

Color Imaging XV: Displaying, Processing, Hardcopy, and Applications

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**19–21 January 2010
San Jose, California, United States**

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

Volume 7528

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 *Color Imaging XV: Displaying, Processing, Hardcopy, and Applications*, edited by Reiner Eschbach, Gabriel G. Marcu, Shoji Tominaga, Alessandro Rizzi, Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 7528, Article CID Number (2010).

ISSN 0277-786X

ISBN 9780819479211

Copublished by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

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SPIE.org

and

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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:

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Contents

vii Conference Committee

ix Abstracts from "Dark Side of Color II" Session
A. Rizzi, Univ. degli Studi di Milano (Italy); G. B. Beretta, Hewlett-Packard Labs. (United States); R. C. Carter, R. Eschbach, Xerox Corp. (United States); J. Gille, Qualcomm Inc. (United States); P. Hubel, Apple Computer, Inc. (United States); J. J. McCann, McCann Imaging (United States); N. Moroney, Hewlett-Packard Labs. (United States); L. D. Silverstein, VCD Sciences, Inc. (United States)

SESSION 1 VISION

7528 02 **Artist's colour rendering of HDR scenes in 3D Mondrian colour-constancy experiments** [7528-01]
C. E. Parraman, Univ. of the West of England (United Kingdom); J. J. McCann, McCann Imaging (United States); A. Rizzi, Univ. degli Studi di Milano (Italy)

7528 03 **Pixel and spatial mechanisms of color constancy** [7528-02]
J. J. McCann, McCann Imaging (United States); C. E. Parraman, Univ. of the West of England (United Kingdom); A. Rizzi, Univ. degli Studi di Milano (Italy)

7528 04 **Investigation and analysis of color terms in modern Japanese** [7528-03]
S. Tominaga, A. Ono, T. Horiuchi, Chiba Univ. (Japan)

SESSION 2 VISION AND APPLICATIONS

7528 05 **Color Universal Design: analysis of color category dependency on color vision type** [7528-04]
Y. G. Ichihara, Kogakuin Univ. (Japan) and NPO Color Universal Design Organization (Japan); N. Kojima, Kogakuin Univ. (Japan); K. Ito, Univ. of Tokyo (Japan) and NPO Color Universal Design Organization (Japan)

7528 06 **An efficient perceived contrast evaluation model for natural images** [7528-05]
Q. S. Chen, C.-W. Kim, Inha Univ. (Korea, Republic of)

7528 07 **Age, colors, and ISO standards** [7528-06]
F. L. van Nes, ERGONES (Netherlands) and Eindhoven Univ. of Technology (Netherlands)

SESSION 3 COLOR REPRODUCTION AND PRINTING

7528 08 **Modelling memory colour region for preference colour reproduction** [7528-07]
H. Zeng, Hewlett-Packard Co. (United States); R. Luo, Univ. of Leeds (United Kingdom)

7528 09 **Real-time color measurement using active illuminant** [7528-08]
S. Tominaga, T. Horiuchi, A. Yoshimura, Chiba Univ. (Japan)

- 7528 0A **Font rendering on a GPU-based raster image processor** [7528-09]
J. L. Recker, G. B. Beretta, I.-J. Lin, Hewlett-Packard Labs. (United States)
- 7528 0B **The development of artists' novel colour palettes for inkjet printing** [7528-10]
C. Parraman, Univ. of the West of England (United Kingdom)
- 7528 0C **A joint color trapping strategy for raster images** [7528-11]
H. Wang, Qualcomm CDMA Technologies (United States); M. Boutin, Purdue Univ. (United States); J. Trask, Hewlett-Packard Co. (United States); J. P. Allebach, Purdue Univ. (United States)

SESSION 4 IMAGE PROCESSING AND APPLICATIONS

- 7528 0D **Descreening of scanned images** [7528-12]
I. V. Kurilin, I. V. Safonov, Samsung Research Ctr. (Russian Federation); H. Lee, S. H. Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of)
- 7528 0E **Spectral matching imager with three-phase quadrature detection** [7528-13]
A. Kimachi, Osaka Electro-Communication Univ. (Japan); S. Ando, The Univ. of Tokyo (Japan); M. Doi, S. Nishi, Osaka Electro-Communication Univ. (Japan)
- 7528 0F **Automatic white balance method for cellular phone** [7528-14]
S. K. Jang, K. T. Kim, C.-W. Kim, Inha Univ. (Korea, Republic of)
- 7528 0G **Spectrophotometric and colorimetric analysis of wine for nuances reproduction** [7528-15]
B. Boisier, A. Mansouri, P. Gouton, LE2I, CNRS, Univ. de Bourgogne (France); P. Trollat, Bureau Interprofessionnel des vins de Bourgogne (France)

