



IS&T

REPORTER

"THE WINDOW ON IMAGING"

Vol. 31, No. 2 April - June 2016

Electronic Imaging Symposium 2016

BEST STUDENT PAPER AWARDS

Digital Photography and Mobile Imaging XII

Virtual DSLR: High quality dynamic depth-of-field synthesis on mobile platforms

Yang Yang¹, Haiting Lin¹, Zhan Yu², Sylvain Paris², and Jingyi Yu¹; ¹University of Delaware and ²Adobe (USA)

Abstract: Shallow depth-of-field (DoF) and a smooth bokeh are signature elements of Digital SLR cameras and high-quality lenses. Producing comparable effects on mobile platforms has long been challenging due to small sensor sizes and short focal lengths of mobile cameras. In this paper, we exploit depth sensing capabilities on emerging mobile devices and develop a new depth-guided refocus synthesis technique particularly tailored for mobile devices. Our technique takes coarse depth maps as inputs and applies novel depth-aware pseudo ray tracing. The depth maps can be obtained from mobile depth sensors, mobile stereo cameras and even from user-inputs. Our pseudo ray tracing scheme resembles light field synthesis and refocusing but does not require actual creation of the light field and hence reduces both memory and computational overhead. At the same time, the scheme can overcome boundary bleeding and discontinuity artifacts observed in previous filtering techniques. Comprehensive experiments show that our approach can produce very high quality DoF comparable to the ones produced by DSLR and the Lytro light field cameras..

Document Recognition and Retrieval XXIII

Intelligent Pen: A least cost search approach to stroke extraction in historical documents

Kevin L. Bauer and William Barrett, Brigham Young University (USA)

Abstract: Extracting strokes from handwriting in historical documents provides high-level features for the challenging problem of handwriting recognition. Such handwriting often contains noise, faint or incomplete strokes, strokes with gaps, overlapping ascenders and descenders and competing lines when embedded in a table or form, making it unsuitable for local line following algo-

EI Scientist of Year and IS&T Honorary Member



Left: 2016 Electronic Imaging Symposium Chair Choon-Woo with 2016 EI Scientist of the Year Michael Kriss. Right: HVEI Conference Chair and long-time IS&T member Bernice Rogowitz receives IS&T's highest distinction, Honorary Membership, from IS&T President Geoffrey Woolfe.



Photos: Jennifer Henderson.

gorithms or associated binarization schemes. We introduce Intelligent Pen for piece-wise optimal stroke extraction. Extracted strokes are stitched together to provide a complete trace of the handwriting. Intelligent Pen formulates stroke extraction as a set of piece-wise optimal paths, extracted and assembled in cost order. As such, Intelligent Pen is robust to noise, gaps, faint handwriting and even competing lines and strokes. Intelligent Pen traces compare closely with the shape as well as the order in which the handwriting was written. A quantitative comparison with an ICDAR hand-written stroke data set shows Intelligent Pen traces to be within 2.58 pixels (mean difference) of the manually created strokes.

[papers continue on page 8](#)

All Proceedings Papers from EI 2016 are available for FREE download at www.ingentaconnect.com/content/ist/ei

* These papers were presented within the conference noted at the IS&T International Symposium on Electronic Imaging, held Feb. 14-18, 2016, in San Francisco, CA.

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Remembering Vivian Walworth: 1922 – 2016 Founding Member of IS&T, President, Editor, Scientist

By Mary McCann

This March, IS&T lost one of its oldest members and long-time supporters. As founding member of the Society of Photographic Scientists and Engineers (est. 1947), now IS&T, Vivian Walworth was active in the Society for 69 years and engaged in imaging projects until her final days. Indeed, she had planned to attend the 2016 Electronic Imaging Symposium in San Francisco, cancelling at the last minute due to health issues. A fixture at the Stereoscopic Displays and Applications Conference (SD&A), Walworth was an inspiration to generations. As SD&A Founding Chair John Merritt said: “We have lost one of the primary pillars of the stereoscopic community and we will miss her deeply.”

Walworth was involved with IS&T at every level. In addition to her involvement in conferences, she served as president of the Board of Directors from 1981-1985. She was the editor of the *Journal of Imaging Science* and its successor *Journal of Imaging Science and Technology* (1989-1996). She founded the *IS&T Reporter*, and served as its editor for 22 years. More than one generation of authors benefited from her thoughtful discussions of content and helpful suggestions for improving clarity of thought. Walworth was given a Service Award (1966) and elected a Senior Member (1974), Fellow (1987), and Honorary Member (2001), the highest honor bestowed by IS&T. She received the rare President's Citation twice (1988, 2009).

Raised in Detroit, Walworth received a BS in Chemistry from the University of Michigan (1942). Upon her arrival at Polaroid in 1944, she joined the development team of Polaroid's first imaging product, working on all

aspects of the program, from design and manufacture to installation of processing equipment and training. She also worked with a 3D imaging material, vectographs, which were used extensively during World War II for displaying aerial reconnaissance information. A hanger-sized display of vectographs of the Normandy coast was part of the Allied preparations for the D-Day Invasion. After the war, her work continued to color vectographs and 3D movies. That work extended into R&D of silver halide emulsions for Polaroid Instant Photography.

Walworth led Polaroid's research on silver halide emulsions from 1961 until she retired in 1985 as senior manager for photo-sensitive materials. In this capacity, she interacted with Ansel Adams and John Sexton, Polaroid consultants, on many photographic projects, and was Polaroid's scientific interface with Wolf Berg and J. W. Mitchel, international experts in emulsion research. Her lab



Clockwise from above: Incoming IS&T President Vivian Walworth with outgoing president Allie Peed; at the ACS dedication of the Land Building in August 2015; in the Polaroid labs.



Photo courtesy of ACS.



Photo: Samuel Kittrosser.



A regular attendee and presenter at the Stereoscopic Displays and Applications (SD&A) Conference, Walworth enjoyed checking out the newest technology and interacting with fellow attendees (with HVEI Chair Bernice Rogowitz, above left). In 2009 Walworth received her second President's Citation from Eric Hanson, for her 22 year editorship of *The Reporter* (above right). At right, she joins EI 2009 Symposium Chair Jan Allebach, in commemorating John Merritt's 20 years of service as chair of the SD&A conference, as SD&A Chair Andrew Woods looks on.



Photos courtesy of Andrew Woods.

provided tailored emulsions for Polaroid instant films, and served as a resource for the company's emulsion pilot and production plants. Her work at Polaroid included R&D of polarizers, 3D imaging processes, photosensitive materials, and photomicrography. Walworth's 28 patents reflect her contributions to these fields.

Her laboratory also provided special support for Polavision, Polaroid's unique instant additive color motion picture film. Unlike most Polaroid film systems that stripped the developed emulsion off the final print, this system left the entire emulsion in place. The change in optical density from projected white to projected black was the result of changes in silver covering power. Unlike most silver images, the entire image had a constant amount of silver. Whites were made by compact chemically developed silver; while blacks were made of diffuse, high-covering power silver. Although Polavision was not a commercial success, the emulsion technology was remarkable.

