Adaptive Optics: Analysis and Methods

Collocated with

Computational Optical Sensing and Imaging

Signal Recovery and Synthesis

Digital Holography and Three-Dimensional Imaging

June 18 - 20, 2007

Sheraton Vancouver Wall Centre
Vancouver, BC, Canada

Postdeadline Submissions: May 29, 2007, 12:00 p.m. noon EDT (16.00 GMT)
Hotel Reservation Deadline: May 16, 2007
Pre-Registration Deadline: May 25, 2007
Sponsor: Optical Society of America

General Chair

Brent L. Ellerbroek, *Thirty Meter Telescope Project, USA*

Program Chairs

Brent L. Ellerbroek,*Thirty Meter Telescope Project, USA*
Julian C. Christou, *Ctr. for Adaptive Optics, USA*
Norbert Hubin, *European Southern Observatory, Germany*

Due to increasing delays in securing visas to the US, we strongly encourage international attendees to begin this process as early as possible (but no later than three months before the meeting) to ensure timely processing. Please refer to the Letter of Invitation section of this website for additional information.

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Adaptive Optics: Analysis and Methods

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About AO

SCOPE

The mission of the Topical Meeting on Adaptive Optics is

- to provide a forum for the presentation and discussion of adaptive optics (AO) system concepts, control algorithms, and analysis/simulation methods;
- to promote an interdisciplinary exchange between the developers and users of AO component technologies,
- to publicize recent progress in AO laboratory and field tests, and to summarize plans for future systems;
- to facilitate AO solutions to challenges in fields including vision science and optical communications, and to promote synergy between classical and innovative applications of adaptive optics

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Meeting Topics to Be Considered:

1. AO concepts and applications

- Advanced system concepts for atmospheric turbulence compensation, including multi-conjugate, multi-object, ground-layer, and extreme AO
- Innovative applications, including vision science and optical communication

2. AO control algorithms

- Optimal and adaptive control
- Computationally efficient algorithms
- Amplitude and phase control

3. Simulation and modeling methods

4. Component technologies

- Conventional, MEMS, and large deformable mirrors
- Wavefront sensing optics and detectors
- Signal processing electronics
- Lasers and fiber optics for laser guidestar systems

5. AO laboratory and field tests

Invited Speakers — Adaptive Optics: Analysis and Methods

AMA1, **A Comparison of Tomography Reconstruction Techniques for MCAO and MOAO: Theory and Laboratory Experience,** *Donald Gavel, Mark Ammons, Edward Laag; Univ. of California at Santa Cruz, USA.* 6/18/2007 2:00 p.m.–2:30 p.m.

ATuA1, **PSF Reconstruction for Advanced AO Systems,** *Jean-Pierre Veran; Natl. Res. Council of Canada, Canada.* 6/19/2007 10:30 a.m.–11:00 a.m.

ATuB1, **Wavefront Sensing for AO,** *Gerard Rousset; Univ. Paris, France.* 6/19/2007 2:00 p.m.–2:30 p.m.

ATuB2, **Wavefront Sensing in a Volume: Results and Perspective,** *Roberto Ragazzoni; Astronomical Observatory of Padova, Italy.* 6/19/2007 2:30 p.m.–3:00 p.m.

ATuD1, **MEMS Wavefront Correctors: Electromechanical Theory and Recent Performance Advances,** *Thomas Bifano; Boston Univ., USA.* 6/19/2007 5:00 p.m.–5:30 p.m.

AWA1, **Simulation and Design of Adaptive Optics Systems: Application to SPHERE-SAXO,** *Thierry Fusco; ONERA, France.* 6/20/2007 8:00 a.m.–8:30 a.m.

AWB1, **Adaptive Wavefront Calibration and Control for the Gemini Planet Imager,** *Lisa Poyneer[1], Jean-Pierre Véran[2]; [1]Lawrence Livermore Natl. Lab, USA, [2]Herzberg Inst. of Astrophysics, Canada.* 6/20/2007 10:30 a.m.–11:00 a.m.

AWC1, **Pyramid Wave-Front Sensing for High Contrast AO Applications,** *Christophe Verinaud; Lab d'Astrophysique Observatoire de Grenoble, France.* 6/20/2007 2:00 p.m.–2:30 p.m.

AWC2, **Focal Plane and Nonlinear Curvature Wavefront Sensing for High Contrast Imaging Adaptive Optics,** *Olivier Guyon; Subaru Telescope, USA.* 6/20/2007 2:30 p.m.–3:00 p.m.

AWD1, **Applications of Adaptive Optics for Vision and Ophthalmoscopy,** *Austin Roorda; Univ. of California at Berkeley, USA.* 6/20/2007 4:30 p.m.–5:00 p.m.

Program Agenda

	Grand Ballroom A	Grand Ballroom B	Grand Ballroom C
Monday, June 18, 2007			
8:00 a.m.– 10:00 a.m.	**SMA • Imaging Restoration and Reconstruction**	**DMA • Digital Holographic Microscopy**	**CMA • Multiaperture Imaging**
10:00 a.m.– 10:30 a.m.	**Coffee Break, Grand Ballroom D**		
10:30 a.m.– 12:30 p.m.	**SMB • Deconvolution and Compressive Imaging**	**DMB • Digital Holography (DH) and 3-D Imaging**	**CMB • Optical Hardware**
12:30 p.m.– 2:00 p.m.	**Lunch Break (on your own)**		
2:00 p.m.– 4:00 p.m.	**SMC • Phase Retrieval and Multiframe Imaging**	**AMA • Laboratory and Field Tests**	**CMC • Spectroscopy and Sensing**
4:00 p.m.– 4:30 p.m.	**Coffee Break, Grand Ballroom D**		
4:30 p.m.– 6:00 p.m.	**SMD • Synthesis and Instrumentation**	**PMA • AO/DH Postdeadline Papers Session**	**CMD • Information and Optics** ***(until 7:00 p.m.)***
6:30 p.m.– 8:00 p.m.	**Dinner Break (on your own)**		
8:00 p.m.– 9:00 p.m.		**JMA • Joint Plenary Session**	
Tuesday, June 19, 2007			
8:00 a.m.– 9:45 a.m.	**JTuA • Wavefront Reconstruction and Phase Diversity**	**DTuA • DH and Integral Imaging**	**CTuA • Task Specific Sensing**
10:00 a.m.– 10:30 a.m.	**Coffee Break, Grand Ballroom D**		
10:30 a.m.– 12:30 p.m.	**ATuA • PSF Reconstruction and Image Processing**	**DTuB • DH Poster Session** ***(Grand Ballroom D)***	**CTuB • Computational Imaging**
12:30 p.m.– 2:00 p.m.	**Lunch Break (on your own)**		
2:00 p.m.– 4:00 p.m.	**ATuB • Tomographic Wavefront Sensing**	**DTuC • 3-D Imaging**	**CTuC • Mathematical Methods**
4:00 p.m.– 5:00 p.m.	**ATuC • AO Poster Session and Coffee Break, Grand Ballroom D**		
5:00 p.m.– 7:00 p.m.	**ATuD • Deformable Mirrors**	**DTuD • DH Techniques**	**PTuA • COSI/SRS Postdeadline Papers Session**
Wednesday, June 20, 2007			
8:00 a.m.– 10:00 a.m.	**AWA • System Modeling and Design**	**DWA • 3-D Display**	
10:00 a.m.– 10:30 a.m.	**Coffee Break, Grand Ballroom D**		
10:30 a.m.– 12:30 p.m.	**AWB • Supervisory Control Algorithms**	**DWB • Computer-Generated Holography (CGH)**	
12:30 p.m.– 2:00 p.m.	**Lunch Break (on your own)**		
2:00 p.m.– 4:00 p.m.	**AWC • Innovative Wavefront Sensing**	**DWC • DH Applications**	
4:00 p.m.– 4:30 p.m.	**Coffee Break, Grand Ballroom D**		
4:30 p.m.– 6:30 p.m.	**AWD • Adaptive Optics for Vision Science**	**DWD • DH and Display**	

Adaptive Optics: Analysis and Methods Abstracts

• Sunday, June 17, 2007 •

Grand Ballroom Foyer
3:00 p.m.–6:00 p.m.
Registration Open

• Monday, June 18, 2007 •

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

AMA • Laboratory and Field Tests

Grand Ballroom B
2:00 p.m.–4:00 p.m.
AMA • Laboratory and Field Tests
Thomas Rimmele; Natl. Solar Observatory, USA, Presider

AMA1 • 2:00 p.m. **•Invited•**
A Comparison of Tomography Reconstruction Techniques for MCAO and MOAO: Theory and Laboratory Experience, *Donald Gavel, Mark Ammons, Edward Laag; Univ. of California at Santa Cruz, USA.* We compare multiple guidestar tomography reconstruction techniques for adaptive optics systems. We also present some early test results from experiments with the multi-guidestar AO testbed at the Laboratory for Adaptive Optics.

AMA2 • 2:30 p.m.
MAD On-Sky Results in Star Oriented Mode, *Enrico Marchetti[1], Roland Brast[1], Bernard Delabre[1], Rob Donaldson[1], Enrico Fedrigo[1], Christoph Frank[1], Norbert Hubin[1], Johann Kolb[1], Miska Le Louarn[1], Jean-Louis Lizon[1], Sylvain Oberti[1], Roland Reiss[1], Christian Soenke[1], Sebastien Tordo[1], Andrea Baruffolo[2], Paolo Bagnara[2], Antonio Amorim[3], Jorge Lima[3]; [1]European Southern Observatory, Germany, [2]INAF - Osservatorio Astronomico di Padova, Italy, [3]Faculdade de Ciencias, Univ. de Lisboa, Portugal.* The MAD demonstrator performed on-sky observations at VLT telescope for validating Ground-Layer, Laser Tomography and Multi-Conjugate Adaptive Optics correction. Here we present the results obtained on the sky and in laboratory for Star Oriented mode.

AMA3 • 2:45 p.m.
Performance Characteristics of a Solar MCAO Prototype System at the German Vacuum Tower Telescope in Tenerife, *Dirk Soltau, Thomas Berkefeld; Kiepenheuer Inst. für Sonnenphysik, Germany.* A solar prototype MCAO system is described. We present test results. Image motion is corrected down to 80 milliarcsec over a field of 50 arcsec. The conjugated mirror introduces intensity fluctuations of one percent rms.

AMA4 • 3:00 p.m.
Progress of a Star Oriented On-Sky MCAO Setup, *Per Knutsson, Pontus Lundin, Mette Owner-Petersen; Lund Observatory, Sweden.* Closed loop lab tests of a dual-conjugate adaptive optics setup are presented. The corrected field of view is improved compared to ground-layer and single-conjugate adaptive optics. The setup is eventually intended for on-sky observations.

AMA5 • 3:15 p.m.
Astronomical Imaging Using Ground-Layer Adaptive Optics, *Christoph J. Baranec, Michael Lloyd-Hart, N. Mark Milton, Tom Stalcup, Miguel Snyder, Roger Angel; Ctr. for Astronomical Adaptive Optics, Univ. of Arizona, USA.* At the 6.5m MMT telescope, ground-layer adaptive optics will be demonstrated for the first time in March 2007 using multiple laser guide stars. We present here the first astronomical images obtained with this system.

AMA6 • 3:30 p.m.
VOLT: The Victoria Open Loop Testbed, *David R. Andersen, Michael D. Fischer, Jean-Pierre Véran, Laurent Jolissaint, Murray Fletcher, Kaushala Bandara; Herzberg Inst. of Astrophysics, Natl. Res. Council of Canada, Canada.* VOLT (the Victoria Open Loop Testbed) will demonstrate open loop control on sky and in the lab using a simple, on-axis AO testbed. Here, we introduce VOLT and describe early simulations and design work.

AMA7 • 3:45 p.m.
UVic Woofer-Tweeter Test Bed: Status and Plans, *Rodolphe Conan, Colin Bradley, Peter Hampton, Onur Keskin, Aaron Hilton, Celia Blain; Univ. of Victoria, Canada.* The AO Laboratory of the University of Victoria has built a Woofer-Tweeter test bed. An upgraded version of the AO bench is planned for this year which uses new cutting-edge DMs.

Grand Ballroom D
4:00 p.m.–4:30 p.m.
Coffee Break

Grand Ballroom B
4:30 p.m.–6:30 p.m.
PMA • Joint AO/DH Postdeadline Papers Session

6:30 p.m.–8:00 p.m.
Dinner Break (on your own)

JMA • Joint Plenary Session

Grand Ballroom B
8:00 p.m.–9:00 p.m.
JMA • Joint Plenary Session

JMA1 • 8:00 p.m. **►Plenary◄**
Digital Image Formation from Holograms: Early Motivations and Modern Capabilities, *Joseph W. Goodman; Stanford Univ., USA.* I review the first case (1967) of detection of a hologram and reconstruction of the corresponding image by purely electronic means. I also discuss the circumstances that led to the experiment in the first place.

Adaptive Optics: Analysis and Methods (continued)

● Tuesday, June 19, 2007 ●

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

JTuA • Wavefront Reconstruction and Phase Diversity

Grand Ballroom A
8:00 a.m.–9:45 a.m.
JTuA • Wavefront Reconstruction and Phase Diversity
[Joint AO/SRS Session]
Curt Vogel; Montana State Univ., USA, Presider

JTuA1 • 8:00 a.m.
A Comparison of Multigrid V-Cycle Versus Fourier Domain Preconditioning for Laser Guide Star Atmospheric Tomography, *Luc Gilles[1], Brent Ellerbroek[1], Curtis Vogel[2]; [1]Thirty Meter Telescope, USA, [2]Montana State Univ., USA.* We present simulation results assessing the expected performance of the Thirty Meter Telescope closed loop laser guide star adaptive optics system running either Multigrid V-cycle or Fourier Domain preconditioned conjugate gradient algorithms for atmospheric tomography.

JTuA2 • 8:15 a.m.
Sparse-Matrix Regularization for Minimum-Variance Reconstruction of Pseudo-Kolmogorov Turbulence, *Lawton H. Lee; Lockheed Martin Advanced Technology Ctr., USA.* Zonal regularization for minimum-variance wavefront reconstruction is derived for approximately Kolmogorov turbulence statistics. The formulation yields sparse matrices and is reminiscent of strain energy relationships. Comparisons with Kolmogorov-optimal regularization are made using Zernike polynomials.