SESSION 5 GAMUT MAPPING

- 7528 0H **The use of spatially based complexity measures toward color gamut mapping and image resizing** [7528-16]
V. Monga, The Pennsylvania State Univ. (United States); R. Bala, C. Fillion, Xerox Corp. (United States)
- 7528 0I **Filter methods to preserve local contrast and to avoid artifacts in gamut mapping** [7528-17]
M. Meili, D. Küpper, Z. Barańczuk, U. Caluori, K. Simon, EMPA (Switzerland)
- 7528 0J **Aspects of computational geometry in gamut mapping implementations** [7528-18]
D. Küpper, K. Simon, EMPA (Switzerland)

SESSION 6 COLOR SCIENCE

- 7528 0K **Supplementary dataset for color difference evaluation** [7528-19]
A. Trémeau, C. Godau, D. Muselet, Lab. Hubert Curien CNRS, Univ. Jean Monnet (France)
- 7528 0L **LabRGB: evaluation of the weighting factors** [7528-20]
F. Nakaya, N. Ohta, Fuji Xerox Co., Ltd. (Japan)

- 7528 0M **Evaluation and compensation of fluorescence for spectral imaging of art materials and historical documents** [7528-21]
W. A. Christens-Barry, Equipoise Imaging, LLC (United States); K. Boydston, MegaVision, Inc. (United States); R. L. Easton, Jr., Rochester Institute of Technology (United States)

SESSION 7 DISPLAYS

- 7528 0N **Display color synthesis in the space-time continuum (Invited Paper)** [7528-22]
L. D. Silverstein, VCD Sciences, Inc. (United States)
- 7528 0O **Design principles of wide gamut YCC color encoding space for effective signal sub-sampling** [7528-23]
Y. Kwak, Ulsan National Institute of Science and Technology (Korea, Republic of)
- 7528 0P **Investigating color dependent depth, shape, and motion perception using 3D rendering on monoscopic displays** [7528-24]
F. Lebowsky, STMicroelectronics (France)
- 7528 0Q **Adaptive color reproduction method to various users' monitor environment in color printer** [7528-25]
D.-C. Kim, I.-S. Jang, Kyungpook National Univ. (Korea, Republic of); C.-H. Son, K.-M. Kim, SAMSUNG Electronics Co., Ltd. (Korea, Republic of); Y.-H. Ha, Kyungpook National Univ. (Korea, Republic of)

SESSION 8 THE DARK SIDE OF COLOR

- 7528 0V **Color naming: color scientists do it between Munsell sheets of color (Invited Paper)** [7528-30]
G. B. Beretta, N. M. Moroney, Hewlett-Packard Labs. (United States)

SESSION 9 HALFTONING I

- 7528 0X **Memory efficient hierarchical error diffusion** [7528-32]
Z. He, Z. Fan, Xerox Corp. (United States)
- 7528 0Y **Clustered-dot color halftone watermarks using spatial frequency and color separability** [7528-33]
B. Oztan, G. Sharma, Univ. of Rochester (United States)
- 7528 0Z **Moiré-based autostereoscopic images by duplex printing on transparencies** [7528-34]
S.-G. Wang, Xerox Research Ctr. (United States)

SESSION 10 HALFTONING II

- 7528 10 **Electro-photographic-model-based halftoning** [7528-35]
P. Goyal, M. Gupta, Purdue Univ. (United States); D. Shaked, C. Staelin, M. Fischer, Hewlett-Packard Labs. (Israel); O. Shacham, Hewlett-Packard Indigo Ltd. (Israel); R. Jodra, Hewlett-Packard Co. (United States); J. Allebach, Purdue Univ. (United States)

