Human Vision and Electronic Imaging 2023

Conference Chair
Damon Chandler, Ritsumeikan University (Japan)

PROGRAM AND PROCEEDINGS

This document details the conference program, held as part of the 2023 IS&T International Symposium on Electronic Imaging, 15-19 January 2023. Manuscripts of conference papers are reproduced from PDFs as submitted and approved by authors; no editorial changes were made.

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Human Vision and Electronic Imaging 2023

Conference overview

The conference on Human Vision and Electronic Imaging explores the role of human perception and cognition in the design, analysis, and use of electronic media systems. It brings together researchers, technologists, and artists, from all over the world, for a rich and lively exchange of ideas. We believe that understanding the human observer is fundamental to the advancement of electronic media systems, and that advances in these systems and applications drive new research into the perception and cognition of the human observer. Every year, we introduce new topics through our Special Sessions, centered on areas driving innovation at the intersection of perception and emerging media technologies. The HVEI website (https://jbmulligan.github.io/HVEI/) includes additional and historical information.

Conference Sponsors

Paper authors listed as of 1 January 2023; refer to manuscript for final authors. Titles that are not listed with the proceedings files were presentation-only.

Human Vision and Electronic Imaging 2023

MONDAY 16 JANUARY 2023

Monday 16 January PLENARY: Neural Operators for Solving PDEs
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
2:00 PM – 3:00 PM
Cyril Magnin I/II/III

Deep learning surrogate models have shown promise in modeling complex physical phenomena such as fluid flows, molecular dynamics, and material properties. However, standard neural networks assume finite-dimensional inputs and outputs, and hence, cannot withstand a change in resolution or discretization between training and testing. We introduce Fourier neural operators that can learn operators, which are mappings between infinite dimensional spaces. They are independent of the resolution or grid of training data and allow for zero-shot generalization to higher resolution evaluations. When applied to weather forecasting, neural operators capture fine-scale phenomena and have similar skill as gold-standard numerical weather models for predictions up to a week or longer, while being 4-5 orders of magnitude faster.

Anima Anandkumar, Bren professor, California Institute of Technology, and senior director of AI Research, NVIDIA Corporation (United States)

Anima Anandkumar is a Bren Professor at Caltech and Senior Director of AI Research at NVIDIA. She is passionate about designing principled AI algorithms and applying them to interdisciplinary domains. She has received several honors such as the IEEE fellowship, Alfred. P. Sloan Fellowship, NSF Career Award, and Faculty Fellowships from Microsoft, Google, Facebook, and Adobe. She is part of the World Economic Forum's Expert Network. Anandkumar received her BTech from Indian Institute of Technology Madras, her PhD from Cornell University, and did her postdoctoral research at MIT and assistant professorship at University of California Irvine.

EI 2023 Highlights Session
Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
3:30 – 5:00 PM
Cyril Magnin II

Join us for a session that celebrates the breadth of what EI has to offer with short papers selected from EI conferences.

NOTE: The EI-wide "EI 2023 Highlights" session is concurrent with Monday afternoon COIMG, COLOR, IMAGE, and IQSP conference sessions.

IQSP-309
Evaluation of image quality metrics designed for DRI tasks with automotive cameras, *Valentine Klein, Yiqi LI, Claudio Greco, Laurent Chanas, and Frédéric Guichard, DXOMARK (France)*

SD&A-224

Human performance using stereo 3D in a helmet mounted display and association with individual stereo acuity, *Bonnie Posselt, RAF Centre of Aviation Medicine (United Kingdom)*

IMAGE-281

Smartphone-enabled point-of-care blood hemoglobin testing with color accuracy-assisted spectral learning, *Sang Mok Park[1], Yuhyun Ji[1], Semin Kwon[1], Andrew R. O'Brien[2], Ying Wang[2], and Young L. Kim[1]; [1]Purdue University and [2]Indiana University School of Medicine (United States)*

