Guest Editorial: Special Section on CVPR 2014

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THIS special section contains selected papers from the premier annual computer vision conference, IEEE Computer Vision and Pattern Recognition (CVPR), June, 2014, jointly sponsored by the IEEE and the Computer Vision Foundation. In 2014, there were 1,807 submissions to CVPR, from which 540 were selected for oral or poster presentation. From the accepted papers, area chairs recommended a subset that were especially appreciated by the reviewers for their technical contributions, and for their expected impacts to the field. We, program chairs from that conference, invited authors of those papers to submit a longer manuscript to this special section. The submitted papers underwent a second review process to guarantee that all papers included in this special section be rigorously peer-reviewed. As a result, seven papers were accepted for publication in this special section. These papers cover areas like 3D computer vision; computational photography, sensing and display; medical and biological image analysis; optimization methods; and physics-based vision and shape-from-X. We found these papers to be delightful, and we hope that you will, too.

The first paper, "The Information Available to a Moving Observer on Shape with Unknown, Isotropic BRDFs," authored by Manmohan Chandraker, addresses the problem of shape reconstruction of objects with unknown reflectance properties from differential stereo pairs of images. This paper, which was awarded best paper award at the CVPR 2014 conference, provides a comprehensive mathematical treatment of this subject for both perspective and orthographic cameras, deriving in particular the minimal number of images needed for surface recovery.

The second paper, "3D Shape and Indirect Appearance by Structured Light Transport," by Matthew O'Toole, John Mather, and Kiriakos N. Kutulakos, describes the design of a new structured light imaging sensor that allows to manipulate the flow of direct and indirect light and recover 3D shape. The key idea behind this paper, which received the best paper award honorable mention at the CVPR 2014 conference, is that only direct light in a projector-camera pair obeys the epipolar geometry and that it can be separated from indirect light by optically controlling the contribution of different light paths. This is physically realized through the combination of a high speed programmable projector and a programmable sensor mask at the video camera.

The third paper, "Reflectance and Fluorescence Spectral Recovery via Actively Lit RGB Images," authored by Ying Fu, Antony Lam, Imari Sato, Takahiro Okabe, and Yoichi Sato, considers objects whose bounding surfaces combine reflectance and fluorescent properties. Unlike ordinary specular surfaces, which reflect light of the same wavelength as the incoming light, fluorescent surfaces emit light of higher wavelengths than the incoming light. The paper uses invariance properties to derive an algorithm for recovering the reflectance and fluorescent chromaticity of objects from RGB images obtained under varied colored illuminants.

The fourth paper, "Multiscale Centerline Detection," authored by Amos Sironi, Engin Türetken, Vincent Lepetit, and Pascal Fua, provides an algorithm for detecting the centerline and radius of linear structures, such as road and rivers in images, or axons and dendrites in image stacks. Other methods use hand designed filters or classification approaches, while this paper uses a regression formulation, which is shown to provide better performance for the given problem. Using a boosting algorithm, a regressor is trained to estimate the distance of pixels to nearby centerlines in scale space, and the centerlines are then found as local maxima in the estimated distance map.

The fifth paper, "Lifting Object Detection Datasets into 3D," is authored by Joao Carreira, Sara Vicente, Lourdes Agapito and Jorge Batista. It defines an innovative algorithm to recover the 3D shape of an object from 2D images. The proposed algorithm estimates the camera model with structure-from-motion methods, facilitating the estimation of the object's 3D shape by filling in the visual hull that maximizes within-class similarity. These results are significant because they provide a new mechanism to enhance object recognition algorithms without the use of specific 3D cameras or manual annotations of large numbers images.

The sixth paper "Dictionary learning for sparse coding: Algorithms and analysis" by Chenglong Bao, Hui Ji, Yuhui Quan and Zuowei Shen, presents an approach to sparse dictionary learning that is guaranteed strong convergence in short running times. Specifically, the authors combine a multi-block hybrid proximal alternating iteration scheme with the acceleration technique of K-SVD, yielding this much sought out solution. These results are important in a varitey of computer vision and image processing problems, e.g., object recognition and image restoration.