7528 11 **Half-tone moiré due to imager distortion** [7528-36]
O. Bulan, Univ. of Rochester (United States); R. Loce, B. Xu, Xerox Corp. (United States)

7528 12 **Clustered-dot halftoning with direct binary search** [7528-37]
M. Gupta, Purdue Univ. (United States); C. Staelin, M. Fischer, Hewlett-Packard Labs. (Israel);
O. Shacham, Hewlett-Packard Indigo Ltd. (Israel); R. Jodra, Hewlett-Packard Co. (United
States); J. Allebach, Purdue Univ. (United States)

INTERACTIVE PAPER SESSION

7528 13 **Design of transducer structure parameters and materials characteristics analyses for electrical capacitance tomography system** [7528-38]
M. Qin, Harbin Univ. of Science and Technology (China)

7528 14 **Color schemes for encoding information in digital maps** [7528-39]
R. Zeng, Liming Vocational Univ. (China); H. Zeng, Hewlett-Packard Co. (United States)

Author Index

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- 4 Image Processing and Applications
Gabriel G. Marcu, Apple, Inc. (United States)

- 5 Gamut Mapping
Choon-Woo Kim, Inha University (Korea, Republic of)
- 6 Color Science
Choon-Woo Kim, Inha University (Korea, Republic of)
- 7 Displays
Gabriel G. Marcu, Apple Computer, Inc. (United States)
- 8 The Dark Side of Color
Alessandro Rizzi, Università degli Studi di Milano (Italy)
- 9 Halftoning I
Jan P. Allebach, Purdue University (United States)
- 10 Halftoning II
Reiner Eschbach, Xerox Corporation (United States)

The dark side of color II

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ABSTRACT

This year, at Electronic Imaging 2010, will be held for the second time, as part of the "Color Imaging XV: Displaying, Hardcopy, Processing, and Applications" conference, the special session entitled, "Dark Side of Color". This session aims at introducing innovative thinking, and discussion from experts working in a wide range of disciplines related with color, to foster ideas and stimulate about open issues and common misunderstanding in color science and technology. It is composed by a limited number of invited short presentations that are presented as summaries in this paper together with an overall description of the session point of view.

Keywords: Dark side of color, Color, Color models, Color teaching, Colorimetry, Color related phenomena

1. WHAT THIS SESSION IS ABOUT

What is the dark side of color ?

Color is a very complex phenomenon that cannot be explained with only physics principles. The human vision system is what transforms the physical stimuli into the colors we see.

Color related topics are sometime taught and communicated without presenting their inner complexity, their limits and the simplifications that sometime are at their base. A-critically following pre-defined "recipes" can lead to the risk of loosing the overall framework and consequently a complete understanding of the chosen technique.

Classic colorimetric methods, specifically designed to deal with color in aperture mode (isolated, out of visual context), have become dominant in digital color science and technology. Their use has been extended to deal with a great variety of situations in which color is considered inside a visual context, thus outside its initial scope. Color science is facing this transitional evolution in order to deal with color in context and appearance, but without substantial changes in their original foundation.

There is a need for widening the scientific debate and discuss about paradigms. This can be achieved by, for example, new questions, different attention for details; information in the margins that so far are often discounted or overlooked. These aspects are what we consider to be the "dark side of color".

The invited speakers of this section have been asked to stimulate ideas and discussions on the needs and the characteristics of possible alternative approaches and/or point of view. This session aims at suggesting paradigm shifts, lateral thinking and bottom up experimentation by re-addressing the current state of the evolving situation in color in sciences, arts and technologies.

Following these principles, every speaker has chosen a topic of his/her preference and presents open issues and problems in a short 15-minutes presentation. The presentation abstracts are reported in the following sections to give the reader a glance on the discussed topics.

We would like to stress that basically no answers are expected to arise from the presentations of this session, but more likely questions and perspective shifts.

2. THE SPEAKERS

Here are the abstracts of the speakers that will participate at this second edition of the session of the Dark Side of Color. They are listed in alphabetical order.

