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EDITORIAL

IJCARS special issue: BVM 2007 German conference on medical image processing

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Medical image processing applications have become a ubiquitous part of modern imaging systems and the related processes of clinical diagnosis and intervention. Over the past years significant progress has been made in the field, both on methodological and on application level. Despite this progress, there are still big challenges to meet in order to achieve systems that are more robust, more accurate, and more intuitive to interact with. To address these problems, the German Conference on Medical Image Processing (Bildverarbeitung für die Medizin, BVM) has been established. Since 1993, the BVM is held annually with participants from engineering and computer science, medicine, and industry. In 2007, the BVM was hosted by the Klinikum rechts der Isar of the Technische Universität München with 250 participants. In this issue, four awarded BVM 2007 contributions, complemented with two regular journal submissions, are assembled to present some of the latest advances in the field of medical image processing.

The scope of new developments in the field is broad. Therefore, the contributions in this issue can reflect only some of them. Nevertheless, a number of core areas are addressed: acquisition [1], registration and fusion [3,5], visualization and simulation [6], validation [4], and segmentation [2]. Primary application areas for the new or enhanced methods range from general improvements for an entire class of imaging devices or tasks [1,3], to the support of either the diagnosis and treatment planning [2,6], or the intervention [4,5], for different medical specialties (vascular diseases, abdominal and cardiac surgery, neurology and neurosurgery).

What are the trends we can observe in the fields where these approaches are used?

The developments in image acquisition can be considered from two viewpoints: the engineering of novel imaging devices, and the methods for processing raw data to compute images, volumes, and corresponding time series. One major trend is the tremendous increase of the number of images per patient study, e.g. for multi-detector computed tomography. To keep the radiation dose delivered to the patient in an acceptable range, the computational methods for processing raw data must become more dose efficient. The paper [1] is an excellent example of such an improvement, using multiple reconstructions for locally adaptive anisotropic wavelet denoising.

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Addressing a key challenge, progress in image registration and fusion is an important prerequisite for advances in computer-aided diagnosis and image-guided intervention. Robust and fast methods for acquisition of morphological and functional (molecular, metabolic) information in a unified reference coordinate system, both for visualization and for further utilization in the clinical process. Due to the complex mechanical properties of soft tissue in many applications, such as abdominal surgery, non-linear elastic registration methods are of high relevance. Following the general attempt in medical image processing of making analysis methods more robust against missing values and variations, in registration the correspondence of points in images of a body region in the same patient in different modalities or in different patients in one modality, the contribution by Hufnagel et al. [3] enhances a powerful method by replacing exact correspondences by iteratively evolving correspondence probabilities. Models built on the basis of such correspondences can also improve the robustness of model-based segmentation approaches. In Rasche et al. [5] the challenging fusion of volumetric ultrasound data with 3D X-ray imaging data for a combined visualization of the cardiac morphology and function is shown to be feasible.

Major advances in the field of visualization and simulation address more accurate reconstruction of surfaces. Optimized density and quality of triangles, locally adapted to the degree of surface complexity, are one of the goals to achieve. The surface quality must be especially high if the surfaces are to be used for dynamical simulations, since even small artifacts in the surface may cause large disturbances. In Schumann et al. [6] an accurate and high-quality reconstruction method for vascular structures is presented which could help paving the way for blood flow simulations.

In the field of image-guided intervention, recent advances extend the scope of applications from surgical targets with rather rigid geometry, such as brain surgery, toward surgical targets with the ability of large movements and distortions both between planning and doing surgery, and also during the surgical procedure, as this is the case for example in abdominal surgery. Particular attention has to be paid on validation of systems for image-guided intervention, and in this context physical phantoms play an important role. With their exactly defined and known geometry they provide the assessment baseline within the validation procedures. In Maier-Hein et al. [4] a new radiologic phantom for the simulation of respiratory liver motion is presented which can be used for the validation of image-guided liver surgery systems.

Another core problem in a broad variety of application contexts is the task of segmentation. Continuous progress has been made toward sophisticated, more robust and (semi-) automatic segmentation methods. In Su Huang et al. [2] a novel automatic tissue segmentation method for brain magnetic resonance images is presented.

In conclusion, we observe that the field of medical image processing is under rapid development with clear trends toward more accurate and more robust methods and applications for a broader range of medical specialties. The contributions in this issue are examples of how the efforts toward creating a more complete, multimodal insight into the human morphology and function are taking place in current research and development.

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