The last paper, "Partial Optimality by Pruning for MAP-Inference with General Graphical Models," authored by Paul Swoboda, Alexander Shekhovtsov, Jorg Hendrik Kappes, Christoph Schnörr, and Bogdan Savchynskyy, introduces a novel polynomial time algorithm to obtain an optimal non-relaxed integral solution of the energy minimization problem in undirected graphical models. The original problem is NP-hard, but the authors propose a clever work around by defining a convex relaxation of the cost function. The proposed solution is shown to work in high-order models and a variety of applications.

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The guest editors would like to thank all the authors for their valuable contributions to this special section. They also thank the reviewers of these manuscripts, who made many helpful suggestions for changes to the papers. They also thank the editorial staff of *IEEE Transactions on Pattern Analysis and Machine Intelligence* for their support. We hope that the papers selected in this special section will become useful resources for researchers and practitioners in computer vision, pattern recognition, and beyond.

Ronen Basri received the BSc degree in mathematics and computer science from Tel Aviv University in 1985 and the PhD degree from the Weizmann Institute of Science in 1991. He spent two years as a postdoctoral fellow in the Massachusetts Institute of Technology at the Department of Brain and Cognitive Science and the Artificial Intelligence Laboratory, after which he joined the Department of Computer Science and Applied Mathematics, Weizmann Institute of Science, where he currently is a professor. His research in computer vision has focused on the areas of object recognition, shape reconstruction, lighting analysis, and image segmentation. His work deals with the design of algorithms, analysis, and implications to human vision.

Cornelia Fermüller received the PhD degree from the Vienna University of Technology in 1993 and the MS degree from the Graz University of Technology, Austria, in 1989, both in applied mathematics. She is a research scientist at the University of Maryland Institute for Advanced Computer Studies, and her research interests include the areas of computer vision, robotics, and human vision. She studies principles of active vision systems and develops biological-inspired algorithms that cover the areas of visual motion, stereo, shape, texture, and action recognition. Her recent work has focused on interpreting human actions through the integration of perception, action, language, and reasoning. She is a member of the IEEE.

Aleix M. Martinez is a professor in the Department of Electrical and Computer Engineering at The Ohio State University (OSU), where he is the founder and director of the the Computational Biology and Cognitive Science Lab. He is also affiliated with the Department of Biomedical Engineering and the Center for Cognitive and Brain Sciences, where he is a member of the executive committee. Prior to joining OSU, he was affiliated with the Electrical and Computer Engineering Department, Purdue University and with the Sony Computer Science Lab. He has served as an associate editor of *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *IEEE Transaction on Affective Computing*, *Computer Vision and Image Understanding*, and *Image and Vision Computing*. He has been an area chair in many major conferences and was a program chair of CVPR 2014. He is also a member of the Cognition and Perception study section at NIH. He is most known for his face perception work, having defined the problems of occlusion, expression-invariance and compound emotions, and his discriminant analysis algorithms.

René Vidal received the BS degree in electrical engineering (valedictorian) from the Pontificia Universidad Católica de Chile in 1997, and the MS and the PhD degrees in electrical engineering and computer sciences from the University of California at Berkeley in 2000 and 2003, respectively. He has been a faculty member in the Department of Biomedical Engineering of The Johns Hopkins University since 2004. He is a coauthor of the book "*Generalized Principal Component Analysis*", coeditor of the book "*Dynamical Vision*" and has coauthored more than 200 articles in biomedical image analysis, computer vision, machine learning, hybrid systems, and robotics. He has been an associate editor of the *IEEE Transactions on Pattern Analysis and Machine Intelligence*, the *SIAM Journal on Imaging Sciences,* and the *Journal of Mathematical Imaging and Vision*, a program chair for ICCV 2015, CVPR 2014, WMVC 2009, and PSIVT 2007, and an area chair for MICCAI 2013 and 2014, ICCV 2007, 2011, and 2013, and CVPR 2005 and 2013. He has received many awards for his work including the 2012 J.K. Aggarwal Prize, the 2009 ONR Young Investigator Award, the 2009 Sloan Research Fellowship, the 2005 NFS CAREER Award, and best Paper Awards at ICCV-3DRR 2013, PSIVT 2013, CDC 2012, MICCAI 2012, CDC 2011, and ECCV 2004. He is a fellow of the IEEE and a member of the ACM and SIAM.