2.1 “Color naming: color scientists do it between Munsell Sheets of Color” Giordano Beretta and Nathan Moroney

With the advent of high dynamic range imaging and wide gamut color spaces, gamut mapping algorithms have to nudge image colors much more drastically to constrain them within a rendering device's gamut. Classical colorimetry is concerned with color matching and the developed color difference metrics are for small distances. For larger distances, categorization becomes a more useful concept. In the gamut mapping case, lexical distance induced by color names is a more useful metric, which translates to the condition that a nudged color may not cross a name boundary. The new problem is to find these color name boundaries. We compare the experimental procedures used for color naming by linguists, ethnologists, and color scientist and propose a methodology that leads to robust repeatable experiments.

2.2 “Size matters: The problem of color-difference estimation for small visual targets” Robert C. Carter and Louis D. Silverstein

A longstanding problem in color science is the accurate estimation of color differences for visual targets of small angular subtense. For instance, “What is the magnitude of a half-degree color difference that will be as discriminable as a given two-degree color difference?” Or, “What is the reduced angular subtense (or increased distance) at which two visual fields of given colors will become appreciably less discriminable than they were at larger subtense (or smaller distance)?” Past attempts at solving this problem have been specific to a particular color difference equation and, as such, the work lost relevance as improved color difference formulae were developed. This presentation proposes a structural model based upon the response of retinal cone cells to small-subtense target images scattered by the ocular media. The method is demonstrated to be applicable without alteration to very different contemporary color difference equations, to be practical with a wide range of surround intensities, and to have high correlation with human search performance involving small color targets on an electronic information display.

2.3 “Controlled versus uncontrolled viewing conditions in color evaluation” Reiner Eschbach

A large part of the information we are gathering on Human Perception comes from carefully designed controlled visual experiments. In these experiments the experimental parameters are carefully controlled and any extraneous influence is reduced or eliminated. But what, if the experiment does not agree with the noisy observations in the real world ? Are there ways to identify the source of the problem ? Actually, a more interesting question is: where do I look for the noise source. Which data points do I mistrust and how do I design an experiment to distinguish ? This talk describes our current hypothesis in light of such a contradiction in our own experiments.

2.4 “Mind over Matter” Jennifer Gille

We generally treat color as a separable property of objects. The physiological evidence of color channels in early vision would seem to support this view. Still, many color phenomena belie this simple idea. What does this mean for our characterization of color?

2.5 “Globalization of color” Paul Hubel

Digital image rendering brings the ability to apply complex color and tone correction algorithms. One of the more difficult aspects of newer rendering techniques is the balance between global and some kind of local correction. In the case of computer vision where the reproduction of surface color is desired, local corrections that can separate out the illumination is desirable. In photography, however, the characteristics of the illumination are fundamental to the scene and removal can destroy not only the artistic intent but also move the rendering further from the scene perception. In terms of tone this kind of thing can remove depth perception - in faces, for example - and in color this can turn warm sunset illumination into cold noonday sun. Clearly some local manipulation is necessary, particularly for HDR mapping. Examples will be shown and the challenge for the future is getting the balance between global and local influence to match both perception and photographic preference.

2.6 “The appearance of illusions and the delusion of reality” John McCann

Physicists born in the 18th century still influence our impressions of reality. Take for example, the work at the Royal Institution, London around 1800. Sir Humphrey Davy and Josiah Wedgwood developed a precursor to silver-halide photography. Thomas Young taught at the Royal Institution at the time and proposed that three types of retinal receptors at the same location could explain our color response to all visible wavelengths. It is tempting to think that vision behaves the same as silver-halide film. We tend to think that the response of a single pixel can successfully model the response of every pixel in the entire image, with curious exceptions, that we call “illusions”.

Webster defines illusion as the state, or fact, of being intellectually deceived or misled. The usage for visual test targets makes sense if, and only if, we assume that human vision must behave the same as photographic film. However, by 1800 there were shrewd observations to the contrary by da Vinci, von Guericke, Count Rumford, and many others. They showed that vision was different from film. All the neurophysiology of the second half of the 20th century has shown the visual pathway is a sequence of spatial operators. These operators compare the response of one part of the retinal image with another. Color is the result of spatial comparisons of all the pixels in the scene. The pixel model of human color vision is a delusion.

For vision, we need to free our thinking from the single-pixel models of physicists. If we measure a display, the quantum catch of a single pixel can describe the light. However, if we look at a display, we apply our spatial image-processing pathway to the image on our retinas. Our spatial transformation of retinal images is the reality of human color vision.

