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Editorial

Medical imaging informatics research and development trends—an editorial

Medical informatics, which studies healthcare information, has gradually evolved and established itself as a rigorous scientific discipline during the past 15 years [1–7]. There are now at least 10 major training programs supported by the National Library of Medicine (NLM) in the US with many more throughout the world, teaching students, the concepts and methods of health information gathering, data structure, information extraction, retrieval and distribution, and knowledge representation [8–14].

Medical Imaging Informatics is a subset of medical informatics that studies image/data information acquisition; processing; manipulation; storage; transmission; security; management; distribution; visualization; image-aided detection, diagnosis, surgery, and therapy; as well as knowledge discovery from large-scale biomedical image/data sets. Although, it is based on many existing concepts, theories, terminology, and methodology derived from medical informatics, Imaging Informatics deals with different types of data including multi-dimensional medical images, graphics, waveforms, and text. Accordingly, imaging informatics requires new concepts and new tool sets to handle these types of data [15]. Although there exist training programs in medical imaging and telemedicine [16–18], focused training dedicated to imaging informatics is limited because of its novelty [19].

Recent advances in medical imaging technology, e.g. Picture Archive and Communication systems (PACS), image-guided surgery and therapy, computer-aided diagnosis (CAD), electronic Patient Record (ePR) with image distribution have propelled imaging informatics as a discipline to manage and synthesize knowledge from medical images for effective and efficient patient care as well as outcomes [20].

This Special Issue in Medical Imaging Informatics consists of 13 papers spanning the Imaging Informatics field. The first paper is an editorial on 'Medical Imaging Informatics Research and Development Trends'. The subsequent 12 papers are divided into five groups as follows.

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1. Group 1: imaging informatics technology

Two important imaging informatics technologies are image storage and distribution, and image communication. Two papers are included in this group.

Liu et al.—Utilizing data grid architecture for the backup and recovery of clinical image data
Chan et al.—International Internet 2 performance and automatic tuning protocol for medical imaging applications.

Grid computing is the most exciting incarnation of contemporary computing technologies including parallel, peer-to-peer, and client–server models. It has been used mostly in physical and engineering applications. Liu et al. present a model using the Data Grid for the backup and recovery of clinical image data—one of the most difficult problems facing large-scale clinical image databases today.

Internet 2 is the high-speed communication backbones established by the education and research community during the past 5 years through the support of the US National Science Foundation (NSF). Internet 2 applications have been mostly confined to the US. Chan et al. describe their experience of connecting the Hong Kong Polytechnic University networks to the Image Processing and Informatics (IPI) Laboratory, University of Southern California (USC) through Internet 2 with medical image communication as the application.

2. Group 2: electronic patient record (ePR) with image distribution

Electronic patient record (ePR) with image distribution is a current R&D topic in imaging informatics. Traditional customized small-scale ePR systems without images have been developed for over 10 years, however, ePR systems with image distribution is relatively novel derived from clinical needs and the successful implementation of many Picture Archiving and Communication systems

(PAC systems) around the world. Three papers are included in this group:

Zhang et al.—Web-based ePR for collaborative medical applications
Law—A model of DICOM-based ePR in radiation therapy
Cheung et al.—Integrating images into the ePR of the hospital authority of Hong Kong.

Zhang et al. describe a web-based ePR system for collaborative consultation with medical image/data in a teleradiology and collaborative consultation application during the Severe Acute Respiratory Syndrome (SARS) period, May 2003, in China. This paper represents an integration of four current information technologies: Web, ePR, DICOM (Digital Imaging and Communication in Medicine) standard, and collaborative consultation.

DICOM-based medical image standard has been successfully implemented in diagnostic radiology during the past 10 years. However, despite the introduction of DICOM radiation therapy (RT) objects since 1999, the RT community has not yet to take advantage of the power and infrastructure of imaging informatics. Law presents an ePR model of DICOM-based radiation therapy information system, where seven RT DICOM objects are included, as a first attempt at such a development to utilize these concepts.