AVM-118

Designing scenes to quantify the performance of automotive perception systems, *Zhenyi Liu[1], Devesh Shah[2], Alireza Rahimpour[2], Joyce Farrell[1], and Brian Wandell[1]; [1]Stanford University and [2]Ford Motor Company (United States)*

VDA-403

Visualizing and monitoring the process of injection molding, *Christian A. Steinparz[1], Thomas Mitterlehner[2], Bernhard Praher[2], Klaus Straka[1,2], Holger Stitz[1,3], and Marc Streit[1,3]; [1]Johannes Kepler University, [2]Moldsonics GmbH, and [3]datavisyn GmbH (Austria)*

COIMG-155

Commissioning the James Webb Space Telescope, *Joseph M. Howard, NASA Goddard Space Flight Center (United States)*

HVEI-223

Critical flicker frequency (CFF) at high luminance levels, *Alexandre Chapiro[1], Nathan Matsuda[1], Maliha Ashraf[2], and Rafal Mantiuk[3]; [1]Meta (United States), [2]University of Liverpool (United Kingdom), and [3]University of Cambridge (United Kingdom)*

HPCI-228

Physics guided machine learning for image-based material decomposition of tissues from simulated breast models with calcifications, *Muralikrishnan Gopalakrishnan Meena[1], Amir K. Ziabari[1], Singanallur Venkatakrishnan[1], Isaac R. Lyngaas[1], Matthew R. Norman[1], Balint Joo[1], Thomas L. Beck[1], Charles A. Bouman[2], Anuj Kapadia[1], and Xiao Wang[1]; [1]Oak Ridge National Laboratory and [2]Purdue University (United States)*

3DIA-104

Layered view synthesis for general images, *Loïc Dehan, Wiebe Van Ranst, and Patrick Vandewalle, Katholieke University Leuven (Belgium)*

ISS-329

A self-powered asynchronous image sensor with independent in-pixel harvesting and sensing operations, *Ruben Gomez-Merchan, Juan Antonio Leñero-Bardallo, and Ángel Rodríguez-Vázquez, University of Seville (Spain)*

COLOR-184

Color blindness and modern board games, *Alessandro Rizzi[1] and Matteo Sassi[2]; [1]Università degli Studi di Milano and [2]consultant (Italy)*

TUESDAY 17 JANUARY 2023

KEYNOTE: Perceptual Video Quality 1 (T1) Joint Session

Session Chairs: Lukáš Krasula, Netflix, Inc. (United States) and Mohamed Chaker Larabi, Université de Poitiers (France)

9:05 – 10:10 AM

Cyril Magnin III

This session is jointly sponsored by: Human Vision and Electronic Imaging 2023, and Image Quality and System Performance XX.

Joint Conference Welcome

HVEI-258

KEYNOTE: Bringing joy to Netflix members through perceptual encoding optimization, *Anne Aaron, Netflix, Inc. (United States)*

As Director of Encoding Technologies, Anne Aaron leads the team responsible for media processing and encoding at Netflix. Her team works on video, audio, images and timed-text, from analysis to processing, encoding, packaging and DRM. On the streaming side, they strive to deliver a compelling viewing experience for millions of Netflix members worldwide, no matter where, how and what they watch. For the Netflix studio, they build media technologies that can improve content production. In her previous role at Netflix, Aaron led the Video Algorithms team. As a team, they researched and deployed innovation in the video encoding space (per-title encoding, video quality assessment and perceptual metrics, shot-based encoding, HDR, next-generation codecs) that benefited Netflix members as well as impacted the rest of the industry. Recent recognitions include: Some recent recognitions: SMPTE 2019 Workflow Systems Medal, Forbes' 2018 America's top women in Tech, Business Insider's 2017 Most powerful female engineers in US tech in 2017.

