

Image Quality and System Performance VI

Susan P. Farnand Frans Gaykema Editors

19–21 January 2009 San Jose, California, USA

Sponsored and Published by IS&T—The Society for Imaging Science and Technology SPIE

Volume 7242

Proceedings of SPIE, 0277-786X, v. 7242

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publishers are not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in Image Quality and System Performance VI, edited by Susan P. Farnand, Frans Gaykema, Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 7242, Article CID Number (2009).

ISSN 0277-786X ISBN 9780819474926

Copublished by SPIE P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445 SPIE.org and IS&T—The Society for Imaging Science and Technology 7003 Kilworth Lane, Springfield, Virginia, 22151 USA Telephone +1 703 642 9090 (Eastern Time) · Fax +1 703 642 9094 imaging.org

Copyright © 2009, Society of Photo-Optical Instrumentation Engineers and The Society for Imaging Science and Technology.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by the publishers subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/09/\$18.00.

Printed in the United States of America.

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

xi Conference Committee

SESSION 1 IMAGE QUALITY STANDARDS FOR PRINT

- 7242 02 Characteristic measurements for the qualification of reflection scanners in the evaluation of image quality attributes (Invited Paper) [7242-01]
 E. K. Zeise, Eastman Kodak Co. (United States)
- 7242 03 INCITS W1.1 standards for perceptual evaluation of text and line quality [7242-02]
 E. N. Dalal, Xerox Corp. (United States); E. H. Barney Smith, Boise State Univ. (United States);
 F. Gaykema, Océ-Technologies B.V. (Netherlands); A. Haley, Monotype Imaging (United States); K. Kirk, Xerox Corp. (United States); D. Kozak, M. Robb, Lexmark International (United States); T. Qian, Brady Corp. (United States); M.-K. Tse, Quality Engineering Associates (United States)
- W1.1 macro uniformity [7242-03]
 D. R. Rasmussen, Xerox Corp. (United States); F. Gaykema, Océ-Technologies B.V. (Netherlands); Y. S. Ng, Eastman Kodak Co. (United States); K. D. Donohue, Univ. of Kentucky (United States); W. C. Kress, Toshiba America DSE (United States); S. Zoltner, Xerox Corp. (United States)
- 7242 05 Measurement of contributing attributes of perceived printer resolution [7242-04] E. K. Zeise, Eastman Kodak Co. (United States); S. H. Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); B. E. Cooper, Lexmark International, Inc. (United States); F. Sigg, Rochester Institute of Technology (United States)

SESSION 2 IMAGE QUALITY STANDARDS FOR CAPTURE AND DISPLAY

- Softcopy quality ruler method: implementation and validation (Invited Paper) [7242-05]
 E. W. Jin, B. W. Keelan, J. Chen, Aptina Imaging, LLC (United States); J. B. Phillips, Eastman Kodak Co. (United States); Y. Chen, Vista Point Technology (United States)
- 7242 07 Correlating objective and subjective evaluation of texture appearance with applications to camera phone imaging [7242-06]
 J. B. Phillips, S. M. Coppola, Eastman Kodak Co. (United States); E. W. Jin, Aptina Imaging, LLC (United States); Y. Chen, J. H. Clark, Vista Point Technologies (United States); T. A. Mauer, Hewlett-Packard (United States)
- 7242 08 Imaging performance taxonomy [7242-07]
 D. Williams, Image Science Associates (United States); P. D. Burns, Carestream Health, Inc. (United States); L. Scarff, Vistapoint Technologies (United States)
- 7242 09 Extended use of ISO 15739 incremental signal-to-noise ratio as reliability criterion for multiple-slope wide dynamic range image capture [7242-08] D. Hertel, Sensata Technologies, Inc. (United States)

