IS&T REPORTER
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HIGHLIGHTED PAPERS

Color and Imaging CIC 19

Winner of the MERL Best Student Paper Award

Hiding Patterns with Daylight Fluorescent Inks

Romain Rossier and Roger D. Hersch, Ecole Polytechnique Fédérale de Lausanne (EPFL) (Switzerland)

Abstract: We propose a method for hiding patterns within printed images by making use of classical and of two daylight fluorescent magenta and yellow inks. Under the D65 illuminant we establish in the CIELAB space the gamut of a classical cmyk printer and the gamut of the same printer using a combination of classical inks with daylight fluorescent inks. These gamuts show that a significant part of the classical ink gamut can be reproduced by combining classical inks with daylight fluorescent inks. By printing parts of images with a combination of classical and daylight fluorescent inks instead of using classical inks only, we can hide security patterns within printed images. Under normal daylight, we do not see any difference between the parts printed with classical inks only and the parts printed with daylight fluorescent inks and continues on page 2

To view the full papers of these abstracts for no fee go to www.imaging.org/ist/publications/reporter/index.cfm

* These papers were presented at CIC19, held November 7-11, 2012, in San Jose, CA.

Technologies in Digital Photo Fulfillment TDPF2012

Preservation of Photographic Images for Future Generations: New Opportunities for Prints and Photo Books

Joseph E. LaBarca, Pixel Preservation International (USA)

Abstract: Upon discovering the 120 year old object in their grandparents' attic, most people today would be hard-pressed to play back a recording made on a wax cylinder of the late 1800s. What will people do just 50 years from now with an optical disk or magnetic hard drive? Over time, we have recorded our memories in many ways: letters, post cards, photographs, movies, audio and video recordings are a few examples. In earlier days, interpreting those recordings was independent of the technology used to create them – you could hold and view a hard copy document in your hand. How will future generations deal with those post cards, letters to the family, and photographs that have now been replaced by "Word documents", email, and digital images on the computer? While professional and mass-portrait labs recognize the importance of hard copy images, the word needs to spread from there. The end consumer in particular needs to become aware of long-term storage issues that relate to the preservation of the data behind digital documents including photographic images. Longer-term issues beyond routine backup and migration of data need to be considered, and preservation via human-readable hardcopy images is a key option. This paper continues on page 4

To view the full papers of these abstracts for no fee go to www.imaging.org/ist/publications/reporter/index.cfm

* These papers were presented at the International Symposium on Technologies in Digital Photo Fulfillment conference, held January 8-9, 2012, in Las Vegas, NV.

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classical inks. By changing the illumination, e.g. by viewing the printed image under a tungsten lamp or under a UV lamp, the daylight fluorescent inks change their colors and reveal the security pattern formed by combinations of classical inks and of daylight fluorescent inks.

Winner of the Cactus Award

TangiPaint: A Tangible Digital Painting System

Anthony Blatner, James Ferwerda, Benjamin Darling, and Reynold Bailey, Rochester Institute of Technology (USA)

Abstract: TangiPaint is a digital painting application that provides the experience of working with real materials such as canvas and oil paint. Using fingers on the touchscreen of an iPad or iPhone, users can lay down strokes of thick, three-dimensional paint on a simulated canvas. Then using the Tangible Display technology introduced by Darling and Ferwerda, users can tilt the display screen to see the gloss and relief or "impasto" of the simulated surface, and modify it until they get the appearance they desire. Scene lighting can also be controlled through direct gesture-based interaction. A variety of "paints" with different color and gloss properties and substrates with different textures are available and new ones can be created or imported. The tangiPaint system represents a first step toward developing digital art media that look and behave like real materials.

A Study on Spectral Response for Dichromatic Vision

Hiroaki Kotera, Kotera Imaging Laboratory (Japan)

Abstract: The paper proposes a novel approach to analyze the dichromatic color vision defects from a point of spectral responses based on the projection theory of spectral space to/from 2-D dichromatic Human Visual Sub-Space. The visible spectra to the dichromats (protanopes, deutanopes, and tritanopes) are extracted from an n-dimensional spectral input with the 2-D version of Matrix-**R** notated as $\mathbf{R}_{\text{dichro}}$. Since the matrix $\mathbf{R}_{\text{dichro}}$ is an identical and invariant mapping operator inherent in human vision that is independent of any linear transformation or any illuminant, the fundamental spectra **C***dichro sensed with matrix $\mathbf{R}_{\text{dichro}}$ are also inherent in the dichromats. The lost spectra are easily obtained as a difference in the fundamentals between the normals and the the dichromats. These lost spectral profiles tell us why the color appearances are similar to the protanopes and deutanopes, and dissimilar to the tritanopes.The perceived colors are simulated based on the two hypotheses of substitution and nulling processes.

