



High Performance Computing for Imaging 2023

Conference Chairs

Xiao Wang, Oak Ridge National Laboratory (US)

Peng Chen, The National Institute of Advanced Industrial Science and Technology (Japan)

Yuankai Huo, Vanderbilt University (US)

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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High Performance Computing for Imaging 2023

Conference overview

In recent years, the rapid development of imaging systems and the growth of compute-intensive imaging algorithms have led to a strong demand for High Performance Computing (HPC) for efficient image processing. However, the two communities, imaging and HPC, have largely remained separate, with little synergy. This conference focuses on research topics that converge HPC and imaging research with an emphasis on advanced HPC facilities and techniques for imaging systems/algorithms and applications. In addition, the conference provides a unique platform that brings imaging and HPC people together and discusses emerging research topics and techniques that benefit both the HPC and imaging community. Papers are solicited on all aspects of research, development, and application of high-performance computing or efficient computing algorithms and systems for imaging applications.

Conference Chairs: **Xiao Wang**, Oak Ridge National Laboratory (US); **Peng Che**, The National Institute of Advanced Industrial Science and Technology (Japan); and **Yuankai Huo**, Vanderbilt University (US)

Program Committee: **Shunxing Bao**, Vanderbilt University (US); **Tekin Bicer**, Argonne National Laboratory (US); **Ana Gainaru**, Oak Ridge National Laboratory (US); **Hongyang Sun**, University of Kansas (US); **Singanallur Venkatakrishnan**, Oak Ridge National Laboratory (US); **Mohamed Wahib**, RIKEN Center for Computational Science (Japan); **Lipeng Wan**, Georgia State University (US); and **Yuhao Zhu**, University of Rochester (US)

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.

High Performance Computing for Imaging 2023

MONDAY 16 JANUARY 2023

AI Methods for Imaging (M1)

Session Chair: Muralikrishnan Gopalakrishnan Meena, Oak Ridge National Laboratory (United States)

9:05 – 10:20 AM

Mason

9:05

Conference Welcome

9:10

HPCI-227

HPC+AI-enabled real-time nanoscale x-ray imaging (Invited), *Mathew Cherukara, Argonne National Laboratory (United States)*

9:40

HPCI-228

Physics guided machine learning for image-based material decomposition of tissues from simulated breast models with calcifications, *Muralikrishnan Gopalakrishnan Meena¹, Amir K. Ziabari¹, Singanallur Venkatakrishnan¹, Isaac R. Lyngaas¹, Matthew R. Norman¹, Balint Joo¹, Thomas L. Beck¹, Charles A. Bouman², Anuj Kapadia¹, and Xiao Wang¹; ¹Oak Ridge National Laboratory and ²Purdue University (United States)*

10:00

HPCI-229

WearMask: Fast in-browser face mask detection with serverless edge computing for COVID-19, *Zekun Wang¹, Pengwei Wang², Peter C. Louis³, Lee E. Wheless³, and Yuankai Huo¹; ¹Vanderbilt University (United States), ²Shandong University (China), and ³Vanderbilt University Medical Center (United States)*

Ptychographic Imaging (M2)

Session Chair: Xiao Wang, Oak Ridge National Laboratory (United States)

10:50 AM – 12:10 PM

Mason

10:50

HPCI-230

High-performance ptychographic reconstruction using GPUs (Invited), *Tekin Bicer, Argonne National Laboratory (United States)*

11:20

HPCI-231

Image gradient decomposition for parallel and memory-efficient ptychographic reconstruction (Invited), *Xiao Wang, Oak Ridge National Laboratory (United States)*

11:50

HPCI-232

AI-assisted automated workflow for real-time x-ray ptychography data analysis via federated resources, *Anakha V Babu, Tekin Bicer, Saugat Kandel, Tao Zhou, Daniel J. Ching, Steven Henke, Sinisa Veseli, Ryan Chard, Antonio Miceli, and Mathew Cherukara, Argonne National Laboratory (United States)*

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 Park¹, Yuhyun Ji¹, Semin Kwon¹, Andrew R. O'Brien², Ying Wang², and Young L. Kim¹; ¹Purdue University and ²Indiana University School of Medicine (United States)

AVM-118

Designing scenes to quantify the performance of automotive perception systems, Zhenyi Liu¹, Devesh Shah², Alireza Rahimpour², Joyce Farrell¹, and Brian Wandell¹; ¹Stanford University and ²Ford Motor Company (United States)

