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Electronic Imaging Symposium 2015

BEST STUDENT PAPER AWARDS

Digital Photography and Mobile Imaging XI

Blind deconvolution of images with model discrepancies using maximum a posteriori estimation with heavy-tailed priors

Jan Kotera[1,2] and Filip Šroubek[1], [1]Czech Academy of Sciences and [2]Charles University in Prague (Czech Republic)

Abstract: Single image blind deconvolution aims to estimate the unknown blur from a single observed blurred image and recover the original sharp image. Such task is severely ill-posed and typical approaches involve some heuristic or other steps without clear mathematical explanation to arrive at an acceptable solution. We show that a straight-forward maximum a posteriori estimation incorporating sparse priors and mechanism to deal with boundary artifacts, combined with an efficient numerical method can produce results which compete with or outperform much more complicated state-of-the-art methods. Our method is naturally extended to deal with overexposure in low-light photography, where linear blurring model is violated.

Document Recognition and Retrieval XXII

Intelligent indexing: A semi-automated, urainable system for field labeling

Robert Clawson and William Barrett, Brigham Young University (USA)

Abstract: We present Intelligent Indexing: a general, scalable, collaborative approach to indexing and transcription of non-machine-readable documents that exploits visual consensus and group labeling while harnessing human recognition and domain expertise. In our system, indexers work directly on the page, and with minimal context switching can navigate the page, enter labels, and interact with the recognition engine. Interaction with the recognition engine occurs through preview windows that allow the indexer to quickly verify and correct recommendations. This interaction is far superior to conventional, tedious, inefficient post-correction and editing. Intelligent Indexing is a trainable system that improves over time and can provide benefit even without prior knowledge. A user study was performed to compare Intelligent Indexing to a basic, manual indexing system. Volunteers report that using Intelligent Indexing is less mentally fatiguing and more enjoyable than the manual indexing system. Their results also show that it reduces significantly (30.2%) the time required to index census records, while maintaining comparable accuracy. (a video demonstration is available at youtube.com/gqdVzEPnBEw)

Gaussian process style transfer mapping for historical Chinese character recognition

Jixiong Feng and Liangrui Peng, Tsinghua University (China), and Franck Lebourgeois, Universitè de Lyon (France)

Abstract: Historical Chinese character recognition is very important to larger scale historical document digitalization, but is a very challenging problem due to papers continue on page 9

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 within the conference noted at the IS&T/SPIE Electronic Imaging Symposium, held Feb. 8–12, 2015, in San Francisco, CA.*

Delp and Rabbani Honored with EI Scientists of the Year

Photo: Stephen Keith.

Symposium Co-chair Choon-Woo Kim (far left) and Symposium Chair Sheila Hemami (far right) present the 2015 EI Scientist of the Year Award to two well-known and highly-respected members of the EI community, Prof. Edward Delp of Purdue University and Dr. Majid Rabanni of Eastman Kodak Company.

INSIDE THIS ISSUE

HIGHLIGHTS FROM ELECTRONIC IMAGING 2015

By Mojgan Rabbani, Xerox Corporation

The 27th I&T/SPIE Electronic Imaging (EI) Symposium was held February 8-12 at the Hilton San Francisco Union Square. The 960 participants, who were roughly divided evenly between US and non-US locations, represented 43 countries and spanned a diverse set of disciplines from academia, industry, and government labs.

Symposium Chair and Co-chair Sheila Hemami (Northeastern University, USA) and Choon-Woo Kim (Inha University, Republic of Korea), respectively, led a commitee team that included Short Course Chair Majid Rabbani (Eastman Kodak Company, USA).

The Symposium consisted of 347 oral presentations, 91 interactive poster presentations, and 15 short courses. It contained seven main technology clusters, each made up of one to five technical conferences, for a total of 21 conferences. The seven clusters were: (i) 3D imaging, Interaction, and Metrology, (ii) Visualization, Perception, and Color, (iii) Image Processing, (iv) Image Capture, (v) Computer Vision, (vi) Media Processing and Communication, and (vii) Mobile Imaging. As it is apparent from the cluster titles, the EI Symposium addresses a broad set of topical areas in the field of electronic imaging making it one of the premier venues in this field.

Following a historic trend, the two conferences with the greatest number of accepted papers were "Human Vision and Electronic Imaging (HVEI)" (57 papers)—which celebrated its 25th anniversary in 2013—and "Stereoscopic Displays and Applications" (49), which celebrated its 25th anniversary last year. These were followed closely by "Color Imaging XX: Displaying, Processing, Hardcopy, and Applications" (45), and "Image Processing: Algorithms and Systems XIII" (44).

The HVEI conference continued to attract its dedicated group of researchers and authors. The conference brings in research in the areas of psychology, art and social sciences to study the interpretation of the information by the human visual system. At the end of each day, the conference holds a daily interactive discussion with authors and participants while generously providing snacks and drinks thanks to industry sponsors. Additionally, HVEI held a special panel on "New Frontiers in Perceptual Image Quality" featuring some of the most prominent researchers in the field.

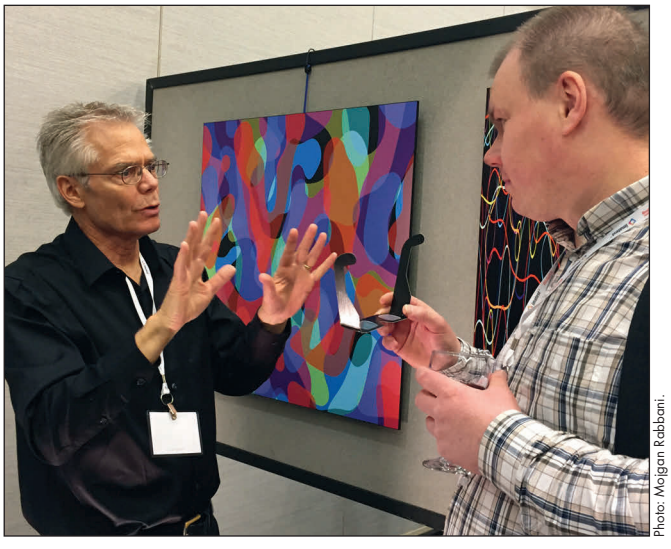

Photo: Mojgan Rabbani.