Perceptual Video Quality 2 (T2) Joint Session

Session Chairs: Lukáš Krasula, Netflix, Inc. (United States) and Mohamed Chaker Larabi, Université de Poitiers (France)
10:50 AM – 12:30 PM
Cyril Magnin III

This session is jointly sponsored by: Human Vision and Electronic Imaging 2023, and Image Quality and System Performance XX.

10:50 HVEI-259
Video quality of video professionals for Video Assisted Referee (VAR), *Kjell Brunnström[1,2], Anders Djupsjöbacka[1], Johsan Billingham[3], Katharina Wistel[3], Börje Andrén[1], Oskars Ozolins[1,4], and Nicolas Evans[3]; [1]RISE Research Institutes of Sweden AB (Sweden), [2]Mid Sweden University (Sweden), [3]Fédération Internationale de Football Association (FIFA) (Switzerland), and [4]KTH (Royal Institute of Technology) (Sweden)*

11:10 HVEI-260
User perception for dynamic video resolution change using VVC, *Sachin G. Deshpande and Philip Cowan, Sharp (United States)*

11:30 IQSP-261
Proposing more ecologically-valid experiment protocol using YouTube platform, *Gabriela Wielgus, Lucjan Janowski, Kamil Koniuch, Mikolaj Leszczuk, and Rafal Figlus, AGH University of Science and Technology (Poland)*

11:50 IQSP-262
Evaluation of motion blur image quality in video frame interpolation, *Hai Dinh, Fangwen Tu, Qinyi Wang, Brett Frymire, and Bo Mu, Omnivision Technology (United States)*

12:10 IQSP-263
Subjective video quality for 4K HDR-WCG content using a browser-based approach for "at-home" testing, *Lukáš Krasula[1], Anustup Choudhury[2], Scott Daly[2], Zhi Li[1], Robin Atkins[2], Ludovic Malfait[2], and Aditya Mavlankar[1]; [1]Netflix, Inc. and [2]Dolby Laboratories, Inc. (United States)*

Tuesday 17 January PLENARY: Embedded Gain Maps for Adaptive Display of High Dynamic Range Images

Session Chair: Robin Jenkin, NVIDIA Corporation (United States)
2:00 PM – 3:00 PM
Cyril Magnin I/II/III

Images optimized for High Dynamic Range (HDR) displays have brighter highlights and more detailed shadows, resulting in an increased sense of realism and greater impact. However, a major issue with HDR content is the lack of consistency in appearance across different devices and viewing environments. There are several reasons, including varying capabilities of HDR displays and the different tone mapping methods implemented across software and platforms. Consequently, HDR content authors can neither control nor predict how their images will appear in other apps.

We present a flexible system that provides consistent and adaptive display of HDR images. Conceptually, the method combines both SDR and HDR renditions within a single image and interpolates between the two dynamically at display time. We compute a Gain Map that represents

the difference between the two renditions. In the file, we store a Base rendition (either SDR or HDR), the Gain Map, and some associated metadata. At display time, we combine the Base image with a scaled version of the Gain Map, where the scale factor depends on the image metadata, the HDR capacity of the display, and the viewing environment.

Eric Chan, Fellow, Adobe Inc. (United States)

Eric Chan is a Fellow at Adobe, where he develops software for editing photographs. Current projects include Photoshop, Lightroom, Camera Raw, and Digital Negative (DNG). When not writing software, Chan enjoys spending time at his other keyboard, the piano. He is an enthusiastic nature photographer and often combines his photo activities with travel and hiking.

Paul M. Hubel, director of Image Quality in Software Engineering, Apple Inc. (United States)

Paul M. Hubel is director of Image Quality in Software Engineering at Apple. He has worked on computational photography and image quality of photographic systems for many years on all aspects of the imaging chain, particularly for iPhone. He trained in optical engineering at University of Rochester, Oxford University, and MIT, and has more than 50 patents on color imaging and camera technology. Hubel is active on the ISO-TC42 committee Digital Photography, where this work is under discussion, and is currently a VP on the IS&T Board. Outside work he enjoys photography, travel, cycling, coffee roasting, and plays trumpet in several bay area ensembles.

