



The Society for Imaging
Science and Technology

Final Program and Proceedings

Image Processing Image Quality Image Capture Systems Conference

*An International Technical Conference on
Digital Image Capture and
Associated System, Reproduction
and Image Quality Technologies*

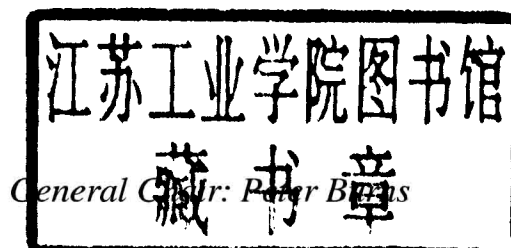
April 7 - 10, 2002
Portland Marriott Downtown Hotel
Portland, Oregon, USA

Final Program and Proceedings

IS&T's PICS Conference
55th Annual Conference

An International Technical Conference on
**Digital Image Capture and Associated System,
Reproduction and Image Quality Technologies**

April 7-10, 2002
Portland Marriott Downtown Hotel
Portland, Oregon, USA



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The Tutorials Program

Sunday, April 7, 2002

Full Day Classes, 8:00 am to 5:00 pm

T1 - The Technologies of the Still Digital Photography System,
Instructor: Michael A. Kriss, Sharp Laboratories of America

T2 - Characterization and Prediction of Image Quality,
Instructors: Brian Keelan, Paul Kane, Karin Töpfer, and Richard Wheeler, Eastman Kodak Company

Morning Classes, 8:00 am to 12:00 noon

T3 - Image Resolution and MTF for Digital Cameras and Scanners,
Instructors: Peter Burns and Don Williams, Eastman Kodak Company

T4 - Multispectral Color Imaging,
Instructor: Jon Y. Hardeberg, Gjovik University

T5 - Optics for Image Acquisition,
Instructor: Russ Palum, Eastman Kodak Company

Afternoon Classes, 1:00 to 5:00 pm

T6 - Measurement and Calibration of Display Devices,
Instructor: Jeffrey Mulligan, NASA Ames Research Center

T7 - Introduction to Image Quality and Digital Halftoning,
Instructor: Stephen Herron, Xerox Corporation

T8 - Color Quality Factors in Electronic Display,
Instructor: Gabriel Marcu, Apple Computer

Monday, April 8, 2002

Half Day Classes, 9:30 am to 12 noon, continuing 1:00 to 2:30 pm

T9 - Color Quality Factors in Desktop Printing,
Instructor: Gabriel Marcu, Apple Computer

T10 - Contrast Sensitivity and the Description of Image Quality with the SQRI,
Instructor: Peter Barten, Barten Consultancy

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Schedule of Events

Sunday, April 7, 2002

8:00 am to 5:00 pm Tutorials
6:00 to 8:00 pm *Welcome Reception*

Monday, April 8, 2002

8:15 am Opening Remarks
8:30 am to 4:30 pm Applied Vision Models (TRACK 1)
8:30 am Keynote Speaker: Jeffrey B. Mulligan
8:30 am to 12 noon Digital Image Capture (TRACK 2)
8:30 am Keynote Speaker: Albert Theuwissen
9:30 am to 12 noon Tutorials
1:00 to 2:30 pm Tutorials
10:00 to 10:30 am Honors and Awards Presentations
1:30 to 4:30 pm Digital Photography (TRACK 2)

Tuesday, April 9, 2002

8:00 am to 12 noon Image Quality Modeling and Psychophysics (TRACK 1)
8:00 am Keynote Speaker: Hiroaki Kotera
8:00 am to 12 noon Optics for Digital Imaging (TRACK 2)
10:00 am to 3:00 pm CIPE Education Workshop for Teachers
9:00 am Keynote Speaker: W. Thomas Cathey
10:30 am Keynote Speaker: Nicholas George
1:30 to 4:00 pm Image Quality Standards and Measurement (TRACK 1)
1:30 pm Keynote Speaker: Toshihiko Inagaki
1:30 to 3:30 pm Museum and Archive Imaging (TRACK 2)
1:30 pm Keynote Speaker: Steven Puglia
3:30 to 5:00 pm CIPE Student Poster Session
6:30 to 8:30 pm *Conference Reception*