SESSION 3 SUBJECTIVE IMAGE QUALITY EVALUATION METHODOLOGY I

- 7242 0A Web-based psychometric evaluation of image quality [7242-09]
 I. Sprow, Z. Barańczuk, T. Stamm, P. Zolliker, EMPA—Swiss Federal Lab. for Materials Testing and Research (Switzerland)
- 7242 0B Development of a balanced test image for visual print quality evaluation [7242-10]
 H. Salmi, R. Halonen, Helsinki Univ. of Technology (Finland); T. Leisti, Univ. of Helsinki (Finland);
 P. Oittinen, H. Saarelma, Helsinki Univ. of Technology (Finland)
- 7242 0C **Perceptual image attribute scales derived from overall image quality assessments** [7242-11] K. H. Oh, S. Triantaphillidou, R. E. Jacobson, Univ. of Westminster (United Kingdom)

SESSION 4 SUBJECTIVE IMAGE QUALITY EVALUATION METHODOLOGY II

- Subjective experience of image quality: attributes, definitions, and decision making of subjective image quality [7242-12]
 T. Leisti, J. Radun, T. Virtanen, Univ. of Helsinki (Finland); R. Halonen, Helsinki Univ. of Technology (Finland); G. Nyman, Univ. of Helsinki (Finland)
- Toward an automatic subjective image quality assessment system [7242-13]
 M. Chambah, S. Ouni, M. Herbin, Univ. de Reims Champagne-Ardenne (France);
 E. Zagrouba, Institut Supérieur d'Informatique (Tunisia)
- 7242 0G Methods for measuring display defects as correlated to human perception [7242-35] H. Kostal, G. Pedeville, R. Rykowski, Radiant Imaging, Inc. (United States)

SESSION 5 IMAGE QUALITY ATTRIBUTES CHARACTERIZATION AND MEASUREMENT I

- 7242 OH A strobe-based inspection system for drops-in-flight [7242-15] Y. Kipman, P. Mehta, K. Johnson, ImageXpert, Inc. (United States)
- 7242 01 Image on paper registration measurement and analysis: determining subsystem contributions from a system level measurement [7242-16] R. Kulkarni, A. Islam, D. Costanza, Xerox Research Ctr. Webster (United States)
- 7242 OJ **Effect of image path bit depth on image quality** [7242-17] E. Bernal, R. P. Loce, Xerox Corp. (United States)

SESSION 6 IMAGE QUALITY ATTRIBUTES CHARACTERIZATION AND MEASUREMENT II

- 7242 0K **Determination of optimal coring values from psychophysical experiments** [7242-18] H. J. Park, Z. Pizlo, J. P. Allebach, Purdue Univ. (United States)
- 7242 OL Detection of worms in error diffusion halftoning [7242-19] M. Pedersen, Gjøvik Univ. College (Norway); F. Albregtsen, Univ. of Oslo (Norway); J. Y. Hardeberg, Gjøvik Univ. College (Norway)

7242 OM Characterization of '2D noise' print defect [7242-20]

K.-Y. Lee, Y. Bang, H.-K. Choh, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)

7242 ON Measurement of printer MTFs [7242-21] A. J. Lindner, Ecole Polytechnique Fédérale de Lausanne (Switzerland), Institut TELECOM, CNRS, TELECOM ParisTech (France), and Océ Print Logic Technologies (France); N. Bonnier, Institut TELECOM, CNRS, TELECOM ParisTech (France) and Océ Print Logic Technologies (France); C. Leynadier, Océ Print Logic Technologies (France); F. Schmitt, Institut TELECOM, CNRS, TELECOM ParisTech (France)

SESSION 7 **OBJECTIVE METRICS OF PERCEPTUAL IMAGE QUALITY I**

- 7242 00 Image quality assessment by preprocessing and full reference model combination [7242-22] S. Bianco, G. Ciocca, F. Marini, R. Schettini, Univ. degli Studi di Milano-Bicocca (Italy)
- 7242 OP Image quality assessment with manifold and machine learning [7242-23] C. Charrier, G. Lebrun, O. Lezoray, GREYC, Univ. de Caen Basse-Normandie, CNRS (France)
- 7242 0Q Three-component weighted structural similarity index [7242-24] C. Li, Jiangnan Univ. (Ching) and The Univ. of Texas at Austin (United States); A. C. Bovik, The Univ. of Texas at Austin (United States)
- 7242 OR An image similarity metric based on quadtree homogeneity analysis [7242-25] E. P. Lam, T. N. Luong, M. P. Miller, F. Tom, Thales Raytheon Systems (United States)

