Image and Signal Processing Laboratory -KLab-

Hisakazu Kikuchi, Professor
IEICE Fellow
Department of Electrical and Electronic Engineering
Niigata University
http://telecom0.eng.niigata-u.ac.jp/?FrontPage

I. Introduction

THE borderless penetration of image/video transmission and archiving is a tidal tendency in modern applications. High-reality image communications are demanded by professional experts and the general public.

Some important imaging technologies have been emerged and are in progress for higher reality and deeper impression. Multi-spectral or many-primary color imaging is studied for wide-gamut color reproduction. Since the advent of super high-definition (SHD) imagery, spatial resolution and bit depth of color components are increasing; 2K/4K/8K-pixel/line in digital cinema, 40K-pixel/line for virtual slides in coming telepathology. High-dynamic range (HDR) image applications are expansive over many fields including entertainment, medicine, and archiving. High-speed CMOS image sensors allow to capture a sequence of images at a thousand frames per second or more. All of these issues increase the data rates of digital images and their quality demands innovations in image processing technology.

II. Fields of Research

- Image/Video Coding
- Image/Video Analysis and Processing
- Color Demosaicing and Digital Halftoning
- Digital Signal Processing

A few topics are briefed in the following sections.

III. Personnel of KLab in 2009

- 6 PhD students (3-year course)
- 10 Master students (2-year course)
- 6 Bachelor students

The above numbers apply to a strict sense of KLab. Greater KLab is operated with the other three faculties: Prof. S. Sasaki in wireless communication systems, Assoc. Prof. S. Muramatsu in image coding/DSP/VLSI implementations, and Assoc. Prof. M. Yukawa in adaptive signal processing. As a result, Greater KLab including ten overseas students is of quite a large scale and scope.

IV. Image/Video Coding

Various types of image contents including color images, (high dynamic range) grayscale images, color-quantized images, bilevel document images, and halftone images are compressed with the *simple bit-plane coding* in reasonable power consumption. Major functionalities include progressive transmission/decoding, selectable tile-partitioning, arbitrarily shaped ROI (See Fig. 1), pixel accuracy scalability before encoding, and repetition resilience against near lossless compression. *Bit modeling by pixel value estimates* is the new context modeling and helps adaptive binary arithmetic coding to work efficiently. (See Table I)

TABLE I
Profile Comparison among Major Standard Codecs.

Item	SBC	JPEG 2000	JPEG-LS	JBIG2
Power consumption	⍟⍟⍟	⍟	⍟⍟⍟⍟	⍟
Functionality	⍟⍟⍟⍟	⍟⍟⍟⍟	⍟	⍟⍟
Color images	⍟⍟⍟	⍟⍟⍟	⍟⍟⍟	⍟
Color-quantized images	⍟⍟⍟⍟	⍟	⍟⍟	⍟⍟
Bilevel images	⍟⍟⍟	⍟	⍟⍟	⍟⍟⍟⍟
Halftone images	⍟⍟⍟⍟	⍟	⍟	⍟⍟⍟⍟

Marks imply; ⍟⍟⍟⍟ excellent, ⍟⍟⍟ good, ⍟⍟ fair, and ⍟ poor.

Fig. 1. Arbitrarily shaped ROI transmission. Original and ROI-decoded.

V. Color Demosaicing

Scenes and portraits are imaged onto an image sensor equiped with a color filter array in single-chip digital cameras. The most popular CFA consists of a periodic 4-pixel block where two pixels are for green and the other two pixels are for red and blue, respectively. Hence two thirds of color values on pixels are missing and they have to be estimated to generate natural color images. For high-quality color demosaicing, edge directions are estimated around local neighborhoods and color values are corrected in the hue vector field. The method outperforms the other existing ones at present. (Figs. 2 & 3)

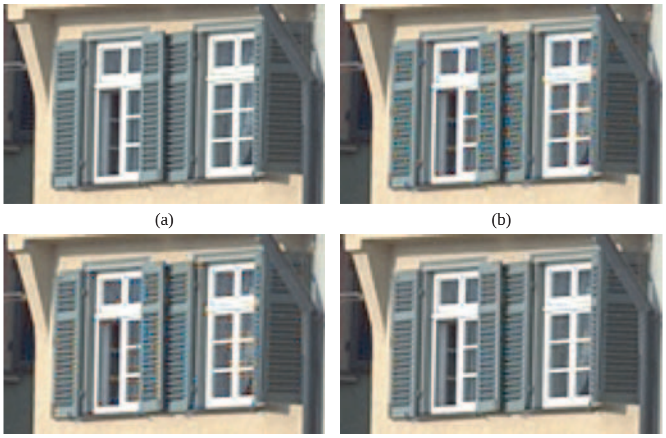

Fig. 2. Visual appearance of the color reproduction. (a) Original. (b) ACPI. (c) PCSD. (d) Proposed.

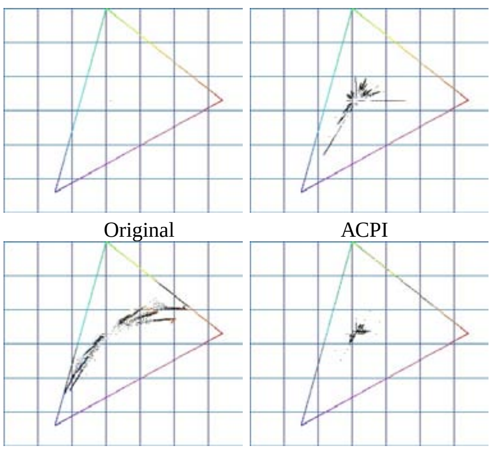

Fig. 3. False color distribution in CIE 1931 chromaticity diagram. The test image is *square snake*, a rectangular-spiral gradation of gray tones.

