

Guest editorial

New frontiers in biomedical science and engineering during 2014–2015

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Abstract. The International Conference on Biomedical Engineering and Biotechnology (ICBEB) is an international meeting held once a year. This, the fourth International Conference on Biomedical Engineering and Biotechnology (ICBEB2015), will be held in Shanghai, China, during August 18th–21st, 2015. This annual conference intends to provide an opportunity for researchers and practitioners at home and abroad to present the most recent frontiers and future challenges in the fields of biomedical science, biomedical engineering, biomaterials, bioinformatics and computational biology, biomedical imaging and signal processing, biomechanical engineering and biotechnology, etc. The papers published in this issue are selected from this Conference, which witness the advances in biomedical engineering and biotechnology during 2014–2015.

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1. Introduction

It is a challenge to improve the accuracy of diagnosis and treatment in clinical practices, which depends on the methods and technology in biomedical science and engineering. To provide an opportunity for researchers and practitioners to exchange the most recent advances and future challenges in this field, the 4th International Conference on Biomedical Engineering and Biotechnology (ICBEB2015) aims at new frontiers and advances in biomedical science and engineering during 2014–2015, which intends to support the treatment and diagnosis in clinics. This

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event will be held in Shanghai, China, during August 18th-21st, 2015 and the past events were held on 28th to 30th May 2012 in Macau, 11th to 13th October 2013 in Wuhan and 25th to 28th September 2014 in Beijing.

2. Highlighted papers

Recommended by the conference committees and reviewers, some papers are highlighted as follows.

2.1. Biomedical imaging

The paper entitled “*Fast iterative reconstruction for helical pinhole SPECT imaging*” studies of the feasibility of an iterative helical pinhole SPECT image reconstruction for a small animal. The helical SPECT system has some advantages of increasing the field-of-view, preventing the image truncations of multi-bed pinhole system, and reducing the photon emission rate decay. The authors studies about the helical SPECT system with iterative reconstruction method based on voxel-driven (VD) algorithm model, which can be integrated with geometric symmetries from helical trajectory, in order to reduce the computational complexity of helical SPECT system. The results indicate that the VD model can handle a longer object with manageable storage space and also show the reasonable possibility of clinical acceptance in terms of computation time.

The paper entitled “*Variation of patient imaging doses with scanning parameters for linac-integrated kilovoltage cone beam CT*” studies about the accurate and precise dose measurement methods for LINAC combined cone beam CT using CT ion chamber and phantom with CT dose index (CTDI) values. The CT radiation dose is an important issue for clinical application, so it is one of the things that must be fully understood. Especially, CT imaging for those who are receiving radiation therapy is essential, thus the dose control is also an important issue. The authors have dealt with this issue using CTDI value, which is generally used as index for CT dose calculation, and this approach can be easily applied to clinical field to evaluate the patient dose in linac-integrated cone beam CT due to its characteristics of simplicity and reproducibility.

The paper entitled “*Diffusion tensor imaging to determine the potential motor network connectivity between the involved and non-involved hemispheres in stroke*” studies about the determination of microstructural changes and associated motor network in unilateral hemiparetic stroke patients using fractional anisotropy (FA), node degree, and edge betweenness centrality (EBC) values. Recently, the researches of brain network analysis are becoming important issues and hot topics because many researchers want to acquire a more accurate information about the brain connectome. In this regard, although this paper is dealing with a simple results, it is an important point to indicate the brain network analysis using diffusion tensor MR imaging.

2.2. Biomechanical engineering

To compare the biomechanical characters of three-level anterior cervical fusion and hybrid constructs by measuring coupled motion changes of the cervical spine, Liao, et al. investigates eighteen adult human cadaveric cervical spines under eccentric displacement control in lateral bending and axial rotation by measuring vertebral motion (X, Y, Z -axis) in the paper entitled “*Coupled motion of cervical spine in three level hybrid constructs*”. The 3DPD condition displays similarly coupled motion compared to the intact condition both in lateral bending and in axial rotation, while the 3PDP

condition is similar only in lateral bending. However, the coupled motion of the cervical spine under 3P conditions markedly changed in both lateral bending and axial rotation. Considering the coupled motion characteristics, the 3DPD hybrid construct is biomechanically advantageous in three types of reconstructions (3DPD, 3PDP, 3P).

Since the vessels in the biological tissues are characterized by low seepage Reynolds numbers and contracting or expanding walls, more attention is paid to the viscous flow outside the porous pipe with small expansion or contraction. Thus the paper, entitled “*The exterior unsteady viscous flow and heat transfer due to a porous expanding or contracting cylinder*”, presents a numerical solution of the flow and heat transfer outside an expanding or contracting porous cylinder. The coupled nonlinear similarity equations are solved by Bvp4c, which is a collocation method with MATLAB. The effects of the different physical parameters, namely the permeability Reynolds number, the expansion ratio and the Prandtl number, on the velocity and temperature distribution are obtained and the results are shown graphically.

2.3. Biosensors and bio-signal processing

The paper entitled “*A block-wise approximate parallel implementation for ART algorithm on CUDA-enabled GPU*” studies about the improvement of block-wise approximate parallel implementation for ART algorithm of CT image reconstruction with GPU acceleration method. A lot of demands for improving the computation time of CT image reconstruction are increased, and the studies of the reconstruction method using a small sample as a part of these demands are actively in progress. The authors of this study applied CUDA-enable GPU calculation process to CT image reconstruction with ART algorithm. The results indicate that the improvement of time efficiency by a factor of 20 is over the existing only CPU implementation method.