Left: Steve Mason, an artist from Yavapai College in Prescott, AZ, explains his 3D art during the Demonstration Session. Mason's art requires viewers to use ChromaDepth glasses to achieve a 3D effect from a single image. **Below:** Prof. Brian A. Wandell, Isaac and Madeline Stein Family Professor at Stanford University, is presented with Honorary Membership—the highest award of the Society—for outstanding contributions and leadership in furthering our understandings of human vision, color science and color imaging by IS&T President Alan Hodgson.

Photo: Stephen Keith.

The Stereoscopic Displays and Applications (SD&A) conference—the world's longest-running technical conference dedicated to the discussion of technical stereoscopic imaging topics—covers topics such as autostereoscopic displays, 3D cinema, 3DTV, 3D image processing, visual comfort, and 3D image quality. The sessions at the conference included keynote presentations, live demonstrations of stereoscopic equipment, and the ever-popular 3D Theatre.

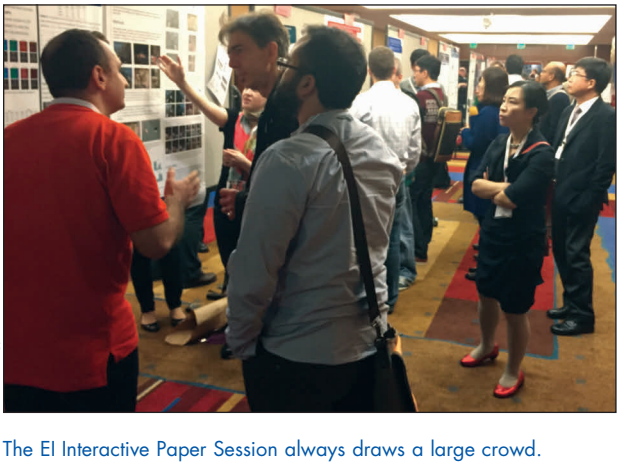

Photo: Mojgan Rabbani.

The EI Interactive Paper Session always draws a large crowd.

Symposium Plenary and Conference Keynote Speakers

The two symposium plenary presentations, scheduled on Tuesday and Wednesday mornings, along with the Symposium-wide keynotes (see page 4 for a full

EI2015

Attendees*:	959
Oral Papers:	347
Interactive Papers:	91
Short Courses:	15
Exhibitors:	8
Dates:	February 8–12, 2015
Location:	San Francisco, California

*includes Short Course only and guests

listing) planned by the individual conferences throughout the week, are my personal favorites and among the most informative events of the conference. The plenary talks, which report on pioneering research in the broader field of electronic imaging, always attract a full house.

James Rehg (Georgia Institute of Technology, USA) and Alexie (Alyosha) Efros (University of California, Berkeley, USA), delivered engaging talks that expanded the areas of traditional imaging and image processing. In his fascinating talk "Analyzing Social Interactions through Behavioral Imaging" Rehg discussed a multi-institution effort he is leading to develop the science and technology of behavior imaging, namely the capture, modeling, and analysis of social and communicative behavior using multi-modal sensing to support the study and treatment of developmental disorders such as autism.

Alexie Efros, who joined the Berkeley staff in 2013 after a career at Carnegie Mellon University, delivered an engaging

Photos: Stephen Keith.

Left: James Rehg presented the Tuesday Plenary: Analyzing Social Interactions through Behavioral Imaging. www.cc.gatech.edu/home/rehg/

Below: What makes Big Visual Data Hard? was the title of the Wednesday Plenary delivered by Alexei (Alyosha) Efros www.eecs.berkeley.edu/Faculty/Homepages/efros.html.

presentation on "What Makes Big Visual Data Hard?" His current research concerns the development of efficient methods for visual matching, image retrieval, visual data mining, and interactive visual data exploration. His talk concentrated on effective computational methods for interpreting the massive amounts of visual data (photos and videos) available on the web.

As always, the conference keynote presentations provided an informative landscape of leading edge research in the emerging applications of electronic imaging. For example, with the advent of affordable smart phones and wearable capture devices, electronic capture has become an integral part of modern human life, and acts as a new limb to the human body to enrich the experience of life around us.

The Keynote "Computational Photography and State-of-The-Art in Image Processing" given in the Computational Photography Conference by Payman Milanfar (Google, USA) explored this topic. He noted how nowadays everyone owns a mobile device with a powerful processor and a high-resolution camera, which with the employment of computational photography algorithms can profoundly redefine the rules of capture. He demonstrated how by recording information in space, time, and across other degrees of freedom, and by executing leading edge computational photography algorithms onboard the camera, ordinary capture devices can be transformed into scientific instruments.

Photo courtesy of Mojgan Rabbani.

The inaugural Women in Electronic Imaging lunch brought together 40 female colleagues from a wide range of experience and backgrounds to share stories and expand their connections.

Short Courses

Technical short courses are an efficient way of coming up to speed in a certain technology area, and have always been a strong component of the EI conference. Registration at the conference is not required for taking a short course. The course attendees receive CEUs to fulfill continuing education requirements.

