



IS&T

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"THE WINDOW ON IMAGING"

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SELECTED CONFERENCE ABSTRACTS: ELECTRONIC IMAGING SYMPOSIUM 2009

Enriching a Document Collection by Integrating Information Extraction and PDF Annotation

Brett Powley, Robert Dale, and Ilya Anisimoff, Macquarie University (Australia)

Abstract: Modern digital libraries offer all the hyper-linking possibilities of the World Wide Web: when a reader finds a citation of interest, in many cases she can now click on a link to be taken to the cited work. This paper presents work aimed at providing the same ease of navigation for legacy PDF document collections that were created before the possibility of integrating hyperlinks into documents was ever considered. To achieve our goal, we need to carry out two tasks: first, we need to identify and link citations and references in the text with high reliability; and second, we need the ability to determine physical PDF page locations for these elements. We demonstrate the use of a high-accuracy citation extraction algorithm which significantly improves on earlier reported techniques, and a technique for integrating PDF processing with a conventional text-stream based information extraction pipeline. We demonstrate these techniques in the context of a particular document collection, this being the ACL Anthology; but the same approach can be applied to other document sets.

Multi-Object Segmentation using Coupled Nonparametric Shape and Relative Pose Priors

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Abstract: We present a new method for multi-object segmentation in a maximum a posteriori estimation framework. Our method is motivated by the observation that neighboring or coupling objects in images generate configurations and co-dependencies which could potentially aid in segmentation if properly exploited. Our approach employs coupled shape and inter-shape pose priors that are computed using training images in a nonparametric multivariate kernel density estimation framework. The coupled shape prior is obtained by estimating the joint shape distribution of multiple objects and the inter-shape pose priors are modeled via standard moments. Based on such statistical models, we formulate an optimization problem for segmentation, which we solve by an algorithm based on active contours. Our technique provides significant improvements in the segmentation of weakly contrasted objects in a number of applications. In particular for medical image analysis, we use our method to extract brain Basal Ganglia structures, which are members of a complex multi-object system posing a challenging segmentation problem. We also apply our technique to the problem of handwritten character segmentation. Finally, we use our method to segment cars in urban scenes.

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To view full papers go to www.imaging.org/pubs/reporter/

* These papers were presented at the IS&T/SPIE 21st Annual Electronic Imaging Symposium, held January 18-22, 2009, in San Jose, California.

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Weighting of Field Heights for Sharpness and Noisiness

Brian W. Keelan and Elaine W. Jin, Aptina Imaging, LLC (USA)

Abstract: Weighting of field heights is important in cases when a single numerical value needs to be calculated that characterizes an attribute's overall impact on perceived image quality. In this paper we report an observer study to derive the weighting of field heights for sharpness and noisiness. One-hundred-forty images were selected to represent a typical consumer photo space distribution. Fifty-three sample points were sampled per image, representing field heights of 0, 14, 32, 42, 51, 58, 71, 76, 86, and 100%. Six observers participated in this study. The field weights derived in this report include both: the effect of area versus field height (which is a purely objective, geometric factor); and the effect of the spatial distribution of image content that draws attention to or masks each of these image structure attributes. The results show that relative to the geometrical area weights, sharpness weights were skewed to lower field heights, because sharpness-critical subject matter was often positioned relatively near the center of an image. Conversely, because noise can be masked by signal, noisiness-critical content (such as blue skies, walls, etc.) tended to occur farther from the center of an image, causing the weights to be skewed to higher field heights.

