Keigo Hirakawa

CONTACT INFORMATION

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RESEARCH INTERESTS

Statistical signal processing, imaging, Bayesian analysis, missing data problems, harmonic analysis, computer vision, non-Gaussian noise, joint signal processing-hardware solutions, embedded systems.

EDUCATION

Cornell University, Ithaca, NY GPA=3.81 **2003 - 2005**
Ph.D. (May 2005) in Electrical and Computer Engineering. Minor in Mathematics.
- Dissertation: *Image Processing Using Sensor Noise and Human Visual System Models*.
- Research Advisor: Prof. Thomas W. Parks.

Cornell University, Ithaca, NY GPA=3.83 **2000 - 2003**
M.S. (May 2003) in Electrical and Computer Engineering.
- Thesis: *Metric Neighborhood Modeling: Theory and Application*.
- Research Advisor: Prof. Thomas W. Parks.

Princeton University, Princeton, NJ GPA=3.81/3.75 **1996 - 2000**
B.S.E. (May 2000) in Electrical Engineering, *magna cum laude*. Certificates in CS and in Music.

New England Conservatory of Music, Boston, MA GPA=3.96 **2004 - 2006**
M.M. (May 2006) in Jazz Studies, Piano Performance, *cum laude*.

HONORS AND AWARDS

- *Keynote Speaker*, IS&T CGIV 2008.
- Docomo USA Labs *Innovative Paper Award*, IEEE ICIP 2007.
- *Tutorial*, IEEE ICIP 2008.
- *Top 10%* of Accepted Papers, IEEE ICIP 2005; *Top Paper* in Its Category, IEEE ICASSP 2005.
- *Best Student Presentation*, IEEE WNYIP 2003.
- Lockheed Martin *Fellowship Award*, 2001.
- Princeton University: graduated *magna cum laude*, 2000.
- Sigma Xi Scientific Research Society, 2000; Tau Beta Pi National Engineering Honor Society, 1999.

ACADEMIC EXPERIENCES

Harvard University, Cambridge, MA
Research Associate, School of Engineering and Applied Sciences **2008 - present**
Postdoctoral Research Fellow, School of Engineering and Applied Sciences **2007 - 2008**
- Advisors: Prof. Xiao-Li Meng, Statistics; Prof. Patrick Wolfe, SEAS
- Expertise: signal processing with missing data, EM algorithm, Bayesian hierarchical models, computer vision, non-Gaussian noise, joint signal processing-hardware solutions.
- Collaborate research on signal-dependent noise removal funded by Sony Corporation.
- Advise Ph.D students.

Preceptor, Department of Statistics (see *Teaching Experience*) **2006 - 2007**

Cornell University, Ithaca, NY
Graduate Research Assistant **2002 - 2004**
- Research Advisor: Prof. Thomas W. Parks.
- Expertise: filter designs, signal/image modeling, digital cameras, sensor noise characterization, filterbanks/wavelets, human perceptual models.
- Collaborate research on digital cameras funded by Texas Instruments and Agilent Technologies.

PROFESSIONAL EXPERIENCES

Hewlett-Packard/Agilent Technologies, Corvallis, Oregon

Research Scientist, Lecturer **Summer 2003**

- Project lead. Supervised embedded ASIC MPEG-4 codec architecture development. Developed Matlab MPEG-4 codec reference model. Performed video quality analysis.
- Offered classes in MPEG.

Research Scientist, Lecturer **Summer 2002**

- Chief imaging scientist. Developed algorithms for demosaicking interpolation and bad pixel amelioration. Supervised many other algorithmic developments.
- Offered classes in: color science, optical image formation, demosaicking algorithms.

ASIC Hardware Engineer, Research Scientist, Lecturer **Spring 2001, Summer 2001**

- Chief imaging scientist. Conducted feasibility study of ASIC embedded MPEG modules. Supervised product definition and high-level architecture development of ASIC MPEG-4 codec. Designed motion compensation and frame buffer modules.
- Offered classes in: filterbanks, wavelets, MPEG.

ASIC Hardware Engineer **Summer 1999, Summer 2000**

- Designed, verified, and synthesized demosaicking, data-reformat, controller interface, multi-rate processor, demultiplexer for imaging coprocessor (600K gate ASIC; HP *Photosmart* 812/935).

NEC Corporation, Kanagawa, Japan

Research Engineer **Summer 1998**

- Analyzed multi-core DSP throughput and improved instruction cache. Developed parallel H.261 codec in assembly language. Designed non-preemptive priority-scheduled thread routine.