In the past, ePR has been developed as a small-scale customized electronic patient based system. Cheung et al.'s paper describes the planning and preliminary results of an enterprise level ePR with image distribution in Hong Kong. The ePR system involves 43 hospitals (93% of the Hong Kong market) with a total of 29,000 beds. The ePR system is based on the existing Clinical Management System (CMS) developed in-house at the Hong Kong Hospital Authority which currently contains 6.4 million patients' records.

3. Group 3: image-aided detection and diagnosis

One reason for developing the medical imaging infrastructure is to take advantage of tools within the infrastructure for large-scale longitudinal and horizontal clinical service and research, as well as systematic education and training. Among these tools are image processing, visualization, image matching, content-based retrieval, data mining, and computer-assisted detection and diagnosis. Four papers are included in this group:

Lehmann et al.—Automatic categorization of medical images for content-based retrieval and data mining
Pietka et al.—Informatics infrastructure of CAD system
Long et al.—Image Informatics at a National Research Center
H. Huang et al.—Imaging matching as a diagnostic support tool for brain diseases in children.

Automatic categorization is the first step for image content-based retrieval and data mining. Lehmann et al. present a method to automatically categorize medical images into 81 classes using 10,000 clinical images with the highest accuracy compared with other existing categorization systems.

Pietka et al. describe an informatics infrastructure for large-scale computer-aided diagnosis (CAD) system for bone age assessment of children based on a digital atlas containing over 1000 normal hand digital radiographs of four different ethnic origins and genders.

Among all Institutes, Centers, and Libraries under the umbrella of NIH (National Institutes of Health), the National Library of Medicine (NLM) is probably the most active in intramural informatics and imaging informatics research. Long et al. describe the activities with collaboration around the world at the Lister Hill National Center for Biomedical Communications, NLM.

Imaging matching is an important research area in imaging informatics. H. Huang et al. present a novel diagnostic support tool based on image matching using an image database containing 2500 pediatric MR brain images.

4. Group 4: surgical simulation and interactive multimedia learning

Imaging informatics is a very broad field using many tools and technologies, which may or may not be developed originally for medical imaging applications. Two papers are included in this group. Although, they may not fall exactly under the realm of imaging informatics, the outcomes of using imaging and technologies to achieve their goals are very similar to that of imaging informatics. In addition, some of the tools and technologies used have great potential of being adopted for imaging informatics applications and expanding the realm of Imaging Informatics.

Montgomery et al.—User interface paradigms for patient-specific surgical planning
C. Huang—Designing high-quality interactive multimedia learning modules.

In surgery, the first innovations of using image-aided tools are 3D display and image-based surgical planning. The current research and development trend is in surgical simulation. Although contents in Montgomery et al.'s paper did not explicitly mention imaging informatics, readers can no doubt identify many terms and technologies in the paper that overlap with those used in imaging informatics.

In interactive multimedia learning, images, graphic, drawings, video clips are among those being used as inputs to the learning tools. C. Huang's paper describes a methodology currently being used for building learning modules. In the paper, the author also points out

the similarity of technologies used in imaging informatics and in interactive multimedia learning.

5. Group 5: HIPAA compliance

Imaging informatics is dealing with clinical images that are acquired, stored, transmitted through public networks, and displayed. During these processes, the image integrity could have been compromised at any stage. HIPAA (Health Insurance Portability and Accountability Act) is a mandate for medical image user compliance. However, HIPAA only tells the user to comply, but does not provide protocols to be followed. Zhou et al.'s paper 'HIPAA Compliant Auditing System for Medical Images' describes a framework for HIPAA compliance using a workflow-auditing paradigm.

In summary, the 12 papers included in this Special Issue in Medical Imaging Informatics covers five groups of papers: state-of-the-art technologies ePR with images; image-aided detection and diagnosis; surgical simulation and interactive multimedia learning; and HIPAA compliance. Together, they provide a glimpse of current research and development (R&D) trends in this field. It is hoped that this issue will stimulate further R&D in imaging informatics to benefit the steadily fast growing medical imaging community.

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H.K. Huang*
Division of Imaging Informatics, Department of Radiology, The Keck School of Medicine, Information Sciences Institute, University of Southern California, 4676 Admiralty Way, Suite 601, Marina del Ray, CA 90292, USA
E-mail address: hkhuang@aol.com

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*Tel.: +1 310 448 9435; fax: +1 310 448 9441.