JTuA3 • 8:30 a.m.
Performance of LQG Control for VLT-Type MCAO Systems, *Cyril Petit[1], Jean-Marc Conan[1], Caroline Kulcsár[2], Henri-Francois Raynaud[2]; [1]ONERA, France, [2]Inst. Galilée, L2TI, Univ. Paris, France.* We analyze the performance of LQG based optimal control compared to classic integrator based control on an end-to-end MCAO simulator. The LQG control brings a significant gain of correction in the Field of View.

JTuA4 • 8:45 a.m.
Closed-Loop AO Performance with FrIM, *Clémentine Béchet, Michel Tallon, Éric Thiébaut; CRAL - Observatoire de Lyon, France.* The Fractal Iterative Method (FrIM), a fast wavefront reconstruction algorithm, is here exploited for closed-loop application, opening interesting solutions to stability issues and modelization improvements, and reducing the debatable computational burden to 79N operations.

JTuA5 • 9:00 a.m.
Phase and Retinal Images Restoration by 3-D Phase Diversity, *Guillaume Chenegros[1], Laurent Mugnier[1], François Lacombe[2], Marie Glanc[3]; [1]ONERA, France, [2]Mauna Kea Technologies, France, [3]LESIA, France.* We report on a myopic 3-D deconvolution method developed in a Bayesian framework for retinal imaging. Several useful constraints are enforced, notably a longitudinal support constraint similar to the phase diversity technique.

JTuA6 • 9:15 a.m.
Phase Diversity with Broadband Illumination, *Matthew R. Bolcar, James R. Fienup; Inst. of Optics, Univ. of Rochester, USA.* We explore the limitations of phase diversity when a broadband source is present but is assumed to be monochromatic. A new implementation of phase diversity that accounts for broadband sources is also investigated.

JTuA7 • 9:30 a.m.
An Adaptive Cross-Correlation Algorithm for Extended Scene Shack-Hartmann Wavefront Sensing, *Erkin Sidick, Joseph J. Green, Catherine M. Ohara, David C. Redding; JPL, Caltech, USA.* We present an adaptive cross-correlation algorithm for large dynamic range extended-scene Shack-Hartmann wavefront sensing. We show that it accurately measures very fine image shifts over many pixels under a variety of practical imaging conditions.

Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

ATuA • PSF Reconstruction and Image Processing

Grand Ballroom A
10:30 a.m.–12:30 p.m.
ATuA • PSF Reconstruction and Image Processing
Michael Lloyd-Hart; Steward Observatory, Univ. of Arizona, USA, Presider

ATuA1 • 10:30 a.m. **●Invited●**
PSF Reconstruction for Advanced AO Systems, *Jean-Pierre Veran; Natl. Res. Council of Canada, Canada.* This paper reviews the state of the art of AO PSF reconstruction and discusses the possibility of estimating the PSF in advanced AO systems, such as laser-based, multi-conjugate and extreme AO systems.

ATuA2 • 11:00 a.m.
PSF Reconstruction for NACO: Current Status and Perspective, *Yann Clénet[1], Chris Lidman[2], Eric Gendron[1], Thierry Fusco[3], Gérard Rousset[1], Markus Kasper[4], Nancy Ageorges[2], Olivier Marco[2]; [1]Observatoire de Paris, LESIA, France, [2]ESO, Chile, [3]ONERA/DOTA, France, [4]ESO, Germany.* PSF reconstruction is a powerful tool to determine the PSF simultaneously to the science observations. We present the PSF reconstruction software we are developing for NACO, its first results and the contemplated next steps.

ATuA3 • 11:15 a.m.
Long Exposure Point Spread Function Estimation from Adaptive Optics Loop Data: Results and Validation, *Jose Marino[1], Thomas Rimmele[2]; [1]New Jersey Inst. of Technology, USA, [2]Natl. Solar Observatory, USA.* We introduce a method to estimate the long exposure point spread function of an adaptive optics corrected solar image from the AO loop data. Latest results from solar and star observations will be presented.

ATuA4 • 11:30 a.m.
Multi-Channel Planet Detection Algorithm for Angular Differential Imaging, *Laurent M. Mugnier[1], Jean-François Sauvage[1], Thierry Fusco[1], Gérard Rousset[1,2]; [1]ONERA DOTA, France, [2]Observatoire de Paris, LESIA, France.* We propose a novel method, based on detection theory, for the efficient detection of planets using angular difference imaging, and we validate it by simulations.

ATuA5 • 11:45 a.m.
Statistical Decision Theory and Adaptive Optics: A Rigorous Approach to Exoplanet Detection, *Luca Caucci[1], Harrison H. Barrett[2], Nicholas Devaney[3], Jeffrey J. Rodríguez[1]; [1]Dept. of Electrical and Computer Engineering, Univ. of Arizona, USA, [2]College of Optical Sciences and Dept. of Radiology, Univ. of Arizona, USA, [3]Dept. of Physics, Natl. Univ. of Ireland, Ireland.* Statistical decision theory is applied to the problem of exoplanet detection with AO. We derive optimal observers for the detection of exoplanets in AO images. Theoretical results are verified by running simulation tests.

ATuA6 • 12:00 p.m.
Amplitude Calibration of Adaptive Optics Supported Solar Speckle Imaging, *Friedrich Woeger[1,2], Oskar von der Luehe[2]; [1]Natl. Solar Observatory, USA, [2]Kiepenheuer-Inst. für Sonnenphysik, Germany.* Adaptive optics supported solar speckle imaging requires calibration of the reconstruction's Fourier amplitudes with the transfer function of atmosphere and optics. We propose analytical models for relevant transfer functions of arbitrarily correcting adaptive optics systems.

ATuA7 • 12:15 p.m.
"Lucky Imaging" with Adaptive Optics, *Szymon Gladysz[1], Julian C. Christou[2], Michael Redfern[1]; [1]Dept. of Experimental Physics, Natl. Univ. of Ireland, Galway, Ireland, [2]Div. of Astronomical Sciences, Natl. Science Foundation, USA, USA.* We present a new image-sharpening approach, which combines AO and frame selection. Observations were carried out with the Shane telescope. The method performs best when seeing is poor or when static speckles dominate the noise.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

ATuB • Tomographic Wavefront Sensing

Grand Ballroom A
2:00 p.m.–4:00 p.m.
ATuB • Tomographic Wavefront Sensing
Michel Tallon; Ctr. de Recherche Astrophysique de Lyon, France, Presider

ATuB1 • 2:00 p.m. **•Invited•**
Wavefront Sensing for AO, *Gerard Rousset; Univ. Paris, France.* No abstract available.

ATuB2 • 2:30 p.m. **•Invited•**
Wavefront Sensing in a Volume: Results and Perspective, *Roberto Ragazzoni; Astronomical Observatory of Padova, Italy.* No abstract available.

ATuB3 • 3:00 p.m.
Estimating C_n^2 Profile Using Modal Covariance Measurements from Multiple Guide Stars, *N. Mark Milton, Michael Lloyd-Hart, Jessica Bernier, Christoph Baranec; Ctr. for Astronomical Adaptive Optics, Univ. of Arizona, USA.* We outline a technique for estimating the C_n^2 profile using modal covariance measurements from multiple guide star wavefront sensor data permitting the optimization of tomographic reconstructors to match the current observing conditions.

ATuB4 • 3:15 p.m.
A New Linear Optical Differentiation Wavefront Sensor for Laser Tomography on ELTs, *Eric Gendron, Florence Pouplard, Fabrice Vidal, Zoltan Hubert, Denis Perret, Gerard Rousset; Observatoire de Paris-Meudon, France.* We present a new concept for an optical differentiation wavefront sensor, providing a high number of phase measurements in the pupil, and featuring a linear response versus the phase gradient.

ATuB5 • 3:30 p.m.
Modeling Laser Guide Star Aberrations, *Richard M. Clare[1], Marcos A. van Dam[1], Antonin H. Bouchez[2]; [1]W. M. Keck Observatory, USA, [2]Caltech Optical Observatories, USA.* When using a laser guide star (LGS) adaptive optics system, quasi-static aberrations are observed between the measured wavefronts from the LGS wavefront sensor (WFS) and the natural guide star WFS. We model these LGS aberrations.

ATuB6 • 3:45 p.m.
Study of the Parameters for a Radial CCD Using Laser Guide Stars, *Sandrine J. Thomas[1], Sean Adkins[2], Donald Gavel[1], Brent Ellerbroek[3], Luc Gilles[3], Thierry Fusco[4]; [1]LAO, UCO/Lick Observatory, USA, [2]W.M.Keck Observatory, USA, [3]Thirty Meter Telescope, USA, [4]ONERA, France.* A study of different centroid estimation is given for elongated spot in the context of laser guide star adaptive optics. The framework is a new CCD development with a special geometry, aligned with the elongation.

ATuC • AO Poster Session and Coffee Break

Grand Ballroom D
4:00 p.m.–5:00 p.m.
ATuC • AO Poster Session and Coffee Break

ATuC1 • 4:00 p.m.
MOSP: A New Instrument to Measure Wavefront Outer Scale Profiles, *Jérôme Maire, Aziz Ziad, Julien Borgnino, François Martin; Univ. de Nice Sophia-Antipolis, France.* We retrieve the vertical distribution of wavefront outer scale by analyzing angular correlation of wavefront Angle of Arrival fluctuations deduced from Moon's limb image motion. We present results obtained during two campaigns of observation.

ATuC2 • 4:00 p.m.
The Impact of Segment Vibrations on Adaptive Optics at the Keck Telescope, *Ralf Flicker, Christopher Neyman; W. M. Keck Observatory, USA.* The impact of segment vibration on the performance of adaptive optics at Keck Observatory was modeled. Errors after correction are significant but comparable to other errors in future adaptive optics systems.

ATuC3 • 4:00 p.m.
Miniaturized Wavefront Sensors for MOAO, *Fanny Chemla, Eric Gendron, Isabelle Guinouard, Florence Cornu, Pascal Jagourel; Observatoire de Paris, France.* The original concept of multi-object AO requires wavefront sensors laying in the focal plane of telescopes. Our approach is based on a miniaturized Shack-Hartmann head including fibers transporting light from the focal plane towards detection.

ATuC4 • 4:00 p.m.
The Victoria Open Loop Testbed: System Architecture, Control and Monitoring, *Michael Fischer, David R. Andersen, Jean-Pierre Veran, Kris Caputa; Herzberg Inst. of Astrophysics, Natl. Res. Council Canada, Canada.* The Victoria Open Loop Testbed (VOLT) is an open-loop experiment to be conducted on the Dominion Astrophysical Observatory's 1.2m telescope. We will briefly outline the system architecture, control scheme, and data collection for performance evaluation.

ATuC5 • 4:00 p.m.
Discrete-Time Models for Adaptive Optics Systems with Wavefront Sensors Using Partial Frame Integration, *Douglas Looze; Univ. of Massachusetts at Amherst, USA.* This paper extends a discrete-time model of adaptive optics systems. The WFS produces measurements at discrete-time intervals (the frame period) by integrating the input wavefront over a part of the frame.

ATuC6 • 4:00 p.m.
Magnetic ALPAO and Piezo-Stack CILAS Deformable Mirrors Characterization, *Celia Blain, Rodolphe Conan, Colin Bradley, Onur Keskin, Peter Hampton, Aaron Hilton; Univ. of Victoria, Canada.* We present the results of the characterization of two deformable mirrors. First is a magnetic ALPAO mirror with 8×8 actuators. Second is a piezo-stack prototype for NFIRAOS designed by CILAS with 9×9 actuators.

ATuC7 • 4:00 p.m.
Performance Assessment of Laser Guide Star Wave Front Sensing, *Rodolphe Conan, Colin Bradley, Peter Hampton, Onur Keskin, Aaron Hilton, Celia Blain; Univ. of Victoria, Canada.* The AO Laboratory of the University of Victoria is building a LGS simulator to asses LGS wavefront sensing performance. A preliminary design has been written and the LGS simulator will be integrated during Summer 2007.

ATuC8 • 4:00 p.m.
Integrated Testing of the ESO AO Facility: The Development of ASSIST, *Remko Stuik[1], Robin Arsenault[2], Bernard Delabre[2], Simone Esposito[3], Pascal Hallibert[1], Norbert Hubin[2], Sarah Kendrew[1], Andreas Quirrenbach[1], Armando Riccardi[3], Stefan Stroebele[2]; [1]Leiden Observatory, Leiden Univ., Netherlands, [2]ESO, Germany, [3]Osservatorio Astrofisico di Arcetri, Italy.* ASSIST--the Adaptive Secondary Setup and Instrument STimulator--is being developed for the testing and calibrating of the AO Facility of the VLT, specifically the deformable secondary mirror and AO systems GALACSI and GRAAL.

ATuC9 • 4:00 p.m.
Field Dependent Spectral Ratios of Solar Adaptive Optics Systems, *Friedrich Woeger[1,2], Oskar von der Luehe[2]; [1]Natl. Solar Observatory, USA, [2]Kiepenheuer-Inst. für Sonnenphysik, Germany.* Anisoplanatism induced by atmospheric turbulence cause a field dependency of the performance of an adaptive optics system. We suggest a new method to model its impact on solar adaptive optics spectral ratios.

ATuC10 • 4:00 p.m.
Point Spread Function Reconstruction Using a Dual DM Adaptive Optics System, *Onur Keskin, Rodolphe Conan, Colin Bradley; Univ. of Victoria, Canada.* In this paper the development, implementation and testing of an improved Point Spread Function (PSF) reconstruction technique for the University of Victoria's dual Deformable Mirror (DM) Woofer-Tweeter (WT) Adaptive Optics (AO) system will be presented.

ATuD • Deformable Mirrors

Grand Ballroom A
5:00 p.m.–6:45 p.m.
ATuD • Deformable Mirrors
Jean-Christophe Sinquin; CILAS, France, Presider

ATuD1 • 5:00 p.m. **•Invited•**
MEMS Wavefront Correctors: Electromechanical Theory and Recent Performance Advances, *Thomas Bifano; Boston Univ., USA.* No abstract available.

ATuD2 • 5:30 p.m.
Experimental Results on the Open-Loop Control of an Electrostatic DM for MOAO, *Eric Gendron[1], Fabrice Vidal[1], Frederic Zamkotsian[2], T. Heurtebize[1], Zoltan Hubert[1], Denis Perret[1], Fanny Chemla[1], Pascal Jagourel[1]; [1]Observatoire de Paris-Meudon, France, [2]Lab d'Astrophysique de Marseille, France.* We present experimental results on the wavefront error obtained in open-loop with a micromachined electrostatic deformable mirror, thanks to new control techniques that allow to properly manage actuator coupling.