Other Highlights

- Residency, Institute for Mathematics and Its Applications (IMA), Univ. of Minnesota, 2007.
- Tutorial, IEEE ICIP 2008; Session Chair, IEEE ICASSP 2007 & 2008.
- Visiting Scholar, Oregon State University, Spring 2003.
- Collaborations: AZ Electronic Materials, Sony, Texas Instruments, Agilent Technologies, NEC.
- AHD demosaicking algorithm is by now the *de facto* standard for most open-source raw image converters, including DCRaw, VueScan, SharpRaw, UFRaw, SUSE Linux.

TEACHING EXPERIENCES

Harvard University, Cambridge, MA

Preceptor, Department of Statistics **2006 - 2007, 3 semesters**

- Chaired a committee to train new graduate students to become teaching associates.
- Chaired a commission by dean to study the effectiveness of extracurricular teaching resources.
- Taught "Intro to Quantitative Methods." Designed the curriculum, lectured, conducted weekly review sessions, prepared/graded homeworks and exams. This sophomore class of 180 students covers linear regression, confidence intervals, hypothesis testing, probability, central limit theorem, Bayes rule, experimental designs.

Cornell University, Ithaca, NY

Head Teaching Assistant—"Color Imaging" **2002, 1 semester**

- Designed the curriculum, taught lectures, prepared reading material, designed/administered labs, prepared/graded homework and exams. This new graduate course covers colorimetry, device calibration, psycho-visual experiments, and color image processing.

Head Teaching Assistant—"Digital Signal Processing" **2001, 1 semester**

- Prepared lectures, designed/administered labs, prepared/graded homework and exams, supervised final projects. This advanced senior level course covers polyphase/filterbanks/wavelets, non-uniform sampling, multi-dimensional systems, filter designs, spectral analysis, generalized FFT.

Head Teaching Assistant—"Introductory Logic Design" **2000 - 2001, 2 semesters**

- Designed the curriculum, taught lectures, conducted weekly review sessions, prepared/graded homework and exams. This sophomore introductory class of 180 students covers sequential logic and state machines. Best ECE teaching assistant award.

Princeton University, Princeton, NJ

Teaching Assistant—"Introductory Logic Design" **1999 - 2000**

GRANTS

- Co-PI, "Multispectral Appearance: Acquisition, Representation, and Applications," NSF Information & Intelligent Systems. PI: Todd Zickler. Submitted October 2008.
- Co-author, "Overcomplete Representations with Incomplete Data: Theory, Algorithms, and Signal Processing Applications," NSF Focused Research Group. PI: Xiao-Li Meng. $900,000 award, 2007.
- Co-PI, "A New Spatio-Spectral Sampling Paradigm for Imaging: A Novel Design for Sensors and Displays," contract with Sony, $170,000 award. PI: Patrick Wolfe, 2007-2009.
- Co-PI, "A Novel Imaging Solution to Sensor Crosstalk," in negotiation with Texas Instruments, 2008.
- Co-author. "Digital Camera Color Space," contract with Agilent Technologies, $30,000 award. PI: Thomas W. Parks, 2003.
- Co-author. "High Image Quality Digital Cameras," contract with Texas Instruments, $120,000 award. PI: Thomas W. Parks, 2002.

BOOK CHAPTERS

- K.H., "Color Filter Array Image Analysis for Joint Denoising and Demosaicking," to appear in *Single-Sensor Imaging: Methods and Applications for Digital Cameras*, ed. R. Lukac, CRC Press, 2008.
- K.H., P.J. Wolfe, "Spatio-Spectral Sampling and Color Filter Array Design," to appear in *Single-Sensor Imaging: Methods and Applications for Digital Cameras*, ed. R. Lukac, CRC Press, 2008.

JOURNAL PUBLICATIONS

- K.H., P.J. Wolfe, "Optimal Color Filter Array Design by Spatio-Spectral Sampling," *IEEE Trans. Image Processing*, October 2008.
- K.H., T.W. Parks, "Total Least Squares Method for Image Denoising," *IEEE Trans. Image Processing*, September 2006.
- K.H., T.W. Parks, "Joint Demosaicing and Denoising," *IEEE Trans. Image Processing*, August 2006.
- K.H., T.W. Parks, "Adaptive Homogeneity-Directed Demosaicing Algorithm," *IEEE Trans. Image Processing*, March 2005.
- K.H., P.J. Wolfe, "Wavelet- and Filterbank-Based Poisson Intensity Estimation Using the Skellam Distribution," under review by sponsor, to be submitted to IEEE TIT.
- K.H., F. Baqai, P.J. Wolfe, "Poisson Intensity Estimation for Image Denoising: A Comparative Study," under review by sponsor, to be submitted to IEEE TIP.
- A. Chakrabarti, K.H., T. Zickler, "Computational Color Constancy with Spatial Correlations," in preparation, to be submitted to IEEE PAMI.

