

1. Record Nr.	UNINA9910830206803321
Autore	Rangayyan Rangaraj M
Titolo	Biomedical Signal Analysis
Pubbl/distr/stampa	Newark : , : John Wiley & Sons, Incorporated, , 2024 ©2024
ISBN	1-119-82586-5 1-119-82588-1
Edizione	[3rd ed.]
Descrizione fisica	1 online resource (721 pages)
Collana	IEEE Press Series on Biomedical Engineering Series
Altri autori (Persone)	KrishnanSridhar
Disciplina	610.28
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Cover -- Title Page -- Copyright -- Contents -- About the Authors -- Foreword by Prof. Willis J. Tompkins -- Foreword by Prof. Alan V. Oppenheim -- Preface -- Acknowledgments -- Symbols and Abbreviations -- About the Companion Website -- 1 Introduction to Biomedical Signals -- 1.1 The Nature of Biomedical Signals -- 1.2 Examples of Biomedical Signals -- 1.2.1 The action potential of a cardiac myocyte -- 1.2.2 The action potential of a neuron -- 1.2.3 The electroneurogram (ENG) -- 1.2.4 The electromyogram (EMG) -- 1.2.5 The electrocardiogram (ECG) -- 1.2.6 The electroencephalogram (EEG) -- 1.2.7 Event-related potentials (ERPs) -- 1.2.8 The electrogastrogram (EGG) -- 1.2.9 The phonocardiogram (PCG) -- 1.2.10 The carotid pulse -- 1.2.11 The photoplethysmogram (PPG) -- 1.2.12 Signals from catheter-tip sensors -- 1.2.13 The speech signal -- 1.2.14 The vibroarthrogram (VAG) -- 1.2.15 The vibromyogram (VMG) -- 1.2.16 Otoacoustic emission (OAE) signals -- 1.2.17 Bioacoustic signals -- 1.3 Objectives of Biomedical Signal Analysis -- 1.4 Challenges in Biomedical Signal Analysis -- 1.5 Why Use Computer-aided Monitoring and Diagnosis? -- 1.6 Remarks -- 1.7 Study Questions and Problems -- 1.8 Laboratory Exercises and Projects -- References -- 2 Analysis of Concurrent, Coupled, and Correlated Processes -- 2.1 Problem Statement -- 2.2 Illustration of the Problem with Case Studies -- 2.2.1 The ECG and the PCG -- 2.2.2 The PCG and the carotid pulse -- 2.2.3

The ECG and the atrial electrogram -- 2.2.4 Cardiorespiratory interaction -- 2.2.5 Heart-rate variability -- 2.2.6 The EMG and VMG -- 2.2.7 The knee-joint and muscle-vibration signals -- 2.3

Application: Segmentation of the PCG -- 2.4 Application: Diagnosis and Monitoring of Sleep Apnea -- 2.4.1 Monitoring of sleep apnea by polysomnography -- 2.4.2 Home monitoring of sleep apnea. 2.4.3 Multivariate and multiorgan analysis -- 2.5 Remarks -- 2.6 Study Questions and Problems -- 2.7 Laboratory Exercises and Projects --