ATuD3 • 5:45 p.m.
Electrostatic Micro-Deformable Mirror for Adaptive Optics: Development and Control-Command, *Frederic Zamkotsian[1], Véronique Conedera[2], Eric Gendron[3], Patrick Lanzoni[1], Norbert Fabre[2]; [1]Lab d'Astrophysique de Marseille, France, [2]LAAS-CNRS, France, [3]LESIA, Observatoire de Meudon, France.* MOEMS-based electrostatic micro-deformable mirrors (MDM) are promising for future AO systems. Original complete polymer mirrors have been designed and realized. Specific control-command strategy is presented and tested; electrostatic MDM are well-suited for open-loop operation.

ATuD4 • 6:00 p.m.
High Order Piezo Array Deformable Mirrors toward New Needs, *Jean-Christophe Sinquin; CILAS, France.* We expose a brief history of CILAS Piezo Array Deformable Mirrors and main technical advantages of this technology. Then we give two evolutions: one toward very high order deformable mirrors, one toward adaptive secondary mirrors.

ATuD5 • 6:15 p.m.
A Nickel-Carbon-Fibre Mirror for Large Adaptive Secondaries, *Samantha J. Thompson, Peter Doel, David Brooks; Univ. College London, UK.* We describe a new type of mirror substrate for the development of large, lightweight adaptive mirrors for use in the next generation of extremely large telescopes (ELTs); methods, simulations and results are presented.

ATuD6 • 6:30 p.m.
Thin Shell Active Polishing for Large Deformable Secondary Mirrors, *Emmanuel Hugot[1], M. Ferrari[1], G. Lemaitre[1], D. Fappani[2]; [1]Lab d'Astrophysique de Marseille, France, [2]SESO, France.* The new stress polishing process developed for the manufacturing of the large (1.1m diameter) convex aspheric thin shell (2mm thickness), to be implemented in the VLT Deformable Secondary Mirror, is presented.

Adaptive Optics: Analysis and Methods (continued)

• Wednesday, June 20, 2007 •

Grand Ballroom Foyer
7:00 a.m.–3:00 p.m.
Registration Open

AWA • System Modeling and Design

Grand Ballroom A
8:00 a.m.–10:00 a.m.
AWA • System Modeling and Design
Jean-Pierre Veran; Inst. Herzberg d'Astrophysique, Canada, Presider

AWA1 • 8:00 a.m. •Invited•
Simulation and Design of Adaptive Optics Systems: Application to SPHERE-SAXO, *Thierry Fusco; ONERA, France.* A detailed description of the SPHERE system is proposed. The main trade-offs are discussed and justified. The realization phase has begun in 2006 for a first light at the VLT expected in 2010.

AWA2 • 8:30 a.m.
Performance Evaluation Using a Discrete-Time Model of a AO System, *Douglas Looze; Univ. of Massachusetts at Amherst, USA.* AO systems can be viewed as a sampled-data feedback systems with a continuous-time disturbance and discrete-time measurement noise. This paper illustrates the ability to determine the performance of an AO system using a discrete-time model.

AWA3 • 8:45 a.m.
Polychromatic Imaging with Monochromatic Adaptive Optics: Limitations due to Weak Scintillation, *Lawton H. Lee; Lockheed Martin Advanced Technology Ctr., USA.* Polychromatic imaging through turbulence using monochromatic adaptive optics is degraded by multi-wavelength scintillation. Resultant weak-regime correction error variances are proportional (not equal) to Rytov log-amplitude variances. Wave-optic simulations validate coefficients derived from spatial filters.

AWA4 • 9:00 a.m.
Adaptive Optics Challenges for Mid-IR ELT Instrumentation, *Sarah Kendrew[1], Remko Stuik[1], Bernhard Brandl[1], Rainer Lenzen[2], Lars Venema[3], Ulli Kaeufl[4], Alistair Glasse[5]; [1]Leiden Observatory, Leiden Univ., Netherlands, [2]Max Planck Inst. for Astronomy, Germany, [3]Astron, Netherlands, [4]ESO, Germany, [5]UK Astronomy Technology Ctr., UK.* Adaptive optics issues particular to a system operating at mid-infrared wavelengths are discussed in the context of MIDIR, the mid-IR instrument for the European ELT. Particular focus is on atmospheric properties at these wavelengths.

AWA5 • 9:15 a.m.
Ground Layer Adaptive Optics for Dome C: Optimisation and Performance, *Brice Le Roux[1], Maud Langlois[1], Marcel Carbillet[2], Thierry Fusco[3], Marc Ferrari[1], Denis Burgarella[1]; [1]Lab d'Astrophysique de Marseille - OAMP, France, [2]Lab Universitaire d'Astrophysique de Nice, France, [3]Office Natl. d'Etude et Recherche en Aérospatiale, France.* We present simulations of a GLAO system in Dome C. The number of guide stars, the temporal frequency or the number of sub-apertures in the wave front sensor have to be optimized. Performances are presented.

AWA6 • 9:30 a.m.
The ESO Adaptive Optics Program, *Norbert Hubin; European Southern Observatory, Germany.* We present the status of the 1st & 2nd generation of AO systems as well as MAD and HOT demonstrators. A roadmap for the Adaptive Optics systems for the European ELT is given.

AWA7 • 9:45 a.m.
Analysis and Modeling of Conventional and Multiple-Conjugate AO Systems with Commercial Ray Tracing Software, *Robert S. Upton; Natl. Solar Observatory, USA.* Shack-Hartmann wavefront sensors, atmospheric phase screens, system noise, and reconstructors are modeled using ZEMAX and MATLAB, which allows in-situ evaluation of the telescope model. Post reconstruction RMS wavefront errors are smaller than 20 nm.

Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

AWB • Supervisory Control Algorithms

Grand Ballroom A
10:30 a.m.–12:30 p.m.
AWB • Supervisory Control Algorithms
Lisa Poyneer; Lawrence Livermore Natl. Lab, USA, Presider

AWB1 • 10:30 a.m. •Invited•
Adaptive Wavefront Calibration and Control for the Gemini Planet Imager, *Lisa Poyneer[1], Jean-Pierre Véran[2]; [1]Lawrence Livermore Natl. Lab, USA. [2]Herzberg Inst. of Astrophysics, Canada.* Quasi-static errors in the science leg and internal AO flexure will be corrected. Wavefront control will adapt to current atmospheric conditions through Fourier modal gain optimization, or the prediction of atmospheric layers with Kalman filtering.

AWB2 • 11:00 a.m.
Compensating Nonlinear Effects in AO Control Loops, *Enrico Fedrigo, Markus Kasper, Riccardo Muradore; European Southern Observatory, Germany.* In this paper we propose an architecture to deal with nonlinear effects like saturation that can severly limit the performance of an AO system while preserving good performance in both PSF output and piston management.

AWB3 • 11:15 a.m.
Strategies for Dealing with DM Actuator Saturations in Advanced AO Systems, *Jean-Pierre Véran[1], Lisa A. Poyneer[2]; [1]Herzberg Inst. of Astrophysics, Canada, [2]Lawrence Livermore Natl. Lab, USA.* We discuss different strategies for handling DM actuator saturations (clipping) to prevent controller wind-up and invisible mode build up. Applications include conventional AO systems as well as multi-conjugate, extreme and woofer-tweeter based AO systems.

AWB4 • 11:30 a.m.
Phase Correction Distribution Methods for a Woofer-Tweeter System of Deformable Mirrors, *Peter J. Hampton, Rodolphe Conan, Colin Bradley, Pan Agathoklis; Univ. of Victoria, Canada.* A woofer-tweeter system of deformable mirrors divides the spatial and temporal adaptive optics phase correction between at least two mirrors. This paper introduces approaches to develop orthogonal actuator modes applicable to such a system.

AWB5 • 11:45 a.m.
Woofer-Tweeter Control Algorithm for the Gemini Planet Imager, *Jean-François Lavigne[1,2,3], Jean-Pierre Véran[2], Lisa A. Poyneer[4]; [1]Univ. de Montreal, Canada, [2]Herzberg Inst. of Astrophysics, Canada, [3]Inst. Natl. d'Optique, Canada, [4]Lawrence Livermore Natl. Lab, USA.* The Gemini Planet Imager requires two deformable mirrors: the woofer and the tweeter. This paper shows that command splitting computational efficiency greatly improves if moved from the tweeter command space to the Fourier domain.

AWB6 • 12:00 p.m.
Sodium Layer Altitude Tracking in an LGS AO System, *Douglas Looze[1], Glen Herriot[2], Jean-Pierre Véran[2]; [1]Univ. of Massachusetts at Amherst, USA, [2]Herzberg Inst. of Astrophysics, Canada.* An ELT focus mode controller can include the ability to off-load the defocus caused by variations in the sodium layer. This paper formulates the design of the altitude tracking controller as a discrete-time estimation problem.

AWB7 • 12:15 p.m.
The Real Time Controller for the Thirty Meter Telescope Adaptive Optics, *Corinne Boyer[1], Brent L. Ellerbroek[1], Steve Browne[2], Glenn Tyler[2], Glen Herriot[3], Jean Pierre Veran[3]; [1]Thirty Meter Telescope, USA, [2]Optical Sciences Co., USA, [3]Herzberg Inst. of Astrophysics, Canada.* This paper presents the requirements, challenges and feasible concepts of the Real Time Controller, which will be implemented with the first light Adaptive Optics System of the Thirty Meter Telescope.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

AWC • Innovative Wavefront Sensing

Grand Ballroom A
2:00 p.m.–4:00 p.m.
AWC • Innovative Wavefront Sensing
Donald Gavel; Univ. of California at Santa Cruz, USA, Presider

AWC1 • 2:00 p.m. **●Invited●**
Pyramid Wave-Front Sensing for High Contrast AO Applications, *Christophe Verinaud; Lab d'Astrophysique Observatoire de Grenoble, France.* This paper presents results of studies highlighting the improvement of coronagraphic image quality that can be expected by using a Pyramid Wave-Front sensor in High Contrast Imaging applications like exoplanets direct detection.

AWC2 • 2:30 p.m. **●Invited●**
Focal Plane and Nonlinear Curvature Wavefront Sensing for High Contrast Imaging Adaptive Optics, *Olivier Guyon; Subaru Telescope, USA.* Wavefronts can be accurately estimated from either focal plane or defocused pupil plane images, in schemes similar to phase diversity. These techniques offers fundamental advantages over more traditional techniques for high contrast Adaptive Optics.

AWC3 • 3:00 p.m.
Hartmann Fourier Analysis for Sensing and Correction, *Erez N. Ribak[1], Yuval Carmon[1], Amos Talmi[2], Oded Glazer[1], Carmen Canovas[3]; [1]Technion, Israel, [2]Timi Technologies Ltd., Israel, [3]Univ. de Murcia, Spain.* The Hartmann pattern lends itself naturally to Fourier analysis, providing directly mirror commands. Slopes are integrated without returning to the image domain. We modeled, simulated and tested these algorithms on two separate adaptive optics systems.

AWC4 • 3:15 p.m.
Fast Computing-Free Wavefront Sensing, *Geoff P. Andersen[1], Fassil Ghebremichael[2], Ken S. Gurley[2]; [1]USAF Acad., USA, [2]Lockheed Martin Missiles and Fire Control, USA.* We present results of a fast holographic modal wavefront sensor. A single multiplexed hologram is used to diffract an input beam into multiple focused beams: each pair giving the amplitude of a particular Zernike component.

AWC5 • 3:30 p.m.
Modal Gain Optimization for Pyramid Wavefront Sensor, *Visa A. Korkiakoski[1], Christophe Vérinaud[2], Miska Le Louarn[1]; [1]European Southern Observatory, Germany, [2]LAOG, France.* A heuristic modal scaling method is presented to improve the performance of non-modulated Pyramid wavefront sensor. Comparison is made to a known method of modulating the Pyramid during calibration. Both methods reach equally good results.

AWC6 • 3:45 p.m.
The Use of an Optical Fiber Amplifier in the Reference Arm of a Wavefront Sensing Interferometer, *Scott Shepard; Univ. of Central Florida, USA.* When a fiber amplifier is part of an optical wavefront sensor, design constraints are different than in standard applications. We illustrate amplifier optimizations (for this regime) facilitated by novel closed-form solutions for gain and noise.

Grand Ballroom D
4:00 p.m.–4:30 p.m.
Coffee Break

AWD • Adaptive Optics for Vision Science

Grand Ballroom A
4:30 p.m.–6:30 p.m.
AWD • Adaptive Optics for Vision Science
Brent Ellerbroek; CELT Development Corp., USA, Presider

AWD1 • 4:30 p.m. **●Invited●**
Applications of Adaptive Optics for Vision and Ophthalmoscopy, *Austin Roorda; Univ. of California at Berkeley, USA.* AO reduces blur, offering both ultra-sharp vision and observations of living retina with unprecedented resolution, and is driving a paradigm shift in how we investigate the eye and human vision.

AWD2 • 5:00 p.m.
First Adaptive Optics Images with the Upgraded Quinze-Vingts Hospital Retinal Imager, *Marie Glanc[1], Leonardo Blanco[1], Laurent Vabre[1], François Lacombe[1,2], Pascal Puget[1], Gérard Rousset[1,3], Guillaume Chenegros[4], Laurent Mugnier[4], Michel Pâques[5], Jean-François Le Gargasson[5], Alain José Sahel[5]; [1]PHASE/LESIA Observatoire de Paris, France, [2]Mauna Kea Technologies, France, [3]PHASE/LESIA Univ. Paris 7, France, [4]PHASE/DOTA ONERA, France, [5]Ctr. d'Investigations Cliniques des Quinze-Vingts, France.* In a retinal imaging instrument, the ocular aberrations are time-varying, leading to images degradation. Adaptive Optics improves resolution. We describe here several modifications made on our system and their impact in terms of image quality.

Postdeadline Papers to follow at the end of the session.

Computational Optical Sensing and Imaging Abstracts

• Sunday, June 17, 2007 •

Grand Ballroom Foyer
3:00 p.m.–6:00 p.m.
Registration Open

• Monday, June 18, 2007 •

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

CMA • Multiaperture Imaging

Grand Ballroom C
8:00 a.m.–10:00 a.m.
CMA • Multiaperture Imaging
David Brady; Duke Univ., USA, Presider

CMA1 • 8:00 a.m. **•Invited•**
PERIODIC: Integrated Computational Array Imaging Technology, *Robert J. Plemmons[1], Sudhakar Prasad[2], Mark Mirotznik[3], Joe van der Gracht[4], Victor P. Pauca[1], Todd C. Torgersen[1], Scott Matthews[3], Greg Behrmann[5], Ryan Barnard[1], Brian Gray[1]; [1]Wake Forest Univ., USA, [2]Univ. New Mexico, USA, [3]Catholic Univ. of America, USA, [4]Holospex, Inc., USA, [5]EM Photonics, Inc., USA.* An array imaging system, dubbed PERIODIC, is presented, capable of exploiting diversities, including subpixel displacement, phase, polarization, and wavelength, to produce superresolution images. The hardware system and software interface described, and sample results are shown.

