In the Spotlight: Biomedical Signal Processing

I WISH to start this year’s contribution to Biomedical Signal Processing (BSP) remarking on the importance of a correct handling of this topic in BME University Programs. In conjunction with the 23rd Annual International Conference of IEEE-EMBS which was held on August 30th–September 3rd, 2011, in Boston, MA, a Symposium called “International BME Department Heads & Leaders Forum” was organized in which many chairmen of BME Programs all over the world interacted and exchanged their opinions about the design, structure and didactical impact of the educational modules. Without entering into details, a basic issue was “under the assumption that BME is a multidisciplinary area in which engineering concepts must properly interact with basic sciences and life sciences, noticeably biology and medicine, should BME have an engineering core or rather an interdisciplinary core?” In other words, should BME Programs be located in an Engineering School or Department or in an Interdisciplinary School or Department? This is a tough issue, and the best reply so far is that it depends on the local context: many examples of very efficient BME Programs were presented belonging to the two different models. But it is worth for the large community to be alerted to and reflect upon these issues, because BME lives in a very dynamic environment and changes may come very quickly.

Coming back to BSP, there is no doubt that it is very easy to find in Engineering Schools very solid courses on Digital Signal Processing or Signal & Data Analysis which could constitute an important prerequisite for students’ training who need also one or more courses oriented towards the applications. Training in Signal Processing requires going deep into some innovative methods which are the ones more frequently used in a modern concept of BSP and that a basic course is not able to address. A risk in interdisciplinary-core Programs (mainly with Biology or Medicine) is that BSP is taught with emphasis on the applicative tools and not on the basic methods. The risk to excessively synthesize is to trivially teach how to use Mat Lab by simply “pushing the button” of FFT, PCA, ICA or WD routines applied to biomedical signals. Instead, the teacher has to provide students not only mathematical or technical concepts and how to build up proper algorithms, as well as how to create a critical vision of all the pros/cons in the various methods and their performances which are extremely connected with the objectives of the processing procedure. Hence, I still wish to remark the strong link between biomedical signals and the modelling of the physiological or biological system underneath: in fact, this is the best setting for successfully teaching a graduate course on BSP.

Addressing still the area of BSP training, I wish to mention that the 8th IEEE-EMBS International Summer School on Advanced Biomedical Signal Processing—Signal Processing and Modelling in Neuroengineering: from Gene to Cell to Central Nervous System was held at the Certosa di Pontignano, University of Siena, Italy, June 26–July 3, 2011. This School happens every two years and it is the fifth time it is held in Siena. This year the School has had the participation of 48 Students and 10 Faculties. The Program of the School included fundamental contributions on the state-of-the-art knowledge on emerging areas in advanced biomedical signal processing methods applied to Neuroengineering; a clear focus was given to the integration between neurophysiological considerations and advanced methods of information processing. The methods made reference to the so-called “multi-paradigm,” where multivariate approaches from different sources (multisources) were integrated, having in mind a multiscale interpretation model: from the processing at the level of genes, proteins, cells up to the whole organ. Prominent experts in the area of biomedical signal processing, applied neurophysiology and bioinformatics have efficiently designed a solid didactic methodology, re-
marking also the importance of the integration of information across these different scales. Overall this approach constitutes an interesting paradigm for a modern concept of BSP that should perhaps be utilized as the blue print for course syllabus in BME programs. Students participated actively and two evenings were dedicated to the discussion of posters displaying their works in the various areas of Neuroengineering and Signal Processing. At the end of the School, a jury constituted by all the Faculty as well as Students voted for the best three posters which were awarded to: Marianna Meo, Laboratoire d’Informatique, Signaux et Systèmes de Sophia Antipolis, Nice, France Non-invasive Prediction of Catheter Ablation Outcome in Persistent Atrial Fibrillation: Exploiting the Spatial Variability of the F-wave Amplitude in the Surface ECG; Jlenia Toppi, Department of Computer Science and Systems, University of Roma “La Sapienza”, Italy, The issue of multiple comparison corrections in a study of high resolution EEG and Nawel Jmail, Laboratory INSERM UMR 751, University of Marseille, France Brain networks in oscillatory and transient activity. Further information about the Summer School may be found in [1].

Another major event in 2011 has been the aforementioned 23rd Annual International Conference of IEEE-EMBS in Boston, MA [2]. This year the BSP Theme had more than 400 contributions, scoring among the themes with more submissions. Two keynotes were strongly related to BSP: 1) “Applications and Opportunities for Wearable Technologies in Physiological Monitoring,” by D. Wiggins from Philips Co, where it was stated that these new formidable wearable technological applications require proper signal processing, not only in the pre-processing stage where they are generally more corrupted by noises when compared to the traditional diagnostic equipment, but also in the parameter setting stage to be enhanced from various sensors, which require synthesis of the information. 2) “Modularity for Motor Coordination,” by E. Bizzi from MIT, where complex tasks of motor control could be reduced to a relatively small amount of synergies on the basis of the EMG signal parameters extracted, inserted into a very elegant hierarchical controlling model. Workshops of interest for BSP research area were: “Guaranteeing a future for Blind Source Separation in BSP”, “Bioacoustical Signal Processing with Application to Body Sounds Analysis”, “Social Impact and Sustainable Research for Biosignals and Biorobotics”. Further, inside the sessions in our Theme #1, Biomedical Signal Processing, various topics were approached like “Advances in algorithms and techniques for physiological system modelling,” “Signal processing in patients’ monitoring systems,” “Signals and Systems,” “Sensor Signal Processing,” “Time-Frequency, Time-Scale and Wavelet analysis,” Empirical Mode Decomposition,” “Nonlinear Analysis of Biological Signals,” “Non-stationary Signal analysis,” “Processing of Biological Signals via Support Vector Machine Algorithms,” “Principal Component and Independent Component Analysis,” “Adaptive and Kalman Filtering,” “Multivariate and Multiscale Signal Processing.” Then, applications have been in various physiological signals like ECG and Heart Rate Variability (HRV) analysis, Arterial Blood Pressure (ABP) and Respiration, EEG, Evoked Potentials (EP) and Event-Related Potentials (ERP) and EMG. It is worth mentioning that more than 70 contributions in the Conference have been dedicated to Optical Imaging: this is a sign of a growing interest in the topic, with important applications in both the molecular level and in various bodily systems, like cardiovascular and CNS. Interesting reviews may be found in [3], [4]. Finally, further fusion of different physiological systems have found many possible applications, as widely reported in the recent literature, like “cardio-respiratory” system [5], [6], the studying of “cardio-renal” syndrome associated to cardiovascular and renal pathologies and in general to dialysis treatment [7], [8], as well as the “neuro-vascular coupling” in the studying of CNS behavior [9], [10].

REFERENCES


