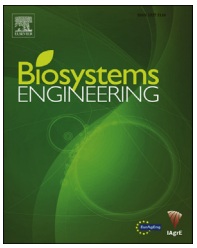
Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/issn/15375110



Editorial

Special issue on innovations in medicine and healthcare

Foreword

This Special Issue is at the edge of our domain. It has been developed both to demonstrate the importance of engineering innovation and physical science understanding in relation to medicine and healthcare issues, and also to highlight the strong common purpose that exists in science and technological advance between medicine and our more typical targets in agriculture and the environment. I hope that readers from both areas will value the engineering approaches that these papers highlight, and will be encouraged to investigate new research opportunities across the domain boundary.

At present there is no intention to extend the domain of Biosystems Engineering into the medical area for general submissions, but we will always be prepared to consider papers that address issues at the interface.

Dr Bill Day
Editor-in-Chief
Biosystems Engineering

Editorial

This special issue contains research articles including ones based on some of the best papers presented at the InMed 2014 conference held in July 2014 in San Sebastian, Spain, as well as some contributions from the open call for papers. The aim of the Special Issue is to provide a snapshot of current hot topics and approaches in this very active domain. The new wave of innovation comes through the introduction of new Information and Communication Technologies (ICT) both in the daily relation of patients and physicians and in the way that people take control of their personal health by making use of assistive technologies. Also, ICT has an increasing presence in the analytical processes carried out in order to obtain diagnostic information, or to aid in the diagnostic decision. There is a growing body of work on medical decision support systems (aka clinical decision support systems), as well as on intelligent analysis of medical imaging and physiological signal data. In this regard, many of the papers in this issue are directly related to recent developments of ICT in medicine and healthcare. One very interesting phenomena in the ICT and machine learning fields is the availability of free code solutions, which are boosting research effort and facilitating comparisons between methods, as well as providing some kind of standardisation of the analysis and results. The Special Issue also contains examples of more classical bioengineering problems related to the design of specific devices and their calibration.

Caetano dos Santos, Paci, Nanni, Brahnam, & Hyttinen, 2015 report on computer vision approaches for virus segmentation and classification in transmission electron microscopy images. Virus images are very noisy, with low contrast and high variability of shape and position of the object in the image. Hence, the choice of the authors is to use texture features for the classification of virus images. After careful experimentation with several standard texture features, such as the Local Binary Patterns, Local Ternary Patterns, and variation. Moreover, they test Edge, bag of words, and multiquinary coding enhanced versions. In conclusion, the authors propose a new ensemble of descriptors to achieve results improving on the state of the art. The classifier approach is the Support Vector Machine (SVM), which has become the conventional tool. Moreover, tests with a deep learning approach did not show improvement over SVM.

Bellows, Shehata, Smith, Mcguire, and Smith (2015) consider the segmentation of a specific blood vessel, the inferior vena cava (IVC), in ultrasound images of critically ill patients in resuscitation procedures, where the measurement of blood flow is a critical parameter to assess the effectiveness of the treatments. Ultrasound images have low contrast and are very noisy, with the shape and localisation of the anatomical structures changing due to patient and sensor positioning. The authors have developed a semi-automatic algorithm, in which the human operator guides a morphological watershed-based segmentation algorithm by selecting seed points for region segmentation and evaluating the results of region merging. No classification method is embedded in the loop.

Pota et al. (2015) use texture features in Computerised Tomography (CT) images to detect parotid gland shrinkage, which may happen during radiotherapy of head-and-neck cancer. Early detection is critical, because contracted parotid

glands are at risk of receiving higher than planned radiation doses, leading to toxicity problems. The authors provide a categorisation of parotid gland morphology assessing their risk level. The segmentation of the parotid glands is impeded by their very low contrast with surrounded tissues in CT images. Texture features, such as entropy and fractal dimension, are classified by a likelihood fuzzy analysis approach, which allows explanations of the reasoning leading to the final classification.

