Biosignal Interpretation I

Advanced Methods for Studying Cardiovascular and Respiratory Systems

K. Yana[1]; S. Cerutti[2]; L. Mainardi[2]; Y. Yamamoto[3]

[1]Department of Applied Informatics, Hosei University, Tokyo, Japan;
[2]Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milan, Italy;
[3]Graduate School of Education, University of Tokyo, Tokyo, Japan

The following two focus themes of *Methods of Information in Medicine* Biosignal Inter- pretation I: "Advanced Methods for Stu- dying Cardiovascular and Respiratory Sys- tems" and "Biosignal Interpretation II: Ad- vanced Methods for Studying Neural Sig- nals and Images" include selected and up- dated papers presented at the seventh In- ternational Workshop on Biosignal Inter- pretation held on July 2– 4, 2012 in Como, Italy.

The workshop aims at exploring the fields of biosignal interpretation including model based signal analysis, data interpre- tation and integration, medical decision making extending the existing signal pro- cessing methods and technologies for the effective utilization of biosignals in a clini- cal environment as well as for a deeper understanding of biological functions from the whole organism, system, to cellular, protein and gene scales.

Methods of Information in Medicine has a long tradition of publishing selected papers from the BSI workshop. The pre- vious BSI related special issues listed in [1– 7] enable readers to follow the foot- prints and the progressive development of the field. The 7th BSI-workshop has been the joint initiative of the International Medical Informatics Association (IMIA), the International Federation for Medical and Biological Engineering (IFMBE), the IEEE Engineering in Medicine and Biology Society (EMBS), as well as the IEEE Italian Chapter on BME, the Italian Bioengi- neering Group (GNB), the Italian Society of Electrical and Telecommunication Engineering (AEIT) and the Department of Bioengineering of the Politecnico di Milano.

The first focus theme includes eight papers on cardiovascular and respiratory signals (heart rate variability: analysis, modeling and monitoring, sleep apnea de- tection, physiological interpretation of ar- rhythmia, respiratory sound classification and a novel point process nonlinear model- ing of cardiovascular and respiratory sys- tems). Fischer et al. [8] applied a bivariate segmented Poincaré plot analysis to blood pressure and beat-to-beat interval series to perform risk stratification of pregnant women suffering from hypertension and pre-eclampsia. Results demonstrate that the proposed method is able to provide a superior classification, distinguishing chronic and gestational hypertension from pre-eclampsia. Sen et al. [9] proposes a novel classification method for the diag- nosis of bronchiectasis and interstitial pul- monary disease. Signal parameters derived from 14-channel vector autoregressive model are fed into a support vector ma- chine (SVM) yielded a good classification accuracy. Valenza et al. [10] proposes a Point-Process-based method for discrimi- nating mood states in bipolar patients. The proposed approach is based on a Nonlinear Autoregressive Integrative (NARI) model applied to heart rate variability (HRV) measures. Instantaneous features of HRV in time and frequency domain including higher order statistics are utilized for the successful dynamic state classification be- tween euthymic and depressive phase of bi-

Correspondence to:
Kazuo Yana
Department of Applied Informatics
Hosei University
Tokyo
Japan
E-mail: yana@hosei.ac.jp

polar patients. Maier et al. [11] are pres- enting a robust and accurate detection method of the presence of sleep apnea based on Holter ECG recordings. They in- troduced a novel time-domain feature called the joint local similarity index (jLSI) which quantifies the time-locked occur- rence of characteristic low-frequency modulations in ECG, respiratory myogram interference, QRS amplitude and the heart rate. Migliorini et al. [12] examined the re- liability of piezoelectric sensors integrated into the mattress for the nocturnal heart rate monitoring. They introduced the strength of the cesptrum peak value as a new index to evaluate the “confidence” for each extracted heart beat intervals. Com- parison of the method with the standard ECG analysis confirmed its high reliability in bed side heart rate monitoring. Beren- feld et al. [13] showed Atrial Fibrillation (AF) patterns recorded from the surface of the sheep heart and interpreted them in terms of transmural patterns. Their method combines endocardial-epicardial optical mapping, phase and spectral analy- sis and computer simulation of the re-en- trant activity in the myocardial wall. The results present basic physiological under- standing of the activation patterns during AF. Bueno-Orovio et al. [14] studied the ef- fect of the slow phase of action potential duration (APD) adaptation on dispersion of repolarization and reentry in the human ventricle. A combined analysis of in-vivo human data and computer simulations to examine the contribution of this compo- nent to arrhythmogenese in human ven- tricle is presented. Minchole et al. [15] proposed a method to quantify the time adaptation of Tpeak-to-Tend (Tpe) and QT intervals’ duration after a change in heart rate, in particular, during the head up tilt test. An efficient method to estimate the dynamical nonlinear model parameters are introduced and the evidence that Tpe inter- vals adapt faster than QT intervals during the tilt experiment has been revealed.