A strong advocate of microscopy in the analysis of photographic systems, Walworth was simultaneously the manager of the Research Microscopy Laboratory. Under her guidance, the lab expanded their light and electron microscopy capabilities and became a resource for the entire company.

Walworth was a role model and mentor to both women and men in science and in corporate life. She was a full-time working mother of five, who with her husband Wilbur found time to tend a summer garden and spend summers in Nova Scotia at the family's vacation home. Every fall, she hosted the "Beast Feast," roasting a whole lamb on a spit in her back yard.

For 15 years, she was co-leader of the Concord Mariners, a senior Girl Scout troop that featured sailing, seamanship, and community service. She was also a member of the Boston Mycological Club from the early 1950s. A long-time member of the American Chemical Society, she served on the local chapter's editorial board and was recognized for her 75 year involvement last year when the Polaroid Osborne Street site was designated an ACS National Historic Chemical Landmark (see *The Reporter*, vol. 3. #1).

Called the "Boswell of Instant Photography", Walworth worked closely with Polaroid President and Director of Research Edwin Land. They collaborated on journal articles and she was his "ghost writer" for "The Universe of One-Step Photography" in IS&T's *Pioneers of Photography*. She also worked

with Land and Howard Rogers to publish "One-Step Photography" in the seventh edition of *Neblette's Handbook of Photography and Reprography*, as well as authored numerous other publications.

Walworth never left her passion for science behind. After retiring from Polaroid, she continued to work in stereographic photography, first consulting at Roland Institute for Science on bringing color vectographs into the digital age, then—with other Polaroid scientists—founding Stereo Jet Inc., which continues to develop ink-jet processes for printing 3D images. She is responsible for the standard use of circular polarizers in 3D viewing glasses to reduce image interaction and allow viewers' head tilt.

Her passion for life and learning serves as an inspiration for all. She was a scientist, inventor, scholar, author, editor, senior manager, role model, hiker, expert mycologist, and community leader. At the same time she was a wife, mother, and grandmother. All of those fortunate enough to have known her will remember her warm smile, her enthusiasm, her gentle encouragement, her skill at bringing people together, and her fierce skill at proof-reading. ▲

IS&T International Symposium on

Electronic Imaging 2017

SCIENCE AND TECHNOLOGY

29 Jan. – 2 Feb. • Burlingame, CA, USA



Photo: Diane Gonzalez



Photo: Stephen Keith



Photo: Stephen Keith

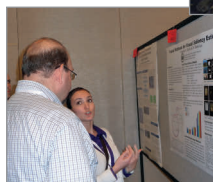


Photo: Diane Gonzalez



Photo: Francisco



Photo: San Francisco Travel Association/Can Bolognini

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HIGHLIGHTS FROM ELECTRONIC IMAGING 2016

By Mojgan Rabbani, Xerox Corporation

The IS&T Electronic Imaging (EI) held its 28th annual International Symposium February 14-18 at the Hilton San Francisco Union Square. As announced last year, EI is now solely sponsored by IS&T. This year's event attracted 856 participants representing 38 countries and spanning a diverse set of disciplines from academia, industry, and government labs.

The Symposium was chaired by Choon-Woo Kim (Inha University, Korea) and Nitin Sampat (Rochester Institute of Technology, USA). Short Course Chairs were Majid Rabbani (Kodak, USA), and Mohamed-Chaker Larabi (University of Poitiers, France). The At-Large Conference Chair Representative is Adnan Alattar (Digimarc Corp. USA); the Local Liaison Chair and incoming Symposium chair is Joyce Farrell (Stanford University, USA); the Exhibit and Sponsorship Chair was Kevin Matherson (Microsoft Corp., USA).

EI addresses a broad set of topical areas in the field of electronic imaging making it one of the premier venues in this field, always keeping up with the latest imaging applications. The Symposium consisted of 449 oral and 69 interactive (poster) presentations, along with 8 exhibitors, 20 demonstration session participants, and 17 short courses.



Photo: Jennifer Henderson.

The Demonstration Session allows attendees to directly interact with the hardware and software presented in papers at the Symposium.

New for 2016 were free electronic access to the papers (many of them prior to or during the Symposium), more joint sessions, more plenary talks, a new format for short courses with many new topics, and a free short course of their choosing offered to student conference registrants.

A major change compared to the past is that all the conference proceedings reside in the IS&T Digital Library and are available to everyone for free download—yes, no more printed proceedings or CDs. Conference papers were posted pre- or post-EI depending on the preferences of the individual conference chairs.

Three plenary talks by leaders in the field of electronic imaging were given, along with 17 keynote and invited talks. Twelve joint sessions highlighting cross-disciplinary pursuits of the conference took place over

EI2015	
Attendees*:	856
Oral Papers:	449
Interactive Papers:	69
Short Courses:	17
Exhibitors:	8
Dates:	February 14-18, 2016
Location:	San Francisco, California
*includes Short Course only and guests	

the four days of technical sessions. A new short course format offered two- or four-hour courses (no more day-long short courses), with 11 new topics presented. Participation in the short course program was phenomenal, partly due to the free course offering to registered students, but mostly due to the change in course format and the addition of new topics.

The symposium was organized into eight main technology groupings, each made up of one to six technical conferences, for a total of 20 conferences. The conference groupings were: (i) Human Perception and Cognition for Emerging Technologies, (ii) Image Capture Systems, (iii) Image Reproduction and Material Appearances, (iv) Document Processing and Media Security, (v) Image and Video Pro-

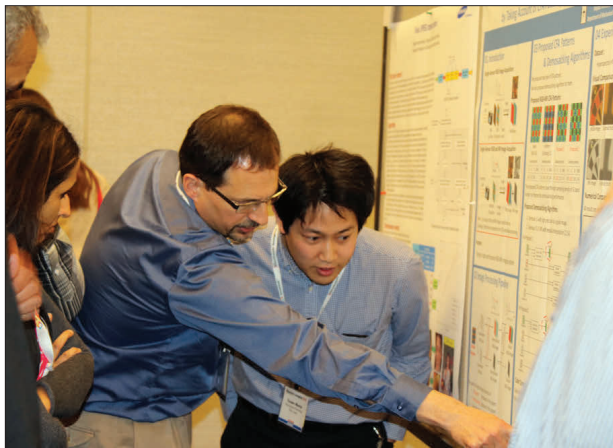


Photo: Jennifer Henderson.

The Interactive (Poster) Paper Session allows presenters to have a dialogue with attendees in an exchange that benefits all parties.

cessing, Quality and Systems, (vi) Virtual and Augmented Reality, 3D, and Stereoscopic Systems, (vii) Real-time Image and Video, (viii) Web and Mobile Imaging and Visualization. Some of the new conferences covered emerging topics such as intelligent robots, machine vision, virtual reality, and various mobile imaging applications. Although the symposium was organized in 20 distinct conferences, due to technology overlaps between the various conferences, which is a consequence of the rapid advances in the dynamic field of EI, many joint sessions were held to cultivate better the interaction among the researchers of various areas.