Chromatic Aberration Reduction through Optical Feature Modeling

Jooyoung Kang, Hyunwook Oka, JaemGuyn Lima, and Seong-Deok Lee, Samsung Electronics Co. Ltd, (Korea)

Abstract: This paper presents a method of digitally removing or correcting Chromatic Aberration (CA) of lens, which generally occurs in an edge region of image. Based on the information of the lens' and sensor's features in camera, it determines CA level and the dominant chrominance of CA and efficiently removes extreme CA such as purple fringe and blooming artifacts, as well as a general CA to be generated at an edge in an image captured by a camera. Firstly, this method includes a CA region sensing part analyzing a luminance signal of an input image and sensing a region having CA. Secondly, the CA level sensing part calculates the weight, which indicates a degree of CA, based on a difference between gradients of color components of the input image. Thirdly, for removing the extreme CA such as purple fringe and blooming artifact which caused by the feature of lens and sensor, it uses 1-D Gaussian filters having different sigma values to get the weight. The sigma value indicates the feature of lens and sensor. And, for removing the general CA, it includes the adaptive filter, based on luminance signal. Finally, by using these weights, final filter will be produced adaptively with the level of CA and lens's and sensor's features. Experimental results show the effectiveness of this proposed method.

Basic Theory on Surface Measurement Uncertainty of 3D Imaging Systems

J-Angelo Beraldin, National Research Council Canada (Canada)

Abstract: Three-dimensional (3D) imaging systems are now widely available, but standards, best practices and comparative data have started to appear only in the last 10 years or so. The need for standards is mainly driven by users and product developers who are concerned with 1) the applicability of a given system to the task at hand (fit-for-purpose), 2) the ability to fairly compare across instruments, 3) instrument warranty issues, 4) costs savings through 3D imaging. The evaluation and characterization of 3D imaging sensors and algorithms require the definition of metric performance. The performance of a system is usually evaluated using quality parameters such as spatial resolution/uncertainty/accuracy and complexity. These are quality parameters that most people in the field can agree upon. The difficulty arises from defining a common terminology and procedures to quantitatively evaluate them through metrology and standards definitions. This paper reviews the basic principles of 3D imaging systems. Optical triangulation and time delay (time-of-flight) measurement systems were selected to explain the theoretical and experimental strands adopted in this paper. The intrinsic uncertainty of optical distance measurement techniques, the parameterization of a 3D surface and systematic errors are covered. Experimental results on a number of scanners (Surphaser[®], HDS6000[®], Callidus CPW 8000[®], and ShapeGrabber[®] 102) support the theoretical descriptions.

Effects of Sampling on Depth Control in Integral Imaging

Jun Arai, Masahiro Kawakita, and Fumio Okano, NHK (Japan)

Abstract: In integral imaging, lens arrays are used to capture the image of the object and display the three-dimensional (3-D) image. In principle, the 3-D image is reconstructed at the position where the object was. We have hitherto proposed a method for controlling the depth position of the reconstructed image by applying numerical processing to the captured image information. First, the rays from the object are regenerated by numerical processing by using information captured from the actual object together with a first virtual lens array. Next, the regenerated rays are used to generate 3-D information corresponding to a prescribed depth position by arranging a second virtual lens array. In this paper, we clarify the spatial frequency relationship between the object and the depth controlled reconstructed image, and we propose filter characteristics that can be used to avoid aliasing. We also report on experiments in which we confirm the effectiveness of the proposed filter.

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EI2009 Features New Symposium-Wide Offerings

by Jan Allebach, EI2009 and EI2010 Symposium Co-chair

The 21st Annual IS&T/SPIE Electronic Imaging Symposium took place this year from Sunday 18 January to Thursday 22 January in San Jose, California at the San Jose Convention Center and adjoining Marriott Hotel. This event served as an umbrella for 18 different conferences organized into six technology areas: 3D Imaging, Interaction, and Measurement (three conferences); Imaging, Visualization, and Perception (four conferences); Image Processing (six conferences); Digital Imaging Sensors and Applications (four conferences); Multimedia Processing and Applications (four conferences); and Visual Communications and Image Processing (one conference).

Typically, each conference consisted of 20 to 50 papers, published in a separate proceedings, given over one to four days. This year more than 600 Oral and 115 Interactive papers were presented during the four-day period of the conference (Sunday is reserved for Short Courses).

The Annual Electronic Imaging Symposium has traditionally served as the gathering spot for a vibrant and multidisciplinary global community of researchers whom—in many cases—only see each other annually at this event. Despite the difficult economic situation, this year's attendance figures did not drop sig-

nificantly. There were 1,046 attendees from 37 countries (157 from Asia/Pacific region, 391 from Europe/Middle East, and 598 from the Americas).