The paper entitled “*Sparse coded image super-resolution using K-SVD trained dictionary based on regularized orthogonal matching pursuit*” studies about the signal processing scheme for super-resolution brain MR images using the modified K-SVD trained dictionary. The main key points of this study are the training of dictionary using modified K-SVD dictionary learning procedure, and the use of regularized orthogonal matching pursuit (ROMP) to seek the vector of sparse representation coefficients for underlying patch in super-resolution reconstruction. The results indicate that the superiority of the quantitatively calculates values, such as peak signal-to-noise ratio (PSNR) and structure similarity index metric (SSIM), when the proposed super-resolution process method is used.

In the paper “*A study of sleep staging based on a sample entropy analysis of the electroencephalogram*”, authors have reported a new detection method for determining the quality of sleep that is based on a single channel electroencephalogram. This method is an improvement over the pre-existing polysomnography method as it is relatively easy to set up at homes. This method can automatically evaluate the quality of sleep by performing sleep staging (Deep sleep, REM sleep, Light Sleep and Awakening). To analyze the sleep data, authors divided EEG data into equal time intervals and calculated Sample Entropy. The results based on Sample Entropy are in close concordance with the results obtained from another commercially available system called ZEO. Thus, Sample Entropy could be used as a criterion to discriminate between different sleep stages.

2.4. Biomaterials

In the paper “*Nanofiber containing carbon nanotubes enhanced PC12 cell proliferation and neuritegenesis by electrical stimulation*”, Su, et al. fabricate polycaprolactone (PCL) nanofiber with or

without carbon nanotubes (CNTs) by electrospinning and promoted the neural differentiation of PC12 cells by electric stimulation. They use scanning electron microscope (SEM) and fluorescence microscope to observe the NGF-induced growth of PC12 cells on PCL nanofiber. Axon formation and cellular activity expression, which confirms that PC12 cells can grow well on PCL nanofiber, and the gene expressions of MAP1b and GAP43 significantly increase after electric stimulation. Based on the results, the structure of nanofibers containing CNTs can effectively induce neural differentiation of PC12 cells in an electric field. This experimental model can be used for future clinical applications.

In the paper “*Strength degradation and lifetime prediction of dental zirconia ceramics under cyclic normal loading*”, the authors study mechanical behavior and predict the lifetime of dental zirconia ceramics under cyclic normal contact loading with experiments. Cyclic normal contact loading test and three-point bending test are carried on specimens made of two brands of dental zirconia ceramic to obtain flexure strength and damage degree after different number of loading cycles. By means of a damage mechanics model, damage degrees under different numbers of contact loading cycles are calculated according to flexure strength, and verified by SEM photographs of the cross-section morphology of zirconia ceramics specimen phenomenologically. Relation curve of damage degree and the number of cycles are fitted by polynomial fitting, and then the number of loading cycles can be concluded when the specimen is complete damaged. Strength degradation of two brands dental zirconia ceramics is researched *in vitro* and prediction method of contact fatigue lifetime is established.

2.5. Antioxidant therapy and natural bioactives

The rational use of antioxidants and natural bioactive compounds holds great promises for the prevention and treatment of important diseases. This special issue includes some interesting papers that present new insights into the application of classical and innovative bioactives in a range of physiopathological conditions.

In the paper titled “*Protective effect of vitamin E against acute kidney injury*”, P. Liu and co-authors give us an overview of the use of vitamin E in *in vivo* models of acute kidney injury, including combination therapies with other drugs - like vitamin C, *N*-acetylcysteine and selenium - and with stem cells. The potential protective mechanisms of vitamin E, beyond its free radical scavenging capacity, are discussed and the failure to exert significant effects in some studies is pointed out.

In the paper “*Assessment of various traditional Chinese medicine formulas on skin micro-circulatory perfusion*”, He, et al. take advantage of the Laser Doppler technique to investigate the acute effect of Chinese medicine formulas in mice skin micro-circulation. The authors tested formulas with different flavonoid content and identified 2 preparations as best candidates for skin health applications. Interestingly, the formulas with higher (total) flavonoid content show no detectable improvement of micro-circulation, reinforcing the importance of the relative potency of individual components in the mixtures.

Hydrogen sulfide (H₂S) is an endogenous antioxidant and cell signaling molecule that can mediate a wide range of biological responses. It can also be administered exogenously and show remarkable cardioprotective actions. In the paper “*Effects of hydrogen sulfide on myocardial fibrosis in diabetic rats: Changes in matrix metalloproteinases parameters*”, Xiao, et al. use a streptozotocin-induced diabetic model and examined the effect of an 8-week treatment with the H₂S donor NaHS in myocardial fibrosis and the possible regulation of metalloproteinases (MMPs) expression. In addition to a beneficial effect on myocardial fibrosis as suggested by histological analysis, NaHS treatment attenuated diabetes-induced changes in the expression of MMPs implicated in diabetic cardiac

remodeling, as well as in the levels of the MMPs modulators TIMP1 and TGF 1. This relevant work adds to the current understanding of the MMPs role in diabetic cardiopathology and H₂S protection.

The works by Zang, et al. and J. Liu, et al. explore the potential of active polysaccharides and peptides to modulate cell responses. The pharmacological properties of *Ginkgo biloba* extracts are generally ascribed to their flavonoid and terpenoid constituents, but the paper by Zang, et al. suggests that polysaccharides derived from *Ginkgo biloba* leaf may also inhibit the production of inflammatory cytokines by macrophages. J. Liu, et al. study the effect of collagen peptides with different molecular weight on osteoblast *in vitro* differentiation to determine the fractions that more efficiently enhance osteogenesis. The authors produce peptide fractions from bovine gelatin by digestion and ultrafiltration separation, and assessed osteogenic differentiation by a series of specific assays. This strategy may lead to new active ingredients useful for the prevention and treatment of osteoporosis, or for the development of bioengineered materials.

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