The conference on Human Vision and Electronic Imaging (HVEI) (28th year), continued to attract its dedicated group of researchers and authors exploring the role of human perception and cognition in the design, analysis, and use of electronic media systems. It covers research in the areas of neuropsychological processes, art and social sciences to study the interpretation of the information by the human visual system. Among the cutting edge topics covered in HVEI this year were the physiology of eye, the psychophysics of perception, the presentation of texture in art and its comprehension by human observer. The conference faithfully held their new tradition of author discussion sessions at the end of each day; Monday through Thursday, with a vibrant participation from authors and attendees

with industry sponsors providing the generous refreshments.

The HVEI conference banquet was held Monday evening with an invited talk by Stephen E. Palmer, professor of psychology and cognitive science at the University of California, Berkeley. He spoke on “Bach to the blues: Color, music, emotion, and synesthesia.” The talk explored the perceptual and emotional associations between color and music, mainly focused on synesthetes, people with atypical sensory experiences such as seeing colors when music or a number is presented. Using a wide range of different musical genres from classical to heavy metal, salsa, and country western, the research found clear systematic patterns, independent of cultural upbringing.

Stereoscopic Displays and Applications (SD&A) conference (27th year), which is 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 two keynote presentations by stereoscopic experts from industry and academia, a discussion panel, two joint sessions with the Engineering Reality of



The EI Exhibition offers attendees yet another way to learn about the latest advancements in the world of electronic imaging.

Photo: Jennifer Henderson.

Virtual Reality, and the 3D Image Processing, Measurement, and Applications, and the ever popular 3D Theatre. This year a new ‘oral presentation only’ category was included for industry authors which did not submit a manuscript.

Noteworthy was the keynote presentation by the SD&A conference co-chair Andrew Woods (Curtin University) entitled “Two shipwrecks, 2500 meters underwater, six 3D cameras—let the survey begin”. It summarized an expedition led by Curtin University, WA Museum and DOF Subsea to conduct a 3D imaging survey of the two historic shipwrecks off the Australian coast—the HMAS Sydney (II) and HSK Kormoran. The presentation provided an overview of the expedition, a summary of the technology deployed, and an insight into the 3D imaging materials captured.

Symposium Plenary and Conference Keynote Speakers

The EI Steering Committee (EISC) experimented with two changes in this area this year. One was to hold three plenaries instead of the traditional two. The presentation time was also moved to early afternoon from the traditional 9 am. It appeared that both of these changes were received positively by the attendees. The plenaries were well received and was attended by several hundred people. Additionally, 17 keynote and invited talks were planned by the individual conferences



Photo courtesy of Jennifer Henderson.

2017 EI Symposium Co-chair Joyce Farrell (far right) leads one of the discussions at the second annual Women in Electronic Imaging Luncheon. The event brought together 40 female colleagues from a wide range of experiences and backgrounds to share stories and expand their connections.

EI 2016 Conference Keynotes and Invited Talks

Color Imaging XXI: Displaying, Processing, Hardcopy and Applications: Vision security – the role of imaging, Marius Pedersen and Jon Yngve Hardeberg, Gjøvik University College (Norway)

Computational Imaging XIV: Indoor and outdoor image based localization for mobile devices, Avideh Zakhor, University of California, Berkeley (USA)

Digital Photography and Mobile Imaging XII: Photo editing on mobile devices, Sylvain Paris, Adobe (USA)

Document Recognition and Retrieval XXIII: OCR at Google: Books and beyond, Yasuhisa Fujii, Dmitry Genzel, Otavio Good, Patrick Hurst, Yuanpeng Li, Ashok Popat, and Ray Smith, Google Inc. (USA)

Human Vision and Electronic Imaging (HVEI) 2016: Towards a rudimentary neural model of multisensory integration in human neocortex, John Foxe, University of Rochester Medical Center, and Sophie Molholm, Albert Einstein College of Medicine (USA)

Human Vision and Electronic Imaging (HVEI) 2016: Optimizing for visual cognition in high performance scientific computing, Colin Ware, University of New Hampshire (USA)

Human Vision and Electronic Imaging (HVEI) 2016: Lessons learned from the colorization and 3D conversion of feature films and how they can be applied to the emerging mediums of virtual and augmented reality: A creative, consumer, and neuroscience perspective, Barry Sandrew, Augmented Vision Works (USA)

Image Quality and System Performance XIII: Objective image quality assessment: Facing the real-world challenges, Zhou Want, University of Waterloo (Canada)

Imaging and Multimedia Analytics in a Web

EI 2016 Plenary Speakers



Photo of Bowden: Jennifer Henderson; others courtesy of the speaker.

Left: The Opening Plenary was given by Audrey (Ellerbe) Bowden (Stanford University). Her informative talk “Novel Tools for Optical Imaging and Sensing at the Microscale and Nanoscale” can be found on YouTube. Middle: Ren Ng, faculty member in EECS Department at the University of California, Berkeley, presented the Tuesday keynote on Pushing Computational Photography Deeper into Imaging System Design. Right: Achin Bhowmik, vice president and general manager of the perceptual computing group at Intel Corporation presented the Wednesday keynote: Intel® RealSense Technology: Adding Human-Like Sensing and Interactions to Computing Devices.

and Mobile World 2016: Browsing heterogeneous multimedia social networks contents on mobile devices, Chang Wen Chen, State University of New York at Buffalo (USA)

Imaging and Multimedia Analytics in a Web and Mobile World 2016: Deep 3D shape representation, Yi Fang, New York University Abu Dhabi (USA)

Intelligent Robots and Computer Vision XXXIII: Algorithms and Technique: The 23rd Annual Intelligent Ground Vehicle Competition: Building engineering students into robotists, Bernard Theisen, US Army TARDEC (USA)

Measuring, Modeling, and Reproducing Material Appearance 2015: Computational imaging for inverse scattering, Ioannis Gkioulekas¹, Kavita Bala², Frédo Durand³, Anat Levin⁴, Shuang Zhao⁵, and Todd Zickler¹; ¹Harvard University (USA), ²Cornell University (USA), ³Massachusetts Institute of Technology (USA), ⁴The Weizmann Institute of Science (Israel), and ⁵University of California, Irvine (USA)

Measuring, Modeling, and Reproducing Material Appearance 2015: Refractive object reconstruction using computational imaging, Gordon Wetzstein, Stanford University (USA)

Media Watermarking, Security, and Forensics 2015: Security, privacy, and regulatory challenges of unmanned aerial vehicle integration, Evan Carr, AppFolio Inc. (USA)

Stereoscopic Displays and Applications XXVII: Two shipwrecks, 2500 metres underwater, six 3D cameras—let the survey begin, Andrew Woods, Andrew Hutchison, and Joshua Hollick, Curtin University, and Tim Eastwood, Western Australian Museum (Australia)

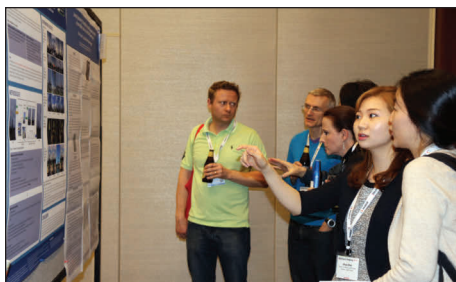
Stereoscopic Displays and Applications XXVII: 3-D movie rarities, Robert Furmanek and Greg Kintz, 3-D Film Archive (USA)

Visualization and Data Analysis 2016: Visualization for the masses, redux, Alex Pang, University of California at Santa Cruz (USA)

IS&T Honors and Awards

celebrate the achievements and service of members of the imaging community. We encourage you to nominate colleagues for these prestigious tributes. To do so, visit www.imaging.org/ist/Membership/honors.cfm.