Keynote Talks

The Symposium featured two plenary talks. Tuesday morning, David Gallo and William Lange, both from Woods Hole Oceanographic Institute, showcased underwater imaging technology in a presentation entitled “Neptune’s Garden: Exploring the Secrets of the Deep Undersea.” The speakers narrated a fascinating film of undersea life that showed remarkable diversity and beauty, despite the seemingly inhospitable habitat of the deep ocean—and the image quality was astonishing. On Wednesday morning, Andy Setos, president of engineering for the Fox Entertainment Group, spoke about the opportunities and challenges in the content creation and delivery business in his talk “Audio and Video: Making It and Selling It in the 21st Century.” He focused on the directions that Fox is pursuing to provide consumers with convenient access to content, while still protecting the rights of those responsible for creation and delivery.

Conference and Society Awards

Prior to the Wednesday plenary, a num-

EI2009 STATISTICS	
Attendees:	1,046
Oral Papers:	600
Interactive Papers:	115
Short Courses:	15
Dates:	Jan. 18-22, 2009
Location:	San Jose, CA

ber of awards were presented to recognize some of the outstanding individuals in the electronic imaging community. Morley Blouke was given the 2009 Electronic Imaging Scientist of the Year Award in recognition of his sustained contributions to the design of electronic imaging sensors. He is especially well known for his work on the Hubble Telescope and on CCD sensors for medical imaging.

The Document Recognition and Retrieval Conference Best Student Paper Award was presented to Sebastián Peña Saldarriaga, Université de Nantes (France) for “On-line Handwritten Text Categorization.” The VCIP Conference presented their Best Student Paper Award to Hu Chen, Technische Universität München (Germany) for “Low-complexity Bayer-pattern Video Compression Using Distributed Video Coding.” VCIP also presented two Best Paper Awards to Adarsh K. Ramasubramonian and John W. Woods,



Left: The phantogram exhibit is an annual highlight of the Electronic Imaging Symposium. **Right:** This year's event featured the Science 2 photograph exhibit, which is currently touring the US.

Rensselaer Polytechnic Institute (USA) for “Video Multicast Using Network Coding” and to Chao Yu and Gaurav Sharma, University of Rochester (USA) for “Sensor Scheduling for Lifetime Maximization in User-centric Image Sensor Networks.”

IS&T recognized new Fellow Reiner Eschbach, and presented Vivian Walworth with a President’s Citation in recognition of her long service to publications of the Society. SPIE recognized new Fellows John

Merritt, Bernice Rogowitz and Shoji Tominaga.

Networking Opportunities and Conference Highlights

Highlights of the Symposium were the Interactive Paper/Demonstration Session on Tuesday evening, the Symposium Reception on Wednesday evening, and the Exhibit Hall/Science Gallery event.

During the combined Interactive Pa-

per and Symposium Demonstration Session, approximately 115 posters were presented and generated a lively exchange between authors and attendees. The unique Symposium Demonstration Session provided an opportunity for authors of papers presented at EI to showcase their technologies in a tabletop setting. This year there were nearly 50 separate demonstrations—many of them in the 3D area—held amidst a buzz of excitement.

SD&A CONFERENCE CELEBRATES 20 YEARS

An important facet of Electronic Imaging 2009 was the celebration of the twentieth year of the Stereoscopic Displays and Applications (SD&A) Conference. Events included the customary 3D Theatre, a number of excellent papers, and two lively panel discussions. The customary group dinner at BoTown was enlivened by a slide presentation featuring conference scenes from over the years.

The Monday morning SD&A session was followed by the presentation of an Outstanding IS&T/SPIE Service Award to John Merritt. Co-founder of the SD&A Conference, John has served as conference co-chair for the past 20 years and as one of the instructors for the outstanding pre-conference short course on the same topic. John was further honored during a symposium-wide plenary session at which he was named SPIE Fellow.

