Special Issue – Mathematical Imaging

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The multidisciplinary subject of Imaging Science concerning the generation, collection, duplication, analysis, modification, restoration, enhancement, comparison, feature extraction, and visualisation of images is developing in a rapid speed. It is increasingly used in more and more application areas, especially in cutting edge technologies. Mathematical Imaging firmly establishes mathematics as a rigorous basis for imaging science, complementing the image processing methodologies, in the discrete setting, of computer science and information science.

The Centre for Mathematical Imaging Techniques (CMIT) based at the Department of Mathematical Sciences of the University of Liverpool had the pleasure of hosting the Third International Workshop on *Image Processing Techniques and Applications, incorporating Mathematical Imaging with Biomedical Applications* during 6–8 July 2015 at CMIT. This followed two previously workshops held in CMIT, respectively, in 1997 and 2001.

The organisation committee comprises

- Ke Chen (Chair, Centre for Mathematical Imaging Techniques, University of Liverpool)
- Harish Poptani (Centre for Preclinical Imaging, University of Liverpool)
- Violaine See (Centre of Cell Imaging, University of Liverpool)
- Ian Prior (Cellular and Molecular Imaging University of Liverpool)
- Yalin Zheng (Department of Eye and Vision Science, University of Liverpool).

In this meeting, 16 international speakers gave invited presentations attended by 50 participants; see https://www.liverpool.ac.uk/cmit/workshop_15/Workshop_schedule.htm.

The selected and refereed papers were submitted by speakers and participants of this workshop. They cover new Mathematical Imaging models and algorithms. We thank the anonymous reviewers for prompt reviews and the publisher for publishing the papers in a quick way (with revisions competed in March and publications allocated in April).

Specifically, the 10 papers published in this Special Issue are concerned with these topics:

Paper 1 by Constantin Sandmann, Erlend Hodneland, Jan Modersitzki entitled "A practical guideline for t1 reconstruction from various ip angles in MRI" discusses dierent ways to stabilize and to simplify T_1 reconstruction in dynamic contrast enhanced MRI imaging and proposes a novel family of T_1 reconstruction methods for the variable flip angle technique.

Paper 2 by Da Chen, Jean-Marie Mirebeau, Laurent D Cohen entitled "Vessel tree extraction using radius-lifted keypoints searching scheme and anisotropic fast marching method" proposes a new imaging model for segmentation of a full vessel tree structure given a single initial root point.

Paper 3 by Zhanjiang Zhi, Baoli Shi, Yi Sun entitled "Primal-dual method to smoothing TV-based model for image denoising" proposes a primal dual method to solve the smoothed TV-based ROF model and gives some convergence analysis for the resulting algorithm.

Paper 4 by Bryan M Williams, Jack A Spencer, Ke Chen, Yalin Zheng, Simon Harding entitled "An effective variational model for simultaneous reconstruction and segmentation of blurred images" deals with the blind deconvolution and segmentation problem and proposes two variational models for simultaneous reconstruction and segmentation of blurred images with spatially invariant blur, without assuming a known blur or a known blur type.

Paper 5 by Bryan M Williams, Jianping Zhang, Ke Chen entitled "A new image deconvolution method with fractional regularisation" applies the fractional derivatives based (non-local) regulariser to image deblurring problem and achieves good quality restoration for both smooth and non-smooth images.

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Paper 6 by E Loli Piccolomini, E Morotti entitled "A fast TV-based iterative algorithm for digital breast tomosynthesis image reconstruction" uses a weighted smoothed version of the total variation regularization for the reconstruction of digital breast tomosynthesis images and considers an efficient implementation in the fixed point framework.

Paper 7 by Matthew D Blackledge, Mihaela Rata, Nina Tunariu, Dow-Mu Koh, Angela George, Andrea Zivi, David Lorente, Gerhardt Attard, Johann S de Bono, Martin O Leach, David J Collins entitled "Visualizing whole body treatment response heterogeneity using multi-modal magnetic resonance imaging" proposes a novel post-processing methodology, using whole-body diffusion-weighted imaging and T1-weighted contrast-enhanced imaging data, to assess whole body tumor heterogeneity in patients with metastatic disease.

Paper 8 by Jack Spencer, Ke Chen entitled "Stabilised bias field: segmentation with intensity inhomogeneity" proposes a model incorporating bias field estimation in the two-phase piecewise-constant Mumford-Shah model to segment images with intensity inhomogeneity and also considers how to extend the method to selective segmentation.

Paper 9 by Mazlinda Ibrahim, Ke Chen, Lavdie Rada entitled "An improved model for joint segmentation and registration based on linear curvature smoother" proposes a joint segmentation and registration based on active contour without edges framework. Their model using high-order regularizers allows large deformation and offers more robustness than previous work.

Paper 10 by Jianping Zhang, Ke Chen entitled "A new augmented Lagrangian primal dual algorithm for elastica regularisation" proposes a new algorithm to solve variational models with the high-order Euler elatica regularizer for both an image restoration problem and an image segmentation model. They use Legendre-Fenchel transformations to derive their new primal dual algorithm, combining with an augmented Lagrangian formulation and solving efficiently an equivalent unconstrained optimization that has fewer variables to work with than previous works based on splitting methods.

We hope you find the papers interesting to read, and look forward to the future workshops in the series.