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throughout the week. These talks, which provided an informative landscape of leading edge research in the emerging applications of EI, were presented by leading researchers and attracted large crowds, making them one of the most informative events of the conference.

Short Courses

EI Symposium has historically showcased a strong short course selection that covers both fundamental and state-of-the-art topics. Registration at the conference is not a requirement for short course attendance.

This year witnessed a new short course format inspired by IS&T's successful approach in their major conferences such as CIC and NIP. Instead of the traditional full- and half-day sessions, the courses were organized in 2- or 4-hour sessions, which created a multitude of agile learning opportunities. The short course committee was able to attract prominent educators from industry and academia to teach 17 courses covering a diverse set of topics. The short course registrations set a record at 345 and the attendance was up significantly in both the new and the existing topics. In fact, one of the new 4-hour courses, entitled "The Fundamentals of Deep Learning," was so popular that the committee had to cap the number of registrations. The conference for the first time offered a free short course for the student attendees, which was received very positively.

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 the "Symposium reception".



The interactions and immediate feedback a venue like EI offers can't be replicated via social media. The ability to touch, see, and experience hardware and software, as well as talk with colleagues is a highlight of the Symposium.



Women in Electronic Imaging Lunch

The IS&T Women in EI Lunch—the brainchild of Dr. Bernice Rogowitz as a venue for female colleagues to share their experiences and expand their network—was held for the second year. Each of the seven tables in the room was attended by a senior coordinator from either academia or industry who facilitated and led the discussions. The informal atmosphere of this luncheon allows for the attendees (especially students) to discuss relevant topics, share experiences, and make valuable networking connections with their fellow scientists. This year IS&T Executive Director Suzanne Grinnan selected the book "Crucial Conversations: Tools for Talking When Stakes Are High, by Patterson, Grenny, McMillan, and Switzler" to be given to ten of the attendees via a random drawing. The attendees and particularly the students welcomed the networking opportunity. Those interested in participating in this conversation virtually are



Photos: Jennifer Henderson

welcome to join the Women in Electronic Imaging group on LinkedIn.

3D Theatre

One of the most popular events in the symposium is the two-hour 3D theatre session on Monday evening that showcases 3D content from around the world produced by stereoscopic professionals and enthusiasts alike. The 3D content was screened in high-quality polarized 3D on the conference's large projection screen, with special glasses provided. Overall there were 30 pieces (or segments thereof) screened; 22 of them in the Competition category, and 8 in the Demonstration category. Content contributors self-selected which category they wanted to participate.

The best show awards were given to "Amongst" by Chia and Benjamine Harley (USA), which showed the world of wild dolphins as they maneuvered the deep oceans gracefully. The award in the category of Best of Show Animation went to "Chlamydomonas reinhardtii 3D- from Biological Cells to Biofuels", by Björn Sommer and Niklas Biere (Australia / Germany). *Chlamydomonas reinhardtii* is a green algae which is often used in biotechnology as a model organism.

Symposium Demonstration Session

The symposium demonstration session, which was scheduled for 90 minutes on Tuesday evening, showcased software, hardware, and research products in the field of electronic imaging and was a very popular event as usual. The rooms were buzzing with presenters demoing enthusiastically their products while the attendees examined curiously and participated in the discussion. The trend of 3D imaging, capture as well as display, has a significant thrust forward. One example of the 360° 3D capture was by Tim Macmillan and his team at GoPro, showcasing an array of 16 GoPro cameras arranged on a full circle and mounted on a pole. The capture from this device can be uploaded to the new YouTube 360° 3D channel.

Another interesting demo was the Colorblind Image Simulator created in Stanford University Vista Lab by Haomiao Jiang, Joyce Farrell, and Brian Wandell. This tool can be used to convert normal images to colorblind images. With this tool, we can easily know how the image is perceived by the eyes of colorblind.

Interactive Presentations

The Interactive Paper (Poster) Session was scheduled for 90 minutes on Wednesday evening. The authors were required to set-up their posters starting at 10:00 am on Monday 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. Light refreshments were served during the session and the discussions were energetic and the authors and the attendees were fully engaged.

Industry Exhibit

This event, which continued from 10 am on Tuesday until 4 pm on Wednesday, was a great venue for the industry to exhibit their products and services as well as an excellent opportunity for the scientists and engineers to interact directly with industry representative and learn about their offerings. This event provides a great opportunity to learn firsthand about the related products, services, and career opportunities and initiate contact.

Among the showcased products and services were calibration equipment, Image Quality systems (especially geared towards sensors and capture), tunable spectral lighting, light booths with LEDs, calibration equipment for sensors, light sources and light booths now with LEDs, Image Quality targets and IQ quantification software especially for capture/sensors.

Symposium and Society Awards

The Symposium and Society awards were presented prior to the plenary sessions on Monday and Tuesday.

Monday afternoon prior to the Plenary talk 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. The award was presented by the Symposium Chair, Choon-Woo Kim, to Dr. Michael Kriss.

The “Honorary Membership Award,” the highest award bestowed by the Society that recognizes outstanding contributions to the advancement of imaging science or engineering, was presented to Dr. Bernice E. Rogowitz. She was recognized for her outstanding leadership, teaching, research and building a multi-disciplinary community of scientists and technologists as conference chair of the Human Vision and Electronic Imaging Conference

Several conferences also awarded their best student paper and/or best paper awards (see page 1 for abstracts of awarded these papers).