Wednesday, April 10, 2002

8:00 am to 12 noon Image Quality Standards and Measurement (con't.) (TRACK 1)
8:00 am Keynote Speaker: Peter Barten
1:30 to 3:00 pm Imaging Performance Evaluation (TRACK 1)
8:00 am to 3:00 pm Digital Image Processing (TRACK 2)

Welcome to the Conference

We are pleased to welcome you Portland for PICS 2002, an international technical conference on digital imaging. This is the 55th annual spring meeting held by IS&T, the Society for Imaging Science and Technology. The PICS conference series is the continuing technical forum for the presentation of advances in digital image capture, quality, processing and systems development. This year's conference includes over 60 oral and poster presentations, and ten tutorial classes.

On Sunday, we begin with short courses at both the introductory and advanced levels. Two more tutorials are offered on Monday, when the technical program starts. The technical sessions, which run from Monday to Wednesday, are limited to two simultaneous tracks.

Track 1 includes:

- Applied Vision Models
- Image Quality Definition and Psychophysics
- Imaging Quality Standards and Measurements
- Imaging Performance Evaluation

Track 2 will address the specifics of various imaging systems:

- Digital Image Capture
- Digital Photography
- Optics for Digital Imaging
- Museum and Archive Imaging
- Digital Image Processing

The informal conference format and timing of all presentations is designed to provide ample opportunity for technical discussions of the various subjects of interest to attendees.

Five of the technical sessions will include extended keynote talks by experts in the imaging field. In the Applied Vision Models session, we are pleased to welcome Jeffrey Mulligan of NASA, who will present, 'Vision-Based Approaches to Digital Halftoning'. Albert Theuwissen of Delft University will discuss limitations to advances in electronic detector design. Hiroaki Kotera of Chiba University will present, 'Image-Dependent Quality and Preference Control', which will open the session on Image Quality Definition and Psychophysics. On Tuesday afternoon, Toshihiko Inagaki of Fuji Xerox will present, 'Challenges in International Standardization of Image Quality Evaluation'. Also on Tuesday, Steven Puglia, with the U.S. National Archives and Records Administration, will speak on imaging requirements for cultural institutions.

In the session on Optics for Digital Imaging, Thomas Cathey of University of Colorado will present, 'A New Paradigm for Imaging Systems'. Nicholas George of University of Rochester will then present a keynote talk on the application of novel optical elements in advanced digital cameras. Wednesday will begin with Peter Barten presenting, 'Nonlinear Effect of Modulation on Image Quality'.

This week PICS will also include a Student Poster Contest, in conjunction with a workshop for high school science teachers. Both of these events will be organized by the Center for Image Processing in Education (CIPE), which joined us in Portland two years ago.

In what has been a rather difficult year, it is a pleasure to acknowledge the members of our Conference Committee, in organizing the program. Their help in recruiting and selecting papers is appreciated, as is the support of the very able staff of IS&T.

Peter Burns

General Chair of PICS 2002 Conference

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The Corporate Members of your Society provide a significant amount of financial support that assists IS&T in disseminating information and providing professional services to imaging scientists and engineers. In turn, the Society provides a number of material benefits to its Corporate Members. For complete information on the Corporate Membership programme, contact IS&T, 7003 Kilworth Lane, Springfield, VA 22151.

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CIPE Teacher Workshop and Student Research Contest

Session Chair: Steve Moore, CIPE

The Center for Image Processing in Education (CIPE) is a nonprofit organization whose mission is to promote the innovative use of visualization technologies in education. Since its inception in 1992, CIPE has published a number of award-winning instructional materials, including A&P Technologist, Biotechnologist, and the Hands-On Image Processing Series in Biology, Mathematics and Physics. CIPE's staff, which is drawn primarily from the ranks of accomplished classroom teachers, has trained more than 6000 educators nationwide in the use of state-of-the-art image processing technology as a teaching tool. More information about CIPE may be found at <http://www.evisual.org>.

