

Preface

It is our great pleasure to present, combined in a single volume, the contributions from two closely related workshops that took place on September 22, 2013, in Nagoya, Japan, under the auspices of the 16th International Conference on Medical Image Computing and Computer Assisted Intervention, MICCAI 2013.

The MICCAI Workshop on Computational Diffusion MRI is already the fifth event in a successful series, following the exciting and well-attended workshops in 2008, 2010, 2011, and 2012. Despite, and partly because of, the rapid development the field has witnessed over the past few years, and the fact that diffusion MRI is now widely used both in scientific research and in the clinic, the field continues to face important computational challenges. For anyone interested in learning about Computational Diffusion MRI or already working in the field, the 17 original research papers collected in the first four parts of this volume will provide new insights and perspectives, state-of-the-art solutions to specific problems, and inspiration for future work.

The Mathematical Methods for Brain Connectivity Workshop is a recent addition to MICCAI. Connectivity analysis is a burgeoning sub-field of medical imaging that focuses on pairwise relationships between brain regions. The five original research papers collected in the fifth part of this volume clearly demonstrate the vibrancy and diversity of the field. Topics range from empirical studies of structural connectivity to multimodal analyses that further our insight into the complex nature of the brain. This workshop provides a snapshot of the current state-of-the-art methods and highlights some open challenges in the field.

A challenge in applying diffusion MRI in the clinic is the fact that it requires relatively long measurement times. Therefore, contributions in the first part of this volume, which is devoted to diffusion MR acquisition, consider the effects of reducing the field of view or the number of acquired diffusion directions, acceleration through simultaneous multi-slice acquisition, or application of model-based super-resolution.

Mathematical modeling of diffusion MRI data has always been a challenging problem and the subject of intense research. Contributions in the second part of this volume address improved estimation of (fiber) orientation distribution

functions (ODFs), and of the full diffusion propagator, by integrating explicit prior assumptions, or by data-driven dictionary learning.

The third part is concerned with mapping the large-scale connectivity of the human brain, which remains a key application of diffusion MRI. Papers in this part contribute to its mathematical foundations and present novel methods for validation, as well as for assessing the effects of noise and other sources of uncertainty.

The fourth part deals with statistical analysis, which is an important tool to gain neuroanatomic insight from diffusion MR data, and requires registration to establish correspondences between subjects. This part presents novel algorithms for diffusion MR registration and for tractography-based statistical analysis, and it includes applications to specific conditions and diseases.

Connectivity measures inform us about the anatomical and functional organization of the brain. However, these statistics are only meaningful if they reflect intrinsic biological properties. The first two papers in the fifth part quantify the effects of various acquisition and preprocessing parameters on the structural connectome. Such information is crucial to developing robust models of brain interaction.

The final three papers in this part explore multimodal and clinical applications. Connectivity analysis is particularly attractive for clinical populations, as patients are not required to perform challenging experimental paradigms. Another exciting prospect is to combine the connectivity metrics with behavioral, imaging and genetic information, to better characterize the evolution of a disease.

We are thrilled to provide this record of the exciting work presented at CDMRI and MMBC 2013. Each contribution in this volume has been peer-reviewed by multiple members of the respective International Program Committee. We would like to express our gratitude to all authors and reviewers for ensuring the quality of the presented work. We are grateful to the MICCAI 2013 chairs for providing a platform to present and discuss the work collected in this volume, and to the editors of the Springer book series *Mathematics and Visualization* as well as Martin Peters and Ruth Allewelt (Springer, Heidelberg) for their support to publish this collection as part of their series.

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