Editorial Review: Engineering Modelling and Intelligent Computing are Synergistic in Translational Medicine Research

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Abstract: The field of engineering modelling and intelligent computing research has developed a large and substantial body of knowledge, based mostly in medical, healthcare, science and engineering programs. The basic paradigm has been the use of engineering and computational techniques, with the randomised clinical trial forming the main basis for progress. Quantitative models to analyse questions related to healthcare and personalised medicine have been used to design, validate and support the effective clinical applications. The use of advanced engineering and computational models to solve biomedical and healthcare problems for optimal design or resource allocations are key components of personalised medicine for decades. The development, implementation and transfer into clinical practice of data-driven models to support biological and medical research is an important research area in related fields. This special issue contains several ongoing research projects aimed at developing current signal and imaging and functional informatics techniques focusing on modern engineering modelling and computational medicine. Those papers represent important original scientific contributions to the modern biomedical and healthcare fields.

Keywords: computational informatics; signal processing; medical imaging; functional informatics.

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1 Introduction

Engineering modelling and intelligent computing have been used widely to achieve innovation and accomplishments in developing new procedures, devices, drugs, and diagnostics. They serve as a significant component and have revolutionised the traditional personalised medicine and related biomedical research to be applicable in clinical application. Utilising the engineering modelling and intelligent computing techniques for interdisciplinary research in biomedical fields has stated to lead many advances. This special issue contains full-length original scientific papers focusing on biomedical engineering modelling and computational technique varying from signal processing and medical imaging aspects to genome mapping research. Advanced engineering design

and computational methods are introduced with medical and biological sciences to improve healthcare diagnosis and treatment.

2 Scientific themes

This special issue is a collection of outstanding papers covering biomedical imaging, medical image quality analysis, biomedical signal processing, engineering treatment and biological computational modelling. Several included research papers in this issue can be grouped into following categories based on their contents.

2.1 Biomedical signal processing and modelling

Biomedical signal processing and modelling involves the application of engineering and computational methods for the improvement of human health. The signals encountered are typically derived from human beings or biological processes. Researchers have been working on various developments of signal processing algorithms to extract useful information from biomedical and biological signals for diagnosis, treatment and other related applications. Engineering modelling plays important roles in those fields to advance significant biomedical and biological applications and at the same time to use the requirements of the physical and mathematical problems people are interested in to push the advancement of signal processing and modelling theory and practice.

Biomedical signal processing and modelling techniques have become crucial in a wide range of personalised medicine applications. Biomedical signal processing technique is used to automate the measurement of various medical and biological signal characteristics to extract desired signal components. This field encompasses techniques for the acquisition, processing, classification, and analysis of digital biomedical information. A variety of signal detection, extraction, and filtering methods have been investigated in this field to uncover components or hidden activity. Signal processing research varies from hearing to voice recognition to wireless sensors, etc. In speech recognition fields, Wang, Botros and Shahin presented a feature analysis and stress compensation technique to investigate the stressed speech signals. Different stress styles were studied to analyse the recognition performance. Their results showed increased recognition rate for stressed speech with stress compensation (Wang et al., 2009). Sztajnberg et al. investigated a novel computational architecture to develop a remote assisted living application including blood pressure measurements. It can potentially help healthcare personnel to monitor and assist patients during their daily activities and improve patients' compliance and quality of life (Sztajnberg et al., 2009). Doppler ultrasound induced bioeffects are used for clinical treatment and therapy. An ultrasound modelling work was described to study the bubble cavitation danamics, expansion and collapse in ultrasonic bioeffects (Zhou, 2009). Engineering modelling methods were discussed in this work in understanding the existing phenomenon.

2.2 Medical imaging and analysis

Medical imaging is essential in diagnosis and detection of various diseases in modern society. It is used to create anatomical or physiological information of the human body for clinical purposes. The influence and impact of medical imaging on modern science

and technology are tremendous. It is a truly interdisciplinary subject that draws from synergistic developments involving engineering modelling, computational methods, computer vision, image processing and many other fields. The continuing progress in computerised medical imaging has propelled this field into a very important one in medical diagnosis and treatment. The rapid advances in medical imaging technology make it possible to create high-resolution, three-dimensional anatomical and physiological images to enable powerful advances in diagnosis and intervention. Medical imaging has advanced from a marginal role in healthcare to become an essential tool of diagnostics over the last few decades. The development of software programs, tools, and applications is significant to the advancement of research and innovation in medical imaging. Liang, Zhang and Ying proposed a novel acquisition and reconstruction schedule to reduce artifacts and improve resolution from limited-view acquisition for photoacoustic imaging. The proposed method is promising to eliminate the mechanical scanning artifacts with limited cost of ultrasonic transducer (Liang et al., 2009). Jiang and Wilson investigated quantitative experimental techniques to evaluate the image quality of different flat-panel detectors in X-ray fluoroscopy imaging. Ideal observer modelling and simulation were also designed to predict the performance. Their study demonstrated that the detector scintillator thickness plays important roles for detector performance of interventional devices (Jiang and Wilson, 2009).

2.3 Computational informatics

Computational informatics is an interdisciplinary field to understand the mechanisms and to improve the diagnosis, prediction and treatment of human disease through applications of mathematics, physics, engineering, and computational science. Today, computational technology is robust in almost every industry and organisation. In molecular biology, computational informatics is used to solve biological problems using mathematical and computational approach. This technology can be utilised in various genome studies, including genome mapping. Sharma, Evans and Bhavsar presented a very interesting work of transcription factor mapping between bacteria genomes with computational modelling and analysis (Sharma et al., 2009).

3 Leading motif

The recent rapid advances in functional informatics and personalised medicine will continue and allow us to make significant advances in our understanding of life, and our ability to deliver quality healthcare. Engineering modelling and computational informatics are contributing to a remarkable synergy of efforts to achieve dynamic, quantitative information of the medical and biological systems. With continuing evolutionary progress in biomedical engineering modelling and computational methods, we can fully expect to benefit from new knowledge about life and disease processes, and from new methods of diagnosis and treatment. The aim of our special issue on modern engineering modelling and intelligent computing technique was to broaden the area of research to learn about issues and problems in biomedical engineering and bioinformatics which could be addressed by engineering and computational methods.

The leading motif of this issue was the computational analysis, engineering modelling, biomedical signal and image analysis and related engineering design.

Topics discussed in this issue have included theoretical and experimental development of bacterial genomes, medical imaging development, remote assisting system, speech recognition, etc. This issue advances our effort to contribute to the functional informatics and personalised medicine areas, where the engineering modelling and computational informatics play essential roles and serve as key components.

We hope this special issue motivates researchers to take the next step beyond building models to implementation, evaluating, comparing and extend proposed approaches to advance our understanding of biomedical engineering and bioinformatics. We also hope that this special issue will be a good source of information and reference for basic and applied researchers in this field.

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