Hernández-Pereira, Álvarez-Estévez, and Moret-Bonillo (2015) deal with the automatic analysis of Polysomnographic (PSG) recordings in a Sleep Apnoea-Hypopnoea Syndrome (SAHS) study aiming to discriminate sleep apnoeic events (apnoeas and hypopnoeas) from normal breathing. They are specifically concerned with the treatment of missing data in the PSG recordings. Features for classification, such as the reduction in airflow, are extracted on a sliding window over the PSG multivariate signal by automated procedures so that missing values may appear for a variety of reasons. They find that the classical bio-inspired Self Organizing Map provides the best imputation results among a battery of five methods, while in a comparison of several classifiers they also find that classical multilayer feedforward neural network with back-propagation training and the Random Forests approach provide the best results, improving over the now in fashion Deep Neural Network.

Colantonio et al. (2015) discuss the development of a smart mirror for monitoring health status by means of semeiotic features, i.e., physical face signs such as skin colour, fat, and facial expression, which may give clues to the health status of the person in front of the mirror with minimal invasion. The device is intended to be embedded in the daily life of the owners, minimising the drop-off risk that has been observed for most well-being monitoring devices currently on the market. User engagement is considered critical for sustained impact on user's health. The system includes intelligent multi-modal information processing, effectively fusing several descriptors, coming from multispectral camera, electronic nose, and high speed camera (for motion analysis). These descriptors are used to build a profile of the user, monitoring evolution over time. Finally, a recommender system provides guidance to navigate towards improved health status. Recommendations are built by a reasoning system.

Gonzalez-Lopez, Ortega, Penedo, and Charlon (2015) propose a web service that provides Optical Coherence Tomography (OCT) of the retina analysis tools allowing multi-centre study and discussion for diagnosis in a collaborative framework. OCT allows identification of retina morphology and pathological structures; therefore it is becoming a standard diagnostic tool. As a consequence uniform analysis procedures as well as tools to manage large amounts of information are required. In their web service, the authors provide an active contour-based retina layer segmentation tool, and a vessel shade detection tool. These tools allow uniform segmentation across the centres using the service, thus enhancing communication among practitioners.

Ramos, Barreira, Pena-Verdeal, Giráldez, and Yebra-Pimentel (2015) deal with the computer vision-based assessment of the eye's tear film state by prediction of the break-up dynamics. Tear film instability leads to dry eye syndrome, which has a high prevalence and high impact on the quality of life of patients. Break-up dynamics is analysed on sequences of video frames between eye blinks, under fluorescent illumination. Stability loss of the tear film is marked by the appearance of dark areas before the blink. The processing involves the detection of sequences of interest where break-up may appear, by means of global eye image features. These sequences are processed selecting regions of interest by edge detection-based iris detection and registration. The break-up regions are detected by thresholding pixel intensity. Their dynamics is characterised by the area evolution between blinks.

Grant, Stockwell, Morrison, and Mann (2015) report empirical calibration of the dispersion pattern obtained with a needle-free injection device. The calibration involved the analysis of high-speed camera recordings of the injection into ballistic gelatine blocks at diverse orifice pressures and with various volumes and densities. Pressure has little effect on the dispersion pattern, while the volume and density have an effect on the penetration depth and dispersion shape.

Viazzi, Lambrechts, Papantoniou, Schrooten, and Aerts (2015) deal with the real time detection of the appropriate time for enzymatic reaction inhibition in cell cultures, in order to avoid cell damage from prolonged cell exposure to enzymes. Microscope images were analysed to measure cell circularity, by background subtraction, cell segmentation, and morphological analysis of cell boundary. Autoregressive models were tuned to predict the cell circularity response to the harvesting solution parameters, and to estimate the appropriate inhibition time. The approach works both in flasks and in clinical scale bioreactors.

Castellano et al. (2015) describe the development and implementation of a real time telemedicine system for remote diagnosis in emergencies. Advanced analysis and diagnostics while travelling may be critical in emergencies, with a high impact in life threatening situations. The system is focused on anticoagulated patients in the event of stroke, when the timely decision about the proper anti-haemorrhagic or antithrombotic treatment may be critical to mitigate the effects of the progression of intracranial haemorrhage. The system is based on a hybrid wireless communication system to transmit the analytical information of haematological tests to the referral hospital while in transit, minimising connection loss.

