Biosignal 2010: Advanced technologies in intensive care and sleep medicine

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EDITORIAL

Biosignal 2010: Advanced technologies in intensive care and sleep medicine

This focus section of *Physiological Measurement* follows the international conference Biosignal 2010: Advanced technologies in intensive care and sleep medicine. The conference was hosted at the Humboldt-Universität zu Berlin and the Charité-Universitätsmedizin Berlin on occasion of their bicentennial and tricentennial, respectively. The event offered an interdisciplinary platform for biomedical engineers, mathematicians, physicists and physicians to develop solutions for monitoring problems in intensive care and sleep medicine. The main objectives of Biosignal 2010 were to provide a forum for the discussion of research results and new scientific knowledge, promote personal contact and synergism, advance interaction between academia and industry and facilitate the exchange of information on new processes and equipment.

The focus section papers in this issue originated from discussions and feedback during the conference. First, Lehnertz (2011) reviews time series analysis techniques to reveal coupling directions from neurophysiological data. Limitations of currently available methods such as limited time series length and required stationarity are discussed and recent developments in the analysis of transient data are described. Lenz *et al* (2011) present a simulation study investigating the possible combined analysis of simultaneously measured electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) data to detect causal relations in the brain, considered as a directed, task specific network with vertices and directed edges. Their results indicate that the convolution effect of the fMRI forward model imposes a challenge for parameter estimation and reduces the influence of fMRI in combined EEG–fMRI models. Sander *et al* (2011) study stroke patients with lesions related to the motor system using magnetoencephalography (MEG) and electromyography (EMG). MEG–EMG coupling phenomena were analyzed using the imaginary part of coherency and are attributed to cortico-muscular coupling driving the muscles, demonstrating the feasibility of electrophysiological and motor function analysis.

Next in the focus section, De Silva and Schier (2011) investigate different wavelet methods for de-noising and tracking temporal variations of the auditory brainstem response (ABR). An ensemble based approach is successfully applied to the extraction of a fully featured ABR, enabling significant reduction of the clinical test time. Lee *et al* (2011) present an algorithm of respiratory rate extraction using a particle filter (PF), which is applicable to both photoplethysmogram (PPG) and electrocardiogram (ECG) signals. Their method is able to accurately extract respiratory rates for both metronome and spontaneous breathing, even during strenuous exercises. This can be an attractive feature for applications since it can be calculated online. Magagnin *et al* (2011) discover that non-stationarities significantly distort short-term spectral, symbolic and entropy heart rate variability (HRV) measures towards sympathetic overestimation. Therefore, they analyze HRV series recorded in healthy subjects during uncontrolled daily activities typical of 24 h Holter recordings and during predetermined levels of robotic-assisted treadmill-based physical exercise. Milde *et al* (2011) perform a methodological study to investigate the interaction of HRV, respiratory movements (RM) and systolic arterial blood pressure (sABP). Using time-variant partial directed coherence the respiratory sinus arrhythmia (RSA) and the Traube–Hering–Mayer components can be separated from the data and therefore discriminate RM and RSA.

Concluding the focus section, Maier *et al* (2011) describe steps towards subject-specific classification in ECG-based detection of sleep apnea. The database comprises simultaneous recordings of polysomnograms (PSGs) and 8-lead Holter-ECGs. They also show that including a measure of body position in the ECG analysis can increase the apnea detection rate. Moorman *et al* (2011) review their previous work aiming at the early diagnosis of sepsis in premature newborn infants based on statistical signal processing and non-linear dynamics. Precursors of this bacterial infection are reduced variability and transient heart rate decelerations from hours to days prior to clinical signs of illness. They find that measurements of standard deviation, sample asymmetry and sample entropy are highly related to imminent clinical illness. Their approach provides predictive monitoring information for clinicians which evidently saves lives. Finally, Huhle *et al* (2012) investigate the degree of hypnosis and nociception during general anaesthesia based on heart rate variability. While standard time domain parameters lacked specificity, one symbolic dynamics parameter seems to be specifically influenced by changes in depth of hypnosis and another one appears to be adequate for specific monitoring of nociception. These retrospective results need to be confirmed in future studies, however. (Please note that this paper does not appear in this focus section and will be published in a subsequent issue.)

The different problems addressed in this focus section underline the complexity of the human system. The authors demonstrate that data analyses and modelling methods may have the ability to lead to significant medical improvements. Patients as well as the whole of society will benefit from the rapid utilization of this potential in clinical practice. Therefore, our goal should always be the development of highly-sophisticated methods that improve individual diagnostics while decreasing patient risks.

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Guest Editors

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