Editorial

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The main purpose of this special issue is to present concepts and methodologies of new engineering modelling and imaging technologies and applications in biomedical research fields. This issue contains full-length research articles which covered a wide range of research and applied activities focusing on fields of medical imaging diagnosis, development of bioinstrumentation, and engineering modelling for biological system. A total of eight papers were selected through a rigorous review process before publication. All papers represent important original scientific contributions to modern biomedical engineering fields.

New approaches of functional MR imaging (fMRI)

Functional Magnetic Resonance Imaging (fMRI) is among essential tools for detection of neural activities in brain. In this special issue, two papers introduced new approaches in the research field of fMRI. Gong et al. described a new method of fMRI registration, which is based on feature utilised Gaussian mixture model and 3D scale-invariant feature transform algorithm. The proposed method was compared with other two image registration methods: iterative closest point (ICP) and expectation maximisation iterative closest point (EM-ICP). Their experimental results demonstrated that the proposed method produced better neural activity pattern recognition, the highest mutual information, and the best signal-to-noise ratio. The authors concluded that the proposed method can improved the image registration performance and provide reliable data pre-processing for fMRI data analysis.

In the other fMRI related paper, Li and Hao developed a new statistical algorithm for fMRI image restoration based on the hidden Markov tree (HMT) model. In fMRI, the blurring and intensity spikes produced by motion artefacts and noise can cause image distortions and reduce quality of MRI images. The proposed algorithm can eliminate the motion burring and spikes in the MRI images. Therefore, it can improve the quality of fMRI images and provide reliable neural activities detection. The proposed algorithm was validated by both simulation and experimental data in the paper. The results showed that the proposed method can successfully restore the image and eliminate the motion blurring and spikes in both simulated and experimental fMRI data sets. In conclusion, the proposed algorithm can effectively reduce image distortions, achieve better signal-to-noise ratio, and increase the mutual information in fMRI image. In addition, the proposed algorithm can also be used for image restoration in other medical imaging applications.

Research on noise induced hearing loss (NIHL)

Noise induced hearing loss (NIHL) is one of most common occupational health problems in military and industrial fields in the USA. The NIHL research is ranked at a high priority level in health related research by the National Institute for Occupational Safety and Health (NIOSH) and the Department of Defense (DOD). Impulse noise produces higher auditory hazard and causes severe hearing loss. To better understand the auditory risk of impulse noise, Wu and Qin investigated the effects of the key parameters of impulse noise in the Auditory Hazard Assessment Algorithm for Humans (AHAAH) model. In the paper, the simulated and experimental generated impulse noise waveforms were used in the AHAAH model to predict auditory risk unit (ARU). Four key parameters of impulse noise were defined and evaluated. The results and conclusions showed that all four key parameters generated significant impacts in the ARU predicted in the AHAAH model.

Improvement of interventional X-ray fluoroscopy

Low dosage X-ray fluoroscopy can provide real-time imaging for interventional procedures, and it remains a principal imaging method in imaging-guided procedures and therapies. Jiang and Chang developed a multi-stage contrast enhancement filter method to enhance the visibility of the stent without significantly increasing quantum and structure noises in an interventional X-ray fluoroscopy system. The developed method was evaluated by X-ray synthetic image sequences with and without clinical

backgrounds. Their study demonstrated that the developed method effectively enhanced stent contrast without significantly boosting image noise. In addition, the authors discussed the optimisation of the contrast enhancement filter as a future study.

Medical imaging modalities for detection of biological systems

Modern medical imaging modalities are used widely as efficient tools for diagnosis purpose to improve the understanding of structural and functional information of biological systems. The colony-based laser scatting imaging has been used to identify the source of microbial contamination of water. Gong et al. investigated the correlation between the colony sizes and the clusters of optical scattering patterns to optimise colony-based laser imaging technology for microbial source tracking. The experimental results showed that the transition of optical scattering patterns is no linear to colony growth time or colony size. However, the inconsistent boundaries of clusters among the optical scattering patterns were observed and defined in this study. The optimised range of colony size has been determined to improve the identification rate of microbial source tracking.

In another paper, Shi and Guo introduced a study of water-fat separation in tissue using magnetic resonance imaging (MRI) based imaging technology. In this study, the original IDEAL (Iterative decomposition of water and fat with echo asymmetry and least-squares estimation) algorithm was modified by using self-calibration multi-peak fat spectral model. The performance of the modified IDEAL algorithm has been evaluated by simulated, phantom, and *in vivo* data. The results showed the modified algorithm can provide reliable water-fat separation.

Medical image quality analysis and algorithms

Tomosynthesis technology has been developed for early detection of breast cancer, and it provides stunning 3D information with comparable dosage to traditional 2D X-ray mammography. Rayford et al. investigated the effect of the number of projection images in a parallel digital breast tomosynthesis (DBT) system. Modulation Transfer Function (MTF) analyses were conducted with two different imaging reconstruction algorithms, Back Projection (BP) and Shift-And-Add (SAA) in this study. The results showed that the number of projection images plays important role in the DBT imaging. When project number increases, the in-plane impulse response peaks become sharper, while the out-of-plane artefacts are reduced. The authors also concluded that the DBT is a very promising technology for the early diagnose of breast cancer.

Biological systems and modelling

Biological systems and modelling has been widely used in biomedicine and bioinformatics research fields to understand complex interactions in biological systems. Mahmood and Botros developed a novel computer simulated model for the renal system. The model can be used to simulate the human body fluid balance under normal conditions, the changes of kidney function, and the urine flow with ingested water. The developed model was validated by using varied water load conditions and hypertonic saline load stress. The simulated results of the developed model are comparable with the data the published literatures.

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