Signal Processing For Electromyography Parameter Estimation

This book constitutes the refereed proceedings of seven workshops held at the 19th International Conference on Image Analysis and Processing, ICIAP 2017, in Catania, Italy, in September 2017: First International Workshop on Brain-Inspired Computer Vision – WBICV 2017; Social Signal Processing and Beyond - SSPandBE 2017; Automatic affect analysis and synthesis - 3AS 2017; Background learning for detection and tracking from RGBD Videos - RGBD 2017; Natural human-computer Interaction and ecological perception in immersive Virtual and Augmented Reality - NIVAR 2017; 1st International Workshop on Biometrics as-a-service: cloud-based technology, systems and applications - IWBAAS 2017; 3rd International Workshop on Multimedia Assisted Dietary Management - MADiMa 2017.

This book gathers selected high-quality research papers presented at International Conference on Advanced Computing and Intelligent Technologies (ICACIT 2021) held at NCR New Delhi, India, during March 20–21, 2021, jointly organized by Galgotias University, India, and Department of Information Engineering and Mathematics Università Di Siena, Italy. It discusses emerging topics pertaining to advanced computing, intelligent technologies, and networks including AI and machine learning, data mining, big data analytics, high-performance computing network performance analysis, Internet of things networks, wireless sensor networks, and others. The book offers a valuable asset for researchers from both academia and industries involved in advanced studies.

In this study, accelerometers, gyroscopes and foot switches are used for the acquisition of kinematics and surface electromyography is used for measuring muscle's activities. These measurement devices are evaluated in a gait study on lower extremity. The signal processing and conversion of bio-information (the dynamic characteristics of body) are discussed, such as filtering, and the prediction of muscle's contraction.

Bioelectrical Signal Processing in Cardiac and Neurological Applications

Electromyography Signal Analysis and Characterization

Volume 2: Compression and Automatic Recognition

ICIAP International Workshops, WBICV, SSPandBE, 3AS, RGBD, NIVAR, IWBAAS, and MADiMa 2017, Catania, Italy, September 11-15, 2017, Revised Selected Papers

"This book provides an updated overview of signal processing applications and recent developments in EMG from a number of diverse aspects and various applications in clinical and experimental research"--Provided by publisher.

This book reports on the latest advances in the study of biomedical signal processing, and discusses in detail a number of open problems concerning clinical, biomedical and neural signals. It methodically collects and presents in a unified form the research findings previously scattered throughout various scientific journals and conference proceedings. In addition, the chapters are self-contained and can be read independently. Accordingly, the book will be of interest to university researchers, R&D engineers and graduate students who wish to learn the core principles of biomedical signal analysis, algorithms, and applications, while also offering a valuable reference work for biomedical engineers and clinicians who wish to learn more about the theory and recent applications of neural engineering and biomedical signal processing.

Invasive electromyography is a well-established diagnostic tool that has been used for decades by neurologists. Recently, new and alternative devices have increasingly become available that permit diagnosis without the use of needles. This developing area of science and the new tools have not, however, been sufficiently investigated in academic training. Consequently a gap exists between what science is making possible and the competence acquired during graduate studies. This handy volume has the aim of filling this gap by providing the information required by medical practitioners in rehabilitation, sports, and occupational health as well as by rehabilitation therapists, ergonomists, and sport coaches. The techniques that are presented and explained will help in monitoring and recording changes, evaluating the effectiveness of treatments and training, evaluating work stations, and preventing and documenting the evolution of occupational disorders of the neuromuscular system.