The second focus theme on advanced methods for studying neural signals and images is scheduled to be published in a separate volume. Those two issues will give readers the opportunity to explore the latest development in the field of biosignal interpretation.

References

1. van Bemmel JH. Detection and parameter esti-mation I. Methods Inf Med 1994; 33 (1): 1–160.
2. van Bemmel JH, Sato S, Kazuo Y, Saranummi N. Biosignal Interpretation. Methods Inf Med 1997; 36 (4–5): 235–375.
3. He B. Biosignal Interpretation III. Methods Inf Med 2000; 39 (2): 99–203.
4. Cerutti S. 4th International Workshop on Biosig- nal Interpretation (BSI 2002). Methods Inf Med 2004; 43 (1): 1–121.
5. Yana K, Yamamoto Y, Cerutti S. BSI Special Issue. Methods Inf Med 2007; 46 (2): 94–250.
6. Chon Kh, Yana K. Biosignal Interpretation Con- ference 2009. Methods Inf Med 2010; 49 (5): 433 –520.
7. Selvaraj N, Lee J, Chon KH. Time-varying Meth- ods for Characterizing Nonstationary Dynamics of Physiological Systems (Review Article). Methods Inf Med 2010; 49 (5): 435 – 442.
8. Fischer C, Schroeder R, Voss A. Coupling of Heart Rate and Systolic Blood Pressure in Hypertensive Pregnancy Disorders. Methods Inf Med 2014; 53 (4): 286–290.
9. Sen I, Saraclar M, Kahya YP. SVM based Classifi- cation of VAR Model Parameters of Respiratory Sounds for Computerized Diagnosis of Respira- tory Disorders. Methods Inf Med 2014; 53 (4): 291–295.
10. Valenza G, Citi L, Gentili C, Lanata A, Mauri M, Schilingo EP, Barbieri R. A Point-Process Nonlin- ear Model Approach for Autonomic Assessment of Depressive States in Bipolar Patients. Methods Inf Med 2014; 53 (4): 296–302.
11. Maier C, Wenz H, Dickhaus H. Robust Detection of Sleep Apnea from Holter ECGs by Joint Assess- ment of Modulations in QRS Amplitude and Respiratory Myogram Interference. Methods Inf Med 2014; 53 (4): 303–307.
12. Migliorini M, Kortelainen JM, Parkka J, Tenhunen M, Himanen SL, Bianchi AM. Monitoring Noctur- nal Heart Rate with Bed Sensor. Methods Inf Med 2014; 53 (4): 308 –313.
13. Berenfeld O, Yamazaki M, Filgueiras-Rama D, Kalifa J. Surface and Intramural Reentrant Patterns during Atrial Fibrillation in the Sheep. Methods Inf Med 2014; 53 (4): 314–319.
14. Bueno-Orovio A, Hanson BM, Gill JS, Taggart P, Rodrigues B. Slow Adaptation of Ventricular Re- polarization as a Cause of Arrhythmia? Methods Inf Med 2014; 53 (4): 320–323.
15. Minchole A, Zacur E, Pueyo E, Laguna P. Model- ing and Quantification of Repolarization Feature Dependency on Heart Rate. Methods Inf Med 2014; 53 (4): 324 –328.
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