## Table of contents

- Section I Introduction to Digital Signal and Image Processing
- Chapter 1 Signals and Biomedical Signal Processing (p. 3)
- 1.1 Introduction and Overview (p. 3)
- **1.2 What Is a "Signal"?** (p. 3)
- 1.3 Analog, Discrete, and Digital Signals (p. 4)
- 1.4 Processing and Transformation of Signals (p. 7)
- 1.5 Signal Processing for Feature Extraction (p. 8)
- 1.6 Some Characteristics of Digital Images (p. 9)
- **1.7 Summary** (p. 12)
- **1.8 Problems** (p. 13)
- Chapter 2 Fourier Transform (p. 15)
- **2.1 Introduction and Overview** (p. 15)
- 2.2 One-Dimensional Continuous Fourier Transform (p. 15)
- **2.3 Sampling and NYQUIST Rate** (p. 28)
- 2.4 One-Dimensional Discrete Fourier Transform (p. 29)
- 2.5 Two-Dimensional Discrete Fourier Transform (p. 32)
- 2.6 Filter Design (p. 35)
- **2.7 Summary** (p. 38)
- **2.8 Problems** (p. 38)
- **Note** (p. 40)
- Chapter 3 Image Filtering, Enhancement, and Restoration (p. 41)
- 3.1 Introduction and Overview (p. 41)
- **3.2 Point Processing** (p. 42)
- 3.3 Mask Processing: Linear Filtering in the Space Domain (p. 52)
- 3.4 Frequency Domain Filtering (p. 66)
- **3.5 Summary** (p. 68)
- **3.6 Problems** (p. 69)
- Notes (p. 70)
- Chapter 4 Edge Detection and Segmentation of Images (p. 71)
- 4.1 Introduction and Overview (p. 71)
- **4.2 Edge Detection** (p. 71)
- 4.3 Image Segmentation (p. 78)
- **4.4 Summary** (p. 86)
- **4.5 Problems** (p. 86)
- Chapter 5 Wavelet Transform (p. 89)
- **5.1 Introduction and Overview** (p. 89)
- 5.2 From Fourier Transform to Short-Time Fourier Transform (p. 89)
- 5.3 One-Dimensional Continuous Wavelet Transform (p. 95)
- 5.4 One-Dimensional Discrete Wavelet Transform (p. 98)
- 5.5 Two-Dimensional Wavelet Transform (p. 103)
- 5.6 Main Applications of the DWT (p. 107)
- 5.7 Discrete Wavelet Transform in Matlab (p. 108)
- **5.8 Summary** (p. 109)

- **5.9 Problems** (p. 109)
- Notes (p. 110)
- Chapter 6 Other Signal and Image Processing Methods (p. 111)
- **6.1 Introduction and Overview** (p. 111)
- 6.2 Complexity Analysis (p. 111)
- **6.3 Cosine Transform** (p. 114)
- 6.4 Introduction to Stochastic Processes (p. 118)
- **6.5 Introduction to Information Theory** (p. 126)
- **6.6 Registration of Images** (p. 130)
- 6.7 Summary (p. 133)
- **6.8 Problems** (p. 134)
- 7.3 Feature Extraction (p. 140)
- **Note** (p. 136)
- Chapter 7 Clustering and Classification (p. 137)
- 7.1 Introduction and Overview (p. 137)
- 7.4 K-Means: A Simple Clustering Method (p. 143)
- **7.5 Bayesian Classifier** (p. 147)
- 7.6 Maximum Likelihood Method (p. 151)
- **7.7 Neural Networks** (p. 153)
- **7.8 Summary** (p. 164)
- **7.9 Problems** (p. 164)
- **Note** (p. 167)
- Section II Processing of Biomedical Signals
- Chapter 8 Electrical Activities of Cell (p. 171)
- 8.1 Introduction and Overview (p. 171)
- 8.2 Ion Transport in Biological Cells (p. 171)
- 8.3 Electrical Characteristics of Cell Membranes (p. 176)
- 8.4 Hodgkin-Huxley Model (p. 180)
- **8.5 Electrical Data Acquisition** (p. 182)
- 8.6 Some Practical Considerations for Biomedical Electrodes (p. 185)
- **8.7 Summary** (p. 186)
- 8.8 Problems (p. 186)
- **Note** (p. 187)
- Chapter 9 Electrocardiogram (p. 189)
- **9.1 Introduction and Overview** (p. 189)
- 9.2 Function and Structure of the Heart (p. 189)
- 9.3 Electrocardiogram: Signal of the Cardiovascular System (p. 194)
- 9.4 Cardiovascular Diseases and the ECG (p. 200)
- 9.5 Processing and Feature Extraction of ECGs (p. 208)
- 9.6 Summary (p. 212)
- **9.7 Problems** (p. 212)
- Notes (p. 213)
- Chapter 10 Electroencephalogram (p. 215)
- 10.1 Introduction and Overview (p. 215)
- 10.2 The Brain and Its Functions (p. 215)
- 10.3 Electroencephalogram: Signal of the Brain (p. 217)

