Editorial

Biomedical Signal Processing and Modeling Complexity of Living Systems 2013

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Biomedical signal processing aims to provide significant insights into the analysis of the information flows from physiological signals. As such, it can be understood as a specific interdisciplinary scientific discipline. In fact, biomedical signals extract information from complex biological models thus proposing challenging mathematical problems, whose solution has to be interpreted from a biological point of view. The focus of this special issue is the mathematical analysis and modeling of time series in living systems and biomedical signals. The main steps of the biomedical signals processing are as follows.

(1) Signal processing of biological data implies many different interesting problems dealing with signal acquisition, sampling, and quantization. The noise reduction and similar problems as image enhancement are a fundamental step in order to avoid significant errors in the analysis of data. Feature extraction is the most important part of the analysis of biological signals because of the importance which is clinically given to even the smallest singularity of the image (signal).

(2) Information flows from signals imply the modeling and analysis of spatial structures, self-organization, environmental interaction, behavior, and development. Usually this is related to the complexity analysis in the sense that the information flows from complex systems so that signals show typical features, such as randomness, nowhere differentiability, fractal behavior, and self-similarity which characterize complex systems. As a consequence typical parameters of complexity such as entropy, power spectrum, randomness, and multifractality play a fundamental role, because their values can be used to detect the emergence of clinical pathologies.

(3) Physiological signals usually come as 1D time series or 2D images. The most known biosignals are based on sounds (ultrasounds), electromagnetic pulses (ECG, EEG, and MRI), radiation (X-ray and CT), images (microscopy), and many others. The clinical signal understanding of them follows from the correct, from a mathematical point of view, interpretation of the signal.

(4) Physiological signals are detected and measured by modern biomedical devices. Among others, one of the main problems is to optimize both the investigation methods and the device performances.

The papers selected for this special issue represent a good panel in recent challenges. They represent some of the most recent advances in many different clinical investigations devoted to the analysis of complexity in living systems, like, for example, network science, dynamical systems theory, dynamical complexity, pattern analysis, implementation, and algorithms. They cannot be exhaustive because of the rapid growing both of mathematical methods of signal analysis and of the technical performances of devices. However they aim...
to offer a wide introduction on a multidisciplinary discipline and to give some of the more interesting and original solution of challenging problems. Among them the most fascinating is to understanding of the biological structure and organization, the intracellular exchange of information, the localization of information in cell nuclei, and in particular the unrevealing of the mathematical information (functionally related) content in DNA.


As already mentioned, the topics and papers are not an exhaustive representation of the area of biomedical signal processing and modeling complexity of living systems. However we believe that we have succeeded to collect some of the most significant papers in this area aiming to improve the scientific debate in the modern interdisciplinary field of biomedical signal processing.

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