applied optics

Imaging systems and signal recovery: introduction to feature issue

Edmund Y. Lam,[1,*] Gisele Bennett,[2] Christy Fernandez-Cull,[3] David Gerwe,[4] Michael Kriss,[5] and Zeev Zalevsky[6]

[1]Department of Electrical and Electronic Engineering, The University of Hong Kong, Pokfulam, Hong Kong
[2]Georgia Tech Research Institute, Georgia Institute of Technology, 925 Dalney Street, Atlanta, Georgia 30332, USA
[3]Lincoln Laboratory, Massachusetts Institute of Technology, 244 Wood Street, Lexington, Massachusetts 02420, USA
[4]Boeing Phantom Works Advanced Space and Network Systems, 700 N. Sepulveda Blvd., El Segundo, California 90245, USA
[5]MAK Consultants, 506 NE 193rd Avenue, Camas, Washington 98607, USA
[6]Faculty of Engineering, Bar Ilan University, Ramat-Gan 5290002, Israel
*Corresponding author: elam@eee.hku.hk

Received 2 April 2015; posted 2 April 2015 (Doc. ID 237492); published 24 April 2015

Imaging systems and signal recovery algorithms have a wide range of applications, from industrial to military, and from consumer electronics to medical instrumentations. Advancement in this field involves both basic science and applied multidisciplinary engineering capabilities. This issue brings together academic researchers and practitioners to show how different imaging hardwares and signal processing techniques combine to determine the overall system performance; together, they underscore an important trend in a closer integration between algorithms and systems design.

OCIS codes: (110.1758) Computational imaging; (110.0110) Imaging systems; (110.3010) Image reconstruction techniques; (100.3020) Image reconstruction-restoration; (100.3190) Inverse problems.

http://dx.doi.org/10.1364/AO.54.000IS1

This feature issue follows up on the OSA Imaging and Applied Optics Congress, held in Seattle, Washington during 13–17 July 2014. Organizers from two of the topical meetings, namely, Signal Recovery and Synthesis (SRS) and Imaging Systems and Applications (IS), join hands in guest editing this feature issue. While it intends to encourage authors from these two meetings to elaborate on their technical work, it is also open to any researcher to report on developments in imaging systems and signal recovery.

Altogether, this feature issue contains 13 articles covering a wide array of topics. Several of them focus on the design and analysis of various imaging systems. Gerwe *et al.* conduct a thorough investigation on the effect of noise on image quality, using a visual information fidelity metric. Jain provides a theoretical study on the modulation transfer function of an ideal one-dimensional image sensor, and investigates in particular the effects of imaging periodic patterns. A number of articles deal with specific imaging applications. Pourhassan *et al.* design a two-mirror telescope, and correct the third-order aberrations through Seidel sum and wavefront reconstruction using Zernike polynomials. Meanwhile, Chiu *et al.* provide detailed analysis of a full-field reflection-type microscope, intended for use in measuring the three-dimensional surface profile of an object. Concerning industrial applications, Ahadi and Saghir tackle the glass wall effect in temperature measurement of transparent fluid using optics. Their solution involves a modification to the Mach–Zehnder interferometer design and further image processing. Eckhard *et al.* acquire spectral reflectance data in outdoor environment, using a commercial Bragg-grating-based hyperspectral imager. They estimate the focus position and exposure time, and the data are then processed to provide proper scaling and image registration. Meanwhile, Lassen *et al.* develop a method to suppress ambient noise in a photoacoustic sensor, and thus enhancing its sensitivity. It involves simple processing of two signals captured out of phase. As for medical applications, Jung *et al.* design a noncontact, wide-field, near-infrared (NIR) optical imaging system using a cost-effective LED light source. They extract spatiotemporal features using singular value decomposition, which are used for noninvasive tissue imaging.

Meanwhile, focusing more on the signal analysis front, Gitin and Kalashnikov enrich the arsenal of image analysis tools with new developments involving the Wigner distribution function (WDF). They show that while positive lenses lead to circular rotation of the WDF, negative lenses are similarly associated with its hyperbolic rotation. On the other hand, Li and Xiao propose hardware implementation of a parallel fast Fourier transform using a graphics processing unit (GPU).

The acceleration facilitates the Fourier transform hyperspectral imaging, and is shown to increase its temporal resolution. Advanced signal processing algorithms are shown to benefit imaging systems in a number of ways. For instance, in denoising, Aum *et al.* are concerned with speckle noise suppression in optical coherence tomography (OCT) images, which are routinely used in retinal imaging. They use nonlocal means filtering, but replace the original Gaussian kernel with an adaptive kernel. In superresolution, Wagner *et al.* study the classical problem of resolution enhancement based on multiple captures of low-resolution images in a diffraction-limited system. They modify the imaging system to involve projecting a set of unknown speckle patterns on the object, followed by iterative reconstruction of the high-resolution image. Counterfeit detection is one of the newer applications of imaging. One such application that involves both algorithm and system designs is the work of Mahmood *et al.*, which aims to authenticate integrated circuits nondestructively. Their design uses x-ray microscopy, followed by a pattern recognition algorithm using a local binary pattern as features and deep neural network as the classifier.

We hope this feature issue will inspire further work and collaboration in imaging systems and algorithm design, and will pave the way for another successful OSA Imaging and Applied Optics Congress, to be held in Arlington, Virginia in June 2015.