CMA2 • 8:30 a.m. **•Invited•**
Information-Optimized Extended Depth-of-Field Imaging Systems, *Sudhakar Prasad; Univ. of New Mexico, USA.* Estimation-theoretic limits on the extension of the depth of field of an imaging system via wavefront coding are analyzed in terms of Fisher information and associated Cramer-Rao lower bounds.

CMA3 • 9:00 a.m.
Compact TOMBO Sensor with Scene-Independent Super-Resolution Processing, *Andrey V. Kanaev[1], John R. Ackerman[1], Erin F. Fleet[2], Dean A. Scribner[3]; [1]SFA Inc., USA, [2]NRL, USA, [3]Northrop Grumman Mission Systems, USA.* Flat sensors are an important goal of modern imaging system development. One solution is to use a lenslet array to form undersampled sub-images. Using a priori calibration, super-resolution algorithms can recover fully sampled images.

CMA4 • 9:15 a.m.
Superresolution for Thin Optics, *Kerkil Choi, Timothy J. Schulz; Michigan Technological Univ., USA.* The thickness of a camera may be significantly decreased by an idea inspired by insects' compound eyes. However, it provokes the needs for computational compensation of resolution. We derive superresolution algorithms for accomplishing this task.

CMA5 • 9:30 a.m.
Multi-Aperture Diversity Imaging: Physical Limitations to the Generalized Sampling Theorem (GST), *Markus E. Testorf[1], John Carter[2], Michael A. Fiddy[2], Thomas J. Suleski[2]; [1]Dartmouth College, USA, [2]Univ. of North Carolina, USA.* The GST describes restoring an image with an N-fold increase in resolution from N low-pass but independent images of the same scene. We consider physical mechanisms that can be exploited to make N very large.

CMA6 • 9:45 a.m.
An Object Selection Engine Based on Compound Imaging and Attractor Selection, *Satoru Irie[1], Ryoichi Horisaki[1], Yusuke Ogura[1], Jun Tanida[1], Yoshizumi Nakao[2], Takashi Toyoda[2], Yasuo Masaki[2]; [1]Graduate School of Information Science and Technology, Osaka Univ., Japan, [2]Funai Electric Co., Ltd., Japan.* An object selection system has been proposed based on compound imaging and the attractor selection, which is inspired by a biological system. An effective model is developed and its characteristics are studied with simulations.

Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

CMB • Optical Hardware

Grand Ballroom C
10:30 a.m.–12:30 p.m.
CMB • Optical Hardware
Mark Allen Neifeld; Univ. of Arizona, USA, Presider

CMB1 • 10:30 a.m. **•Invited•**
3-D Optics for Ultra Thin Cameras, *George Barbastathis[1], Kehan Tian[2], Paul J. Stellman[1]; [1]MIT, USA, [2]IBM Semiconductor Res. and Development Ctr., USA.* In 3-D optics, the optical transfer function is determined by light interaction with an entire refractive-index-modulated volume. We discuss the physics of sub-wavelength, non-periodic 3-D optical elements, and their applications to ultra-thin computational imagers.

CMB2 • 11:00 a.m. **•Invited•**
Joint Digital-Optical Design of Multi-Frame Imaging Systems, *M. Dirk Robinson, David G. Stork; Ricoh Innovations, USA.* Typical imaging systems produce aliasing artifacts. Superresolution algorithms process multiple aliased images to yield a single high-resolution image. We design imaging systems by jointly optimizing the optics and post-processing to maximize such multi-frame imaging performance.

CMB3 • 11:30 a.m.
Improving Depth of Field and Reducing Volume in Annular Folded Imagers, *Eric J. Tremblay[1], Rick L. Morrison[2], Ronald A. Stack[2], Joseph E. Ford[1]; [1]Univ. of California at San Diego, USA, [2]Distant Focus Corp., USA.* We present an arc-section eight-fold imager with depth of field increased 4x and volume reduced 5x compared to its symmetric counterpart. We also present the design of a pupil-phase encoded four-fold imager.

CMB4 • 11:45 a.m.
Structured-Illumination Quantitative Phase Microscopy, *Sri Rama Prasanna Pavani, Ariel R. Libertun, Carol J. Cogswell; Univ. of Colorado at Boulder, USA.* We propose a quantitative phase microscope that is essentially a bright field transmission microscope with two simple modifications: an amplitude mask is introduced in the field diaphragm and a post processing algorithm retrieves the phase.

CMB5 • 12:00 p.m.
A Novel Approximation for the Defocused Modulation Transfer Function of a Cubic-Phase Pupil, *Saeed Bagheri[1], Daniela Pucci de Farias[1], Paulo E. X. Silveira[2]; [1]MIT, USA, [2]CDM Optics Inc., USA.* We introduce a novel approximation for the MTF of a cubic-phase pupil function with defocus that significantly reduces the computational time. We show that the average accuracy of our approximation is better than 97%.

CMB6 • 12:15 p.m.
Detection of the Wave Function of an Optical Field, *Anatoliy Khizhnyak, Vladimir Markov; MetroLaser, Inc., USA.* The wave-function of a laser beam can be measured with a phase-shifting interferometer. Its direct detection enables deriving the correlation function of various orders—the parameters that cannot be measured directly by existing methods.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

CMC • Spectroscopy and Sensing

Grand Ballroom C
2:00 p.m.–4:00 p.m.
CMC • Spectroscopy and Sensing
John Caulfield; Holography Information, USA, Presider

CMC1 • 2:00 p.m. **•Invited•**
Optical Designs for Compressive Single Shot Spectral Imaging, *David J. Brady[1], Michael Gehm[2], Timothy Schulz[3], Renu John[1], Rebecca Willett[1]; [1]Fitzpatrick Ctr., Duke Univ., USA, [2]Univ. of Arizona, USA, [3]Michigan Technological Univ., USA.* Static mask coded aperture spectral imaging enables compact, programmable coding for single shot measurements. We review recent demonstrations of spectral imaging systems in the DISP lab and describes trade-offs in dispersion and coding system design.

CMC2 • 2:30 p.m.
Hyperspectral Imager Based on Coded-Aperture Spectroscopy, *Myung Soo Kim[1], Michael Gehm[2], David Brady[3]; [1]School of Electronic and Information Engineering, Kunsan Natl. Univ., Republic of Korea, [2]Dept. of Electrical and Computer Engineering, Univ. of Arizona, USA, [3]Dept. of Electrical and Computer Engineering, Duke Univ., USA.* A hyperspectral imager based on coded-aperture spectroscopy has excellently generated 3-D data cube that provides 2-D images of a sample with high selectivity of wavelength as well as spectrum with meaningful spectral features.

CMC3 • 2:45 p.m.
An Ultra-High Resolution Tandem Fabry-Perot Etalon Cylindrical Beam Volume Hologram Spectrometer, *Majid Badieirostami[1], Omid Momtahan[1], Chao Ray Hsieh[1], Ali Asghar Eftekhar[1], Ali Adibi[1], David J. Brady[2]; [1]Georgia Tech, USA, [2]Duke Univ., USA.* We have designed a compact spectrometer by cascading a simple Fabry-Perot etalon and a cylindrical beam volume hologram. This spectrometer results in a two-dimensional spatial-spectral mapping in the output plane with ultra-high resolution.

CMC4 • 3:00 p.m.
Coded-Excitation Raman Spectroscopy for Raman Signal Estimation in Highly Fluorescent Media, *Scott T. McCain, Rebecca M. Willett, David J. Brady; Duke Univ., USA.* Raman signal estimation in highly fluorescent media is investigated using multiple excitation lasers and an iterative EM spectral reconstruction algorithm. Results from an 8-laser system show estimation performance increases with the number of excitation lasers.

CMC5 • 3:15 p.m.
Spectral Analysis in Integrated Optical Sensors Using Compact On-Chip Photonic Crystal Spectrometers, *Babak Momeni, Ehsan Shah Hosseini, Murtaza Askari, Saeed Mohammadi, Mohammad Soltani, Siva Yegnanarayanan, Ali Adibi; Georgia Tech, USA.* We demonstrate a compact photonic crystal spectrometer for on-chip spectral interrogation in lab-on-a-chip applications. We also discuss the potential for integration with other sensing components, and investigate their performance in terms of current sensing demands.

CMC6 • 3:30 p.m.
Slit-less Holographic Spectrometers with Large Spectral Operating Range Using Multiplexed Cylindrical Beam Volume Holograms, *Chaoray Hsieh, Omid Momtahan, Ali Adibi; Georgia Tech, USA.* Compact slit-less spectrometers using cylindrical beam holograms are presented with several advantages over conventional spectrometers. Large spectral range spectrometers using spatially multiplexed cylindrical beam holograms are demonstrated without adding any moving part in spectroscopic systems.

CMC7 • 3:45 p.m.
Quantitative Dynamic Range Management Techniques for Spectroscopic Detection and Estimation, *Michael E. Gehm, Joseph M. Kinast; Univ. of Arizona, USA.* Introduction of active filters into spectrometer design results in flexible systems that are insensitive to source/detector dynamic range mismatch, thereby allowing detection of spectral features that were previously below the detection limit.

Grand Ballroom D
4:00 p.m.–4:30 p.m.
Coffee Break

CMD • Information and Optics

Grand Ballroom C
4:30 p.m.–7:00 p.m.
CMD • Information and Optics
Joseph N. Mait; ARL, USA, Presider

CMD1 • 4:30 p.m. **•Invited•**
Flat Accurate Nonimaging Point Locator, *John Caulfield[1], Leonid P. Yaroslavsky[2]; [1]Fist Univ., USA, [2]Tel Aviv Univ., Israel.* Suppose there are one or a few point sources out there at infinity and our job is to extract information about their location (θx and θy) relative to the sensor normal and their signal intensity I at the sensor. For each point, we need at least three measurements that embody those parameters and seek to compute the data we need. Imaging, the traditional way of doing this uses the presumption that θx and θy are converted to spatial coordinates in the image plane with a known (possibly θx and θy variant formula), so θx and θy are easily found. It further assumes that the intensity at the point in the imaging plane is proportional to the intensity of the source. Here we examine the possibility of nonimaging systems for obtaining those data and argue that the nonimaging approach should be preferred in some cases.

CMD2 • 5:00 p.m. **•Invited•**
Optical Singularities, *Grover A. Swartzlander; College of Optical Sciences, USA.* Vortices in nature typically exhibit solid body rotation in the eye region and potential flow outside. Analogous Rankine vortex characteristics are demonstrated with partially coherent optical waves.

CMD3 • 5:30 p.m.
Computational Optimization of Volume Holographic Imaging Systems, *Jonathan M. Watson[1], Patrick Wissmann[1,2], Se Baek Oh[1,3], Michael Stenner[4], George Barbastathis[1]; [1]MIT, USA, [2]Technical Univ. of Aachen, Germany, [3]Korea Advanced Inst. of Science and Technology, Republic of Korea, [4]Univ. of Arizona, USA.* We present two analytical methods for evaluating the response of optical systems utilizing volume holograms for three-dimensional spatial heterodyning. These methods enable the evaluation of system behavior with standard design tools providing a complete simulation.

CMD4 • 5:45 p.m.
The Maximum Extension of the Depth of Field of SNR-Limited Wavefront Coded Imaging Systems, *Saeed Bagheri[1], Daniela Pucci de Farias[1], Paulo E. X. Silveira[2]; [1]MIT, USA, [2]CDM Optics Inc., USA.* We discuss the limit of DOF extension for an imaging system using aspheric surfaces. We consider a general imaging system with arbitrary pupil phase and present the trade-off between the DOF and the spectral SNR.

CMD5 • 6:00 p.m.
A Biomimetic Focal Plane Speed Computation Architecture, *Vivek Pant, Charles M. Higgins; Univ. of Arizona, USA.* A sensor was designed to compute speed at the image focal plane for robotic navigation. It employs an array of parallel sensing and computing blocks, and outputs a signal that varies linearly with image speed.

CMD6 • 6:15 p.m.
Efficient Diffractive Optical Elements for Depth from Diffracted Rotation Systems, *Sri Rama Prasanna Pavani, Rafael Piestun; Univ. of Colorado at Boulder, USA.* We design efficient diffractive optical elements to generate rotating point spread functions for incoherent three-dimensional computational imaging systems. Higher diffraction efficiency is important for increasing signal-to-noise and accuracy. We present examples of three-dimensional information retrieval.

CMD7 • 6:30 p.m.
Nano-Fabrication of Space Varying Spectral Filters Based on Lattice Constant Variations, *Alok Mehta[1], Raymond Rumpf[1], Eric Johnson[2]; [1]Univ. of Central Florida, USA, [2]Univ. of North Carolina at Charlotte, USA.* This paper investigates the design and fabrication of space varying spectral filters. Short wave IR spectral filters are fabricated using a nano-patterned multilayered structure based on a lattice constant variation.

CMD8 • 6:45 p.m.
Polarimetric Interferometric Synthetic Aperture Microscopy: Vectorial Computed Imaging from Optical Coherence Tomography Data, *Brynmor J. Davis, Tyler S. Ralston, Daniel L. Marks, Stephen A. Boppart, P. Scott Carney; Univ. of Illinois, USA.* Interferometric Synthetic Aperture Microscopy (ISAM) obviates the trade-off between depth-of-focus and resolution in interferometric coherence imaging. In this work, ISAM's quantitative image reconstruction techniques are applied in a vectorial setting, thus admitting polarization-sensitive imaging.

7:00 p.m.–8:00 p.m.
Dinner Break (on your own)

JMA • Joint Plenary Session

Grand Ballroom B
8:00 p.m.–9:00 p.m.
JMA • Joint Plenary Session

JMA1 • 8:00 p.m. **►Plenary◄**
Digital Image Formation from Holograms: Early Motivations and Modern Capabilities, *Joseph W. Goodman; Stanford Univ., USA.* I review the first case (1967) of detection of a hologram and reconstruction of the corresponding image by purely electronic means. I also discuss the circumstances that led to the experiment in the first place.