EI Venue for 2016

The next EI Symposium—January 29 to February 2, 2017—will return to SFO Hyatt Regency Burlingame. The Symposium will be chaired by Nitin Sampat (Rochester Institute of Technology) and Joyce Farrell (Stanford Center for Image Systems Engineering). We hope to see you there. ▲



The HVEI conference has been a pioneer in blurring the lines between art and industry, and, continuing in that vein, an artist presented a demo that created the appearance of texture on a 2D surface. This demo was also relevant to the research presented in HVEI regarding human perception of texture.

papers continued from page 1

Human Vision and Electronic Imaging (HVEI) 2015

A transformation-aware perceptual image metric

Petr Kellnhofer¹, Tobias Ritschel^{1,2}, Karol Myszkowski¹, and Hans-Peter Seidel¹; ¹Max-Planck-Institut für Informatik and ²Saarland University (Germany)

Abstract: Predicting human visual perception has several applications such as compression, rendering, editing, and retargeting. Current approaches however, ignore the fact that the human visual system compensates for geometric transformations, e. g., we see that an image and a rotated copy are identical. Instead, they will report a large, false-positive difference. At the same time, if the transformations become too strong or too spatially incoherent, comparing two images indeed gets increasingly difficult. Between these two extrema, we propose a system to quantify the effect of transformations, not only on the perception of image differences, but also on saliency. To this end, we first fit local

papers continue on page 12

The Standards Roundup: Imaging and Graphic Arts

by Ann L. McCarthy, IS&T Standards Coordinator

Standards Tools on imaging.org

The imaging.org standards page has been updated to include the Geometric Distortion and Chromatic Displacement Tool applicable for use in both ISO 17850:2015, *Photography — Digital cameras — Geometric distortion (GD) measurements*, and ISO 19084:2015, *Photography — Digital cameras — Chromatic displacement measurements*. The MATLAB code can be downloaded from www.imaging.org under Standards.

ISO/TC 42 Photography

ISO/TC 42 Standards Working Groups and Projects

TC 42/WG 18 has published ISO/TR 19247, *Photography — Guidelines for reliable testing of digital still cameras*. The motivation for publishing this guideline is the increasing use of digital cameras tests in the industry and press. Complex and, more importantly, reliable camera testing requires a high technical background and expensive test equipment. This guide provides advice and benchmark data for the reliable testing of digital cameras.

TC 42/WG 18 has also published ISO 20087:2016, *Digital still cameras — Battery life measurement*. For digital cameras, battery life is an important feature. The Camera & Imaging Products Association (CIPA) originally defined a CIPA standard “CIPA DC-002-2003 Procedure for Measuring Digital Still Camera Battery Consumption” to specify a standard measurement procedure in 2003. The standardized procedure gives unbiased and useful information on battery life to end-users. Since its publication, the CIPA standard has been adopted as the worldwide practice of battery life measurement since its publication. The ISO 20087:2016 standard is based on the CIPA standard.

TC 42/WG 18 has initiated a New Project ballot for ISO/NP 516, *Photography — Camera mechanical shutters — Timing*. This project, when approved, is intended to update the title, introduction and scope of ISO 516:1999 (Ed. 3) to address current digital camera technology. No other changes to this standard are anticipated. The intention is to limit the title and scope to mechanical shutters, with a clarification that the test methods cannot be applied to assembled digital cameras.

TC 42/WG 18 has published ISO/TS 19567-1:2016 (Ed. 1), *Digital cameras — Texture reproduction measurements — Part 1: Frequency characteristics measurements using cyclic pattern*. This Part 1 provides methods using test charts with cyclical patterns, which correspond well to the texture reproduction capabilities of most cameras. The long term trend in digital cameras to utilize small sensors with high pixel counts results in less light reaching individual pixels. With the signal getting smaller and the noise level remaining at a certain level, in-camera image processing typically reduces the noise after capture. The challenge for the algorithms in this area is to differentiate texture in the actual

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.

scene from the unwanted noise introduced by the capturing system. This technical specification provides methods to investigate the achievement in this trade off. Following on with the 19567 project, a project has been approved and a committee study ballot initiated for ISO/NP TS 19567-2, *Digital cameras — Texture reproduction measurements — Part 2: Texture analysis on non cyclic pattern*.

Work continues in TC 42/WG 18 on the committee draft for ISO/CD 18844, *Electronic still picture imaging — Flare measurement techniques for digital camera systems*. Image flare is defined in this standard to be the remaining flare signal—measured using image data output from digital cameras—after in-camera image processing algorithms have operated. This standard will include test patterns, measurement conditions, and test methods to enable comparisons of this image quality component.

TC 42/JWG 20, *Digital Still Cameras*, has published ISO/TS 17321-4:2016, *Graphic technology and photography — Colour characterization of digital still cameras (DSCs) — Part 4: Programmable light emission system*. ISO/TS 17321-4 specifies programmable light emission systems using multiple LEDs (Light Emitting Diodes) with different spectral distributions—intended for use in digital camera colour characterization. The light emission system can be programmed to approximate an arbitrary spectrum over a uniform area and so can be programmed to match the spectrum from a colored target illuminated by a light source. Improvements in digital camera color characterization support work in many application areas, e.g., medical imaging, cosmetics, e-commerce, digitized color art archiving, and so forth, where colorimetric image capture and colorimetric image reproduction are desired. [Note that an ISO Technical Specification (TS) is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/TS is confirmed for a further three years, it is reviewed again after that three year period, at which time it must either be transformed into an International Standard or be withdrawn.]

TC 42/JWG 23 has published ISO 22028-1:2016 (Ed. 2), *Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 1: Architecture and requirements*. This replaces ISO 22028-1:2004 (Ed. 1) and ISO 22028-1:2004/Cor 1:2007 (Ed. 1). The final ballot was approved unanimously. Japan and the US contributed editorial proofing comments in support of the publication.

TC 42/JWG 25 has begun publication of ISO 12234-3:2016, *Electronic still picture imaging — Removable memory — Part 3: XMP for digital photography*. ISO 12234-3:2016 (PhotoXMP) defines an XMP namespace for the metadata used in digital photography applications that is formatted for exchange using the syntax of XML. It provides unambiguous definitions covering the metadata used in digital photography. The defined XMP namespace is applicable to image databases, including online databases, image editing software, and imaging devices such as digital cameras, digital image display devices, and digital image storage devices. Several different TIFF-based metadata formats have been commonly used in digital cameras, while XML encoded metadata is commonly used in online image databases. ISO 12234-3:2016 unambiguously defines an XMP namespace for all aspects of digital photography, and documents the meaning of each metadata item. This will enable future systems, particularly online digital image storage and sharing systems, to better utilize the metadata created by digital cameras. The XMP namespace is independent of the formats of image files, and can be used in databases of image-related metadata. The metadata of ISO 12234-3 includes a number of items that are defined in either in ISO 16684-1, “Guidelines for Handling Image Metadata”, Version 2.0, November 2010, from the Metadata Working Group, or in CIPA DC-010-2012 *Exif 2.3 Metadata for XMP*.

The ISO/TC 130 XMP standard ISO 16684-1, *Graphic technology — Extensible metadata platform (XMP) specification — Part 1: Data model, serialization and core properties*, provides the basis for ISO 12234-3. XMP (Extensible Metadata Platform) standardizes the creation, processing and interchange of standardized and custom metadata for digital documents and data sets. XMP standardizes a data model, a serialization format, and core properties for the definition and processing of extensible metadata. It also provides guidelines for embedding XMP information into popular image, video and document file formats, such as JPEG and PDF, without breaking their readability in applications that do not support XMP. The serialization of XMP defines how any instance of the XMP data model can be recorded as XML.