This Special Issue highlights the increasing role of ICT in Biosystems Engineering, both in the human healthcare area and for agriculture and the environment. A specific token of this new paradigm is the possibility of having, anytime and anywhere, the relevant biological information about an entity. In healthcare, this token is known as the Electronic Health Record (EHR), but the concept spans all biological knowledge gathering and processing. The big challenges and opportunities ahead are comparable to the pioneering times of chemical or physical sciences applied to the biological areas. The huge information storage, communication and processing requirements as well as the strong conflict between security and privacy on the one hand and global data availability on the other are far from being solved at the scale that will be demanded in the near future. This new paradigm is already changing aspects as diverse as the way to do research on

anonymised data, either to discover trends, correlations, or to raise alarms on unidentified health conditions, the way physician learn from experience, or the legal forensics to trace back errors and malpractice. Exploring computational intelligence techniques for intelligent processing of biological signal and medical imaging data is still in its infancy. Scale problems challenge both the computational resources available nowadays and the design of algorithms able to deal with legacy data as well as with new devices, integrating heterogeneous data that come from sources as diverse as natural language, biochemical laboratory results, and electronic signal measurements, dealing with ambiguity and imprecision as well as noise and human interaction. In this new paradigm, solutions found and developed in one domain, e.g. agriculture, can be translated to another, e.g. healthcare.

REFERENCES

Bellows, S., Shehata, M., Smith, J., Mcguire, P., & Smith, A. (2015). Validation of a computerised technique for automatically tracking and measuring the inferior vena cava in ultrasound imagery. *Biosystems Engineering, 138*, 4–10.

Caetano dos Santos, F. L., Paci, M., Nanni, L., Brahnam, S., & Hyttinen, J. (2015). Computer vision for virus image classification. *Biosystems Engineering, 138*, 11–22.

Castellano, N. N., Gázquez, J. A., García, R. M., Gracia-Escudero, A., Fernández-Ros, M., & Manzano-Agugliaro, F. (2015). Design of a real-time emergency telemedicine system for remote medical diagnosis. *Biosystems Engineering, 138*, 23–32.

Colantonio, S., Coppini, G., Germanese, D., Giorgi, D., Magrini, M., Marraccini, P., et al. (2015). A smart mirror to promote a healthy lifestyle. *Biosystems Engineering, 138*, 33–43.

Gonzalez-Lopez, A., Ortega, M., Penedo, M. G., & Charlon, P. (2015). A web-based framework for anatomical assessment of the retina using OCT. *Biosystems Engineering, 138*, 44–58.

Grant, T. M., Stockwell, K., Morrison, J., & Mann, D. D. (2015). Effect of injection pressure and fluid volume and density on the jet dispersion pattern of needle-free injection devices. *Biosystems Engineering, 138*, 59–64.

Hernández-Pereira, E., Álvarez-Estévez, D., & Moret-Bonillo, V. (2015). Automatic classification of respiratory patterns involving missing data imputation techniques. *Biosystems Engineering, 138*, 65–76.

Pota, M., Scalco, E., Sanguineti, G., Cattaneo, G. M., Esposito, M., & Rizzo, G. (2015). Early classification of parotid glands shrinkage in radiotherapy patients: A comparative study. *Biosystems Engineering, 138*, 77–89.

Ramos, L., Barreira, N., Pena-Verdeal, H., Giráldez, M. J., & Yebra-Pimentel, E. (2015). Computational approach for tear film assessment based on break-up dynamics. *Biosystems Engineering, 138*, 90–103.

Viazzi, S., Lambrechts, T., Papantoniou, I., Schrooten, J., & Aerts, J.-M. (2015). Real-time characterisation of the harvesting process for adherent mesenchymal stem cell cultures based on online imaging and model-based monitoring. *Biosystems Engineering, 138*, 104–113.

Manuel Graña*
University of the Basque Country, UPV/EHU, Computational Intelligence Group, Spain
ENGINE Center, Wroclaw University of Technology, Wroclaw, Poland

Eider Sanchez
Vicomtech, San Sebastian, Spain

Michal Wozniak
Department of Systems and Computer Networks, Wroclaw University of Technology, Wroclaw, Poland

**Corresponding author*. Tel.: +34 943018000.
University of the Basque Country, UPV/EHU, Computational Intelligence Group, Spain.
E-mail address: manuel.grana@ehu.eus

http://dx.doi.org/10.1016/j.biosystemseng.2015.06.009