SESSION 8 **OBJECTIVE METRICS OF PERCEPTUAL IMAGE QUALITY II**

7242 OS Most apparent distortion: a dual strategy for full-reference image quality assessment [7242-26]

E. C. Larson, D. M. Chandler, Oklahoma State Univ. (United States)

- 7242 OT Low level features for image appeal measurement [7242-27] P. Obrador, Telefonica Research Lab. (Spain); N. Moroney, Hewlett-Packard Labs. (United States)
- 7242 OU SCID: full reference spatial color image quality metric [7242-28] S. Ouni, M. Chambah, M. Herbin, Univ. de Reims Champagne Ardenne (France); E. Zagrouba, Institut Supérieur d'Informatique (Tunisia)
- 7242 OV An evaluation of interactive image matting techniques supported by eye tracking [7242-29] C. Rhemann, M. Gelautz, B. Fölsner, Vienna Univ. of Technology (Austria)

SYSTEM PERFORMANCE: ADVANCED DISPLAY TECHNOLOGIES SESSION 9

7242 OW Perception of detail in 3D images [7242-30] I. Heynderickx, Philips Research Labs, (Netherlands) and Delft Univ. of Technology (Netherlands); R. Kaptein, Philips Research Labs. (Netherlands)

7242 0X **Perception of time variable quality of scene objects** [7242-45] L. A. Rønningen, E. Heiberg, Norwegian Univ. of Science and Technology (Norway)

SESSION 10 SYSTEM PERFORMANCE: CAPTURE AND DISPLAY

- 7242 OY **Scanner image quality profiling** [7242-32] C. Cui, Lexmark International, Inc. (United States)
- 7242 0Z Weighting of field heights for sharpness and noisiness [7242-33] B. W. Keelan, E. W. Jin, Aptina Imaging, LLC (United States)
- Identification of image attributes that are most affected with changes in displayed image size [7242-34]
 J. Y. Park, S. Triantaphillidou, R. E. Jacobson, Univ. of Westminster (United Kingdom)
- 7242 11 Simulation of film media in motion picture production using a digital still camera [7242-50] A. M. Bakke, J. Y. Hardeberg, S. Paul, Gjøvik Univ. College (Norway)

SESSION 11 SYSTEM PERFORMANCE: MOBILE PHONES AND CMOS CAMERAS

7242 12 Method for measuring the objective quality of the TV-out function of mobile handsets [7242-36]

M. Nuutinen, P. Oittinen, Helsinki Univ. of Technology (Finland)

- 7242 13 Applying image quality in cell phone cameras: lens distortion [7242-37] D. Baxter, STMicroelectronics (United Kingdom); S. R. Goma, M. Aleksic, AMD (Canada)
- 7242 14 Low light performance of digital cameras [7242-38]
 B. Hultgren, Image Integration, Inc. (United States); D. Hertel, Sensata Technologies, Inc. (United States)
- 7242 15 Color-blotch noise characterization for CMOS cameras [7242-39] R. Safaee-Rad, M. Aleksic, AMD (Canada)
- Photo-response non-uniformity error tolerance testing methodology for CMOS imager systems [7242-40]
 B. McCleary, A. Ortega, Univ. of Southern California (United States)

SESSION 12 SYSTEM PERFORMANCE: VIDEO

- 7242 17 Improved video image by pixel-based learning for super-resolution [7242-41]
 K. Kamimura, N. Tsumura, T. Nakaguchi, Chiba Univ. (Japan); H. Motomura, Panasonic Corp. (Japan); Y. Miyake, Chiba Univ. (Japan)
- 7242 18 Subjective video quality comparison of HDTV monitors [7242-42] G. Seo, C. Lim, S. Lee, C. Lee, Yonsei Univ. (Korea, Republic of)