Short course registrations were strong at 180, a 19% increase over last year. EI 2015 featured 15 short courses in fundamental and current topics in electronic imaging including three new courses: "Introduction to Digital Color Imaging" (Sharma: half day), "Camera Characteri-

zation and Camera Models" (Phillips, Hornung, Denman: full day), and "Recent Trends in Imaging Devices" (Battiato, Farinella: half day).

Special Events

The Symposium special events are always an enriching part of the EI and this year was no exception. The special events included "Women in EI Lunch," 3D Theatre," "Symposium Demo Session," "Industry Exhibition," "Interactive Poster Session," and Symposium desert reception.

Women in Electronic Imaging Lunch

The inaugural Women in Electronic Imaging lunch was held on Monday as a networking venue for women attendees of the conference. The event facilitated the female colleagues from a wide range of experience to share stories and expand their connections. This event is the brain child of Dr. Bernice Rogowitz who both suggested the venue and organized the event.

Photo: Stephen Keith.

Photo: Mojgan Rabbani.

Photo: Stephen Keith.

Above: Participants viewing a stereoscopic image without the need for special glasses. **Right:** The Demonstration Session featured a system designed for a football team to help recruit players through full immersion. **Below Right:** Funny eyewear is the all the rage during the 3D Theatre.

EI 2015 Conference Keynotes

Digital Photography and Mobile Imaging X

- Computational photography and state of the art in image processing, Peyman Milanfar, Google (USA)
- Advances in image restoration: From theory to practice, Filip Sroubek, Institute of Information Theory and Automation (Czech Republic)

Document Recognition and Retrieval XXII

- Printing presses and polyphonic pianos: Unsupervised transcription for documents and music, Dan Klein, Univ. of California, Berkeley (USA)
- The Internet Archive: Challenges and solutions for large scale document repositories, Brewster O. Kahle, Internet Archive (USA)

HVEI XX

- Cognitive psychology meets art: studying creativity, language, and emotion through live musical improvisation in film and theatre, Monica Lopez-Gonzalez, La Petite Noiseuse Productions; Maryland Institute College of Art; and Johns Hopkins Univ. (USA)
- Up periscope!: Designing a new perceptual metric for imaging system performance, Andrew B. Watson, NASA Ames Research Center (USA)

HVEI XX and Color Imaging XX (Joint)

- Next gen perception and cognition: Augmenting perception and enhancing cognition through mobile technologies, Sergio R. Goma, Qualcomm Inc. (USA)

Image Quality and System Performance XII

- Print quality and image quality: Kissing cousins or feuding in-laws? Jan P. Allebach, Purdue University (USA)

Imaging and Multimedia Analytics in a Web and Mobile World 2015

- Recent progress in wide-area surveillance: protecting our pipeline infrastructure, Vijayan K. Asari, Univ. of Dayton (USA)

Measuring, Modeling, and Reproducing Material Appearance 2015

- Generative appearance models in the perception of materials and their properties, Roland W. Fleming, Justus-Liebig-Univ. (Germany)

Media Watermarking, Security, and Forensics 2015

- Piracy conversion: the role of content protection and forensics, Richard Atkinson, Adobe Systems (USA)
- Steganography: the past ten years, Jessica Fridrich, Binghamton Univ. (USA)
- Ultra-high definition, watermark detection, mobile video, and much more: A status report on ATSC 3.0, Jerry Whitaker D.V.M, Madeleine Noland, Advanced Television Systems Committee (USA)
- Do wearables really change anything?, Brian J. Hernacki, Intel Corp. (USA)

Stereoscopic Displays and Applications XXVI

- A stereoscope for the PlayStation generation, Ian H. Bickerstaff, Sony Computer Entertainment Europe Ltd. (UK)
- What is stereoscopic vision good for?, Jenny C. A. Read, Newcastle Univ. (UK)

Visualization and Data Analysis 2015

- The Palomar Transient Factory, Peter E. Nugent, Lawrence Berkeley National Lab and University of California; Yi Cao, Caltech; and Mansi Kasliwal, the Carnegie Observatories (USA)
- Some difficult visualization Problems: Big sciences, big computer systems, and big data, Kenneth I. Joy, University of California, Davis (USA)

The complimentary lunch was sponsored by EI and the 40-person limited space was over booked quickly.

Each of the seven tables in the room had a senior coordinator from either academia or industry who first shared a 3-minute "words of wisdom" from their experience as a female EI scientist/engineer and then led the discussions at their respective table. All the attendees and particularly the students welcomed the networking opportunity. Pei Ying Chua from DSO National laboratories in Singapore volunteered to fulfill a group request to set up a Women in Electronic Imaging group on LinkedIn , which IS&T co-administers.

3D Theatre

This ever popular event was a visual feast that served well to illustrate the diversity of 3D content produced by stereoscopic professionals and enthusiasts alike.

The 3D show/competition, which lasted 2 hours, contained a broad selection of 41 entries from 17 countries, ranging from independent artists to major studios and was attended by ~150 people. The 2015 judges were Lenny Lipton (Leonardo IP) and Eric Kurland (3-DIY), both well-known 3D experts. The producers were John Stern (Intuitive Surgical, retired), Chris Ward (Lightspeed Design Group and DepthQ Stereoscopic), and Andrew Woods (Curtin University). Management and playback of 3D content was expertly handled by Dan Lawrence of DepthQ Stereoscopic.

Photos: Mogjan Rabbani.

During the Demonstration Session, Digimarc showcased aninvisible digital watermarking technology that is periodically repeated over the entire package and contains the same data carried in the product's visible UPC/EAN code. The use of this technology could increase scanning rates from 24 to 36 items per minute.

There has been a noticeable improvement in the quality of 3D content at each year's 3D Theatre session, and this year was no exception. This is a reflection of the maturing of the industry and the improvement in the available stereoscopic hardware and software. Lenny Lipton explained that "the films in the competition show far more imagination than that which is being exhibited in the theatrical cinema and I am happy to see people exploring the medium."