VI. Medical Image Analysis

A project on histopathological image analysis for the classification of borderline grades of oral cancer is conducted as a joint study with Division of Oral Pathology, Graduate School of Medical and Dental Sciences, Niigata University. For accurate and objective diagnosis of the borderline malignancies, a new method has been developed based on a comparison of the elevation levels in the drop shape between *twin-pairs* of neighboring rete ridges (See Fig. 4). It is also possible to investigate the single layer of basal cells which tend to densely align against the interior boundary of the rete ridge.

Fig. 4. A pair of rete ridge twins in epithelial hyperplasia.

VII. Selected Papers

Journal Papers

[1] M.M. Sami, H. Kikuchi, T. Saku, et al., "Twin-pair rete ridge analysis: a computer-aided method for facilitating objective histopathological distinction between epithelial dysplasia and carcinoma in-situ of the oral mucosa," *Oral Medicine & Pathology,* Vol. 14, pp. 81–89, Jan. 2010.

[2] M.M. Sami, M. Saito, H. Kikuchi, and T. Saku, "A Computer-Aided Distinction of Borderline Grades of Oral Cancer," *IEEE ICIP 2009,* pp. 4205–4208, Cairo, Egypt, Nov. 2009.

[3] M. Hiki, S. Muramatsu, and H. Kikuchi, "Motion-Compensated Spatio-Temporal Non-separable Filtering for Scalable Video Coding," *J. ITE,* Vol. 63, No. 11, pp. 1604–1610, Nov. 2009.

[4] K. Shinoda, H. Kikuchi, and S. Muramatsu, "Lossless-by-lossy coding for scalable lossless image compression," *IEICE Trans. Fundamentals,* Vol. E91-A, No. 11, pp. 3356–3364, Nov. 2008.

[5] Y. Takahashi, K. Hiraki, H. Kikuchi, and S. Muramatsu, "Color demosaicing using asymmetric directional interpolation and hue vector smoothing," *IEICE Trans. Fundamentals,* Vol. E91-A, No. 4, pp. 978–986, Apr. 2008.

[6] H. Kikuchi, A. Iijima, S. Muramatsu and S. Sasaki, "Luma-based directional copy interpolation for color bilevel AM halftoning for printing," *IEICE Electronics Express,* Vol. 5, No. 5, pp.170–175, Mar. 2008.

[7] K. Hiraki, Y. Takahashi, H. Kikuchi, and S. Muramatsu, "Color demosaicing that takes care of local areas rich in high spatial frequencies," *J. ITE,* Vol. 61, No. 8, pp. 1209–1217, Aug. 2007.

[8] M. Hiki, S. Muramatsu, T. Ishida, and H. Kikuchi, "Equivalent parallel structure of deinterlacer banks and its application to optimal bit-rate allocation," *IEICE Trans. on Fundamentals,* Vol. E90-A, No. 3, pp. 642–650, Mar. 2007.

[9] K. Shinoda, H. Kikuchi, and S. Muramatsu, "A lossless-by-lossy approach to lossless image compression," *IEEE ICIP 2006,* pp. 2265–2268, Atlanta, Oct. 2006.

[10] T. Ishida, S. Muramatsu and H. Kikuchi, "Motion-JPEG2000 Codec Compensated for Interlaced Scanning Videos," *IEEE Trans. Image Proc.,* Vol. 14, No. 12, pp. 2179–2191, Dec. 2005.

[11] Y. Takahashi, H. Kikuchi, S. Muramatsu, Y. Abe, and N. Mizutani, "A New Color Demosaicing Method Using Asymmetric Average Interpolation and Its Iteration," *IEICE Trans. on Fundamentals,* Vol. E88-A, No. 8, pp. 2108–2116, Aug. 2005.

[12] S. Hasebe, M. Nagumo, S. Muramatsu, and H. Kikuchi, "Two-Step Detection of Video Shot Boundaries in a Wavelet Transform Domain," *J. Inst. Image Electronics Engineers of Japan,* Vol. 34, No. 1, pp. 17–26, Jan. 2005.

Hisakazu Kikuchi received B.E. and M.E. degrees from Niigata University, Niigata, in 1974 and 1976, respectively, and Dr. Eng. degree in electrical and electronic engineering from Tokyo Institute of Technology, Tokyo, in 1988. From 1976 to 1979 he worked at Information Processing Systems Laboratory, Fujitsu Ltd., Tokyo. Since 1979, he has been with Niigata University, where he is Professor in Department of Electrical and Electronic Engineering.

During the 1992 academic year, he was a visiting scholar in Electrical Engineering Department, University of California, Los Angeles. He holds a visiting professorship at Chongqing University of Posts and Telecommunications and Nanjing University of Information Science and Technology, both in China, since 2002 and 2005, respectively. His research interests include digital signal processing and image/video processing.

He is a Fellow of IEICE and a Member of ITE, IIEEJ, and IEEE. He served the chair of Circuits and Systems Group, IEICE, in 2000 and the general chair of Digital Signal Processing Symposium, IEICE, in 1998 and Karuizawa Workshop on Circuits and Systems, IEICE, in 1996, respectively.