Single Fibre Electromyography

EMG Methods for Evaluating Muscle and Nerve Function

Proceedings of ICACIT 2021

A Perspective on Current Applications and Future Challenges

Electroencephalograms (EEGs) are becoming increasingly important measurements of brain activity and they have great potential for the diagnosis and treatment of mental and brain diseases and abnormalities. With appropriate interpretation methods they are emerging as a key methodology to satisfy the increasing global demand for more affordable and effective clinical and healthcare services. Developing and understanding advanced signal processing techniques for the analysis of EEG signals is crucial in the area of biomedical research. This book focuses on these techniques, providing expansive coverage of algorithms and tools from the field of digital signal processing. It discusses their applications to medical data, using graphs and topographic images to show simulation results that assess the efficacy of the methods. Additionally, expect to find: explanations of the significance of EEG signal analysis and processing (with examples) and a useful theoretical and mathematical background for the analysis and processing of EEG signals; an exploration of normal and abnormal EEGs, neurological symptoms and diagnostic information, and representations of the EEGs; reviews of theoretical approaches in EEG modelling, such as restoration, enhancement, segmentation, and the removal of different internal and external artefacts from the EEG and ERP (event-related potential) signals; coverage of major abnormalities such as seizure, and mental illnesses such as dementia, schizophrenia, and Alzheimer’s disease, together with their mathematical interpretations from the EEG and ERP signals and sleep phenomenon; descriptions of nonlinear and adaptive digital signal processing techniques for abnormality detection, source localization and brain-computer interfacing using multi-channel EEG data with emphasis on non-invasive techniques, together with future topics for research in the area of EEG signal processing. The information within EEG Signal Processing has the potential to enhance the clinically-related information within EEG signals, thereby aiding physicians and ultimately providing more cost effective, efficient diagnostic tools. It will be beneficial to psychiatrists, neurophysiologists, engineers, and students or researchers in neurosciences. Undergraduate and postgraduate biomedical engineering students and postgraduate epileptology students will also find it a helpful reference.

In recent years there has been rapid progress in the development of signal processing in general, and more specifically in the application of signal processing and pattern analysis to biological signals. Techniques, such as parametric and nonparametric spectral estimation, higher order spectral estimation, time-frequency methods, wavelet transform, and identifi cation of nonlinear systems using chaos theory, have been successfully used to elucidate basic mechanisms of physiological and mental processes. Similarly, biological signals recorded during daily medical practice for clinical diagnostic procedures, such as electroen cephalograms (EEG), evoked potentials (EP), electromyograms (EMG) and electrocardio grams (ECG), have greatly benefitted from advances in signal processing. In order to update researchers, graduate students, and clinicians, on the latest developments in the field, an International Symposium on Processing and Pattern Analysis of Biological Signals was held at the Technion-Israel Institute of Technology, during March 1995. This book contains 27 papers delivered during the symposium. The book follows the five sessions of the symposium. The first section, Processing and Pattern Analysis of Normal and Pathological EEG, accounts for some of the latest developments in the area of EEG processing, namely: time varying parametric modeling; non-linear dynamic modeling of the EEG using chaos theory; Markov analysis; delay estimation using adaptive least-squares filtering; and applications to the analysis of epileptic EEG, EEG recorded from psychiatric patients, and sleep EEG.

Electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG may be used clinically for the diagnosis of neuromuscular problems and for assessing biomechanical and motor control deficits and other functional disorders. Furthermore, it can be used as a control signal for interfacing with orthotic and/or prosthetic devices or other rehabilitation assists. This book presents an updated overview of signal processing applications and recent developments in EMG from a number of diverse aspects and various applications in clinical and experimental research. It will provide readers with a detailed introduction to EMG signal processing techniques and applications, while presenting several new results and explanation of existing algorithms. This book is organized into 18 chapters, covering the current theoretical and practical approaches of EMG research.

Biomedical Signal Processing

Temporal Gait Parameters Captured by Surface Electromyography Measurement

Physiology, Engineering, and Non-Invasive Applications

Biomechanics and Motor Control of Human Movement

The analysis of bioelectrical signals continues to receive wide attention in research as well as commercially because novel signal processing techniques have helped to uncover valuable information for improved diagnosis and therapy. This book takes a unique problem-driven approach to biomedical signal processing by considering a wide range of problems in cardiac and neurological applications-the two "heavyweight" areas of biomedical signal processing. The interdisciplinary nature of the topic is reflected in how the text interweaves physiological issues with related methodological considerations. Bioelectrical Signal Processing is suitable for a final year undergraduate or graduate course as well as for use as an authoritative reference for practicing engineers, physicians, and researchers. Solutions Manual available online at http://www.textbooks.elsevier.com · A problem-driven, interdisciplinary presentation of biomedical signal processing · Focus on methods for processing of bioelectrical signals (ECG, EEG, evoked potentials, EMG) · Covers both classical and recent signal processing techniques · Emphasis on model-based statistical signal processing · Comprehensive exercises and illustrations · Extensive bibliography · For companion web site with project descriptions and signals for download see www.biosignal.lth.se