SD&A’s Keynote Speaker, Lenny Lipton, gave a lively account of his experiences as songwriter, physicist, and inventor, topped by his contributions to current cinema 3D technology. The evening demonstration session featured many of the 3D systems described during the SD&A sessions, as well as technologies discussed in the concurrent EI conferences. The chance to play a number of 3D games at the EI reception topped off the SD&A contribution to this year’s event.

—Vivian K. Walworth



John Merritt being presented with a special award by EI09 Symposium Co-chair Jan Allebach honoring John’s 20 years of SD&A Conference leadership.



Attendees flocked to the various demonstrations presented by authors and outside companies that highlighted technologies addressed at EI. **Inset:** An EI participant checks out one of the 3D presentations.

On the following evening, the Symposium reception had a fresh look and feel with two interactive 3D gaming areas, raised “lounge areas” with casual and comfortable seating, and salad, pizza, and cupcakes as the culinary fare. The 3D gaming area was especially popular and provided a way for attendees to interact in a fun and relaxed atmosphere. These innovations were much appreciated by those in attendance.

Attendees also were treated to targeted product exhibits, a phantogram display, photos from a recently published book of 3D sports images, and gorgeous images from the traveling exhibit: Images from Science 2.

The individuals conferences themselves continued to show the ingenuity and vitality that is a hallmark of the Electronic Imaging Symposium. Just to mention a very few of the highlights:

- Stereoscopic Displays and Applications XX hosted a special keynote presentation by Lenny Lipton, CTO of Real D, and John Merritt received a special award in recognition of his long service to this conference—he has been a chair since its founding—as he steps down from his position as one of the conference chairs.
- Human Vision and Electronic Imag-



The Electronic Imaging 2009 Scientist of the Year Award was presented by Gloria Putnam, Committee Member for the EI Sensors, Cameras, and Systems for Industrial/Scientific Applications Conference (far left), Jan Allebach, and Nitin Sampat (second and first from right, respectively), EI09 Symposium Co-chairs, to Morley Blouke for his seminal contributions to the field of Electronic Imaging, specifically in the areas of image sensors, focal plan arrays, and CCD technology.

ing XIV held panel sessions on high-dynamic range imaging and art and perception, and introduced haptics and multimodal perception as new topics of the conference.

- Color Imaging Conference XIV playfully examined some of the more challenging issues associated with color imaging systems in a session entitled “Dark Side of Color.”
- Image Quality and System Performance VI continued to broaden its scope with the inclusion of video and mobile devices.
- Visualization and Data Analysis 2009 opened with an invited presentation entitled “Visualizing roles in social media,” by Marc Smith (Teligent Systems, Inc.)
- Computational Imaging VII included a session devoted to computational imaging issues in microscopy, preceded by a keynote presentation by Badrinath Roysam (RPI) on this topic.
- Document Recognition and Retrieval XVI featured an invited presentation on “Pseudo-color enhanced x-ray fluorescence imaging of the Archimedes Pamlipstest,” by Uwe Bergmann (Stanford Linear Accelerator Center) and Keith Knox (Boeing LTS, Inc.).
- Wavelet Applications in Industrial



SD&A Conference Co-Chairs Andrew Woods and Neil Dodgson check out a 3D air guitar game prior to its debut at the Symposium Reception. The opportunity to game in 3D was a highlight of this year’s reception.

Processing VI examined the use of physics-based models in wavelet processing.

- Sensors, Cameras, and Systems for Industrial/Scientific Applications X explored the implications of color and multispectral techniques.
- Digital Photography V hosted an invited paper by Marc Levoy (Stanford University) on computational photography.
- Multimedia on Mobile Devices 2009 considered the important issue of processing large format media on small device, as well as the topic of 3D video delivery for mobile devices.

Special thanks are due to Michael Kriss who stepped down from the EI Steering Committee this year after three



Jenny Leung presents her Interactive Paper “Statistical Identification and Analysis of Defect Development in Digital Imagers” at the Tuesday evening Interactive Paper/Demonstration Session.

years of service in that position, one of which overlapped his tenure as 2007 Symposium Co-chair. Nitin Sampat takes over Michael's role as IS&T technical representative to the Steering Committee. Nitin served as 2008 Symposium Chair and 2009 Symposium Co-chair.

