

Enhanced Spatial Resolution for Capture and Display of Images

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Abstract:

In the first part of the talk, we present a solution to the problem of optimal color filter array design, from the point of view of jointly minimizing spatial and spectral information loss. We show (1) how to quantify the information loss associated with color image acquisition; (2) how to analyze the fundamental limitations to subsequent processing imposed by current hardware; (3) how to design new color filter arrays that minimize these losses and limitations; and (4) how to achieve corresponding gains in image quality through fast linear reconstruction algorithms. The methodologies we present define a new paradigm for capture, processing, and display of color images that will significantly reduce hardware complexity in applications such as digital still and video cameras, while at the same time improving output color image quality. We also present evidence that this optimality framework applies equally well to the design of high-resolution color display devices.

The second part of the talk is concerned with the image sensor measurements subject to degradation caused by the photon and electron leakage. The color image data acquired via a color filter array is vulnerable to the ambiguation between neighboring pixels that measure different portions of the visible spectrum. This so-called "cross-talk" phenomenon is expected to become more severe as the electronics industry's trend to shrink the device footprint continues because the pixel sensors are more densely packed together. We show that an analysis of the mechanism underlying the cross-talk problem is surprisingly straightforward. Our comprehensive analysis admits a simple and effective color correction scheme for a given choice of color filter array in a digital camera.

(in collaboration with Patrick J. Wolfe)

Biography:

Keigo Hirakawa received the B.S.E. degree in electrical engineering from Princeton University, Princeton, NJ, in 2000, the M.S. and Ph.D. degrees in electrical and computer engineering from Cornell University, Ithaca, NY, in 2003 and 2005, respectively, and the M.M. degree in Jazz Performance from the New England Conservatory of Music, Boston, MA, in 2006. He is currently with the School of Engineering and Applied Sciences and the Department of Statistics at Harvard University, where he co-leads a collaboration with Sony Electronics, Inc. He has previously been an ASIC engineer and principal image scientist for the camera division

of Hewlett-Packard/Agilent Technologies, and his past and current collaborations with camera manufacturers include Sony, Micron, Texas Instruments, and NEC. Hirakawa has received a Lockheed Martin fellowship award (2001) and a DoCoMo innovative paper award (jointly with Prof. Wolfe; IEEE ICIP 2007). His research focuses on statistical signal processing, color imaging, and computer vision.