TC 42/JWG 26 initiated work with an NP ballot on ISO/TS 19264-1, *Photography — Archiving Systems — Image quality analysis — Part 1 Reflective originals*. This work will describe a method of analyzing image quality in the area of cultural heritage imaging. The analysis will apply to digital cameras and scanners used for digitization of cultural heritage material. Out of the many image quality characteristics of image capture devices and related software, the work will specify which characteristics should be measured, why those characteristics are important, how they should be measured, and how the results should be presented.

The NP is approved and the project registered for work to begin on ISO 21139-1, *Digital colour prints — Permanence and durability performance in commercial applications — Part 1: Definition of use cases and guiding principles for specifications*, in JWG 27, “Image permanence & durability test methods and specifications for digital prints in commercial applications,” a joint working group of ISO/TC 42, ISO/TC 130, and ISO/IEC JTC1/SC

28. Belgium is providing the project leader, Jürgen Jung (Agfa Materials), and Germany, Japan, Portugal, Switzerland, UK, and US have nominated experts for the project. The multi-part ISO 21139 project will be aligned with the objective image quality evaluation metrics currently under development by ISO/TC 130/JWG 14, another joint working group of ISO/TC 130 (WG 3), ISO/TC 42 (WG 5) and ISO/IEC JTC 1/SC 28 (WG 4).

In TC 42/WG 5, the draft international standard is approved for the revision of ISO 18935:2005 (Ed.1), *Imaging materials — Colour images on paper prints — Determination of indoor water resistance of printed colour images*. ISO/DIS 18935:20xx (Edition 2), received no disapproval votes. The US provided a small number of helpful editorial comments for the purpose of clarifying the standard.

ISO/TC 130 Graphic Technology

The scope of ISO/TC 130 Graphic Technology includes the standardization of terminology, test methods and specifications in the field of printing and graphic technology from the original provided to finished products. The scope includes, in particular, composition, reproduction, printing process, finishing, and the suitability of materials used in graphic technology. Printing is defined in ISO/TC 130 as a process of reproduction involving the transfer of a medium either colored or not to a substrate, using relief, planographic, intaglio, stencil or other image element.

JOINT CGATS/USTAG/ IDEAlliance PPC Activities

Within the US, positions and contributions for ISO/TC 130 are coordinated through joint meetings of CGATS (Committee for Graphic Arts Technology Standards), the ISO/TC 130/US TAG, and the Print Properties & Colorimetrics (PPC) Committee, a working group of the IDEAlliance. CGATS Technical Reports pertaining to graphics industry color and tone are available at: www.npes.org/programs/standardsworkroom/toolsbestpractices/technicalreports.aspx

ISO/TC 130 Standards in Development

TC 130/WG 2 has begun publication of ISO 19445:2016, *Graphic technology — Metadata for graphic arts workflow — XMP metadata for image and document proofing*. ISO 19445 describes a set of metadata suitable to communicate approval status, and related information, such as proof print preparation conditions, for images and documents in a graphic arts print production workflow. The standard is based on the XMP soft-proofing ticket previously defined by the Ghent PDF Workgroup, *Ghent PDF Workgroup Soft-Proofing Ticket – V1*, available from www.gwg.org/wp-content/uploads/GWG_v1_SP2.pdf. The ISO 19445 ImageApproval record includes such fields as the PrintingConditionIdentifier, meant to reference the ICC CMYK characterization data registry (www.color.org), the PrintingConditionProfileID, identifying the ICC printing condition profile used when the image was approved, and the RenderingIntent, required to be one of the four ICC rendering intents. As with ISO 12234-3:2016 discussed

above, ISO 19445 is based on ISO 16684-1, *Graphic technology — Extensible metadata platform (XMP) specification — Part 1: Data model, serialization, and core properties*.

CIE News

CIE Publications

CIE 217:2016, *Recommended Method for Evaluating the Performance of Colour-Difference Formulae*, provides a recommended method to evaluate the strength of the relationship between visually-perceived colour differences in a given set of colour pairs and their corresponding predictions made by a colour-difference formula. This method is based on the Standardized Residual Sum of Squares (STRESS) index used in multidimensional scaling, and tests if two colour-difference formulae are or are not statistically significantly different. The publication is written in English and is readily available at the national Committees of the CIE or via the CIE Webshop.

CIE x041:2016, *Proceedings of CIE Expert Symposium on the CIE S 025 LED Lamps, LED Luminaires and LED Modules Test Standard*, Braunschweig, Germany, is available. This CIE Expert Symposium was organized by CIE Division 2 in cooperation with Physikalisch-Technische Bundesanstalt PTB and CIE Central Bureau, and was hosted by the PTB at their laboratories in Braunschweig, Germany. The Symposium featured contributed papers of leading experts in photometry and radiometry presenting facts and recent research related to the CIE International Standard S 025 Test Method for LED Lamps, LED Luminaires and LED Modules. The publication is written in English, includes 11 contributions, and is readily available at the national Committees of the CIE or via the CIE Webshop.

CIE Tutorial and Symposium

CIE will host the *CIE Tutorial on Visual Appearance Fundamentals and Measurement* (http://div2.cie.co.at/?i_ca_id=985) on September 5, 2016, followed by the 4th CIE Expert Symposium on Colour and Visual Appearance, September 6 – 7, 2016, in Prague, Czech Republic.

The tutorial will be devoted to the BRDF and BTDF of surfaces, a field in which there has been recent progress at both the metrological and instrumental level.

Ten years ago few high-level instruments for the measurement of BRDF, BTDF, or associated quantities, were available. Now there are instruments marketed primarily for this purpose either in a number of fixed measurement geometries (called multi-angle spectrophotometers) or with the possibility to scan across arbitrary geometries using rotating stages (goniospectrophotometers). Performing BRDF and BTDF measurements is not completely trivial and can require adapting such instruments for measurement of the specific quantity. The tutorial presents practical examples and appropriate ways to make such adaptations. Measurements of near-Lambertian, glossy, goniochromatic, sparkling, and translucent surfaces are used to demonstrate instrumental adaptations and case studies with a set of typical samples.

The 4th CIE Expert Symposium on Colour and Visual Appearance is a joint symposium of CIE Division 1 and Division 2 and will be of interest to those concerned with aspects of the perception and measurement of visual appearance and measurement of the bidirectional reflection and transmission distribution functions of modern materials.

The tutorial and symposium be followed by Technical Committee Meetings on September 8 and the Division 1 Annual Meeting on September 9, 2016.

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.

IS&T REPORTER

Executive Editor: Peter Burns
Managing Editor: Donna Smith
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The *IS&T Reporter* is published quarterly by the Society for Imaging Science and Technology (IS&T). Articles and letters to the editor do not necessarily constitute endorsement or reflect the opinions of the editors or IS&T. Advertising and copy are subject to acceptance by the editor.