Work is already underway for EI2010! I will be joined as co-chair in planning the

2010 event by Sabine Süssstrunk. EI will take place in San Jose, California from 17 January to 21 January. Abstracts are due 22 June 2009. Please go to <http://spie.org/electronic-imaging.xml> for additional details. We hope to see you there!



Left: IS&T President Eric Hanson (center) and Executive Director Suzanne Grinnan (right) congratulate Reiner Eschbach on his IS&T Fellowship. **Top:** IS&T President Eric Hanson (left) presents a President's Citation to Vivian Walworth for her years of contributions to IS&T publications, including founding The Reporter. **Above:** Longstanding members of the Electronic Imaging community and newly elected SPIE Fellows John Merritt, Bernice Rogowitz, and Shoji Tominaga (left to right).



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Motion-based Perceptual Quality Assessment of Video

Kalpana Seshadrinathan and Alan C. Bovik, Univ. of Texas at Austin, (USA)

Abstract: There is a great deal of interest in methods to assess the perceptual quality of a video sequence in a full reference framework. Motion plays an important role in human perception of video and videos suffer from several artifacts that have to deal with inaccuracies in the representation of motion in the test video compared to the reference. However, existing algorithms to measure video quality focus primarily on capturing spatial artifacts in the video signal, and are inadequate at modeling motion perception and capturing temporal artifacts in videos. We present an objective, full reference video quality index known as the MOTion-based Video Integrity Evaluation (MOVIE) index that integrates both spatial and temporal aspects of distortion assessment. MOVIE explicitly uses motion information from the reference video and evaluates the quality of the test video along the motion trajectories of the reference video. The performance of MOVIE is evaluated using the VQEG FR-TV Phase I dataset and MOVIE is shown to be competitive with, and even out-perform, existing video quality assessment systems.

Optimizing Color Quality for LED Backlight Modulated LCD TVs

Fritz Lebowsky STMicroelectronics SAS (France);

Abstract: Large-scale, direct view TV screens, in particular those based on liquid crystal technology, are beginning to use LED (light emitting diode) backlight technology. Conservative estimates show that LED-LCD TVs additional cost will be compensated by reduced power consumption over average operational lifetime. Local dimming not only promises power savings but also improving additional features such as overall image contrast and color gamut. Based on a simplified human visual model with regard to content dependent color discrimination and local adaptation possible trade offs with regard to color uniformity, viewing angle, local contrast, and brightness variations are being discussed. Comparing an 'ideal reference' (input to elaborated model) with the output of a tunable model enabled estimating a threshold of artifact visibility for still images as well as video clips that were considered relevant. Overall image quality with regard to dynamic contrast as well as dynamic color gamut, spatially and temporally, was optimized after having obtained visibility thresholds. Finally, some cost functions are proposed that enable optimizing most important color quality parameters.

STANDARDS UPDATE

David Q. McDowell, Editor

Until recently, the standards for viewing conditions, colorimetric measurements, densitometric measurements, and characterization data for profile building were all somewhat independent of each other and contained some significant inconsistencies. The standards that define viewing conditions and densitometric measurements in particular were historic standards that had not caught up with the needs of color management and current market realities.

Over the last couple of years this has all changed. Although the viewing and densitometric standards are the responsibility of ISO TC42 (Photography) and the colorimetric measurement standards are under ISO TC130 (Graphic technology), several Joint Working Groups have been set up to revise these standards in concert with each other. That work is almost complete and the result will be a far better overlap between the various requirements.

The Driving Forces for Change

Although these standards are often used completely independent of each other, the issues driving the need for coordination largely come out of requirements of the color management and graphic arts production areas, which use all of them in a coordinated manner. The following are some examples of the diverse issues facing the community of technical experts who tackled the revision of these documents.