VDA-403

Visualizing and monitoring the process of injection molding, Christian A. Steinparz¹, Thomas Mitterlehner², Bernhard Praher², Klaus Straka^{1,2}, Holger Stitz^{1,3}, and Marc Streit^{1,3}; ¹Johannes Kepler University, ²Moldsonics GmbH, and ³datavisyn 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 Chapiro¹, Nathan Matsuda¹, Maliha Ashraf², and Rafal Mantiuk³; ¹Meta (United States), ²University of Liverpool (United Kingdom), and ³University 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 Meena¹, Amir K. Ziabari¹, Singanallur Venkatakrishnan¹, Isaac R. Lyngaas¹, Matthew R. Norman¹, Balint Joo¹, Thomas L. Beck¹, Charles A. Bouman², Anuj Kapadia¹, and Xiao Wang¹; ¹Oak Ridge National Laboratory and ²Purdue University (United States)

3DIA-104

Layered view synthesis for general images, Loic 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 blindness and modern board games, Alessandro Rizzi¹ and Matteo Sassi²; ¹Università degli Studi di Milano and ²consultant (Italy)

TUESDAY 17 JANUARY 2023

KEYNOTE: High-Performance Imaging (T1)

Session Chair: Xiao Wang, Oak Ridge National Laboratory (United States)

8:50 – 10:20 AM

Mason

8:50

HPCI-233

KEYNOTE: Reducing the barriers to high performance imaging, Charles A. Bouman, Purdue University (United States)

Prof. Charles A. Bouman received a BSEE from the University of Pennsylvania in 1981 and an MS from the University of California at Berkeley in 1982. From 1982 to 1985, he was a full staff member at MIT Lincoln Laboratory and in 1989 he received a PhD in electrical engineering from Princeton University. He joined the faculty of Purdue University in 1989 where he is currently the Showalter Professor of Electrical and Computer Engineering and Biomedical Engineering. Prof. Bouman's research is in the area of computational imaging and sensing where he is focused on the integration of signal processing, statistical modeling, physics, and computation to solve difficult sensing problems with applications in healthcare, material science, physics, chemistry, commercial and consumer imaging. His research resulted in the first commercial model-based iterative reconstruction (MBIR) system for medical X-ray computed tomography (CT), and he is co-inventor on over 50 issued patents that have been licensed and used in millions of consumer imaging products. Professor Bouman is a member of the National Academy of Inventors, a Fellow of the IEEE, a Fellow and Honorary Member of the society for Imaging Science and Technology (IS&T), a Fellow of the American Institute for Medical and Biological Engineering (AIMBE), and a Fellow of the SPIE professional society. He is the recipient of the 2021 IEEE Signal Processing Society, Claude Shannon-Harry Nyquist Technical Achievement Award, the 2014 Electronic Imaging Scientist of the Year award, and the IS&T's Raymond C. Bowman Award; and in 2020, his paper on Plug-and-Play Priors won the SIAM Imaging Science Best Paper Prize. He was previously the Editor-in-Chief for the IEEE Transactions on Image Processing; a Distinguished Lecturer for the IEEE Signal Processing Society; and a Vice President of Technical Activities for the IEEE Signal Processing Society, during which time he led the creation of the IEEE Transactions on Computational Imaging. He has been an associate editor for the IEEE Transactions on Image Processing, the IEEE Transactions on Pattern Analysis and Machine Intelligence, and the SIAM Journal on Mathematical Imaging. He has also been a Vice President of Publications and a member of the Board of Directors for the IS&T Society, and he is the founder and Co-Chair of the long running IS&T conference on Computational Imaging.