The 2015 winner in the live-action category was Ben Schwartz (USA) for "The Whitewashing of 5 Pointz". The prize for animation went to Chris Lavis and Maciek Szczerbowski (Canada) for "Cochemare." Each winner received a copy of the "Stereoscopic Displays and Applications: 20-Year Retrospective" CD, which contains more than 1500 stereoscopic-focused technical manuscripts.

Symposium Demonstration Session

The symposium demonstration session is an attractive, hands-on showcase of hardware, software, displays, and research products related to all the topics covered by EI.

As usual, the 3D display and visualization demos drew a large audience reflecting the recent popularity of 3-D film and television. Demos included 3D vision with and without special equipment. For example, one demo displayed a stereoscopic image without the need for special glasses, while another demo created full immersion in a football game by wearing a headgear. The latter was developed to fulfill a need by a football recruiting team who wanted to share the atmosphere of their football games with potential recruits when no football game had been scheduled at the time of their interview. The immersive six sided CAVE (C6) VR application served the on campus recruiting efforts, while a portable Head Mounted Display (HMD) application was used for off campus recruiting. The technical details were presented at The Engineering Reality of Virtual Reality Conference.

Photo: Mogjan Rabbani.

Image Engineering was one of 8 companies to showcase their products at EI 2015.

Another interesting and non-traditional demo was presented by Steve Mason, an artist from Yavapai College in Prescott, AZ, who was showing his 3D art. The artwork is 2D and requires special ChromaDepth glasses to achieve the 3D effect from a single image. Quoting Steve Mason: "I hope that through my art I will open up myself and others to what makes us see what we see." This ties with one of the HVEI conference's objectives to explore how the visual system interprets what it sees. He creates his art by combining drawing, painting, scanning snapshots into the computer, digital manipulations, and printing in any order and repeating any steps as needed until he achieves his intended representation; the imaginary spaces in 3D.

A demo that hit close to home for me was by Digimarc. Their barcode technology that is based on invisible digital watermarking is currently being used in a number of products for Wegman's, a supermarket that started in Pittsford NY, my current home town. The Digimarc invisible barcode is periodically repeated over the entire package and contains the same data carried in the product's visible UPC/EAN symbol, but can be scanned expeditiously from any part of the package. This can potentially increase the scanning rate to 36 items per minute, compared to the

story continues on page 12

The Standards Roundup: Imaging and Graphic Arts

by Ann L. McCarthy, IS&T Standards Coordinator

ISO/TC 42 Photography

Recent & Upcoming Standards Publications

The second edition minor revision, ISO 15781 (Ed. 2), *Photography — Digital still cameras — Measuring shooting time lag, shutter release time lag, shooting rate, and start-up time,* has been published. This multiple edition standards project is led by Dietmar Wueller (Germany, Image Engineering) and Hoang-Phi Nguyen (USA, DxO). The completed minor revision will be followed by Edition 3, already underway, to expand the scope of this standard to include digital still cameras that continuously shoot images into a buffer and use the exposure button to select an image from among the stream of images that has already been captured. In light of the fact that more and more cameras, in particular cameras in smart phones, work this way, standardized measurements for this capture mode are needed so that customers may compare the performance. As one might imagine, concepts such as shutter time lag, shutter release time lag, capture point, and push duration are affected by such a continuous capture mode.

Following the publication of ISO 17850, *Photography — Digital cameras — Geometric distortion (GD) measurements,* as mentioned in our previous report, additional resources pertaining to that standard will be hosted on imaging.org under the Resources/Photographic Standards menu. The posted MatLab script, LcaGui.m, is a reference implementation script designed to measure lateral color aberration from a black dot chart.

ISO 17850 defines methods to measure the total image distortion of a camera including the lens and the signal processing and includes detailed test methods, reporting guidelines, and examples for use. Two measurement methods are defined in the standard, one using a white chart containing black dots positioned in a regular grid to assess local geometric distortion, and the other, line geometric distortion, measures the bending of a straight horizontal of vertical line at defined distances from the image center.

The local geometric distortion method analyzes the black dot grid formed by the test chart in the center of the image, calculating the ideal positions of the grid based on measured distances, and then locating the actual positions of the grid in the image. Geometric distortion is found as the maximum (peak to peak) distance between the ideal and actual positions. Graphic examples of black dot charts are given in the standard. The size and number of dots should be designed for the camera under test, and should be adjusted for the resolution of the camera and the shooting distance.

Experts are welcome to contribute to ISO standards development through their corresponding national committees. Additional information on photography standards is available from the ISO/TC 42 Secretariat, isotc42@ ansi.org. Additional information on graphic technology standards is available from the ISO/TC 130 Secretariat, tc170_cyc@126.com.

ISO 17850 uses only green channel data to determine geometric distortion because there is a difference in the dot positions for the three color channels, which is evaluated as lateral chromatic displacement. Informative Annex B provides the algorithm overview for the MatLab script, LcaGui.m, posted on imaging.org. Two versions of the script are available: a ZIP file of the Matlab Scripts, which requires Matlab and the Image Processing Toolbox for execution, and a compiled Matlib EXE which requires the Matlab Component Runtime.

Standards in Development

Recent progress in standards development is reported for the following projects and action items:

ISO/NP 17321-4, *Graphic technology and photography — Colour characterization of digital still cameras (DSCs) — Part 4: LED (Light Emitting Diode) colour target,* is one of the standards in development within ISO/TC 42/WG 18. This standard will specify several requirements enabling standardized use of light emission systems using multiple LEDs (Light Emitting Diodes) for use as a color targets for digital camera color characterization. LEDs with different spectral distributions can be used to simulate standard and special purpose color targets. LED light sources can provide a smooth spectral distribution over the spectral range of interest by means of careful combination of the spectral distribution of the LEDs. In practice, such a system will have several advantages: to emit arbitrary designed spectral distributions, to provide shading free calibration with highly uniform targets, to evaluate color metamers, and to measure response to colors with controlled combinations of luminance, hue, and saturation.