Computational Optical Sensing and Imaging (continued)

● Tuesday, June 19, 2007 ●

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

CTuA • Task Specific Sensing

Grand Ballroom C
8:00 a.m.–10:00 a.m.
CTuA • Task Specific Sensing
Sudhakar Prasad; Univ. of New Mexico, USA, Presider

CTuA1 • 8:00 a.m. **●Invited●**
Task Specific Information, *Amit Ashok, Pawan K. Baheti, Mark Allen Neifeld; Univ. of Arizona, USA.* We introduce the notion of task-specific information (TSI) to quantify the performance of imaging systems. We demonstrate the utility of TSI for evaluating the performance of conventional and projective imagers for a detection task.

CTuA2 • 8:30 a.m. **●Invited●**
Adaptive Sensing, *Larry Carin; Duke Univ., USA.* In this talk we explore ideas in adaptive sensing. We direct significant attention on new ideas in compressive sensing (CS), and how adaptive CS may improve performance in a computationally tractable manner.

CTuA3 • 9:00 a.m. **●Invited●**
Photon Counting 3-D Passive Sensing and Object Recognition, *Seokwon Yeom[1], Edward Watson[2], Bahram Javidi[1]; [1]Univ. of Connecticut, USA, [2]U.S. Air Force Res. Lab Wright Patternson Air Force Base, USA.* Three-dimensional (3-D) passive sensing using photon-counting integral imaging is presented. Photon-counting 3-D passive sensing shows significant benefits for ATR. The discrimination capability of the system is quantified in terms of Fisher ratio and ROC curves.

CTuA4 • 9:30 a.m.
Distributed Feature-Specific Imaging, *Jun Ke, Premchandra Shankar, Mark A. Neifeld; Univ. of Arizona, USA.* We describe a distributed network of low-power feature-specific (i.e., compressive) imagers. Several candidate projection types are compared. Linear minimum mean squared error estimation is used for reconstruction. Image quality and sensor lifetime are quantified.

CTuA5 • 9:45 a.m.
Adaptive Feature-Specific Imaging, *Pawan K. Baheti[1], Jun Ke[1], Mark A. Neifeld[1,2]; [1]Dept. of Electrical and Computer Engineering, Univ. of Arizona, USA, [2]College of Optical Sciences, Univ. of Arizona, USA.* Adaptive feature-specific imaging is applied in two applications: image reconstruction and target detection. We demonstrate significant reduction in number of measurements required to achieve a given performance as compared to static feature-specific imaging.

Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

CTuB • Computational Imaging

Grand Ballroom C
10:30 a.m.–12:30 p.m.
CTuB • Computational Imaging
Emmanuel Candes; Caltech, USA, Presider

CTuB1 • 10:30 a.m. **●Invited●**
Optical Tomography with Large Data Sets, *John Schotland; Univ. of Pennsylvania, USA.* We report recent work on reconstruction algorithm for optical tomography with large data sets.

CTuB2 • 11:00 a.m. **●Invited●**
Imaging with an Array of Adaptive Sub-Apertures, *Mikhail Vorontsov, Mathieu Aubailly; Inst. for Systems Res., USA.* An alternative approach for high-resolution imaging based on an array of conformal adaptive optics sub-apertures with complex field sensing capabilities and a digital signal processor capable of synthesis of high-resolution images is presented.

CTuB3 • 11:30 a.m.
The MONTAGE Least Gradient Image Reconstruction, *Nikos P. Pitsianis[1,2,3], David J. Brady[1,2], Xiaobai Sun[1,3]; [1]Fitzpatrick Ctr., Duke Univ., USA, [2]Dept. of Electrical and Computer Engineering, Duke Univ., USA, [3]Dept. of Computer Science, Duke Univ., USA.* We introduce an image reconstruction algorithm for the Compressive Optical MONTAGE Photography Initiative, for recovering the resolution of an image from a set of aliased subimages acquired by a lenslet array optical system.

CTuB4 • 11:45 a.m.
Fourier Analysis and Synthesis Tomography : A Structured Illumination Approach to Computational Imaging, *Daniel Feldkhun, Kelvin Wagner; Univ. of Colorado at Boulder, USA.* We present a lensless image-forming technique that probes the object's fluorescent or coherent spatial spectrum using dynamic interference patterns and a fast nonresolving detector. Fourier transformation and tomographic synthesis is used to compute the image.

CTuB5 • 12:00 p.m.
Error Analysis of Phase-Shifting for Phase and Amplitude Tomographic Reconstruction, *Laura Waller, George Barbastathis; MIT, USA.* We show the propagation of phase-shifting error on amplitude and phase retrieval of a 2D phantom object that is recovered tomographically from its 1D interferometric projections.

CTuB6 • 12:15 p.m.
Extended Depth-of-Field Imaging at 94 GHz, *Joseph N. Mait[1], David A. Wikner[1], Mark S. Mirotznik[2], Gregory P. Behrmann[2], Joseph van der Gracht[3]; [1]ARL, USA, [2]Catholic Univ. of America, USA, [3]Holospex, USA.* We apply extended depth-of-field imaging using a cubic phase element to a 94 GHz imager. Simulations indicate the efficacy of the approach. We are testing the system experimentally using a Rexolite™ cubic phase element.

CTuB7 • 12:30 p.m.
Self-Calibrated Optical Imaging of Sparse RF Arrays, *Benjamin Braker, Kelvin Wagner; Optoelectronic Computing Systems Ctr., Univ. of Colorado, USA.* We present an experimental demo of a wideband Fourier optical beamformer that compensates for beam squint using spectrally selective imaging in a spectral hole burning crystal and corrects for phase errors using optical self-calibration.

12:45 p.m.–2:00 p.m.
Lunch Break (on your own)

CTuC • Mathematical Methods

Grand Ballroom C
2:00 p.m.–4:00 p.m.
CTuC • Mathematical Methods
Presider to Be Announced

CTuC1 • 2:00 p.m. **•Invited•**
Compressive Sampling: Sense-Less but Smart! *Emmanuel Candes; Caltech, USA.* We present a new theory which goes against conventional wisdom and allows the faithful recovery of images from supposedly highly incomplete sets of measurements. Practically, one can obtain super-resolved signals from just a few sensors.

CTuC2 • 2:30 p.m. **•Invited•**
Interferometric Synthetic Aperture Microscopy, *P. Scott Carney, Brynmor J. Davis, Daniel L. Marks, Tyler S. Ralston, Stephen A. Boppart; Univ. of Illinois at Urbana-Champaign, USA.* Interferometric synthetic aperture microscopy provides high-resolution three-dimensional optical images of semitransparent samples with large depth of field without scanning the focal plane. ISAM theory and experiments will be discussed.

CTuC3 • 3:00 p.m. **•Invited•**
Title to Be Determined, *David G. Stork; Ricoh Innovations, USA.* No abstract available.

CTuC4 • 3:30 p.m.
A Hyperprior for Sparse Signal Estimation, *Timothy Schulz; Michigan Tech, USA.* The problem of estimating a sparse signal from compressive sampling data is addressed by utilizing a conditionally independent Gaussian prior for the sparse signal parameters, and a novel hyperprior for the signal variances.

CTuC5 • 3:45 p.m.
Multiframe Image Restoration with Wavelet Domain Regularization, *Premchandra M. Shankar, Mark A. Neifeld; Univ. of Arizona, USA.* We present a novel method for obtaining an object estimate from multiple blurred and noisy low-resolution images. We incorporate wavelet domain priors in a regularized-restoration framework that uses L-curve technique to find optimal regularization parameters.

Digital Holography and Three Dimensional Imaging Abstracts

• Sunday, June 17, 2007 •

Grand Ballroom Foyer
3:00 p.m.–6:00 p.m.
Registration Open

• Monday, June 18, 2007 •

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

DMA • Digital Holographic Microscopy

Grand Ballroom B
8:00 a.m.–10:00 a.m.
DMA • Digital Holographic Microscopy
Ichirou Yamaguchi; Gunma Univ., Japan, Presider

DMA1 • 8:00 a.m. **•Invited•**
Recent Progress and Perspectives in Digital Holographic Microscopy, *Christian Depeursinge; EPFL, Switzerland.* Recent developments in Digital Holographic Microscopy (DHM) have permitted to achieve imaging accuracies and resolutions down to the nano-range. This result could be obtained by careful control of all parameters involved in the wavefront reconstruction.

DMA2 • 8:30 a.m. **•Invited•**
Scanning Holographic Microscopy for Multifunctional Imaging, *Guy Indebetouw; Virginia Tech, USA.* The background of scanning holographic microscopy is reviewed. Advantages of the method illustrate the possibility of capturing simultaneously a number of holograms accessing different imaging modes such as absorbance, reflectance, fluorescence, and phase contrast.

DMA3 • 9:00 a.m. **•Invited•**
Novel Techniques for 3-D Biological Microscopy, *Jim Swoger, James Sharpe; Ctr. for Genomic Regulation, Spain.* Quantitative 3-D imaging is becoming an essential tool in developmental and systems biology. By visualizing mouse and fly embryos, Optical Projection Tomography and Selective Plane Illumination Microscopy are demonstrated as effective tools in this context.

DMA4 • 9:30 a.m. **•Invited•**
Quantitative Phase-Contrast Microscopy for Analysis of Live Cells by Using Lateral Shearing Approach in Digital Holography, *Pietro Ferraro, Lisa Miccio, S. Grilli, S. De Nicola, A. Finizio, L. De Petrocellis; Inst. Nazionale di Ottica Applicata (INOA) del CNR, Italy.* Quantitative phase microscopy (QPM) can be obtained by adding the concept of digital Lateral Shear Interferometry (LSI) to Digital Holography (DH). We demonstrate that the proposed approach offer some important advantages compared to other methods.

Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

DMB • Digital Holography (DH) and 3-D Imaging

Grand Ballroom B
10:30 a.m.–12:30 p.m.
DMB • Digital Holography (DH) and 3-D Imaging
Joseph Rosen; Ben Gurion Univ. of the Negev, Israel, Presider

DMB1 • 10:30 a.m. **•Invited•**
How Can Computer-Generated Holograms Contribute to 3-D Imaging? *Leonid Yaroslavsky; Tel Aviv Univ., Israel.* Generating a hologram of the scene to be viewed is an ultimate solution for 3-D visualization. For generating synthetic holograms, one doesn't need to imitate optical holograms of the scene. The paper discusses possible options.

DMB2 • 11:00 a.m. **•Invited•**
Real-Time Automated 3-D Sensing and Recognition of Biological Microorganisms, *Inkyu Moon, Bahram Javidi; Univ. of Connecticut, USA.* We present an overview of approaches for automatically identifying biological microorganisms without bio-chemical/molecular processing. These methods are based on 3-D optical coherent imaging interfaced with computers to perform specially developed recognition algorithms.

DMB3 • 11:30 a.m.
Phase Contrast Movies of Cell Migration by Multi-Wavelength Digital Holography, *Alexander Khmaladze, Christopher Mann, Myung Kim; Univ. of South Florida, USA.* Quantitative phase unwrapped movies of cell migration are generated by phase imaging digital holography. Two or more wavelengths are used for simultaneous illumination of the cells and real-time acquisition of holographic images.

DMB4 • 11:45 a.m.
Digital In-Line Holographic Microscopy of Colloidal Systems of Microspheres, *Jorge Garcia-Sucerquia[1,2], Diana Alvarez-Palacio[2], Jürgen Kreuzer[2]; [1]Univ. Nacional de Colombia, Colombia, [2]Dalhousie Univ., Canada.* We present the application of Digital In-line Holographic Microscopy to image colloidal systems of sub-micron microspheres. The Talbot self-imaging effect is used as a measuring tool of the main features of the resulting self-assembled structures.

DMB5 • 12:00 p.m.
Advances in Plankton Imaging Using Digital Holography, *Jose A. Dominguez-Caballero[1], Nick Loomis[1], Weichang Li[2], Qiao Hu[2], Jerome Milgram[1], George Barbastathis[1], Cabell Davis[2]; [1]MIT, USA, [2]Woods Hole Oceanographic Inst., USA.* An *in situ* plankton imaging system using a high space-bandwidth product camera and fiber coupled diode laser for digital holography was developed. High quality imaging results and solutions for associated computational challenges are discussed.

DMB6 • 12:15 p.m.
Real-Time Birefringence Measurement with Digital Holographic Microscopy, *Tristan Colomb[1,2], Florian Charrière[1], Jonas Kühn[1], Yves Bellouard[3], Christian Depeursinge[1]; [1]Ecole Polytechnique Fédérale de Lausanne, Switzerland, [2]Ctr. de Neurosciences Psychiatriques, Dépt. de Psychiatrie DP-CHUV, Site de Cery, Switzerland, [3]Micro- and Nano-Scale Eng., Mechanical Engineering Dept., Eindhoven Univ. of Technology, Netherlands.* Digital holographic microscopes using two orthogonal polarized reference waves provides real-time polariscopes. Birefringence induced by internal stress is imaged in optical fibers and in fused silica substrates, where lines are written with low-energy femtosecond pulses.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

Grand Ballroom B
2:00 p.m.–4:00 p.m.
AMA • Laboratory and Field Tests

Grand Ballroom D
4:00 p.m.–4:30 p.m.
Coffee Break

Grand Ballroom B
4:30 p.m.–6:30 p.m.
PMA • Joint AO/DH Postdeadline Papers Session

6:30 p.m.–8:00 p.m.
Dinner Break (on your own)

JMA • Joint Plenary Session

Grand Ballroom B
8:00 p.m.–9:00 p.m.
JMA • Joint Plenary Session

JMA1 • 8:00 p.m. **►Plenary◄**
Digital Image Formation from Holograms: Early Motivations and Modern Capabilities, *Joseph W. Goodman; Stanford Univ., USA.* I review the first case (1967) of detection of a hologram and reconstruction of the corresponding image by purely electronic means. I also discuss the circumstances that led to the experiment in the first place.

Digital Holography and Three-Dimensional Imaging (continued)

● Tuesday, June 19, 2007 ●

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

DTuA • DH and Integral Imaging

Grand Ballroom B
8:00 a.m.–10:00 a.m.
DTuA • DH and Integral Imaging
Jung-Young Son; Hanyang Univ., Republic of Korea, Presider

DTuA1 • 8:00 a.m.
Withdrawn.

DTuA2 • 8:15 a.m.
Omnidirectional Integral Photography Images Compression Using the 3-D-DCT, *Nicholas P. Sgouros, Dionisis P. Chaikalis, Panagiotis G. Papageorgas, Manolis S. Sangriotis; Dept. of Informatics and Telecommunications, Univ. of Athens, Greece.* Integral Photography images exhibit high intra-pixel as well as inter-elemental-image correlation. In this work, we present an efficient, omnidirectional Integral Photography compression scheme based on a Hilbert curve scan and a three dimensional transform technique.