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ISSN 2327-4395 print
ISSN 2327-4409 online

UPCOMING IS&T EVENTS

September 12 – 16, 2016; Manchester, UK

Printing for Fabrication

collocated: Technologies in Digital Photo Fulfillment
32nd International Conference on Digital Printing Technologies

November 7 – 11, 2016; San Diego, CA

24th Color and Imaging Conference (CIC24)

Jan. 26 – Feb. 2, 2017; Burlingame, California

Electronic Imaging 2017

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homographies to a given optical flow field and then convert this field into a field of elementary transformations such as translation, rotation, scaling, and perspective. We conduct a perceptual experiment quantifying the increase of difficulty when compensating for elementary transformations. Transformation entropy is proposed as a novel measure of complexity in a flow field. This representation is then used for applications, such as comparison of non-aligned images, where transformations cause threshold elevation, and detection of salient transformations.

Image Quality and Systems Performance XIII Optimized tone curve for in-camera image processing

Praveen Cyriac, David Kane, and Marcelo Bertalmio, *Universitat Pompeu Fabra (Spain)*

Abstract: The sensor values captured by a digital camera are transformed in a non-linear manner prior to quantization in order to make the quantization rate approximately proportional to the sensitivity of the human visual system. We propose an image dependent non-linear transformation that can accurately reproduce the detail and contrast visible in the original scene. The principles underpinning the transform stem from an understanding of natural image statistics, as well as recent experimental and neuro-physiological findings. To optimize the parameters of the model we collect user-feedback and develop a method that can predict the user defined parameters. The method we have developed has an extremely low computational complexity, therefore it operates almost instantaneously making it suitable for in-camera operations. The final image looks natural, without any halos, spurious colors or artifacts. It can also be applied to video sequences, after imposing temporal coherence on the parameter values by smoothing them over time. The proposed approach is validated through psychophysical tests that confirm that it outperforms other state of the art algorithms in terms of users' preference.

Image Sensors and Imaging Systems 2016 A comparative noise analysis and measurement for n-type and p-type pixels with CMS technique

Xiaoliang Ge¹, Bastien Mamdy^{2,3}, and Albert Theuwissen^{1,4}; ¹Technische Universiteit Delft (the Netherlands), ²STMicroelectronics (France), ³Université Claude Bernard Lyon 1 (France), and ⁴Harvest Imaging (Belgium)

Abstract: This paper presents a noise analysis and noise measurements of n-type and p-type pixels with correlated multiple sampling (CMS) technique. The output noise power spectral density (PSD) of both pixel types with different CMS noise reduction factors have been simulated and calculated in the spectral domain. For validation, two groups of test pixel have been fabricated with a state-of-the-art n-type and p-type CMOS image sensor (CIS) technology. The calculated and the measured noise results with CMS show a good agreement. Measurement results also show that the n-type and p-type pixels reach a 1.1 e⁻ and 0.88 h⁺ input-referred

temporal noise respectively with a board-level 64 times digital CMS and ×6 analog gain..

Measuring, Modeling, and Reproducing Material Appearance 2016

Effect of mesoscale surface structure on perceived brightness

Michael Ludwig and Gary Meyer, *University of Minnesota (USA)*

Abstract: Surface geometry can play an important role in our ability to understand and interpret material appearance and properties. This property ranges from large-scale shape changes impacting our identification of reflections to visible surface roughness affecting how glossy a material appears. In this work we present a user study that examines numerous surface geometries that are defined at the mesoscale: small enough to be considered indicative of the material and not object geometry, but large enough to be visible from a distance with the naked eye. Subjects matched the perceived brightness of a ray-traced bumpy surface to a flat surface with adjustable intensity. Multiple classes of bumpy surface were generated and presented to subjects so that the effects of surface pattern on perceived brightness could be studied. We show that two predictive models of brightness are only conditionally accurate but that humans have a consistent means of measuring overall brightness..

Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2016

Supplementation of LiDAR cans with Structure from Motion (SfM) data

Fabian Gassen and Reiner Creutzburg, *Brandenburg University of Applied Sciences (Germany)*

Abstract: Lidar (light and radar or light detection and ranging) and SfM (structure from motion) are valuable tools for generating meshes from real world objects. In the entertainment sector these technologies come in convenient for the production. Since both methods have their advantages this paper examines the process of using both technologies in combination. Point clouds are generated using both methods and combining the results into one point cloud and creating a mesh. This generated 3D object can be used in VFX.

Visualization and Data Analysis (VDA) 2016

MaVis: Machine learning aided multi-model framework for time series visual analytics

Kaiyu Zhao, Matthew Ward, Elke Rundensteiner, and Huong Higgins, *Worcester Polytechnic Institute (USA)*

Abstract: The ultimate goal of any visual analytic task is to make sense of the data and gain insights. Unfortunately, the continuously growing scale of the data nowadays challenges the traditional data analytics in the “big-data” era. Particularly, the human cognitive capabilities are constant whereas the data scale is not. Furthermore, most existing work focus on how to extract interesting in-

formation and present that to the user while not emphasizing on how to provide options to the analysts if the extracted information is not interesting. In this paper, we propose a visual analytic tool called MaVis that integrates multiple machine learning models with a plug-and-play style to describe the input data. It allows the analysts to choose the way they prefer to summarize the data. The MaVis framework provides multiple linked analytic spaces for interpretation at different levels. The low level data space handles data binning strategy while the high level model space handles model summarizations (i.e. clusters or trends). MaVis also supports model analytics that visualize the summarized patterns and compare and contrast them. This framework is shown to provide several novel methods of investigating co-movement patterns of timeseries dataset which is a common interest of medical sciences, finance, business and engineering alike. Lastly we demonstrate the usefulness of our framework via case study and user study using a stock price dataset.

BEST PAPER AWARDS

3D Image Processing, Measurement (3DIPM), and Applications 2016

Markerless motion capture with multi-view structured light

Ricardo Garcia and Avidah Zakhori, University of California, Berkeley (USA)

Abstract: We present a multi-view structured light system for markerless motion capture of human subjects. In contrast to existing approaches that use multiple camera streams or single depth sensors, we reconstruct the scene by combining six partial 3D scans generated from three structured light stations surrounding the subject. We avoid interference between multiple projectors through time multiplexing and synchronization across all cameras and projectors. We generate point clouds from each station, convert them to partial surfaces, and merge them into a single coordinate frame. We develop algorithms to reconstruct dynamic geometry using a template generated by the system itself. Specifically, we deform the template to each frame of the captured geometry by iteratively aligning each bone of the rigged template. We show the effectiveness of our system for a 50-second sequence of a moving human subject.

Digital Photography and Mobile Imaging XII

Use of flawed and ideal image pairs to drive filter creation by genetic programming

Subash Sridhar, Henry Dietz, and Paul Eberhart, University of Kentucky (USA)

Abstract: Traditional image enhancement techniques improve images by applying a series of filters, each of which repairs a specific type of flaw, but most modern digital cameras produce images with a variety of subtle interacting defects. Sequential repair is slow, and the interactions limit the effectiveness.