The DIS ballot recently closed for ISO/DIS 19084, *Photography — Digital cameras — Chromatic displacement measurements,* with 100% approval. Comments submitted by JISC, BSI and ANSI will be addressed prior to proceeding to publication. Chromatic displacement in an output image of a digital camera, defined as a shift in the location of image features in the red and blue channels in relation to the image features in the green channel, may occur as a result of various design and implementation factors. In the case of single sensor digital cameras, chromatic displacement is primarily generated by optical factors (including lateral chromat-

ic aberration, longitudinal chromatic aberration, and characteristic chromatic aberration) and effects of the mosaic color filter array. In the case of two- and three-sensor digital cameras, chromatic displacement may be caused by mechanical and electrical factors. ISO/DIS 19084 provides a measurement using the same dot chart used in ISO 17850, and an alternative measurement using a V pattern chart, both for use with digital cameras and mobile phone cameras. Both chromatic displacement, and radial chromatic displacement, caused by optical lateral chromatic aberration, are calculated and presented in the results.

International Color Consortium

Next Generation Color Management

Work in the ICC on the next of generation color management, in ICC Labs, has resulted in a preliminary specification, and supporting materials, including a reference implementation and Windows executables. The new specification, iccMAX, is not a replacement for ICC.1, the existing ICC color management architecture. Rather, iccMAX is intended for use in workflows that are not fully addressed by the established ICC.1 color management. For example, areas covered by ICC Labs include: multispectral imaging, medical imaging, package printing (e.g., goniophotometric colorants), color management on the internet, fine art, and color information archiving. Now, iccMAX is being released as a preliminary document for public testing, available at http://www.color.org/iccmax/ and a reference implementation is also available on that site.

ISO/TC 130 Graphic Technology

Upcoming Publications

ISO/DIS 16763, *Graphic technology — Post-press — Requirements for bound products,* won 94% approval in the recent DIS ballot. Comments from Austria, India, Japan, Sweden, and the US, will be addressed before moving to the next stage. One question to be addressed is what will happen with the existing standard ISO 11800:1998, *Information and documentation — Requirements for binding materials and methods used in the manufacture of books,* and the coordination with ISO/TC 46 on this topic?

Germany entered the single disapproval vote. In their accompanying comment, Germany stated that they felt compelled to opt out of the ISO/DIS 16763 development in favor of the German book quality requirements publication owned by bvdm (German Print and Media Industries Federation). This document is regarded (in Germany) as a comprehensive and sound quality requirement for bound products. ISO/DIS 16763 standardizes the conversion of printed sheets into end products. Post-press processes have a direct effect on the appearance, usability, and durability of bound products, and as such are the aspect of such products that consumers may first encounter. How many of us are often tempted to judge a book by its cover? ISO/DIS 16763 specifies quality requirements and tolerances of bound products and intermediate components, and includes cutting, folding, assembling, and binding operations. Reference is made to ISO 9706 for material specifications for long life products.

ISO/PDTR 19300.4:2015, *Graphic technology — Guidelines for the use of standards for print media production workflows,* has been approved for publication. The introduction of this technical report describes a broad graphic industries view and takes note of the emphasis on the needs of printers and printers' suppliers in the recent decades of graphic technology standards. The case is made that the standards are applicable to large and small players in any graphic industries supply chain, recognizing that, regardless of size, interoperability during production, and customer satisfaction with the end product, are enhanced by use of standardized methods and measurements. This technical report aims to improve the accessibility of TC 130 and related standards in print media production workflows—to enhance production quality—and generally improved the business outcome for each participant in the supply chain. The report describes stakeholder roles and responsibilities, print use cases and their relationships to various printing technologies, basic concepts such as viewing conditions, color measurement, printing condition, characterization, gray production and gray balance, and workflows at each stage of the supply chain. References to the available defining standards are provided for each technical concept. Discussion of the use of RGB images, process-dependent and process-independent color workflows, preflight requirements in different printing scenarios, and proofing systems requirements, is included. This guideline will be invaluable to any newcomer in any part of a graphic industries supply chain or workflow and is a ready reference to the large family of related standards for any practitioner in the field.

Finally, we can report on the outcome for the ISO/FDIS 15339-1 and ISO/FDIS 15339-2 projects. Raymond Cheydleur, USTAG Chair and CGATS Chair, announced in March 2015 that CIB Resolutions 563 & 564 were passed with considerable majorities. In Resolution 563, "ISO/TC 130 resolves to forward the FDIS manuscript of ISO 15339-1, *Graphic technology — Printing from digital data across multiple technologies — Part 1: Principles, to ISO/CS for publication as a Publicly Available Specification.*" And in Resolution 564, "ISO/TC 130 resolves to forward the FDIS manuscript of ISO 15339-2, *Graphic technology — Printing from digital data across multiple technologies — Part 2: Characterized reference printing conditions, CRPC1 - CRPC7,* to ISO/CS for publication as a Publicly Available Specification." Cheydleur noted in the announcement that the overwhelming majority of the vote showed that much of the greater graphic arts community recognizes the impact that this series of documents can have on the quality and workflow of printers.