SELECTED CONFERENCES & PRESENTATIONS

- K.H., P.J. Wolfe, "SkellamShrink: Poisson Intensity Estimation for Vector-Valued Data," IEEE ICASSP 2009, under review.
- K.H., F. Baqai, P.J. Wolfe, "Wavelet-Based Poisson Rate Estimation Using the Skellam Distribution," SPIE EI/CIC, 2009.
- K.H., "Spatio-Spectral Sampling in Multispectral Imaging," *IS&T CGIV* 2008 (keynote).
- K.H., P.J. Wolfe, T. Nguyen, "Color Imaging Pipeline for Digital Still and Video Cameras," *IEEE ICIP*, 2008 (tutorial session).
- K.H., "Cross-Talk Explained," *IEEE ICIP*, 2008.
- A. Chakrabarti, K.H., T. Zickler, "Color Constancy with Spatial Correlations," Perception of Material Properties in 3D Scenes, 2008 (workshop).
- A. Chakrabarti, K.H., T. Zickler, "Color Constancy Beyond Bags of Pixels" *IEEE CVPR*, 2008.
- K.H., "Enhancing Image Fidelity through Spatio-Spectral Design," *IEEE SPS Santa Clara Valley*, 2008. (invited)
- K.H., "Fourier and Filterbank Analysis of Signal-Dependent Noise," *IEEE ICASSP*, 2008.
- A. Chakrabarti, K.H., "Effective Separation of Sparse and Non-Sparse Image Features For Denoising," *IEEE ICASSP*, 2008.
- K.H., P.J. Wolfe, "Advancing The Digital Camera Pipeline For Mobile Multimedia: Key Challenges From a Signal processing Perspective," *IEEE ICASSP* Special Session, 2008 (invited).
- K.H., P.J. Wolfe, "Second Generation CFA and Demosaicking Design," *SPIE* EI, 2008 (invited).
- K.H., P.J. Wolfe, "Spatio-Spectral Color Filter Array Design for Enhanced Image Fidelity," *IEEE ICIP*, 2007.
- K.H., P.J. Wolfe, "Fourier Domain Display Color Filter Array Design," *IEEE ICIP*, 2007.
- K.H., X.-L. Meng, P.J. Wolfe, "A Framework For Wavelet-Based Analysis and Processing of Color Filter Array Images with Applications to Denoising and Demosaicking," *IEEE ICASSP*, 2007.
- K.H., "Signal-Dependent Noise Characterization in Haar Filterbank Domain," *SPIE OP*, 2007 (invited).
- K.H., X.-L. Meng, "An Empirical Bayes EM-Wavelet Unification for Simultaneous Denoising, Interpolation, Demosaicing, and/or Super Resolution," *IEEE ICIP*, 2006.
- K.H., X.-L. Meng, "Wavelet-Based Image Denoising with Missing Data," *Graybill*, 2006 (invited).
- K.H., T.W. Parks, "Joint Demosaicing and Denoising," *IEEE ICIP*, 2005.

- K.H., T.W. Parks, “Chromatic Adaptation and White-Balance Problem,” *IEEE ICIP*, 2005.
- K.H., T.W. Parks, “Image Denoising for Signal-Dependent Noise,” *IEEE ICASSP*, 2005.
- K.H., T.W. Parks, “Adaptive Homogeneity-Directed Demosaicing Algorithm,” *IEEE ICIP*, 2003.
- K.H., T.W. Parks, “Tone-Curve Filtering,” *IEEE WNYIP Workshop*, 2003.
- K.H., H. Igura, “Parallel DSP Task-Management Algorithms,” *IEICE Info. Sys. Soc.*, 1998.

PATENTS

- K.H., P.J. Wolfe, ”A Novel Color Filter Array Design,” submitted 2006.
- K.H., X.-L. Meng, P.J. Wolfe, ”Wavelet-Based Denoising and Demosaicing,” submitted 2006.
- K.H., ”System and Method for Cross-talk Correction,” submitted 2008.
- A. Chakrabarti, K.H., T. Zickler, ”System and Method for Color Constancy” submitted 2008.

PROFICIENCIES Strong background in Matlab, ASIC, Verilog, C/C++, LaTeX, assembly language, parallel programming.

PERSONAL Japanese Citizen. US Permanent Resident. Fluent in Japanese.