DTuA3 • 8:30 a.m.
Dynamic 3-D Object Reconstruction of Digital Holograms Using Complex-Modulated Spatial Light Modulators, *Chau-Jern Cheng[1], Mao-Ling Chen[1], Mei-Li Hsieh[2]; [1]Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan, [2]Inst. of Electro-Optical Science and Technology, Natl. Taiwan Normal Univ., Taiwan.* We propose and demonstrate a cascaded LC-SLM module combined the phase- and amplitude-modulated characteristics of two LC-SLMs to dynamically perform three-dimensional object reconstruction of digital holograms. Both analytical and experimental results are presented and discussed.

DTuA4 • 8:45 a.m.
Evaluation of Light-Ray Reproducibility in Full-Parallax Holographic Stereogram, *Masahiro Yamaguchi[1], Haruhiko Higuchi[1], Ryota Kojima[1], Shingo Maruyama[2]; [1]Tokyo Inst. of Technology, Japan, [2]TOPPAN Printing Co., Ltd., Japan.* A system to measure the angular distribution of light-rays reproduced by a 3-D display is developed, and applied to the evaluation of full-parallax holographic stereogram. The angular resolution was shown to be higher than 0.3-Deg.

DTuA5 • 9:00 a.m.
A Thin and Small 3-D/2-D Convertible Display Using an Organic Light Emitting Diode (OLED) Panel Based on Integral Imaging, *Youngmin Kim, Heejin Choi, Seong-Woo Cho, Byoungho Lee; School of Electrical Engineering, Seoul Natl. Univ., Republic of Korea.* A thin and compact 3-D/2-D convertible display based on integral imaging was demonstrated by the use of an OLED panel. The proposed system has a thin structure and simple convertibility.

DTuA6 • 9:15 a.m.
Compression of Sub-Image-Transformed Elemental Images in Integral Imaging, *Ho-Hyun Kang[1], Dong-Hak Shin[2], Eun-Soo Kim[1]; [1]Kwangwoon Univ., Republic of Korea, [2]Dongseo Univ., Republic of Korea.* A novel compression scheme of sub-image-transformed elemental images using Karhunen-Loeve transform in integral imaging is proposed. To show the usefulness of the proposed scheme, some experiments are carried out and the results are presented.

DTuA7 • 9:30 a.m.
Magnification Display of 3-D Images in One-dimensional Integral Imaging Using a Lenslet Array, *Dong-Hak Shin[1], Joon-Jae Lee[1], Byoungho Lee[2], Eun-Soo Kim[3]; [1]Dongseo Univ., Republic of Korea, [2]Seoul Natl. Univ., Republic of Korea, [3]Kwangwoon Univ., Republic of Korea.* In this paper, a magnification display of three-dimensional images in one-dimensional integral imaging system using lenslet array is proposed. To show the feasibility of proposed system, some experiments are carried out and results are presented.

DTuA8 • 9:45 a.m.
Pickup Method from OpenGL by Reverse Projection Matrix for Real-Orthoscopic Integral Imaging, *Gilbae Park, Seong-Woo Cho, Joohwan Kim, Yunhee Kim, Heejin Choi, Joonku Hahn, Byoungho Lee; Seoul Natl. Univ., Republic of Korea.* We propose a new method using a reverse projection matrix in OpenGL, which can reconstruct real-orthoscopic images in computer-generated integral imaging without any additional device. This technique is verified through computer-generated integral imaging system.

DTuB • DH Poster Session

Grand Ballroom D
10:30 a.m.–12:30 p.m.
DTuB • DH Poster Session

DTuB1 • 10:30 a.m.
Optical Phase-Dependent Visual Secret Sharing Systems, *Hsuan Ting Chang, Chien-Yi Lu, Chao-Chin Chen; Dept. of Electrical Engineering, Natl. Yunlin Univ. of Science and Technology, Taiwan.* Optical phase-dependent visual secret sharing (OPVSS) systems are proposed such that any *k*-1 of the *k* retrieved phase keys can be used to dependently reconstruct one of the *k* content images.

DTuB2 • 10:30 a.m.
Technique for Estimation of Quality of the Particles Images Reconstructed from Digital Holograms, *Victor V. Dyomin, Alexey Olshukov; Tomsk State Univ., Russian Federation.* The technique is suggested which is based on the areas comparison of holographic images of the model plane opaque particles with various shapes and the areas of model particles themselves with correspondent shapes.

DTuB3 • 10:30 a.m.
ROM Type Holographic Disk Using Computer Generated Hologram, *Shuhei Yoshida[1], Takumi Sano[1], Manabu Yamamoto[1], Masahiro Nakajima[2], Toshihiro Kobayashi[2]; [1]Tokyo Univ. of Science, Japan, [2]Mitsubishi Kagaku Media Corp., Japan.* Holographic ROM disk that can be made by the optical disk cutting method was studied. CGH was recorded on the master disk. The simulation showed that multiplex recoding became possible by the orthogonal aperture multiplexing.

DTuB4 • 10:30 a.m.
White Light Computer-Generated Element Based on Halftoning Technique, *Cristhiane Gonçalves, José Carlos Pizolato Junior, Giuseppe Antônio Cirino, Luiz Gonçalves Neto; Univ. of São Paulo, Brazil.* This work presents a method to generate white light digital holograms using halftoning technique and binary optics. Some advantages are low- cost production, easy illumination processes, no distortion effects and no iterative algorithms.

DTuB5 • 10:30 a.m.
Accurate Phase-Added Stereogram, *Hoonjong Kang, Takeshi Yamaguchi, Hiroshi Yoshikawa; Dept. of Electronics and Computer Science, Nihon Univ., Japan.* In this paper, we propose "Accurate Phase-Added Stereogram" which is calculated by a similar way to the Phase-Added Stereogram, and its reconstructed image is as clear as the Fresnel hologram.

DTuB6 • 10:30 a.m.
Analysis of Photopolymer's Hologram Recording Characteristics, *Shuhei Yoshida, Manabu Yamamoto; Tokyo Univ. of Science, Japan.* We analyzed the recording characteristics of photopolymer media and also carried out real-time monitoring of recording process at short time pulse. From the analysis and experiment, we made clear a two stage recording process.

DTuB7 • 10:30 a.m.
Fast Generation of Computer Generated Hologram with Reduced Look-up Table, *Seung-Cheol Kim, Jong-Kil Lee, Eun-Soo Kim; 3D Display Res. Ctr., Republic of Korea.* In this paper, the Reduced Look-up Table is proposed to increase the speed of CGH generation and to reduce the space required to store a precomputed table.

DTuB8 • 10:30 a.m.
Extraction of Depth Cue of a 3-D Object Using a Computational Integral Imaging Reconstruction Scheme, *Dong-Choon Hwang[1], Dong-Hak Shin[2], Eun-Soo Kim[1]; [1]Kwangwoon Univ., Republic of Korea, [2]Dongseo Univ., Republic of Korea.* In this paper, a novel depth extraction scheme using a CIIR technique is proposed. 3-D object images can be computationally reconstructed. Depth data of 3-D objects can be extracted by an image separation technique.

DTuB9 • 10:30 a.m.
Joint Image Encryption and Multiplexing by Use of Non-Negative Matrix Factorization Adopting Digital Holography, *Hsuan Ting Chang, Chih-Wei Hsu; Dept. of Electrical Engineering, Natl. Yunlin Univ. of Science and Technology, Taiwan.* In this paper, a joint multiple-image encryption and multiplexing system, which utilizes the non-negative matrix factorization (NMF) scheme and digital holography, is proposed.

DTuB10 • 10:30 a.m.
Computer-Generated Cylindrical Hologram, *Takeshi Yamaguchi, Tomohiko Fujii, Hiroshi Yoshikawa; Nihon Univ., Japan.* It is difficult to make a computer-generated cylindrical hologram due to the needs of high resolution output and huge computation. We propose a new approach to calculate the cylindrical hologram of the 3-D object.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

DTuC • 3-D Imaging

Grand Ballroom B
2:00 p.m.–4:00 p.m.
DTuC • 3-D Imaging
Toyohiko Yatagai; Univ. of Tsukuba, Japan, Presider

DTuC1 • 2:00 p.m. **•Invited•**
Toward Full Spectral 3-D View Synthesis, *Jong-Il Park, Moon-Hyun Lee, Hanhoon Park; Hanyang Univ., Republic of Korea.* Capturing and rendering 3-D real video contents using multiple cameras are important enabling technologies for 3-D display. This paper explores spectral capturing and rendering for faithful color reproduction in 3-D view synthesis.

DTuC2 • 2:30 p.m. **•Invited•**
Viewing Zones in Multiview 3-Dimensional Imaging Systems, *Jung-Young Son[1,2,3], Shin-Hwan Kim[1], Vladimir V. Saveljev[2], Dae-Sik Kim[3]; [1]Daegu Univ., Republic of Korea, [2]Hanyang Univ., Republic of Korea, [3]Samsung Electronics, Republic of Korea.* Viewing zone structures in various multiview 3-dimensional Imaging systems are compared and image compositions perceived at different parts of the zone are analyzed. The analysis enables to compare the perceived image qualities of the systems.

DTuC3 • 3:00 p.m.
Hilbert Transform by Optical Scanning Holography, *K. B. Doh[1], I. Kim[2], T.-C. Poon[3]; [1]Hankuk Aviation Univ., Republic of Korea, [2]Paichai Univ., Republic of Korea, [3]Virginia Tech, USA.* We propose a technique of obtaining the Hilbert transform for incoherent objects. We design pupil functions in optical scanning holography so as to obtain the hologram of the Hilbert transform of the scanned object.

DTuC4 • 3:15 p.m.
Numerical Optics in Digital Holography, *Tristan Colomb[1,2], Florian Charrière[1], Jonas Kühn[1], Frédéric Montfort[3], Christian Depeursinge[1]; [1]Ecole Polytechnique Fédérale de Lausanne, Switzerland, [2]Ctr. de Neuroscience Psychiatrique, Dept. de Psychiatrie DP-CHUV, Site de Cery, Switzerland, [3]Lyncée Tec SA, Switzerland.* As digital holography achieves numerical reconstruction of the complex wavefront diffracted by specimen, a numerical optics formalism has been developed: numerical filters replace pinholes in Fourier planes, numerical lenses allow aberrations compensation and image magnification.

DTuC5 • 3:30 p.m.
Acquisition of Information-Rich Images Using Synthetic-Aperture Digital Holography, *Tatsuya Nakatsuji, Kyoji Matsushima; Kansai Univ., Japan.* A synthetic-aperture technique is applied to the acquisition of information-rich images in phase-shifting digital holography. Since the images have a large viewing zone, diverse reconstructions can be obtained in various manners.

DTuC6 • 3:45 p.m.
Optical 3-D Image Display in Integral Imaging System Using a Depth Camera, *Dong-Hak Shin[1], Seung-Hyun Lee[2], Eun-Soo Kim[2]; [1]Dongseo Univ., Republic of Korea, [2]Kwangwoon Univ., Republic of Korea.* In this paper, we propose an optical integral imaging system using a depth camera to display three-dimensional objects. To show the usefulness of proposed system, we carry out the experiment and present the experimental results.

Grand Ballroom D
4:00 p.m.–5:00 p.m.
AO Poster Session and Coffee Break

DTuD • DH Techniques

Grand Ballroom B
5:00 p.m.–7:00 p.m.
DTuD • DH Techniques
Eun-Soo Kim; Kwangwoon Univ., Republic of Korea, Presider

DTuD1 • 5:00 p.m.
Two-Wavelength Digital Holography, *Thomas Höft[1], Richard Kendrick[2], Joseph Marron[1], Nathan Seldomridge[1,2]; [1]Lockheed Martin Coherent Technologies, USA, [2]Lockheed Martin Advanced Technology Ctr., USA.* With two-wavelength digital holography, 3-D images of diffuse objects are generated by computing the phase difference between coherent images recorded at two wavelengths. Results are presented that show robust, fine resolution 3-D imaging.

DTuD2 • 5:15 p.m.
Phase-Shifting Interference Microscopy with Multi-Wavelength Optical Phase Unwrapping, *Nilanthi Warnasooriya, Myung Kim; Univ. of South Florida, USA.* A combination of phase shifting interferometry with the multi-wavelength optical phase unwrapping is used to image quantitative phase profiles of microscopic objects. The results show a surface profile with a height range of several microns.

DTuD3 • 5:30 p.m.
Computer Simulation of Reconstructed Image from Rainbow Hologram, *Hiroshi Yoshikawa, Takeshi Yamaguchi, Haruyoshi Fujita; Nihon Univ., Japan.* The image reconstruction simulation of full color rainbow hologram is proposed. Image from any observing position can be simulated from Fourier components of segmented hologram. It is useful to confirm computed result before printing hologram.

DTuD4 • 5:45 p.m.
Two-Wavelength Phase-Shifting Low-Coherence Digital Holography, *Yoshio Hayasaki, Mitsue Otaka, Hirotsugu Yamamoto; Univ. of Tokushima, Japan.* We propose a novel interferometric method based on digital holography, low-coherence interferometry, phase-shifting technique, and two-wavelength interferometry. We demonstrate topographic imaging of an object in a light scattering medium.

DTuD5 • 6:00 p.m.
Digital Holographic Superresolution by Rotating the Object Wavefield, *Bryan M. Hennelly, Thomas J. Naughton, John McDonald; Natl. Univ. of Ireland at Maynooth, Ireland.* We create superresolved digital holograms by stitching together multiple holograms of 3-D objects. The object wavefield is rotated between captures and stitched together using digital signal processing techniques. The numerical aperture is increased significantly.

DTuD6 • 6:15 p.m.
White-Light Single-Shot Digital Hologram Recorder, *Natan T. Shaked, Joseph Rosen, Adrian Stern; Ben-Gurion Univ. of the Negev, Israel.* A new technique, coined integral holography, for recording holograms of three-dimensional objects under spatially incoherent white-light illumination, and in a single camera shot, is presented. Experimental results validate the correctness of the new technique.

DTuD7 • 6:30 p.m.
Filtering of Phase-Difference Images in Digital Holography, *Diego A. Hincapie, Jorge A. Herrera, Jorge I. Garcia-Sucerquia; Univ. Nacional de Colombia Sede Medellin, Colombia.* Phase difference images are used to measure topography and/or deformations of macroscopic objects. These images contain inherent high-contrast speckle noise. We present the development and implementation of a phase-shifting like algorithm for filtering these images.

