PREFACE

Variational or Partial-Differential Equations (PDE) approaches have proven to be powerful for biomedical image analysis. The basic ingredients of image analysis are basically comprised by the trilogy of segmentation, registration, and visualization. Variational and PDE approaches enable soft tissue modeling and detailed structural analysis of complicated topologies, and create the capability of alignment of tissues for subsequent statistical analysis. This two-volume set, *Deformable Models*: *Biomedical and Clinical Applications*, and *Theory and Biomaterial Applications* provides a wide cross-section of the methods and algorithms of variational and PDE methods in biomedical image analysis. The chapters are written by well-known researchers in this field, and the presentation style goes beyond an intricate abstraction of the theory into real application of the methods and description of the algorithms that were implemented. As such these chapters will serve the main goal of the editors of these two volumes in bringing down to earth the latest in variational and PDE methods in modeling of soft tissues. Researchers at various levels will find these chapters useful to understand the theory, algorithms, and implementation of many of these approaches.

The two volumes not only introduce application research but also novel theoretical ideas related to the problem under investigation. A list of algorithms is found in most of the chapters to provide an opportunity for those who want to implement the algorithms and repeat the results. Nearly all the chapters have a theoretical and algorithmic aspect of variational and PDE-based methods. A brief summary of the chapters in Volume 1 follows.

Chapter 1 deals with simulation of bacterial biofilms and ubiquitous life forms on the planet. More than 90 aggregates of cells attached to both biotic and abiotic surfaces. Level sets are combined with other numerical methods to model biofilms to explore the variety of their behavior.

Chapter 2 examines the distance transform and other distance measures and provides an approach to evaluate them. Interpolation and skeletonization are discussed as applications for the distance transform in image analysis and processing.

Chapter 3 deals with structural inversion for modeling structural information in medical imaging. It provides a brief introduction to some techniques that have been recently developed for solving structural inverse problems using level sets.

Chapter 4 deals with shape- and texture-based deformable models as applied to facial image analysis. The chapter examines various characteristics of active shape, appearance, and morphable models.

Chapter 5 describes a method for identification of the breast boundary in mammograms and its use in CAD systems for the breast and other applications.

Chapter 6 describes the use of statistical deformable models for cardiac segmentation and functional analysis in Gated Single Positron Emission Computer Tomography (SPECT) perfusion studies.

Chapter 7 presents an implicit formulation for dual snakes based on the level set approach. The key idea is to view the inner/outer contours as a level set of a suitable embedding function. Details of the approach are provided with applications to segmentation of cell images.

Chapter 8 describes a generalized approach for monotonically tracking advancing fronts using a multistencil fast marching (MSFM) method, which computes a solution at each grid point by solving the eikonal equation along several stencils and then picks the solution that satisfies the fast marching causality relationship.

Chapter 9 examines the use of deformable models for image segmentation and introduces an approach to reduce the dependency on initialization that utilizes object and background differentiation through watershed theories.

Chapter 10 describes the use of deformable models for detection of renal rejection as detected by Dynamic Contrast Enhanced Magnetic Resonance Images (DCE-MRI). The approach involves segmentation of the kidney from surrounding tissues and alignment of the segmented cross-sections to remove the motion artifices. The renogram describing the kidney perfusion is constructed from the graylevel distribution of the aligned cross-sections.

Chapter 11 deals with a class of physically and statistically based deformable models and their use in medical image analysis. These models are used for segmentation and shape modeling.

Chapter 12 reviews deformable organisms, a decision-making framework for medical image analysis that complements bottom–up, data-driven deformable models with top–down, knowledge-driven mode-fitting strategies in a layered fashion inspired by artificial life modeling concepts.

Chapter 13 provides a detailed description and analysis for use of PDE methods for path planning with application to virtual colonoscopy. The method works in two passes: the first identifies the important topological nodes, while the second pass computes the flight path of organs by tracking them starting from each identified topological node.

Chapter 14 describes an approach for object tracking in a sequence of ultrasound images using the Hausdorff distance and entropy in level sets. The approach tracks the region of interest (TOI) using information in previous and current slices and accomplishes segmentation with Tsallis entropy. The Hausdorff distance is used to match candidate regions against the ROI in the previous image. This information is then used in a level set formulation to obtain the final output.

Chapter 15 describes a deformable model-based approach for image registration. A nonuniform interpolation functions is used in estimating the joint histogram between the target and reference scans. A segmentation-guided nonrigid registration framework is described.

The authors of these chapters deserve a lot of credit and have the responsibility for preparing first class manuscripts that will stand the test of time and will guarantee the long-term value of these two volumes. Several people at Springer deserve special credit for making every effort to carry out this project in such a beautiful and professional fashion. In particular, Aaron Johnson, Senior Editor, Beverly Rivero, Editorial Assistant, Tim Oliver, Project Manager, and Amy Hendrickson, LaTeX Consultant, have made every effort to make this project smooth to its superb completion.

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Jasjit Suri and Aly Farag
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