

Advances in medical image processing

A Special Issue on the Workshop in Aachen, Germany, March 2010

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Abstract For more than 20 years, the German Workshop on Medical Image Processing (Bildverarbeitung für die Medizin, BVM) is held annually and has been established recently as a European conference. In 2010, the workshop was held in Aachen, Germany. Based on a double-blind review process with at least three experts reviewing each manuscript, the best 20 papers have been invited contributing to this special issue. The thirteen submissions received have passed an international peer review process. Finally, eleven

papers have been accepted for publication. This includes two invited papers by Scholl et al. and Wismueller.

Keywords Biomedical imaging · Medical image computing · Computational intelligence · Computer-assisted radiology · Computer-assisted diagnosis

1 Introduction

Medical image processing is an exciting and active field of research, where disciplines such as Engineering, Computer Science, Physics, Biology and Medicine interdisciplinarily cooperate in order to improve health care. Most frequently, medical images are the basis of diagnostics, treatment planning, and treatment, but medical images are likewise important for medical education, research and epidemiology. Since the discovery of X-rays more than 100 years ago, several imaging modalities have been developed to visualize anatomy, tissue morphology, as well as muscular-skeletal and nervous functionality of the human body. Computed tomography (CT), magnet resonance imaging (MRI) and Ultrasound (US) are commonly known, but others, such as magnetic resonance spectroscopy imaging (MRSI), fluorescence endoscopy, CT angiography or optical surface scanning (OSS) are also applied in clinical routine.

The discipline of medical image processing deals with generation and reconstruction, pre-processing and improvement, analysis and quantification, as well as visualization and management of all kind of medical images. Frequently used steps in the image processing pipeline are image registration, which aims at aligning image data from different modalities, subjects, or points of time, as well as image segmentation, which aims at localization and delineation of relevant objects in two-dimensional (2D) projections and three-dimensional (3D) visualization.

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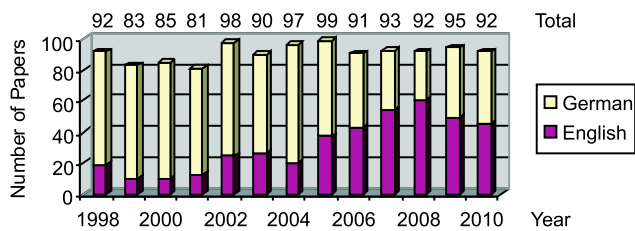


Fig. 1 Number and languages of papers from the Workshops Bildverarbeitung für die Medizin (BVM) that have been published in Springer Proceedings. The years 1998 to 2010 refer to [2–13] and [1], respectively

In this context, national and international meetings have been formed to support academic exchange in medical image processing research and development. The German Workshop on Image Processing in the Medical Sciences (Bildverarbeitung für die Medizin, BVM, <http://bvm-workshop.org>) has a history of more than 20 years. Almost 15 years ago, Springer started publishing the proceedings of this workshop [1–13], where particularly young scientists and PhD candidates are reporting on their results. Today, the workshop has become rather a European conference, with about 250 attendees every year, and about 90 presentations held as oral, poster or software demonstrations. Starting with German as conference language, English has become a co-equal basis of presentations, and nowadays the majority of papers are published in English language (Fig. 1). Based on this increasing level of scientific content, this special issue was composed.

2 Material and methods

The workshop in 2010 was held in Aachen, Germany, as a joint venture of RWTH Aachen University, Aachen University of Applied Science, and Research Center Juelich. All submissions to the workshop have been reviewed by three experts from both technical and medical background. Based on this pre-selection, the 20 best conference presentations were invited to participate in this special issue, and thirteen submissions have been received. Guest editor assessment was performed to ensure that each journal submission differ substantially from the proceedings paper that has been published already [1]. Based on a blinded peer review process consulting international experts, eleven manuscripts have been accepted for this special issue. These include two invited papers by Scholl et al. and Wismüller.

3 Results

The two invited papers report on recent challenges in medical image processing. Scholl et al. face the problems rising from the fast increase of data load that is produced by the imaging modalities, which are continuously improved

with respect to spatial and temporal resolution as well as sensitivity. Wismüller reports on computational intelligence in biomedical imaging for multi-dimensional analysis of spatio-temporal pattern. A third overview paper is provided by Schubert & Scholl, who compare graphic with central processing units for multi-volume visualizations. Fast processing has become more important, since biomedical image processing is to be established into the clinical workflow, e.g., supporting surgeons. Behrens et al. also report on real-time imaging, particularly focussing fluorescence endoscopy. The paper of Kaster et al. describes an object-oriented framework for systematic training and optimization of classifiers applied to computer-aided diagnosis (CAD).

Another bunch of papers is dealing with segmentation. Wellein et al. present a generic pipeline supporting manual segmentation. User interaction and system responses must be designed carefully to guide the user within the complex 3D domain. However, automation of the segmentation process is another challenge in medical image processing. Since most imaging modalities are harmful to living cells and human bodies, the signal to noise ratio is rather poor. Ruppertshofen et al. describe a Hough Transform-based technique to localize joints in lower extremities. Detection of such joints is, for example, important for orthopaedic measurements. Gooßen et al. present a model-based approach to detect joints in the lower limbs. Segmentation and measurement of coronary calcium is in the focus of Teßmann et al., describing an application to 3D CT angiography.

Visualization and documentation of medical image data is topic of the last two papers in this special issue. Behrens et al. present a non-linear multi-scale blending algorithm for fluorescence bladder images, while John, Schwanecke & Brüllmann describe a novel technique for contact-free volumetric measurements of facial turgors after dental surgery. Here, 3D reconstruction of OSS is applied as imaging modality, and this visualizations are documented in the patient's records.

4 Conclusions

Medical image processing is a mature field and the German BVM workshop has developed to a full scientific conference on European level. Real time image composition and processing has become a novel focus of research, while segmentation and quantitative measurement still are major fields of ongoing research.

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