Standards in Development and New Work Discussions

ISO/CD 19593, *Graphic technology — Use of PDF to associate processing steps and content data,* will standardize an alternative

for workflow communication and control in packaging and other segments of the printing industry. PDF objects and metadata in the PDF container can define attributes of processing steps beyond printing, such as die cutting, and creasing. ISO/CD 19593 describes a method for storing data in a PDF (objects and metadata) that correspond to processing steps of printed products other than the actual printing. The intent is that processing steps data in a PDF can be used, for example, by a quality control person to verify the design before production, in configuring production to generate tools needed, or directly by digitally controlled finishing devices. Without an established standard, multiple ad hoc methods are currently used to store such data in PDFs—with the encoding depending on the application—which of course limits open system interoperability. This standard is based on work done in the packaging subcommittee of the Ghent Workgroup, however, it is applicable to other segments of the print industry such as sign and display, and commercial print.

An extension, in the form of an informative annex, is proposed for ISO 18619, *Image technology colour management — Black point compensation,* to guide the use of the method of the standard to apply black point compensation to profiles that have more than four primary colorants. The method given in the proposed annex extends the method given in the body of the standard to n-color profiles with up to seven output channels. The underlying requirement that three of the primary colorants combine to form a neutral color still applies. In addition to the neutral color trio and black, the method assumes that the other three colors are red, green, and blue, and that the colorants have similar transparency to process CMYK inks.

Discussion at the May 2015 ISO/TC 130/WG 3 meeting in Bologna raised the question of the need for further standardization in the area of spectrophotometers, with regard to inter-instrument and inter-manufacturer agreement. Currently, differences between instruments from different manufacturers, even different models from the same manufacturers, can cause issues with meeting delta E tolerance requirements at every workflow stage, including certification and client acceptance. Inline and near-line press instruments further complicate matters. Devolving to require using the same instrument make and model throughout a supply chain is not preferred. Insufficient user training also contributes to measurement differences. Tools such as ChromacChecker (https://chromachecker.com/) and Voglesong (from www.chromix.com/colorgear/) can help to expose issues, but cannot adjust the instruments to make corrections. Currently, although ISO 13655 requires that "The conformance of M1 measurement condition shall be judged indirectly by measuring a set of certified reference materials" and Annex F of that standard defines the necessary characteristics of a set of CRMs for the printing industry, such CRMs are not available for widespread use.

On a similar note, work has started, led by Danny Rich (Sun Chemical), on edition 3 of ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images,* with the objective to bring ISO 13655 into agreement with recommendations from the CIE and to improve the specifications on the spectral nature of backing materials. Both changes are aimed at improving the inter-laboratory agreement of color measurements in graphic production.

For questions about the activities of TC 42, for suggestions for (or input to) future updates, or standards questions in general, please contact the IS&T Standards Coordinator at standards@imaging.org.

papers continued from page 1

lack of labeled training samples. This paper proposes a novel non-linear transfer learning method, namely Gaussian Process Style Transfer Mapping (GP-STM). The GP-STM extends traditional linear Style Transfer Mapping (STM) by using Gaussian process and kernel methods. With GP-STM, existing printed Chinese character samples are used to help the recognition of historical Chinese characters. To demonstrate this framework, we compare feature extraction methods, train a modified quadratic discriminant function (MQDF) classifier on printed Chinese character samples, and implement the GP-STM model on Dunhuang historical documents. Various kernels and parameters are explored, and the impact of the number of training samples is evaluated. Experimental results show that accuracy increases by nearly 15 percentage points (from 42.8% to 57.5%) using GP-STM, with an improvement of more than 8 percentage points (from 49.2% to 57.5%) compared to the STM approach.

Image Quality and Systems Performance

Image quality optimization, via application of contextual contrast sensitivity and discrimination functions

Edward Fry, Sophie Triantaphillidou, John Jarvis, and Gaurav Gupta, University of Westminster (UK)

Abstract: What is the best luminance contrast weighting-function for image quality optimization? Traditionally measured contrast sensitivity functions (CSFs), have been often used as weighting-functions in image quality and difference metrics. Such weightings have been shown to result in increased sharpness and perceived quality of test images. We suggest contextual CSFs (cCSFs) and contextual discrimination functions (cVPFs) should provide bases for further improvement, since these are directly measured from pictorial scenes, modeling threshold and suprathreshold sensitivities within the context of complex masking information. Image quality assessment is understood to require detection and discrimination of masked signals, making contextual sensitivity and discrimination functions directly relevant.

In this investigation, test images are weighted with a traditional CSF, cCSF, cVPF and a constant function. Controlled mutations of these functions are also applied as weighting-functions, seeking the optimal spatial frequency band weighting for quality optimization. Image quality, sharpness and naturalness are then assessed in two-alternative forced-choice psychophysical tests. We show that maximal quality for our test images, results from cCSFs and cVPFs, mutated to boost contrast in the higher visible frequencies.

Measuring, Modeling, and Reproducing Material Appearance 2015

Multiplexed acquisition of bidirectional texture functions for materials

Dennis den Brok, Heinz C. Steinhausen, Matthias B. Hullin, and Reinhard Klein, Institut für Informatik II, Universität Bonn (Germany)

Abstract: The bidirectional texture function (BTF) has proven a valuable model for the representation of complex spatially-varying material reflectance. Its image-based nature, however, makes material BTFs extremely cumbersome to acquire: in order to adequately sample high-frequency details, many thousands of images of a given material as seen and lit from different directions have to be obtained. Additionally, long exposure times are required to account for the wide dynamic range exhibited by the reflectance of many real-world materials.

We propose to significantly reduce the required exposure times by using illumination patterns instead of single light sources ("multiplexed illumination"). A BTF can then be produced by solving an appropriate linear system, exploiting the linearity of the superposition of light. Where necessary, we deal with signal-dependent noise by using a simple linear model derived from an existing database of material BTFs as a prior. We demonstrate the feasibility of our method for a number of real-world materials in a camera dome scenario.