Computational Models of Vision (T3)

Session Chair: Rafal Mantiuk, University of Cambridge (United Kingdom)
3:30 – 4:50 PM
Cyril Magnin I

3:30 HVEI-246
Modelling contrast sensitivity of discs, *Maliha Ashraf[1], Rafal Mantiuk[2], and Alexandre Chapiro[3]; [1]University of Liverpool (United Kingdom), [2]University of Cambridge (United Kingdom), and [3]Meta (United States)*

3:50 HVEI-247
An intrinsic image network evaluated as a model of human lightness perception, *Richard F. Murray[1], David H. Brainard[2], Alban Flachot[1], and Jaykishan Y. Patel[1]; [1]York University (Canada) and [2]University of Pennsylvania (United States)*

4:10 HVEI-248
Are unique hues defined by complementary color pairings rather than opponent processes?, *Christopher W. Tyler, The Smith-Kettlewell Eye Research Institute (United States)*

4:30 HVEI-249
Natural scene statistics and distance perception: ground surface and non-ground objects (JPI-first), *Xavier Morin Duchesne and Michael Langer, McGill University (Canada)*

DISCUSSION: Tuesday End of Day (T4)
Session Chair: Damon Chandler, Ritsumeikan University (Japan)
4:50 – 5:30 PM
Cyril Magnin I

Please join us for a lively discussion of today's presentations. Participate in an interactive, moderated discussion, where key topics and questions are discussed from many perspectives, reflecting the diverse HVEI community.

WEDNESDAY 18 JANUARY 2023

KEYNOTE: AR/VR Special Session 1 (W1) Joint Session
Session Chair: Alexandre Chapiro, Meta (United States)
9:05 – 10:10 AM
Cyril Magnin II

This session is jointly sponsored by: Engineering Reality of Virtual Reality 2023, Human Vision and Electronic Imaging 2023, and Stereoscopic Displays and Applications XXXIV.

Joint Conference Welcome

HVEI-219
KEYNOTE: Display consideration for AR/VR systems, *Ajit Ninan, Reality Labs at Meta (United States)*

Ajit Ninan is a display industry veteran and led the way to the industry adopting HDR. His inventions & innovations are manifest in millions of shipped HDR TV's and consumer electronics from multiple companies. He holds 400+ granted patents in imaging and display technology and now works in imaging related to AR/VR at Meta as Senior Director of Applied Perceptual Science and Image Quality. His work spans multiple subjects ranging from Displays, Imaging, Color, Video, Compression, Audio and Networking. His career spans early start-ups to public companies. Ninan is the inventor of the local dimmed quantum dot TV and led the way to the industry adoption of quantum dot displays by working with Vizio, Nanosys and 3M to release the first of its kind R-series QD TV with HDR. He also led the effort with the JPEG committee to standardize JPEG-XT to enable JPEG HDR images. Ninan was inducted as a SMPTE Fellow for his contributions to imaging and standards. The display that caused the world to adopt HDR called the "Pulsar" capable of 4000nits down to .005nits with P3 color in 2010, built by Ninan and his team, has received many awards including the Advanced Imaging Society's Lumiere award which enabled the development of Dolby Vision and earned Ninan an Emmy.

AR/VR Special Session 2 (W2) Joint Session

Session Chairs: Nicko Caluya, Ritsumeikan University (Japan) and Alexandre Chapiro, Meta (United States)
10:50 AM – 12:30 PM
Cyril Magnin II

This session is jointly sponsored by: Engineering Reality of Virtual Reality 2023, Human Vision and Electronic Imaging 2023, and Stereoscopic Displays and Applications XXXIV.

