Medical Imaging and Telemedicine – from medical data production, to processing, storing, and sharing: A short outlook

Editorial

The editorial first presents the papers of this special issue and the context of the conference they were selected from. Then, a further outlook is given into the broad range of topics in medical imaging and the future developments that we regard as important.

This issue of the International Journal of Computerized Medical Imaging and Graphics highlights extended versions of the best papers presented at the First International Conference on Medical Imaging and Telemedicine (MIT) 2005. MIT took place in Wuyi Shan in the Fujian province of China in August 2005. MIT is financed and organized in part by the TIME[1] project (Tele-Imaging in MEdicine) to create a bridge between China and Europe on collaborative health care and particularly in the imaging field. The TIME project is organized by the European Union Asia ICT Program and includes several Universities in Europe and Asia.

Although MIT 2005 was the first conference in this series a large variety of submissions was obtained. In total, over 60 papers were submitted to the conference organizers and 45 were chosen for presentation after peer-review, among them 36 for oral presentation and 9 posters. Subjects varied from Telemedicine to image management, classical image analysis and processing towards simulation, and also on new image capturing devices.

The guest editors of this special issue had the difficult decision to select papers presented at the conference for their inclusion into this special issue. Criteria for selection were not only the content of the paper and the quality of the oral presentation at the conference itself but also the scientific potential. Goal was to give also younger researchers the possibility to present their work to a larger audience. In a first step, 13 authors were chosen who submitted an extended version of their papers to the guest editors who reviewed the papers giving comments on necessary improvements. Then, a peer review process was started that reduced the list of 13 potential papers to the best 10. The papers represent well the extreme variety of topics that were present at the conference highlighting the variety of the medical imaging field itself:

Papers 1 and 2 are describing the first step of the imaging circle, the image production. Improvement of imaging modalities is presented with two new approaches for ultrasound and for a micro-tomography device. Paper 3 presents another paper linked to tomographic image production but this time on the signal treatment side after raw image acquisition, to improve the reconstruction quality of tomographic images. Paper 4 is giving some insights on a very different set of images: color images. The exact reproduction of these images with standard methods is important for imaging files in dermatology or pathology, for example, where it is important to exactly reproduce colors. Papers 5 and 6 both deal with the simulation of biologic activities. With computational power getting easier accessible, finer models can be made of biological systems to simulate and better understand them. Paper 7 presents an approach to detect the exact way a heart beats from ultrasound data to identify abnormalities. Paper 8 is dealing with 3D navigation to allow navigation in the patient without the need for a surgical endoscopic intervention for such navigation. The last two papers highlight two projects on image data management and image sharing. Paper 9 is on an open source PACS (Picture Archival and Communication System) system, allowing a low cost application in a field where much of the money for a hospital computer infrastructure is being spent. Paper 10

[1] http://www.mitime.org/

finally gives an insight into a telemedicine project in French speaking African countries; on the one hand presenting limited technical possibilities in these regions but also the impact that even low tech can have in the medical imaging field.
We can clearly see the variety of these papers with respect to modality as well as techniques used from production, treatment, simulation to management and image sharing.
In the same lines as the papers in this issue, we expect advances in the medical imaging fields along the following four axes:

- Image production, new modalities;
- Image processing, visualization, and system simulation;
- Image management and retrieval;
- Telemedicine.

Image production has gone a long way and in the production may lay the key for many future developments, as well. Only if the capturing devices do capture the relevant structures in sufficient detail, can image processing and analysis be used up to its full potential. PET/CT combinations have already shown how to combine structural and functional imaging. Time series MRI and CT also produce large 4D datasets allowing getting more information on moving structures such as the heart. Sometimes, even small changes such as a slightly improved resolution can help to advance the outcome of research significantly. This can also be improved by new contrast agents, for example. On the other hand, image processing needs to be adapted continually for the new images produced as the same algorithms might need different parameters once the characteristics of the images change.
The classical image processing also has many very active research domains with great potential, starting with the simulation of biological systems, or the simulation of flows, for example blood flow in aneurisms. This can help to plan interventions by simulating several stents in aneurisms and their effects on the blood flow. New computing resources and particularly grid technologies can make the computing power available to create these increasingly complex models that are often based on imaging data. Basic image processing such as exact segmentation of structures will of course be needed for many of the further steps such as simulation and also visualization.
All these new developments from image production to processing and simulation have once thing in common: They produce an increasing amount of data and an increasing complexity of data that the medical doctors need to understand and use. Getting access to the right information at the right time in the right place is thus a crucial task and image information retrieval might just help with this. Whereas first image retrieval systems mainly used very low level visual features such as grey level histograms, new systems are currently being developed for similarity based retrieval as diagnostic aid for a variety of domains (lung CT images, dermatology, …) not only relying on the images but also using structured data and free text available from the patient record to find similar cases and allow the treating physician to get access to these past data from the patient record. The management of the data in PACS systems is of course the central point of the multimedia patient record allowing access to the data in all departments. Besides radiology and increasing number of departments (Dermatology, Pathology, Ophthalmology …) are getting connected and the data gets increasingly varied. Reliability of these infrastructures also for legal reasons is extremely important once the image archive is fully in digital form. On the other hand the cost pressure in the medical domain is high, helping solutions that are at least partly build upon open source solutions, although the main cost factor is often not a single product, but the hardware and maintenance costs.
Finally, telemedicine can help to make expert knowledge available at places or at times when no experts are available. This can be particularly useful in an imaging world that is getting increasingly complex and varied for most practitioners. This can be particularly useful in

settings where experts are scarce and the infrastructure poor, such as many developing countries. On the other hand this can also be useful on a regional scale in most countries to respond to cost pressure and at the same time improve the quality through increased specialization.
All these fields have in common that a standardized evaluation is necessary to compare techniques developed in laboratories around the work and not create overly specialized solutions that will only work perfectly well for a very small number and variety of images. Accessible image databases and evaluation mechanisms need to be created and updated to really compare published results and measure the advances of the field of medical imaging and give all research groups access to these.

We would like to thank all authors for their cooperation to include quickly all the reviewers comments and produce a high-quality final version of their contribution. Then, we would of course like to thank all external reviewers for their work and all the good propositions they made. Of course, the final goal is that you, the readers will have a varied and interesting special issue that covers many aspect of the field of computerized medical imaging.

The guest editors: Henning Müller, Xiaohong Gao, Qiang Lin, Thomas M. Lehmann, Simon Thom, Paolo Inchingolo, Jyh-Cheng Chen, John Clark

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