Reflects on developments in noninvasive electromyography, and includes advances and applications in signal detection, processing and interpretation Addresses EMG imaging technology together with the issue of decomposition of surface EMG Includes advanced single and multi-channel techniques for information extraction from surface EMG signals Presents the analysis and information extraction of surface EMG at various scales, from motor units to the concept of muscle synergies.

Spectral parameters obtained from the surface EMG signal have been used as indicators of fatigue during a sustained contraction. These same parameters have not been tested with the EMG signals obtained from fine wire electrodes. One such parameter is the median frequency which is known to decline with fatigue. A comparison was done between the median frequencies obtained from the surface EMG and those obtained from the fine wire EMG. The median frequencies from both types of electrodes decreased with time indicating that fine wire electrodes could be used to measure fatigue. In addition, a new technique, time frequency analysis, was applied to the EMG signal. This technique generates a continuos representation of the changing spectrum of the signal through time. Three types of time frequency distributions were applied to the EMG signal As predicted, differences existed between the distributions. The amplitude differential from the first time slice of the distribution to the last was the smallest for the STFT distribution. The Wigner-Ville distribution was spread out across the most frequencies. Walls appeared in the Choi-Williams distribution, but otherwise it was the most compressed. All the distributions displayed the expected spectral compression; however, more work is necessary to clarify the results.

Emerging Trends in Research and Applications

Towards an Effective EMG-based Neuromuscular Interface for Human-robot Interaction

Biomedical Signal Analysis

Advanced Computing and Intelligent Technologies

First published in 1986: The presentation of the material in the book follows the flow of events of the general signal processing system. After the signal has been acquired, some manipulations are applied in order to enhance the relevant information present in the signal. Simple, Optimal, and adaptive filtering are examples of such manipulations. The detection of wavelets is of importance in biomedical signals; they can be detected from the enhanced signal by several methods. The signal very often contains redundancies. When effective storing, transmission, or automatic classification are required, these redundancies have to be extracted.

This first of two volumes on EMG (Electromyography) covers a wide range of subjects, from Principles and Methods, Signal Processing, Diagnostics, Evoked Potentials, to EMG in combination with other technologies and New Frontiers in Research and Technology. The authors vary in their approach to their subjects, from reviews of the field, to experimental studies with exciting new findings. The authors review the literature related to the use of surface electromyography (SEMG) parameters for measuring muscle function and fatigue to the limitations of different analysis and processing techniques. The final section on new frontiers in research and technology describes new applications where electromyography is employed as a means for humans to control electromechanical systems, water surface electromyography, scanning electromyography, EMG measures in orthodontic appliances, and in the ophthalmological field. These original approaches to the use of EMG measurement provide a bridge to the second volume on clinical applications of EMG.