- 10.4 Evoked Potentials (p. 222)
- 10.5 Diseases of the Central Nervous System and the EEG (p. 225)
- 10.6 EEG for Assessment of Anesthesia (p. 228)
- 10.7 Processing and Feature Extraction of EEGs (p. 229)
- **10.8 Summary** (p. 233)
- **10.9 Problems** (p. 234)
- Notes (p. 235)
- Chapter 11 Electromyogram (p. 237)
- 11.1 Introduction and Overview (p. 237)
- **11.2 Muscle** (p. 237)
- **11.3 EMG: Signal Muscles** (p. 242)
- 11.4 Neuromuscular Diseases and the EMG (p. 246)
- 11.5 Other Applications of the EMG (p. 249)
- 11.6 Processing and Feature Extraction of the EMG (p. 250)
- **11.7 Summary** (p. 253)
- **11.8 Problems** (p. 253)
- Notes (p. 255)
- Chapter 12 Other Biomedical Signals (p. 257)
- 12.1 Introduction and Overview (p. 257)
- 12.2 Blood Pressure and Blood Flow (p. 257)
- **12.3 Electrooculogram** (p. 258)
- 12.4 Magnetoencephalogram (p. 260)
- **12.5 Respiratory Signals** (p. 262)
- 12.6 More Biomedical Signals (p. 264)
- **12.7 Summary** (p. 265)
- **12.8 Problems** (p. 265)
- **Note** (p. 266)
- Section III Processing of Biomedical Images
- Chapter 13 Principles of Computed Tomography (p. 269)
- **13.1 Introduction and Overview** (p. 269)
- 13.2 Formulation of Attenuation Computed Tomography (p. 273)
- 13.3 The Fourier Slice Theorem (p. 278)
- **13.4 Summary** (p. 280)
- **13.5 Problems** (p. 281)
- Chapter 14 X-Ray Imaging and Computed Tomography (p. 283)
- 14.1 Introduction and Overview (p. 283)
- **14.2 Physics of X-Rays** (p. 283)
- 14.6 Biomedical CT Scanners (p. 296)
- 14.3 Attenuation-Based X-Ray Imaging (p. 288)
- **14.4 Image Quality** (p. 293)
- **14.5 Computed Tomography** (p. 295)
- 14.7 Diagnostic Applications of X-Ray Imaging (p. 299)
- 14.8 CT Images for Stereotactic Surgeries (p. 300)
- 14.9 CT Registration for Other Image-Guided Interventions (p. 300)
- 14.10 Complications of X-Ray Imaging (p. 301)
- **14.11 Summary** (p. 302)

- **14.12 Problems** (p. 302)
- Notes (p. 304)
- Chapter 15 Magnetic Resonance Imaging (p. 305)
- 15.1 Introduction and Overview (p. 305)
- 15.2 Physical and Physiological Principles of MRI (p. 306)
- **15.3 MRI** (p. 313)
- 15.4 Formulation of MRI Reconstruction (p. 317)
- **15.5 Functional MRI (fMRI)** (p. 320)
- 15.6 Applications of MRI and fMRI (p. 322)
- 15.7 Processing and Feature Extraction of MRI (p. 326)
- 15.8 Comparison of MRI with Other Imaging Modalities (p. 328)
- 15.9 Registration with MR Images (p. 329)
- **15.10 Summary** (p. 330)
- 15.11 Problems (p. 331)
- **Notes** (p. 332)
- Chapter 16 Ultrasound Imaging (p. 333)
- 16.1 Introduction and Overview (p. 333)
- **16.2 Why Ultrasound Imaging?** (p. 333)
- 16.3 Generation and Detection of Ultrasound Waves (p. 334)
- 16.4 Physical and Physiological Principles of Ultrasound (p. 335)
- 16.5 Resolution of Ultrasound Imaging Systems (p. 342)
- 16.6 Ultrasound Imaging Modalities (p. 343)
- 16.7 Modes of Ultrasound Image Representation (p. 353)
- **16.8 Ultrasound Image Artifacts** (p. 354)
- 16.9 Three-Dimensional Ultrasound Image Reconstruction (p. 356)
- **16.10** Applications of Ultrasound Imaging (p. 357)
- 16.11 Processing and Feature Extraction of Ultrasonic Images (p. 358)
- **16.12 Image Registration** (p. 359)
- 16.13 Comparison of CT, MRI, and Ultrasonic Images (p. 360)
- 16.14 Bio-Effects of Ultrasound (p. 360)
- **16.15 Summary** (p. 361)
- 16.16 Problems (p. 361)
- **Notes** (p. 364)
- Chapter 17 Positron Emission Tomography (p. 365)
- 17.1 Introduction and Overview (p. 365)
- 17.2 Physical and Physiological Principles of PET (p. 365)
- 17.3 PET Signal Acquisition (p. 368)
- **17.4 PET Image Formation** (p. 371)
- 17.5 Significance of PET (p. 372)
- **17.6 Applications of PET** (p. 373)
- 17.7 Processing and Feature Extraction of PET Images (p. 377)
- 17.8 Comparison of CT, MRI, and PET Images (p. 378)
- **17.9 Summary** (p. 379)
- 17.10 Problems (p. 379)
- Notes (p. 381)
- Chapter 18 Other Biomedical Imaging Techniques (p. 383)

- 18.1 Introduction and Overview (p. 383)
- **18.2 Optical Microscopy** (p. 384)
- **18.3 Fluorescent Microscopy** (p. 385)
- **18.4 Confocal Microscopy** (p. 388)
- 18.5 Near-Field Scanning Optical Microscopy (p. 389)
- 18.6 Electrical Impedance Imaging (p. 391)
- **18.7 Electron Microscopy** (p. 394)
- **18.8 Biometrics** (p. 397)
- **18.9 Summary** (p. 403)
- **18.10 Problems** (p. 404)
- **Notes** (p. 404)
- Related Titles (p. 405)
- **Index** (p. 407)