- a. With the move to widely available spectral reflectance measurement equipment, the industry would like to be able to compute both density and colorimetry from the same spectral data. This required a spectral definition of density. In addition, provision needed to be made for a common illuminant spectral power distribution (SPD) in the measurement equipment and a common backing to be used under the specimen being measured.
- b. For color management, it was desirable to be able to correlate what was seen in the viewing booth with the colorimetric measurements made of the proof and print being compared. Here the issue was to be sure that the SPD of the viewing booth matched the SPD used in the illumination system of the spectral measurement equipment and that the illumination used for computation of colorimetry also matched. In many situations the backing used for both measurement and viewing was also an issue.
- c. Recently, the paper industry has started using more optical brightening agents (OBAs) to make paper appear brighter and whiter. These absorb energy in the UV and emit in the blue portion of the visible spectrum. This impacts the specifications of the SPD of the illuminants used in measurement equipment and viewing booths by adding a requirement to also control the UV portion of the spectrum.
- d. Although for years the European community has used polarization filters for density measurements, and to a lesser extent colorimetric measurements, the standards have not made any provision for polarization.
- e. Although the SPD of a light source can be specified, the tolerances on the compliance of a real illumination source to the specified SPD must be defined in terms of the effect of the variations on viewing. Thus, tests like chromaticity, color rendering index, metameric index, etc., must be used for evaluation. Unfortunately, the computational requirements of these tests are sensitive to small variations in reference data and are difficult to “get right”. Therefore, it was felt to be important to include an annex (to the viewing standard) that laid out a step-by-step example calculation of the specified evaluation procedure.

The Standards Involved

The full and correct names of the standards involved are:

- ISO 5, Photography — Density measurements
 - Part 1: Terms, symbols and notations
 - Part 2: Geometric conditions for transmittance density
 - Part 3: Spectral conditions
 - Part 4: Geometric conditions for reflection density
- ISO 3664, Viewing conditions — Graphic technology and photography
- ISO 13655, Graphic technology — Spectral measurement and colorimetric computation for graphic arts images

In addition The ICC specification, ISO 15076-1, Image technology colour management — Architecture, profile format and data structure — Part 1: Based on ICC.1:2004-10, references these specifications and refines the viewing conditions and profile measurement conditions for color management.

Current Status

As to their status, all parts of ISO 5 are in DIS ballot (that is the last ISO ballot in which changes can be introduced) and significant changes are not expected. ISO 3664 has completed all ballots and is in preparation for publication. ISO 13655 is just getting ready to start a second DIS ballot (the results of the first DIS ballot have had a lot of discussion and committee review) and it is hoped that few changes will be needed. ISO 15076-1 was published without a lot of ISO scrutiny (it took most of its text directly from earlier ICC Specifications) and a new version is in preparation by the ICC Specification Working Group. It has been completely reviewed for compliance with ISO requirements, and those technical changes approved by the ICC since its initial publication have been added. It will be placed in both ISO TC130 and ICC balloting, hopefully in

April. The balloting is expected to go smoothly as the only technical changes are those associated with the approved ICC changes.

Making the Standards Work Together

There are many ways to describe the interaction and coordination between these standards that have resulted from this latest set of revisions. This report will simply identify key areas and show how they are handled.

Backing

The driving force behind the backing issue is that traditionally densitometry has used a black backing to minimize the effects of printing or other marks on the back side of the specimen being measured. However, in color management, when prints and proofs are being measured colorimetrically, black backing will darken the appearance of a thin or translucent sheet. If all proofs were made on the same substrate as was used for printing, this could minimize the problem. However, most proofing materials are more opaque than the printed sheet that they are simulating, and thus less sensitive to the backing showing through. A white backing allows the substrate of the printed sheet and that of the proof to more closely match.

Thus if color management profiles are to be used to help make proofs that match printing (or print to match the proof), colorimetric measurements for color management applications (e.g. building characterization data sets) must be made with a white backing. Add in the desire to get both density and colorimetry from one spectral measurement, and we have a real dilemma. At one point in the development of ISO 13655 it was suggested that self-backing (multiple sheets of the substrate used) should also be considered. However this was discarded as being to unpredictable.