Efficient Spectral Imaging based on Imaging Systems with Scene Adaptation Using Tunable Color Pixels

Andy L. Lin and Francisco Imai, Canon USA, Inc. (USA)

Abstract: Conventional spectral imaging systems use a set of predetermined filters to capture multi-band images. Liquid crystal tunable filters (LCTF) and active illumination allow reconfiguration of spectral sensitivities but these techniques have shortcomings such as latency due to multiple captures and the fact that the same filtering or illumination is applied to the whole frame of the image. There are emerging device technologies that allow independent adjustment of the filtering for each region or even at a pixel level of the imaging frame. The operation of such imaging systems is controlled by adapting to the scene based on scene analysis. Experiments were run by simulating a spectral imaging system which adjusts pixel sensitivities based on color information from the scene. As a result this new system exhibits superior performance compared to traditional spectral imaging systems in terms of color accuracy and imaging capture efficiency.

Predicting Image Differences Based on Image-Difference Features

Ingmar Lissner, Jens Preiss, and Philipp Urban, Technische Universität Darmstadt (Germany)

Abstract: An accurate image-difference measure would greatly simplify the optimization of imaging systems and image processing algorithms. The prediction performance of existing methods is limited because the visual mechanisms responsible for assessing image differences are not well understood. This applies especially to the cortical processing of complex visual stimuli.

We propose a flexible image-difference framework that models these mechanisms using an empirical data-mining strategy. A pair of input images is first normalized to specific viewing conditions by an image appearance model. Various image-difference features (IDFs) are then extracted from the images. These features represent assumptions about visual mechanisms that are responsible for judging image differences. Several IDFs are combined in a blending step to optimize the correlation between image-difference predictions and corresponding human assessments.

We tested our method on the Tampere Image Database 2008, where it showed good correlation with subjective judgments. Comparisons with other image-difference measures were also performed. ▲

MCS13 Collocates with CIC19 in the Silicon Valley

By Stephen Westland and Xuemei Zhang, CIC19 Program Chairs

The 19th Color and Imaging Conference (CIC19) was held on November 7-11, 2011 at the historic Sainte Claire Hotel in San Jose, California, in the heart of Silicon Valley. The conference was attended by 217 delegates from 18 countries and was chaired by Geoff Wolfe (Canon Information Systems Research Australia Pty. Ltd.) and James Ferwerda (Munsell Color Science Lab/RIT).

The 13th International Symposium on Multispectral Color Science was collocated with CIC this year. It was held Friday afternoon and consisted of two sessions oral paper sessions Spectral Acquisition (chaired by Norimchi Tsumura, Chiba University) and Spectral Illumination and Visualization (chaired by Shigeki Nakauchi, Toyohashi University of Technology) and a short paper session.

Photo: Diana Gonzalez.

Shigeki Nakauchi (Toyohashi University of Technology) presents his Short Paper, "An Efficient Designing Method of Spectral Distribution of Illuminant for the Enhancement of Color Discrimination."

Awards

A highlight of the conference was the awarding of the MERL Best Student Paper to Romain Rossier (Ecole Polytechnic Federale De Lausanne) for his work with Roger Hersch on "Hiding Patterns with Daylight Fluorescent Inks." The paper describes a clever method of hiding watermarks in printed image using a combination of classical and daylight-fluorescent inks. The Cactus (Best Short Paper) Award went to "TangiPaint: A Tangible Digital Painting System" by Anthony Blatner, James Ferwerda, Benjamin Darling, and Reynold Bailey (Rochester Institute of Technology), a fun paper that also came with a demo of a cool digital oil-painting application on the iPad.