Teacher Workshop Imaging and Optical Discoveries for Science and Mathematics Education

April 9, 2002 - 10:00 am to 3:00 pm

Digital imaging and optical principles pervade students' lives, but educators can have difficulty integrating these principles into conventional instructional practice. This hands-on workshop introduces activities that help teachers meet national and local standards for science and mathematics education while engaging students in exciting explorations of optical and imaging principles. A CD-ROM with activities and software will be provided to all participants.

Student Research Contest

April 9, 2002 - 3:30 to 5:00 pm

CIPE is sponsoring a student poster contest in conjunction with the Society for Imaging Science and Technology and the Eastman Kodak Company. Student posters will demonstrate creative uses of image analysis or optics technology. Student posters will be judged by members of the PICS community and prizes donated by the Eastman Kodak Company will be given for the best student research displayed as part of the conference poster sessions.

The Technical Papers Program

Track 1

Monday Morning, April 8, 2002, 8:15 am – Noon

Applied Vision Models Session

Session Chair: Scott Daly, Sharp Corporation (USA)

8:15 am	Opening Remarks	
8:30 am	<i>(Keynote Paper)</i> Vision-Based Approaches to Digital Halftoning Jeffrey B. Mulligan, NASA Ames Research Center (USA)	1
9:30 am	Halftone Quality Evaluation Using Color Visual Models Xiao-fan Feng, Jon Speigle and Atsuhisa Morimoto, Sharp Laboratories of America, Inc. (USA)	5
10:00 am	IS&T Honors and Awards	
10:30 am	Coffee Break	
11:00 am	Visibility of Ink Dots as Related to Dot Size and Visual Density Ming-Shih Lian, Qing Yu and Douglas W. Couwenhoven, Electronic Imaging Products, R&D, Eastman Kodak Company (USA)	11
11:30 am	On Contrast Sensitivity in an Image Difference Model Garrett M. Johnson and Mark D. Fairchild, Munsell Color Science Laboratory, Center for Imaging Science, Rochester Institute of Technology (USA)	18
Noon	Lunch Break (on your own)	

Monday Afternoon, April 8, 2002, 1:30 – 4:30 pm

Applied Vision Models Session (*continued*)

Session Chair: Scott Daly, Sharp Corporation (USA)

1:30 pm	A Metric of Perceived Image Degradation Based on Foveal and Peripheral Visual Performance , Jian Yang and Michael E. Miller, Electronic Imaging Products, R&D, Corporate Design & Usability Eastman Kodak Company (USA)	24
2:00 pm	A Wide Field, High Dynamic Range, Stereographic Viewer Greg Ward, Exponent – Failure Analysis Assoc. (USA)	30
2:30 pm	High Quality LCD Imaging System - Beyond 8 Bits Yasuhiro Yoshida and Yoichi Yamamoto, Design Technology Development Center, IC Group, SHARP Corp. (Japan)	35
3:00 pm	Coffee Break	

3:30 pm	Wavelet Analysis of Print Defects Kevin D. Donohue and M. Vijay Venkatesh, University of Kentucky (USA); and Chengwu Cui, Lexmark International, Inc. (USA)	42
4:00 pm	Beyond the Visual System: A Cognitive Model of Color Categorization and its Application to Color Image Quality Serguei Endrikhovski, Eastman Kodak Company (USA)	48

Tuesday Morning, April 9, 2002, 8:00 am – Noon

Image Quality Modeling and Psychophysics Session

Session Chair: Sergueri Endrikhovski, Eastman Kodak Company (USA)

8:00 am	<i>(Keynote Paper)</i> Image-Dependent Quality and Preference Control Hiroaki Kotera, Department of Information and Image Sciences, Chiba University (Japan)	53
9:00 am	Preference in Image Quality Modeling Karin Töpfer, Brian Keelan, Scott O'Dell, and Robert Cookingham, Eastman Kodak (USA)	60
9:30 am	Extending Image Quality Models Peter G. Engeldrum, Imcotek (USA)	65
10:00 am	Coffee Break	
10:30 am	The Effect of Reduced Color Depth on the Color Reproduction of Web Images Efthimia Bilissi, Ralph E. Jacobson, and Geoffrey G. Attridge, Imaging Technology Research Group, University of Westminster (United Kingdom)	70
11:00 am	Color Image Quality for Multi-Function Peripherals Jon Y. Hardeberg, Gjøvik University College (Norway)	76
11:30 am	Predicting Multivariate Image Quality from Individual Perceptual Attributes Brian W. Keelan, Eastman Kodak Company (USA)	82
12:00 Noon	Lunch Break (on your own)	