In recent years, the requirements of individual assistant systems for elderly and disabled people are daily increasing, as well as the function expansion of prosthetic control, military, residential and commercial robots. In this case, human-robot interactions have become a popular research area. Since these robots are directly interacted with the users, there are several challenges in the design and control of such human-robot interaction technology. Electromyography (EMG) signal is the electrical signals of the human body, which contains a wealth of information on human action and can be used to determine the user's intent. The purpose of this thesis is to develop an EMG-based human-robot interface, which can identify the body's response by signal processing and model calculations, and can also transform the response into the motion control instructions, and control the robot to complete the body movement intentions. The existing physiological models have provided a continuous motion prediction method. This method of the 'simplified musculoskeletal model' took the mechanical revolute instead of human joint, the straight line instead of skeleton, and the straight segment between the muscle starting point and adhesion point instead of the muscle. During the complex motion of human body, the prediction accuracy of this model is greatly reduced since it is not close to the human actual physiological structure. Also, it cannot be used for the calculation when the muscular force line crosses the joint center. Currently, the studies of the impact of physiological model parameters to the sensitivity of interface have three problems: the amount of assessed parameters was few, the evaluation method was single, and the results of different researches had disagreement. Especially, the analysis of overall parameters in the neuromuscular model was less. The existing sensitivity evaluation was focused on the impact of musculotendon parameters sensitivity to the model. Through two cases study of elbow flexion/extension and forearm pronation/supination, this thesis overviews the new progresses that aim to address the existing gaps in this research field. The elbow joint was selected to implement a new method of muscle modeling, which could improve the accuracy of model during the complex motion of the elbow, while ensuring the real-time processing of the interface. The forearm rotation was chosen because of the weak EMG of forearm muscles, the short moving time and small changes in muscle length. The interface for forearm rotation has its particularity. A new EMG-driven elbow physiological model has been developed to predict the elbow flexion and extension. In the process of modeling, this thesis made assumptions based on the physiological properties of muscle. Through the elbow experiments from a plurality of subjects and a variety of movements, the model's ability of accurately predicting different moving trajectories was verified. The model was also implemented and verified by a single degree of freedom (DOF) exoskeleton. A new EMG-driven physiological model for forearm pronation/supination has been established. It can predict the forearm continuous rotation movement by the EMG activations from the superficial part of three muscles. The model contained a unique physiology musculoskeletal model. The experiments from four subjects showed the effectiveness of this method. The establishment of this forearm physiological model has opened up a new way for the prediction of complex joint system with small amplitude motions. A new sensitivity assessment method of model parameters, three-step layered approach, has been established. By using this method, this thesis analyzed the characteristics of the model parameters. A relatively small subset of the parameters was generated for parameter tuning. This method provided a new way of thinking for the parameters sensitivity analysis. The purpose of parameter tuning is to make the model can precisely match every subject. This thesis programmed two kinds of evolutionary algorithm - Differential Evolution (DE) and Genetic Algorithm (GA), and experimentally compared their performances in three aspects. Because of the high accuracy and fast convergence capability, DE can be used for fast online tuning. And GA can only be used in offline tuning. A controller based on the fusion of EMG and force information has been proposed to validate the proposed models in real time control environment. A 5-DOF upper limb exoskeleton was developed by the Medical and Rehabilitation Research Group at the University of Auckland, the exoskeleton was used to evaluate the effectiveness of the EMG based controller (EBC). The results showed that the dynamic auxiliary effect of the exoskeleton is obvious (the decrease of muscle activation could be ensured above 52% when the assistance works), and the physiological model based EBC can adapt to different individuals. This also showed the effectiveness and online adaptability of the EMG-based Neuromuscular Interface proposed by this thesis.

Atlas of Muscle Innervation Zones

EEG Signal Processing

SENIAM Project

Computational Intelligence in Electromyography Analysis

This book covers emerging trends in signal processing research and biomedical engineering, exploring the ways in which signal processing plays a vital role in applications ranging from medical electronics to data mining of electronic medical records. Topics covered include statistical modeling of electroencephalograph data for predicting or detecting seizure, stroke, or Parkinson’s; machine learning methods and their application to biomedical problems, which is often poorly understood, even within the scientific community; signal analysis; medical imaging; and machine learning, data mining, and classification. The book features tutorials and examples of successful applications that will appeal to a wide range of professionals and researchers interested in applications of signal processing, medicine, and biology.