References -- 3 Filtering for Removal of Artifacts -- 3.1 Problem Statement -- 3.2 Random, Structured, and Physiological Noise -- 3.2.1 Random noise -- 3.2.2 Structured noise -- 3.2.3 Physiological interference -- 3.2.4 Stationary, nonstationary, and cyclostationary processes -- 3.3 Illustration of the Problem with Case Studies -- 3.3.1 Noise in event-related potentials -- 3.3.2 High-frequency noise in the ECG -- 3.3.3 Motion artifact in the ECG -- 3.3.4 Power-line interference in ECG signals -- 3.3.5 Maternal ECG interference in fetal ECG -- 3.3.6 Muscle-contraction interference in VAG signals -- 3.3.7 Potential solutions to the problem -- 3.4 Fundamental Concepts of Filtering -- 3.4.1 Linear shift-invariant filters and convolution -- 3.4.2 Transform-domain analysis of signals and systems -- 3.4.3 The pole-zero plot -- 3.4.4 The Fourier transform -- 3.4.5 The discrete Fourier transform -- 3.4.6 Convolution using the DFT -- 3.4.7 Properties of the Fourier transform -- 3.5 Synchronized Averaging -- 3.6 Time-domain Filters -- 3.6.1 Moving-average filters -- 3.6.2 Derivative-based operators to remove low-frequency artifacts -- 3.6.3 Various specifications of a filter -- 3.7 Frequency-domain Filters -- 3.7.1 Removal of high-frequency noise: Butterworth lowpass filters -- 3.7.2 Removal of low-frequency noise: Butterworth highpass filters -- 3.7.3 Removal of periodic artifacts: Notch and comb filters -- 3.8 Order-statistic Filters -- 3.9 The Wiener Filter -- 3.10 Adaptive Filters for Removal of Interference -- 3.10.1 The adaptive noise canceler -- 3.10.2 The least-mean-squares adaptive filter -- 3.10.3 The RLS adaptive filter -- 3.11 Selecting an Appropriate Filter -- 3.12 Application: Removal of Artifacts in ERP Signals. 3.13 Application: Removal of Artifacts in the ECG -- 3.14 Application: Maternal-Fetal ECG -- 3.15 Application: Muscle-contraction Interference -- 3.16 Remarks -- 3.17 Study Questions and Problems -- 3.18 Laboratory Exercises and Projects --

References -- 4 Detection of Events -- 4.1 Problem Statement -- 4.2 Illustration of the Problem with Case Studies -- 4.2.1 The P, QRS, and T waves in the ECG -- 4.2.2 The first and second heart sounds -- 4.2.3 The dicrotic notch in the carotid pulse -- 4.2.4 EEG rhythms, waves, and transients -- 4.3 Detection of Events and Waves -- 4.3.1 Derivative-based methods for QRS detection -- 4.3.2 The Pan-Tompkins algorithm for QRS detection -- 4.3.3 Detection of the P wave in the ECG -- 4.3.4 Detection of the T wave in the ECG -- 4.3.5 Detection of the dicrotic notch -- 4.4 Correlation Analysis of EEG Rhythms -- 4.4.1 Detection of EEG rhythms -- 4.4.2 Template matching for EEG spike-and-wave detection -- 4.4.3 Detection of EEG rhythms related to seizure -- 4.5 Cross-spectral Techniques -- 4.5.1 Coherence analysis of EEG channels -- 4.6 The Matched Filter -- 4.6.1 Derivation of the transfer function of the matched filter -- 4.6.2 Detection of EEG spike-and-wave complexes -- 4.7 Homomorphic Filtering -- 4.7.1 Generalized linear filtering -- 4.7.2 Homomorphic deconvolution -- 4.7.3 Extraction of the vocal-tract response -- 4.8 Application: ECG Rhythm Analysis -- 4.9 Application: Identification of Heart Sounds -- 4.10 Application: Detection of the Aortic Component of S2 -- 4.11 Remarks -- 4.12 Study Questions and Problems -- 4.13 Laboratory Exercises and Projects -- References -- 5