10:50 HVEI-220
Comparison of AR and VR memory palace quality in second-language vocabulary acquisition (Invited), *Xiaoyang Tian, Nicko Caluya, and Damon M. Chandler, Ritsumeikan University (Japan)*

11:10 HVEI-221
Projection mapping for enhancing the perceived deliciousness of food (Invited), *Yuichiro Fujimoto, Nara Institute of Science and Technology (Japan)*

11:30 HVEI-222
Real-time imaging processing for low-vision users, *Yang Cai, CMU (United States)*

11:50 HVEI-223
Critical flicker frequency (CFF) at high luminance levels, *Alexandre Chapiro[1], Nathan Matsuda[1], Maliha Ashraf[2], and Rafal Mantiuk[3]; [1]Meta (United States), [2]University of Liverpool (United Kingdom), and [3]University of Cambridge (United Kingdom)*

12:10 HVEI-253
A multichannel LED-based lighting approach to improve color discrimination for low vision people, *Linna Yang[1], Éric Dinet[1], Pichayada Katemake[2], Alain Trémeau[1], and Philippe Colantoni[1]; [1]University Jean Monnet Saint-Etienne (France) and [2]Chulalongkorn University (Thailand)*

Wednesday 18 January PLENARY: Bringing Vision Science to Electronic Imaging: The Pyramid of Visibility

Session Chair: Andreas Savakis, Rochester Institute of Technology (United States)
2:00 PM – 3:00 PM
Cyril Magnin I/II/III

Electronic imaging depends fundamentally on the capabilities and limitations of human vision. The challenge for the vision scientist is to describe these limitations to the engineer in a comprehensive, computable, and elegant formulation. Primary among these limitations are visibility of variations in light intensity over space and time, of variations in color over space and time, and of all of these patterns with position in the visual field. Lastly, we must describe how all these sensitivities vary with adapting light level. We have recently developed a structural description of human visual sensitivity that we call the Pyramid of Visibility, that accomplishes this synthesis. This talk shows how this structure accommodates all the dimensions described above, and how it can be used to solve a wide variety of problems in display engineering.

Andrew B. Watson, chief vision scientist, Apple Inc. (United States)

Andrew Watson is Chief Vision Scientist at Apple, where he leads the application of vision science to technologies, applications, and displays. His research focuses on computational models of early vision. He is the author of more than 100 scientific papers and 8 patents. He has 21,180 citations and an h-index of 63. Watson founded the Journal of Vision, and served as editor-in-chief 2001-2013 and 2018-2022. Watson has received numerous awards including the Presidential Rank Award from the President of the United States.

PANEL: AR/VR Special Session (W3.1) Joint Session
Session Chairs: Nicko Caluya, Ritsumeikan University (Japan) and Alexandre Chapiro, Meta (United States)
Panelists: Alexandre Chapiro, Meta (United States); Yuichiro Fujimoto, Nara Institute of Science and Technology (Japan); Nicolas Holliman, King's College London (United Kingdom); and Ajit Ninan, Reality Labs at Meta (United States)
3:30 – 4:50 PM
Cyril Magnin II

This session is jointly sponsored by: Engineering Reality of Virtual Reality 2023, Human Vision and Electronic Imaging 2023, and Stereoscopic Displays and Applications XXXIV.

DISCUSSION: Wednesday End of Joint Sessions (W3.2) Joint Session
Session Chair: Damon Chandler, Ritsumeikan University (Japan)
4:50 – 5:30 PM
Cyril Magnin II

This session is jointly sponsored by: Engineering Reality of Virtual Reality 2023, Human Vision and Electronic Imaging 2023, and Stereoscopic Displays and Applications XXXIV.

Please join us for a lively discussion of today's presentations. Participate in an interactive, moderated discussion, where key topics and questions are discussed from many perspectives, reflecting the diverse HVEI community.

BANQUET: 2023 Friends of HVEI (W5)
Session Chairs: Damon Chandler, Ritsumeikan University (Japan) and Rafal Mantiuk, University of Cambridge (United Kingdom)
7:00 – 10:00 PM
MISSION I/II/III

Join us for a wonderful evening of conversations, a banquet dinner, and an enlightening speaker. This banquet is associated with the Human Vision and Electronic Imaging Conference (HVEI), but everyone interested in research at the intersection of human perception/cognition, imaging technologies, and art is welcome. Banquet registration required, online or at the registration desk. Location will be provided with registration.