9:50

HPCI-234

High-performance embedded imaging: An optics, sensor, and computing co-design approach (Invited), Yuhao Zhu, University of Rochester (United States)

X-ray Scatter and MR Imaging (T2)

Session Chair: Venkatesh Sridhar, Lawrence Livermore National Laboratory (United States)

10:50 AM – 12:10 PM

Mason

10:50

HPCI-235

A system for large-scale inverse multiple-scattering imaging on GPU supercomputers with real data (Invited), Mert Hidayetoglu; Stanford University and SLAC National Accelerator Laboratory (United States)

11:20

HPCI-236

Fast massively parallel physics-based algorithm for modeling multi-order scatter in CT (Invited), Venkatesh Sridhar¹, Xin Liu¹, and Kyle Champley²; ¹Lawrence Livermore National Laboratory and ²Ziteo Medical (United States)

11:50

HPCI-237

Clinical validation of rapid GPU-enabled DTI tractography of the brain, Felix Liu¹, Vanitha Sankaranarayanan¹, Javier Villanueva-Meyer¹, Shawn Hervey-Jumper¹, James Hawkins¹, Pablo Damasceno², Mauro Bisson³, Josh Romero³, Thorsten Kurth³, Massimiliano Fatica³, Eleftherios Garyfallidis⁴, Ariel Rokem⁵, Jason Crane¹, and Sharmila Majumdar¹; ¹University of California, San Francisco, ²Janssen Pharmaceutical, ³NVIDIA Corporation, ⁴Indiana University, and ⁵University of Washington (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.

High Performance Tomographic Reconstruction (T3)

Session Chair: Peng Chen, Japan National Lab (AIST) (Japan)

3:30 – 5:30 PM

Mason

3:30

HPCI-238

Training end-to-end unrolled iterative neural networks for SPECT image reconstruction: A fast and memory efficient Julia toolbox (Invited), Zongyu Li, Yuni K. Dewaraja, and Jeff Fessler, University of Michigan (United States)

4:00

HPCI-239

Fast GPU-based tomographic reconstruction with efficient data transfers between CPU, GPU, and NVMe SSDs (Invited), Viktor Nikitin, Argonne National Laboratory (United States)

4:30

HPCI-240

Hierarchical communications for 3D image reconstruction with synchrotron light source and 24,576 GPUs (Invited), Mert Hidayetoglu; Stanford University and SLAC National Accelerator Laboratory (United States)

5:00

HPCI-241

High-performance image reconstruction on GPU-accelerated supercomputers (Invited), Peng Chen¹, Mohamed Wahib², Xiao Wang³, Jintao Meng⁴, and Yusuke Tanimura¹; ¹Japan National Lab (AIST) (Japan), ²RIKEN Center for Computational Science (Japan), ³Oak Ridge National Laboratory (United States), and ⁴Shenzhen Institute of Advanced Technology, CAS (China)

WEDNESDAY 18 JANUARY 2023

PANEL: High-Performance Computing in Imaging: from Academia to Industry (W1)

Panelists: Yuankai Huo, Vanderbilt University (United States); Yucheng Tang, NVIDIA Corporation (United States); and Xiao Wang, Oak Ridge National Laboratory (United States)

9:10 – 10:10 AM

Mason

AI Acceleration & System Design (W2)

Session Chair: Mohamed Wahib, RIKEN Center for Computational Science (Japan)

10:50 AM – 12:30 PM

Mason

10:50

HPCI-242

TVM enabled automatic kernel generation for irregular GEMM optimization on ARM architectures

(Invited), Du Wu^{1,2}, Chen Zhuang², Haidong Lan³, Wenxi Zhu³, Minwen Deng³, Peng Chen⁴, Mohamed Wahib⁵, Jintao Meng², Bingqiang Wang⁶, Yanjie Wei², Yi Pan², and Shengzhong Feng⁷; ¹Southern University of Science and Technology of China (China), ²Shenzhen Institute of Advanced Technology, Chinese Academy of Science (China), ³Tencent AI Lab, Shenzhen (China), ⁴Japan National Lab (AIST) (Japan), ⁵RIKEN Center for Computational Science (Japan), ⁶Peng Cheng Laboratory, Shenzhen (China), and ⁷National Supercomputer Center in Shenzhen, China (China)

11:20

HPCI-243

Towards real-time formula driven dataset feed for large scale deep learning training, Edgar Josafat Martinez Noriega¹ and Rio Yokota²; ¹National Institute of Advanced Industrial Science and Technology and ²Tokyo Institute of Technology (Japan)

11:40

HPCI-244

Algorithmic enhancements to data colocation grid frameworks for big data medical image processing (Invited), Shunxing Bao¹ and Yuankai Huo²; ¹Vanderbilt University and ²presenter only (United States)

12:10

HPCI-245

Bridging the gap between high-performance computing and high-performance imaging applications, Mohamed Wahib, RIKEN Center for Computational Science (Japan)

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.