Analysis of Waveshape and Waveform Complexity -- 5.1 Problem Statement -- 5.2 Illustration of the Problem with Case Studies -- 5.2.1 The QRS complex in the case of bundle-branch block -- 5.2.2 The effect of myocardial ischemia on QRS waveshape. 5.2.3 Ectopic beats -- 5.2.4 Complexity of the EMG interference pattern -- 5.2.5 PCG intensity patterns -- 5.3 Analysis of ERPs -- 5.4 Morphological Analysis of ECG Waves -- 5.4.1 Correlation coefficient -- 5.4.2 The minimum-phase correspondent and signal length -- 5.4.3 ECG waveform analysis -- 5.5 Envelope Extraction and Analysis -- 5.5.1 Amplitude demodulation -- 5.5.2 Synchronized averaging of PCG envelopes -- 5.5.3 The envelopogram -- 5.6 Analysis of Activity -- 5.6.1 The RMS value -- 5.6.2 Zero-crossing rate -- 5.6.3 Turns count -- 5.6.4 Form factor -- 5.7 Application: Normal and Ectopic ECG Beats -- 5.8 Application: Analysis of Exercise ECG -- 5.9 Application: Analysis of the EMG in Relation to Force -- 5.10 Application: Analysis of Respiration -- 5.11 Application: Correlates of Muscular Contraction -- 5.12 Application: Statistical Analysis of VAG Signals -- 5.12.1 Acquisition of knee-joint VAG signals -- 5.12.2 Estimation of the PDFs of VAG signals -- 5.12.3 Screening of VAG signals using statistical parameters -- 5.13 Application: Fractal Analysis of the EMG in Relation to Force -- 5.13.1 Fractals in nature -- 5.13.2 Fractal dimension -- 5.13.3 Fractal analysis of physiological signals -- 5.13.4 Fractal analysis of EMG signals -- 5.14 Remarks -- 5.15 Study Questions and Problems -- 5.16 Laboratory Exercises and Projects -- References -- 6 Frequency-domain Characterization of Signals and Systems -- 6.1 Problem Statement -- 6.2 Illustration of the Problem with Case Studies -- 6.2.1 The effect of myocardial elasticity on heart sound spectra -- 6.2.2 Frequency analysis of murmurs to diagnose valvular defects -- 6.3 Estimation of the PSD -- 6.3.1 Considerations in the computation of the ACF -- 6.3.2 The periodogram -- 6.3.3 The need for averaging PSDs -- 6.3.4 The use of windows: spectral resolution and leakage. 6.3.5 Estimation of the ACF from the PSD -- 6.3.6 Synchronized averaging of PCG spectra -- 6.4 Measures Derived from PSDs -- 6.4.1 Moments of PSD functions -- 6.4.2 Spectral power ratios -- 6.5 Application: Evaluation of Prosthetic Heart Valves -- 6.6 Application: Fractal Analysis of VAG Signals -- 6.6.1 Fractals and the $1/f$ model -- 6.6.2 FD via power spectral analysis -- 6.6.3 Examples of synthesized fractal signals -- 6.6.4 Fractal analysis of segments of VAG signals -- 6.7 Application: Spectral Analysis of EEG Signals -- 6.8 Remarks -- 6.9 Study Questions and Problems -- 6.10 Laboratory Exercises and Projects -- References -- 7 Modeling of Biomedical Signal-generating Processes and Systems -- 7.1 Problem Statement -- 7.2 Illustration of the Problem -- 7.2.1 Motor-unit firing patterns -- 7.2.2 Cardiac rhythm -- 7.2.3 Formants and pitch in speech -- 7.2.4 Patellofemoral crepitus -- 7.3 Point Processes -- 7.4 Parametric System Modeling -- 7.5 Autoregressive or All-pole Modeling -- 7.5.1 Spectral matching and parameterization -- 7.5.2 Optimal model order -- 7.5.3 AR and cepstral coefficients -- 7.6 Pole-Zero Modeling -- 7.6.1 Sequential estimation of poles and zeros -- 7.6.2 Iterative system identification -- 7.6.3 Homomorphic prediction and modeling -- 7.7 Electromechanical Models of Signal Generation -- 7.7.1 Modeling of respiratory sounds -- 7.7.2 Modeling sound generation in coronary arteries -- 7.7.3 Modeling sound generation in knee joints -- 7.8 Electrophysiological Models of the Heart -- 7.8.1 Electrophysiological modeling at the cellular level -- 7.8.2 Electrophysiological modeling at the tissue and organ levels -- 7.8.3 Extensions to the models of the heart -- 7.8.4 Challenges and future considerations in modeling the heart -- 7.9 Application: Heart-rate Variability -- 7.10 Application: Spectral