HVEI-250

KEYNOTE: How to let your pictures shine! The impact of high dynamic range imaging on photography, *Timo Kunkel, Dolby Laboratories, Inc. (United States)*

Dr. Timo Kunkel is director of image technology & standards in the CTO office of Dolby Laboratories, Inc. His fields of expertise include image processing, color science, high dynamic range imaging, color appearance modeling, and advanced display technologies. Kunkel is engaged in developing color management models for both professional and consumer displays (dynamic range and gamut mapping concepts). This involves active research, code development and QA as well as applying metrological and psychophysical concepts for verification, including picture quality assessment and tuning for several display technologies from customers all over the world. Additionally, he has experience in neuroscience and psychological concepts related to the Human Visual System (signal processing in the retina and higher visual cortex), and has been involved in developing the core concepts of what is now Dolby Vision. Kunkel is also actively involved with international standards work, serving as technical expert and member of IEC TC100 (Audio, video and multimedia systems and equipment) and TC110 (Electronic displays), the International Color Consortium (ICC), as well as the SID International Committee of Display Metrology (ICDM). Further, Kunkel has a background in Physical Geosciences (remote sensing and geospatial image processing, GIS, Vegetation- and Ecosystem Modeling) and has worked in these fields with research departments at Lund University in Sweden, Lincoln University in New Zealand, and the University of Dar es Salaam in Tanzania. This work is supported by more than 20 years of experience as a freelance landscape and architecture photographer for clients in Europe and the US, winning several prizes with images combining HDR and computational photography aspects. Kunkel served as president of Bristol Chapter, ACM SIGGRAPHACM SIGGRAPH, 2006 - 2008, and was co-founder of the Bruder & Bär publishing company (Germany), serving there as Art Director, 2003 - 2006. Kunkel holds a PhD in computer science from University of Bristol, United Kingdom, and a MSc from University of Freiburg, Germany.

THURSDAY 19 JANUARY 2023

Creative Intent and Perception in Visualization and Displays (R1)
Session Chair: Damon Chandler, Ritsumeikan University (Japan)
9:30 – 10:10 AM
Mission I/II

9:30 HVEI-251
Am I safe? An examination of how everyday people interpret covid data visualizations, *Bernice Rogowitz[1] and Paul Borrel[2]; [1]Visual Perspectives (United States) and [2]consultant (France)*

9:50 HVEI-254
Biosensors for landing creative intent, *Scott Daly, Evan Gitterman, Dan Darcy, and Shane Ruggieri, Dolby Laboratories, Inc. (United States)*

EEG/fMRI/Retina (R2)
Session Chair: Bernice Rogowitz, Visual Perspectives (United States)
10:50 – 11:50 AM

Mission I/II

10:50 HVEI-255
Self-regulation of attentional stance facilitates induction of meditative states, *Glenn Hartelius[1,2], Lora T. Likova[3], and Christopher W. Tyler[3]; [1]Alef Trust, [2]Naropa University, and [3]The Smith-Kettlewell Eye Research Institute (United States)*

11:10 HVEI-256
Spatial cognition training rapidly induces cortical plasticity in blind navigation, *Lora T. Likova, Zhangziyi Zhou, Michael Liang, and Christopher W. Tyler, The Smith-Kettlewell Eye Research Institute (United States)*

SFMOMA Museum Tour & Casual Dinner (R3)
2:00 – 8:00 PM
OFFSITE - Meet at Registration

Join your HVEI colleagues for an excursion to the SFMOMA after Thursday's lunch recess. Meet and depart from the EI 2023 registration desk at 2:00 pm. Visit SFMOMA 2:30 - 5:00 pm. Gather informally for dinner at 6:00 pm.