier Transformations	376
Matrix Signal Processing	381
Signal Processing Implementations	385
Conclusions	389
References	390

<b>11. VLSI ARRAY PROCESSOR FOR SIGNAL PROCESSING</b>	<b>393</b>
<b>S. Y. Kung</b>	
Introduction	<b>395</b>
Impact of VLSI on Array Processes Design	<b>395</b>
VLSI Array Processors for Signal Processing	<b>400</b>
Algorithm Analysis to Architecture Design	<b>406</b>
Wavefront Array Processor	<b>413</b>
Wavefront Arrays Based on Givens Rotation	<b>418</b>
Wavefront Array for Solving Toeplitz Linear Systems	<b>429</b>
Conclusions	<b>436</b>
Acknowledgments	<b>437</b>
References	<b>437</b>
<b>INDEX</b>	<b>441</b>