Editorial

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Biographical notes: Xin Qian is currently a Clinical Physicist in the Department of Radiation Oncology at New York Presbyterian Hospital, Columbia University. Before joined Columbia University, he had been working as a Research Assistant Professor at The University of North Carolina at Chapel Hill. His research focuses on biomedical imaging, medical physics, digital tomographic imaging and radiation dosimetry.

Ying Chen is an Associate Professor in the Department of Electrical and Computer Engineering at Southern Illinois University, Carbondale, Illinois, USA. She received her PhD from Duke University. Her research interests include biomedical imaging, image reconstruction, digital tomosynthesis, image processing and image quality analysis.

This special issue contains full-length research papers focusing on engineering modelling and algorithmic development in biomedicine. Research and applications of digital medical imaging, therapeutic modelling, computational algorithms and simulation, and medical instrumentation signal analysis are included. The scientific themes of this special issue are to present concepts and methodologies of advanced engineering models and algorithms in biomedical research fields. Through a rigorous review process, a total of eight papers were selected in this special issue. All papers represent important original scientific contributions to modern biomedical modelling and algorithms development.

New approaches of medical imaging and radiation therapy

Medical imaging plays essential roles for screening and detection in clinical applications. In this special issue, one paper reviewed novel approaches in the research fields of digital mammography breast imaging. New developments in tomographic imaging and detector

technologies make it possible to produce advanced digital breast imaging tools and algorithms, including computer-aided diagnosis, dual energy, three-dimensional digital tomographic imaging, etc. The active research areas of digital mammography were presented and discussed. Advantages of digital mammography compared with conventional mammography were described. Digital detector technologies including direct-conversion and indirect-conversion were described. Image quality merits of signal and noise properties in frequency domains were introduced with explanations. The rapid technical developments of digital mammography will translate into improved patient care efficiently.

Digital tomosynthesis is a novel three-dimensional imaging technology to challenge traditional X-ray radiography. In this special issue, research on breast tomosynthesis imaging was presented by a research group. Computer simulation with wire and spherical objects were investigated to optimise tomosyntheis imaging configurations and image reconstruction algorithms.

In minimally invasive interventional research fields, fluoroscopy is among the major sources of diagnostic X-ray imaging modalities. Jiang proposed a two-stage order statistic filter development to improve the image quality with reduced noise levels. Human observer model was used to quantitatively assess the visibility of objects in X-ray fluoroscopy image sequences.

Radiation therapy uses high-energy radiation for cancer treatment. As a well-established tumour treatment modality, microbeam radiation therapy employs microscopically thin planar beams of synchrotron-generated X-rays to kill cancer cells. Wang at Mahanhattan and Qian reviewed the potentials of microbeams for central nervous system research. Microbeam radiation is capable to selectively ablate slices of difference cell types, and offer a unique engineering tool for studying the effects of selective removal of mitotic and non-mitotic cells to improve radiation therapy efficiency.

Engineering models in biomedical applications and understanding

Engineering models are valuable in understanding how tissue works. It is important to integrate biology and medicine with engineering to model the biomedical process itself. In this special issue, several engineering models in biomedical applications and understanding were included. One paper presented a novel assessment function to evaluate the quality of photoplethysmography to calculate the continuous cuffless arterial blood pressure. Kalman filter was developed as a fusion method to improve the blood pressure calculation. Multiparameter intelligent monitoring in intensive care database was used to evaluate the proposed models and measurement method.

In another paper, engineering modelling of therapeutic ultrasound to deal with kidney stone diseases were investigated. The numerical models of bubble dynamics in shock wave lithotripsy were studied and dynamics of cavitation bubbles was simulated using Gilmore formulation. The acoustic pressure produced by different generations of devices was measured and compared. This engineering modelling research will help to understand the therapeutic ultrasound for clinical applications.

Monte Carlo simulation is an effective method to model wave propagations and wave interactions with objects such as tissues. The individual photon history can be traced based on ray-tracing and photon population statistics. One paper in this special issue presented the computational modelling and investigation of Monte Carlo method for

wave transport simulations. Computer algorithms were developed to simulate the photon migration. Several tissue attenuation coefficients were used to understand the three-dimensional light-tissue interactions.

Engineering models have been widely applied to bioinformatics research fields. A framework model to accelerate the coding of interactive programs for learning genetics was presented in the last paper in this special issue. The authors created a program for understanding the *lac* operon to illustrate the mechanisms of gene regulation, an inherent property of all organisms. The operon system in bacteria was studied. Algorithms and models were developed to realise the interactive tutorial tools.

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