CIC 19

Attendees*:	217
Oral Papers:	40
Interactive Papers:	28
Short Courses:	21
Dates:	November 7-11, 2012
Location:	San Jose, CA

*includes Short Course only and guests

Keynotes

The main technical program consisted of 37 full-length, 3 keynotes, and 28 short papers covering a wide gamut of color topics. The Keynote lectures were of a particularly high standard featuring Kathy Mullen (McGill University) who described some of the latest advances in functional magnetic resonance imaging (fMRI) and how they were shaping our understanding of the mechanisms of human color vision; David Brainard (University of Pennsylvania) who reviewed work that clarifies the demosaicing algorithm used by the human visual system and presented results that showed that natural images contain sufficient statistical structure to support unsupervised learning of cone classes; and Robert Hunt (consultant) who rounded off an entertaining series of invited talks that began in 2009 by discussing how higher-order visual phenomena that affect material appearance and color. Delegates also enjoyed an evening lecture by David Gallo (Woods Hole Oceanographic Institute) who presented stunning visual images and movies to illustrate his fascinating talk about the world of color beneath the sea.

Special and Technical Sessions

The CIC week kicked off with a special two-day class on Color Science and Imaging and 20 two-hour courses covered topics such as LED Lighting Characterization and Visual Quality (presented by Francois Vienot, Museum National D'Histoire Naturelle), Color Pipelines for Computer Animated Features (presented by Rod Bogart, Pixar, and Stefan Luka, Walt Disney Feature Animation) and Display Technologies (Gabriel Marcu, Apple Computer).

A special session with four oral papers on Color Rendering Index was chaired by Lorne Whitehead (University of British Columbia). It discussed recent developments and new issues in assessing color rendering quality of new types of illuminants such as LED lighting. The session included a thought-provoking panel moderated by Mike Brill (Datacolor) a featuring Gerard Harbers (Xicato), Charles Hunt (University of California, Davis), Ronnier Luo (University of Leeds), Steve Paolini (Lunera Lighting), Mark Rea (Rensselaer Polytechnic Institute), Kevin Smet (University of British Columbia), and Whitehead. The panel discussion followed

There was also a special session on High Dynamic Range (HDR) Imaging, chaired by Anders Ballestad (Dolby Canada Corporation) and Mahdi Nezamabadi (Dolby Laboratories) that included four oral papers on HDR research in areas of color and tone reproduction, capturing and display, and in low vision applications.

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Photo: Diana Gonzalez.

Alessandro Rizzi (University of Milan) and John McCann (consulting) signed their recently released "The Art and Scienc of HDR Imaging," an IS&T/Wiley Series book, available from IS&T.

Third Symposium on Digital Photo Fulfillment Brings Key Industry Participants Together

By Stuart Gordon, TDPF Symposium Chair and Steve Howe, TDPF Program Chair

TDPF 2012

Attendees:	varied by session
Oral Papers:	15
Dates:	January 8-9, 2012
Location:	Las Vega, NV

The Third International Symposium on Technologies for Digital Photo Fulfillment was held in Las Vegas, January 8-9, 2012. It featured 15 excellent papers covering a wide range of topics, including papers on image enhancement, CD media, photo books, industry trends and numerous papers dealing with the permanence and durability of hard and soft copy images. The symposium reflects the continuation of digital imaging as the consumer's choice mode for taking photos in the 21st century. While capture and image processing have directly effected the growth of digital photography, fulfillment of images captured is lagging behind. This was the first time the conference was run as a track of the PMA-DIMA CLiQ program and this definitely helped increase the number of attendees. Both PMA and the conference attendees expressed satisfaction with the new format. While growth in traditional 4"x6" images appears to be limited, personalized photo gifting including photo books, provides significant growth opportunities for this market.

Because the conference was being run as a track during CLiQ, there was no keynote specific for the conference. However, conference attendees were treated to the CLiQ keynote given by Tia Newcomer (Hewlett-Packard Company) who spoke on "Customer at the Core: Hardware is Important, but Experience is King."

The more intimate nature of the conference allowed old friends and new acquaintances to engage in more lively and informative discussions during the sessions, as well as at the networking events.

