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Guest Editorial

JMIV Special Issue Mathematics and Image Analysis

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This special issue highlights some recent developments in the field of mathematical image analysis. The emphasis of the issue is on the interplay between advanced mathematical methods (such as non smooth convex optimization, variational methods and low-complexity regularization, partial differential equations) and their application in image processing, computer vision and computer graphics. The special issue comprises nine papers which cover a wide range of topics in mathematical image analysis as outlined below.

Sparsity has become a major prior in image processing. A first series of papers composing this special issue is concerned with the development of sparsity-based mathematical methods for image processing. The paper *"Analysis of Inpainting via Clustered Sparsity and Microlocal Analysis"* (doi:10.1007/s10851-013-0422-y) by King et al. presents one of the first theoretical analysis of the performance of directional sparse representation-based image inpainting algorithms. In *"Matrix Recipes for Hard Thresholding Methods"* (doi:10.1007/s10851-013-0434-7), Kyrillidis and Cevher describe some new low-rank recovery algorithms, study their acceleration and establish their convergence guarantees. In the paper *"An Evaluation of the Sparsity Degree for Sparse Recovery with Deterministic Measurement Matrices"* (doi:10.1007/s10851-013-0453-4), Berthoumieu et al. describe a greedy algorithm to estimate the maximal sparsity level below which exact and stable recovery by ℓ_1-minimization is guaranteed, with an application to discrete tomography. By combining elements of dictionary learning and sparse representations for image patches, Salmon et al. propose a statistical Poisson noise removal algorithm for the challenging situation of photon-limited images in the paper titled *"Poisson Noise Reduction with Non-Local PCA"* (doi:10.1007/s10851-013-0435-6).

Variational methods are at the heart of several mathematical successes in image processing, in particular for inverse problems. In the paper *"Fully Smoothed ℓ_1-TV models: Bounds for the Minimizers and Parameter Choice"* (doi:10.1007/s10851-013-0420-0), Baus et al. investigate the influence of the smoothing parameters on the properties of the minimisers of a smoothed ℓ_1-TV (anisotropic) model, which enables to clearly assess the smoothing approximation. A variational problem combining two regularizing terms, the total variation and the total variation of the first derivatives of an image, is proposed, theoretically studied and numerically solved by Papafitsoros and Schönlieb in *"A Combined First and Second Order Variational Approach for Image Reconstruction"* (doi:10.1007/s10851-013-0445-4).

Applications in computer vision, computer graphics and computational geometry can gain a major benefit from a deep mathematical analysis and understanding. Using tools from PDEs and variational analysis, Valente et al. introduce

Dedicated to the memory of Vicent Caselles.

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an algorithm to explore an unknown compact environment that is guaranteed to complete exploration in a finite number of steps in the paper titled *"Information-Seeking Control Under Visibility-Based Uncertainty"* (doi:10.1007/s10851-013-0423-x). In *"Differential-Based Geometry and Texture Editing with Brushes"* (doi:10.1007/s10851-013-0443-6), Krauth et al. propose an interactive modeling framework, based on tools from differential geometry, for 3-D shapes and texture maps editing. The paper *"Feature-Preserving Surface Reconstruction and Simplification from Defect-Laden Point Sets"* (doi:10.1007/s10851-013-0414-y) by Digne et al. capitalizes on tools from the theory of optimal transportation to derive a robust and feature-capturing surface reconstruction and simplification method.

This special issue is dedicated to the memory of Vicent Caselles (August 10, 1960–August 14, 2013). Vicent Caselles has been an outstanding mathematician, with the most elegant and major contributions in image processing and computer vision. The benefits of his mathematical contributions are at the heart of those of many colleagues. Beside his top-rank theoretical work, he also contributed to many practical problems related to the area of image and video processing. Indeed, he was one of the inventors of several new mathematical methods such as geodesic snakes or inpainting. The latter has sparked a whole research direction in the community. Vicent Caselles was an extremely active researcher and animator of the mathematical image processing community, where he was a member of the editorial board of several top journals in the field among which the JMIV. Vicent Caselles has left a great scientific legacy, and the scientific community has lost a great mind.

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