BEST PAPER AWARDS

Digital Photography and Mobile Imaging XI

Stable image acquisition for mobile image processing applications

Kai-Fabian Henning, Alexander Fritze, Eugene Gillich, Uwe Mönks, and Volker Lohweg, Ostwestfalen-Lippe University of Applied Science (Germany)

Abstract: Today, mobile devices (smartphones, tablets, etc.) are widespread and of high importance for their users. Their performance as well as versatility increases over time. This leads to the opportunity to use such devices for more specific tasks like image processing in an industrial context. For the analysis of images requirements like image quality (blur, illumination, etc.) as well as a defined relative position of the object to be inspected are crucial. Since mobile devices are handheld and used in constantly changing environments the challenge is to fulfill these requirements. We present an approach to overcome the obstacles and stabilize the image capturing process such that image analysis becomes significantly improved on mobile devices. Therefore, image processing methods are combined with sensor fusion concepts. The approach consists of three main parts. First, pose estimation methods are used to guide a user moving the device to a defined position. Second, the sensors data and the pose information are combined for relative motion estimation. Finally, the image capturing process is automated. It is triggered depending on the alignment of the device and the object as well as the image quality that can be achieved under consideration of motion and environmental effects.

Image Processing: Machine Vision Applications VIII

Depth-map and Albedo estimation with duperior information-theoretic performance

Adam P. Harrison and Dileepan Joseph, University of Alberta (Canada)

Abstract: Lambertian photometric stereo (PS) is a seminal computer vision method. However, using depth maps in the image formation model, instead of surface normals as in PS, reduces model parameters by a third, making it preferred from an information-theoretic perspective. The Akaike information criterion (AIC) quantifies this trade-off between goodness of fit and overfitting. Obtaining superior AIC values requires an effective maximum-likelihood (ML) depth-map & albedo estimation method. Recently, the authors published an ML estimation method that uses a two-step approach based on PS. While effective, approximations of noise distributions and decoupling of depth-map & albedo estimation have limited its accuracy. Overcoming these limitations, this paper presents an ML method operating directly on images. The previous two-step ML method provides a robust initial solution, which kick starts a new nonlinear estimation process. An innovative formulation of the estimation task, including a separable nonlinear least-squares approach, reduces the computational burden of the optimization process. Experiments demonstrate visual improvements under noisy conditions by avoiding overfitting. As well, a comprehensive analysis shows that refined depth maps & Albedos produce superior AIC metrics and enjoy better predictive accuracy than with literature methods. The results indicate that the new method is a promising means for depth-map & albedo estimation with superior information-theoretic performance

Image Sensors and Imaging Systems 2015

2.2um BSI CMOS image sensor with two layer photo-detector

H. Sasaki, A. Mochizuki, Y. Sugiura, R. Hasumi, K. Eda, Y. Egawa, H. Yamashita, K. Honda, T. Ohguro, H. S. Momose, H. Ootani, Y. Toyoshima, and T.Asami, Toshiba Corporation Semiconductor & Storage Products Company (Japan)

Abstract: Back Side Illumination (BSI) CMOS image sensors with two-layer photo detectors (2LPDs) have been fabricated and evaluated. The test pixel array has green pixels (2.2um x 2.2um) and a magenta pixel (2.2um x 4.4um). The green pixel has a single-layer photo detector (1LPD). The magenta pixel has a 2LPD and a vertical charge transfer (VCT) path to contact a back side photo detector. The 2LPD and the VCT were implemented by high-energy ion implantation from the circuit side. Measured spectral response curves from the 2LPDs fitted well with those estimated based on light-absorption theory for Silicon detectors. Our measurement results show that the keys to realize the 2LPD in BSI are; (1) the reduction of crosstalk to the VCT from adjacent pixels and (2) controlling the backside photo detector thickness variance to reduce color signal variations.

Multi-camera synchronization core implemented on USB3 based FPGA platform

Ricardo M. Sousa[1,2], Martin Wäny[2], Pedro Santos[2], and Morgado-Dias[1,3]; [1]University of Madeira, [2]Awaiba Lda, and [3]Madeira Interactive Technologies Institute (Portugal)

Abstract: Centered on Awaiba's NanEye CMOS image sensor family and a FPGA platform with USB3 interface, the aim of this paper is to demonstrate a new technique to synchronize up to 8 individual self-timed cameras with minimal error. Small form factor self-timed camera modules of 1 mm x 1 mm or smaller do not normally allow external synchronization. However, for stereo vision or 3D reconstruction with multiple cameras as well as for applications requiring pulsed illumination it is required to synchronize multiple cameras. In this work, the challenge of synchronizing multiple self-timed cameras with only 4 wire interface has been solved by adaptively regulating the power supply for each of the cameras. To that effect, a control core was created to constantly monitor the operating frequency of each camera by measuring the line period in each frame based on a well-defined sampling signal. The frequency is adjusted by varying the voltage level applied to the sensor based on the error between the measured line period and the desired line period. To ensure phase synchronization between frames, a Master-Slave interface was implemented. A single camera is defined as the Master, with its operating frequency being controlled directly through a PC based interface. The remaining cameras are setup in Slave mode and are interfaced directly with the Master camera control module. This enables the remaining cameras to monitor its line and frame period and adjust their own to achieve phase and frequency synchronization. The result of this work will allow the implementation of smaller than 3mm diameter 3D stereo vision equipment in medical endoscopic context, such as endoscopic surgical robotic or micro invasive surgery.