DTuD8 • 6:45 p.m.
Creation of Multicolor Images by Diffractive Optical Elements, Arranged in a Stacked Setup, *Thomas Kämpfe, Ernst-Bernhard Kley, Andreas Tünnermann; Friedrich Schiller Univ. Jena, Germany.* We present two novel stacked diffractive optical elements for multicolor image generation: Firstly, the combination of highly dispersive diffraction gratings with computer generated holograms (CGH) and, secondly, two CGHs working in the optical nearfield.

Digital Holography and Three-Dimensional Imaging (continued)

● Wednesday, June 20, 2007 ●

Grand Ballroom Foyer
7:00 a.m.–3:00 p.m.
Registration Open

DWA • 3-D Display

Grand Ballroom B
8:00 a.m.–10:00 a.m.
DWA • 3-D Display
Hiroshi Yoshikawa; Nihon Univ., Japan, Presider

DWA1 • 8:00 a.m. **•Invited•**
Foundations of Computer Generated Holograms for 3-D Display, *William Dallas; Dept. of Radiology, College of Medicine, Univ. of Arizona, USA.* We begin with events in the history of computer holography related to 3-D display. Next is an examination of computer hologram structure. Finally, we scrutinize the encoding of the 3-D information in the 2-D hologram.

DWA2 • 8:30 a.m. **•Invited•**
Record and Display of Color 3-D Images by Electronic Holography, *Kunihiro Sato; Hyogo Univ., Japan.* A holographic color display is developed with a reflective liquid-crystal display (LCD) panel and with low-power RGB lasers. A holographic system is also developed for simultaneous recording of 3-D color images with a color CCD.

DWA3 • 9:00 a.m. **•Invited•**
Wide-Angle Computer-Generated Holograms for 3-D Display, *Toyohiko Yatagai, Mark A. Tachiko, Yusuke Sando, Masahide Itoh; Univ. of Tsukuba, Japan.* We propose fast calculation methods for diffraction to non-planar surfaces, such as cylinders and spheres, using the fast-Fourier transform (FFT) algorithm. The principle of the fast calculation and the simulation results are presented.

DWA4 • 9:30 a.m. **•Invited•**
Making Holographic Television a Consumer Product, *V. Michael Bove, Daniel E. Smalley, Quinn Y. J. Smithwick; MIT Media Lab, USA.* Recent holographic video research at the MIT Media Laboratory has focused on making a display suitable for consumer use. We discuss our new display architecture, and its novel electro-optical aspects.

Grand Ballroom D
10:00 a.m.–10:30 a.m.
Coffee Break

DWB • Computer-Generated Holography (CGH)

Grand Ballroom B
10:30 a.m.–12:30 p.m.
DWB • Computer-Generated Holography (CGH)
William Dallas; Optical Sciences Ctr., USA, Presider

DWB1 • 10:30 a.m.
Creation of Multicolor Images by Reflective, Wavelength Selective, Computer Generated Holograms, *Thomas Kämpfe[1], Ernst-Bernhard Kley[1], Peter Dannberg[2], Gerhard Hochenbleicher[3], Andreas Tünnermann[1]; [1]Friedrich Schiller Univ. Jena, Germany, [2]Fraunhofer Inst. Angewandte Optik und Feinmechanik, Germany, [3]LINHOF Präzisions-Systemtechnik GmbH, Germany.* We present two novel approaches to realize diffractive optical elements for multicolor image generation, which maintain some important and unique advantages of monochromatic image generation by Fourier-type, computer generated holograms.

DWB2 • 10:45 a.m.
Diffraction Efficiency of Computer-Generated Volume Holograms Directly Written with a Femtosecond Laser, *Tim D. Gerke, Rafael Piestun; Dept. of Electrical Engineering, Univ. of Colorado, USA.* We demonstrate computer-generated volume holograms fabricated by femtosecond laser micromachining. The design is based on a scalar diffraction model. The structures are tested numerically and experimentally for angular and frequency dependence.

DWB3 • 11:00 a.m.
Improvement of Hidden-Surface Removal for Computer-Generated Holograms from CG, *Tomohiko Fujii, Hiroshi Yoshikawa; Nihon Univ., Japan.* For computer-generated rainbow holograms (CGRHs), it is important to display surface model shaded images like computer graphics (CG). We have proposed a simple process to obtain 3-D data for CGRH from two CG images.

DWB4 • 11:15 a.m.
Rotational Transformation for Reconstruction of Digital Holography and CGH Creation, *Kyoji Matsushima; Kansai Univ., Japan.* Rotational transformation allows the reconstruction of images on an arbitrarily tilted plane in a digital holography and the creation of arbitrarily tilted polygon light sources in CGHs. Examples of transformation applications are demonstrated.

DWB5 • 11:30 a.m.
Replay of Digitally-Recorded Holograms Using a Computational Grid, *J. J. Nebrensky, Peter R. Hobson; Brunel Univ., UK.* Each plane within an in-line hologram of a particle field can be reconstructed by a separate computer. We investigate strategies to reproduce the sample volume as quickly and efficiently as possible using Grid computing.

DWB6 • 11:45 a.m.
Computer-Generated Hologram Calculated from Multi-View Images of Real Existing Objects, *Kei Kushimoto, Yuji Sakamoto; Graduate School of Information Science and Technology, Hokkaido Univ., Japan.* We proposed a method of computer-generated hologram for real objects. A hologram is generated from a distribution of a light wave witch is calculated from multi-view images, and three-dimensional objects are reconstructed by the method.

DWB7 • 12:00 p.m.
A Fast Calculation Method of Cylindrical Computer-Generated Holograms Which Perform Image-Reconstruction of Volume Data, *Akifumi Kashiwagi, Yuji Sakamoto; Graduate School of Information Science and Technology, Hokkaido Univ., Japan.* It takes a lot of time for calculation of a cylinder hologram which displays a 3-dimensional object. We propose a new method for fast calculation of the hologram to reduce the calculation time for it.

DWB8 • 12:15 p.m.
Comparison of Simulated and Fabricated Computer Generated Holograms Generated Using Phase Optimised General Error Diffusion, *Jamie L. Ramsey[1], Jean Lapointe[2], Trevor J. Hall[1]; [1]Univ. of Ottawa, Canada, [2]Natl. Res. Council of Canada, Canada.* A comparison is made of the results of simulation and experimental measurements on computer generated holograms fabricated by e-beam lithography and designed using a phase optimised general error diffusion algorithm.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

DWC • DH Applications

Grand Ballroom B
2:00 p.m.–4:00 p.m.
DWC • DH Applications
P. Ferraro; Inst. Nazionale di Ottica Applicata (INOA) del CNR, Italy, Presider

DWC1 • 2:00 p.m.
Mathematical Morphology and Roughness Measurement of Particles Observed by a Digital Holographic Microscope, *Alejandro Restrepo-Martínez, Jorge A. Herrera, Román Castañeda; Univ. Nacional de Colombia Sede Medellin, Colombia.* Roughness factors were estimated in synthetic range phase images and unwrapped phase images of organic matter imaged by digital holography microscopy, by using mathematical morphology. The particles could be classified in different scales.

DWC2 • 2:15 p.m.
Monitoring of Paint Drying Process by Phase-Shifting Digital Holography, *Ichirou Yamaguchi[1], Takasi Ida[1], Masayuki Yokota[1], Koichi Kobayashi[2]; [1]Gunma Univ., Japan, [2]Toyo Seiki Seisaku-syo, Ltd., Japan.* State of drying paint is monitored from the dynamic behaviors of images reconstructed by phase-shifting digital holography. For quantitative analysis cross-correlation coefficient of complex amplitude, named here, coherence factor, between successive frames.

DWC3 • 2:30 p.m.
Inverse Problem Approach for Particle Digital Holography: Field of View Extrapolation and Accurate Location, *Ferreol Soulez[1,2], Eric Thiebaut[1], Loïc Denis[2], Corinne Fournier[2]; [1]Ctr. de Recherche Astronomique de Lyon, France, [2]Lab Hubert Curien, France.* We present a method to estimate 3-D position and size of micron sized particles from a single hologram. Our method achieves to largely extrapolate the field of view of the camera with improved accuracy.

DWC4 • 2:45 p.m.
Digital Holography for *in situ* Monitoring of Periodic Domain Formation in Ferroelectric Crystals, *Simonetta Grilli, Melania Paturzo, Lisa Miccio, Pietro Ferraro; Inst. Nazionale Ottica Applicata del CNR, Italy.* Digital Holography (DH) is presented as a diagnostic and non-invasive technique to monitor the reversing domains in Lithium Niobate crystals. By means quantitative amplitude-contrast and phase-contrast image is possible to investigate the dynamics of poling.

DWC5 • 3:00 p.m.
Fast Computation of Focal Planes for Sparsely Populated Digital Holograms Using a Spectral l_1 Norm, *Weichang Li[1], Nick Loomis[2], Qiao Hu[1], Cabell Davis[1]; [1]Woods Hole Oceanographic Inst., USA, [2]MIT, USA.* A new focus measure utilizing l_1 norms in the Fourier domain provides focal depth estimates without reconstructing an object image. A polar implementation reduces the problem to one dimension, yielding two orders of computational speedup.

DWC6 • 3:15 p.m.
Animal Tissue Tomography by Digital Interference Holography, *Mariana C. Potcoava, Myung K. Kim; Univ. of South Florida, USA.* Wavelength-Scanning digital interference holography is an important method of in vitro imaging animal tissue non-invasively to achieve high-resolution volumetric datasets. Using this technique, we have demonstrated tomographic imaging of multiple-layered sub-surface structures of mouse tissues.

DWC7 • 3:30 p.m.
Characterization of Liquid Crystal Spatial Light Modulators Using Digital Holographic Microscopy, *Yu-Chih Lin[1], Mei-Li Hsieh[1], Han-Yen Tu[2], Chau-Jern Cheng[3]; [1]Inst. of Electro-Optical Science and Technology, Natl. Taiwan Normal Univ., Taiwan, [2]Dept. of Electronic Engineering, St. John's Univ., Taiwan, [3]Dept. of Electro-Optical Engineering, Natl. Taipei Univ. of Technology, Taiwan.* We propose a new technique to characterize liquid crystal devices by use of digital holographic microscopy. The complex-modulated wavefront of liquid crystal spatial light modulator are measured directly from the reconstructed field of digital holograms.

DWC8 • 3:45 p.m.
Holographic Femtosecond Laser Processing Using a Multiplexed Phase Fresnel Lenses Designed with Optical Estimation, *Satoshi Hasegawa, Yoshio Hayasaki; Dept. of Optical Science and Technology, Faculty of Engineering, Univ. of Tokushima, Japan.* Multiplexed phase Fresnel lenses used in holographic femtosecond laser processing is optimized with optical estimation of the diffraction peaks. The uniformity of the diffraction peaks is improved in compared with the computational optimization.

Grand Ballroom D
4:00 p.m.–4:30 p.m.
Coffee Break

DWD • DH and Display

Grand Ballroom B
4:30 p.m.–6:30 p.m.
DWD • DH and Display
Kunihiro Sato; Hyogo Univ., Japan, Presider

DWD1 • 4:30 p.m. ●Invited●
Time Resolved Digital Holographic Interferometry for Investigations of Dynamical Events, *Giancarlo Pedrini, Wolfgang Osten; Univ. of Stuttgart, Germany.* A sequence of digital holograms of an object that has been subjected to dynamic deformation is recorded. The phase of the wave calculated from the holograms is used to determine the time resolved deformation.

DWD2 • 5:00 p.m. **●Invited●**

Free Viewpoint Television (FTV), *Masayuki Tanimoto; Nagoya Univ., Japan.* We realized Free viewpoint TV (FTV) that enables us to view a 3-D world by changing our viewpoints freely. We have been developing ray capturing, processing and display technologies through the development of ray-reproducing FTV.

DWD3 • 5:30 p.m.

How Sharp Must Depth Maps Be for Good 3-D Video Synthesis: Experimental Evaluation and Applications, *Ianir A. Ideses, Leonid P. Yaroslavsky, Barak Fishbain; Tel-Aviv Univ., Israel.* We present experimental results of analysis of the impact of depth map blurring on 3-D perception of synthetic 3-D video. These results are then used to increase the quality of synthetic 3-D video.

DWD4 • 5:45 p.m.

View Point Tracking for Autostereoscopic Displays Using a Low Cost 3-D CMOS Imager, *Giora Yahav[1], Thomas Reiner[1], SeungHyun Lee[2]; [13]DV Systems, Israel, [2]Kwangwoon Univ., Republic of Korea.* We present an eye tracking system using a low cost 3-D CMOS imager for 3-D displays that ensures a correct autostereoscopic view of position-dependent stereoscopic 3-D images.

DWD5 • 6:00 p.m.

Development of an Advanced Autostereoscopic Display Employing Temporal Multiplexing, *Stephen A. Kupiec[1], Vladimir B. Markov[1], Adrian R. L. Travis[2], Darrel G. Hopper[3], Gurdail Sani[3]; [1]MetroLaser, Inc., USA, [2]Engineering Dept., Univ. of Cambridge, UK, [3]AFRL, USA.* The development of an autostereoscopic display based upon temporally multiplexing is described. The advent of high framerate spatial light modulators, high performance graphical processing units and high bandwidth data buses render such a design viable.

DWD6 • 6:15 p.m.

Generation of Computer Generated Holographic 3-D Images with Continuous Parallax Using a Sparse Array of Spatial Light Modulators and Galvano Mirrors, *Howon Lee, Hwi Kim, Joonku Hahn, Jihyun Lee, Byoungho Lee; Seoul Natl. Univ., Republic of Korea.* In this paper, a novel system configuration for generating computer generated holographic 3-D images with continuous parallax using a sparse array of spatial light modulators and galvano mirrors is presented.

Signal Recovery and Synthesis Abstracts

● Sunday, June 17, 2007 ●

Grand Ballroom Foyer
3:00 p.m.–6:00 p.m.
Registration Open

● Monday, June 18, 2007 ●

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

SMA • Imaging Restoration and Reconstruction

Grand Ballroom A
8:00 a.m.–10:00 a.m.
SMA • Imaging Restoration and Reconstruction
Peter Doerschuk; Purdue Univ., USA, Presider

SMA1 • 8:00 a.m. ►**Plenary**◄
Signal Recovery as Estimation: A Discourse on Null Functions and Nuisance Parameters, *Harrison Barrett[1], Kyle J. Myers[2]; [1]Univ. of Arizona, USA, [2]FDA/NIBIB Lab for the Assessment of Medical Imaging Systems, USA.* Signal recovery from image data is fundamentally impossible because all imaging systems have null functions. It may or may not be possible to estimate parameters of the signal. This paper will discuss whether parameters are estimable and whether we should care.