This paper describes a fundamentally different approach in which a single filter is created to repair the potentially myriad in-

teracting defects associated with a particular camera configuration and set of exposure parameters. Genetic programming (GP) is used to automatically evolve a filter algorithm that will convert flawed images into images minimally differing at the pixel level from the corresponding provided ideal images. For example, the flawed images might be shot at a high ISO and the ideal ones might be the exact same static scenes, aligned at the pixel level, but shot at a low ISO using appropriately longer exposure times. Just as easily, the flawed images might be technically well-corrected, while the ideal ones were manually-edited to adjust and smooth skin tones, sharpen hair, enhance shadow regions, etc. The custom-coded parallel GP, its performance, and performance of the generated filters is discussed with an example.

Image Processing: Algorithms and Systems XIV

Fast edge-directed single-image super-resolution

Mushfiqur Rouf¹, Dikpal Reddy², Kari Pulli², and Rabab Ward¹; ¹University of British Columbia (Canada) and ²Light Co. (USA)

Abstract: We present a novel method for single-image super-resolution (SR). In natural images, spatial edges usually have smooth contours. From this observation, we derive a fast edge-preserving natural image prior using our proposed fast edge-directed interpolation (EDI) method, and combine this prior with the well-known sparse gradient prior into a maximum-a-posteriori (MAP) formulation of the SR problem. We develop an efficient primal-dual algorithm to solve the inverse problem. The application of our edge-preserving prior adds little computational overhead and the output produced by our method demonstrates that results are better than those of the state-of-the-art conventional methods.

Image Processing: Machine Vision Applications IX

Marker-less AR framework using on-site 3D line segment based model generation (JIST-first)

Yusuke Nakayama and Hideo Saito, Keio University, and Masayoshi Shimizu and Nobuyasu Yamaguchi, Fujitsu Laboratories Ltd. (Japan)

Abstract: The authors propose a line-segment-based marker-less augmented reality (AR) framework that involves an on-site model-generation method and on-line camera tracking. In most conventional model-based marker-less AR frameworks, correspondences between the 3D model and the 2D frame for camera-pose estimation are obtained by feature-point matching. However, 3D models of the target scene are not always available, and feature points are not detected from texture-less objects. The authors' framework is based on a model-generation method with an RGB-D camera and model-based tracking using line segments, which can be detected even with only a few feature points. The camera pose of the input images can be estimated from the 2D–3D line-segment correspondences given by a line-segment feature descriptor. The experimental results show that the proposed framework can achieve AR when other point-based frameworks

cannot. The authors also argue that their framework can generate a model and estimate camera pose more accurately than their previous study.

Image Quality and System Performance XIII

Using binocular and monocular properties for the construction of a quality assessment metric for stereoscopic images

Iana Iatsun, Mohamed-Chaker Larabi, and Christine Fernandez-Maloigne, Université de Poitiers (France)

Abstract: More and more people are getting access to 3D; 3D-TV is a next expecting step in telecommunication. Before being presented to the public, any 3D content has to be coded, compressed and transmitted. All these treatments can impact the quality of the final product, thus it is essential to have a measurement tool for the estimation of the quality of stereoscopic content. Several studies have already modified the existing 2D quality metrics to be able to evaluate 3D images, however the results are not satisfying. In this work, we propose a full-reference metric for a quality assessment of stereoscopic images employing the properties of binocular perception. The principle of the metric estimates the probability of fusion, that can be obtained perceptually. The quality of one view is assessed relatively to the other, and according to the result metric makes a decision, that is based on the binocular fusion properties. The comparison between views is performed only on the salient area. It is detected using the visual attention model based on the monocular depth cues and interest points. The metric has been tested on the publicly available dataset, and its results are coherent to the subjective scores.

Image Sensors and Imaging Systems 2016

Non-negative Matrix Completion for the enhancement of Snapshot Mosaic Multispectral Imagery

Grigorios Tsagkatakis¹, Murali Jayapala², Bert Geelen², and Panagiotis Tsakalides¹; ¹FORTH (Greece) and ²IMEC (Belgium)

Abstract: Multi- and Hyperspectral Imaging (HSI) are characterized by the discrepancy between the dimensionality of hyperspectral image and video data and the dimensionality of the spectral detectors. This issue has been addressed by various schemes, including the Snapshot Mosaic Multispectral Imaging architecture, where each pixel (or group of pixels) is associated with a single spectral band. An unavoidable side effect of this design is the hard trade-off between spatial and spectral resolution. In this work, we propose a formal approach for overcoming this trade-off by formulating the problem of full resolution recovery as a low rank Matrix Completion problem. Furthermore, we extend the traditional formulation of Matrix Completion by introducing non-negativity constraints during the recovery process, thus significantly enhancing the reconstruction quality. Experimental results suggest that the Non-Negative Matrix Completion (NN-MC) framework is capable of estimating a high spatial and spectral resolution hypercube from a single exposure, surpassing

state-of-the-art schemes like the nearest-neighbors as well as the unconstrained Matrix Completion techniques.

Mobile Devices and Multimedia: Enabling Technologies, Algorithms, and Applications 2016

Comparative visualization of geometry of a hollow box girder using 3D-LiDAR – Part 1: Cross sectional area

Jenny Knackmuss¹, Stefan Maack², and Reiner Creutzburg¹; ¹Brandenburg University and ²Bundesanstalt für Materialprüfung (Germany)

Abstract: With the mandatory introduction of the directive for recalculation of bridges in May 2011 in Germany, the administrations of the federal and state governments have a duty to demonstrate the stability of their bridge inventory. The requisite verification will be realized under consideration of the new increased traffic loads on the construction, in a four-step process. Particularly in older bridges the verification succeeds only using the computational resources of the original structural design. One option these reserves to be considered is the exact determination of the dead weight of the bridge. Since the existing as-built documents of the construction often digress significantly from the real dimensions, there are two options to resolve the issue. In addition to the technically very complicated and relatively expensive method of weighing the construction, the calculation can also be done indirectly through a combined process of photogrammetric measurement and non-destructive testing. On a practical case study will be demonstrated how the solution of this problem can succeed. For this is done in the first step to scan in detailed the inner topography of a part of the construction by a 3D laser scanner. The results of these tests are compared with the existing stock plans of the building. The aim of this study is to determine the dead weight of structure. Therefore, in the first part of this work sectional plans were extracted of the technical drawing and the point cloud to calculate the area of the interior. Based on the calculated areas in the sectional planes, the volume calculation should take place in the next step.

Visualization and Data Analysis 2016

End-user development of visualizations

Kostas Pantazos and Søren Lauesen, IT University of Copenhagen (Denmark)

Abstract: In this article the authors investigated a visualization tool (uVis) for end-user developers, in order to see how end users actually use it. The tool was an early version and the investigation helped the authors to improve it. The investigation showed that users appreciated the simple formula language, the coordinated panels, and the drag-and-drop mechanism. However, the most important thing for them was the immediate response when they changed something, for instance part of a formula. The entire visualization was updated immediately without having to switch from development view to production view.