- 7242 19 **Constructing a metrics for blur perception with blur discrimination experiments** [7242-43] C.-C. Chen, K.-P. Chen, C.-H. Tseng, National Taiwan Univ. (Taiwan); S.-T. Kuo, K.-N. Wu, Industrial Technology Research Institute (Taiwan)
- 7242 1A Objective perceptual picture quality measurement method for high-definition video based on full reference framework [7242-44]
 O. Sugimoto, S. Naito, S. Sakazawa, A. Koike, KDDI R&D Labs., Inc. (Japan)
- Motion blur perception considering anisotropic contrast sensitivity of human visual system
 [7242-46]
 S. Nakagawa, T. Nakaguchi, N. Tsumura, Y. Miyake, Chiba Univ. (Japan)

INTERACTIVE PAPER SESSION

- A geometry calibration and visual seamlessness method based on multi-projector tiled display wall [7242-47]
 Y. Liu, Beijing Univ. of Posts and Telecommunications (China) and Beijing Information Science and Technology Univ. (China); Q. Jia, H. Sun, Beijing Univ. of Posts and Telecommunications (China); J. Su, Harbin Univ. of Science and Technology (China) and Harbin Engineering Univ. (China); J. Zhang, Beijing Univ. of Posts and Telecommunications (China)
- 7242 1D A facial expression image database and norm for Asian population: a preliminary report [7242-48]

C.-C. Chen, National Taiwan Univ. (Taiwan); S. Cho, Fu-Jen Catholic Univ. (Taiwan); K. Horszowska, M.-Y. Chen, C.-C. Wu, National Taiwan Univ (Taiwan); H.-C. Chen, National Taiwan Normal Univ. (Taiwan); Y.-Y. Yeh, C.-M. Cheng, National Taiwan Univ. (Taiwan)

Author Index

Conference Committee

Symposium Chairs

Nitin Sampat, Rochester Institute of Technology (United States) Jan P. Allebach, Purdue University (United States)

Conference Chairs

Susan P. Farnand, Rochester Institute of Technology (United States) Frans Gaykema, Océ-Technologies B.V. (Netherlands)

Program Committee

Peter D. Burns, Carestream Health, Inc. (United States)
Majed Chambah, Université de Reims Champagne-Ardenne (France)
Luke C. Cui, Lexmark International, Inc. (United States)
Mark D. Fairchild, Rochester Institute of Technology (United States)
Jason E. Gibson, Hewlett-Packard Company (United States)
Dirk W. Hertel, Sensata Technologies, Inc. (United States)
Robin Jenkin, Aptina Imaging, LLC (United States)
Sang Ho Kim, Samsung Electronics Company (Korea, Republic of)
Yoichi Miyake, Chiba University (Japan)
Göte S. Nyman, University of Helsinki (Finland)
D. René Rasmussen, Xerox Corporation (United States)
Sophie Triantaphillidou, University of Westminster (United Kingdom)
Lindsay W. MacDonald, London College of Communication (United Kingdom)
Eric K. Zeise, Eastman Kodak Company (United States)

Session Chairs

1	Image Quality Standards for Print
	Susan P. Farnand, Rochester Institute of Technology (United States)

- Image Quality Standards for Capture and Display
 Dirk W. Hertel, Sensata Technologies, Inc. (United States)
- Subjective Image Quality Evaluation Methodology I Luke C. Cui, Lexmark International, Inc. (United States)
- 4 Subjective Image Quality Evaluation Methodology II Sophie Triantaphillidou, University of Westminster (United Kingdom)

- 5 Image Quality Attributes Characterization and Measurement I **Eric K. Zeise**, Eastman Kodak Company (United States)
- 6 Image Quality Attributes Characterization and Measurement II Frans Gaykema, Océ-Technologies B.V. (Netherlands)
- 7 Objective Metrics of Perceptual Image Quality I **Robin B. Jenkin**, Aptina Imaging, LLC (United States)
- 8 Objective Metrics of Perceptual Image Quality II
 D. René Rasmussen, Xerox Corporation (United States)
- 9 System Performance: Advanced Display Technologies Frans Gaykema, Océ-Technologies B.V. (Netherlands)
- 10 System Performance: Capture and Display Peter D. Burns, Carestream Health, Inc. (United States)
- 11 System Performance: Mobile Phones and CMOS Cameras Göte S. Nyman, University of Helsinki (Finland)
- 12 System Performance: Video Majed Chambah, Université de Reims Champagne-Ardenne (France)