Tuesday Afternoon, April 9, 2002, 1:30 – 4:00 pm

Image Quality Standards and Measurement Session

Session Chair: Edul Dalal, Xerox Corporation (USA)

1:30 pm	<i>(Keynote Paper)</i> Challenges in International Standardization of Image Quality Evaluation Toshihiko Inagaki, Research & Development Center, Document Products Company, Fuji Xerox Co., Ltd. (Japan)	88
2:30 pm	Measurement and Analysis of Color Registration Errors of Print Engines William Kress, Minolta-QMS (USA); and Kate Johnson and Prashant Mehta, ImageXpert (USA)	94

3:00 pm	Automating the Rank Order Test for Printing Quality Evaluation Chengwu Cui and Shaun Love, Lexmark International, Inc. (USA); and Laurence G. Hassebrook and Chun Guan, University of Kentucky (USA)	99
3:30 pm	Utilizing Flatbed Scanners To Measure Printer Motion Quality Error Michael C. Mongeon, Edul Dalal, and Rene Rasmussen, Xerox Corporation (USA)	104

CIPE STUDENT POSTER SESSION

4:00 to 5:00 pm

Session Chair: Steve Moore, CIPE:
The Center for Image Processing in Education

Poster papers will be presented by Portland
area secondary school students.

Wednesday Morning, April 10, 2002, 8:00 am – Noon

Image Quality Standards and Measurement Session (*continued*)

Session Chair: Ralph Jacobson, University of Westminster (England)

8:00 am	(<i>Keynote Paper</i>) Nonlinear Effect of Modulation on Image Quality Peter G. J. Barten, Barten Consultancy (The Netherlands)	109
9:00 am	An Objective Resolution Metric for Digital Printers David Towner, Norman Burningham, and Eric Schneider, Hewlett-Packard Company (USA)	115
9:30 am	Gloss Patch Selection Based on Support Vector Regression Chunhui Kuo, Yee Ng and C. Jeffrey Wang, NexPress Solutions LLC. (USA)	121
10:00 am	Coffee Break	
10:30 am	Instrumental Analysis of Gloss and Micro-Gloss Variations in Printed Images J. S. Arney and James Michel, Rochester Institute of Technology (USA); and Klaus Pollmeier, George Eastman House (USA)	126
11:00 am	Modeling the Modulation Transfer Function of Various Imaging Devices Samira Bouzit and Lindsay MacDonald, Colour & Imaging Institute, University of Derby (United Kingdom)	130
11:30 am	Migration from Contrast Transfer Function to ISO 16067-1 Spatial Frequency Response Troy D. Strausbaugh and Robert G. Gann, Hewlett Packard Company (USA)	136
12:00 Noon	Lunch Break (on your own)	

Wednesday Afternoon, April 10, 2002, 1:30 – 3:00 pm

Image Performance Evaluation Session

Session Chair: Paul Kane, Eastman Kodak Company (USA)

1:30 pm	Effect of Gamma Correction in Discrete Imaging Systems upon Determination of MTF R. Jenkin, R. E. Jacobson, N. R. Axford, and E. Allen, Imaging Technology Research Group, University of Westminster (United Kingdom)	142
2:00 pm	Enhanced Mottle Measurement Dave Wolin, ImageXpert Inc. (USA)	148
2:30 pm	Variation and Calibration Error in Electronic Imaging Peter D. Burns, Eastman Kodak Company (USA)	152

Track 2

Monday Morning, April 8, 2002, 8:15 am – Noon

Digital Image Capture Session

Session Chair: Paul De Keyser, Agfa Gevaert (Belgium)