Visualization and Data Analysis 2015

An Evaluation-Guided Approach for Effective Data Visualization on Tablets

Peter S. Games, Boise State University, and Alark Joshi, University of San Francisco (USA)

Abstract: There is a rising trend of data analysis and visualization tasks being performed on a tablet device. Apps with interactive data visualization capabilities are available for a wide variety of domains. We investigate whether users grasp how to effectively interpret and interact with visualizations. We conducted a detailed user evaluation to study the abilities of individuals with respect to analyzing data on a tablet through an interactive visualization app.

Based upon the results of the user evaluation, we find that most subjects performed well at understanding and interacting with simple visualizations, specifically tables and line charts. A majority of the subjects struggled with identifying interactive widgets, recognizing interactive widgets with overloaded functionality, and understanding visualizations which do not display

data for sorted attributes. Based on our study, we identify guidelines for designers and developers of mobile data visualization apps that include recommendations for effective data representation and interaction.

iGraph: A graph-based technique for visual analytics of image and text collections

Yi Gu and Chaoli Wang, University of Notre Dame; Jun Ma and Robert J. Nemiroff, Michigan Technological University; and David L. Kao, NASA Ames Research Center (USA)

Abstract: In our daily lives, images and texts are among the most commonly found data which we need to handle. We present iGraph, a graph-based approach for visual analytics of large image and text collections. Given such a collection, we compute the similarity between images, the distance between texts, and the connection between image and text to construct iGraph, a compound graph representation which encodes the underlying relationships among these images and texts. To enable effective visual navigation and comprehension of iGraph with tens of thousands of nodes and hundreds of millions of edges, we present a progressive solution that offers collection overview, node comparison, and visual recommendation. Our solution not only allows users to explore the entire collection with representative images and keywords, but also supports detailed comparison for understanding and intuitive guidance for navigation. For performance speedup, multiple GPUs and CPUs are utilized for processing and visualization in parallel. We experiment with two image and text collections and leverage a cluster driving a display wall of nearly 50 million pixels. We show the effectiveness of our approach by demonstrating experimental results and conducting a user study.

Exploring hierarchical visualization designs using phylogenetic trees

Shaomeng Li[1], R. Jordan Crouser[2], Garth Griffin[2], Connor Gramazio[3], Hans-Jörg Schulz[4], Hank Childs[1], and Remco Chang[2]; [1]University of Oregon (USA), [2]Tufts University (USA), [3]Brown University (USA), and [4]Fraunhofer IGD (Germany)

Abstract: Ongoing research on information visualization has produced an ever-increasing number of visualization designs. Despite this activity, limited progress has been made in categorizing this large number of information visualizations. This makes understanding their common design features challenging, and obscures the yet unexplored areas of novel designs. With this work, we provide categorization from an evolutionary perspective, leveraging a computational model to represent evolutionary processes, the phylogenetic tree. The result—a phylogenetic tree of a design corpus of hierarchical visualizations—enables better understanding of the various design features of hierarchical information visualizations, and further illuminates the space in which the visualizations lie, through support for interactive clustering and novel design suggestions. We demonstrate these benefits with our software system, where a corpus of two-dimensional hierarchical visualization designs is constructed into a phylogenetic tree. This software system supports visual interactive clustering and suggesting for novel designs; the latter capacity is also demonstrated via collaboration with an artist who sketched new designs using our system. ▲

IS&T REPORTER

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industry average of 24 items per minute when using a UPC symbol.

Interactive Presentations

The Interactive Paper Session was scheduled for 90 minutes on Tuesday evening and contained 116 poster presentations. The authors were asked to setup their posters starting at 8:00 am on Tuesday to give the conference attendees the opportunity to browse through them at their leisure and prepare for an in-depth discussion with the authors during the interactive session.

Industry Exhibit

The Electronic Imaging Symposium hosted the annual industry exhibit, providing a unique opportunity to meet company representatives working in related EI spaces and to become familiar with their products and services while meeting prospective employers.

Conference Award Presentations

The Symposium and Society awards were presented before the plenary sessions on Tuesday and Wednesday mornings.

The IS&T awards, which were presented on Tuesday, included Honorary Membership Award (the highest Society award), presented to Brian A. Wandell, director of Stanford's Center for Cognitive and Neurological Imaging, and Service Awards to Karen Egiazarian (Tampere University of Technology, Finland), Stuart Perrry (CISRA, Australia), Nitin Sampat (Rochester Institute of Technology, USA), and Andrew Woods (Curtin University, Australia). SPIE presented Fellowship to Nasir Memon (NYU Polytechnic, USA).

Wednesday morning marked the recognition of the Symposium awards. The most noteworthy was the "EI Scientist of the Year" award that is granted to a member of the EI community who has demonstrated excellence and commanded respect of his/her peers by making significant contributions to the field of electronic imaging via research, publication, and/or service. For the first time in the 17-year history of this award, there were two recipients, one from academia and one from industry. The award was presented by the Symposium Chair Sheila Hemami, to Dr. Majid Rabbani (Eastman Kodak Company, UAS) and Professor Edward Delp (Purdue University, USA).

Several conferences also awarded their Best Student Paper and/or Best Paper awards. The abstracts for these papers are found beginning on page 1.

EI Venue for 2016

News regarding the sponsorship of EI came in early November 2014 with the announcement of SPIE's decision to withdraw from co-sponsoring the Symposium beyond 2015. The good news for the EI enthusiasts is that IS&T has clearly stated its commitment to continue serving the EI community in 2016 and beyond. The IS&T Board of Directors is fully behind this decision and welcomes input from the community.

EI 2016 will once again be held at the Hilton San Francisco Union Square, February 14-18, 2016. The Symposium Chair is Choon-Woo Kim (Inha University, Republic of Korea), Co-chair is Nitin Sampat (Rochester Institute of Technology, USA), and the Short Course Chairs is Chaker Larabi (University of Poitiers, France) and Majid Rabbani (Eastman Kodak Company). We hope to see you there. ▲