Feedback from the symposium participants indicates that most found the conference useful and would attend again. Being part of the PMA-DIMA program definitely made the conference more successful. There appears to be interest in running this again in 2013. These views will be taken into consideration as IS&T makes plans for the next International Symposium on Technologies for Digital Photo Fulfillment. ▲

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provides an update on preservation strategies for the consumer and suggestions for the professional imaging laboratories to communicate these strategies to the consumer. While the familiar advice to "make a hard copy" provides a solid foundation, we go beyond this recommendation, with the intent to raise consumer awareness of the need to create a long-term preservation plan for their most treasured images and the data behind them.

HP-Indigo Technology and its Application to Photo Printing

Boaz Tagansky, Hewlett Packard Company (Israel)

Abstract: HP-Indigo technology delivers superb print quality at a high printing speed over a wide range of substrates, including glossy matt and textured papers, as well as photo or other non paper substrates. Together with its flexibility and end to end solution portfolio it brings state of the art capabilities to a variety of photo applications, making HP-Indigo the dominant player in the digital photo printing market.

HP Indigo digital presses use liquid electrophotography based on ElectroInk®, with a hot transfer blanket. After electrically charging the photoconductor a latent image is created by a multi-beam laser scanning unit. Then ink is developed onto the latent image by one of the various colored ink development stations. After ink transfers to the blanket using electric field, the carrier liquid is evaporated off the hot blanket, and the resultant hot melted ink film is transferred to the substrate by means of pressure and tackiness. This process is repeated once for each color.

During the printing process a nearly solid ink image is created on a blanket, subsequently adhered to the surface of the substrate with almost no change and without penetrating into the media. Thus the high image quality is independent from the substrate characteristics. In addition, the ink layer is thin enough to achieve the feel of the substrate, so by choosing the substrate one can control the feel of the image, without compromising on image quality.

The flexibility of the technology enable both sheet fed and web fed presses, with nearly identical image characteristics. By using HP Indigo unique special inks, such as the white ink or the photo inks (light cyan, light magenta), print providers can create premium products.

End to end solutions of workflow and finishing are also provided by HP Indigo and through a network of partners. Work flow solutions include creation software, automatic image enhancement, imposition, high speed rips, and color transforma-

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The technical program included the following session: Color and Perception (chaired by Francois Vienot, Museum National D'Histoire Naturelle); Image Quality (chaired by Hagit Hel-Or, University of Haifa, Israel); Computational Imaging (chaired by Sabine Süsstrunk, Ecolé Polytechnique Fédérale de Lausanne); Color in Displays (chaired by Jennifer Gille, Qualcomm QMT); Color Printing (chaired by Xuemei Zhang, Apple Computer); Aesthetics Color (chaired by Jan Allebach, Purdue University); and Miscellaneous Color Curiosities (chaired by Vien Cheung, University of Leeds).

Shorter oral papers were presented in two sessions on Wednesday, spanning a wide range of topics and chaired by Nicolas Bonnier (Océ Print Logic Technologies) and Yonghui Zhao (Xerox Corporation). This year the short papers were presented in a new format, where each author gave a short presentation twice in a half-hour slot. Slide-sets and demos were supported via monitors. The new format received mixed feedback, but the short papers were of a high quality and were well-received by attendees.

Photo: Diana Gonzalez

IS&T President Robert Buckley presents Michael Brill with his Senior Membership award.

All papers from the conference are available from IS&T as either a hardcopy proceedings book and CD, or as downloadable PDFs. The next Color and Imaging Conference (CIC20) celebrates the twentieth year of the conference. It will be held in November 12-16 in Los Angeles, CA. General Chairs Stephen Westland (University of Leeds) and Xuemei Zhang (Apple Computer) look forward to welcoming you there. ▲

IS&T REPORTER

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Standards Editor: David McDowell

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Imaging.org focuses on all aspects of imaging, with particular emphasis on digital printing, electronic imaging, image perception, photo fulfillment, color imaging, image preservation, digital fabrication, and the physics and chemistry of imaging processes. For more information, visit imaging.org. IS&T publishes the *Journal of Imaging Science & Technology* and (with SPIE) *Journal of Electronic Imaging*.

Please send inquiries to: *info@imaging.org*

tions. Finishing solutions include in-line lamination, in-line liquid coating, cutting, stacking, book binding and more.