The final solution was that both black and white backing are allowed in ISO 5-4, ISO 13655, and ISO 3664 with the requirement that the backing used be identified. In addition in ISO 13655 a procedure is given to modify tristimulus data for

halftone images for different substrate reflectances such as those caused by differences in backing materials. This correction method is also included later in this document.

Computation of density from digital data

Prior to this revision the ISO 5 series of standards ISO 5-3 made no provision for computation of density from digital data. It defined the spectral response functions that a filter densitometer was required to meet when the illumination system, the optical system, the detector, and any necessary filters were combined. The required response was defined at 10 nm intervals.

This revision of ISO 5.3 interpolated that data to a 1 nm interval. At 1 nm the spectral response function and spectral weighting factors are the same. However, once the data interval is increased to 5 or 10 nm, or even greater intervals, the spectral weighting factors must include both the densitometric spectral products and the coefficients of a polynomial for interpolating the spectral reflectance factor or transmittance.

These spectral weighting factors allow the computation of density directly from spectral reflectance (or transmittance) data. The standard also describes how to compute the spectral weighting factors for any data interval. These computations assume that the illumination system for measurement is CIE illuminant A.

Polarization

Prior versions of ISO 5-4 did not include any provision for the use of polarization in making density measurements, in spite of the fact that polarization is widely used in Europe and other parts of the world. This revision of ISO 5-4 adds polarization and defines a requirement and test for polarization efficiency.

While polarization is not common in colorimetric measurements and not very practical in viewing, a designation for that type of illumination is provided in all three of the standards.

Illumination sources

The issue that created the most difficulty

was the issue of illumination conditions and their applicability. These conditions are fully defined in ISO 13655 and referenced from the other standards. Although each condition is not generally applicable in some of the standards, provision is made in each standard for identifying the condition used. The key issues in our discussions were both specifying the measurement conditions required as we go forward and facing the reality of papers containing varying amounts of optical brightening agents, as well as providing adequate definitions of how much of our existing data was measured. Another issue was compatibility between metrology and viewing. The four conditions specified are as follows.

- **Measurement condition M0:**
Historically many spectrophotometers used in the graphic arts have used an incandescent lamp with a relative spectral power distribution that is close to CIE standard illuminant A. In addition this illuminant has historically been required for the measuring of density. Given that both colorimetric and density data are often required from the same spectral measurement, M0 is provided as a method of providing provenance to existing spectral data as well to meet the requirements for measuring spectrally, data that will be used for the calculation of density.
- **Measurement condition M1:**
To minimize the variations in measurement results between instruments due to fluorescence (by optical brighteners in the substrate and/or fluorescence of the printing and/or proofing colorants) the spectral power distribution of the light flux incident on the specimen surface for the measurement should match the CIE illuminant D50. There are two methods provided to achieve conformance to condition M1. 1) The spectral power distribution of the measurement source at the sample plane should match CIE illuminant D50. Conformance is based on the criteria specified in ISO 3664, including the metamerism in-

dex requirements for the UV region.

2) A spectral match of the spectral power distribution of the measurement source in the range of from 400 nm to 700 nm at the sample plane is not required if a compensation method is used with a controlled adjustment of the radiant power in the UV spectral region below 400 nm. This can be done by active adjustment of the relative power in this range with respect to a calibrated standard for D50. This compensation aims only to correct the effects of fluorescence of optical brighteners in the substrate. The power spectral distribution in the range from 400 to 700 nm shall be continuous.

- **Measurement condition M2:**

To exclude variations in measurement results between instruments due to fluorescence of optical brightening agents in the substrate surface, the source shall only contain substantial radiation power in the wavelength range above 400 nm (e.g. contain a UV cut filter).

- **Measurement condition M3:**

For use in special cases, an instrument may be equipped with means for polarization in order to suppress the influence of first-surface reflection on the color co-ordinates. An instrument fitted with a polarization filter must also fulfill the requirements of measurement condition M2.