8:15 am	Opening Remarks	
8:30 am	(<i>Keynote Paper</i>) Small is Beautiful! Yes, But Also for Pixels of Digital Still Cameras? Albert J.P. Theuwissen, Philips Semiconductors, and Delft University (The Netherlands)	156
9:30 am	They Said It Couldn't Be Done – System Design and Image Processing in the EFS-1 Electronic Film System Matthew S. Whalen, Jon Stern, Itzhak Sapir, Chris Selstad, and William LaSor, SiliconFilm Technologies (USA)	158
10:00 am	IS&T Honors and Awards	
10:30 am	Coffee Break	
11:00 am	Measuring Scanner Dynamic Range Dietmar Wueller, Image Engineering Dietmar Wueller (Germany)	163
11:30 am	Color Encodings: sRGB and Beyond Kevin E. Spaulding, Eastman Kodak Company (USA); and Jack Holm, Hewlett-Packard Company (USA)	167
12:00 Noon	Lunch Break (on your own)	

Monday Afternoon, April 8, 2002, 1:30 – 4:30 pm

Digital Photography Session

Session Chair: Dietmar Wueller, Image Engineering (Germany)

1:30 pm	Multi-Resolution Enhancement of Photographic Images Koen Vande Velde and Paul A. Delabastita, Agfa-Gevaert N.V. (Belgium)	172
2:00 pm	Color Accuracy in ICC Color Management System Huanzhao Zeng, Digital Printing Technologies, Hewlett-Packard Company (USA)	175
2:30 pm	Color Inconstancy Index: A Proposal and Case Study for Consumer Digital Cameras Don Williams, Eastman Kodak Company (USA)	181
3:00 pm	Coffee Break	
3:30 pm	Standard Reference Fulfillment Environments for the Management of Spatial Image Characteristics Robert J. Parada, Jr. and Richard B. Wheeler, Eastman Kodak Company (USA)	185
4:00 pm	Refined Slanted-Edge Measurement for Practical Camera and Scanner Testing Peter D. Burns and Don Williams, Eastman Kodak Company (USA)	191

Tuesday Morning, April 9, 2002, 8:00 am – Noon

Optics for Digital Imaging Session

Session Chair: Chris Dainty, Imperial College (England)

8:00 am	Recent Developments in Adaptive Optics J. C. Dainty, Blackett Laboratory, Imperial College (England)	196
8:30 am	<i>(Keynote Paper)</i> A New Paradigm for Imaging Systems W. Thomas Cathey and Edward R. Dowski, University of Colorado and CDM Optics, Inc. (USA)	199
9:30 am	How Many Photons are There? Russ Palum, Eastman Kodak Company (USA)	203
10:00 am	Coffee Break	
10:30 am	<i>(Keynote Paper)</i> Smart Cameras Using The Logarithmic Asphere Nicholas George and Wanli Chi, The Institute of Optics, University of Rochester (USA)	207
11:30 am	Evolution of the Optics of the Modern Laser Printer Larry Hubby, Hewlett-Packard Laboratories (USA)	208
12:00 Noon	Lunch Break (on your own)	

Tuesday Afternoon, April 9, 2002, 1:30 – 3:30 pm

Museum and Archive Imaging Session

Session Chair: Stephen Chapman, Harvard University (USA)

1:30 pm	<i>(Keynote Paper)</i> Digitization vs. Photographic Duplication: Tone Reproduction, Image Quality, and Longevity Issues Relating to the Reformatting of Photographs in Cultural Institutions Steven Puglia, National Archives and Records Administration (USA)	209
2:30 pm	A Simplified Standard Method of Digital Image Tonal Capture for Archival Projects Daniel L. Johnston, University of California (USA)	210
3:00 pm	Successes and Failures: A Case Study of Implementing ICC Color Management Across Harvard University Art Museums Peter Siegel, Harvard University Art Museums (USA)	214

CIPE STUDENT POSTER SESSION

3:30 to 5:00 pm

Session Chair: Steve Moore, CIPE:
The Center for Image Processing in Education

Poster papers will be presented by Portland
area secondary school students.