Guest Editorial: Medical Image Understanding and Analysis

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In London in 2011, we carried on a tradition which began in Oxford in 1997, by organising the Medical Image Understanding and Analysis conference, the annual UK meeting for presenting advances in medical and biomedical image analysis. The meeting was held on the Guy’s Hospital campus in close proximity to the rapidly rising Shard tower and well-known London landmarks such as Tower Bridge, HMS Belfast and the Tower of London. Exemplifying the cross-disciplinary nature of the meeting, oral presentations and keynotes took place in the academic School of Medicine and poster sessions took place in the hospital atrium. Fifty-five papers in all were presented and we were lucky to have three excellent invited key-note speakers in the shape of Professor Daniel Rueckert, Professor Steve Williams and Mr Tom Carrell, FRCS.

After the conference, we invited authors of the best submitted papers (as judged by the reviewing panel) to submit extended versions for publication here. These papers were subject to another round of reviewing and revision to get to the final accepted versions which comprise this special issue. As usual for MIUA, the papers cover a diverse set of topics including segmentation, registration, discrimination, network analysis and atlas-construction in diverse applications such as liver, brain, histological and retinal imaging.

Three contrasting papers focus on different brain imaging applications. Janousova et al present a computationally efficient approach to biomarker discovery which they use to identify highly discriminating localised brain regions in MRI and PET of Alzheimer’s disease. This was the best-submitted paper prize-winner at MIUA 2011 and covers a topic of considerable importance to disease monitoring and therapy evaluation. At the other end of the age spectrum, Serag et al present methods to construct spatio-temporal multi-modal atlases of the fetal and neonatal brain which could be used to provide developmental standards. Finally Deligianni et al investigate the connectivity properties of the brain using
a graph-based approach applied to Diffusion Tensor Imaging, a topic of considerable current importance in advancing our understanding the macro-scale connectome. It is worth noting that all three of these papers feature first authors from Imperial College in London which is obviously a force to be reckoned with in this area.

Two papers focus on the mathematical underpinnings of medical image analysis. Vialard and Risser et al (also at Imperial College when the paper was written) present a new technique for computing representations of average organs, which builds on the established Large Deformation Diffeomorphic Metric Mapping technique. The work is evaluated in brain applications but has wider applicability and the ability to construct optimal, unbiased average shape representations is becoming one of the corner-stones of current analysis. The work of Papiez and Matuszewski moves away from the brain (and from London) to present a new algorithm for estimating consistent inverses of three-dimensional deformation fields. The technique is applied to the registration of pelvic MRI for prostate applications where substantial shape and size changes make establishing robust correspondences particularly challenging.

Other work focussing on abdominal imaging comes from Bakas et al who tackle the difficult problem of tracking and characterising focal liver lesions using contrast-enhanced ultrasound. The dynamic imaging with contrast means that the appearance of both the liver and associated lesions can vary greatly during the scan. A very different abdominal application comes from Nawaz et al who present interesting work to reduce the incidence of false positives seen in CT Colonography Computer-Aided Diagnosis systems for colorectal lesion detection. Such systems are of particular importance in improving diagnosis and minimising unnecessary patient trauma in colorectal disease.

The final two papers illustrate the diversity of material at MIUA. Cao et al present detailed work on the segmentation of microvasculature in pre- and post-operative registered retinal angiograms for which they were awarded Best Poster at MIUA 2011. This work could allow detection of temporal circulatory changes indicative of micro-embolism allowing early intervention to improve patient recovery. Leskovsky et al examine methods to extract corresponding points for registration of high-resolution histological slides – images which far exceed the resolution of standard non-invasive imaging systems. Obtaining high-quality correspondence sets is a key part of virtual microscopy systems, allowing fast navigation and automated tracking between slides to reduce operator burden and improve robustness.

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