HP-Indigo equipment is used by the Photofinisher and professional lab, to create photo books, self-Published books, calendars, invitations, greeting cards, yearbooks, portraits, photo prints, theme items and more. Most of the photo books printed worldwide today are produced using HP-Indigo technology because there is a consensus among Print Service Providers about the Indigo technology being the one appropriate for the quality needs of the segment

The Cracking of Inkjet Colorant Receiver Layers on Exposure to Light

Eugene Salesin and Daniel Burge, Image Permanence Institute (USA)

Abstract: The purpose of this investigation was to determine whether exposure to light or ozone increases the sensitivity of some inkjetprinted images to surface cracking during handling. In previous studies, several inkjet print examples showed a potential for significant cracking and flaking of the image area when handled after exposure to light and ozone. In these new experiments both printed and unprinted samples of two glossy porous photo inkjet papers from different manufacturers were exposed in separate experiments to 50 kilo-lux fluorescent and 50 kilo-lux xenon light in increments of time for up to twelve weeks and to 5 ppm ozone for one and two weeks. The exposed samples were tested for cracking according to the procedure described in ISO 18907 "Imaging Materials – Photographic Films and Papers – Wedge Test for Brittleness". The samples were evaluated visually both with and without magnification to determine the wedge diameter where cracking is first seen. The samples were also measured with a Gretag Spectroscan to determine if the increase in cracking came before or after noticeable colorant fade or paper yellowing occurred. Even though the two papers selected for this study were the same type, they behaved entirely differently. One paper showed sensitivity to crack before exposure and increasing propensity to crack with exposure to light and ozone. The other paper was not sensitive to crack before exposure and only after twelve weeks exposure to xenon light showed surface disintegration. Because of this, it is difficult to reach general conclusions that represent the entire spectrum of inkjet print media. Additional work is needed to provide a more complete picture of brittleness behavior of these materials after exposure to light and ozone. ▲

STANDARDS UPDATE:

David Q. McDowell, Editor

This issue of *Standards Update* focuses on the work of CIE Division 1, Technical Committee 57, Standards in Colorimetry, and the duel logo ISO/CIE standards ISO 11664 (CIE 014).

Background

TC1-57 has been working for several years to create a family of joint CIE/ISO standards to supplement the existing CIE/ISO standards for Standard Colorimetric Observers and Standard llluminants for Colorimetry. These new standards define the method of calculating CIE tristimulus values and chromaticity coordinates, a uniform color space and its associated metrics, and a formula for industrial color difference evaluation. These definitions have previously been largely contained in CIE Publication 15, Colorimetry. CIE Publication 15 is written as a report or recommendation and cannot be easily referenced as a normative document by the standards community.

Although the standard illuminants were originally published as ISO 10527/CIE S 014-1 and the standard observers were documented in ISO 10526/CIE S 014-2 they have been updated and made part of an ISO multipart standard called ISO 11664, *Colorimetry*, which also carries the designation CIE S 014. The various parts are:

- *Part 1: CIE standard colorimetric observers*
- *Part 2: CIE standard illuminants*
- *Part 3: CIE tristimulus values*
- *Part 4: CIE 1976 L*a*b* colour space*
- *Part 5: CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram*
- *Part 6: CIEDE2000 Colour difference formula.*

The technical work on these has all been completed and Parts 1, 2, 4, and 5 are published as CIE standards. Part 3 is in final ISO balloting and Part 6 is in CIE National Body balloting.

Copies of these standards may be obtained from the ISO website (www.iso.org), National Standards bodies (e.g. www.ANSI.org), the National Committees of the CIE or via the website of the Central Bureau of the CIE (www.cie.co.at).

Part 1: CIE standard colorimetric observers

Colours with different spectral compositions can look alike. An important function of colorimetry is to determine whether a pair of such metameric colours will look alike. It has long been the practice in colorimetry to make use of sets of colour-matching functions to calculate tristimulus values for colours: equality of tristimulus values for a pair of colours indicates that the colour appearances of the two colours match, when they are viewed in the same conditions by an observer for whom the colour-matching functions apply. The use of standard sets of colour-matching functions makes the comparison of tristimulus values obtained at different times and locations possible.