SMA2 • 8:45 a.m.
Phase Shift Estimation in Structured Illumination Imaging for Lateral Resolution Enhancement, *Sapna A. Shroff, James R. Fienup, David R. Williams; Univ. of Rochester, USA.* Lateral resolution enhancement using structured illumination imaging requires accurate knowledge of phase shifts in the sinusoidal illumination on the object. We discuss a method to estimate these phase shifts and the resulting image reconstructions.

SMA3 • 9:00 a.m.
Binary Image Restoration by Signomial Programming, *Yijiang Shen, Edmund Y. Lam, Ngai Wong; Univ. of Hong Kong, Hong Kong.* We present a signomial programming optimization approach to restore binary images which are degraded by additive white Gaussian noise. Numerical experiments confirm the proposed approach is efficient with good accuracy.

SMA4 • 9:15 a.m.
Ultrasonic Imaging of Micro-Bubbles Based on Time-Frequency Transformations, *Markus Testorf, Marvin M. Doyley; Dartmouth College, USA.* Time-frequency transformations are used to identify resonant particles from ultrasound scans. Short time Fourier transformations of the time domain signal indicate a potential for both detection as well as localization in the joint domain.

SMA5 • 9:30 a.m.
Improved Elastic Image Registration Method for SR in Remote Sensing Images, *Feng Li, Donald Fraser, Xiuping Jia, Andrew Lambert; School of ITEE, Univ. of New South Wales at ADFA, Australia.* The following aspects are contributed here: (1) we improve the efficiency of original elastic registration method; (2) we combine this registration method with our modified IBP method to reconstruct better SR images.

SMA6 • 9:45 a.m.
Artifact Reduction in Magnetic Resonance Imaging, *Philip Bones, Julian Maclaren; Univ. of Canterbury, New Zealand.* Both patient motion and T2 signal decay cause artifacts in magnetic resonance images. Techniques to reduce the effects of these artifacts are described and results obtained using a moving phantom are presented.

Grand Ballroom D
10:00 a.m.–10:30 p.m.
Coffee Break

SMB • Deconvolution and Compressive Imaging

Grand Ballroom A
10:30 a.m.–12:30 p.m.
SMB • Deconvolution and Compressive Imaging
Markus Testorf; Dartmouth College, USA, Presider

SMB1 • 10:30 a.m. ●**Invited**●
Title to Be Determined, *Matthew O'Donnell; Univ. of Washington, USA.* No abstract available.

SMB2 • 11:00 a.m. ●**Invited**●
Noise Reduction in Support-Constrained Multi-Frame Blind-Deconvolution Restorations as a Function of the Number of Data Frames and the Support Constraint Sizes, *Charles L. Matson, Alim Haji; AFRL, USA.* We show that the amount of relative noise reduction in multi-frame blind deconvolution image restorations is greatest for just a few data frames and is a more complicated function of the support constraint sizes.

SMB3 • 11:30 a.m. ●**Invited**●
Multidimensional Spatial and Coherence Imaging Using Single Shot Spectral Imagers, *David J. Brady; Fitzpatrick Ctr., Duke Univ., USA.* A spectral imaging system may efficiently sense 10-100 spectral channels but the full data cube is often redundant. We propose to exploit this redundancy to computationally expand depth of field or obtain multidimensional spatial images.

SMB4 • 12:00 p.m.
Compressive Spectral Imaging and Multiscale Reconstruction Methods, *Rebecca M. Willett, Michael E. Gehm, David J. Brady, Renu John; Duke Univ., USA.* In this work we develop a single-shot, dual-disperser spectral imaging system and associated multiscale photon-limited multispectral reconstruction methods that have been designed to exploit the emerging theory of compressive sensing.

SMB5 • 12:15 p.m.
Evaluation of a Multi-Frame Blind Deconvolution Algorithm Using Cramér-Rao Bounds, *Charles C. Beckner, Charles L. Matson; AFRL, USA.* Sample statistics from a maximum-likelihood based multi-frame blind-deconvolution (MFBD) algorithm are compared with Cramer-Rao bound results in order to evaluate the noise reduction performance of the MFBD algorithm.

12:30 p.m.–2:00 p.m.
Lunch Break

SMC • Phase Retrieval and Multiframe Imaging

Grand Ballroom A
2:00 p.m.–4:00 p.m.
SMC • Phase Retrieval and Multiframe Imaging
Rick P. Millane; Univ. of Canterbury, New Zealand, Presider

SMC1 • 2:00 p.m. **●Invited●**
Phase Error Correction for Digital Holographic Imaging, *Samuel T. Thurman, James R. Fienup; Inst. of Optics, Univ. of Rochester, USA.* The performance of various image sharpness metrics is compared, through simulation, for correcting phase errors in digital holographic or heterodyne array imaging of diffuse extended objects. The correction of anisoplanatic phase errors is demonstrated experimentally.

SMC2 • 2:45 p.m.
Reconstruction of Imagery Reflected from Water Surface, *Zhiying Wen, Andrew Lambert, Donald Fraser; School of Information Technology and Electrical Engineering, Univ. of New South Wales at Australian Defence Force Acad., Australia.* This paper studies the reconstruction of an object from a sequence of distorted images reflected by moving water surface. The problem is cast as a phase-recovery task, and is solved effectively by the bispectrum technique.

SMC3 • 3:00 p.m.
Efficient Image Registration Algorithms for Computation of Invariant Error Metrics, *Manuel Guizar-Sicairos, Samuel T. Thurman, James R. Fienup; Inst. of Optics, Univ. of Rochester, USA.* Three efficient algorithms for sub-pixel image registration, based on nonlinear optimization and the discrete Fourier transform, are developed to compute a translation invariant error metric. Their accuracy and computational performance is investigated and compared.

SMC4 • 3:15 p.m.
Phase Retrieval in Ultrashort-Laser-Pulse Measurement Using Frequency-Resolved Optical Gating, *Lina Xu, Rick Trebino; Georgia Tech, USA.* Frequency-Resolved Optical Gating (FROG) uses two-dimensional phase-retrieval to measure ultrashort laser pulses. We study the performance of the generalized projections (GP) algorithm to retrieve the intensity and phase of complex ultrashort laser pulses.

SMC5 • 3:30 p.m.
Progressive Restoration of Nonuniformly Warped Images by Shiftmap Prediction Using Kalman Filter, *Murat Tahtali, Andrew J. Lambert, Don Fraser; Australian Defence Force Acad., Univ. of New South Wales, Australia.* The anisoplanatic warp of imagery through atmospheric turbulence was modelled as a simple oscillator at pixel level and the prediction of restoration shiftmaps using Kalman filter has been successfully demonstrated with robust performance to noise.

SMC6 • 3:45 p.m.
Multi-Aperture Diversity Imaging: Digital Superresolution and Beyond, *Markus Testorf[1], Michael A. Fiddy[2]; [1]Dartmouth College, USA, [2]Univ. of North Carolina at Charlotte, USA.* Digital superresolution and compressive imaging is reformulated in terms of a linear spectral estimation technique. Prior information is explored as the means to construct a generalized sampling expansion which overcomes the diffraction limit.

Grand Ballroom D
4:00 p.m.–4:30 p.m.
Coffee Break

SMD • Synthesis and Instrumentation

Grand Ballroom A
4:30 p.m.–6:00 p.m.
SMD • Synthesis and Instrumentation
Brian Thelen; Michigan Technological Res. Inst., USA, Presider

SMD1 • 4:30 p.m. **●Invited●**
Three-Dimensional Synthesis Problems in Diffractive Optics, *Rafael Piestun; Univ. of Colorado at Boulder, USA.* I present three-dimensional (3-D) synthesis problems that appear in diffractive optics, namely the synthesis of light fields in a 3-D domain with one-sided and multi-sided illumination and the design of computer generated volume holograms.

SMD2 • 5:00 p.m.
Range Information from Rotating Beam Patterns: Beam Synthesis and Range Detection, *Markus E. Testorf[1], Canh Ly[2], Joseph N. Mait[2]; [1]Thayer School of Engineering at Dartmouth College, USA, [2]ARL, USA.* Linear superpositions of Laguerre-Gaussian beams are used to measure range by encoding the propagation distance as a unique spatial intensity pattern. Strategies for beam synthesis and the recovery of range information are discussed.

SMD3 • 5:15 p.m.
Inverse Synthesis of Phase-Shifting Mask for Optical Lithography, *Stanley H. Chan[1], Alfred K. Wong[2], Edmund Y. Lam[1]; [1]Univ. of Hong Kong, Hong Kong, [2]Magma Design Automation, USA.* We applied an inverse synthesis method to design phase-shifting mask (PSM) via gradient descent optimization under the coherent illumination assumption. The synthesized PSMs have high fidelity and sharp image slope.

SMD4 • 5:30 p.m.
Second Order Statistics of Depth-Scan Photocurrent in Optical Coherence Tomography with Differential Detection, *Sherif S. Sherif[1], Carla C. Rosa[2], Costel Flueraru[1], Shoude Chang[1], Youxin Mao[1], Adrian G. Podoleanu[3]; [1]Inst. for Microstructural Sciences, Canada, [2]Univ. do Porto, Portugal, [3]Univ. of Kent, UK.* We present the time-variant second order statistics of the depth-scan photocurrent in time-domain optical coherence tomography (TD-OCT) systems. Our results are prerequisite for the future development of statistical image processing techniques for TD-OCT.

SMD5 • 5:45 p.m.
Direct Diffractive Image Simulation Using MSDI Method, *Aleksey P. Maryasov[1], Nicolas P. Maryasov[2]; [1]Inst. of Applied Optics, Natl. Acad. of Science of Ukraine, Ukraine, [2]Inst. of Electronics and Control Systems, Natl. Aviation Univ., Ukraine.* We present direct diffractive approach and modeling results of test object image simulation under focusing. It allows getting image shape in presence of arbitrary wave front aberrations and different segmentation geometries.

Postdeadline papers to follow at the end of the session.

6:30 p.m.–8:00 p.m.
Dinner Break (on your own)

JMA • Joint Plenary Session

Grand Ballroom B
8:00 p.m.–9:00 p.m.
JMA • Joint Plenary Session

JMA1 • 8:00 p.m. **►Plenary◄**
Digital Image Formation from Holograms: Early Motivations and Modern Capabilities, *Joseph W. Goodman; Stanford Univ., USA.* I review the first case (1967) of detection of a hologram and reconstruction of the corresponding image by purely electronic means. I also discuss the circumstances that led to the experiment in the first place.

Signal Recovery and Synthesis (continued)

● Tuesday, June 19, 2007 ●

Grand Ballroom Foyer
7:00 a.m.–5:00 p.m.
Registration Open

JTuA • Wavefront Reconstruction and Phase Diversity

Grand Ballroom A
8:00 a.m.–9:45 a.m.
JTuA • Wavefront Reconstruction and Phase Diversity
[Joint AO/SRS Session]
Curt Vogel; Montana State Univ., USA, Presider

JTuA1 • 8:00 a.m.
A Comparison of Multigrid V-Cycle Versus Fourier Domain Preconditioning for Laser Guide Star Atmospheric Tomography, *Luc Gilles[1], Brent Ellerbroek[1], Curtis Vogel[2]; [1]Thirty Meter Telescope, USA, [2]Montana State Univ., USA.* We present simulation results assessing the expected performance of the Thirty Meter Telescope closed loop laser guide star adaptive optics system running either Multigrid V-cycle or Fourier Domain preconditioned conjugate gradient algorithms for atmospheric tomography.

JTuA2 • 8:15 a.m.
Sparse-Matrix Regularization for Minimum-Variance Reconstruction of Pseudo-Kolmogorov Turbulence, *Lawton H. Lee; Lockheed Martin Advanced Technology Ctr., USA.* Zonal regularization for minimum-variance wavefront reconstruction is derived for approximately Kolmogorov turbulence statistics. The formulation yields sparse matrices and is reminiscent of strain energy relationships. Comparisons with Kolmogorov-optimal regularization are made using Zernike polynomials.

JTuA3 • 8:30 a.m.
Performance of LQG Control for VLT-Type MCAO Systems, *Cyril Petit[1], Jean-Marc Conan[1], Caroline Kulcsár[2], Henri-Francois Raynaud[2]; [1]ONERA, France, [2]Inst. Galilée, L2TI, Univ. Paris, France.* We analyze the performance of LQG based optimal control compared to classic integrator based control on an end-to-end MCAO simulator. The LQG control brings a significant gain of correction in the Field of View.

JTuA4 • 8:45 a.m.
Closed-Loop AO Performance with FrIM, *Clémentine Béchet, Michel Tallon, Éric Thiébaut; CRAL - Observatoire de Lyon, France.* The Fractal Iterative Method (FrIM), a fast wavefront reconstruction algorithm, is here exploited for closed-loop application, opening interesting solutions to stability issues and modelization improvements, and reducing the debatable computational burden to 79N operations.

JTuA5 • 9:00 a.m.
Phase and Retinal Images Restoration by 3-D Phase Diversity, *Guillaume Chenegros[1], Laurent Mugnier[1], François Lacombe[2], Marie Glanc[3]; [1]ONERA, France, [2]Mauna Kea Technologies, France, [3]LESIA, France.* We report on a myopic 3-D deconvolution method developed in a Bayesian framework for retinal imaging. Several useful constraints are enforced, notably a longitudinal support constraint similar to the phase diversity technique.

JTuA6 • 9:15 a.m.
Phase Diversity with Broadband Illumination, *Matthew R. Bolcar, James R. Fienup; Inst. of Optics, Univ. of Rochester, USA.* We explore the limitations of phase diversity when a broadband source is present but is assumed to be monochromatic. A new implementation of phase diversity that accounts for broadband sources is also investigated.

JTuA7 • 9:30 a.m.
An Adaptive Cross-Correlation Algorithm for Extended Scene Shack-Hartmann Wavefront Sensing, *Erkin Sidick, Joseph J. Green, Catherine M. Ohara, David C. Redding; JPL, Caltech, USA.* We present an adaptive cross-correlation algorithm for large dynamic range extended-scene Shack-Hartmann wavefront sensing. We show that it accurately measures very fine image shifts over many pixels under a variety of practical imaging conditions.

Key to Authors and Presiders