Editorial

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According to the definitions by Wikipedia, model or modelling can be conceptually very broad. A model is a pattern, plan, representation (especially in miniature), or description designed to show the main object or workings of an object, system or concept. Model may also refer to numerous other matters depending on the exact conditions. Biomedical imaging presents a particular domain where its methodologies and applications heavily involve various approaches of modelling, identification and computing.

The techniques of medical imaging visualise physical measurements such as electrical signals, attenuation values of X-rays, gamma rays from radionuclide in human body, reflected wave of ultrasound, etc., and play a key role in healthcare for diagnosis, treatment and monitoring. This visualisation can reflect the details of human body anatomically, biologically, pathologically and functionally. Many theories and methods are employed to process the original measurements to obtain high quality images, in the aspects of modelling, filtering, transformation, reconstruction, inference and clinical applications. The technique of modelling numerically simulates the process of data acquisition, the physiological activities, the propagation of a wave, the characteristics of radionuclide and the psychological and physical reactions to stimuli. It is always challenging for deriving a first principle model, determining the structure of a model based on data, parameters identifications, statistically evaluation and improvement and, most importantly, the applications.

Based on the obtained model, observed data can be analysed for hypothesis testing, error correction, non-linearity compensation, noise detection and isolation and pathological inference. Computation is an important factor for method implementation. The improvement of computational efficiency contributes to a new balance between the complexity of approximation, accuracy and time consuming in clinical routine work.

On the other hand, in healthcare and life sciences, a common practice is to use laboratory animals to model humans because many tests cannot be done on human objects due to both ethical and practical constraints. Considering the similarity in biology between animals and humans, normal animals of various species are used to study structural, functional and metabolic properties at different physiological or pathological conditions and to investigate chemical pharmaceutics and interventional instruments for biocompatibility and potential human toxicity. Moreover, animal models of human diseases can be spontaneously established in cases with a naturally occurring disease or chemically, physically and genetically induced in order to acquire etiological and mechanistical insights for expanding knowledge about these diseases and to conduct preclinical research and development on new diagnostic and therapeutic modalities for conquering these diseases. In fact, historically appropriate animal models of human diseases often lead to important discoveries in medicine.

Despite diverse comprehensions over the terminology on modelling by the researchers with engineering and biomedical background, the current journal issue has hybridised a number of interesting articles contributed by such different author groups in an attempt to improve their mutual understandings or probably to trigger inspirations for any potentially more innovative collaboration. Indeed, animal research will likely remain crucial during many years to come, unless suitable alternatives such as pure computer modelling become equally valid, where joint efforts are definitely needed.

The paper entitled ‘Time-varying parametric modelling and time-dependent spectral characterisation with applications to EEG signals using multi-wavelets’, decomposes the potential regressors using multi-wavelet to increase the obtainability of accuracy, to approximate a complex time-varying system. The base functions are

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locally defined so that it can be more flexible and adaptive for tracking the dynamics of EEG signals. The model validation demonstrated that the observed EEG signal can be simulated with high accuracy so that the underline characteristics of EEG can be effectively extracted and analysed.

Radiofrequency ablation (RFA) is a newly emerging but rapidly spreading minimally invasive cancer therapy. The variables identified to have significant impact on RFA heating include electrical conductivity of the tumour and surrounding tissue, thermal conductivity of tissue, tissue perfusion and RF generator output. These constitute a dynamic and complex matter that makes it difficult to achieve an optimal RFA in clinical practice. The paper entitled 'Formulation of 3D finite elements for hepatic radiofrequency ablation' is intended to propose a specialised 3D finite element modelling in order to develop a fast analysis tool for clinicians to optimise RFA parameters and to predict the ablation outcomes.

The paper entitled 'Analysis of connectivity in the resting state of the default-mode of brain function: a major role for the cerebellum?' modified the base functions, combining with independent component analysis and functional connection analysis, to improve the performance of a functional MRI modelling for the detection of brain activity during rest. This study integrates the cerebellum and angular gyrus within the concept of a default-mode network.

The paper entitled 'Development, evaluation and application of reperfused liver infarction in rats as a practical model for studying ischemic diseases and screening new drugs' aims at highlighting a number of relevant aspects about this particular rat model as an easier substitute of brain and heart infarction models useful for developing necrosis avid contrast agents or tracers to enhance the sensitivity and specificity of magnetic resonance imaging (MRI) or nuclear imaging modalities, facilitating those interested academic or industrial researchers to apply this model in their own experimental studies and exploiting new potential applications.

The paper entitled 'Tomography in frequency domain using wave equation' introduces a topographic method using an acoustic wave equation to describe the propagation and reflection of the wave. The forward modelling and image processing are performed in frequency domain to reach higher computational accuracy. The images are reconstructed using not only travel time, but also the signal waveform to reduce errors and noise. The method has the potential of increasing the accuracy of ultrasound in clinical applications.

The paper entitled 'Methodologies for pharmacokinetic post-contrastographic dynamic contrast enhancement' proposes a pharmacokinetic model, a dynamic state space system, for dynamic contrast enhancement MRI analysis, to investigate vascularisation induced by cancer or inflammatory diseases. This approximated model is physiologically meaningful and can be useful for clinical diagnosis.

The paper entitled 'Rodent models and magnetic resonance imaging: diagnostic and therapeutic utilities for stroke' briefly summarises a number of common rodent models of stroke and recent MRI findings from such animal models as well as their impacts on experimental and clinical studies on this major life threatening disease.

The paper entitled 'Animal models of ischemic heart disease for cardiac MR imaging research' covers a variety of experimental models of ischemic heart disease induced by coronary interventions and their utilities in cardiac MRI research. In particular the advantages of a newly modified rabbit model of myocardial infarction are emphasised by experimental examples.

The paper entitled 'Investigation of multiwavelets and set partitioning algorithm on mammogram images' improves the set partitioning algorithm by shuffling the coefficients of multi-wavelet decomposition, and applies this method to increase the compression performance for mammography database. This could improve the efficiency of clinical routine procedures for database loading, saving, storing, transmitting, analysing and administrations.

Life-threatening cardiovascular disorders such as stroke and heart attack are the leading causes of mortality and morbidity in the modern societies. The pathogenic precursor of these consequences is atherosclerosis, a disease of the vessel wall that occurs in the central and peripheral arteries. The paper entitled 'Choices for animal models of atherosclerosis in MR molecular imaging study' is aimed to introduce the background knowledge about atherosclerosis and its pathology, to overview various atherosclerotic models with advantages and limitations as reported in the literature, to summarise the available MR techniques that can be used for imaging atherosclerosis, to identify some recently emerging methodologies in atherosclerosis research and to provide certain criteria for making practical choices in consideration of MR cellular or molecular imaging research.