This International Standard specifies colour-matching functions for use in colorimetry. Two sets of colour-matching functions are specified:

- **Colour-matching functions for the CIE 1931 standard colorimetric observer.** This set of colour-matching functions is representative of the colour-matching properties of observers with normal colour vision for visual field sizes of angular subtense from about 1° to about 4°, for vision at photopic levels of adaptation.
- **Colour-matching functions for the CIE 1964 supplementary standard colorimetric observer.** This set of colour-matching functions is representative of the colour-matching properties of observers with normal colour vision for visual field sizes of angular subtense greater than about 4°, for vision at sufficiently high photopic levels and with spectral power distributions such that no participation of the rod receptors of the retina is to be expected.

Part 2: CIE standard illuminants

CIE standard illuminants are used in colorimetry to compute the tristimulus values of reflected or transmitted object colours under specified conditions of illumination.

This International Standard specifies two illuminants for use in colorimetry:

- **CIE standard illuminant A.** This is intended to represent typical, domestic, tungsten-filament lighting. CIE standard illuminant A should be used in all applications of colorimetry involving the use of incandescent lighting, unless there are specific reasons for using a different illuminant.
- **CIE standard illuminant D65.** This is intended to represent average daylight. CIE standard illuminant D65 should be used in all colorimetric calculations requiring representative daylight, unless there are specific reasons for using a different illuminant. Variations in the relative spectral power distribution of daylight are known to occur, particularly in the ultraviolet spectral region, as a function of season, time of day, and geographic location. However, CIE standard illuminant D65 should be used pending the availability of additional information on these variations.

Part 3: CIE tristimulus values

Colour stimuli with different spectral distributions can look alike. An important function of colorimetry is to determine which stimuli look alike to a given observer with a given set of colour-matching functions. This is done by calculating a set of three tristimulus values for each stimulus. Equality of tristimulus values indicates equality of colour appearance under equal irradiation and viewing conditions.

This International Standard is based on long-standing CIE recommendations for the calculation of tristimulus values. It specifies methods of calculating the tristimulus values of colour stimuli for which the spectral distributions are provided. These colour stimuli may be produced by self-luminous light sources or by reflecting or transmitting objects.

The standard method is defined as summation at 1 nm intervals over the wavelength range from 360 nm to 830 nm. Alternative abridged methods are defined for larger intervals (up to 5 nm) and shorter ranges (down to 380 nm to 780 nm). The alternative methods are to be used only when appropriate and when the user has reviewed the impact on the final results.

The Standard may be used in conjunction with the CIE 1931 standard colorimetric observer or the CIE 1964 standard colorimetric observer that are documented in Part 2 of this International Standard.

Part 4: CIE 1976 L*a*b* colour space

The three-dimensional colour space produced by plotting CIE tristimulus values (X,Y,Z) in rectangular coordinates is not visually uniform, nor is the (x,y,Y) space nor the two-dimensional CIE (x,y) chromaticity diagram. Equal distances in these spaces and diagrams do not represent equally perceptible differences between colour stimuli.

For this reason, in 1976, the CIE introduced and recommended two new spaces (known as CIELAB and CIELUV) whose coordinates are non-linear functions of X, Y and Z. The recommendation was put forward in an attempt to unify the then very diverse practice in uniform colour spaces and associated colour difference formulae. Both these more-nearly uniform colour spaces have become well accepted and widely used. Numerical values representing approximately the relative magnitude of colour differences can be described by simple Euclidean distances in the spaces or by more sophisticated formulae that improve the correlation with the relative perceived size of differences.

The purpose of this CIE Standard is to define procedures for calculating the coordinates of the CIE 1976 L*a*b* (CIELAB) colour space and the Euclidean colour difference values based on these coordinates. The standard does not cover more sophisticated colour difference formulae based on CIELAB, such as the CMC formula, the CIE94 formula, the DIN99 formula, and the CIEDE2000 formula nor does it cover the alternative uniform colour space, CIELUV.

Part 5: CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram

This CIE Standard specifies the method of calculating the coordinates of the CIE 1976 L*u*v* colour space including correlates of lightness, chroma, saturation and hue. It includes two methods for calculating Euclidean distances in this space to represent the relative perceived magnitude of colour differences. It also specifies the method of calculating the coordinates of the u',v' uniform chromaticity scale diagram.

