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Advances and recent developments in medical image computing

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Medical image computing is a rapidly evolving field of research. Based on the German Conference on Medical Image Computing (BVM) 2009, recent contributions in segmentation, registration, analysis, and visualization have been reviewed and selected for this special issue of the *International Journal of Computer Assisted Radiology and Surgery*. In particular, methods for model-based image segmentation, application and optimization of non-linear image registration algorithms, e.g., for the estimation of 3D motion fields in 4D image data or the modeling of tumor growth, methods for quantitative analysis of follow-up studies as well as new techniques for the visualization of medical images are included in this special issue.

Medical image computing has become a key technology in image-based diagnostics and therapy. Software assistance

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is growing in importance for image-based diagnostics, and image analysis systems integrating advanced image computing methods are needed to extract quantitative parameters to characterize the state and changes of image structures of interest (e.g., tumors, organs, vessels, bones etc.) in a reproducible and objective way. Furthermore, in the field of software-assisted and navigated surgery medical image computing methods play a key role and open up new opportunities for patient treatment. However, further development is needed to increase the automation, accuracy, reproducibility and robustness of image computing methods [1–7].

For more than 20 years, an annual conference on medical image computing (Bildverarbeitung für die Medizin—BVM) has been held in Germany with more than 200 participants. For this special issue, authors of the best presentations at BVM 2009 were invited to submit a manuscript on their latest developments and results for possible publication in IJCARS. After a rigorous international peer reviewing process, ten excellent papers were selected that contain the most timely and important contributions in medical image processing and analysis.

These papers represent the breadth and heterogeneity of new developments in the field of medical image computing. New methods for model-based image segmentation, application and optimization of non-linear image registration algorithms, e.g., for the estimation of 3D motion fields in 4D image data or the modeling of tumor growth, methods for quantitative analysis of follow-up studies as well as new techniques for the visualization of medical images are included.

Paulus et al. present a new approach for quality assessment of retinal fundus photography combining local and global image statistics to measure image quality of fundus photographs in an objective and automatic way. The method enables evaluation of the image quality directly after image

generation using criteria inspired by diagnosis procedures based on the advice of an eye expert. A model-based method for the segmentation of healthy and pathological lymph nodes in CT image data using an extended spring-mass model is described by Dornheim et al.

A main focus of this special issue is image registration. A tensor grid-based approach for non-linear image registration is proposed by Ruppertshofen et al. to accelerate the registration procedure with high image resolution in selected image regions. Werner et al. describe the optimization and comparison of different non-linear registration approaches for accurate local motion estimation of the lung in 4D image data. This work shows that the quality of registration depends strongly on the chosen registration methods and parameters, and that high accuracy can be achieved using an optimal setting. Becker et al. propose in-silico modeling of tumor growth using a diffusion-based approach and non-linear registration methods for the modeling of the tumor deformation. The model is applied describing the growth of brain tumors of the glioblastoma multiforme type and evaluated by magnetic resonance imaging (MRI) data of a follow-up study.

A novel approach for the quantitative analysis of morphological changes in brain is given by Fritsche et al. Specific image scores are computed automatically from MR images and used for the prediction of progression from mild cognitive impairment to Alzheimer's disease. The comparison of the predictive value of the automated system with manual measurements shows promising results.

Another focus of this special issue is medical image visualization. While Rössling et al. present techniques for fast and flexible visualization of distances for treatment planning, Süßmuth et al. compute distance fields for color-coded visualization of pathological cranial nerve-vessel contacts in MRI during surgical planning. Special two-dimensional (2D) transfer functions combining information about the intensity and the object size are used by Wesarg et al. for volume visualization of three-dimensional (3D) medical image data. The new approach enables highlighting of anatomical structures in 3D visualizations of unsegmented image data sets. In the last article of the special issue, Kubisch et al. present techniques for interactive visualization of segmented inner images structures that are hidden by other structures. Visualization methods like Ghosting and Breakaway Views are implemented on a GPU to enable their use during interactive operation planning sessions.

The contributions to this special issue illustrate the breadth of the development in the interdisciplinary field of medical image computing. They conform to previous and future trends in advances and recent developments in medical image computing. The image computing methods presented here enable new insights into the patient's image data and have potential to improve medical diagnostics and patient treatment in future.

Special issues reporting on advances and recent developments in Medical Image Computing

Conference	Journal	Reference
BVM 2010	Computer Science—Research and Development 2011	In press
BVM 2009	International Journal of Computer Assisted Radiology and Surgery 2010	In press
BVM 2008	Methods of Information in Medicine 2009; 48(4)	[4]
	GMS Medical Informatics Biometry and Epidemiology 2009; 5(3)	[7]
BVM 2007	International Journal of Computer Assisted Radiology and Surgery 2008; 2(5)	[3]
BVM 2006	Methods of Information in Medicine 2008; 46(3)	[2]
BVM 2005		
BVM 2004	Methods of Information in Medicine 2004; 43(4)	[6]
BVM 2003		

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