



Special Issue on Simulation and Synthesis in Medical Imaging

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Guest Editors

The medical imaging community has always been fascinated by the possibility of creating simulated or synthetic data upon which to understand, develop, assess, and validate image analysis and reconstruction algorithms.

From very basic digital phantoms all the way to very realistic *in silico* models of medical imaging and physiology, our community has progressed enormously in terms of the available techniques and their applications. For instance, mechanistic models (imaging simulations) emulating the geometrical and physical aspects of the acquisition process have been used now for a long time. Advances on computational anatomy and physiology have further enhanced the potential of such simulation platforms by incorporating structural and functional realism to the simulations that can now account for complex spatio-temporal dynamics due to changes in anatomy, physiology, disease progression, patient and organ motion, etc. just to name a few. More recently, developments in machine learning together with the growing availability of ever larger scale databases have provided the theoretical underpinning and the practical data access to develop phenomenological models (image synthesis) that learn models directly from data associations across subjects, time, modalities, resolutions, etc. These are data-driven models that exist only in the weights of a deep neural network, in the words of a learnt dictionary or in the genes of a genetic algorithm, i.e. in the parameter space of whatever machine learning approach is being used. These techniques may provide ways to address tasks in medical image analysis that are difficult to model from first principles like cross-cohort normalization, image imputation in the presence of missing or corrupted data, transfer of knowledge across imaging modalities, views or domains. To this date, these two main research avenues (simulation and synthesis) remain pretty much independent efforts in spite of sharing common challenges.

This special issue will overview the state-of-the-art in methods and algorithms at the forefront of synthesis and simulation in/for medical imaging research. We hope this collection will stimulate new ideas leading to theoretical links, practical synergies, and best practices in evaluation and assessment common to these two research directions. In particular, we welcome contributions from cross-disciplinary teams with expertise, among others, on machine learning, statistical modeling, information theory, computational mechanics, computational physics, computer graphics, applied mathematics, etc.

Contributions are sought on methods that address, but are not limited to, the following:

- Fundamental methods for image-based biophysical modeling and image synthesis
- Image synthesis in high dimensional spaces (vectors, tensors, spatio-temporal features, etc.)
- High-throughput simulation and synthesis from large-scale image databases
- Quantification of uncertainty in imaging biomarkers and handling incomplete data via image simulation and synthesis
- Image synthesis and simulation techniques for data normalization, protocol harmonization, and intensity correction
- Mechanistic and data-driven predictive imaging models of disease progression or organ development
- Biomechanical and data-driven computational imaging models of organ motion and deformation
- Physical and data-driven models of image formation and acquisition in clinical and cellular imaging
- Methods and tools for cross modality (PET/MR, PET/CT, CT/MR, etc.) image synthesis and simulation
- Methods for automated quality assessment of simulations and synthetic images
- Novel evaluation metrics and benchmarking of state-of-the-art approaches in simulation and synthesis
- Normative and annotated datasets for benchmarking and learning models

T-MI seeks high quality research papers for this special issue. This special issue will welcome full-paper 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 their cover letter that the manuscript is submitted for the special issue on *Simulation and Synthesis in Medical Imaging*. Authors intending to submit articles are encouraged to discuss informally their submissions with the Guest Editors to determine suitability for this special issue. Authors are also encouraged to present their work and gather early feedback from the community at the homologous MICCAI 2016 Workshop (<http://www.cistib.org/sashimi>).

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Schedule:

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