The Standard is applicable to tristimulus values calculated using the colour-matching functions of the CIE 1931 standard colorimetric system or the CIE 1964 standard colorimetric system.

The Standard may be used for the specification of colour stimuli perceived as belonging to a reflecting or transmitting object, where a three-dimensional space more uniform than tristimulus space is required. This includes self-luminous displays, like cathode ray tubes, if they are being used to simulate reflecting or transmitting objects and if the stimuli are appropriately normalized.

The Standard, as a whole, does not apply to colour stimuli perceived as belonging to an area that appears to be emitting light as a primary light source, or that appears to be specularly reflecting such light. Only the u',v' chromaticity diagram defined in Section 4.1 and the correlates of hue and saturation defined in Section 4.3 apply to such colour stimuli.

Part 6: CIEDE2000 Colour difference formula.

The three-dimensional colour space produced by plotting CIE tristimulus values (*X,Y,Z*) in rectangular coordinates is not visually uniform, nor is the (*x,y,Y*) space nor the two-dimensional CIE (*x,y*) chromaticity diagram. Equal distances in these spaces and diagrams do not represent equally perceptible differences between colour stimuli.

For this reason the CIE has standardized two more-nearly uniform colour spaces (known as CIELAB and CIELUV) whose coordinates are non-linear functions of *X, Y* and *Z*. Numerical values representing approximately the relative magnitude of colour differences can be described by simple Euclidean distances in these spaces or by more sophisticated colour-difference formulae that improve the correlation with the relative perceived size of differences.

The purpose of this CIE Standard is to define one such formula, the CIEDE2000 formula. The Standard is based on CIE Technical Report 142-2001. The formula is an extension of the CIE 1976 (*L*a*b**) colour-difference formula contained in Part 4 with corrections for variation in colour-difference perception dependent on lightness, chroma, hue and chroma-hue interaction.

Reference conditions define material and viewing environment characteristics to which the formula applies.

For questions about the activities of TC 130 , for suggestions for (or input to) future updates, or standards questions in general, please contact the editor at mcdowell@npes.org.

UPCOMING IS&T EVENTS

May 6-9, 2012; Amsterdam, the Netherlands
CGIV 2012
General Chair: Theo Gevers

June 12-15, 2012; Copenhagen, Denmark
Archiving 2012
General Chairs: Mogens Koch and Jonas Palm

September 9–13, 2012; Quebec City, Canada
NIP28: 28th International Conference on Digital Printing Technologies/Digital Fabrication 2012
General Chairs: Scott Silence (NIP28) and Paul Benning (Digital Fabrication 2012)

November 12-16, 2012; Los Angeles, California
Twentieth Color Imaging Conference (CIC20)
General Chairs: Stephen Westland and Xuemei Zhang

January 3-7, 2013; San Francisco Airport Hyatt Regency
Electronic Imaging 2013
Symposium Chairs: Gaurav Sharma and Sergio Goma

To learn about all upcoming IS&T meetings, go to www.imaging.org/ist/Conferences/.
For a complete list of imaging-related meetings, go to www.imaging.org/ist/conferences/events.cfm

New Korea Chapter Partnering with MCS 2012

IS&T is pleased to announce that a new Chapter is currently in the process of being formed within Korea. Those interested in learning more about these efforts should contact info@imaging.org to be put in touch with chapter leadership. One of the first things the Korea Chapter is undertaking is the co-sponsorship of MCS 2012.

September 26-27, 2012 Daegu, Korea
MCS (Multispectral Colour Science) 2012

History: The MCS symposium was launched in 1999 as The International Symposium on Multispectral Imaging and Color Reproduction for Digital Archives under the initiative of Yoichi Miyake (Chiba University). The symposium rotates locations.

Scope: Many aspects of multispectral image acquisition, processing, and reproduction have been extensively researched. This symposium is intended to review the current state of the art and address major challenges and future directions in multispectral color science and imaging. Scientists and engineers from all over the world are invited to exchange knowledge, technology, and ideas on various topics such as novel multispectral techniques, multispectral encoding, spectral-based image processing, the evaluation and applications of multispectral systems, and color imaging.

Scope: www.mcs2012.org

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