IEEE TRANSACTIONS ON
MEDICAL IMAGING

Special Issue on Imaging and The Virtual Physiological Human

Alejandro F. Frangi, Bart Bijnens, Rod Hose, Peter J. Hunter
Guest Editors

According to the STEP research roadmap (http://www.europhysiome.org) the Virtual Physiological Human (VPH) is *a methodological and technological framework that once established will enable the investigation of the human body as a single complex system*. Underlying the VPH concept, the International Union for Physiological Sciences (IUPS) has been sponsoring for more than a decade now the IUPS Physiome Project (www.physiome.org.nz), which is a *worldwide public domain effort to provide a computational framework for understanding human physiology*. It aims to develop integrative models at all levels of biological organization, from genes to the whole organism via gene regulatory networks, protein pathways, integrative cell function, and tissue and whole organ structure/function relations.

In this context, the roles of medical imaging and image computing play, and will continue to play, an increasingly important role as they provide systems and methods to image, quantify and fuse both structural and functional information of the human being *in vivo*. These two main research areas include the transformation of generic computational models to represent specific subjects thus paving the way for personalized computational models. Individualization of generic computational models through imaging can be realized in three complementary directions: a) definition of the subject-specific computational domain (anatomy) and related subdomains (tissue types); b) definition of boundary and initial conditions from (dynamic) imaging; and c) characterization of the structural and functional tissue properties. In addition, imaging has also a pivotal role in the evaluation and validation of such models both in human and in animal models, and in the translation of such models to the clinical setting with both diagnostic and therapeutic applications.

The applications of image-based VPH/Physiome models in basic and clinical domains are vast but, broadly speaking, they hold the promise to become new *virtual imaging techniques*. Effectively more, and often non-observable, parameters will be imaged *in silico* based on the integration of observable but sometimes sparse and inconsistent multimodal images and physiological measurements. Computational models will serve to engender interpretation of the measurements in a way compliant with the underlying biophysical, biochemical or biological laws of the physiological or pathophysiological processes under investigation. Ultimately, such investigative tools and systems will help our understanding of disease processes, the natural history of disease evolution, and the influence on the course of a disease of pharmacological and/or interventional therapeutic procedures.

We invite submission of papers describing new methods and tools for image-based approaches to the VPH/Physiome. The special issue will give particular attention to contributions describing methods and tools combined with a thorough clinical evaluation. Suggested topics include but are not restricted to:

- image-related ontologies to organize biomedical knowledge and their cross-linkage to image databases
- markup languages to encode image-derived models of human and biological structure and function in a standard format for sharing between different application programs and for re-use as components of more comprehensive models
- image databases providing access to structural/functional information at the cell, tissue, organ and system levels
- methods to render and integrate image information with computational models of cell function such as ion channel electrophysiology, cell signaling and metabolic pathways, transport, motility, the cell cycle, etc. in 2D and 3D graphical form
- techniques for displaying and interacting with organ and system models, across all spatial and temporal scales and including multiscale applications
- techniques for image-based non-invasive estimation of fine structure, tissue distribution and material properties in order to personalize computational models
- techniques for efficient and high-throughput pre- and post-processing of image-based computational models
- applications of computational models for subject-specific interventional planning and therapy customization
- applications of computational models for *in silico* understanding of disease processes and their progression
- applications of computational models for design, assessment and optimization of medical devices and products in *in silico* populations derived from image information
- applications of large-scale modeling and simulation studies involving imaging information and enabling computational technologies (e.g. grid computing, high-performance computing, distributed databases, etc.)

T-MI seeks high quality research papers for this special issue. This special issue will welcome both full-paper and short-communication submissions. Authors should submit their manuscripts electronically through the IEEE Manuscript Central Office (http://tmi-ieee.manuscriptcentral.com) following the T-MI Instructions and indicating in the *Comments to the Editor-in-chief* that the manuscript is submitted for the special issue on *Imaging and the Virtual Physiological Human*. Authors intending to submit articles are encouraged to discuss their submissions with the Guest Editors to determine suitability for this special issue.

Guest Editors:

Alejandro F. Frangi, PhD & Bart Bijnens, PhD

Center for Computational Imaging & Simulation Technologies in Biomedicine
Information & Communications Technologies Department
Universitat Pompeu Fabra
Barcelona, Spain
Phone/Fax: +34 93 5421451 / +34 93 5421451
e-mail: alejandro.frangi@upf.edu
bart.bijnens@upf.edu

Rod Hose, PhD

Academic Unit of Medical Physics
University of Sheffield
Sheffield, UK

Phone/Fax: +44 114 2713921 / +44 114 2712078
e-mail: d.r.hose@sheffield.ac.uk

Peter J. Hunter, PhD

Bioengineering Institute
University of Auckland
Auckland, New Zealand

Phone/Fax: +649 3737599 / +649 3677157
e-mail: p.hunter@auckland.ac.nz

Schedule:

Submission of manuscripts:	15th September 2008
Acceptance/rejection notification:	1st January 2009
Revised manuscripts due:	1st March 2009
Publication:	July 2009