It is important to realize that when measuring specimens that have no OBAs and do not use fluorescent inks, measurement conditions M0, M1, and M2 all produce identical results.

Validation of D50

SPD ISO 3664 specifies four criteria (and tolerances) for evaluating the adequacy of the conformance of an illumination source to CIE D50. These are:

1. Chromaticity aim and tolerance,
2. Color rendering index, general and special,
3. Visible metamerism index, and
4. UV metamerism index.

Although these are all defined in referenced CIE publications, from a practical point of view the varying subtleties between the documents and tests can be very confusing. This often leads to small disagreements between the calculations of various individuals or laboratories. To try to help this situation, informative Annex D has been added to ISO 3664. This annex provides a detailed step by step review of the required computations and pointers to the specific equations to be used. It also provides worked examples of each by utilizing CIE illuminants D55 and F8 as test sources to simulate the reference D50 illuminant. These were chosen, not because they are valid substitutes for D50, but because their SPD is documented in appropriate CIE publications, and therefore are readily available and will be consistent for any user. The intent is that anyone developing evaluation software can use these data to test and validate their computations and increase the probability that computations from various laboratories will match.

Color characterization data

ISO 15076-1 points to ISO 13655 as the basis for the colorimetric data in characterization data sets, but notes that white backing is preferred for color management applications. As ISO 13655 requires that the backing used be specified, this enables the use of the tristimulus correction method, where necessary, to convert data measured on other than a standard white backing to be converted to a white backing equivalent.

Tristimulus correction method

Although the tristimulus correction method preceded the work involved in bringing these standards into agreement, it did play a significant part in enabling the vision that this coordination was possible.

Looking to the Future

It is true that not all of the documents that include the changes described have received final approval. That is not anticipated to be a problem.

In addition these documents are living documents within the TC130 and TC42 committees and will be revised many times in the future. It is the responsibility of the TC130, TC42, and ICC communities to monitor these documents to both initiate needed changes and to insure that any changes are reflected across all documents.

Fortunately there are overlaps in membership among all three communities and this should help ensure that disconnects between the documents do not occur.

For suggestions for (or input to) future updates, or standards questions in general, please contact the author at
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IS&T REPORTER

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UPCOMING EVENTS

*IS&T Conferences listed in blue;
other organization's meetings in black*

April 27– 29, 2009; Philadelphia, Pennsylvania
Organic Photovoltaics 2009
For more information: www.organicphotovoltaics2009.com

May 5–8, 2009; Arlington, Virginia
Archiving 2009
General Chair: William G. LeFurgy

May 27–29, 2009; Budapest, Hungary
CIE Midterm Meeting and Lighting Conference 2009
For more information: <http://cie-hungary.hu>

May 31–June 5, 2009; San Antonio, Texas
SID's 47th International Symposium, Seminar and Exhibition Display
For more information: www.sid2009.org

June 7–8, 2009; Rochester, New York
**Inter-Society Color Council (ISCC) 2009 Annual Meeting and
Munsell Color Science Laboratory 25th Anniversary Symposium**
For more information: www.iscc.org/meetings/AM2009/

July 10–13, 2009; Orlando, Florida
6th International Conference on Cybernetics and Information Technologies, Systems and Applications: CITSA 2009
For more information: www.2009iisconferences.org/CITSA

July 13 - July 17, 2009; Baoan, Shenzhen, China
The 8th International Symposium of Display Holography
For more information: www.isdh.org.cn

July 27 - July 31, 2009; Carrabassett Valley, Maine
Digital Printing Summer Camp
For more information: imi@imiconf.com

September 20–25, 2009; Louisville, Kentucky
NIP25: 25th International Conference on Digital Printing Technologies/Digital Fabrication Processes 2009
General Chairs: Huoy-Jen Yuh (NIP25) and Reinhard Baumann (DF2009)

November 9–13, 2009; Albuquerque, New Mexico
Seventeenth Color Imaging Conference (CIC17)
General Chairs: Karen Braun and Moshe Ben-Chorin

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