The classic book on human movement in biomechanics, newly updated Widely used and referenced, David Winter's Biomechanics and Motor Control of Human Movement is a classic examination of techniques used to measure and analyze all body movements as mechanical systems, including such everyday movements as walking. It fills the gap in human movement science area where modern science and technology are integrated with anatomy, muscle physiology, and electromyography to assess and understand human movement. In light of the explosive growth of the field, this new edition updates and enhances the text with: Expanded coverage of 3D kinematics and kinetics New materials on biomechanical movement synergies and signal processing, including auto and cross correlation, frequency analysis, analog and digital filtering, and ensemble averaging techniques Presentation of a wide spectrum of measurement and analysis techniques Updates to all existing chapters Basic physical and physiological principles in capsule form for quick reference An essential resource for researchers and student in kinesiology, bioengineering (rehabilitation engineering), physical education, ergonomics, and physical and occupational therapy, this text will also provide valuable to professionals in orthopedics, muscle physiology, and rehabilitation medicine. In response to many requests, the extensive numerical tables contained in Appendix A: "Kinematic, Kinetic, and Energy Data" can also be found at the following Web site: www.wiley.com/go/biomechanics

Neuro-muscular and musculoskeletal disorders and injuries highly affect the life style and the motion abilities of an individual. This brief highlights a systematic method for detection of the level of muscle power declining in musculoskeletal and Neuro-muscular disorders. The neuro-fuzzy system is trained with 70 percent of the recorded Electromyography (EMG) cut off window and then used for classification and modeling purposes. The neuro-fuzzy classifier is validated in comparison to some other well-known classifiers in classification of the recorded EMG signals with the three states of contractions corresponding to the extracted features. Different structures of the neuro-fuzzy classifier are also comparatively analyzed to find the optimum structure of the classifier used.

New Trends in Image Analysis and Processing – ICIAP 2017

Advances in Theory, Algorithms and Applications

Surface Electromyography

Electromyography

Electromyography (EMG) signal gives an electrical representation of neuromuscular activation associated with contracting muscle provides information about the performance of muscles and nerves. EMG signal acquires noise while traveling through different tissues. With the appropriate choice of the Wavelet Function (WF), it is possible to remove interference noise. Higher Order Statistics (HOS) can suppress white Gaussian noise in detection, parameter estimation and solve classification problems. Based on the RMS error, it is noticed that WF db2 can perform denoising most effectively among the other WFs (db6, db8, dmey). Power spectrum analysis is performed to the denoised EMG where mean power frequency is calculated to indicate changes in muscle contraction. Gaussianity and linearity tests are conducted to understand changes in muscle contraction. According to the results, increase in muscle contraction provides significant increase in EMG mean power frequency. The study also verifies that the power spectrum of EMG shows a shift to lower frequencies during fatigue. The bispectrum analysis shows that the signal becomes less Gaussian and more linear with increasing muscle force.

The book will help assist a reader in the development of techniques for analysis of biomedical signals and computer aided diagnoses with a pedagogical examination of basic and advanced topics accompanied by over 350 figures and illustrations. Wide range of filtering techniques presented to address various applications 800 mathematical expressions and equations Practical questions, problems and laboratory exercises Includes fractals and chaos theory with biomedical applications

A complete overview of electromyography with contributions from pacesetters in the field In recent years, insights from the field of engineering have illuminated the vast potential of electromyography (EMG) in biomedical technology. Featuring contributions from key innovators working in the field today, Electromyography reveals the broad applications of EMG data in areas as diverse as neurology, ergonomics, exercise physiology, rehabilitation, movement analysis, biofeedback, and myoelectric control of prosthesis. Bridging the gap between engineering and physiology, this pioneering volume explains the essential concepts needed to detect, understand, process, and interpret EMG signals using non-invasive electrodes. Electromyography shows how engineering tools such as models and signal processing methods can greatly augment the insight provided by surface EMG signals. Topics covered include: Basic physiology and biophysics of EMG generation Needle and surface electrode detection techniques Signal conditioning and processing issues Single- and multi-channel techniques for information extraction Development and application of physical models Advanced signal processing techniques With its fresh engineering perspective, Electromyography offers physiologists, medical professionals, and students in biomedical engineering a new window into the far-reaching possibilities of this dynamic technology.

Advances in Processing and Pattern Analysis of Biological Signals

Signal Processing in Medicine and Biology

Applications, Challenges, and Advancements in Electromyography Signal Processing

Time Frequency Analysis of the Electromyogram During Fatigue